MITSUBISHI SEMICONDUCTORS 1987

GENERAL PURPOSE ICs

OPERATIONAL AMPLIFIER
COMPARATOR
VOLTAGE REGULATOR
TIMER
MOTOR DRIVER
ANALOG SWITCHE
LEVEL INDICATOR
TRANSISTOR ARRAY
MISCELLANEOUS

DATA BOOK

MITSUBISHI ELECTRIC

MITSUBISHI SEMICONDUCTORS 1987

GENERAL PURPOSE ICs

OPERATIONAL AMPLIFIER
COMPARATOR
VOLTAGE REGULATOR
TIMER
MOTOR DRIVER
ANALOG SWITCHE
LEVEL INDICATOR
TRANSISTOR ARRAY
MISCELLANEOUS

DATA BOOK

MITSUBISHI
ELECTRIC

CONTENTS

1 GUIDANCE

2 OPERATIONAL AMPLIFIER

3 COMPARATOR

CONTENTS

4 VOLTAGE REGULATOR

5 TIMER

6 MOTOR DRIVER

CONTENTS

7 ANALOG SWITCHE

8 LEVEL INDICATOR

9 TRANSISTOR ARRAY

CONTENTS

10 MISCELLANEOUS

CONTENTS

1

GUIDANCE

ALTHA-NUMERICAL INDEX

OPERATIONAL AMPLIFIER, PRE AMPLIFIER

Function	Generic No.	Mitsubishi Pin For Pin Replacement	Mitsubishi Recommended (Features)
Single op amp	741	M51802P/M5F741P	●M51802L/P [Single in line package]
Dual op amp	4557, 4558, 4559	M5218P/M5R4558P	●M5218L [Compatible with 4557, 4558, 4559 single in line package]
	358/2904	M5223P/M5N358P	●M5223L [Single in line package]
			●M5216P/L [High current output equivalent to 4556]
	324/2902	M5224P/M5N324P	
J.FET Input op amp	072, 082	M5221P/M5T082P	●M5221L [Single in line package]
Switching op amp			△M5201
Dual High Voltage op amp			△M5209
			△M5210
Dual Low noise pre-amp			△M5219
			△M5220
Quad low noise ope amp			△M5228
Dual low noise J-FET Input op amp			△M5238
			△M5240P

Note : △ Mitsubishi original, ● Functional equivalent

VOLTAGE COMPARATOR

Function	Generic No.	Mitsubishi Pin For Pin Replacement	Mitsubishi Recommended (Features)
Single comparator			△M51201L [Low input current high output drive, including refference with hysteresis, $V_{CC}1$ 7~6.5V]
			△M51202L [Low input current high output drive, $V_{CC}1$ 7~6.5V]
			△M51203L [Low input current high output drive, V_{CC}3~28V including refference with hysteresis]
			△M51204L [Low input current high output drive, V_{CC}2.5~28V]
			△M51205L [Low input current stabilized power supply terminal including refference with hysteresis]
			△M51206L [Low input current stabilized power supply terminal]
			△M5123TL
Dual comparator			△M51200P
			△M51207L
			△M51922L
			△M51923P/FP
			△M5233
Quad comparator			△M51209P
			△M51924P/FP
			△M5234

Note : △ Mitsubishi original, ● Functional equivalent

VOLTAGE REGULATOR

Function	Generic No.	Mitsubishi Pin For Pin Replacement	Mitsubishi Recommended (Features)
Variable Dual			△M5230L
Variable Single			△M5231TL
3-Terminal Variable			△M5235L
			△M5236
	78L	M5278LXX	
SW Control	494	M5T494P	

Note : △ Mitsubishi original, ● Functional equivalent

DISPLAY DRIVER

Function	Generic No.	Mitsubishi Pin For Pin Replacement	Mitsubishi Recommended (Features)
5-Step bar indicator			△M51903L [Linear mode operation]
6-Step bar indicator			△M51906P [Including AC-DC converter, log scale]
			△M51911L [Including AC-DC converter, low current, log scale]
			△M51912L [Including AC-DC converter, low current, linear scale]
8-Step bar indicator			△M51907P [Including AC-DC converter, low current, log scale]
			△M51909P [Including AC-DC converter, low current, linear scale]
9-Point level indicator			△M51910P [2 inputs indicator]
12-Point level indicator			△M51901P [23-Mode indicator]

Note : △ Mitsubishi original, ● Functional equivalent

TIMER

Function	Generic No.	Mitsubishi Pin For Pin Replacement	Mitsubishi Recommended (Features)
Single timer	555	M51841P/M5E555P	●M51848P/M5E555AP [High speed guaranty reset terminal TTL compatible]
			●M51848L [High speed guaranty reset terminal TTL compatible single in line package]
			△M51843P [Large supply voltage application]
Dual timer	556		●M51847P/M5E556AP [High speed guaranty reset terminal TTL compatible]
Counter timer			△M51849L [Long time capability~50hours]
			△M52051P
			△M58479P [Low power dissipation superior noise immunity, extremely broad time-delay range (50ms~480h)]
			△M58482P [Low power dissipation superior noise immunity, extremely broad time-delay range (50ms~480h)]
Long timer			△M51845L

Note : △ Mitsubishi original, ● Functional equivalent

MOTOR DRIVER

Function	Generic No.	Mitsubishi Pin For Pin Replacement	Mitsubishi Recommended (Features)
Motor control / Position control			△M51660L [Radio control servo]
F-G Servo			△M51970L [Single in line]
PLL Servo			△M51728L [High stability single in line]
			△M51971L,FP
2-Phase brushless			△M51781SP
			△M51781FP
3-Phase brushless			△M51724P
			△M51714P
Bi-directional driver			△M54540AL [$I_{O(max)}/I_O$ ±0 6A/±0 1A]
			△M54541L [$I_{O(max)}/I_O$ ±0.8A/±0 2A]
			△M54542L [$I_{O(max)}/I_O$ ±1.2A/±0 3A]
			△M54543L [$I_{O(max)}/I_O$ ±1.2A/±0 3A Motor braking function]
			△M54544L [$I_{O(max)}/I_O$ ±1 2A/±0 3A Motor braking function]
			△M54545L [$I_{O(max)}/I_O$ ±1 2A/±0 2A Motor braking function]
			△M54546L [$I_{O(max)}/I_O$ ±0 7A/±0 15A Motor braking function]
			△M54547P [$I_{O(max)}/I_O$ ±0 6A/±0 15A Built in error amp, motor braking function]
			△M54548L [$I_{O(max)}/I_O$ ±1 2A/±0.3A Motor braking function op amp and decoder]
			△M54549L [$I_{O(max)}/I_O$ ±1.2A/±0 3A Motor braking function dual bi-directional, thermal shutdown]

Note : △ Mitsubishi original, ● Functional equivalent

MOTOR DRIVER

Function	Generic No.	Mitsubishi Pin For Pin Replacement	Mitsubishi Recommended 〔Features〕
Bi-directional driver			△M54543AL 〔$I_O(max)/I_O \pm 1.2A/\pm 0.3A$ Motor braking function thermal shutdown〕
			△M54544AL 〔$I_O(max)/I_O/\pm 1.2A/\pm 0.3A$ Motor braking function thermal shutdown〕
			△M54549AL
			△M54641L
			△M54642L
			△M54648L
			△M54648AL
			△M54649L
			△M51714P
F-V Servo			△M51722P,FP
			△M51723P,FP

Note : △ Mitsubishi original, ● Functional equivalent

ANALOG SWITCH

Function	Generic No.	Mitsubishi Pin For Pin Replacement	Mitsubishi Recommended 〔Features〕
Analog SW			△M51320P 〔Video SW, 2 inputs 3ch〕
Bipolar SW			△M51326P 〔Video SW, 2 inputs 3ch〕
			△M51321P 〔Video SW, 3 inputs 3ch〕
			△M51327P 〔Video SW, 3 inputs 3ch〕
			△M51329P
			△M51551P/FP〔Audio SW, 2 inputs 2ch〕
CMOS SW	4016B	M4016BP	
	4066B	M4066BP	
	4051B	M4051BP	
	4052B	M4052BP	
	4053B	M4053BP	

Note : △ Mitsubishi original, ● Functional equivalent

TRANSISTOR ARRAY

Function	Generic No.	Mitsubishi Pin For Pin Replacement	Mitsubishi Recommended [Features]
4-Unit Tr array			△M54512L [50mA Single in line package]
	2064		△54532P [1.5A darlington, with clamp diode]
			△M54567P [1 5A darlington with clamp diode input "L" active]
			△M54568L [30mA PNP single in line package]
5-Unit Tr array			△M54516P [500mA darlington]
			△M54521P [500mA darlington]
			△M54529P/AP [320mA with strobe]
6-Unit Tr array			△M54527P [150mA with clamp diode]
			△M54533P [320mA with clamp diode and strobe]
			△M54534P [320mA with clamp diode and strobe]
			△M54578P [700mA with clamp diode and strobe]
			△M54539P [700mA with clamp diode]
			△M54571P [350mA printer driver]
7-Unit Tr array			△M54514AP [50mA NPN driver]
			△M54515P [16mA NPN driver]
			△M54517P [400mA darlington]
			△M54519P [400mA darlington]
	2003	●M54523P	
	2001	●M54524P	
	2002	●M54525P	
	2004	●M54526P	
			△M54528P [150mA darlington with clamp]
			△M54530P [400mA darlington with clamp]
			△M54531P [400mA darlington with clamp]
			△M54535P [150mA with clamp and strobe]
			△M54536P [150mA with clamp and strobe]
			△M54537P [320mA non-darlington driver]
			△M54538P [350mA and motor driver]
			△M54560P [150mA source darlington]
			△M54561P [300mA source darlington]
			△M54566P [400mA darlington input "L" active]

Note : △ Mitsubishi original, ● Functional equivalent

TRANSISTOR ARRAY

Function	Generic No.	Mitsubishi Pin For Pin Replacement	Mitsubishi Recommended (Features)
7-Unit Tr array			△M54576P/FP [30mA input "L" active]
			△M54577P/FP [30mA non-darlington driver]
			△M54580P [100mA source darlington for FL]
8-Unit Tr array			△M54513P [50mA NPN driver]
			△M54522P [400mA darlington with clamp diode]
	2982	●M54562P	
	2981	●M54563P	
			△M54564P [500mA source darlington for FL]
			△M54565P [50mA input "L" active]
			△M54569P [30mA PNP array]
			△M54581P
			△M54583P
			△M54584P
			△M54585P
			△M54586P

Note : △ Mitsubishi original, ● Functional equivalent

MISCELLANEOUS

Function	Generic No.	Mitsubishi Pin For Pin Replacement	Mitsubishi Recommended (Features)
Electonic Volume Control			△M5222
			△M5241L
Voltage Defector			△M5232L
Volume Control			△M50601P
Disk Drive			△M51017AP
Servo Motor Position Control			△M51660L
Dual Channel Electronic ATT			△M51523AL
Zero volt trigger ckt Flame defector			△M5172L
			△M51743P
			△M5174P
Warning driver			△M51920P
Car cooler control			△M51950L
Flasher control			△M51961L
4-BIT A-D Converter			△M52670P,FP
Dual differential amp	3054	M5109P	
8-Digit display driver			△M54940P
2-Digit BCD-7 segment Decoder/driver			△M54847AP
8-BIT Latched driver			△M54975P
			△M54976P
9-BIT Latched driver			△M54970P
12-BIT Latched driver			△M54977P
Single chip CMOS speech synthsizer			△M50800-XXXSP/M50802-XXXP
			△M50805-XXXP,FP/M50806-XXXP,FP

Note : △ Mitsubishi original, ● Functional equivalent

ORDERING INFORMATION

Function and style may be specified by using the following simplified alphanumeric code.

1. FOR MITSUBISHI ORIGINAL PRODUCTS

Example : M 5 45 14 A P

M : indicates the product is a Mitsubishi Electric integrated circuit.

5 : industrial/consumer
(Operating ambient temperature range is −20~+75℃, standard)

9 : High-reliability type

A single or two-digit alphanumeric code indicates circuit type and series name.

0 : CMOS
1~2 : Linear circuit
3 : TTL
10~19 : Linear circuit
20~29 : Linear circuit
32~33 : TTL (equivalent to the TI SN74 family)
41~47 : TTL and others
48~49 : IIL
84 : CMOS
85 : p-channel silicon gate MOS
86 : p-channel aluminum gate MOS
87 : n-channel silicon gate MOS
88 : p-channel aluminum gate ED-MOS
89 : COMS
S0~S2 : Schottky TTL (equivalent to the TI SN74S family)

This group consists of a two- or three-digit serial number to indicate the type of circuit within the series.

Consists of a single letter which indicates the difference of outer appearance or some part of the device specifications as listed below.

(1) For linear circuits, this is one letter of the alphabet, chosen in alphabetical order but not including I or O, which is used to flag devices for which parts of the specifications differ.

(2) For devices with identical specifications having only pin-bending direction differences, an R is assigned to this group following group (5).

(3) When this group designation is not required, the next group is shifted to the left to follow group (5) immediately.

Package style

K : Low melting point glass sealed ceramic-type package
L, **SL**, **TL** : Plastic molded SIP (Single In-line Package)
P, **SP** : Plastic molded DIP (Dual In-line Package)
FP, **GP** : Plastic molded FLAT package
S : Metal-sealed ceramic

2. FOR SECOND SOURCE PRODUCTS

Example : **M 5 K 4116 S-2**

- **M** : Mitsubishi integrated prefix
- **5** — Indicates application and temperture range
  - **5** : Standard industrial/commercial (0～+70/75℃ or −20～+85℃)
  - **9** : High reliability
- **K** — Sales designation of original source using 1 or 2 alphabetical characters.
  - **C** : Motorola's MC series
  - **G** : General Instrument's seuies
  - **K** : Mostek's MK series
  - **L** : Intel's series
  - **M** : Mitsubishi products
  - **T** : Texas Instrument's
  - **W** : Western Digital's series
- **4116** — Circuit function identification code of the original source type name.
- **S** — Package style
  - **K** : Low melting point glass sealed ceramic-type package
  - **P** : Plastic molded package
  - **S** : Metal sealed ceramic package
- **2** — Electrical characteristics identification code using 1 or 2 digits.

PACKAGE CODE

Package style may be specified by using the following simplified alphanumeric code

Example : **16 P 4**

- **16** — Number of pins
- **P** — Package structure
  - **K** : Low melting point glass-sealed ceramic
  - **P** : Molded plastic
  - **S** : Metal sealed ceramic
- **4** — Package outline

2 : FLAT	**5A** : ZIP
2W : FLAT wide	**6** : FLAT quip
4 : DIP	**7** : SIP with fin
4B : Shrink DIP	**9** : SIP with fin
5 : SIP	**9B** : Shrink SIP with fin

QUALITY ASSURANCE AND RELIABILITY TESTING

1 INTRODUCTION

IC & LSI have made rapid technical progress in electrical performances of high integration, high speed, and sophisticated functionality. And now they have got boundless wider applications in electronic systems and electrical appliances.

To meet the above trend of expanding utilization of IC & LSI, Mitsubishi considers that it is extremely important to supply stable quality and high reliable products to customers.

Mitsubishi Electric places great emphasis on quality as a basic policy "Quality First", and has striven always to improve quality and reliability.

Mitsubishi has already developed the Quality Assurance System covering design, manufacturing, inventory and delivery for IC & LSI, and has supplied highly reliable products to customers for many years. The following articles describe the Quality Assurance System and examples of reliability control for Mitsubishi General Purpose ICs.

2. QUALITY ASSURANCE SYSTEM

The Quality Assurance System places emphasis on built-in reliability in designing and built-in quality in manufacturing. The System from development to delivery is summarized in Figure 1.

2.1 Quality Assurance in Designing

The following steps are applied in designing stage for new product.

(1) Setting of perfomance, quality and reliability target for new product.
(2) Discussion of performance and quality for circuit design, device structure, process, material and package.
(3) Verification of design by CAD system to meet standardized design rule.
(4) Functional evaluation for bread-board device to confirm electrical performance.
(5) Reliability evaluation for TEG (Test Element Group) chip to detect basic failure mode and investigate failure machanism.
(6) Reliability test (In-house qualification) for new product to confirm quality and reliability target.
(7) Decision of pre-production from the standpoint of performance, reliability, production flow/conditions, production capability, delivery and etc.

2.2 Quality Assurance in Manufacturing

The quality assurance in manufacturing are performed as follows.

(1) Environment control such as temperature, humidity and dust as well as deionized water and utility gases.
(2) Maintenance and calibration control for automatized manufacturing equipments, automatic testing equipments, and measuring instruments.
(3) Material control such as silicon wafer, lead frame, packaging material, mask and chemicals.
(4) In-process inspections in wafer-fabrication, assembly and testing.
(5) 100% final inspection of electrical characteristics, visual inspection and burn-in, if necessary.
(6) Quality assurance test
 -Electrical characteristics and visual inspection, lot by lot sampling
 -Environment and endurance test, periodical sampling.
(7) Inventory and shipping control, such as storage environment, date code identification, handling and ESD (Electro Static Discharge) preventive procedure.

2.3 Reliability Test

To verify the reliability of a product as described in the Mitsubishi Quality Assurance System, reliability tests are performed at three different stages of new product development, pre-production, and mass-production.

At the development of new product the reliability test plan is fixed corresponding to quality and reliability target of each product, respectively. The test plan includes in-house qualification test, and TEG evaluation, if necessary. TEG chips are designed and prepared for new device structure, new process and new material.

After the proto-type product has passed the in-house qualification test, the product advances to the pre-production. In the pre-production stage. The specific reliability tests are programmed and performed again to verify the quality of pre-production product.

In the mass production, the reliability tests are performed periodically to confirm the quality of mass production product according to quality assurance test program.

Table 1 shows an example of reliability test program for plastic encapsulated IC & LSI.

Table 1 TYPICAL RELIABILITY TEST PROGRAM FOR PLASTIC ENCAPSULATED IC & LSI

Group	Test	Test condition
1	Solderability	230℃, 5sec Rosin flux
2	Soldering heat	260℃, 10sec.
	Thermal shock	−55℃, 125℃, 15cycles
	Temperature cycling	−65℃, 150℃, 100cycles
3	Lead fatigue	250gr, 90°, 2arcs
4	Shock	1500G, 0.5msec.
	Vibration	20G, 100~2000Hz X, Y, Z direction 4min./cycle, 4cycles/direction
	Constant acceleration	20000G, Y direction, 1min
5	Steady-state operation life	T_a=Toprmax, Vccmax 1000hours
6	High temperature storage life	T_a=150℃, 1000hours
7	High temperature and high humidity	85℃, 85%, 1000hours
	Pressure cooker	121℃, 100%, 100hours

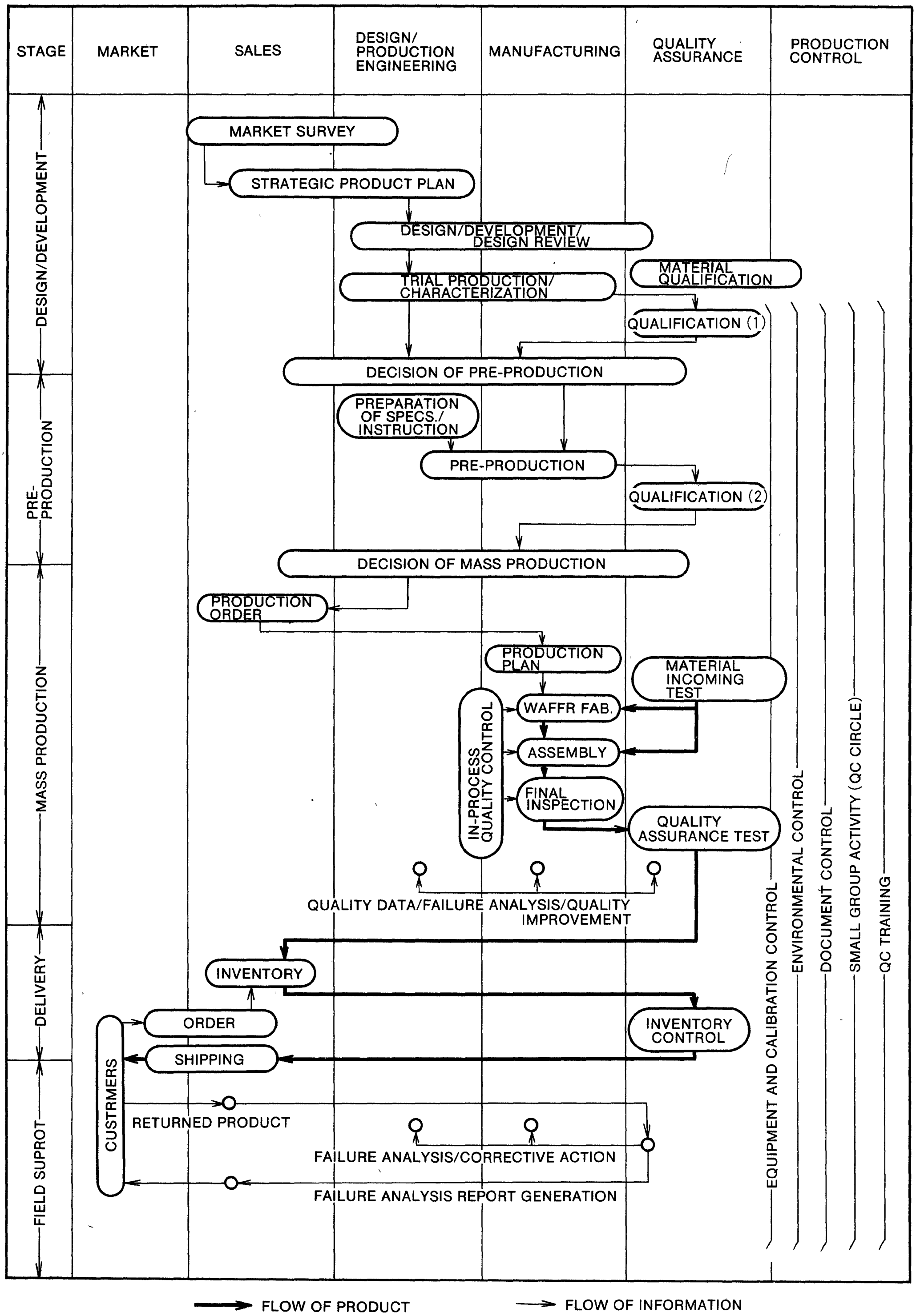


Fig.1 FLOW CHART OF QUALITY ASSURANCE SYSTEM

2.4 Returned Product Control

When failure analysis is requested by a customer, the failed devices are returned to Mitsubishi Electric via the sales office of Mitsubishi using the form of "Analysis Request of Returned Product"

Mitsubishi provides various failure analysis equipments to analyze the returned product. A failure analysis report is generated to the customer upon completion of the analysis. Failure analysis result enforces to take corrective action for the design, fabrication, assembly or testing of the product to improve reliability and realize lower failure rate.

Figure 2 shows the procedure of returned product control from customer.

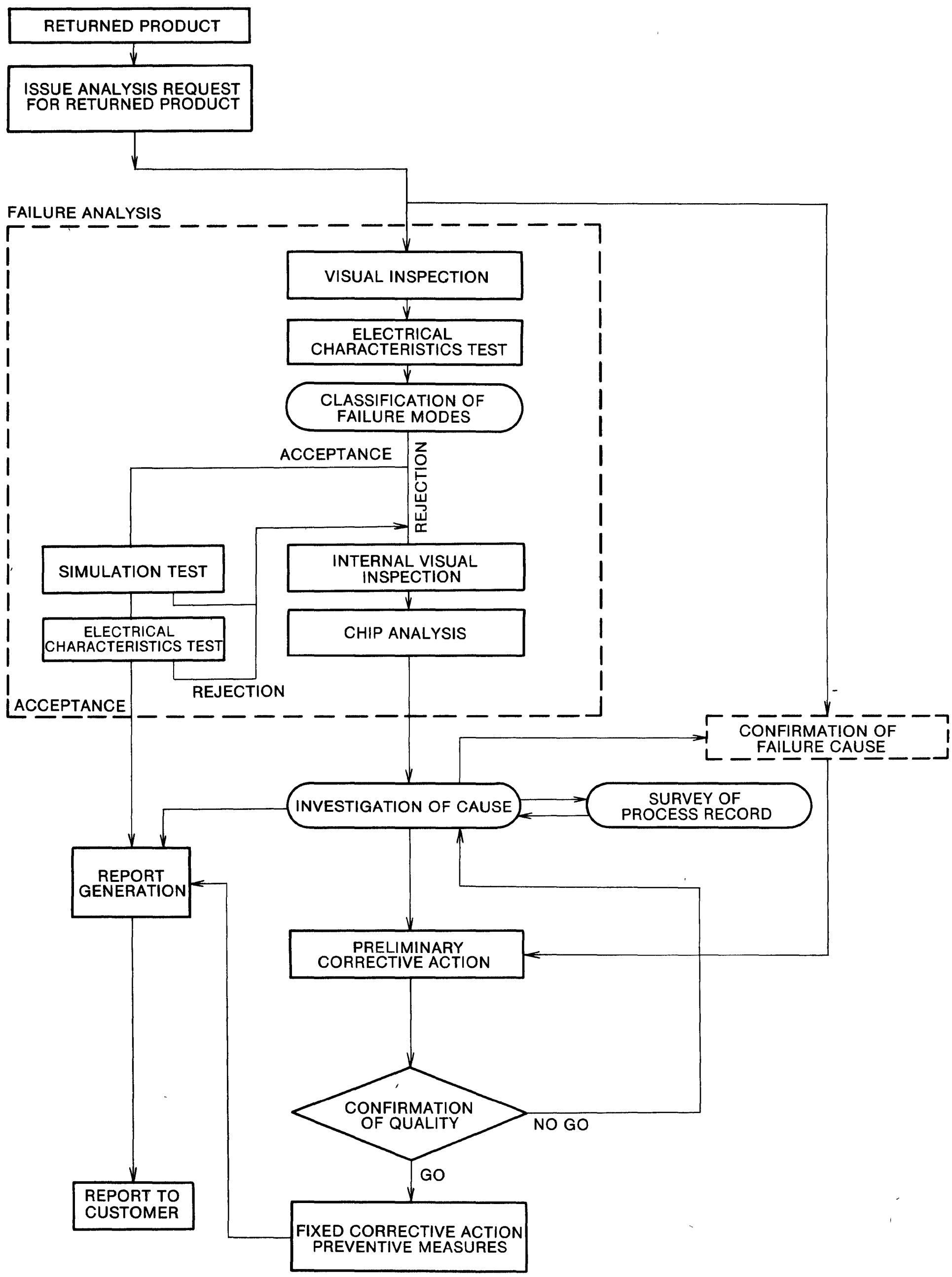


Fig.2 PROCEDURE OF RETURNED PRODUCT CONTROL

3 RELIABILITY TEST RESULTS

The reliability test results for Mitsubishi General Purpose ICs are shown in Table 2, Table 3 and Table 4.

Table 2 shows the result of endurance tests of steady-state operation life and high temperature storage life test for representative types of General Purpose ICs, Operational Amplifier, Voltage Comparator, Timer, Motor Driver, Voltage Regulator and Transistor Array. From Table 2, the combined failure rate of Mitsubishi General Purpose ICs is calculated 0.045%/1000hours (60% confidence level) at maximum rating of operating condition.

Table 3 shows the result of environment test of temperature cycling, high temperature/high humidity and pressure cooker test for the same type of products as of endurance tests.

Table 4 shows the results of mechanical tests for representative products of various package types.

Table 2 ENDURANCE TEST RESULTS

	Test	Steady-State Operation Life			High Temperature Storage Life		
	Test Condition	$T_a=T_{oprmax}$, $V_{CC} \leqq V_{CCmax}$			$T_a=150℃$		
Application	Type Number	Number of Samples	Device Hours	Number of Failures	Number of Samples	Device Hours	Number of Failures
Operational Amplifier	M5216P	22	22,000	0	22	22,000	0
	M5216L	22	22,000	0	22	22,000	0
	M5218P	66	66,000	0	44	44,000	0
	M5218L	66	66,000	0	44	44,000	0
	M5223P	44	44,000	0	22	22,000	0
	M5223L	44	44,000	0	22	22,000	0
	M5224P	22	22,000	0	22	44,000	0
	M5228P	44	44,000	0	22	44,000	0
	M5209P	22	22,000	0	22	22,000	0
	M5209L	22	22,000	0	22	22,000	0
	M5210P	44	44,000	0	22	22,000	0
	M5210L	22	22,000	0	22	22,000	0
	M5219P	44	44,000	0	44	44,000	0
	M5219L	44	44,000	0	22	22,000	0
	M5220P	22	22,000	0	22	22,000	0
	M5220L	22	22,000	0	22	22,000	0
	M5221P	22	22,000	0	22	22,000	0
	M5221L	22	22,000	0	22	22,000	0
	M5238P	22	22,000	0	22	22,000	0
	M5238L	22	22,000	0	22	22,000	0
	M5240P	22	22,000	0	22	22,000	0
	M5201P	22	22,000	0	22	22,000	0
	M5201L	22	22,000	0	22	22,000	0
	M51802P	48	48,000	0	50	50,000	0
	M51802L	48	48,000	0	50	50,000	0
Voltage Comparator	M5233P	44	44,000	0	44	44,000	0
	M5233L	44	44,000	0	22	22,000	0
	M5234P	22	22,000	0	22	22,000	0
	M51204TL	66	132,000	0	50	50,000	0
	M51209P	22	22,000	0	22	22,000	0
Timer	M51848P	70	158,000	0	22	22,000	0
	M51848L	70	158,000	0	22	22,000	0
Motor Driver	M51970L	22	22,000	0	22	22,000	0
	M54543L	44	88,000	0	22	44,000	0
Voltage Regulator	M5230L	66	66,000	0	44	44,000	0
	M5231TL	40	40,000	0	22	22,000	0
	M5236L	44	44,000	0	22	22,000	0
	M5278L	44	44,000	0	44	44,000	0
Transistor Array	M54519P	40	40,000	0	44	44,000	0
	M54523P	44	88,000	0	22	44,000	0
LED Level Indicator	M51903L	22	22,000	0	22	22,000	0
	M51906P	22	22,000	0	22	22,000	0
Voltage Control Amplifier	M5222P	22	22,000	0	22	22,000	0
	M5222L	22	22,000	0	22	22,000	0
	M5241L	22	22,000	0	22	22,000	0
Voltage Detector	M5232L	22	22,000	0	22	22,000	0

QUALITY ASSURANCE AND RELIABILITY TESTING

Table 3 ENVIRONMENTAL TEST RESULTS

Application	Type Number	Soldering Heat / Thermal Shock / Temperature Cycling		High Temperature/High Humidity		Pressure Cooker	
	Test Condition	260℃, 10sec −55℃, 125℃, 15cycles −65℃, 150℃, 100cycles		85℃, 85% 1000hours		121℃, 100%RH 240hours	
		Number of Samples	Number of Failures	Number of Samples	Number of Failures	Number of Samples	Number of Failures
Operational Amplifier	M5216P	22	0	22	0	22	0
	M5216L	22	0	22	0	22	0
	M5218P	44	0	66	0	44	0
	M5218L	44	0	44	0	44	0
	M5223P	22	0	22	0	22	0
	M5223L	22	0	22	0	22	0
	M5224P	22	0	22	0	22	0
	M5228P	22	0	22	0	22	0
	M5209P	22	0	22	0	22	0
	M5209L	22	0	22	0	22	0
	M5210P	22	0	22	0	22	0
	M5210L	22	0	22	0	22	0
	M5219P	22	0	44	0	22	0
	M5219L	22	0	22	0	22	0
	M5220P	22	0	22	0	22	0
	M5220L	22	0	22	0	22	0
	M5221P	22	0	22	0	22	0
	M5221L	22	0	22	0	22	0
	M5238P	22	0	22	0	22	0
	M5238L	22	0	22	0	22	0
	M5240P	22	0	22	0	22	0
	M5201P	22	0	22	0	22	0
	M5201L	22	0	22	0	22	0
	M51802P	22	0	44	0	22	0
	M51802L	22	0	44	0	22	0
Voltage Comparator	M5233P	44	0	44	0	22	0
	M5233L	22	0	22	0	22	0
	M5234P	22	0	22	0	22	0
	M51204TL	22	0	44	0	22	0
	M51209P	22	0	22	0	22	0
Timer	M51848P	22	0	44	0	22	0
	M51848L	22	0	44	0	22	0
Motor Driver	M51970L	22	0	22	0	22	0
	M54543L	22	0	44	0	22	0
Voltage Regulator	M5230L	44	0	44	0	22	0
	M5231TL	22	0	40	0	22	0
	M5236L	22	0	22	0	22	0
	M5278L	22	0	44	0	22	0
Transistor Array	M54519P	22	0	22	0	22	0
	M54523P	22	0	44	0	22	0
LED Level Indicator	M51903L	22	0	22	0	22	0
	M51906P	22	0	22	0	22	0
Voltage Control Amplifier	M5222P	22	0	22	0	22	0
	M5222L	22	0	22	0	22	0
	M5241L	22	0	22	0	22	0
Voltage Detector	M5232L	22	0	44	0	22	0

Table 4 MECHANICAL TEST RESULTS

Test / Test Condition / Package Pin Count	Type Number	Solderability (See Table 1) Number of Samples	Number of Failures	Lead Fatigue (See Table 1) Number of Samples	Number of Failures	Shock, Vibration, Constant Acceleration (See Table 1) Number of Samples	Number of Failures
5P5	M51204TL	22	0	15	0	22	0
8P4	M5218P	44	0	15	0	0	0
	M51802P	22	0	15	0	22	
8P5	M5218L	44	0	15	0	0	0
	M51848L	22	0	15	0	22	
9P9	M54543L	22	0	15	0	22	0
10P5	M5241L	22	0	15	0	0	
14P4	M5224P	44	0	15	0	0	0
	M51906P	22	0	15	0	22	
16P4	M5240P	44	0	15	0	0	0
	M54519P	22	0	15	0	22	
TO-92L	M5278L	44	0	15	0	22	0

4 FAILURE ANALYSIS

Accelerated reliability tests are applied to observe failures casued by temperature, voltage, humidity, current, mechanical stress and those combined stresses on chips and packages.

Examples of typical failure modes are shown below.

(1) Wire Bonding Failure by Thermal Stress

Figure 3, Figure 4 and Figure 5 are example of a failure occurred by temperature storage test of 225℃, 1000hours.

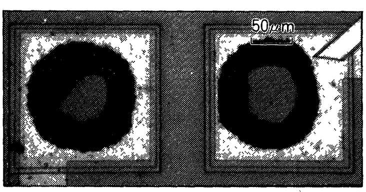


Fig.3 Micrograph of lifted Au ball trace on Al bonding pad

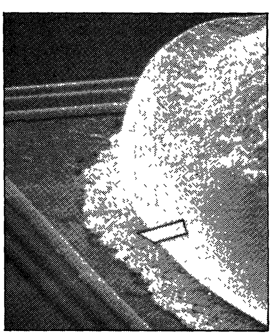


Fig.4 Au-Al plague formation on bonding pad

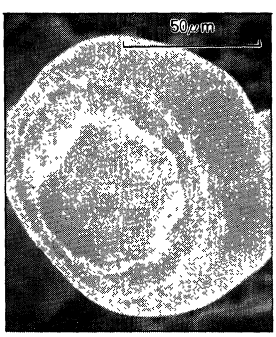


Fig.5 Lifted Au wire ball base

Au-Al intermetallic formation so-called "Purple plague" by thermal overstress makes Au wire lift off from aluminum metallization. The activation energy of this failure mode is estimated approximately 1.0eV and no failure has been observed so far in practical uses.

(2) Aluminum Corrosion Failure by Temperature/Humidity Stress.

Figure 6, Figure 7 and Figure 8 are an example of corroded failure of aluminum metallization of plastic encapsulated IC after accelerated temperature/humidity storage test (pressure cooker test) of 121℃, 100%RH, 1000hours duration.

Aluminum bonding pad is dissolved by penetrated water from plastic package, and chlorine concentration is observed on corroded aluminum bonding pad as shown in Figure 8.

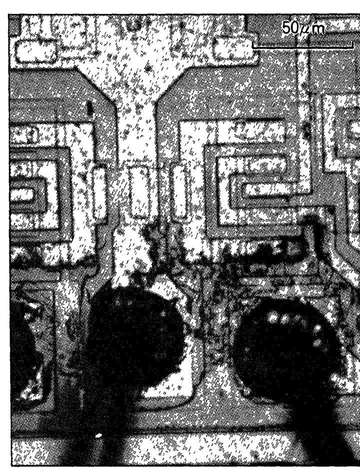


Fig.6 Micrograph of corroded Aluminum metallization

QUALITY ASSURANCE AND RELIABILITY TESTING

Fig.7 Enlarged micrograph of corroded Aluminum bonding pad

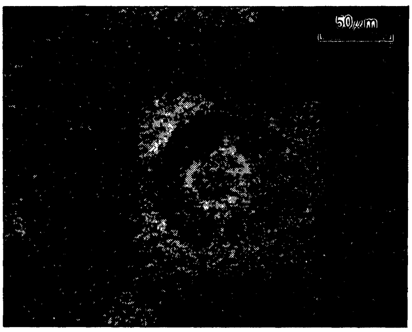


Fig.8 Cl distribution on corroded Aluminum bonding pad

(3) Destructive Failure by Electrical Overstress
Surge voltage marginal tests have been performed to reproduce the electrical overstress failure in field uses. Figure 9 and Figure 10 are an example of failure observed by surge voltage test. The trace of destruction is verified as the aluminum bridge by X ray micro analysis.

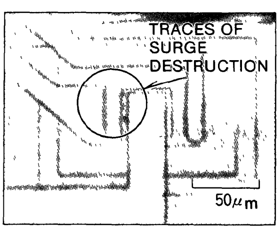


Fig.9 Micrograph of surge voltage destruction

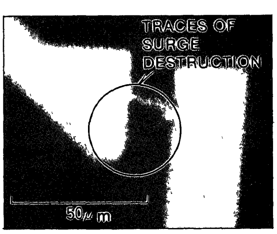


Fig.10 Aluminum trace of destructive spot

(4) Aluminum Electromigration
Figure 11 shows an open circuit of aluminum metallization in high current density region caused by accelerated operation life test. This failure is due to aluminum electromigration. Voids and hillock have been formed in aluminum metallization by high current density operation.

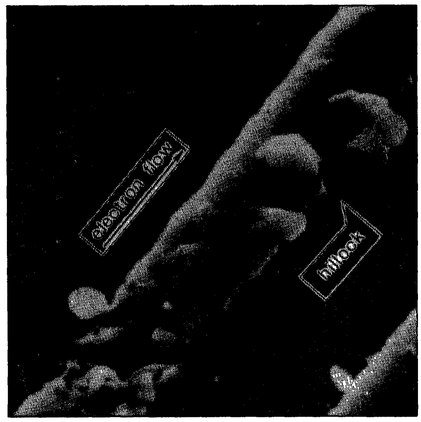


Fig.11 Voids and hillocks formation by Aluminum electromigration

5 SUMMARY

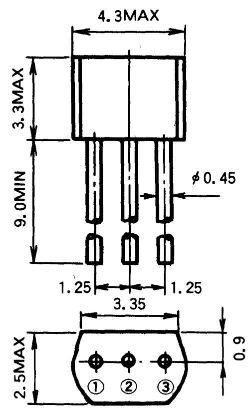
The Mitsubishi quality assurance system and examples of reliability control have been discussed. Customer's interest and requirement for high reliable IC & LSI are increasing significantly. To satisfy customer's expectancy. Mitsubishi as an IC vendor, would like to make perpetual efforts in the following areas.

(1) Emphasis on built-in reliability at design stage and reliability evaluation to investigate latent failure modes and acceleration factors.
(2) Execution of periodical endurance, environment and mechanical test to verify reliability target and realize higher reliability.
(3) Focus on development of advanced failure analysis techniques. Detail failure analysis, intensive corrective action, and quick response to customer's analysis request.
(4) Collection of customer's quality data in qualification, incoming inspection, production and field use to improve PPM, fraction defective and FIT, failure rate.

Mitsubishi would highly appreciate if the customer would provide quality and reliability data of incoming inspection or field failure rate essential to verify and improve the quality/reliability of IC & LSI.

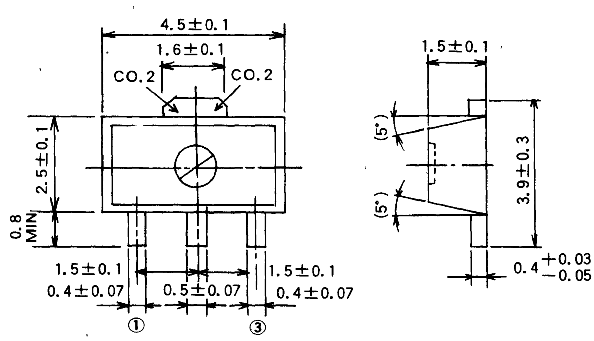
TYPE 3P5 3-PIN MOLDED PLASTIC SIP

Dimension in mm



TYPE SOT-89L 3-PIN TRANSISTOR

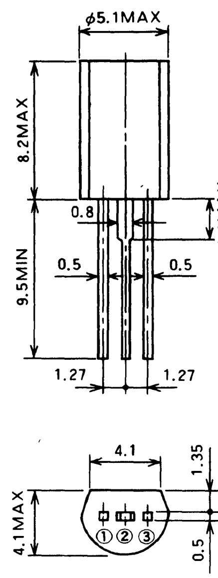
Dimension in mm



MITSUBISHI
ELECTRIC

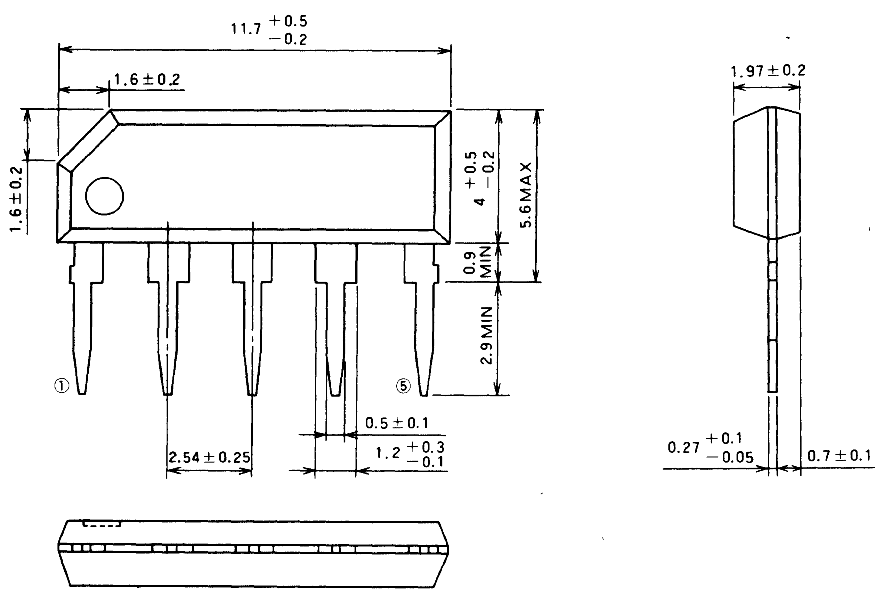
TYPE TO-92L 3-PIN TRANSISTOR

Dimension in mm

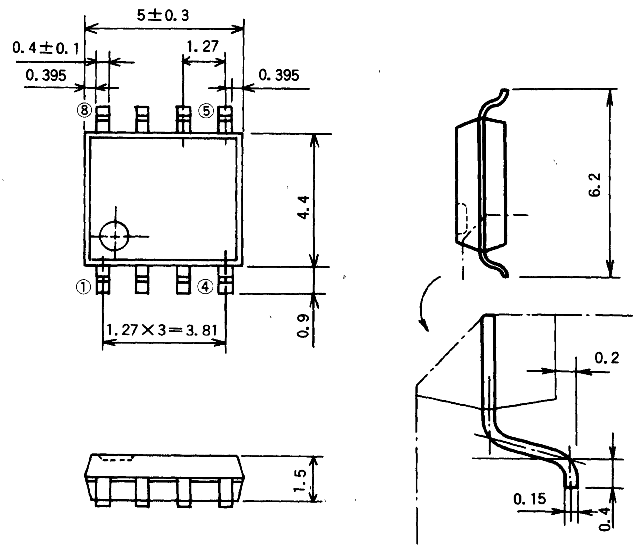


TYPE 5P5 5-PIN MOLDED PLASTIC SIP

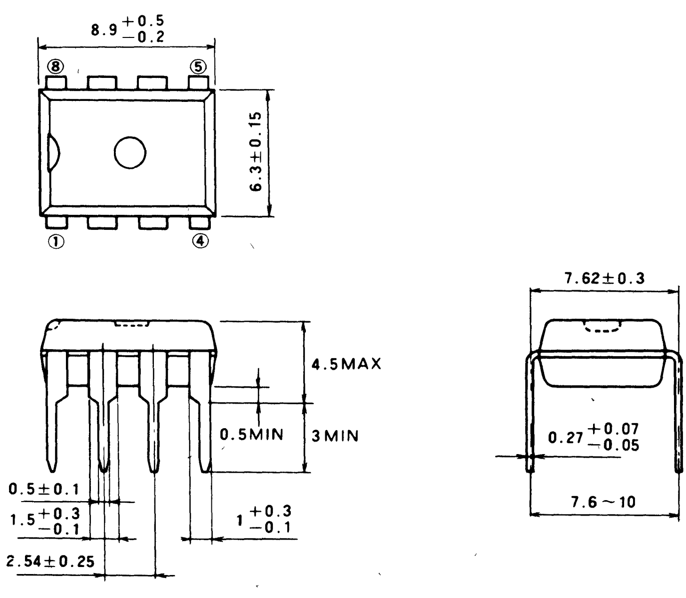
Dimension in mm



TYPE 8P2S 8-PIN MOLDED PLASTIC MINI FLAT Dimension in mm

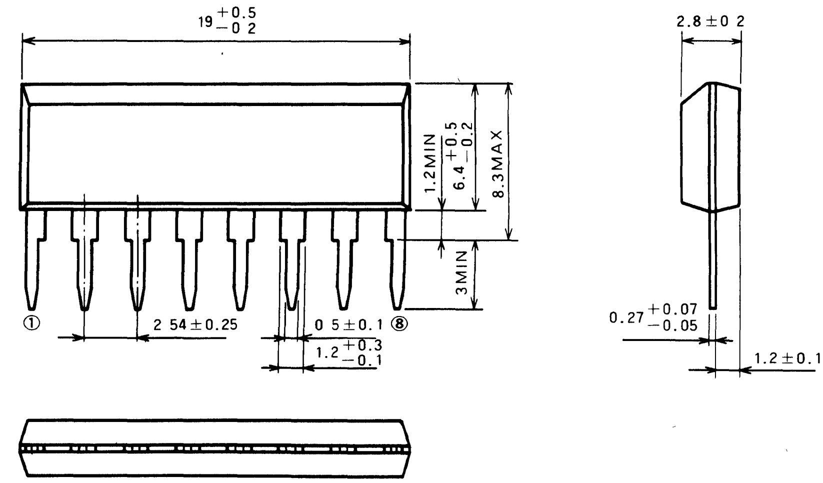


TYPE 8P4 8-PIN MOLDED PLASTIC DIP Dimension in mm



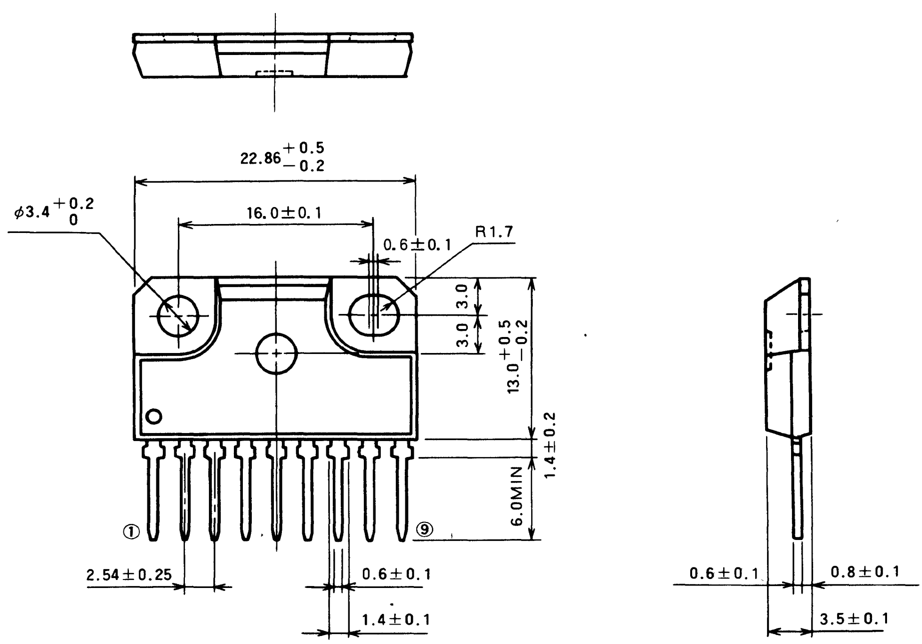
TYPE 8P5 8-PIN MOLDED PLASTIC SIP

Dimension in mm



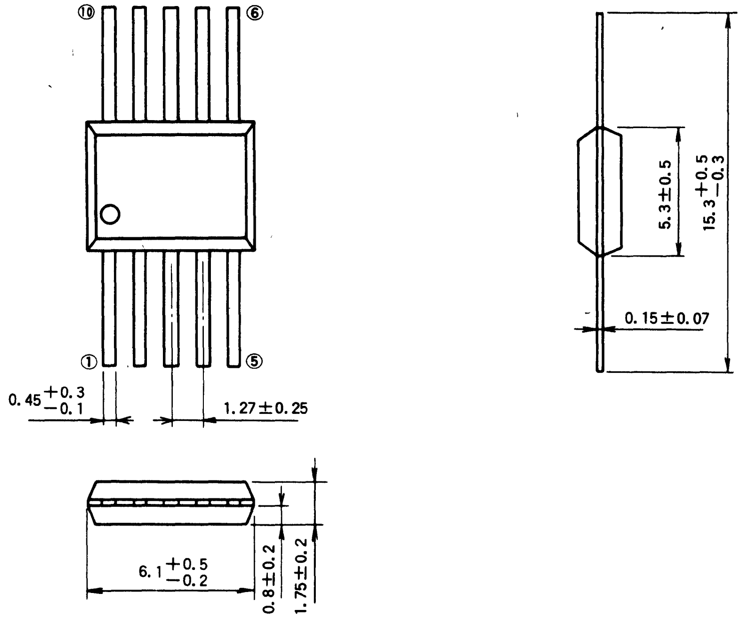
TYPE 9P9 9-PIN MOLDED PLASTIC SIP

Dimension in mm



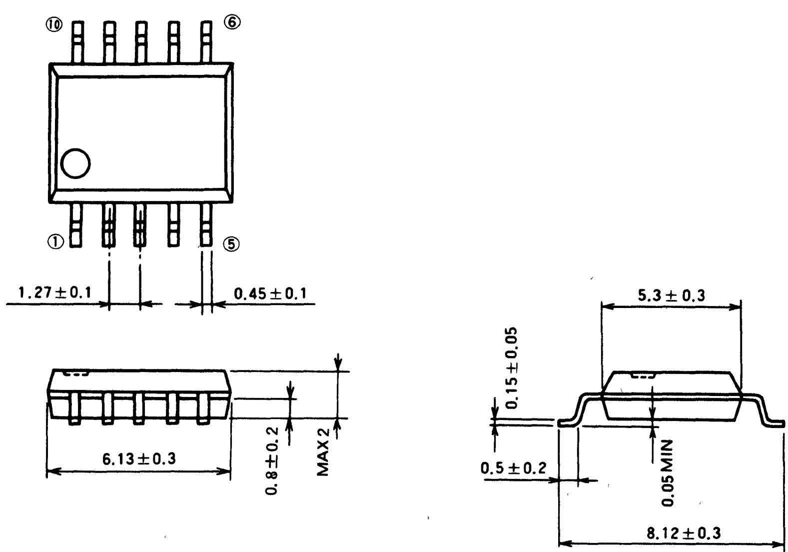
TYPE 10P2 10-PIN MOLDED PLASTIC FLAT

Dimension in mm



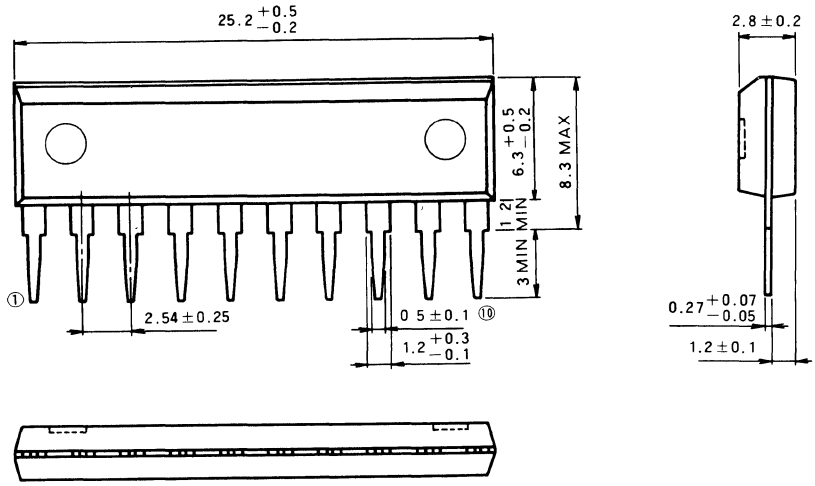
TYPE 10P2-C 10-PIN MOLDED PLASTIC FLAT

Dimension in mm



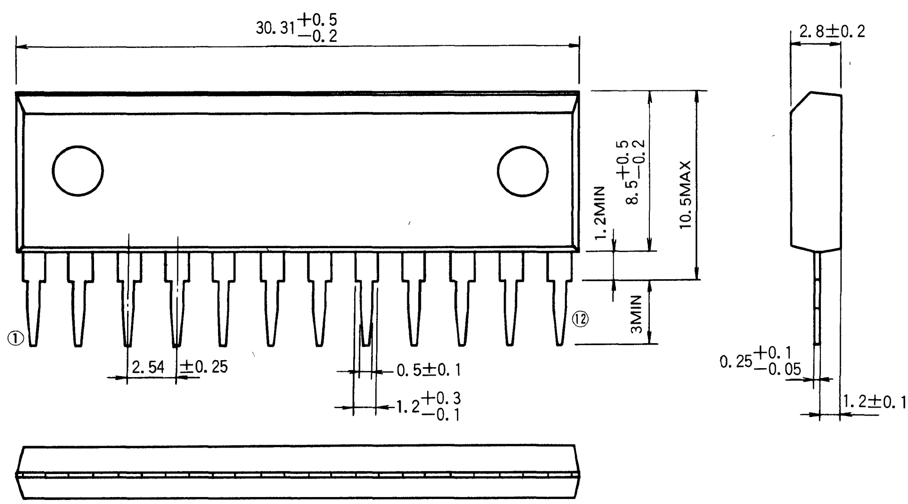
TYPE 10P5 10-PIN MOLDED PLASTIC SIP

Dimension in mm

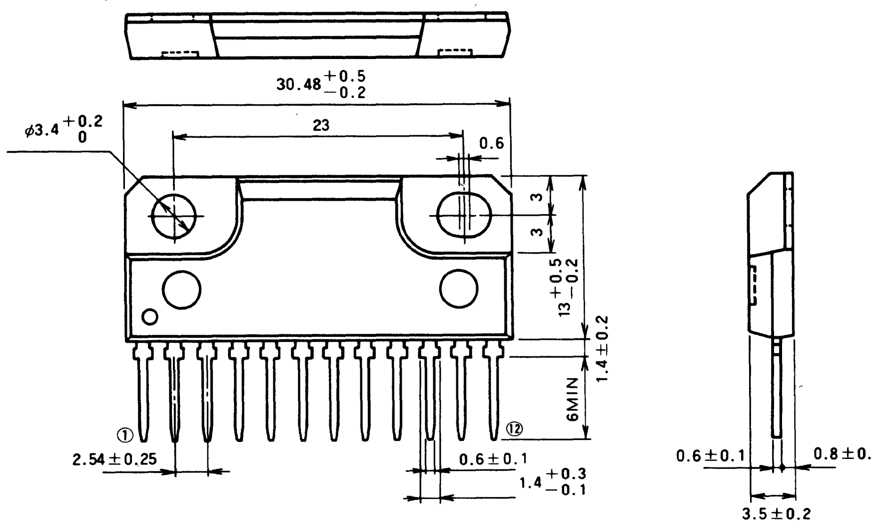


TYPE 12P5 12-PIN MOLDED PLASTIC SIP

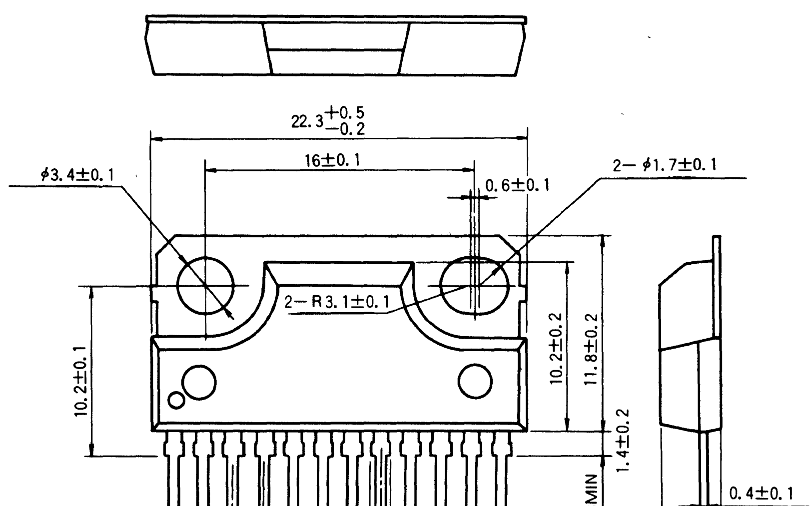
Dimension in mm



TYPE 12P9 12-PIN MOLDED PLASTIC SIP Dimension in mm

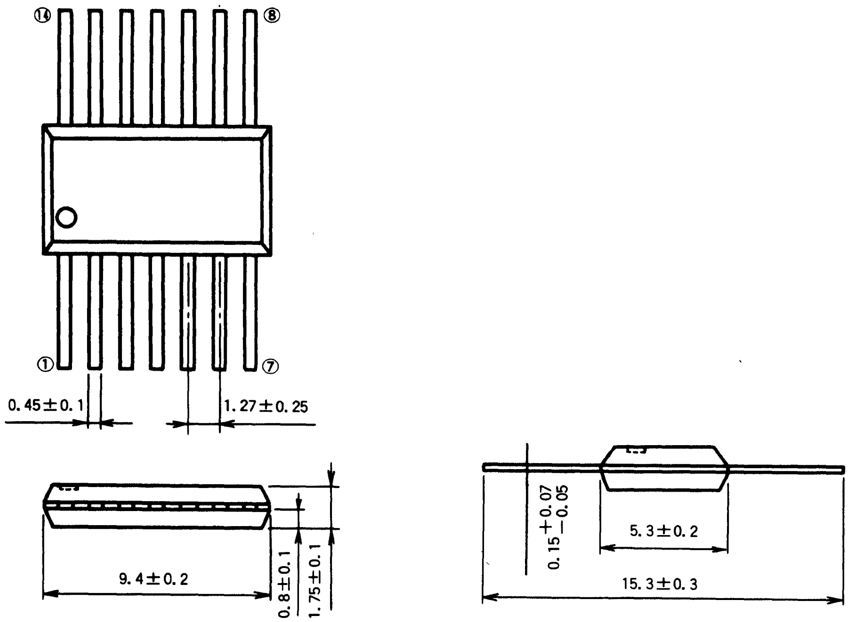


TYPE 12P9B 12-PIN MOLDED PLASTIC SIP Dimension in mm



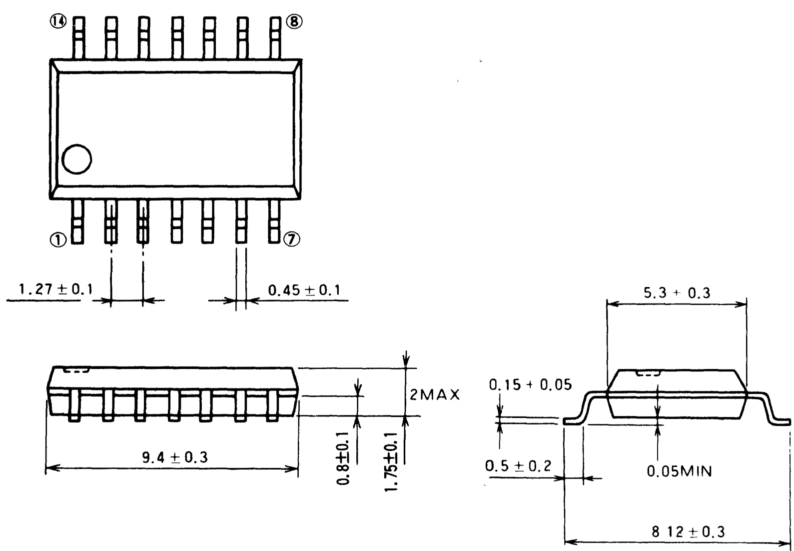
TYPE 14P2 14-PIN MOLDED PLASTIC FLAT

Dimension in mm



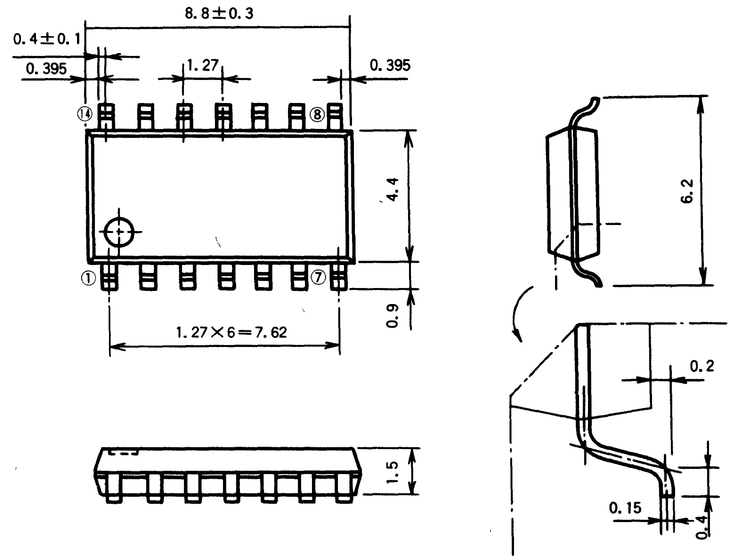
TYPE 14P2-C 14-PIN MOLDED PLASTIC FLAT

Dimension in mm



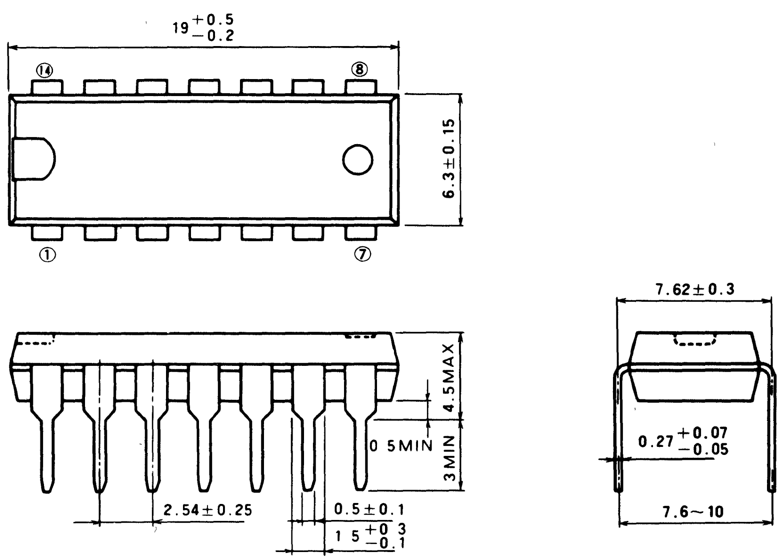
TYPE 14P2S 14-PIN MOLDED PLASTIC MINI FLAT

Dimension in mm



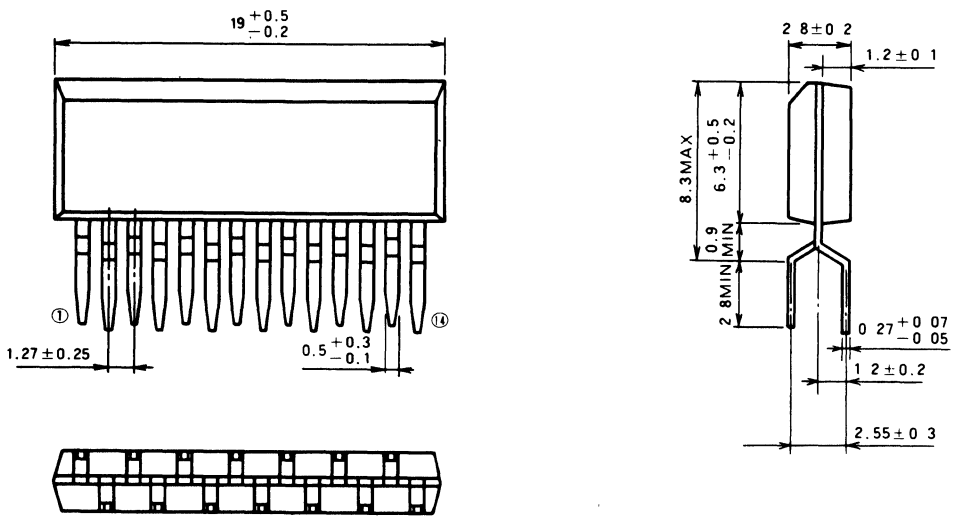
TYPE 14P4 14-PIN MOLDED PLASTIC DIP

Dimension in mm



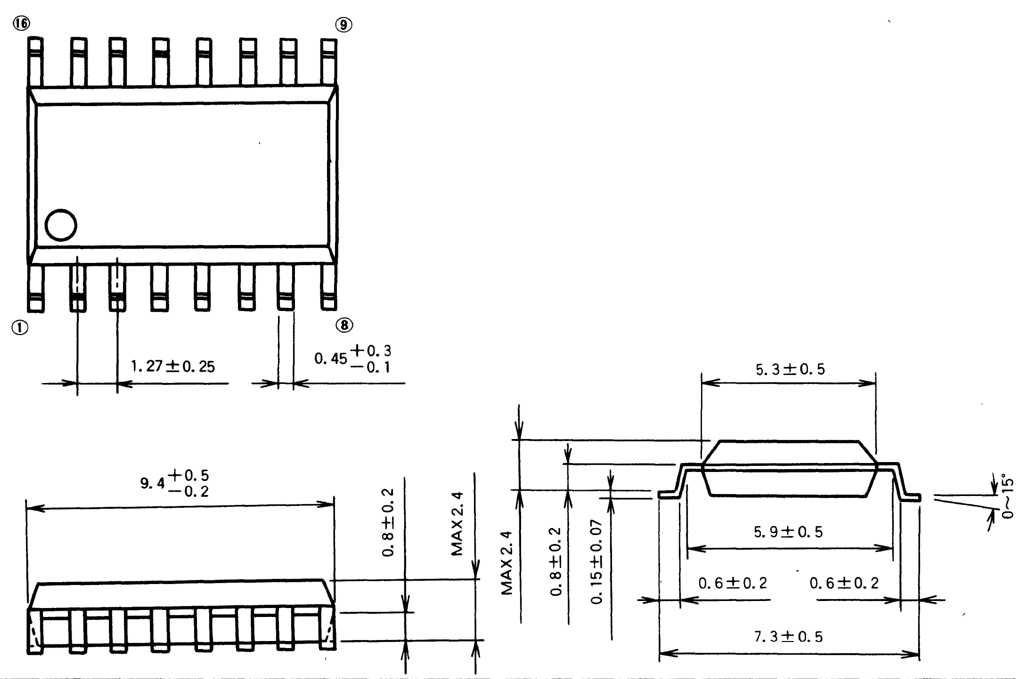
TYPE 14P5A 14-PIN MOLDED PLASTIC ZIP

Dimension in mm



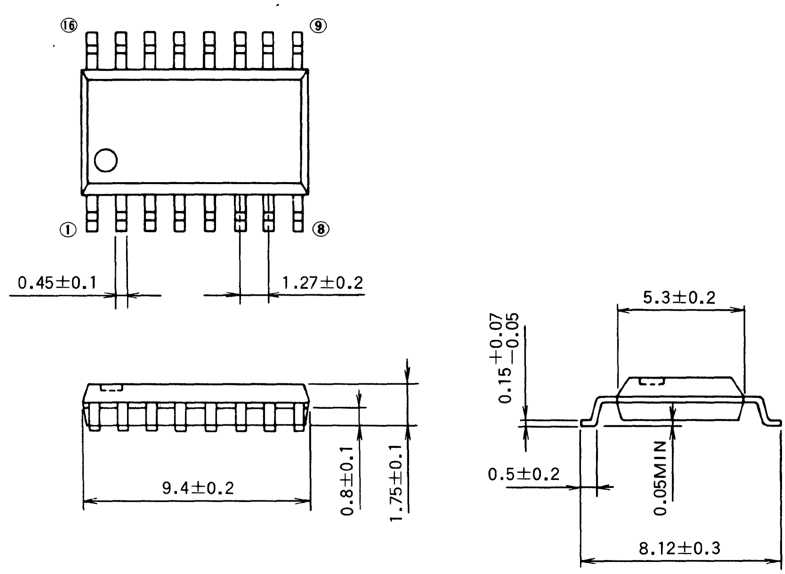
TYPE 16P2-B 16PIN MOLDED PLASTIC FLAT

Dimension in mm



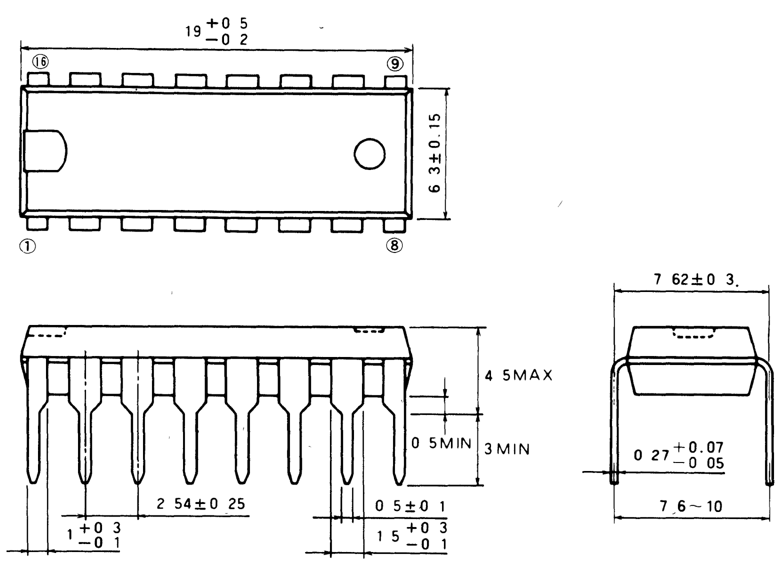
TYPE 16P2-C 16-PIN MOLDED PLASTIC FLAT

Dimension in mm



TYPE 16P4 16-PIN MOLDED PLASTIC DIP

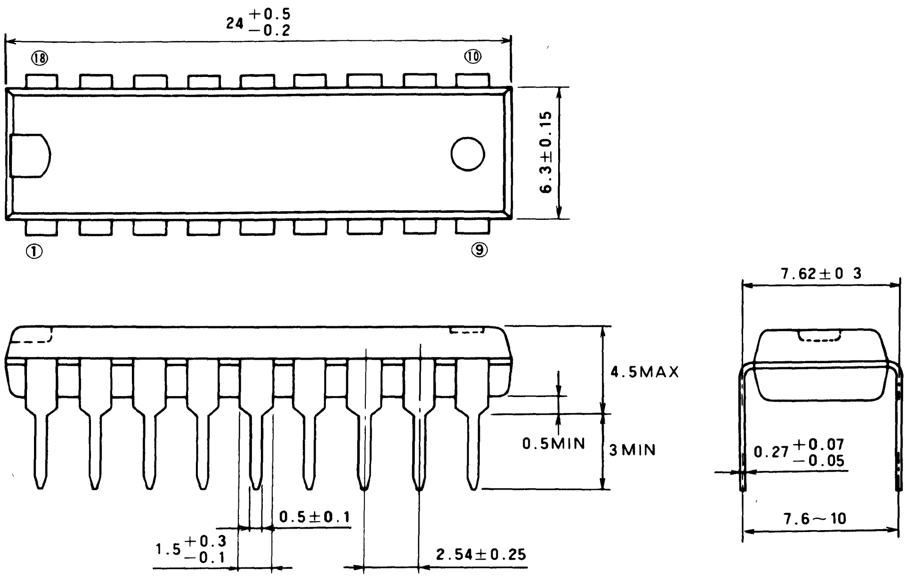
Dimension in mm



MITSUBISHI ELECTRIC

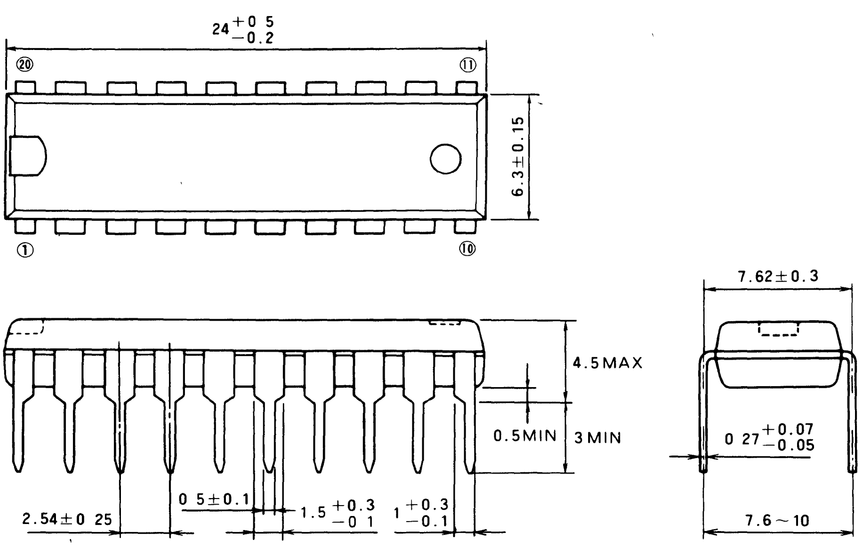
TYPE 18P4 18-PIN MOLDED PLASTIC DIP

Dimension in mm



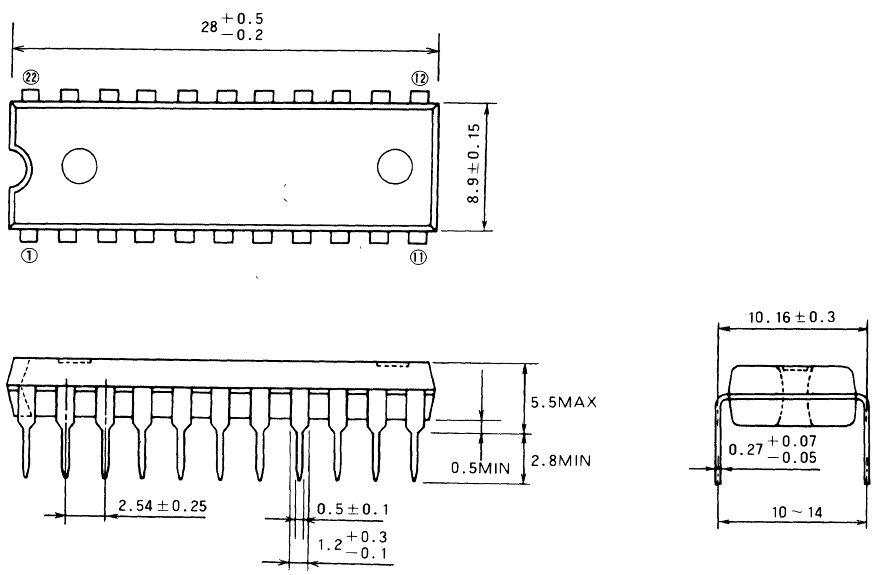
TYPE 20P4 20-PIN MOLDED PLASTIC DIP

Dimension in mm



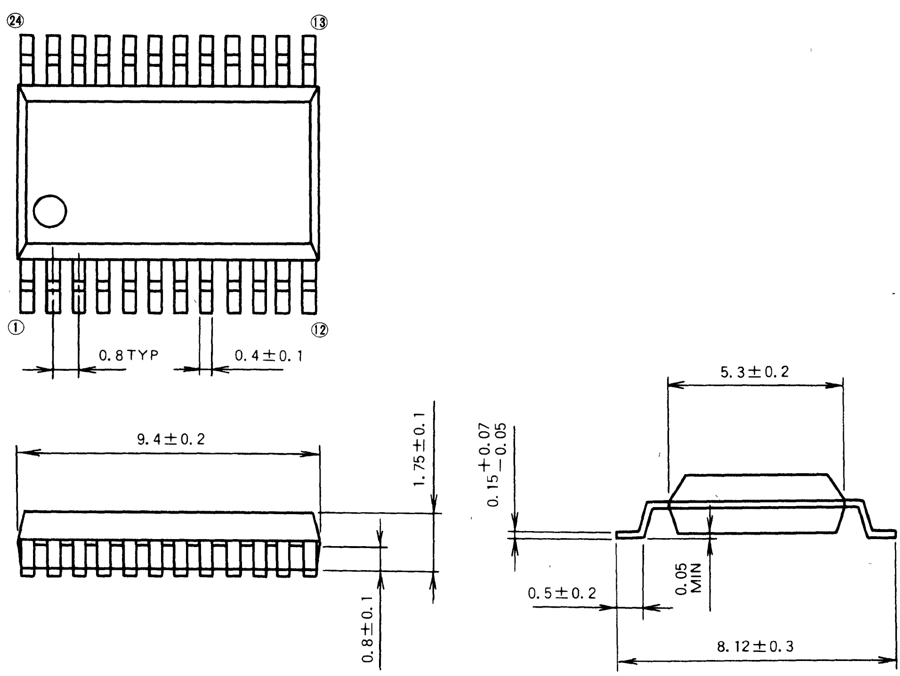
TYPE 22P4 22-PIN MOLDED PLASTIC DIP

Dimension in mm

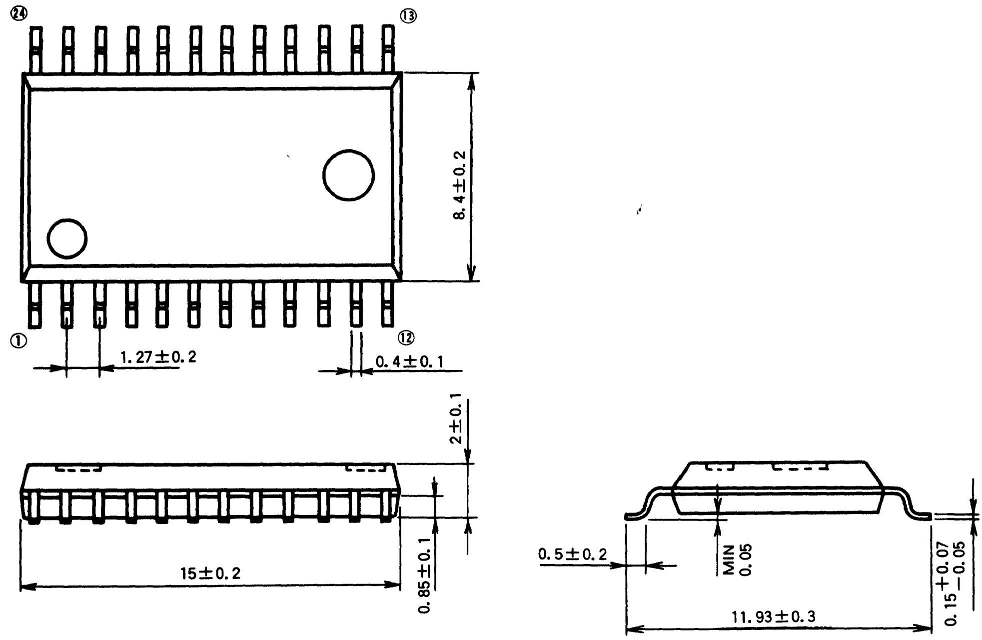


TYPE 24P2T-C 24-PIN MOLDED PLASTIC FLAT

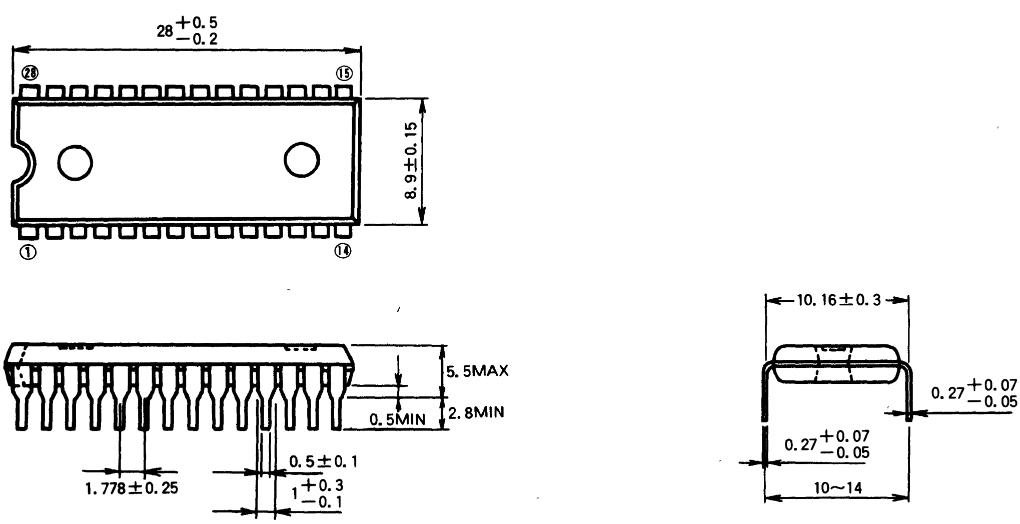
Dimension in mm



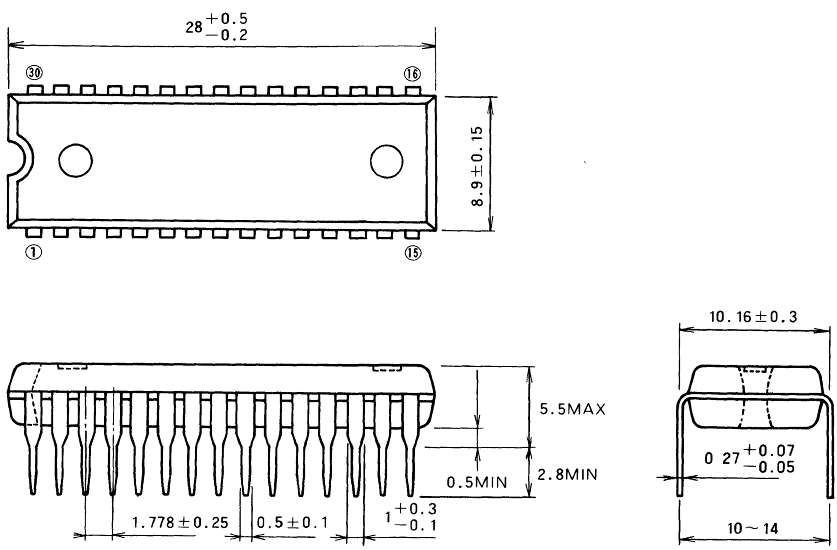
TYPE 24P2W 24-PIN MOLDED PLASTIC FLAT Dimension in mm



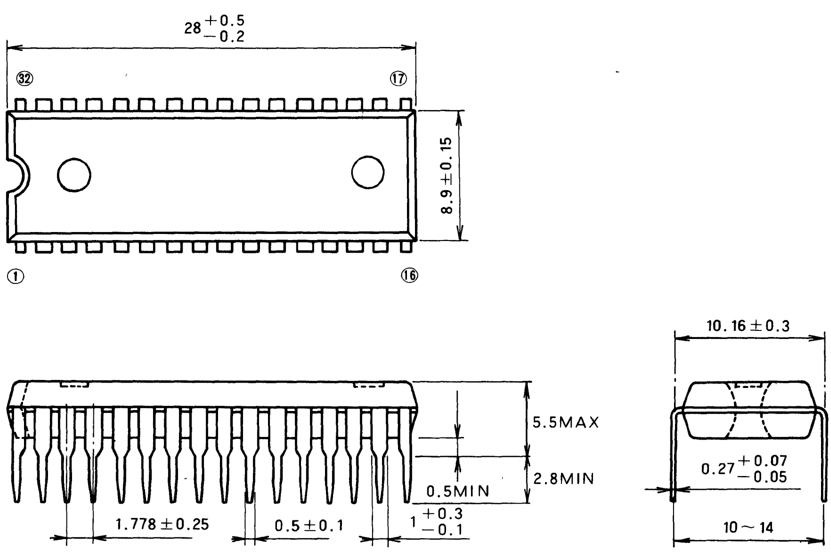
TYPE 28P4B 28-PIN MOLDED PLASTIC DIP(LEAD PITCH 1.778mm) Dimension in mm



TYPE 30P4B 30-PIN MOLDED PLASTIC DIP(SHRINK) Dimension in mm



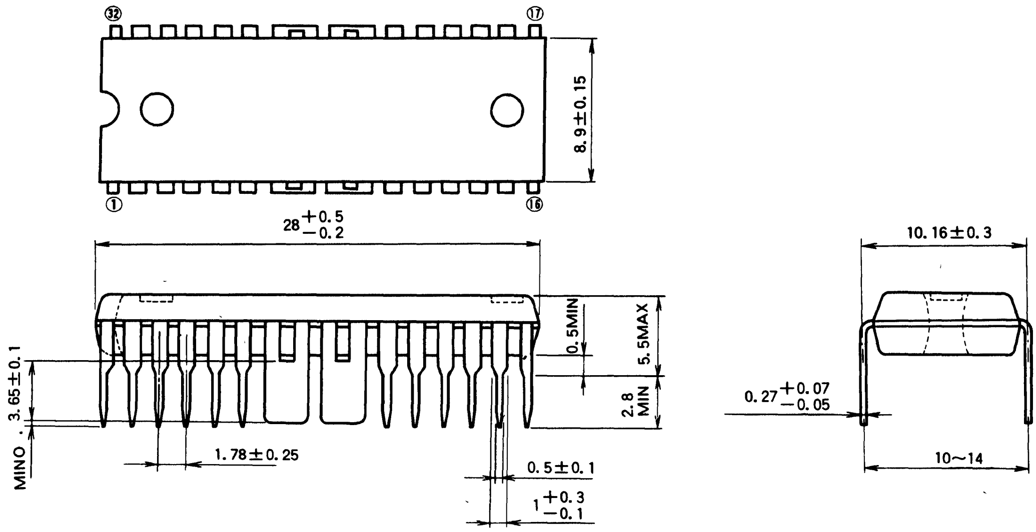
TYPE 32P4B 32-PIN MOLDED PLASTIC DIP (SHRINK) Dimension in mm



MITSUBISHI ELECTRIC

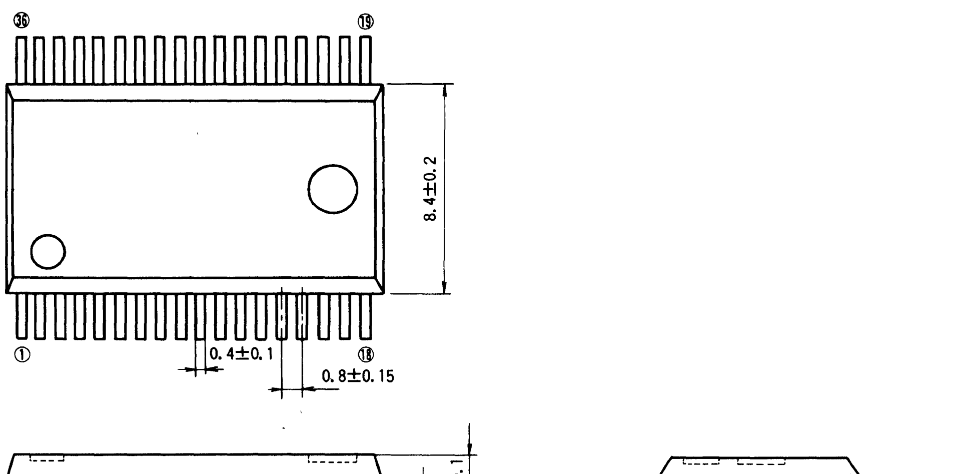
TYPE 32P4B-A 32-PIN PLASTIC DIP(SHRINK)

Dimension in mm



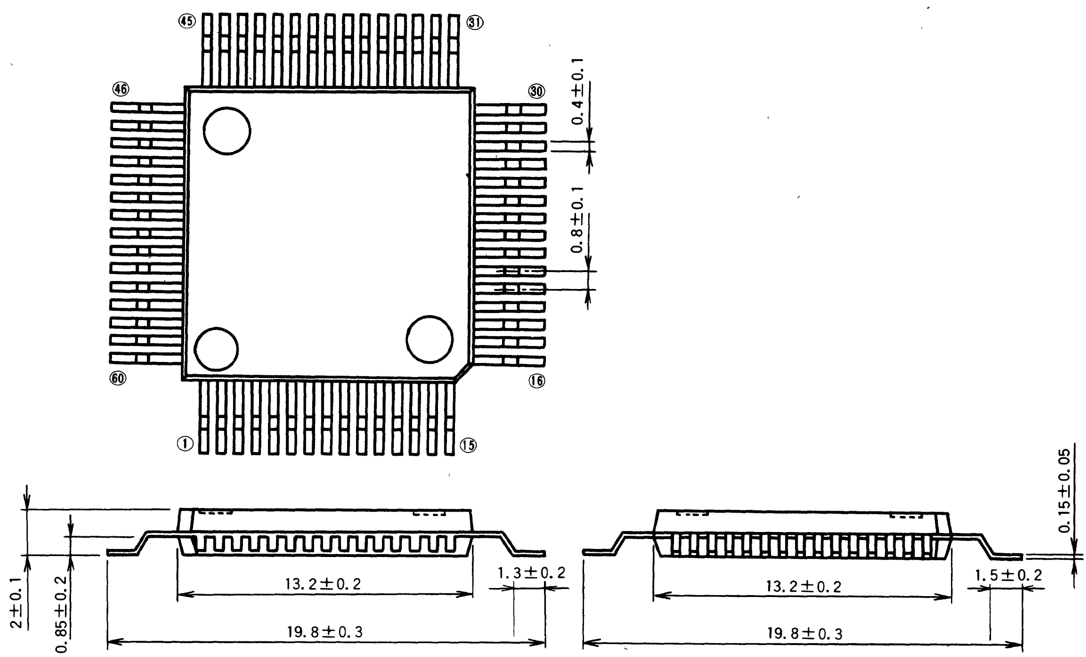
TYPE 36P2R-A 32-PIN MOLDED PLASTIC FLAT

Dimension in mm



TYPE 60P6-B 60-PIN MOLDED PLASTIC FLAT

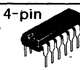
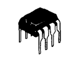
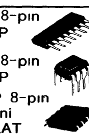
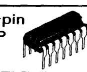
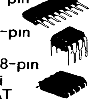
Dimension in mm



OPERATIONAL AMPLIFIER 2

MITSUBISHI ELECTRIC

QUICK REFERENCE TABLE OF OPERATIONAL AMPLIFIERS

Application	Type No	Circuit Function	Features	Maximum Ratings: Operating supply voltage range V_{CC} (V)	Maximum Ratings: Load current I_L (mA)	Maximum Ratings: Allowable power dissipation P_d (mW)	Electrical Characteristics (Typical characteristics): Circuit current I_{CC} (mA)	Input offset voltage V_{IO} (mV)	Input bias current I_B (nA)	Slew rate SR (V/μs)	Gain bandwidth product f_T (MHz)	Input-referred noise voltage V_{NI} (μVrms)	Package Outline	Interchangeable products
General-purpose	M51802	Single with offset adjusting pin	● No latch-up ● Built-in protection circuit against output short circuit ● Easy offset adjustment	±2~±18	—	360(L) 625(P)	1.7	1	150	0.3	0.7	—	L: 8-pin SIP P. 8-pin DIP 	741
General-purpose	M5216	Dual large-current (Headphone amplifier)	● Large-current, high output ● High-speed	±2~±18	±100	(L)(P)(FP) 800/625/440	4.5	0.5	180	3.0	10	1.8 (R_S=1kΩ Flat)	L: 8-pin SIP 	4556
General-purpose	M5218/ M5R4558P	Dual low-noise general-purpose	● Large-current ● High-speed	±2~±18	±50	800/625/440	3.0	0.5	100	2.2	7	2.0 (R_S=1kΩ Flat)	P: 8-pin DIP 	4557 4558 4559
General-purpose	M5223/ M5N358P	Dual single power supply	● Both input and output pins can be operated from 0V (GND) ● High voltage ● Low power dissipation	3~36	±50	800/625/440	0.7	2.0	30	0.6	1	—	FP: 8-pin mini FLAT	358 2904
General-purpose	M5224/ M5N324P	Quad single power supply		3~36	±50	700/550	1.2	2.0	30	0.6	1	—	P, 14-pin DIP 	324 2902
General-purpose	★ M5228	Quad low-noise general-purpose	● Large-currnet ● High-speed	±2~±18	±50	700/550	6.0	0.5	100	2.2	7	2.0 (R_S=1kΩ Flat)	FP: 14-pin FLAT 	4136 6554 4741
Low-noise	★ M5209	Dual high withstand voltage	● High withstand voltage V_{CC}=±25V ● Low-noise, high-speed	±2~±25	±50	800/625/440	3.5	0.5	300	6.5	20	1.2 (R_g=2.2kΩ Flat)	L: 8-pin SIP 	4562
Low-noise	★ M5210	Dual high S/N (microphone amplifier)	● High withstangd voltage V_{CC}=±25V ● Low noise, high-speed	±2~±25	±50	800/625/440	4.0	0.5	700	6.5	20	1.0 (R_g=2.2kΩ Flat)	P: 8-pin DIP 	2043
Low-noise	M5219	Dual 77dB S/N	● Low noise, high-speed ● High withstand voltage V_{CC}=±25V	±2~±25	±50	800/625/440	3.5	0.5	300	6.5	20	0.9 (R_g=2.2kΩ RIAA)	FP: 8-pin mini FLAT	4562
Low-noise	M5220	Dual 83dB S/N	● Low noise, high speed ● High withstand voltage V_{CC}=±25V	±2~±25	±50	800/625/440	4.0	0.5	700	6.5	20	0.75 (R_g=2.2kΩ RIAA)		2043
Bi-FET	M5221/ M5T082P	Dual general-purpose	● High input impedance (1000MΩ) ● High-speed	±5~±18	±50	800/625/440	3.0	5.0	30PA	13	3	2.2 (R_S=100kΩ Flat)	L: 8-pin SIP  P: 8-pin DIP	072 082
Bi-FET	★ M5238	Dual 73dB S/N	● Low noise, high-speed ● High input impedance (1000MΩ)	±5~±18	±50	800/625/440	4.5	5.0	30PA	20	6	1.6 (R_g=2.2kΩ RIAA)	FP 8-pin mini FLAT	—
Bi-FET	★ M5240P	Dual 82dB S/N	● Low noise, high-speed ● External phase compensation pin	±5~±18	±50	1000	10	10.0	200PA	40	18	0.9 (R_g=2.2kΩ RIAA)	16-pin DIP 	—
Complex	★ M5201	Dual input switching (general-purpose switching operational amplifier)	● Operational amplifier equivalent to the M5218 is built-in ● Gain can be set independently ● Small switching shock noise	±2.5 ~±18	±50	800/625/440	2.3	0.5	100	2.2	7	2.0 (R_S=1kΩ Flat)	L: 8-pin SIP P: 8-pin DIP FP: 8-pin mini FLAT 	—

★: New product

INTERCHANGEABLE PRODUCTS OF OPERATIONAL AMPLIFIERS

Appli-cation	Mitsubishi		Interchangeable products of other manufacturers										
	Circuit function	Type No.	JRC	NEC	Matsushita	Toshiba	Hitachi	Tokyo Sanyo	ROHm	TI	NSS	FC	MOTO
Operational amplifier	Dual large-current operational amplifier	M5216L	NJM4556S(9L)										
		M5216P	NJM4556D	μPC4556C									
		★ M5216FP	NJM4556M	μPC4556G									
	Dual general-purpose low-noise operational amplifier	M5218L	NJM4558S(9L) NJM4559S(9L)		AN6551(9L) AN6555(9L)	TA75557S(9L) TA75558S(9L) TA75559S(9L)		LA6458S(9L)	BA715(9L)				
		M5218P M5R4558P	NJM4558D NJM4559D	μPC4557C μPC4558C μPC4559C	AN4558 AN6552 AN6553, 6556	TA75557P TA75558P TA75559P	(HA17458)	LA6458D	BA4558	TL4558P RM4558 RC4558		μA4558 μA4558TC	(MC1458)
		★ M5218FP	NJM4558M NJM4559M	μPC4558G	AN4558S AN6553S AN6556S	TA75558F TA75559F		LA6458M	BA4558F				
	Dual low-noise operational amplifier	M5219L	NJM4562S(9L) NJM4560S(9L)	μPC1224(8L)									
		M5219P	NJM4562D NJM4560D								LM833		
	Dual low-noise operational amplifier	M5220L	NJM2041S(9L) NJM2043S(9L)		AN6557(9L)								
		M5220P	NJM2041D NJM2043D		AN6558						LM833		
	Dual J-FET input operational amplifier	M5221L	NJM072S(9L) NJM082S(9L)		AN6581								
		M5221P M5T082P	NJM072D NJM082D	μPC803C μPC4082C	AN1082		HA17082		BA082	TL072 TL082	LF353		
		★ M5221FP	NJM072M NJM082M	μPC4082G	AN1082S								
	Dual single power supply operational amplifier	M5223L	NJM2904S(9L)		AN6561(9L)			LA6358S(9L)	BA718(9L)				
		M5223P M5N358P	NJM2904D	μPC358C μPC1251C	AN1358 AN6562	TA75358P	HA17904PS	LA6358	BA728 BA10358	LM358P	LM358	LM358 LM2904	MLM358
		★ M5223FP	NJM2904M	μPC358G	AN1358S	TA75358F			BA728F BA10358F				

L. SIP (8-pin), P: DIP(8-pin), (9L): SIP(9-pin), FP· mini FLAT (8-, 14-pin)
★: New product

INTERCHANGEABLE PRODUCTS OF OPERATIONAL AMPLIFIERS (CONTINUED)

Application	Mitsubishi		Interchangeable products of other manufacturers										
	Circuit function	Type No.	JRC	NEC	Matsushita	Toshiba	Hitachi	Tokyo Sanyo	ROHm	TI	NSS	FC	MOTO
Operational amplifier	Quad single power supply operational amplifier	M5224P M5N324P	NJM2902D	µPC324 µPC451C	AN1324 AN6564	TA75902P TA75324P	HA17902PS	LA6324	BA10324	LM2902 LM324N	LM324 LM2902	µA324 µA2902	MLM2902
		M5224FP	NJM2902M	µPC324G	AN1324NS	TA75902F		LA6324M	BA10324F				
	Quad general-purpose low-noise operational amplifier	M5228P	NJM2058 NJM2059	µPC4741	AN6554				BA14741	RC4136		µA4136	
		M5228FP	NJM2058M NJM2059M	µPC4741G	AN6554NS								
	Dual J-FET input, low-noise operational amplifiers	★ M5238L											
		★ M5238P											
	Dual J-FET input, High S/N operational amplifier	M5240P											
	Dual input switching general-purpose operational amplifier	★ M5201L											
		★ M5201P											

L: SIP (8-pin), P: DIP (8-pin), (9L): SIP (9-pin), FP: mini FLAT (8-, 14-pins)

★: New product

HOW TO CHOOSE OPERATIONAL AMPLIFIERS

How to choose operational amplifiers

Choose operational amplifiers according to the following categories of usage.

- By basic circuit configuration of operational amplifiers
  - (1) Dual power supply operational amplifiers M5218/M5R4558P, M5219, M5220...
  - (2) Single power supply operational amplifier M5223/M5N358P, M5224P/M5N324P
- By functional type of operational amplifiers
  - (1) High voltage operational amplifiers M5209, M5219, M5210, M5220 (V_{CC}=~±25V)
  - (2) Low-noise operational amplifiers M5219, M5220, M5240 (S/N=77~83dB)
  - (3) High-speed operational amplifiers M5209, M5210, M5219, M5220, M5221/M5T082P, M5238 (SR=6.5~13V/μs)
  - (4) Large-current operational amplifiers M5216 (I_{LP}=±100mA)
  - (5) High input impedance operational amplifiers M5221/M5T082P, M5238 (Bi-FET operational amplifier R_i=1000MΩ)

Method of choosing operational amplifiers according to the features of each type shown above is explained in the following.

1. Dual power supply and single power supply operational amplifiers

A dual power supply operational amplifier is one of the most popular operational amplifiers, represented by old types 709 or 741 or the more recent type 4558 (Mitsubishi's M5218/M5R4558P) and is usually used at a supply voltage of V_{CC}±15V. As shown in Fig. 1, tow power supplies of positive and negative voltages are applied to GND, and the device is used mainly at near GND level. In this case, V_X and V_Y are residual voltage, generated inside an operational amplifier. Fig. 2 shows the relationship between the input and output of amplifiers, and voltage gain A_V, i.e., ratio of output V_O against input V_i, is determined by ratio of externally connected resistors R_2/R_1. On the other hand a single power supply operational amplifier is used by applying a single power supply and amplification operation for GND level input is made possible. As shown in Fig. 3, the signal can be activated up to GND level.

Residual voltage V_X of $+V_{CC}$ is generated as in dual power supply type operational amplifiers. Fig. 4 shows the input and output characteristics. (Refer to operational logic in the indevidual data of M5223/M5N358P, M5224/M5N324P for details.)

Care must be taken with a single power supply operational amplifier that only a single power supply is applied. The output DC bias level is not determined automatically and an operational amplifier is activated only to GND level. It operates in the same way as a dual power supply operational amplifier operates within the activated range. To sum up, basic DC output levels for both types of amplifiers must be determined by the voltage of non-inverted input (+input). In other words, a single power supply operational amplifier can be used with level-shifted voltages just as a dual operational amplifier used GND level as its basic DC level.

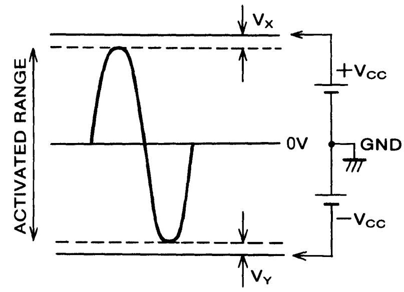


Fig. 1

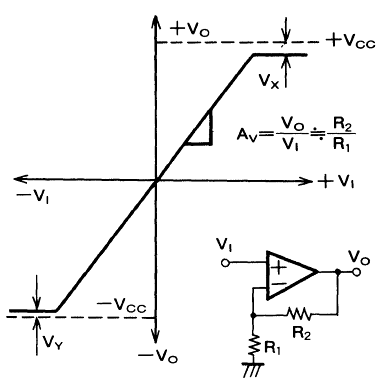


Fig. 2

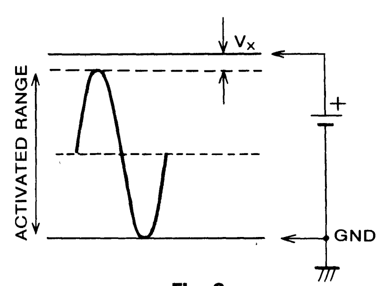


Fig. 3

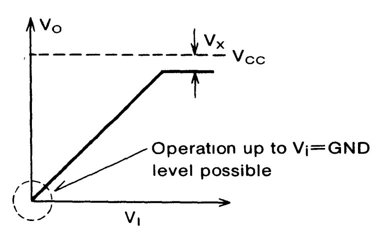


Fig. 4

2. High voltage operational amplifiers

Ordinary amplifiers accept maximum supply voltage of $V_{CC}+18V$ and are usually used at $V_{CC}\pm15V$, but, $V_{CC}\pm 20V$ or above is used for audio amplifiers for a wider dynamic range. Mitsubishi has a variety of products for the M52XX series of operational amplifiers such as the M5209, M5210, M5220, which garantee maximum supply voltage of $V_{CC}\pm25V$ suitable for audio preamplifiers.

3. Low-noise operational amplifiers

To satisfy low-noise specifications required in audio equipment, the M52XX series includes the M5209, M5210, M5219 and M5220. The M5209 and M5210 are suitable for high S/N microphone or line amplifiers. The M5219 and M5220 have suppressed 1/f noise, pulse-related noise and low-wave noise and are suitable for EQ amplifiers of stereo equipment and tape decks. The M5238, M5240 are low-noise Bi-FET operational amplifiers.

4. High-speed operational amplifiers

The M52XX series includes the M5209, M5210, M5219 and M5220, which have characteristics of high-speed as well as high-voltage and low-noise, and $SR=6.5V/\mu s$ typ. The SR stands for slew rate and is a parameter to indicate high speed in an amplifier and is related to high frequency distortion such as 20kHz in processing fast-rising signals and in audio circuits.

Gain bandwidth product f_T is also a high-frequency parameter of an operational amplifier as well as slew rate SR. This parameter indicates the limit of amplification capacity of an operational amplifier in small signal and indicates the frequency at which voltage gain is 1 ($G_V=0$). It is an important parameter for determining the gain and frequency characteristics of an operational amplifier. For example, when an amplifier of $G_V=40dB$ is designed, the M5209 of $f_T=20MHz$ becomes an amplifier with a bandwidth of 200kHz and the M5218/M5R4558P becomes an amplifier with a bandwidth of 70kHz. Choose the most suitable operational amplifier according to usage.

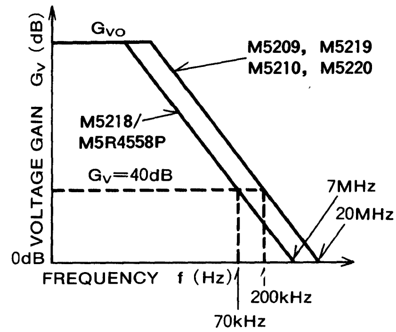


Fig. 5

5. Large-current operational amplifier

The M5216 is a large-current operational amplifier with load current $I_{LP}=\pm100mA$ and is suitable for applications that require large-current, for example, for headphone drive, relay circuit or LED.

6. High input impedance operational amplifier

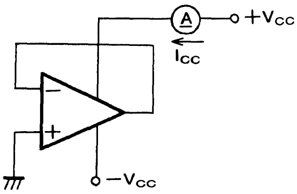
The M5221/M5T082P, M5238 Bi-FET operational amplifiers are high input impedance operational amplifiers, and have characteristic of input impedance $R_i=1000\ M\Omega$ typ. The device is suitable for application that is related to high input impedance, such as sample-hold circuit or various types of filters.

MITSUBISHI ELECTRIC

TEST METHOD OF OPERATIONAL AMPLIFIERS

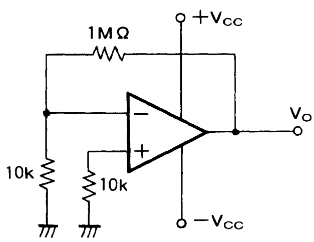
■ Test method of operational amplifiers

(1) Circuit current I_{CC}



* If output pin current is maintained at 0 and in quiescent state, the circuit needs not be a voltage follower as shown above.

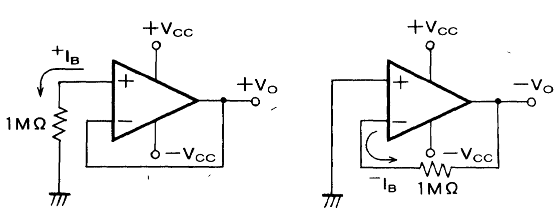
(2) Input offset voltage V_{IO}, supply voltage rejection ratio SVRR



- $V_{IO}=\frac{V_O}{100}$ ($V_{CC}\pm15V$)
- $SVRR=\frac{V_{O1}-V_{O2}}{100\times5}$ (V_{O1}: $V_{CC}\pm17.5V$, V_{O2}: $V_{CC}\pm12.5V$)

*SVRR
Measure change of offset V_{IO} when $V_{CC}=\pm12.5$ and ±17.5 (where $R_S=10k\Omega$).

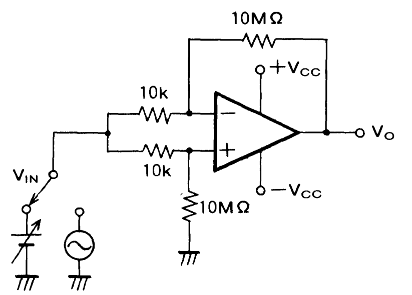
(3) Input bias current I_B, input offset current I_{IO}



* I_B: Base current of first stage L-PNP

- $^{+}I_B=\frac{^{+}V_O}{1M\Omega}$
- $^{-}I_B=\frac{^{-}V_O}{1M\Omega}$
- $I_{IO}=|\,^{+}I_B-\,^{-}I_B\,|$

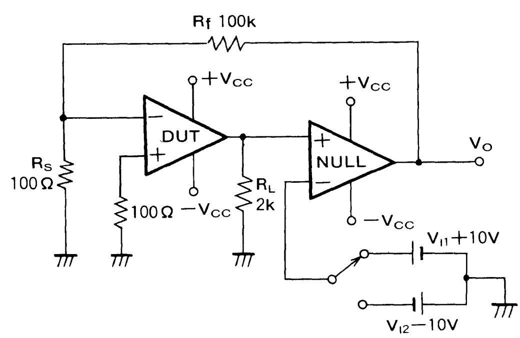
(4) Common phse input voltage width V_{CM}, common phase signal rejection ratio CMR



- V_{CM} DC input voltage when output V_O becomes +10V or −10V by applying DC input voltage to V_{IN}.
- CMR Measure V_O by applying AC input signal 0dBm to V_{IN}.

$$CMR=20\log\frac{V_{IN}}{\frac{V_O}{1000}}$$

(5) Voltage gain



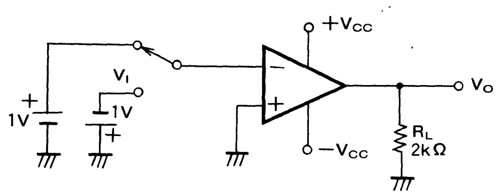
- $G_{VO}=20\log A_{vd}$

$$A_{vd}=\frac{R_S+R_f}{R_S}\times\frac{V_{I1}-V_{I2}}{V_{O1}-V_{O2}}$$
$$=10^3\times\frac{20}{V_{O1}-V_{O2}}$$
$$=\frac{2\times10^4}{V_{O1}-V_{O2}}$$

Example $V_{O1}-V_{O2}=0.2V\rightarrow100dB$

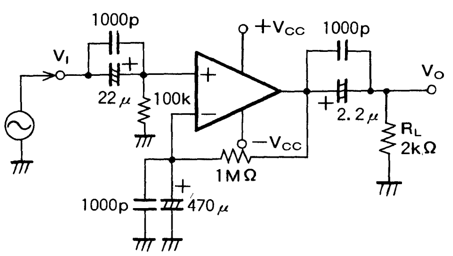
* Measure DC voltage gain by using NULL amplifier. DUT output is maintained at ±10V by varying (−) input of NULL amplifier between +10V and −10V, and output V_O is the DUT input voltage, multiplied by R_S+R_f/R_S times.

(6) Maximum output voltage V_{OM}

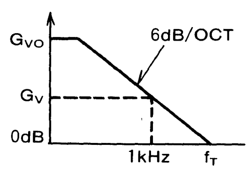


* DUT is used in open status without feedback and output V_O is measured by applying +1V to an input. In this case, the output is saturated when an input is 1V as open gain is high.

(7) Gain bandwidth product f_T, voltage gain G_V

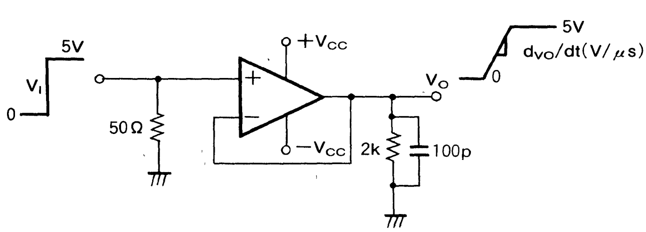


- f_T: Frequency where G_{VO}=0dB



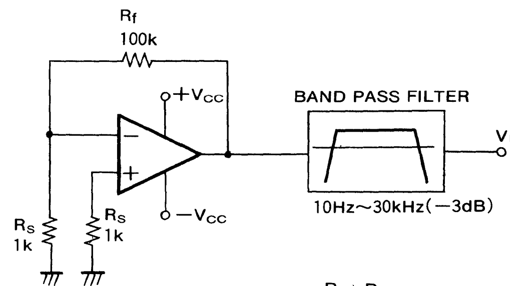
* Measure frequency characteristics of voltage gain G_V when a feedback of 100% (1MΩ) is applied for DC and feedback is open (1000pF//470μ) for AC. The f_T can be simply obtained by multiplying voltage gian of 1kHz by frequency.

(8) Slew rate SR



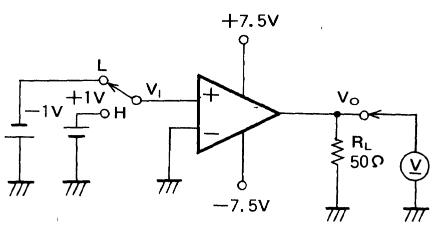
* Measure high-speed capacity of DUT by reading on an oscilloscope and output pulse response (rising speed) by inputting pulse step in a voltage follower circuit of 100% feedback.

(9) Input-referred noise voltage V_{NI}



$$V_{NI}=V_{NO}/\frac{R_f+R_S}{R_S}\doteqdot V_{NO}\cdot 10^{-2}$$

(10) I_{source}, I_{sink} (Single power supply operational amplifier)



V_I { H Isource / L Isink }

$$\text{Isource, Isink}=\frac{V_O}{50\Omega}$$

M51802L,P

INTERNALLY PHASE COMPENSATED OPERATIONAL AMPLIFIERS

DESCRIPTION

The M51802L, P are semiconductor integrated circuits designed for a high-gain, high-stability operational amplifier. No phase compensation is required and the devices come with offset adjusting pins and are suitable for home use and industrial equipment.

FEATURES

- Built-in capacitor for phase compensation
- No latch-up
- Built-in protection circuit for output short circuit
- Easy offset adjustment

APPLICATION

Amplifier for measuring instrument, DC amplifier, various types of operational circuit, comparator, multi-vibrator, and oscillator.

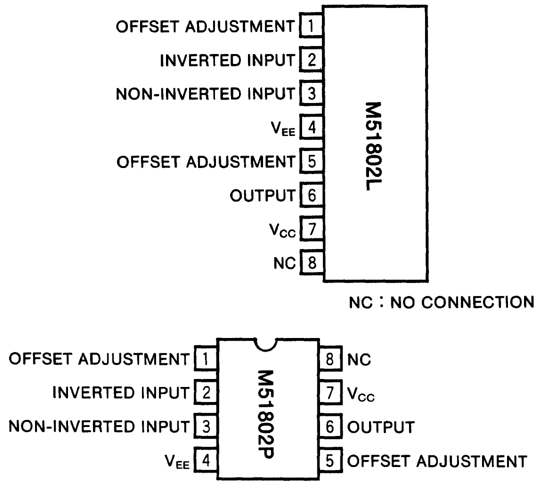
RECOMMENDED OPERATING CONDITIONS

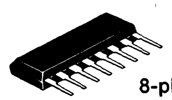
Supply voltage range·········· $V_{CC}(+V)$, $V_{EE}(-V)$ 4~18V
Rated supply voltage··············· $V_{CC}(+V)$, $V_{EE}(-V)$ 15V

APPLICATION EXAMPLES

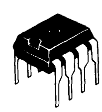
An operational amplifier employs feedback and has a variety of functions by the configuration of feedback circuits. Note (1) shows a method adjusting offset voltage.

PIN CONFIGURATION (TOP VIEW)



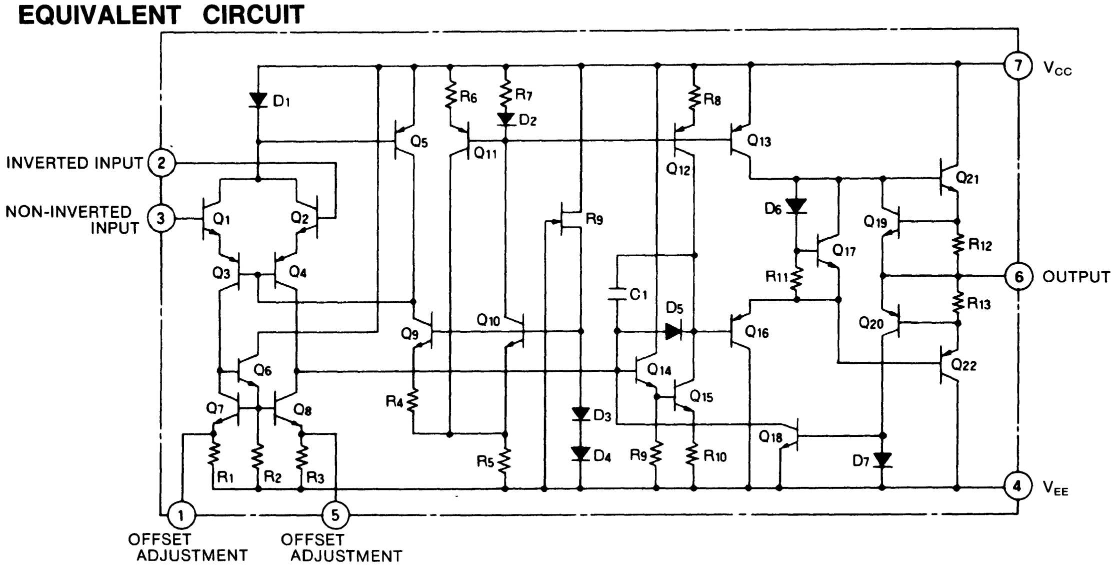


8-pin molded plastic SIP



8-pin molded plastic DIP

EQUIVALENT CIRCUIT



ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

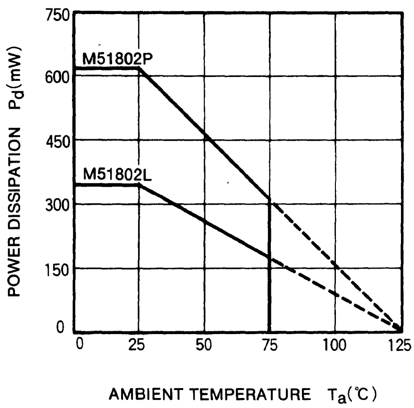
Symbol	Parameter	Condinions	Ratings	Unit
V_{CC}	Supply voltage		18	V
V_{EE}			−18	V
V_{id}	Differential input voltage	−	±30	V
V_{ic}	Common phase input voltage		±15	V
P_d	Power dissipation		360(M51802L)	mW
			625(M51802P)	
K_θ	Thermal derating	T_a≧25℃	3.6(M51802L)	mW/℃
			6.25(M51802P)	
Topr	Operating temperature		−20～+75	℃
Tstg	Storage temperature		−40～+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=+15V, V_{EE}=−15V)

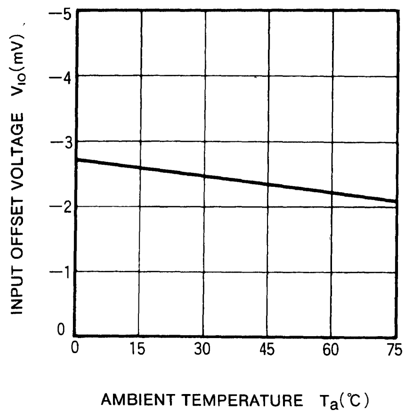
Symbol	Parameter		Test conditions	Limits Min	Typ	Max	Unit
V_{IO}	Input offset voltage		Rg≦10kΩ		1.0	5.0	mV
I_{IB}	Input bias current				150	500	nA
I_{IO}	Input offset current				30	200	nA
R_{in}	Input resistance		Input frequency f=1kHz		1.0		MΩ
G_V	Voltage gain		R_L≧2kΩ, V_O=±10V	86	100		dB
V_{OPP}	Maximum output voltage width		R_L≧10kΩ	±12	±14		V
			R_L≧2kΩ	±10	±13		
V_{ic}	Common phase input voltage range			±12	±13		V
CMRR	Common phase signal rejection ratio		Rg≦10kΩ	70	90		dB
SVRR	Supply voltage rejection ratio		Rg≦10kΩ		80	150	μV/V
P_d	Power dissipation		R_L=∞		50	85	mW
t_r	Transient response	Rising time	V_{in}=20mV, R_L=2kΩ, C_L≦100pF		0.3		μs
K_{OV}		Overshoot			5.0		%
SR	Slew rate		R_L=2kΩ		0.5		V/μs

TYPICAL CHARACTERISTICS (Ta=25°C, V_{CC}=+15V, V_{EE}=−15V, unless otherwise noted)

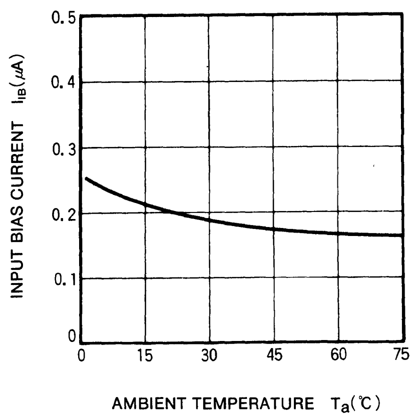
THERMAL DERATING (MAXIMUM RATING)



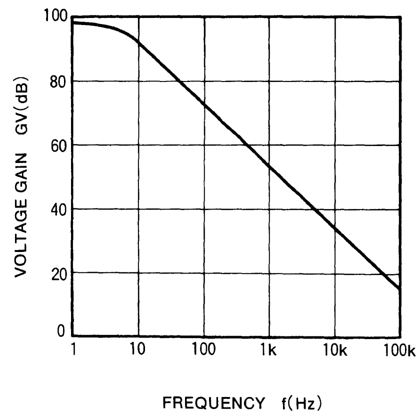
INPUT OFFSET VOLTAGE VS. AMBIENT TEMPERATURE



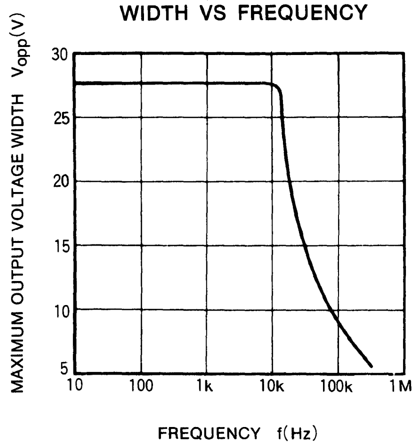
INPUT BIAS CURRENT VS AMBIENT TEMPERATURE



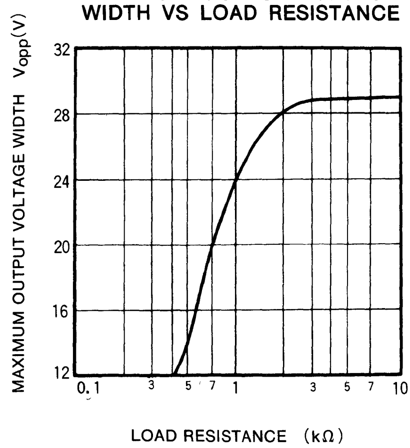
VOLTAGE GAIN VS FREQUENCY RESPONSE



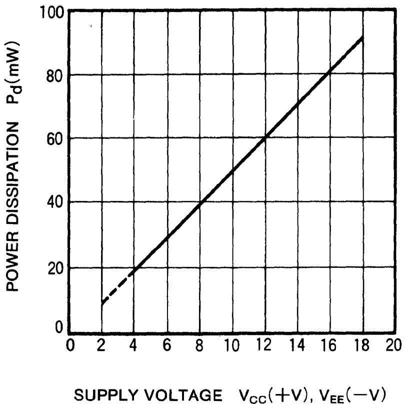
MAXIMUM OUTPUT VOLTAGE WIDTH VS FREQUENCY



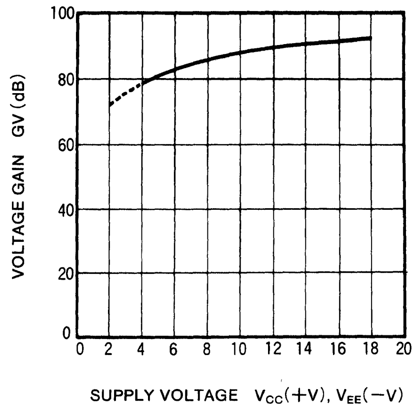
MAXIMUM OUTPUT VOLTAGE WIDTH VS LOAD RESISTANCE



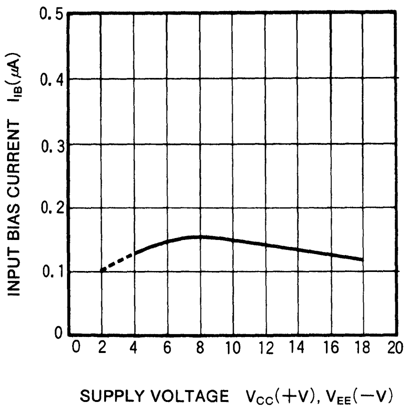
POWER DISSIPATION VS
SUPPLY VOLTAGE



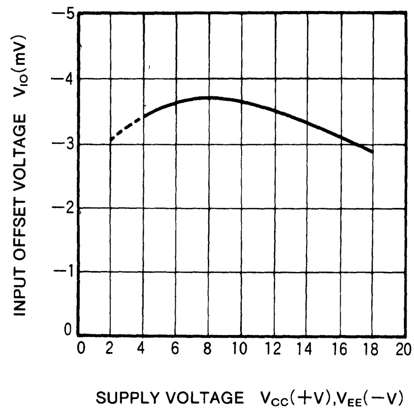
VOLTAGE GAIN VS
SUPPLY VOLTAGE



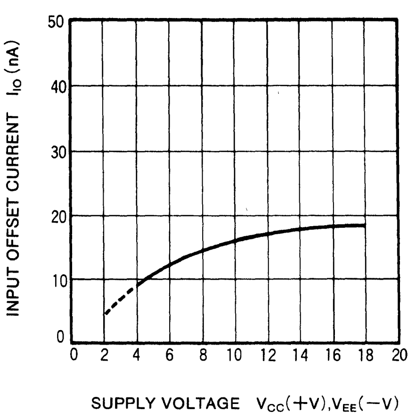
INPUT BIAS CURRENT VS
SUPPLY VOLTAGE



INPUT OFFSET VOLTAGE VS
SUPPLY VOLTAGE



INPUT OFFSET CURRENT VS
SUPPLY VOLTAGE

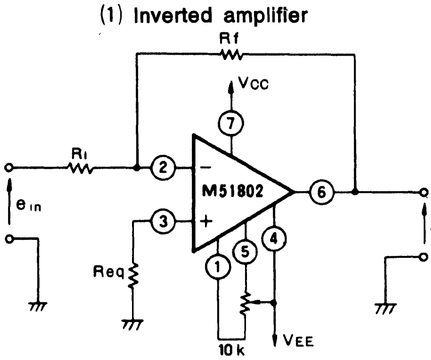


INTERNALLY PHASE COMPENSATED OPERATIONAL AMPLIFIERS

APPLICATION EXAMPLES

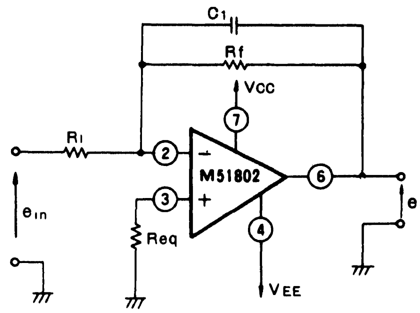
An operational amplifier employs feedback and has a variety of functions by the configuration of feedback circuits. Note (1) shows a method adjusting offset voltage.

(1) Inverted amplifier



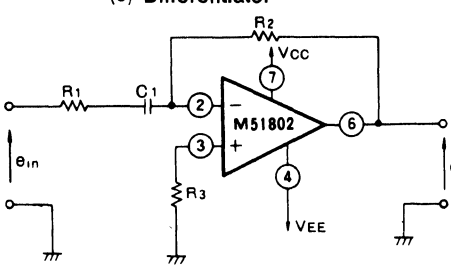
$R_{eq}=\frac{R_f \cdot R_i}{R_f+R_i}$ $A_{VD}=\frac{R_f}{R_i}$

(2) Integrator



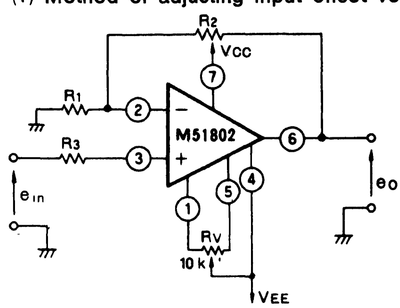
$R_{eq}=\frac{R_f \cdot R_i}{R_f+R_i}$ $e_o=-\frac{1}{R_iC_1}\int e_{in}\,dt$

(3) Differentiator



$e_o=-R_2C_1\frac{de_{in}}{dt}$

Note (1) Method of adjusting input offset voltage



(1) Set e_{in} to equal OV.

(2) Adjust $R_V=10k\Omega$ so that e_o=OV.

DEFINTION OF ABBREVIATED TERMS

CMRR : Common phase signal rejection ratio. Ratio of output voltage against allowable common phase input voltage and ratio against differential gain.

G_V : Voltage gain. Ratio of output voltage against input voltage required to change the output voltage from OV to a fixed value in an open loop circuit.

I_{IB} : Input bias current. Average current supplied to two input pins when output voltage is set at OV.

I_{IO} : Input offset current. Difference of current supplied to two input pins when output voltage is set at OV.

Pd : Power dissipation. DC power required to set no load output at OV in quiescent state.

Rin : Input resistance. Resistance of an integrated circuit measured at one differential input pin by grounding the other input pin.

SR : Slew rate. Time in which output is increased from normal value of 10% to 90% against step input and ratio of the voltage (voltage between 10% to 90%).

SVRR : Supply voltage rejection ratio. Ratio of input offset voltage change to supply voltage change.

tr, K_{OV} : Transient response. Response against pulse in an open loop amplifier circuit.

V_{IC} : Common input voltage range. Common input voltage range in which an amplifier operates normally.

V_{IO} : Input offset voltage. Voltage between input pins when output voltage is set at OV.

V_{OPP} : Maximum output voltage width. Maximum output voltage obtained without being clipped.

M5216L, P, FP

DUAL LARGE-CURRENT OPERATIONAL AMPLIFIERS (DUAL POWER SUPPLY TYPE)

DESCRIPTION

The M5216 is a semiconductor integrated circuit disigned as a high-output and high-speed operational amplifier for use in high-performance headphone amplifiers and mizer amplifiers found in cassette decks.

The device comes in an 8-pin SIP, DIP or FP and it contains two circuits for yielding a high internally phase-compensated gain, a high current capacity and a high slew rate. It can be widely used as a general-purpose dual amplifier in electronic equipment. In addition, it can be used in a single power supply format and employed in conditions where the supply voltage is low. These are features which make this device ideal for headphone amplifiers in portable products.

FEATURES

- Large current capacity .... $I_{LP}=+100mA$
- High power output
  .... $P_O=40mW(typ.)(@V_{CC}=6V, R_L=32\Omega)$
  $P_O=27mW(typ.)$ $\left\{ \begin{array}{l} @V_{CC}=20V(\pm10V) \\ R_O+R_L=100\Omega+8\Omega \end{array} \right\}$
- High slew rate, high f_T ..... $SR=3.0V/\mu s$, $f_T=10MHz(typ.)$
- Low noise($R_S=1k\Omega$)FLAT .... $V_{NI}=1.8\mu Vrms(typ.)$
- Low supply voltage drive possible .... $V_{CC}\geq4V(\pm2V)$
- High allowable power .... $P_d=800mW(SIP)$
  $P_d=625mW(DIP)$, $P_d=440mW(FP)$

APPLICATION

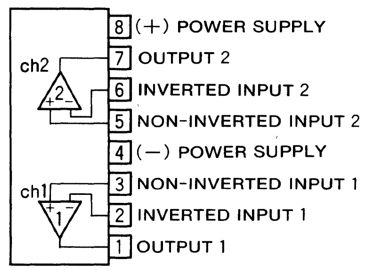
High-performance headphone amplifiers in VTRs, tape decks and stereo cassette tape recorders with bulit-in radios; also as a large current high speed, general-purpose operating amplifier in other electronic products and equipment.

RECCOMENDED OPERATING CONDITION

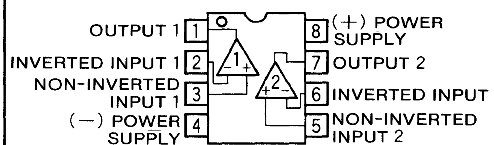
Supply voltage range ··· ±2V~±16V(dual power supply)
±4V~±32V(single power supply)
Rated supply voltage .... ±15V

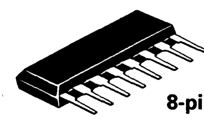
PIN CONFIGURATION (TOP VIEW)

SIP



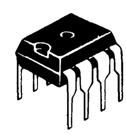
DIP, MINI FLAT





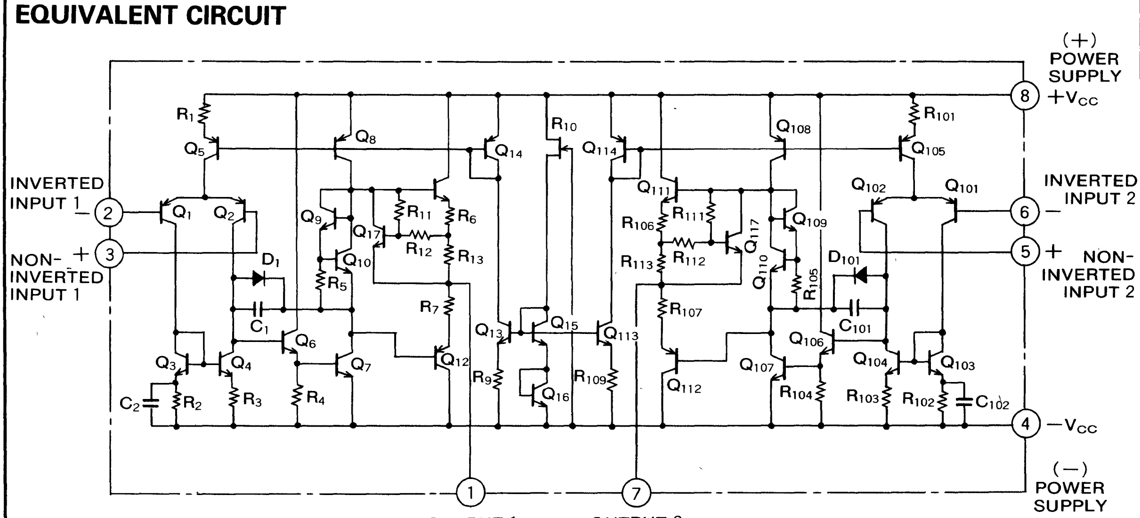
8-pin molded plastic SIP

8-pin molded plastic FP (MINI FLAT)



8-pin molded plastic DIP

EQUIVALENT CIRCUIT



DUAL LARGE-CURRENT OPERATIONAL AMPLIFIERS (DUAL POWER SUPPLY TYPE)

ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

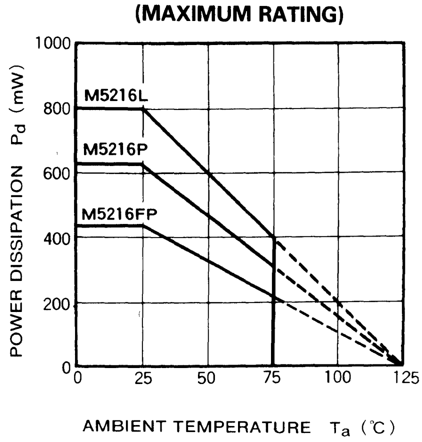
Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		±18	V
I_{LP}	Load current		±100	mA
V_{id}	Differential input voltage		±30	V
V_{ic}	Common input voltage		±15	V
P_d	Power dissipation		800(SIP)/625(DIP)/440(FP)	mW
K_θ	Thermal derating	$T_a \geqq 25$℃	8(SIP)/6.25(DIP)/4.4(FP)	mW/℃
T_{opr}	Ambient temperature		−20～+75	℃
T_{stg}	Storage temperature		−55～+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=±15V)

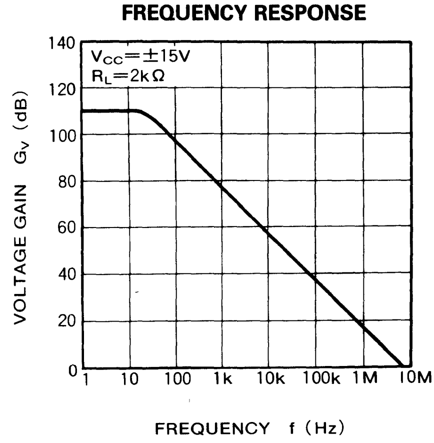
Symbol	Parameter	Test conditions	Limits Min	Limits Typ	Limits Max	Unit
I_{CC}	Circuit current	V_{in}=0		4.5	9.0	mA
V_{IO}	Input offset voltage	$R_S \leqq 10k\Omega$		0.5	6.0	mV
I_{IO}	Input offset current			5	200	nA
I_{IB}	Input bias current			180	500	nA
R_{in}	Input resistance		0.3	5		MΩ
G_{VO}	Open loop voltage gain	$R_L \geqq 2k\Omega$, V_O=±10V	86	110		dB
V_{OM}	Maximum output voltage	$R_L \geqq 10k\Omega$	±12	±13.5		V
		$R_L \geqq 2k\Omega$	±10.5	±11		
V_{CM}	Common input voltage width		±12	±14		V
CMRR	Common mode rejection ratio	$R_S \leqq 10k\Omega$	70	90		dB
SVRR	Supply voltage rejection ratio	$R_S \leqq 10k\Omega$		30	150	μV/V
P_d	Power dissipation			135	270	mW
SR	Slew rate	G_V=0dB, R_L=2kΩ		3.0		V/μs
f_T	Gain bandwidth product			10		MHz
V_{NI}	Input referred noise voltage	R_S=1kΩ, BW=10Hz～30kHz		1.8		μVrms

TYPICAL CHARACTERISTICS

THERMAL DERATING (MAXIMUM RATING)

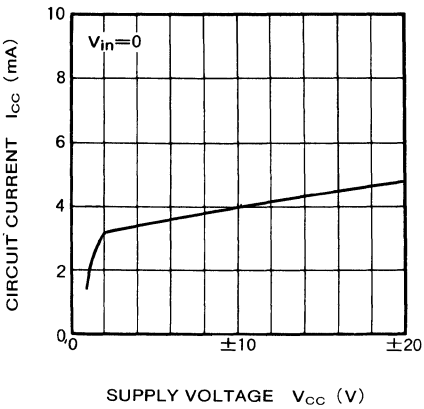


VOLTAGE GAIN VS. FREQUENCY RESPONSE

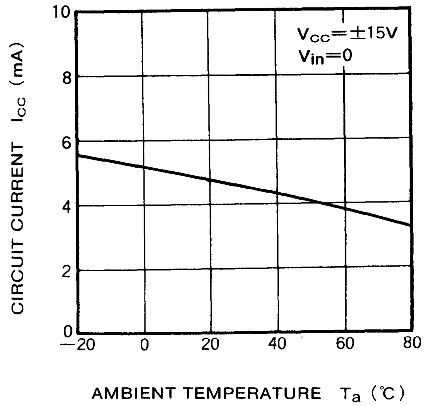


DUAL LARGE-CURRENT OPERATIONAL AMPLIFIERS (DUAL POWER SUPPLY TYPE)

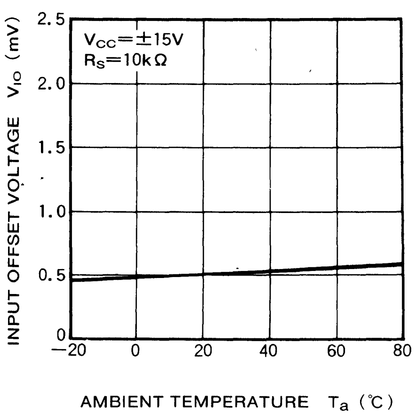
CIRCUIT CURRENT VS. SUPPLY VOLTAGE



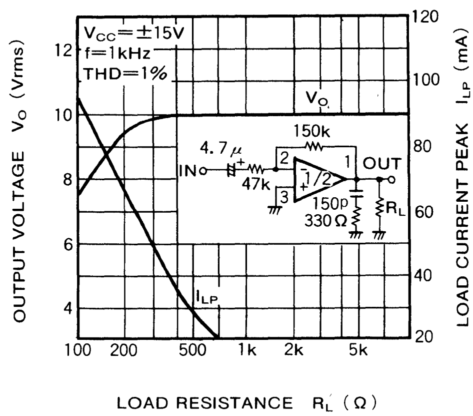
CIRCUIT CURRENT VS. AMBIENT TEMPERATURE



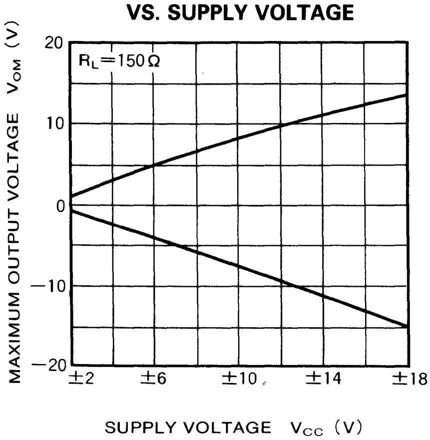
INPUT OFFSET VOLTAGE VS. AMBIENT TEMPERATURE



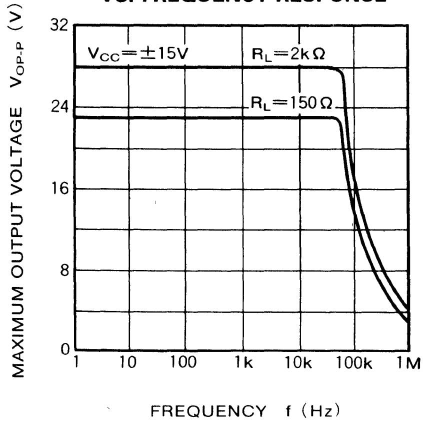
OUTPUT VOLTAGE / LOAD CURRENT PEAK VS. LOAD RESISTANCE



MAXIMUM OUTPUT VOLTAGE VS. SUPPLY VOLTAGE



MAXIMUM OUTPUT VOLTAGE VS. FREQUENCY RESPONSE

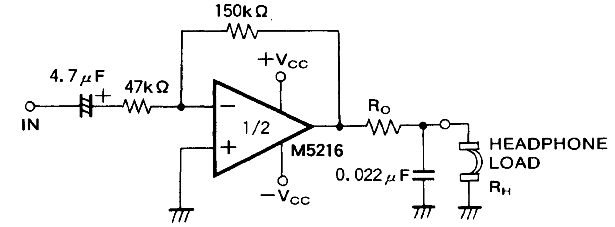


MITSUBISHI ELECTRIC

DUAL LARGE-CURRENT OPERATIONAL AMPLIFIERS (DUAL POWER SUPPLY TYPE)

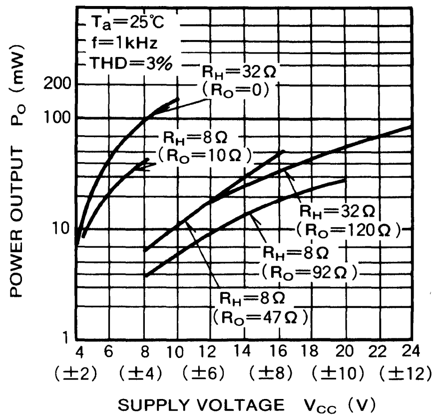
APPLICATION EXAMPLE FOR A HEADPHONE AMPLIFIER (DUAL POWER SUPPLY TYPE)

INVERTED INPUT TYPE



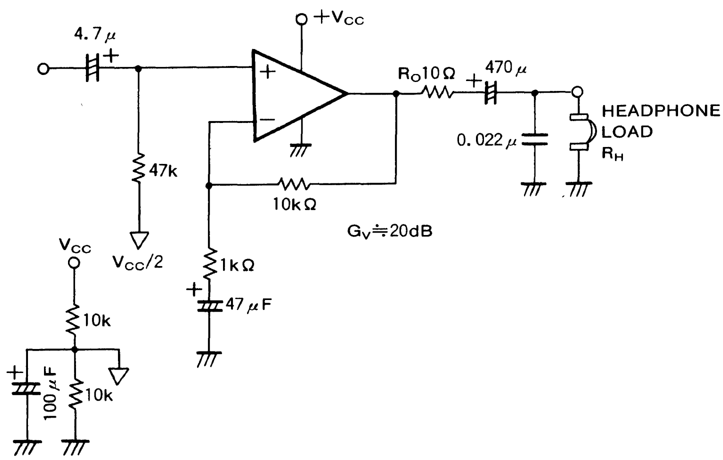
(Note) For a single power supply type, (+) input pin voltage level is shifted at $V_{CC}/2$ and output must be used by AC connection by means of a capacitor

HEADPHONE AMPLIFIER CIRCUIT $P_O - V_{CC}$ CHARACTERISTICS

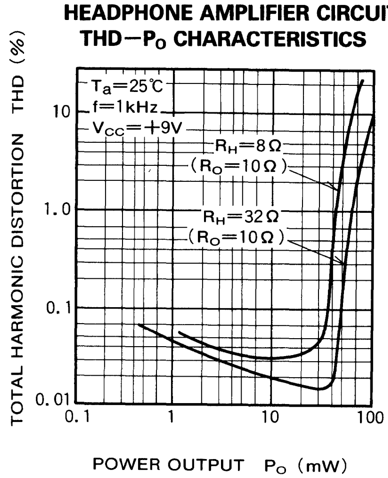


APPLICATION EXAMPLE FOR A HEADPHONE AMPLIFIER (SINGLE POWER SUPPLY TYPE)

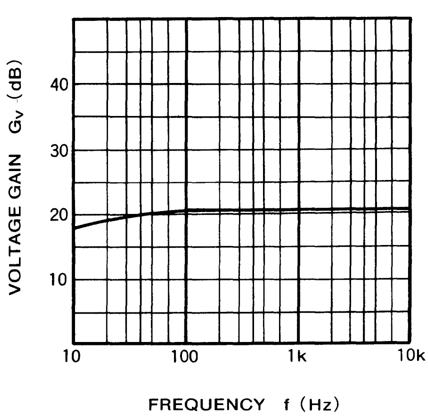
NON-INVERTED INPUT TYPE



HEADPHONE AMPLIFIER CIRCUIT THD$-P_O$ CHARACTERISTICS

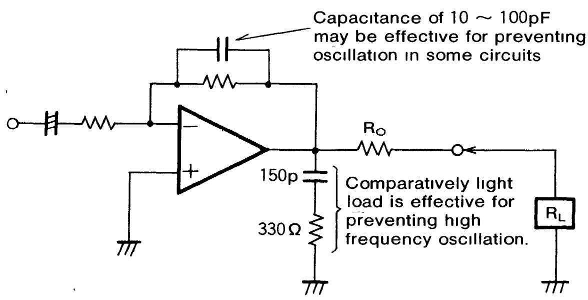


VOLTAGE GAIN VS. FREQUENCY RESPONSE



COUNTERMEASURE AGAINST OSCILLATION

If oscillation occurs due to load condition, substrate wiring condition, instability of power supply after the M5216 is mounted on the equipement, the following preventative circuit is recommended.



R_O is recommended because it is effective for preventing capacitative load oscillation and controlling current when load is shorted.

M5218L, P, FP/M5R4558P

DUAL LOW-NOISE OPERATIONAL AMPLIFIERS (DUAL POWER SUPPLY TYPE)

DESCRIPTION

The M5218/M5R4558P are simiconductor integrated circuits designed for a low noise preamplifier in audio equipment and a general-purpose operational amplifier in other electronic equipment. Two low noise operational amplifier circuits displaying internal phase-compensated high gain and low distortion are contained in an 8-pin SIP, DIP or FP for application over a wide rage as a general-purpose dual amplifier in general electronic equipment.

The devices have virtually the same characteristics as the 4557, 4558, 4559 and 741 operational amplifiers.

The units can also be used as a single power supply type and amplifier in portable equipment. It is also suitable as a headphone amplifier because of its high load current.

FEATURES

- High gain, low distortion ························· G_{VO}=110dB, THE=0.0015%(typ.)
- High slew rate, high f_T ································ SR=2.2V/μs, f_T=7MHz(typ.)
- Low noise(R_S=1kΩ)FLAT ··············· V_{NI}=2μVrms(typ.)
  RIAA ··············· V_{NI}=1μVrms(typ.)
- Operation with low supply voltage ··· V_{CC}≧4V(±2V)
- High load current, high power dissipation ······························ I_{IP}=±50mA, P_d=800mW(SIP)
  P_d=625mW(DIP), P_d=440mW(FP)

APPLICATION

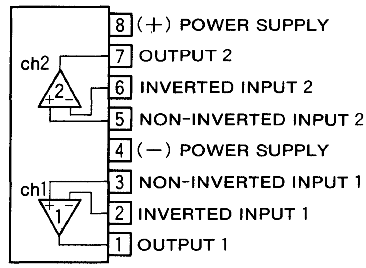
General-purpose amplifier in stereo equipment, tape decks, and radio stereo cassette recorders; active filters, servo amplifiers, operational circuits in other general electronic equipment.

RECOMMENDED OPERATING CONDITIONS

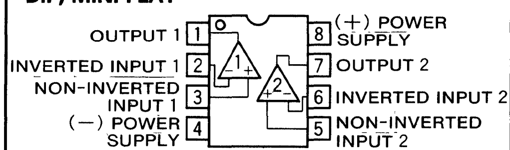
Supply voltage range ······························· ±2~±16V
Rated supply voltage ······································ ±15V

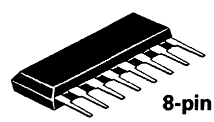
PIN CONFIGURATION (TOP VIEW)

SIP

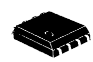


DIP, MINI FLAT

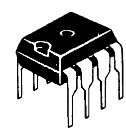




8-pin molded plastic SIP

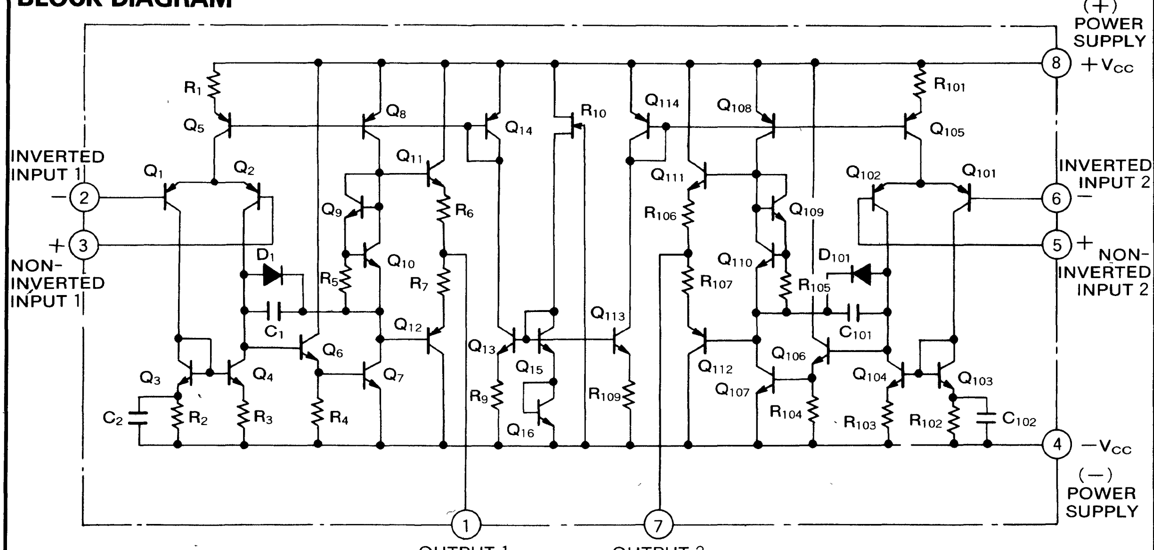


8-pin molded plastic FP (MINI FLAT)



8-pin molded plastic DIP

BLOCK DIAGRAM



DUAL LOW-NOISE OPERATIONAL AMPLIFIERS (DUAL POWER SUPPLY TYPE)

ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

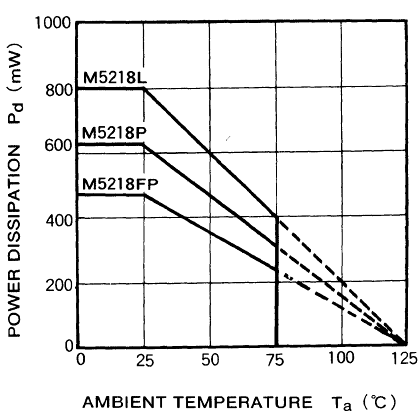
Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		±18	V
I_{LP}	Load current		±50	mA
V_{id}	Differential input voltage		±30	V
V_{ic}	Common input voltage		±15	V
P_d	Power dissipation		800(SIP)/625(DIP)/440(FP)	mW
K_θ	Thermal dirating	$T_a \geqq 25$℃	8(SIP)/6.25(DIP)/4.4(FP)	mW/℃
T_{opr}	Ambient temperature		−20~+75	℃
T_{stg}	Storage temperature		−55~+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=±15V)

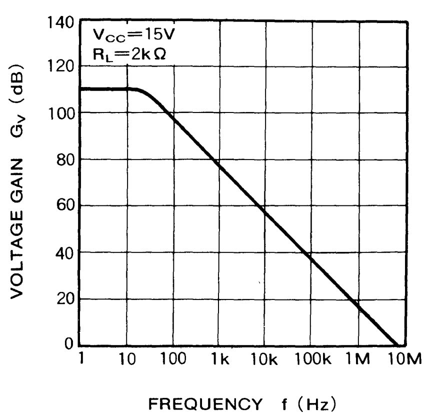
Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
I_{CC}	Circuit current	V_{in}=0		3.0	6.0	mA
V_{IO}	Input offset voltage	$R_S \leqq 10k\Omega$		0.5	6.0	mV
I_{IO}	Input offset current			5	200	nA
I_{IB}	Input bias current				500	nA
R_{in}	Input resistance		0.3	5		MΩ
G_{VO}	Open loop voltage gain	$R_L \geqq 2k\Omega$, V_O=±10V	86	110		dB
V_{OM}	Maximum output voltage	$R_L \geqq 10k\Omega$	±12	±14		V
		$R_L \geqq 2k\Omega$	±10	±13		
V_{CM}	Common input voltage range		±12	±14		V
CMRR	Common mode rejection ratio	$R_S \leqq 10k\Omega$	70	90		dB
SVRR	Sypply voltage	$R_S \leqq 10k\Omega$		30	150	μV/V
P_d	Power dissipation			90	180	mW
SR	Slew rate	G_V=0dB, R_L=2kΩ		2.2		V/μs
f_T	Gain bandwidth product			7		MHz
V_{NI}	Input referred noise voltage	R_S=1kΩ, BW.10Hz~30kHz		2.0		μVrms

TYPICAL CHARACTERISTICS

THERMAL DERATING (MAXIMUM RATING)

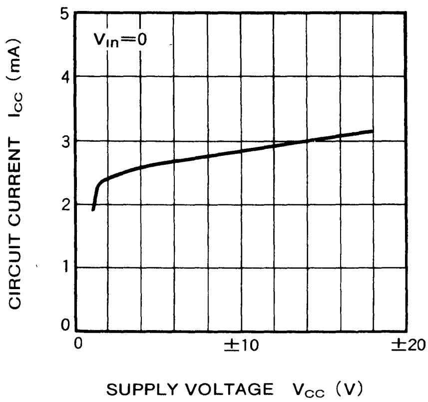


VOLTAGE GAIN VS. FREQUENCY RESPONSE

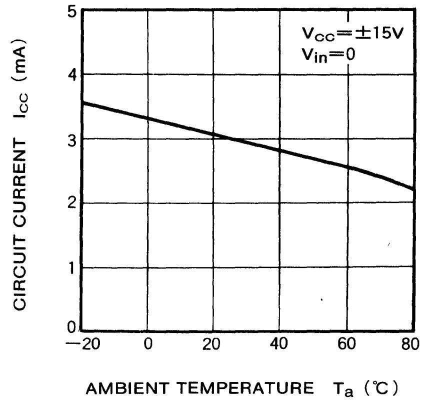


DUAL LOW-NOISE OPERATIONAL AMPLIFIERS (DUAL POWER SUPPLY TYPE)

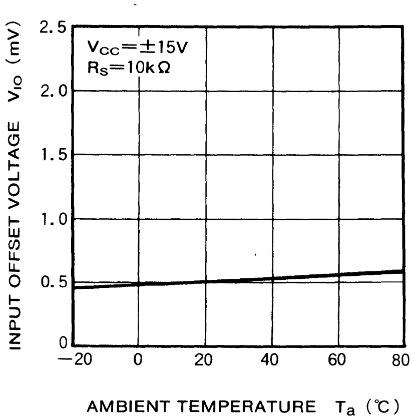
CIRCUIT CURRENT VS. SUPPLY VOLTAGE



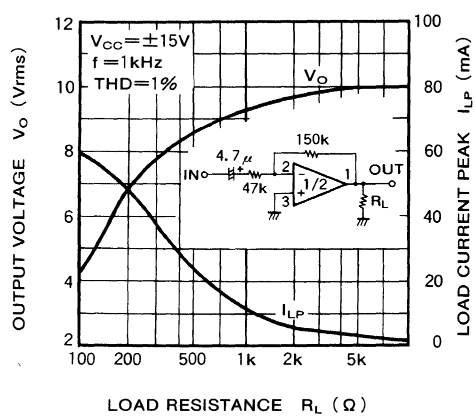
CIRCUIT CURRENT VS. AMBIENT TEMPERATURE



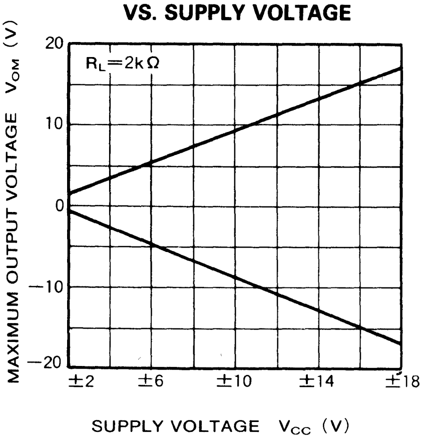
INPUT OFFSET VOLTAGE VS. AMBIENT TEMPERATURE



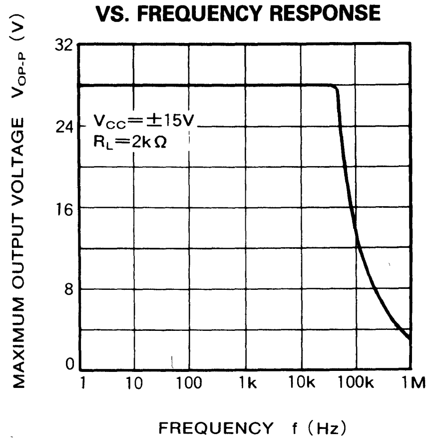
OUTPUT VOLTAGE / LOAD CURRENT PEAK VS. LOAD RESISTANCE



MAXIMUM OUTPUT VOLTAGE VS. SUPPLY VOLTAGE



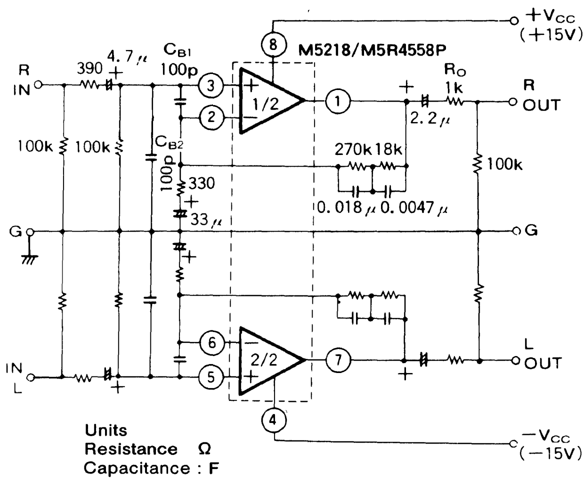
MAXIMUM OUTPUT VOLTAGE VS. FREQUENCY RESPONSE



DUAL LOW-NOISE OPERATIONAL AMPLIFIERS (DUAL POWER SUPPLY TYPE)

APPLICATION EXAMPLES

(1) Stereo Equalizer amplifier circuit

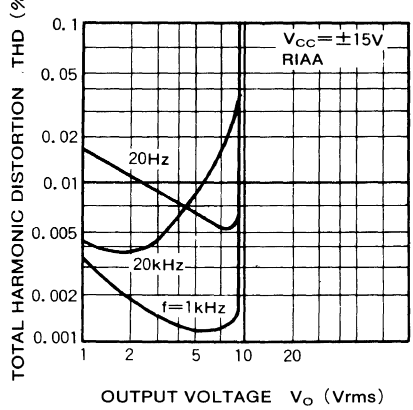


Left channel circuit constants are identical to those of right channel.
C_{B1}, C_{B2} : Capacitors for buzz prevention, use if required.
R_O : Resistor used to prevent parasitic oscillation for capacitive loads and current limiting with shorted and other abnormal load conditions.

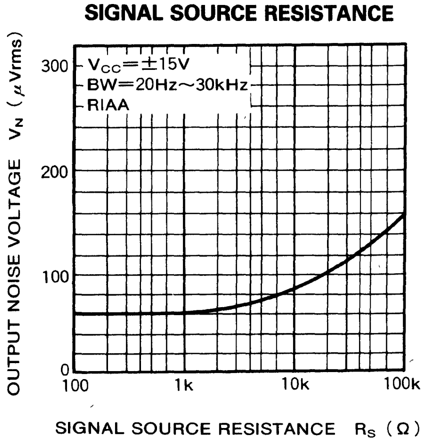
TYPICAL CHARACTERISTICS (V_{CC}=±15V, RIAA)

- G_V=35.6dB(f=1kHz)
- V_{NI}=1μVrms(R_S=1kΩ, BW=20Hz~30kHz)
- Signal-to-noise=72.5dB (IHF-A network, shorted input, 2.5mVrms input sensitivity)
- THD=0.0015%(f=1kHz, V_O=3Vrms)

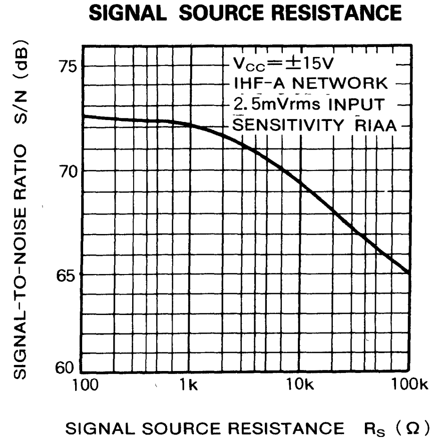
TOTAL HARMONIC DISTORTION VS. OUTPUT VOLTAGE



OUTPUT NOISE VOLTAGE VS. SIGNAL SOURCE RESISTANCE

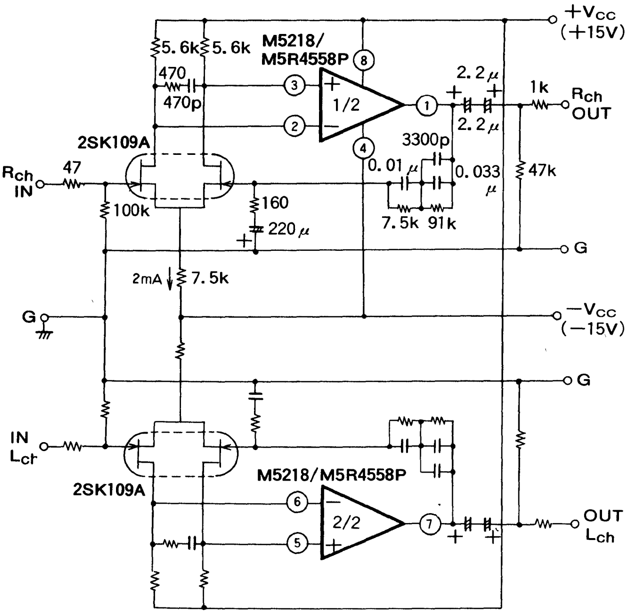


SIGNAL-TO-NOISE RATIO VS. SIGNAL SOURCE RESISTANCE



DUAL LOW-NOISE OPERATIONAL AMPLIFIERS (DUAL POWER SUPPLY TYPE)

(2) High S / N stereo DC ICL equalizer



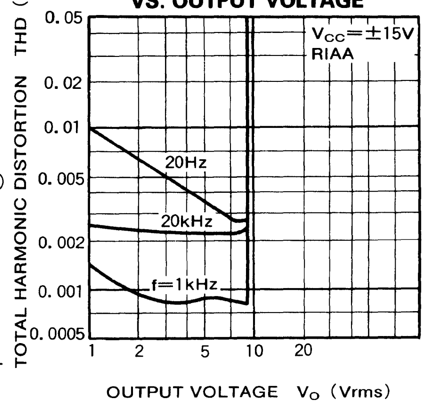
Units Resistance : Ω
Capacitance F

Left channel circuit constants are identical to those of right channel.

TYPICAL CHARACTERISTICS ($V_{CC}=\pm15V$, RIAA)

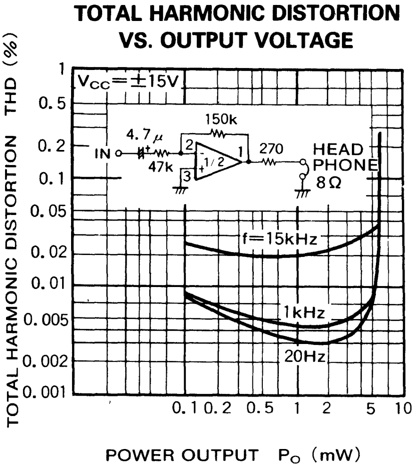
- Signal-to-noise=72.5dB (IHF-A network, shorted input, 2.5mVrms input sensitivity)
- $V_{NI}=0.77\mu Vrms(R_S=5.1k\Omega, BW=5Hz\sim100kHz)$
- $G_V=35.6dB(f=1kHz)$

TOTAL HARMONIC DISTORTION VS. OUTPUT VOLTAGE

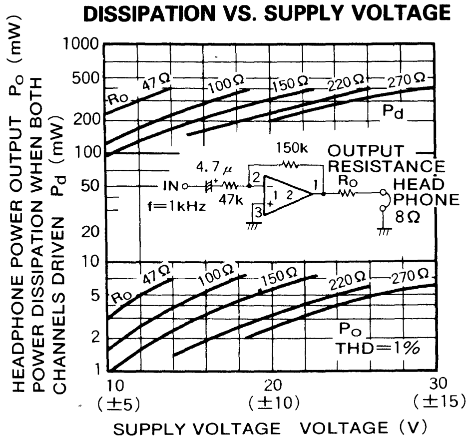


(3) Headphone amplifier

TOTAL HARMONIC DISTORTION VS. OUTPUT VOLTAGE



(Output resistance R_O is made the parameter) POWER OUTPUT / POWER DISSIPATION VS. SUPPLY VOLTAGE



MITSUBISHI ELECTRIC

M5223L, P, FP/M5N358P

DUAL SINGLE POWER SUPPLY OPERATIONAL AMPLIFIERS

DESCRIPTION

The M5223/M5N358P are semiconductor integrated circuits designed as dual operational amplifiers which permit signle power supply operation.

The devices come in a compact 8-pin SIP, DIP or FP and contain two sircuits for yielding a high internal phase compensation and high performance. For both input and output, operation is possible from the GND level and this makes it possible for the divice to be used widely as a general-purpose operational amplifier in the motor control circuits of such equipment as cassette decks, turntables, VTRs and digital audio disc players as well as in automotive electronic products and communications equipment. It can also be employed as a simple comparator.

FEATURES

- Wide common input voltage range and operation permitted with GND level input ·········· $V_I=-0.3V\sim+36V$
- Output voltage level can be reduced to near the GND level
- Wide operating supply voltage range and single power supply operation possible ·········· $V_{CC}=3V\sim36V(V_{CCmax})$
- High voltage gain ···························· $G_{VO}=110dB$(typ.)
- High allowable power dissipation ········ $P_d=800mW$(SIP)
  $P_d=625mW$(DIP)
  $P_d=440mW$(FP)

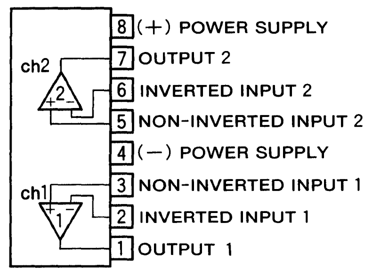
APPLICATION

General-purpose amplifier in control circuits of cassette decks, turntable, VTRs, video disc players and audio disc players; general-purpose amplifier in automotive electronic products, communications equipment and copying machines.

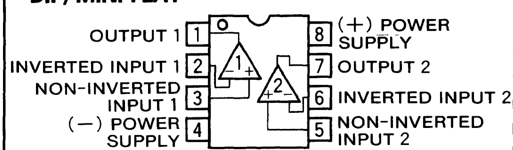
General-purpose amplifier in radio-controlled and electronic toys, and electronic games.

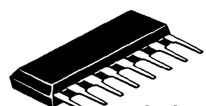
PIN CONFIGURATION (TOP VIEW)

SIP



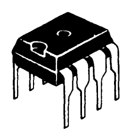
DIP, MINI FLAT





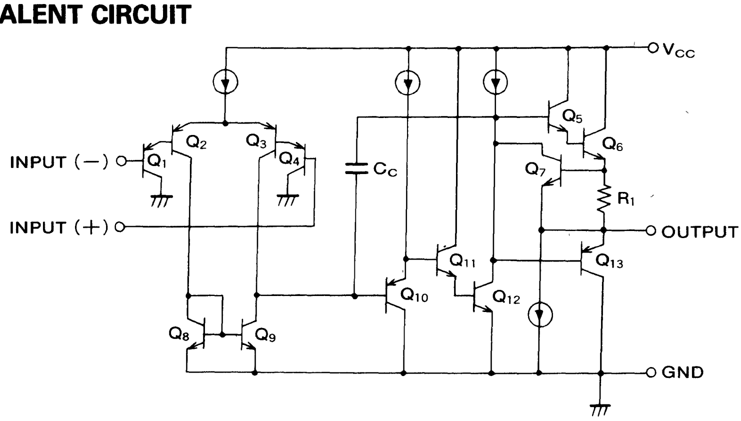
8-pin molded plastic SIP

8-pin molded plastic FP (MINI FLAT)



8-pin molded plastic DIP

EQUIVALENT CIRCUIT



∗ Two circuits are featured in the circuit on the left

DUAL SINGLE POWER SUPPLY OPERATIONAL AMPLIFIERS

ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

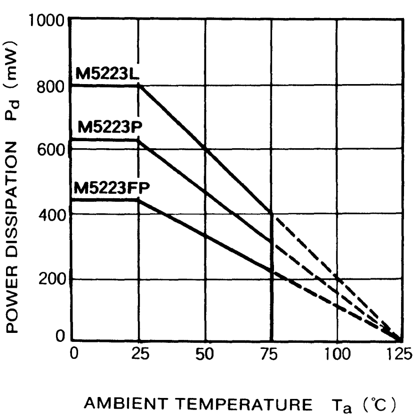
Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		36(±18)	V
I_{sink}	Load current		±50	mA
I_{source}				mA
V_{id}	Differential input voltage		±36	V
V_I	Input voltage		−0.3～+36	V
P_d	Power dissipation		800(SIP)/625(DIP)/440(FP)	mW
K_θ	Thermal derating	$T_a \geq 25$℃	8(SIP)/6.25(DIP)/4.4(FP)	mW/℃
T_{opr}	Ambient temperature		−20～+75	℃
T_{stg}	Storage temperature		−55～+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=+5V)

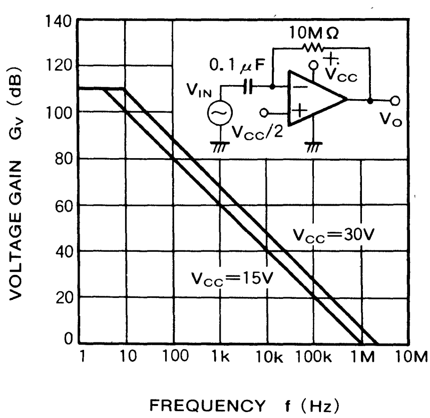
Symbol	Parameter	Test conditions	Limits Min	Limits Typ	Limits Max	Unit
I_{CC}	Circuit current	V_{in}=0		0.7	1.5	mA
V_{IO}	Input offset voltage	R_S=50Ω, V_{CM}=7.5V		2	7	mV
I_{IO}	Input offset current	$\lvert I_{B(+)}-I_{B(-)}\rvert$, V_{CM}=7.5V		5	50	nA
I_{IB}	Input bias current	V_{CM}=7.5V		30	250	nA
CSR	Channel separation	f=1kHz		120		dB
G_{VO}	Open loop voltage gain	$R_L \geq 2$kΩ, V_{CM}=7.5V	90	110		dB
V_{OH}	Maximum output voltage	$R_L \geq 2$kΩ	12.0	13.5		V
V_{OL}		$R_L \geq 2$kΩ		0.9	1.8	
V_{CM}	Common phase input voltage width	R_S=1kΩ, f=100Hz	−0.3		+13.5	V
CMRR	Common phase rejection ratio	R_S=50Ω, V_{CM}=7.5V		85		dB
SVRR	Supply voltage rejection ratio	R_S=50Ω		100		dB
P_d	Power dissipation			10.5	22.5	mW
SR	Slew rate	G_V=0dB, R_L=2kΩ		0.6		V/μs
I_{source}	Output source current	$V_{IN(-)}$=0V, $V_{IN(+)}$=1V	20	40		mA
I_{sink}	Output sink current	$V_{IN(-)}$=1V, $V_{IN(+)}$=0V	10	20		mA

TYPICAL CHARACTERISTICS

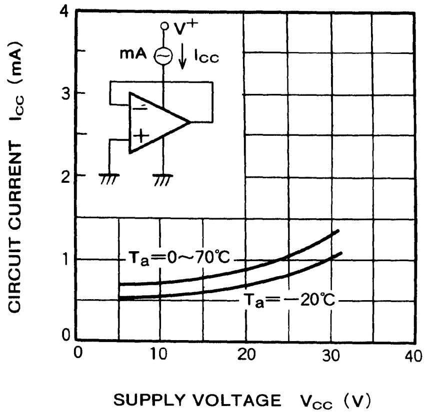
THERMAL DERATING (MAXIMUM RATING)



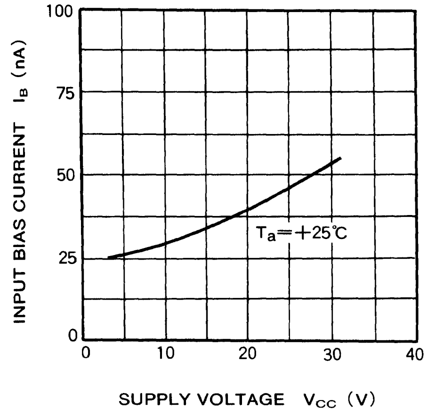
VOLTAGE GAIN VS. FREQUENCY RESPONSE



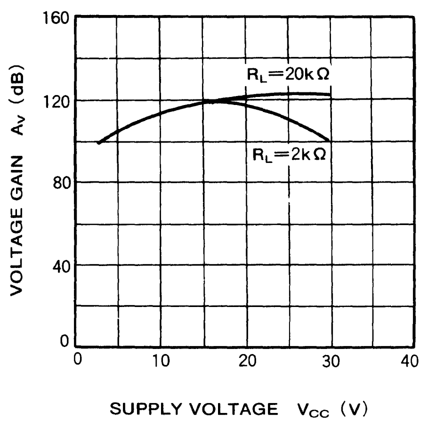
CIRCUIT CURRENT VS. SUPPLY VOLTAGE



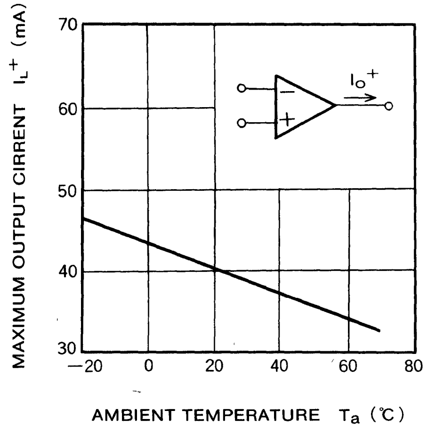
INPUT BIAS CURRENT VS. SUPPLY VOLTAGE



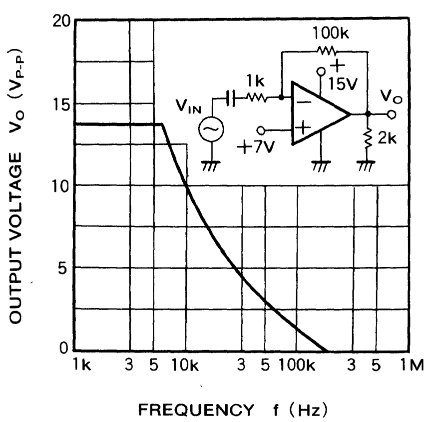
VOLTAGE GAIN VS. SUPPLY VOLTAGE



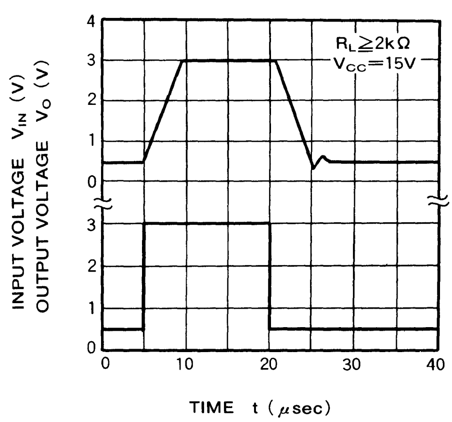
MAXIMUM OUTPUT CURRENT VS. AMBIENT TEMPERATURE



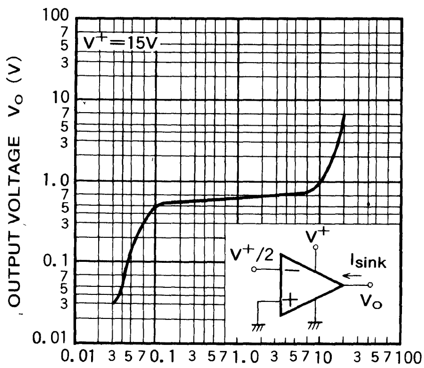
MAXIMUM OUTPUT VOLTAGE VS. FREQUENCY RESPONSE



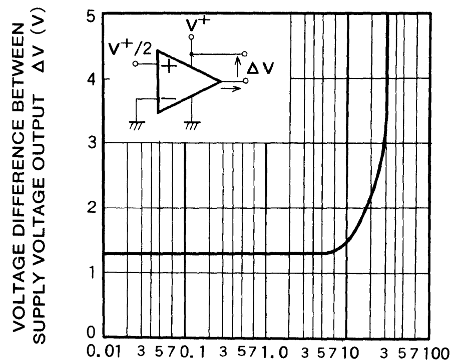
INPUT VOLTAGE / OUTPUT VOLTAGE VS. TIME



V_O VS. I_{sink} CHARACTERISTICS



ΔV VS. I_{source} CHARACTERISTICS



BASIC OPERATION OF SINGLE POWER SUPPLY OPERATIONAL AMPLIFIER

The M5223/M5N358P is an operational amplifier that operates from 0V (GND) level for both input and output if used at a single-power supply voltage.

Basic operation of the device is explained in the following, comparing characteristics of the operational amplifier M5218/M5R4558P.

Dual power supply operational amplifier

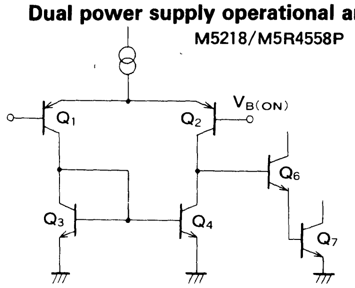


Fig. 1

Single power supply operational amplifier

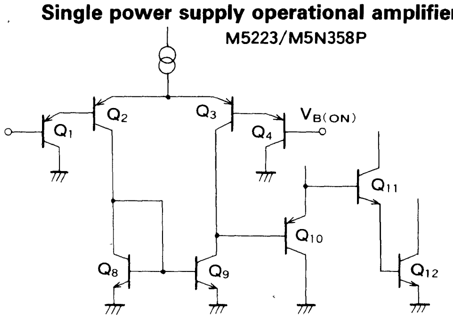


Fig. 2

Fig. 1 illustrates the dual power supply operational amplifier M5218/M5R4558P, and Fig. 2 illustrates an input differential circuit of the single power supply operational amplifier M5223/M5N358P. In this case, the input stage base voltage $V_{B(ON)}$ for operating an input differential circuit in the M5218/M5R4558P is as follow;

$$V_{B(ON)} = V_{BE}7 + V_{BE}6 + V_{CE}2 - V_{BE}2$$

$$(\text{If } V_{BE} \fallingdotseq 0.6V,\ V_{CE} \fallingdotseq 0.5V)$$

$$\fallingdotseq 1.1V$$

and, in the M5223/M5N358P,

$$V_{B(ON)} = V_{BE}12 + V_{BE}11 - V_{BE}10 + V_{CE}3 - V_{BE}3 - V_{BE}4$$

$$\fallingdotseq 1.1V$$

and, in the M5223/M5N358P, the differential circuit is activated even when the input level is 0V. The input and output characteristics are shown in Fig. 3.

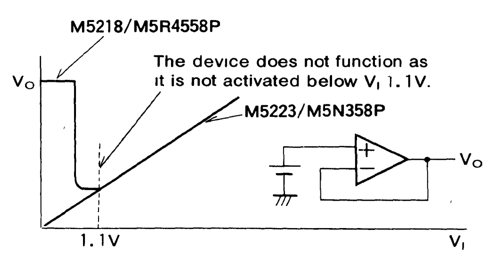


Fig. 3

Operation of an output stage is explained in the following.

M5218/M5R4558P

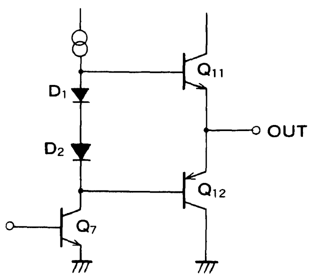


Fig. 4

M5223/M5N358P

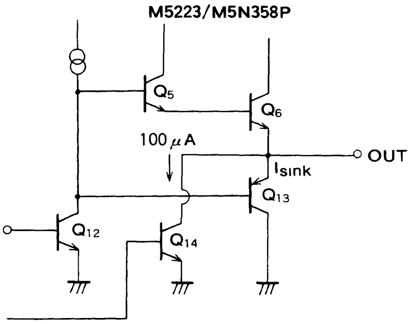


Fig. 5

Fig. 4 illustrates an output stage of the M5218/M5R4558P, which adopts and AB-class push-pull circuit of ordinary operational amplifier output type, where no crossover distortion occurs because idling current is running from D_1, D_2 bias to Q_{11}, Q_{12} in quiescent state. In this case, the output never goes below the level of $V_{BE}12+V_{CE}7$, and the device is activated up to a voltage of approximately 1.1V. Moreover, the voltage changes greatly according to conditions of load current.

Fig. 5 illustrates the M5223/M5N358P, to which rated current circuit of $I_C \fallingdotseq 100\mu A$ is connected by Q_{14} and the output can be reduced to near GND level as A-class bias output stage up to the current of 100μA. For a load in excess of this current, in case of the M5223/M5N358P driven by Q_{13}, no idling current is present because of C-class bias (where the base of output transistors Q_5, Q_6, Q_{13} is shorted), and crossover distortion occurs. Therefore, the device may not be suitable for audio signal amplifiers.

Both single and dual power supply amplifiers operate exactly with the same operating circuit logic (activation level of input and output and load driving methods are different), but bias must be set at $V_{CC}/2$ for output DC current in both single and dual power supply amplifiers.

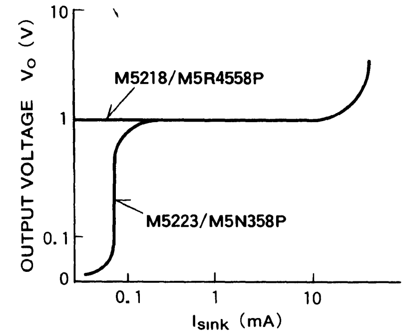


Fig. 6

REDUCTION OF DISTORTION IN A SINGLE POWER SUPPLY OPERATIONAL AMPLIFIER

As has been explained previously, a single power supply operational amplifier operates with low distortion as an A-class bias circuit up to a load condition that can be driven by current (100μA) in a rated current curcuit which is built in the output stage, and it can be used for audio signals but, if the load condition exdeeds the value of current, the device is placed into a C-class bias condition, and crossover destortion occurs. To reduce this distortion, a pull-up resistor (e.g. 3kΩ) for running A-class bias current externally can be connected as shown in Fig. 7 to increase the A-class bias current and reduce distortion. (Refer to Fig. 8 DISTORTION VS OUTPUT VOLTAGE.)

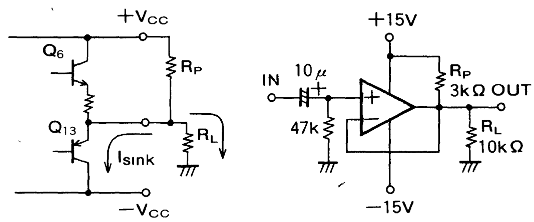


Fig. 7 (Explanation by dual power supply method)

TOTAL HARMONIC DISTORTION VS. OUTPUT VOLTAGE

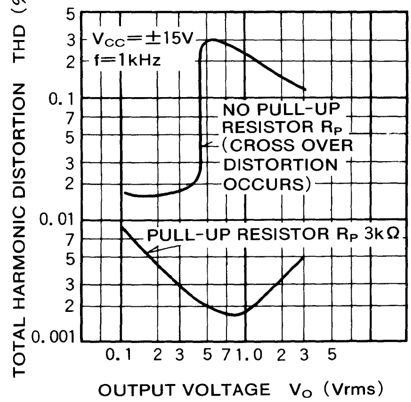


Fig. 8

M5224P, FP/M5N324P

QUAD SINGLE POWER SUPPLY OPERATIONAL AMPLIFIERS

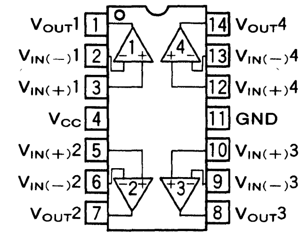
DESCRIPTION

The M5224/M5N324P are semiconductor integrated circuits designed as quad operational amplifiers in which single power supply operation is possible.

The devices come in a standard 14-pin DIP, FP and contain four circuits for yielding a high internal phase compensation and high performance. For both input and output, operation is possible from the GND level and this makes it possible for the device to be used widely as a general-purpose operational amplifier in the motor control circuits of such equipment as cassette decks, turntables, VTRs and digital audio disc players as well as in automotive electronic products and communications equipment. It can be also employed as a simple comparator.

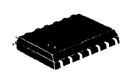
PIN CONFIGURATION (TOP VIEW)

DIP, MINI FLAT

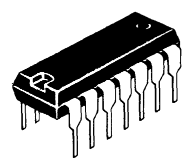


FEATURES

- Wide common input voltage range and operation permitted with GND level input ·········· $V_I = -0.3V \sim +36V$
- Output voltage level can be reduced to near the GND level
- Wide operating supply voltage range and single power supply operation possible ········ $V_{CC} = 3V \sim +36V (V_{CCmax})$
- High voltage gain ···························· $G_{VO} = 110dB$ (typ.)
- High allowable power dissipation
  ···························· $P_d = 700mW$ (M5224P/M5N324P)
  $P_d = 550mW$ (M5224FP)



14-pin molded plastic FP (MINI FLAT)



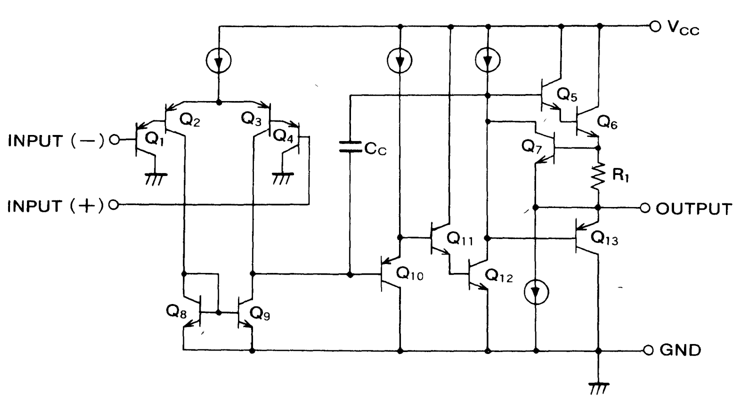
14-pin molded plastic DIP

APPLICATION

General-purpose amplifier in control circuits of cassette decks, turntable, VTRs, video disc players and audio disc players; general-purpose amplifier in automotive electronic products, communications equipment and copying machines.

General-purpose amplifier in radio-controlled and electronic toys, and electronic games.

EQUIVALENT CIRCUIT



* Four circuits are featured in the circuit on the left

QUAD SINGLE POWER SUPPLY OPERATIONAL AMPLIFIERS

ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

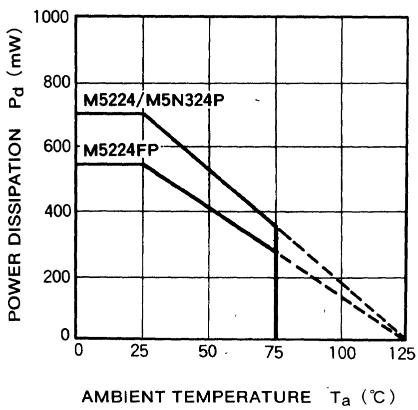
Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		36(±18)	V
I_{sink}	Load current		±50	mA
I_{source}				mA
V_{id}	Differential input voltage		±36	V
V_i	Input voltage		−0.3～+36	V
P_d	Power dissipation		700(DIP)/550(FP)	mW
K_θ	Thermal derating	T_a≧25℃	7(DIP)/5.5(FP)	mW/℃
T_{opr}	Ambient temperature		−20～+75	℃
T_{stg}	Storage temperature		−55～+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=+15V)

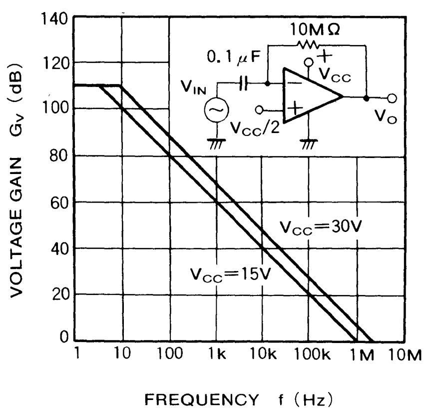
Symbol	Parameter	Test conditions	Limits Min	Typ	Max	Unit
I_{CC}	Circuit current	V_{in}=0		1.2	2.5	mA
V_{IO}	Input offset voltage	R_S=50Ω, V_{CM}=7.5V		2	7	mV
I_{IO}	Input offset current	$\|I_{B(+)}-I_{B(-)}\|$, V_{CM}=7.5V		5	50	nA
I_{IB}	Input bias current	V_{CM}=7.5V		30	250	nA
CSR	Channel separation	f=1kHz		120		dB
G_{VO}	Open loop voltage gain	R_L≧2kΩ, V_{CM}=7.5V	90	110		dB
V_{OH}	Maximum output voltage	R_L≧2kΩ	12.0	13.5		V
V_{OL}		R_L≧2kΩ		0.9	1.8	
V_{CM}	Common phase input voltage width	R_S=1kΩ, f=100Hz	−0.3		+13.5	V
CMRR	Common phase rejection ratio	R_S=50Ω, V_{CM}=7.5V		85		dB
SVRR	Supply voltage rejection ratio	R_S=50Ω		100		dB
P_d	Power dissipation			18	37.5	mW
SR	Slew rate	G_V=0dB, R_L=2kΩ		0.6		V/μs
I_{source}	Output source current	$V_{IN(-)}$=0V, $V_{IN(+)}$=1V	20	40		mA
I_{sink}	Output sink current	$V_{IN(-)}$=1V, $V_{IN(+)}$=0V	10	20		mA

TYPICAL CHARACTERISTICS

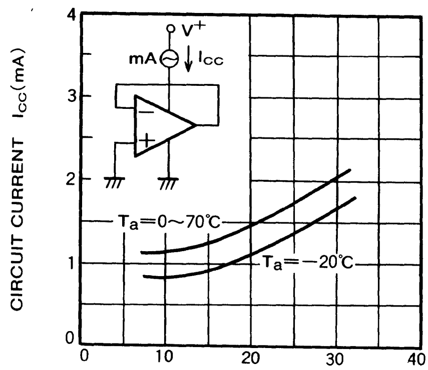
THERMAL DERATING (MAXIMUM RATING)



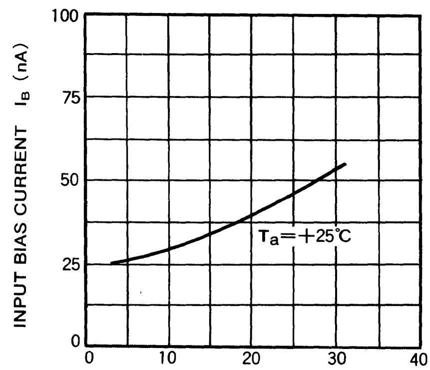
VOLTAGE GAIN VS. FREQUENCY RESPONSE



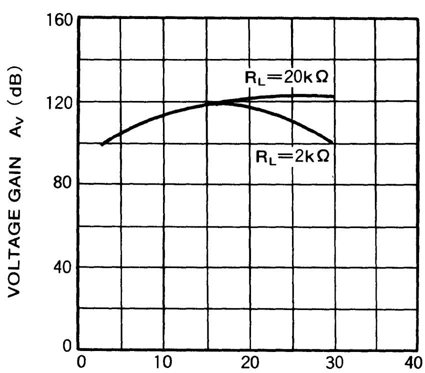
CIRCUIT CURRENT VS. SUPPLY VOLTAGE



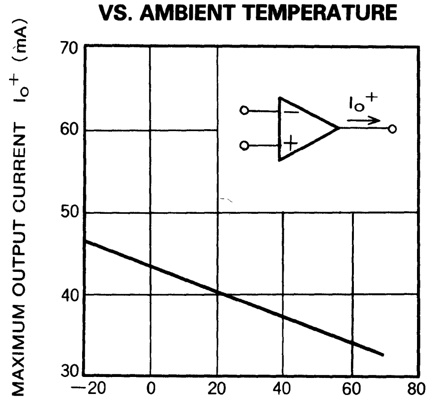
INPUT BIAS CURRENT VS. SUPPLY VOLTAGE



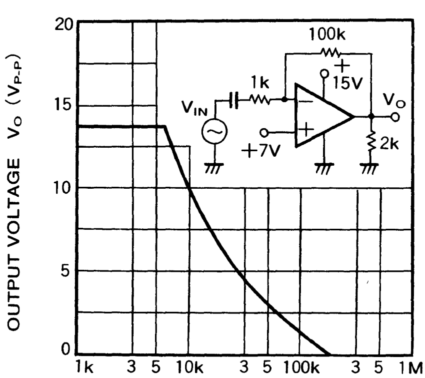
VOLTAGE GAIN VS. SUPPLY VOLTAGE



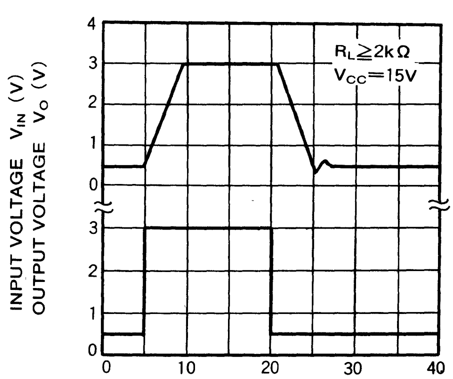
MAXIMUM OUTPUT CURRENT VS. AMBIENT TEMPERATURE



MAXIMUM OUTPUT VOLTAGE VS. FREQUENCY RESPONSE

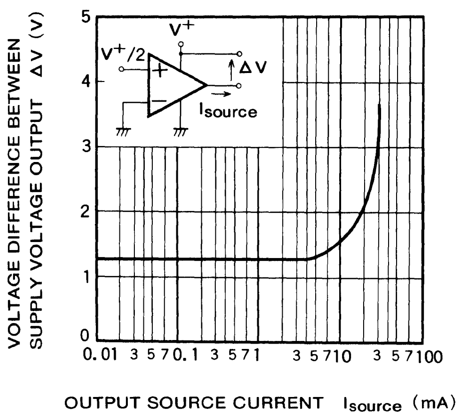


INPUT VOLTAGE / OUTPUT VOLTAGE VS. TIME

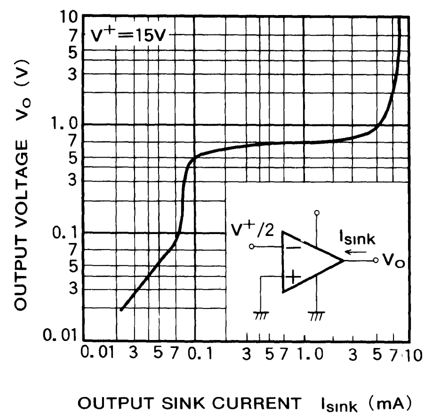


QUAD SINGLE POWER SUPPLY OPERATIONAL AMPLIFIERS

ΔV VS. I_{source} CHARACTERISTICS



V_O VS. I_{sink} CHARACTERISTICS



BASIC OPERATION OF SINGLE POWER SUPPLY OPERATIONAL AMPLIFIER

The M5224/M5N324P is an operational amplifier that operates from 0V (GND) level for both input and output if used at a single power supply voltage.

Basic operation of the device is explained in the following, comparing characteristics of the operational amplifier M5218/M5R4558P.

Dual power supply operational amplifier

M5218/M5R4558P

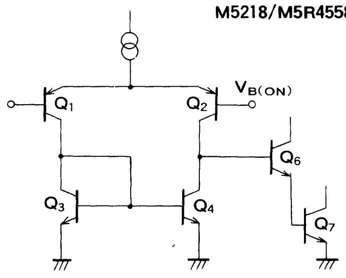


Fig. 1

Single power supply operational amplifier

M5224/M5N324P

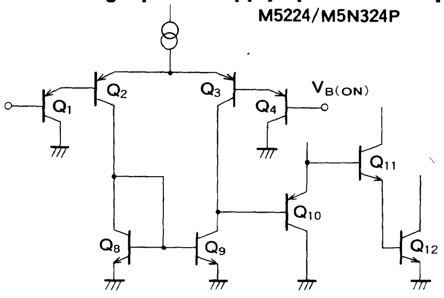


Fig. 2

Fig. 1 illustrates the dual power supply operational amplifier M5218/M5R4558P, and Fig. 2 illustrates an input differential circuit of the single power supply operational amplifier M5224/M5N324P. In this case, the input stage base voltage $V_{B(ON)}$ for operating an input differential circuit in the M5218/M5R4558P is as follow;

$$V_{B(ON)} = V_{BE}7 + V_{BE}6 + V_{CE}2 - V_{BE}2$$

$$(\text{If } V_{BE} \fallingdotseq 0.6V,\ V_{CE} \fallingdotseq 0.5V)$$

$$\fallingdotseq 1.1V$$

and, in the M5224/M5N324P,

$$V_{B(ON)} = V_{BE}12 + V_{BE}11 - V_{BE}10 + V_{CE}3 - V_{BE}3 - V_{BE}4$$

$$\fallingdotseq -0.1V$$

and, in the M5224/M5N324P, the differential circuit is activated even when the input level is 0V. The input and output characteristics are shown in Fig. 3.

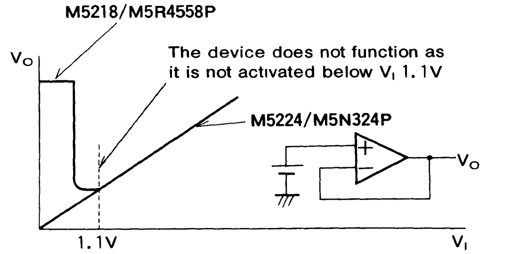


Fig. 3

Operation of an output stage is explained in the following.

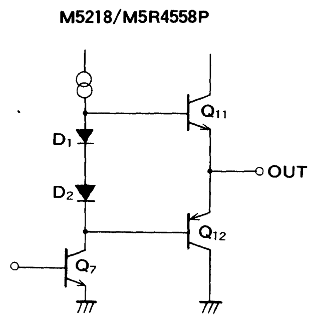


Fig. 4

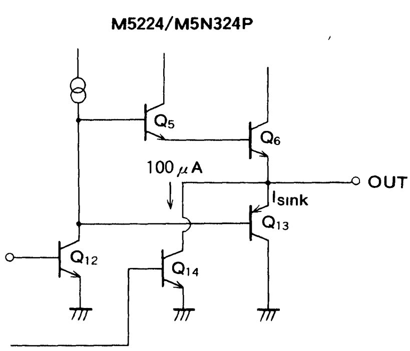


Fig. 5

Fig. 4 illustrates an output stage of the M5218/ M5R4558P, which adopts an AB-class push-puss circuit of ordinary operational amplifier output type, where no crossover distortion occurs because idling current is running from D_1, D_2 bias to Q_{11}, Q_{12} in quiescent state. In this case, the output never reaches below the level of $V_{BE}12+V_{CE}7$, and the device is activated up to voltage of approximately 1.1V. Moreover, the voltage changes greatly according to conditions of load current.

Fig. 5 illustrates the M5224/M5N324P, to which rated current circuit of $I_C \fallingdotseq 100\mu A$ is connected by $Q_{14}$and the output can be reduced to near GND level as A-class bias output stage up to the current of 100μA. For a load in excess of this current, is case of the M5224/ M5N324P driven by Q_{13}, no idling current is present because of C-class bias (where the base of output transistors Q_5, Q_6, Q_{13} are shorted), and crossover distortion occurs. Therefore, the device may not be suitable for audio signal amplifiers.

Both single and dual power supply amplifiers operate exactly with the same operating circuit logic (activation level of input and output and load driving methods are different), but bias must be set at $V_{CC}/2$ for output DC current in both single and dual power supply amplifiers.

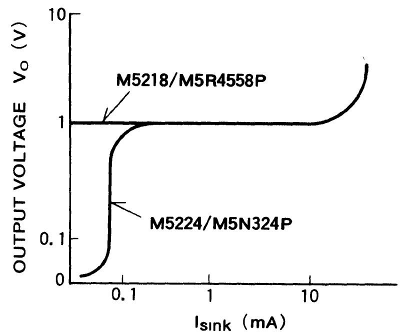


Fig. 6

REDUCTION OF DISTORTION IN A SINGLE POWER SUPPLY OPERATIONAL AMPLIFIER

As has been explained previously, a single power supply operational amplifier operates with low distortion as an A-class bias circuit up to a load condition that can be driven by current (100 μ A) in a rated current circuit which is built in the output stage, and it can be used for audio signals but, if the load condition exceeds the value of current, the device is placed into a C-class bias condition, and crossover distortion occurs. To reduce this distortion, a pull-up resistor (e.g. 3k Ω) for running A-class bias current externally can be connected as shown in Fig. 7 to increase the A-class bias current and reduce distortion. (Refer to Fig. 8 DISTORTION VS OUTPUT VOLTAGE.)

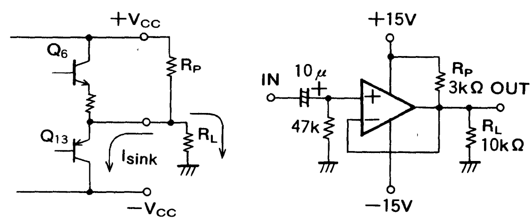


Fig. 7 (Explanation by dual power supply method)

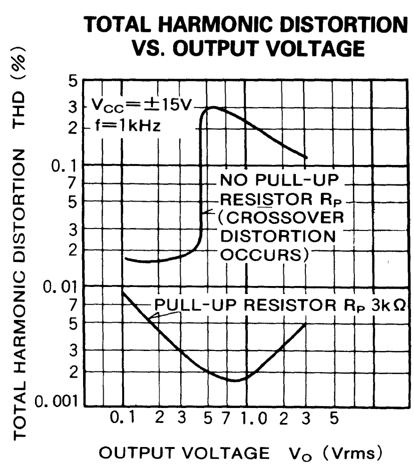


Fig. 8

M5228P, FP

QUAD LOW-NOISE OPERATIONAL AMPLIFIERS (DUAL POWER SUPPLY TYPE)

DESCRIPTION

The M5228 is a semiconductor integrated circuit designed for a low-noise preamplifier in audio equipment and a general-purpose operational amplifier in other electronic equipment. Four low-noise operational amplifier circuits displaying internal phase-compensated high gain and low distortion are contained in a 14-pin standard DIP and 14-pin mini flat (FP) package for application overt a side range as a general-purpose dual amplifier in general electronic equipment.

The device has virtually the same characteristics as the 4557, 4558, 4559 and 741 operational amplifiers. The unit can also be used as a single power supply type and amplifier in portable equipment. It is also suitable as a headphone amplifier because of its high load current.

FEATURES

- High gain, low distortion
  ························ G_{VO}=110dB, THD=0.0015%(typ.)
- High slew rate, high f_T ······· SR=2.2V/μs, f_T=7MHz(typ.)
- Low noise(R_g=1kΩ)FLAT················ V_{NI}=2μVrms(typ.)
  RIAA················ V_{NI}=1μVrms(typ.)
- Operation with low supply voltage ·········· $V_{CC}\geqq$4V(±2V)
- High load current, high power dissipation
  ························ I_{LP}=±50mA, P_d=700mW(M5228P)
  P_d=550mW(M5228FP)

APPLICATION

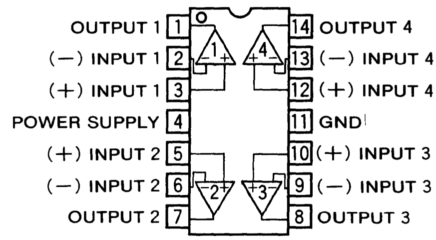
General-purpose amplifier in stereo equipment, tape decks and radio stereo cassette recorders; active filters, servo amplifiers, operational circuits in other general electronic equipment.

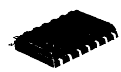
RECOMMENDED OPERATING CONDITIONS

Supply voltage range ······························ ±2~±16V
Rated supply voltage ······································ ±15V

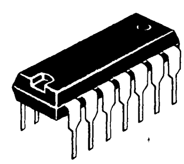
PIN CONFIGURATION (TOP VIEW)

DIP, MINI FLAT



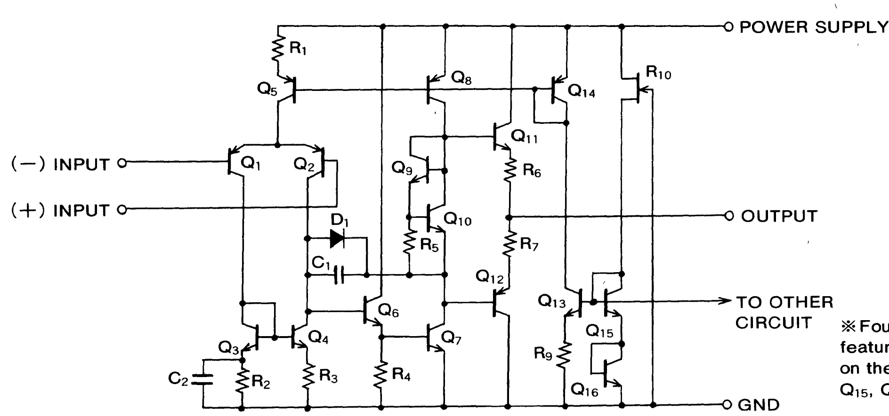


14-pin molded plastic FP (MINI FLAT)



14-pin molded plastic DIP

EQUIVALENT CIRCUIT



※Four circuits are featured in the circuit on the left (except Q_{15}, Q_{16}, R_{10})

QUAD LOW-NOISE OPERATIONAL AMPLIFIERS (DUAL POWER SUPPLY TYPE)

ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

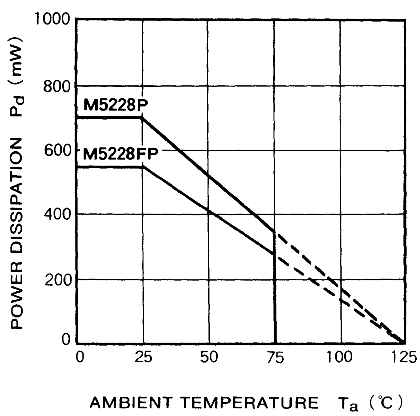
Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		±18	V
I_{LP}	Load current		±50	mA
V_{id}	Differential input voltage		±30	V
V_{IC}	Common input voltage		±15	V
P_d	Power dissipation		700(DIP)/550(FP)	mW
K_θ	Thermal derating	$T_a \geqq 25$℃	7(DIP)/5.5(FP)	mW/℃
T_{opr}	Ambient temperature		−20～+75	℃
T_{stg}	Storage temperature		−55～+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=±15V)

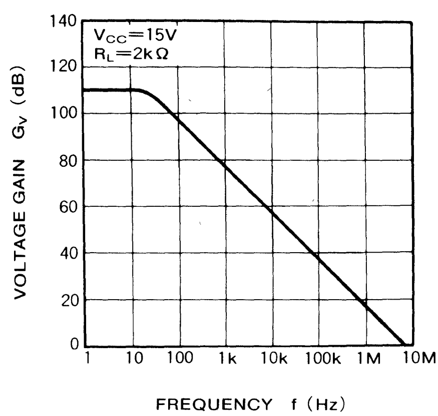
Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
I_{CC}	Circuit current	V_{in}=0		6.0	12.0	mA
V_{IO}	Input offset voltage	$R_S \leqq 10k\Omega$		0.5	6.0	mV
I_{IO}	Input offset current			5	200	nA
I_{IB}	Input bias current				500	nA
R_{in}	Input resistance		0.3	5		MΩ
G_{VO}	Open loop voltage gain	$R_L \geqq 2k\Omega$, V_O=±10V	86	110		dB
V_{OM}	Maximum output voltage	$R_L \geqq 10k\Omega$	±12	±14		V
		$R_L \geqq 2k\Omega$	±10	±13		
V_{CM}	Common input voltage range		±12	±14		V
CMRR	Common mode rejection ratio	$R_S \leqq 10k\Omega$	70	90		dB
SVRR	Supply voltage rejection ratio	$R_S \leqq 10k\Omega$		30	150	μV/V
P_d	Power dissipation			180	360	mW
SR	Slew rate	G_V=0dB, R_L=2kΩ		2.2		V/μs
f_T	Gain bandwidth product			7		MHz
V_{NI}	Input referred noise voltage	R_S=1kΩ, BW 10Hz～30kHz		2.0		μVrms

TYPICAL CHARACTERISTICS

THERMAL DERATING (MAXIMUM RATING)

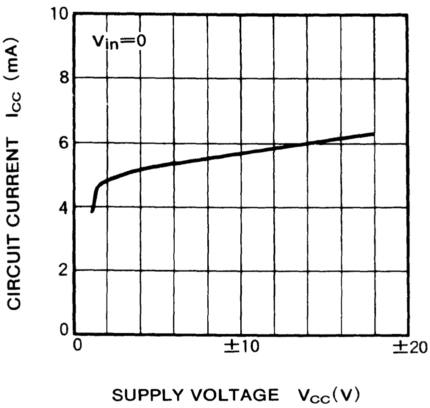


VOLTAGE GAIN VS. FREQUENCY RESPONSE

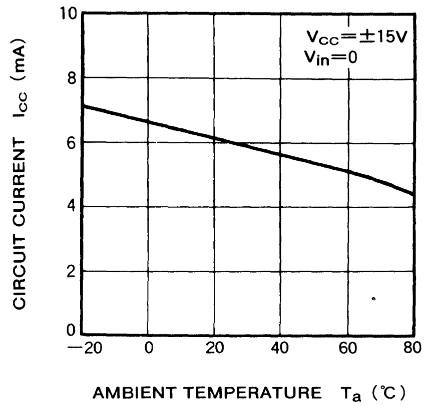


QUAD LOW-NOISE OPERATIONAL AMPLIFIERS (DUAL POWER SUPPLY TYPE)

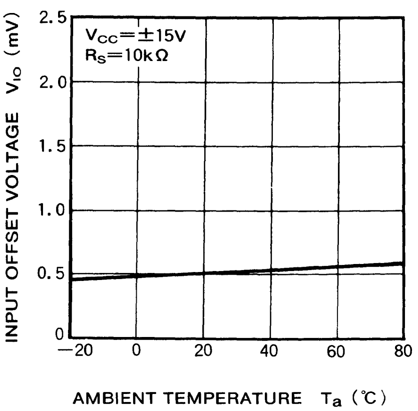
CIRCUIT CURRENT VS. SUPPLY VOLTAGE



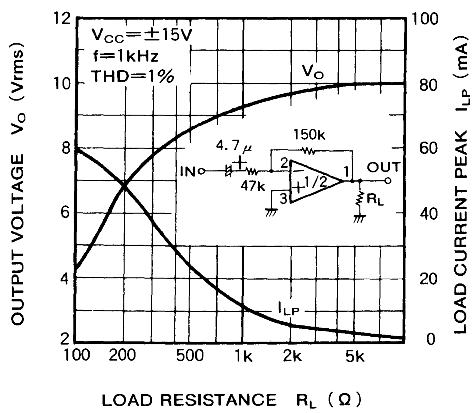
CIRCUIT CURRENT VS. AMBIENT TEMPERATURE



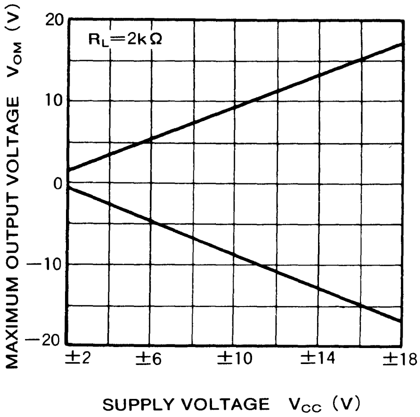
INPUT OFFSET VOLTAGE VS. AMBIENT TEMPERATURE



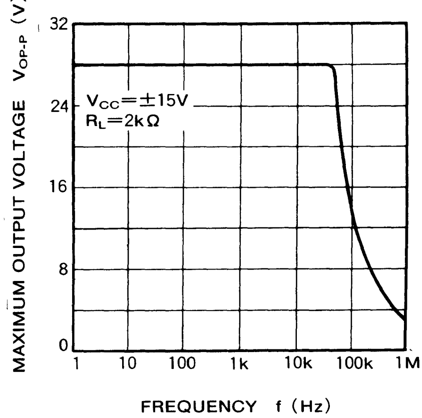
OUTPUT VOLTAGE / LOAD CURRENT PEAK VS. LOAD RESISTANCE



MAXIMUM OUTPUT VOLTAGE VS. SUPPLY VOLTAGE



MAXIMUM OUTPUT VOLTAGE VS. FREQUENCY RESPONSE



M5209L, P, FP

DUAL HIGH-VOLTAGE, HIGH S/N OPERATIONAL AMPLIFIERS (DUAL POWER SUPPLY TYPE)

DESCRIPTION

The M5209 is a semiconductor integrated circuit designed for a preamplifier in audio equipment of stereo and cassette tape decks.

Two low-noise operational amplifier circuits displaying internal phase-compensated high gain and low distortion are contained in a 8-pin SIP, DIP or FP, suitable for application as a microphone and tone control amplifier of stereo equipment and cassette tape decks.

The unit can also be used as a general-purpose amplifier in portable equipment such as a stereo cassette tape recorder of a single power supply type as it operates at a low supply voltage.

FEATURES

- Low noise ·········· $V_{NI}=1.2\mu$Vrms typ. ($R_g=2.2k\Omega$, FLAT)
  S/N=61dB typ. ($R_g=600\Omega$, IHF-A network)
  (microphone amplifier, reference input=−60dBm)
  Higher S/N ratio by 4dB when compared to general operational amplifiers
- High voltage ·········· $V_{CC}=\pm25V(50V)$
- Low maximum input voltage ·········· $V_i=140$mVrms(typ.) ($V_{CC}=\pm22.5V$, $G_V=40dB$)
- High gain, low distortion ·········· $G_{VO}=110dB$, THD=0.004%(typ.)
- High slew rate ·········· SR=6.5V/μs(typ.)
- High load current, high power dissipation ·········· $I_{LP}=\pm50mA$, $P_d=800mW$(SIP) $P_d=625mW$(DIP), $P_d=440mW$(FP)

APPLICATION

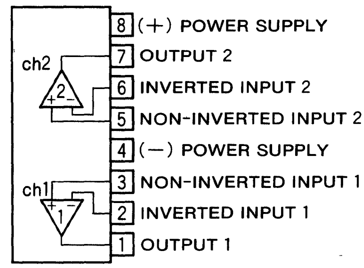
General-purpose preamplifier in stereo equipment, tape decks and radio stereo cassette recorders

RECOMMENDED OPERATING CONDITIONS

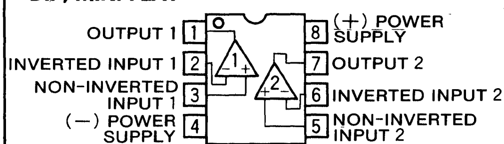
Supply voltage range ·········· ±2~±22.5V
Rated supply voltage ·········· ±22.5V

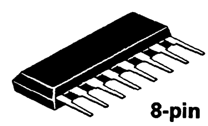
PIN CONFIGURATION (TOP VIEW)

SIP



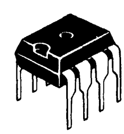
DIP, MINI FLAT





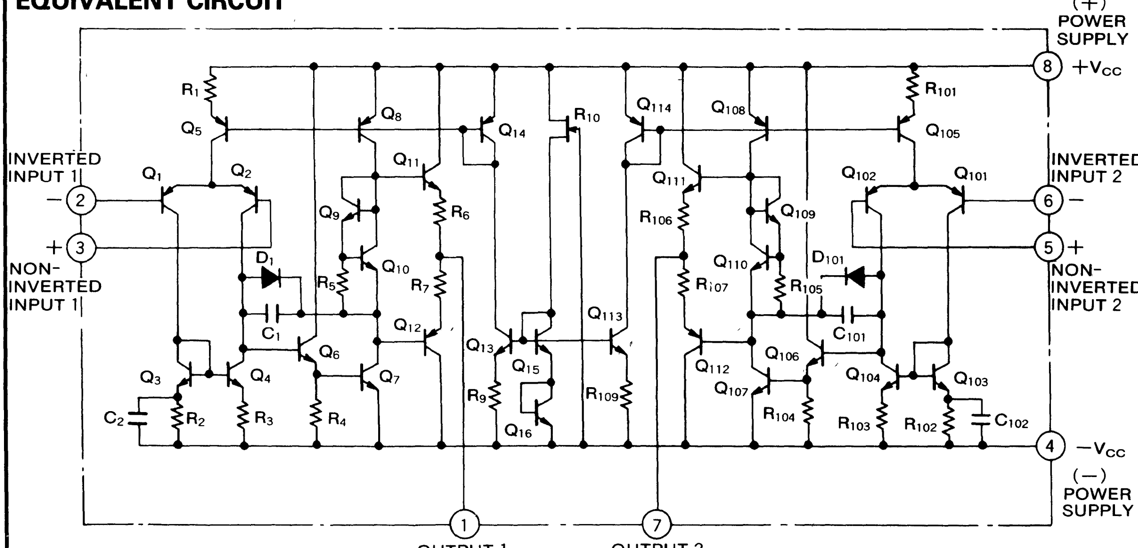
8-pin molded plastic SIP

8-pin molded plastic FP (MINI FLAT)



8-pin molded plastic DIP

EQUIVALENT CIRCUIT



DUAL HIGH-VOLTAGE, HIGH S/N OPERATIONAL AMPLIFIERS (DUAL POWER SUPPLY TYPE)

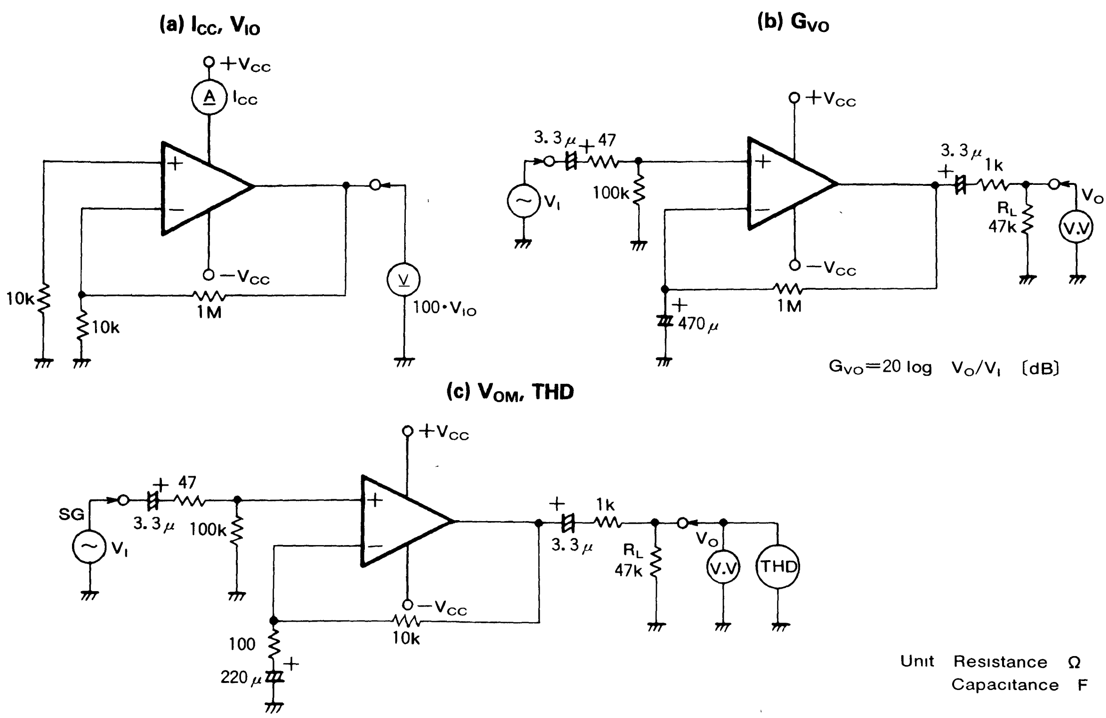
ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		±25(50)	V
I_{LP}	Load current		±50	mA
V_{id}	Differential input voltage		±30	V
V_{ic}	Common input voltage		±22.5	V
P_d	Power dissipation		800(SIP)/625(DIP)/440(FP)	mW
K_θ	Thermal derating	$T_a \geqq 25$℃	8(SIP)/6.25(DIP)/4.4(FP)	mW/℃
T_{opr}	Ambient temperature		−20～+75	℃
T_{stg}	Storage temperature		−55～+125	℃

ELECTLICAL CHARACTERISTICS (T_a=25℃, V_{CC}=±22.5V)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
I_{CC}	Circuit current	V_{in}=0		3.5	7.0	mA
V_{IO}	Input offset voltage	$R_S \leqq 10k\Omega$		0.5	6.0	mV
I_{IB}	Input bias current			0.3		μA
G_{VO}	Open loop voltage gain	f=100Hz, R_L=47kΩ, C_{NF}=470μF	90	110		dB
V_{OM}	Maximum output voltage	f=1kHz, THD=0.1%, R_L=47kΩ, FLAT	12.5	14.0		Vrms
THD	Total harmonic distortion	f=1kHz, V_O=5Vrms, R_L=47kΩ, FLAT		0.004		%
V_{NI}	Input referred noise voltage	Rg=2.2kΩ, BW=10Hz～30kHz, FLAT		1.2	1.8	μVrms
S/N	Signal-to-noise ratio	Rg=600Ω, G_V=40dB, IHF-A network Reference input −60dBm (microphone)		61		dB

TEST CIRCUITS

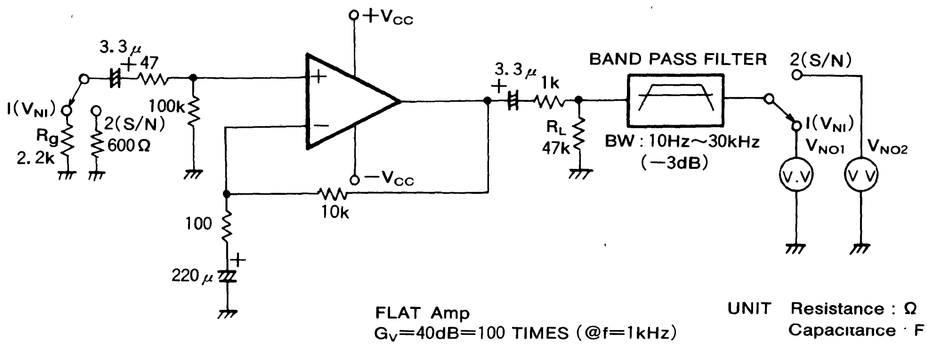


G_{VO}=20 log V_O/V_I 〔dB〕

Unit Resistance Ω
Capacitance F

TEST CIRCUIT

(d) V_{NI}, S/N

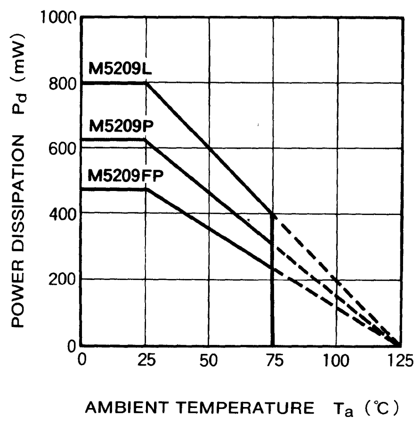


1. $V_{NI}=V_{NO1}/100$ (μVrms)
2. S/N=20 log [775μVrms/(V_{NO2}/100)] (dB) 775μVrms=−60dBm (Microphone reference input voltage)

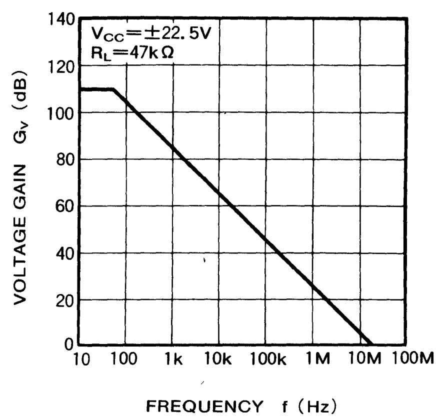
* An AC voltmeter V V with a built-in IHF-A network filter should be used for measuring the S/N ratio.

TYPICAL CHARACTERISTICS

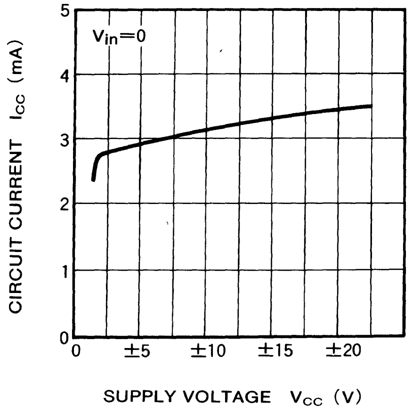
THERMAL DERATING (MAXIMUM RATING)



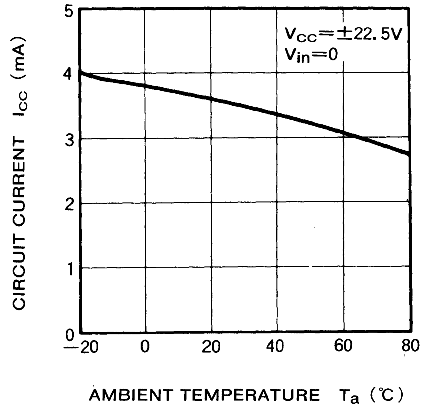
VOLTAGE GAIN VS. FREQUENCY RESPONSE



CIRCUIT CURRENT VS. SUPPLY VOLTAGE

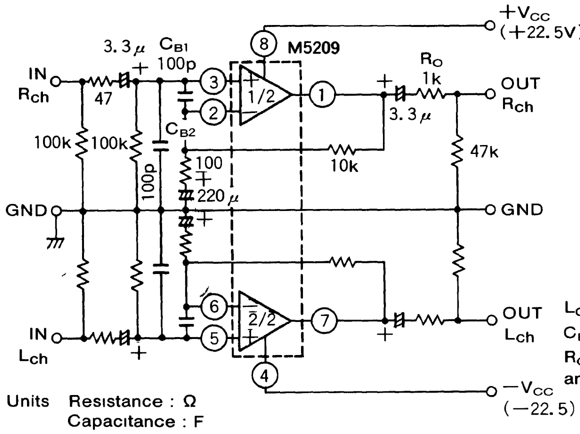


CIRCUIT CURRENT VS. AMBIENT TEMPERATURE



APPLICATION EXAMPLES

(1) Stereo FLAT (microphone) amplifier circuit

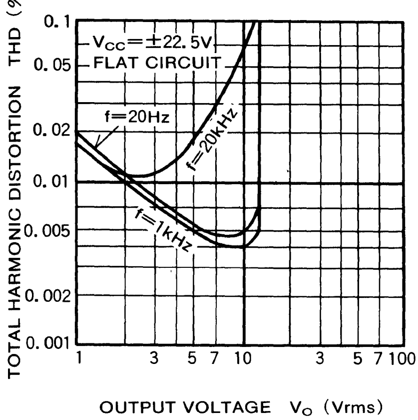


TYPICAL CHARACTERISTICS (V_{CC}=±22.5V, FLAT)

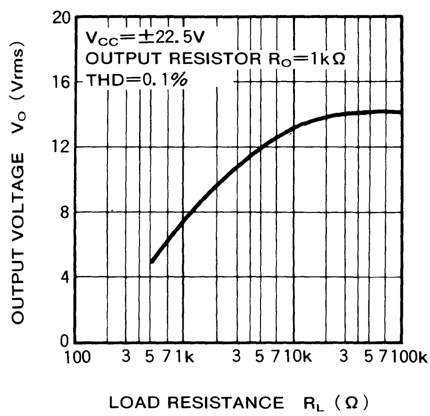
- G_V=40dB (f=1kHz)
- V_{NI}=1.2μVrms(R_g=2.2kΩ, BW=10Hz~30kHz)
- S/N=61dB (IHF-A network, R_g=600Ω, −600dBm input sensitivity)
- THD=0.004%(f=1kHz, V_O=10Vrms)

L_{ch} circuit constants are identical to those of R_{ch}
C_{B1}, C_{B2} : Capacitors for buzz prevention, use if required
R_O : Resistor used to prevent parasitic oscillation for capacitive loads and current limiting with shorted and other abnormal load conditions

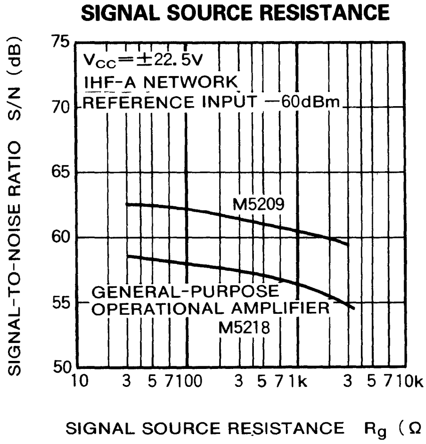
TOTAL HARMONIC DISTORTION VS. OUTPUT VOLTAGE



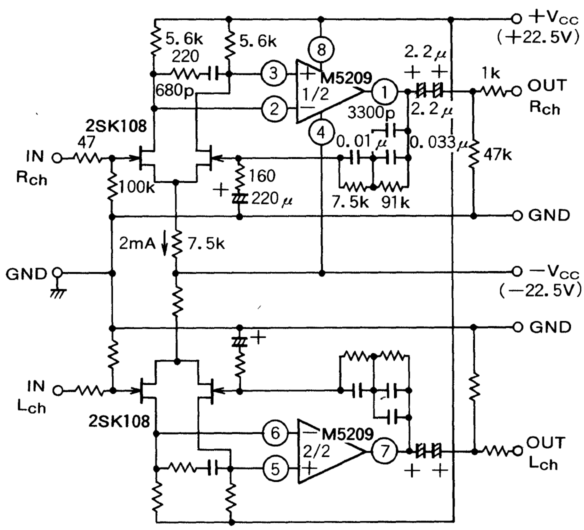
OUTPUT NOISE VOLTAGE VS. LOAD RESISTANCE



SIGNAL-TO-NOISE RATIO VS. SIGNAL SOURCE RESISTANCE



(2) High S/N stereo DC ICL equalizer



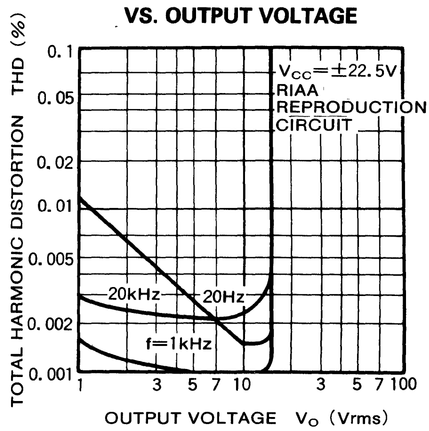
Lch circuit constants are identical to those of Rch

Units Resistance : Ω
Capacitance : F

TYPICAL CHARACTERISTICS (V_{CC}=±22.5V, RIAA)

- S/N=85dB (IHF-A network, shorted input, 2.5mVrms input sensitivity)
- V_{NI}=0.77μVrms(R_g=5.1kΩ, BW=5Hz~100kHz)
- G_V=35.6dB(f=1kHz)

TOTAL HARMONIC DISTORTION VS. OUTPUT VOLTAGE



MITSUBISHI ELECTRIC

M5210L, P, FP

DUAL HIGH-VOLTAGE,HIGH S/N OPERATIONAL AMPLIFIERS (DUAL POWER SUPPLY TYPE)

DESCRIPTION

The M5210 is a semiconductor integrated circuit designed for a preamplifier in audio equipment of stereo and cassette tape decks.

Two low-noise operational amplifier circuits displaying internal phase-compensated high gain and low distortion are contained in a 8-pin (SIP, DIP), suitable for application as a microphone and tone control amplifier of stereo equipment and cassette tape decks.

The unit can also be used as a general-purpose amplifier in portable equipment such as a stereo cassette tape recorder of a single power supply type as it operates at a low supply voltage.

FEATURES

- Low noise ·········· V_{NI}=1.0μVrms typ.(R_g=2.2kΩ, FLAT)
  S/N=66dB typ.(R_g=600Ω, IHF-A network)
  (microphone amplifier, fererence input=−60dBm)
  Higher S/N ratio by 10dB when compared to ordinary operational amplifiers
- High voltage ································ V_{CC}=±25V(50V)
- Low maximum input voltage ············ V_i=140mVrms(typ.) (V_{CC}=±22.5V, G_V=40dB)
- High gain, low distortion
  ···························· G_{VO}=113dB, THD=0.002%(typ.)
- High slew rate ····························· SR=6.5V/μs(typ.)
- High load current, high power dissipation
  ···························· I_{LP}=±50mA, P_d=800mW(SIP)
  P_d=625mW(DIP) P_d=440mW(FP)

APPLICATION

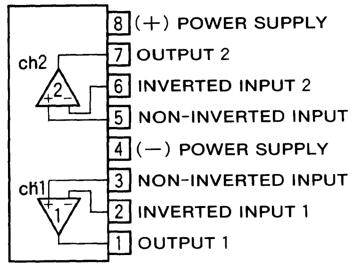
General-purpose preamplifier in stereo equipment, tape decks and radio stereo cassette recorders

RECOMMENDED OPERATING CONDITIONS

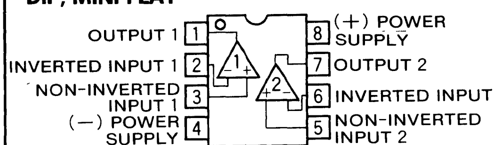
Supply voltage range ···························· ±2~±22.5V
Rated supply voltage ···························· ±22.5V

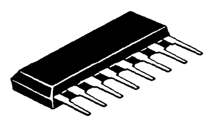
PIN CONFIGURATION (TOP VIEW)

SIP

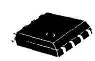


DIP, MINI FLAT

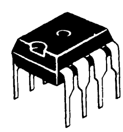




8-pin molded plastic SIP

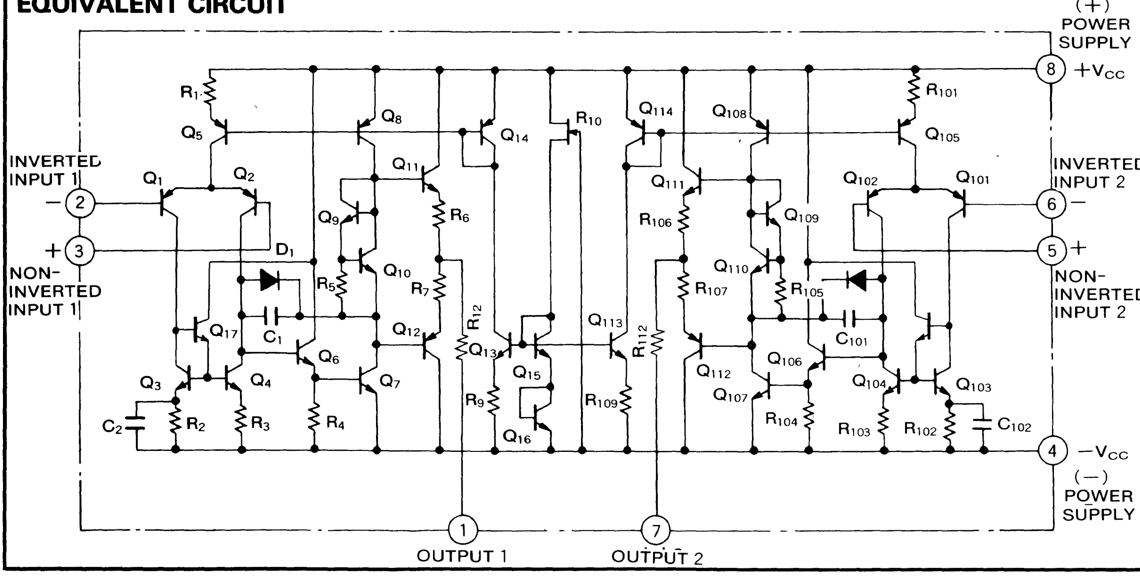


8-pin molded plastic FP (MINI FLAT)



8-pin molded plastic DIP

EQUIVALENT CIRCUIT



DUAL HIGH-VOLTAGE,HIGH S/N OPERATIONAL AMPLIFIERS (DUAL POWER SUPPLY TYPE)

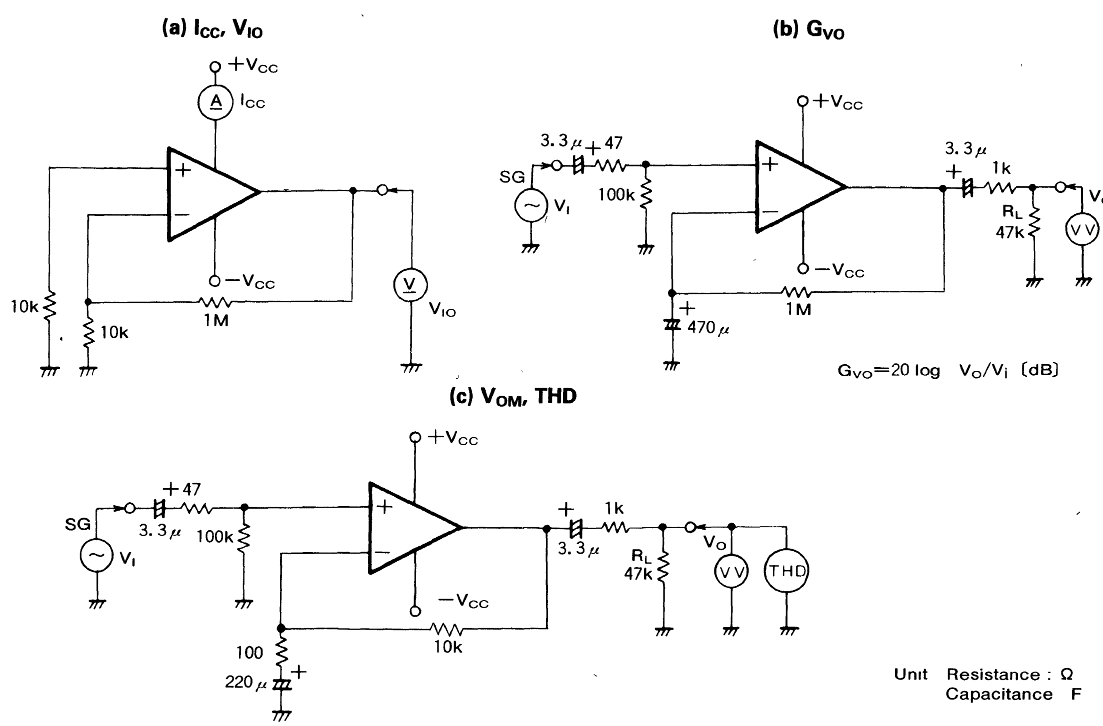
ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		±25(50)	V
I_{LP}	Load current		±50	mA
V_{id}	Differential input voltage		±30	V
V_{ic}	Common input voltage		±22.5	V
P_d	Power dissipation		800(SIP)/625(DIP)/440(FP)	mW
K_θ	Thermal derating	T_a≧25℃	8(SIP)/6.25(DIP)/4.4(FP)	mW/℃
T_{opr}	Operating temperature		−20～+75	℃
T_{stg}	Storage temperature		−55～+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=±22.5V)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
I_{CC}	Circuit current	V_{in}=0	2.0	4.0	8.0	mA
V_{IO}	Input offset voltage	R_S≦10kΩ		0.5	6.0	mV
I_{IB}	Input bias current			0.7		μA
G_{VO}	Open loop voltage gain	f=100Hz, R_L=47kΩ, C_{NF}=470μF	90	113		dB
V_{OM}	Maximum output voltage	f=1kHz, THD=0.1%, R_L=47kΩ, FLAT	12.5	14.2		Vrms
THD	Total harmonic distortion	f=1kHz, V_O=10Vrms, R_L=47kΩ, FLAT		0.002		%
V_{NI}	Input-referred noise voltage	R_g=2.2kΩ, BW=10Hz～30kHz, FLAT		1.0	1.5	μVrms
S/N	Signal to noise ratio	R_g=600Ω, G_V=40dB, IHF-A network Reference input −60dBm (microphone)		66		dB

TEST CIRCUITS



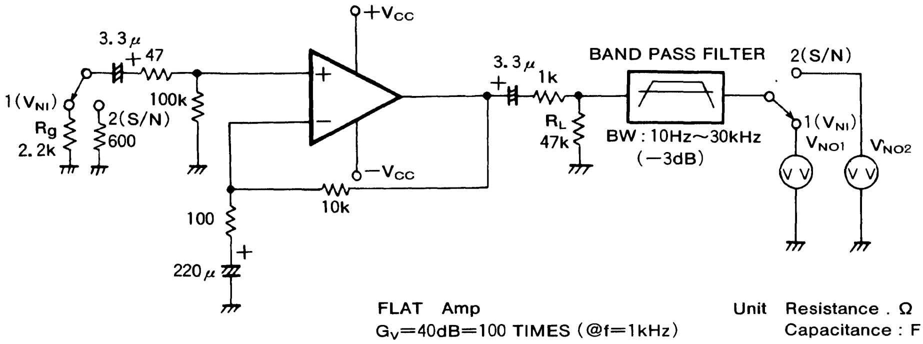
Unit Resistance : Ω
Capacitance F

MITSUBISHI ELECTRIC

DUAL HIGH-VOLTAGE,HIGH S/N OPERATIONAL AMPLIFIERS (DUAL POWER SUPPLY TYPE)

TEST CIRCUIT

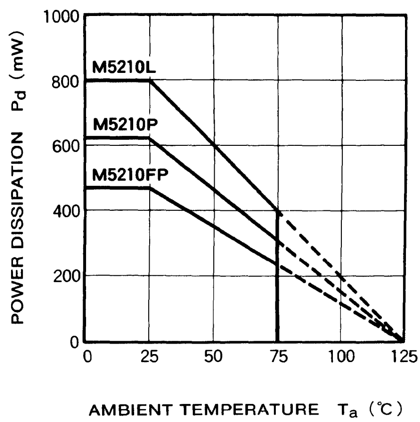
(d) V_{NI}, S/N



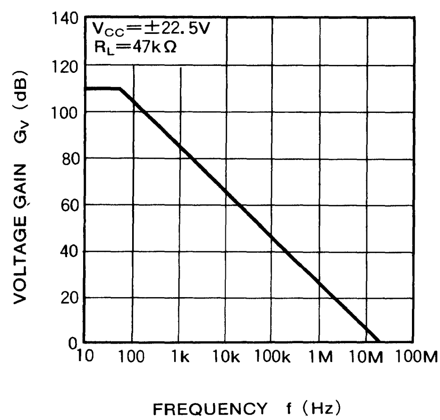
1. $V_{NI}=V_{NO1}/100(\mu Vrms)$
2. S/N=20 log 〔775μVrms/(V_{NO2}/100)〕 (dB) 775μVrms=−60dBm(microphone reference input voltage)
   * An AC voltmeter V.V with a built-in IHF-A network filter should be used for measuring the S/N ratio.

TYPICAL CHARACTERISTICS

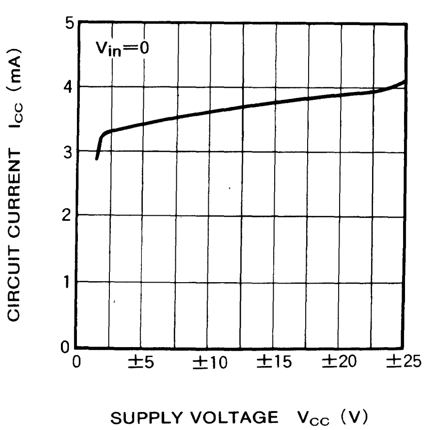
THERMAL DERATING (MAXIMUM RATING)



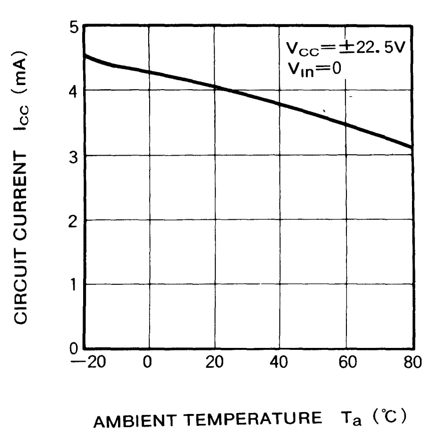
VOLTAGE GAIN VS. FREQUENCY RESPONSE



CIRCUIT CURRENT VS. SUPPLY VOLTAGE

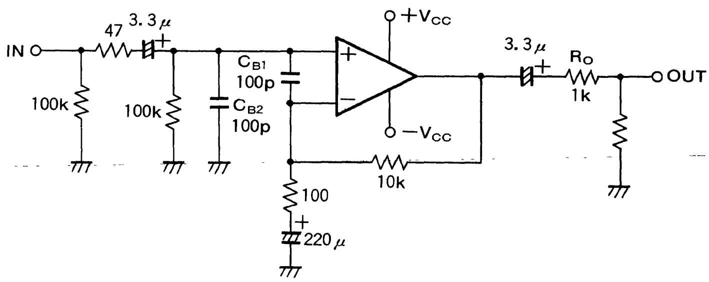


CIRCUIT CURRENT VS. AMBIENT TEMPERATURE



APPLICATION EXAMPLES

(1) Stereo FLAT (microphone) amplifier circuit



Units Resistance : Ω
Capacitance : F

TYPICAL CHARACTERISTICS (V_{CC}=±22.5V, FLAT)

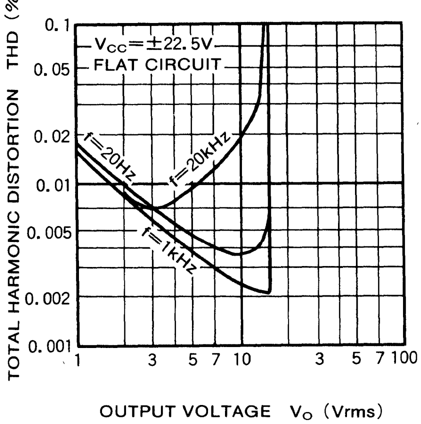
- G_V=40dB (f=1kHz)
- V_{NI}=1.0μVrms(R_g=2.2kΩ, BW=10Hz~30kHz)
- S/N=66dB (IHF-A network, R_g=600Ω, −60dBm input sensitivity)
- THD=0.002%(f=1kHz、V_O=10Vrms)

Left channel circuit constants are identical to those of right channel

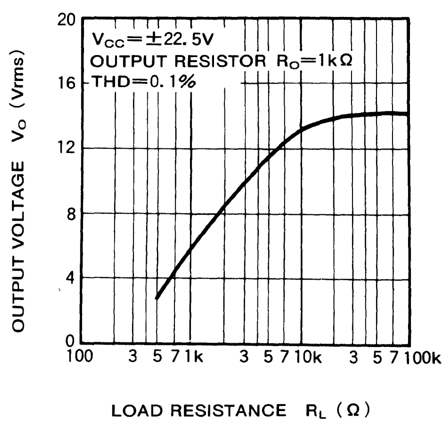
C_{B1}, C_{B2} : Capacitors for buzz prevention, use if required.

R_O : Resistor used to prevent parasitic oscillation for capacitive loads and current limiting with shorted and other abnormal load conditions.

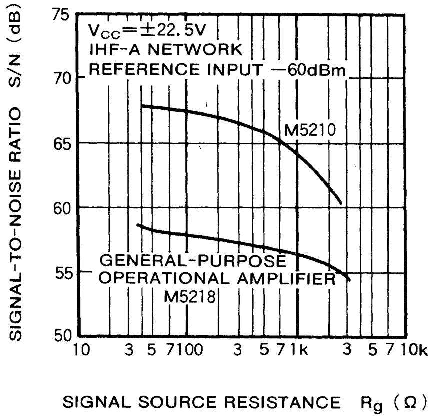
TOTAL HARMONIC DISTORTION VS. OUTPUT VOLTAGE



OUTPUT NOISE VOLTAGE VS. LOAD RESISTANCE



SIGNAL-TO-NOISE RATIO VS. SIGNAL SOURCE RESISTANCE



MITSUBISHI ELECTRIC

M5219L, P, FP

DUAL LOW-NOISE OPERATIONAL AMPLIFIERS(DUAL POWER SUPPLY TYPE)

DESCRIPTION

The M5219 is a semiconductor integrated circuit designed for a preamplifier in audio equipment of stereo and cassette tape decks.

Two low-noise operational amplifier circuits displaying internal phase-compensated high gain and low distortion are contained in a 8-pin SIP, DIP or FP, suitable for application as an equalizer and tone control amplifier of stereo equipment and cassette tape decks.

The unit can also be used as a general-purpose amplifier in portable equipment such as a stereo cassette tape recorder of a single power supply type as it operates at a low supply voltage.

FEATURES

- Low noise ·········· V_{NI}=0.9μVrms typ.(R_g=2.2kΩ, RIAA)
  S/N=77dB typ. (Shorted input, IHF-A network)
  (RIAA, PHONO=2.5mVrms)
- High voltage ······························ V_{CC}=±25V(50V)
- Low PHONO maximum input voltage
  ······························ V_i=230mVrms(typ.)
  (V_{CC}=±22.5V, f=1kHz)
- High gain, low distortion
  ······························ G_{VO}=110dB, THD=0.001%(typ.)
- High slew rate ······························ SR=6.5V/μs(typ.)
- High load current, high power dissipation
  ······························ I_{LP}=±50mA, P_d=800mW(SIP)
  P_d=625mW(DIP), P_d=440mW(FP)

APPLICATION

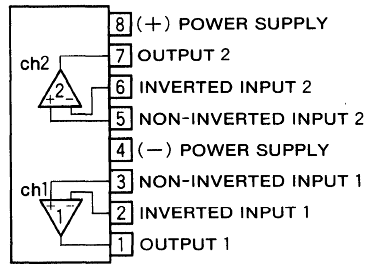
General-purpose preamplifier in stereo equipment, tape decks and radio stereo cassette recorders.

RECOMMENDED OPERATING CONDITIONS

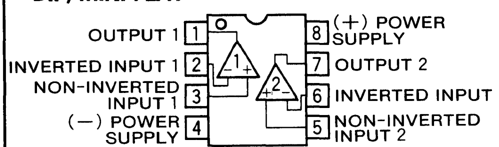
Supply voltage range ······························ ±2~±22.5V
Rated supply voltage ······························ ±22.5V

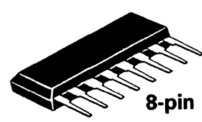
PIN CONFIGURATION (TOP VIEW)

SIP

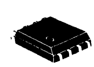


DIP, MINI FLAT

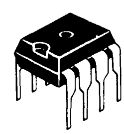




8-pin molded plastic SIP

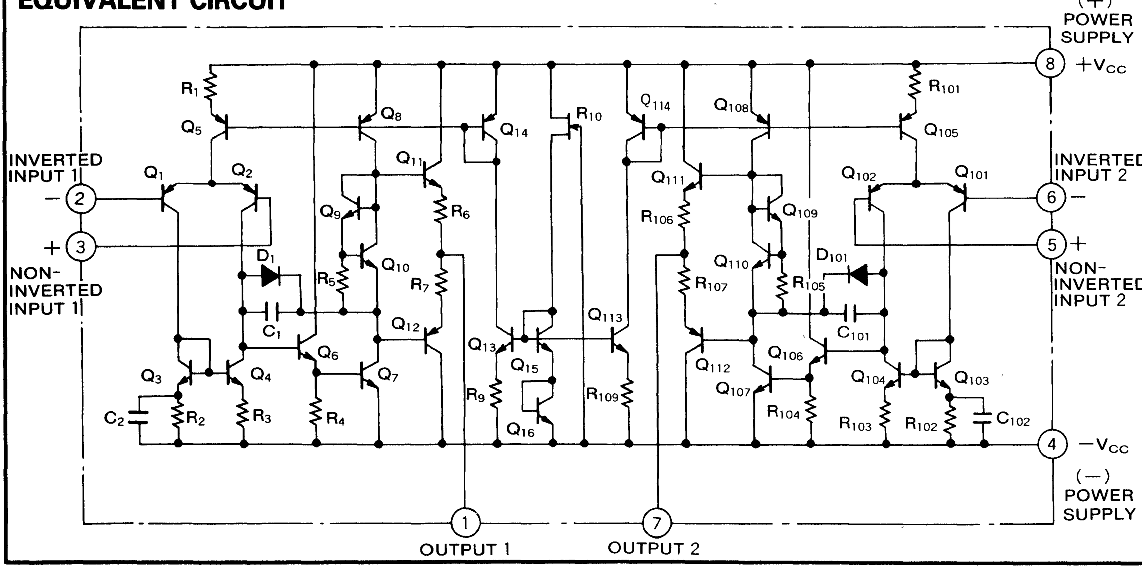


8-pin molded plastic FP (MINI FLAT)



8-pin molded plastic DIP

EQUIVALENT CIRCUIT



DUAL LOW-NOISE OPERATIONAL AMPLIFIERS(DUAL POWER SUPPLY TYPE)

ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

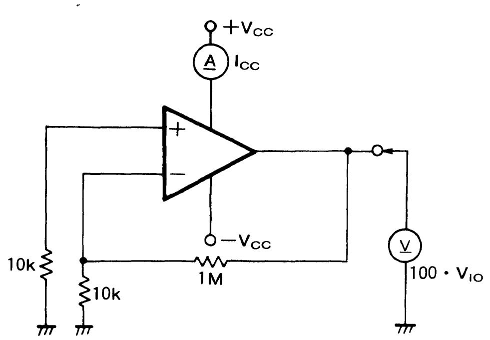
Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		±25(50)	V
I_{LP}	Load current		±50	mA
V_{id}	Differential input voltage		±30	V
V_{ic}	Common input voltage		±22.5V	V
P_d	Power dissipation		800(SIP)/625(DIP)/440(FP)	mW
K_θ	Thermal derating	$T_a \geqq 25$℃	8(SIP)/6.25(DIP)/4.4(FP)	mW/℃
T_{opr}	Ambient temperature		−20~+75	℃
T_{stg}	Storage temperature		−55~+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=±22.5V)

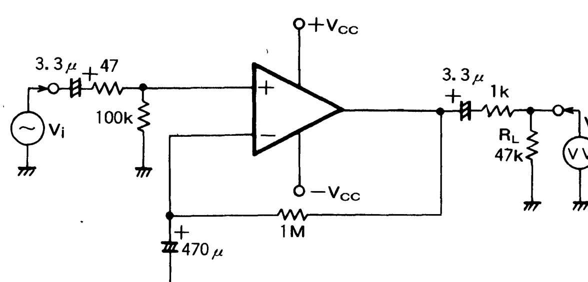
Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
I_{CC}	Circuit current	V_{in}=0		3.5	7.0	mA
V_{IO}	Input offset voltage	$R_S \leqq 10k\Omega$		0.5	6.0	mV
I_{IB}	Input bias current			0.3		μA
G_{VO}	Open loop voltage gain	f=100Hz, R_L=47kΩ, C_{NF}=470μF	90	110		dB
V_{OM}	Maximum output voltage	f=1kHz, THD=0.1%, R_L=47kΩ, RIAA	12.5	14.0		Vrms
THD	Total harmonic distortion	f=1kHz, V_O=5Vrms, R_L=47kΩ, RIAA		0.001	0.03	%
V_{NI}	Input referred noise voltage	R_g=2.2kΩ, BW=10Hz~30kHz, RIAA		0.9	1.8	μVrms
S/N	Signal-to-noise ratio	Shorted input (R_g=47Ω), IHF-A network PHONO=2.5mVrms, RIAA		77		dB

TEST CIRCUITS

(a) I_{CC}, V_{IO}

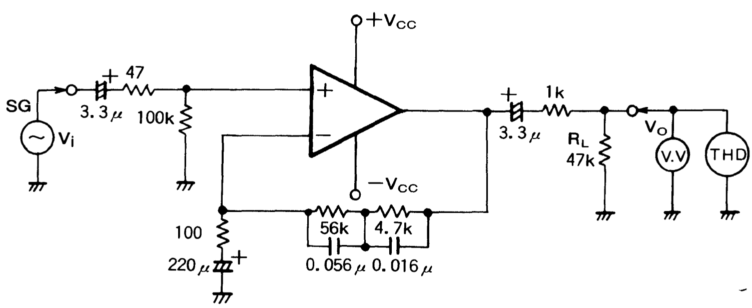


(b) G_{VO}



G_{VO}=20 log V_O/V_I (dB)

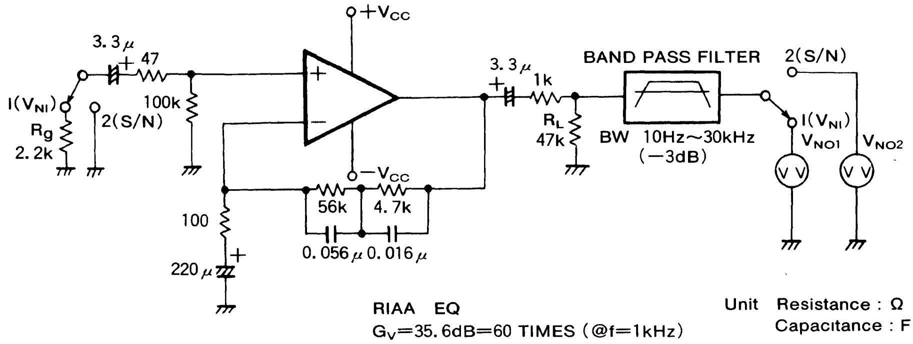
(c) V_{OM}, THD



Unit Resistance : Ω
Capacitance : F

TEST CIRCUIT

(d) V_{NI}, S/N

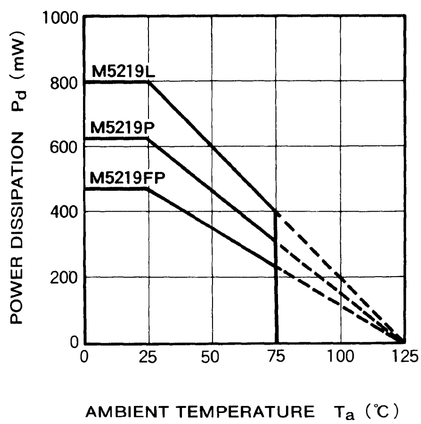


1. $V_{NI}=V_{NO1}/60$ (μVrms)
2. S/N=20 log(2.5mVrms/(V_{NO2}/60)) (dB)

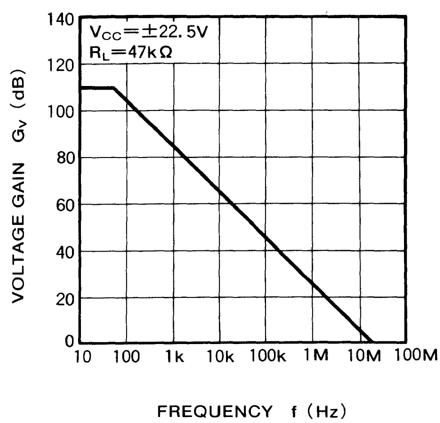
An AC voltmeter V.V with a built-in IHF-A network filter should be used for measuring the S/N ratio

TYPICAL CHARACTERISTICS

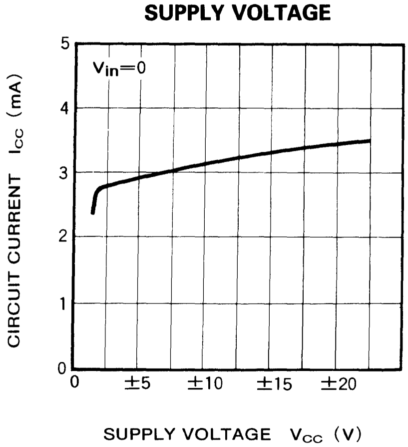
THERMAL DERATING (MAXIMUM RATING)



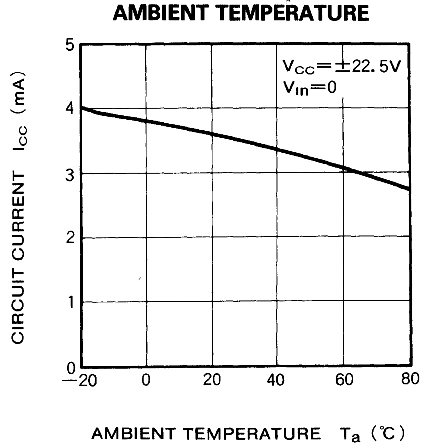
VOLTAGE GAIN VS. FREQUENCY RESPONSE



CIRCUIT CURRENT VS. SUPPLY VOLTAGE



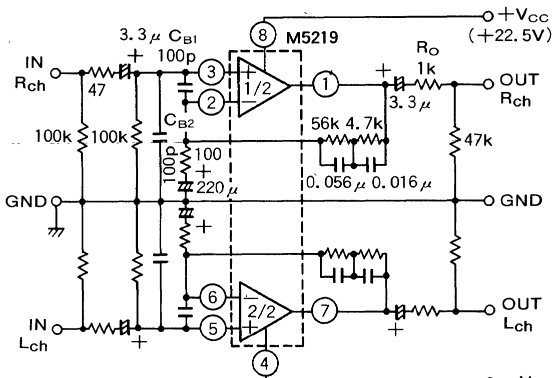
CIRCUIT CURRENT VS. AMBIENT TEMPERATURE



DUAL LOW-NOISE OPERATIONAL AMPLIFIERS(DUAL POWER SUPPLY TYPE)

APPLICATION EXAMPLES

(1) Stereo equalizer amplifier circuit



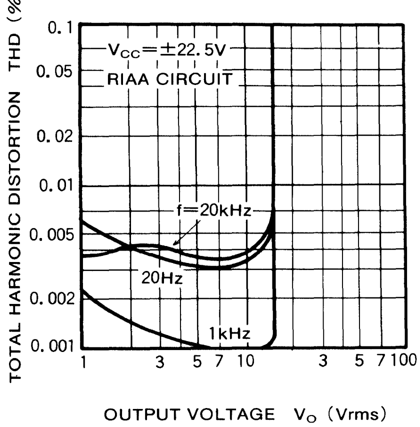
Units Resistance : Ω
Capacitance F

TYPICAL CHARACTERISTICS (V_{CC}=±22.5V, RIAA)

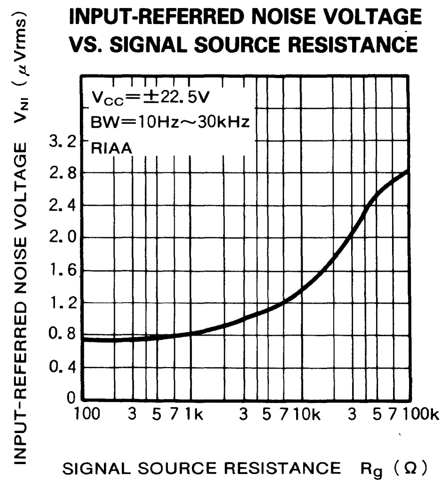
- G_V=35.6dB(f=1kHz)
- V_{NI}=0.9μVrms(R_g=2.2kΩ, BW=10Hz~30kHz)
- S/N=77dB(IHF-A network, shorted input, 2.5mVrms input sensitivity)
- THD=0.001%(f=1kHz, V_O=5Vrms)

L_{ch} circuit constants are identical to those of R_{ch}
C_{B1}, C_{B2} Capacitors for buzz prevention, use if required
R_O : Resistor used to prevent parasitic oscillation for capacitive loads and current limiting with shorted and other abnormal load conditions.

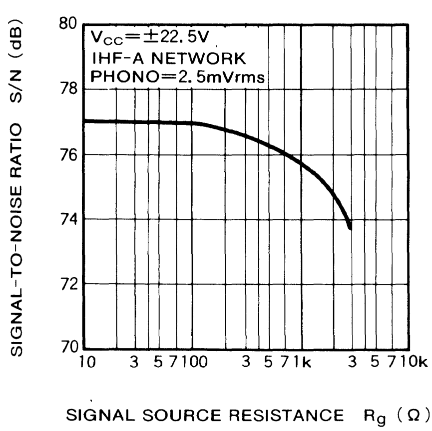
TOTAL HARMONIC DISTORTION VS. OUTPUT VOLTAGE



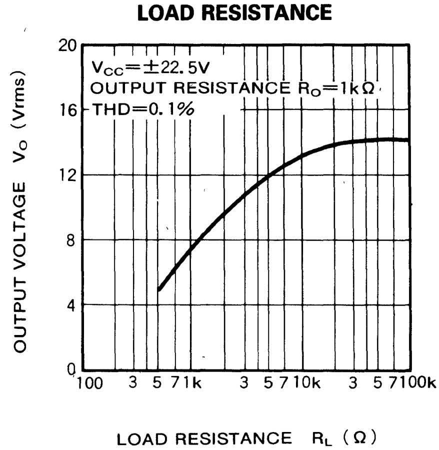
INPUT-REFERRED NOISE VOLTAGE VS. SIGNAL SOURCE RESISTANCE



SIGNAL-TO-NOISE RATIO VS. SIGNAL SOURCE RESISTANCE



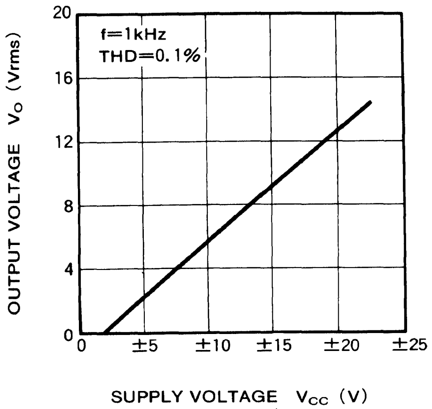
OUTPUT VOLTAGE VS. LOAD RESISTANCE



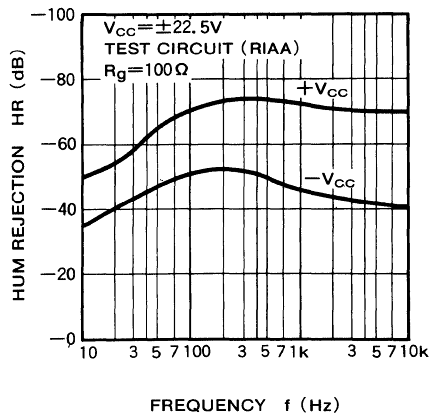
MITSUBISHI ELECTRIC

DUAL LOW-NOISE OPERATIONAL AMPLIFIERS(DUAL POWER SUPPLY TYPE)

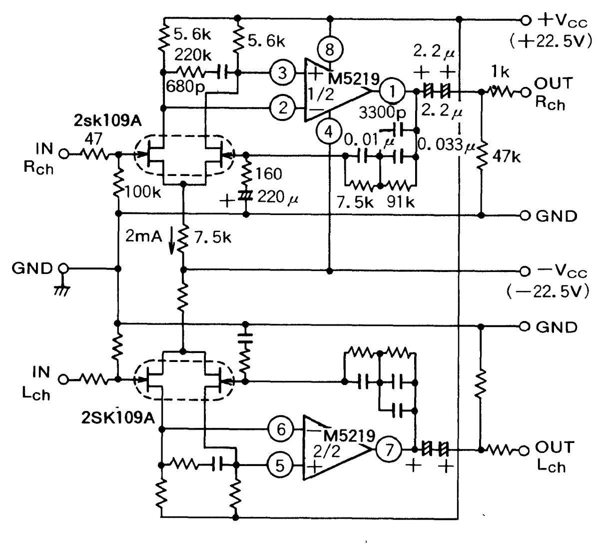
OUTPUT VOLTAGE VS. SUPPLY VOLTAGE



HUM REJECTION VS. FREQUENCY



(2) High S/N stereo DC ICL equalizer circuit



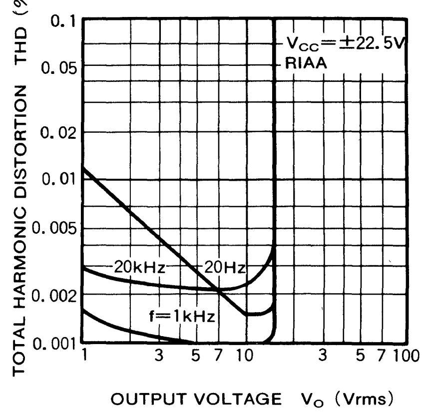
L_{ch} circuit constants are identical to those of R_{ch}.

Units Resistance Ω
Capacitance F

TYPICAL CHARACTERISTICS (V_{CC}=±22.5V. RIAA)

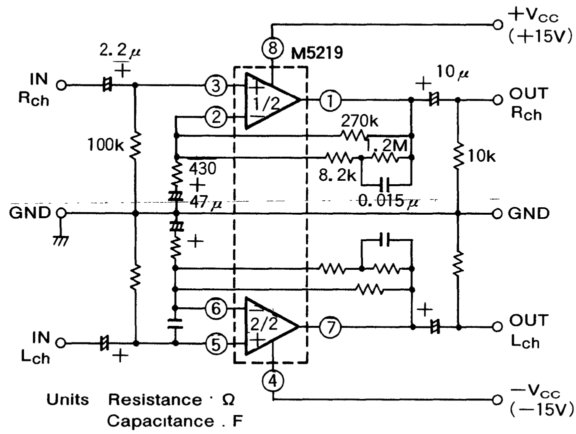
- S/N=85dB(IHF-A network, shorted input, 2.5mVrms input sensitivity)
- V_{NI}=0.77μVrms(R_g=5.1kΩ, BW=5Hz~100kHz)
- G_V=35.6dB(f=1kHz)

TOTAL HARMONIC DISTORTION VS. OUTPUT VOLTAGE



DUAL LOW-NOISE OPERATIONAL AMPLIFIERS(DUAL POWER SUPPLY TYPE)

(3) Tape deck equalizer amplifier circuit

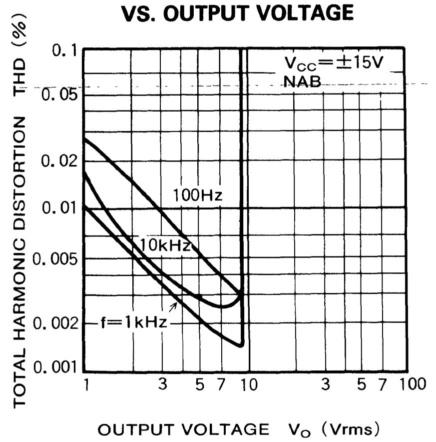


L_{ch} circuit constants are identical to those of R_{ch}

TYPICAL CHARACTERISTICS (V_{CC}=±15V, NAB)

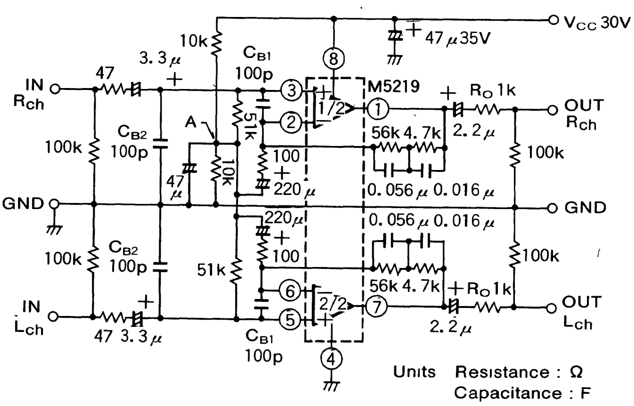
- G_V=29.9dB(f=1kHz)
- V_{NI}=1.4μVrms(R_g=2.2kΩ, BW=20Hz~15kHz) (−117dBv)

TOTAL HARMONIC DISTORTION VS. OUTPUT VOLTAGE



(4) Typical single power supply application

PHONO EQUALIZER AMPLIFIER (RIAA)

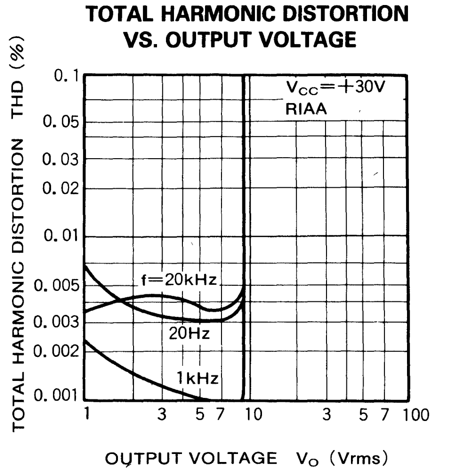


- → Point A is the $V_{CC}/2$ point in DC terms (virtual ground) when the device is used as a single power supply type
- C_{B1}, C_{B2} : Capacitor for buzz prevention, use if required
- R_O : Resistor used to prevent parasitic oscillation for capacitive loads and current limiting with shorted and other abnormal conditions.

TYPICAL CHARACTERISTICS (V_{CC}=+30V, RIAA)

- G_V=35.6dB(f=1kHz)
- V_{NI}=0.9μVrms(R_g=2.2kΩ, BW=10Hz~30kHz)
- S/N=77dB (IHF-A network, shorted input, 2.5mVrms input sensitivity)

TOTAL HARMONIC DISTORTION VS. OUTPUT VOLTAGE



M5220L, P, FP

DUAL LOW-NOISE OPERATIONAL AMPLIFIERS(DUAL POWER SUPPLY TYPE)

DESCRIPTION

The M5220 is a semiconductor integrated circuit designed for a preamplifier in audio equipment of stereo and cassette tape decks.

Two low-noise operational amplifier circuits displaying internal phase-compensated high gain and low distortion are contained in a 8-pin SIP, DIP or FP, suitable for application as an equalizer and tone control amplifier of stereo equipment and cassette tape decks. The unit can also be used as a general-purpose amplifier in portable equipment such as a stereo cassette tape recorder of a single power supply type as it operates at a low supply voltage.

FEATURES

- Low noise ·········$V_{NI}=0.75\mu$Vrms typ.($R_g=2.2k\Omega$, RIAA)
  S/N=83dB typ.(Shorted input, IHF-A network)
  (RIAA, PHONO=2.5mVrms)
- High voltage ································$V_{CC}=\pm25V(50V)$
- Low PHONO maximum input voltage
  ······································ V_i=235mVrms(typ.)
  ($V_{CC}=\pm22.5V$, f=1kHz)
- High gain, low distortion
  ···························G_{VO}=113dB, THD=0.001%(typ.)
- High slew rate ······························ SR=6.5V/μs(typ.)
- High load current, high power dissipation
  ···························$I_{LP}=\pm50mA$, P_d=800mW(SIP)
  P_d=625mW(DIP)
  P_d=440mW(FP)

APPLICATION

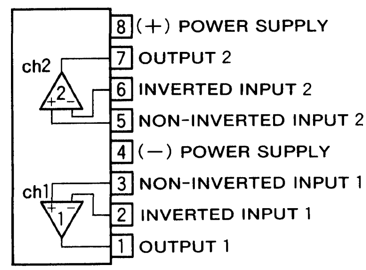
General-purpose preamplifier in stereo equipment, tape decks and radio stereo cassette recorders.

RECOMMENDED OPERATING CONDITIONS

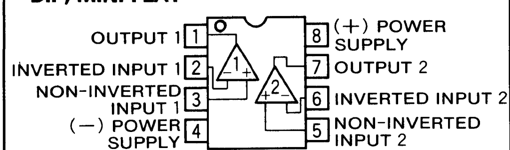
Supply voltage range ························· $\pm2\sim\pm22.5V$
Rated supply voltage ································ $\pm22.5V$

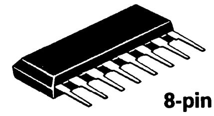
PIN CONFIGURATION (TOP VIEW)

SIP



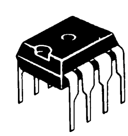
DIP, MINI FLAT





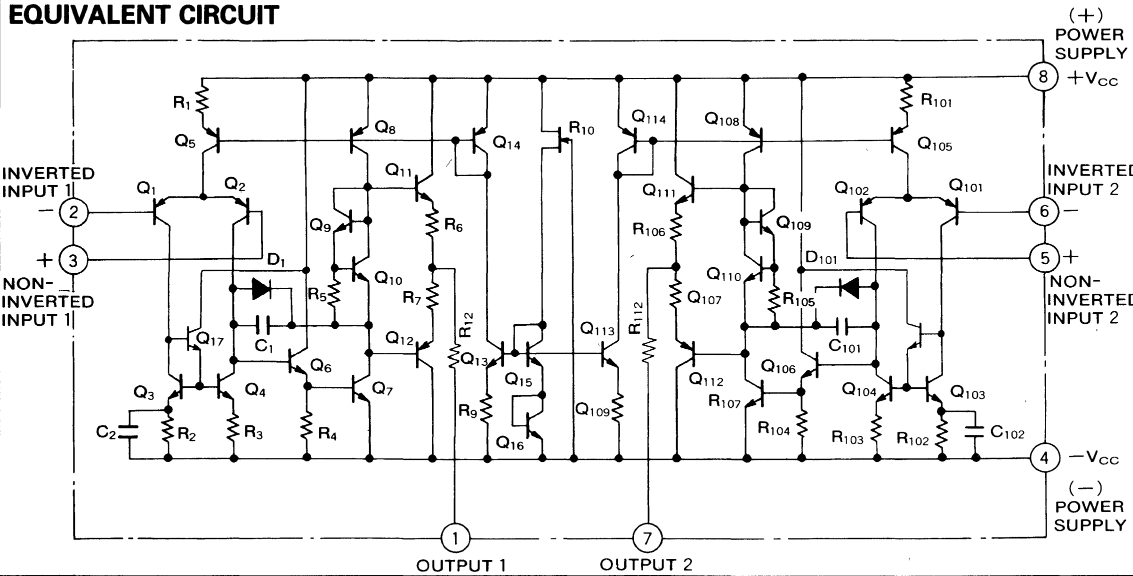
8-pin molded plastic SIP

8-pin molded plastic FP (MINI FLAT)



8-pin molded plastic DIP

EQUIVALENT CIRCUIT



DUAL LOW-NOISE OPERATIONAL AMPLIFIERS(DUAL POWER SUPPLY TYPE)

ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

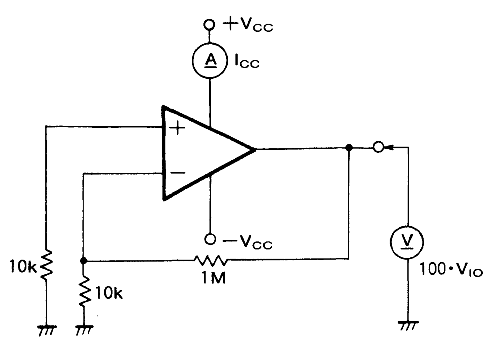
Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		±25(50)	V
I_{LP}	Load current		±50	mA
V_{id}	Differential input voltage		±30	V
V_{ic}	Common input voltage		±22.5	V
P_d	Power dissipation		800(SIP)/625(DIP)/440(FP)	mW
K_θ	Thermal derating	T_a≧25℃	8(SIP)/6.25(DIP)/4.4(FP)	mW/℃
T_{opr}	Ambient temperature		−20～+75	℃
T_{stg}	Storage temperature		−55～+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=±22.5V)

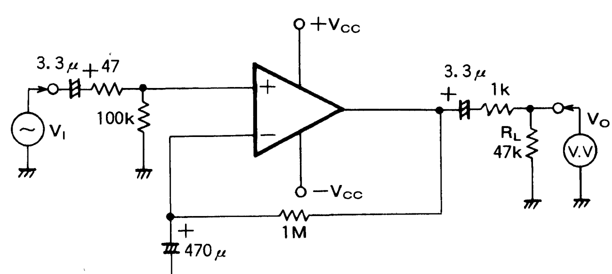
Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
I_{CC}	Circuit current	V_{in}=0		4.0	8.0	mA
V_{IO}	Input offset voltage	R_S≦10kΩ		0.5	3.0	mV
I_{IB}	Input bias current			0.7		μA
G_{VO}	Open loop voltage gain	f=100Hz, R_L=47kΩ, C_{NF}=470μF	90	113		dB
V_{OM}	Maximum output voltage	f=1kHz, THD=0.1%, R_L=47kΩ, RIAA	12.5	14.2		Vrms
THD	Total harmonic distortion	f=1kHz, V_O=5Vrms, R_L=47kΩ, RIAA		0.001	0.03	%
V_{NI}	Input referred noise voltage	Rg=2.2kΩ, BW=10Hz～30kHz, RIAA		0.75	1.8	μVrms
S/N	Signal-to-noise ratio	Shorted input (Rg=47Ω), IHF-A network PHONO=2.5mVrms, RIAA		83		dB

TEST CIRCUITS

(a) I_{CC}, V_{IO}

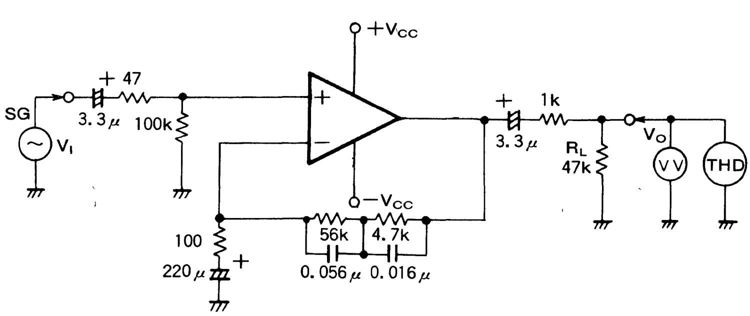


(b) G_{VO}



G_{VO}=20 log V_O/V_I 〔dB〕

(c) V_{OM}, THD



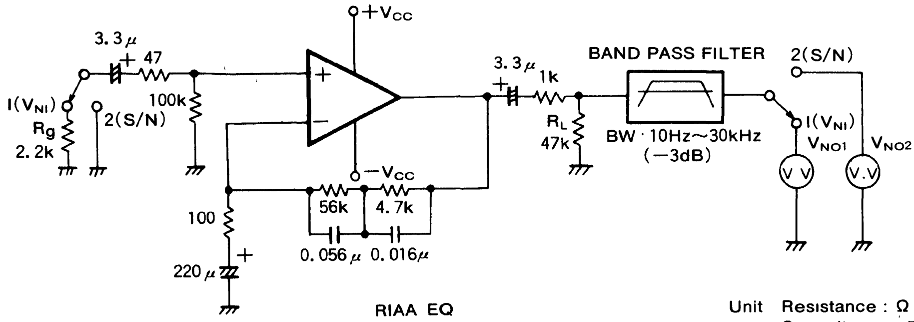
Unit Resistance : Ω
Capacitance : F

MITSUBISHI ELECTRIC

DUAL LOW-NOISE OPERATIONAL AMPLIFIERS(DUAL POWER SUPPLY TYPE)

TEST CIRCUIT

(d) V_{NI}, S/N



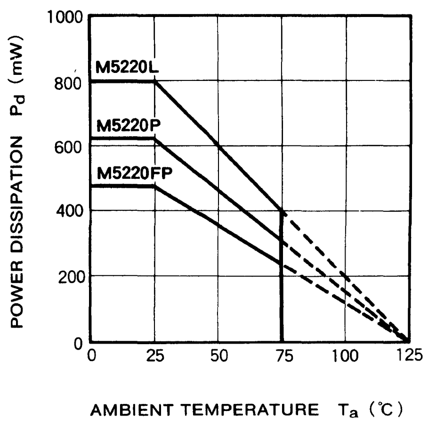
RIAA EQ
G_V=35.6dB=60 TIMES (@f=1kHz)

Unit Resistance : Ω
Capacitance F

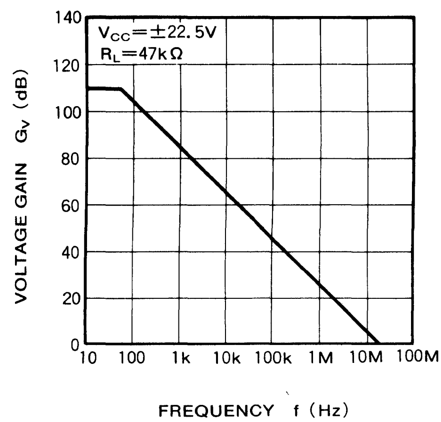
1. $V_{NI}=V_{NO1}/60$ (μVrms)
2. S/N=20 log [2.5mVrms/($V_{NO2/60}$)] (dB)
   * An AC voltmeter V.V with a built-in IHF-A network filter should be used for measuring the S/N ratio.

TYPICAL CHARACTERISTICS

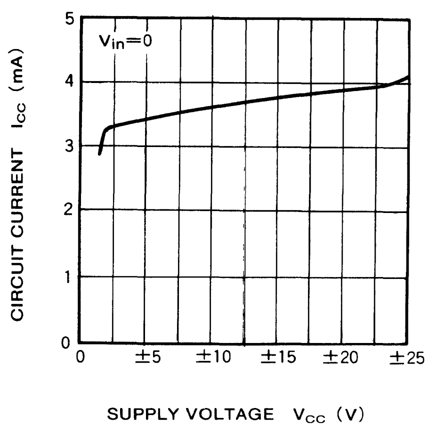
THERMAL DERATING (MAXIMUM RATING)



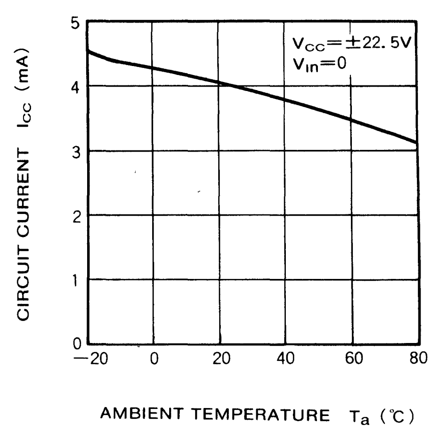
VOLTAGE GAIN VS. FREQUENCY RESPONSE



CIRCUIT CURRENT VS. SUPPLY VOLTAGE

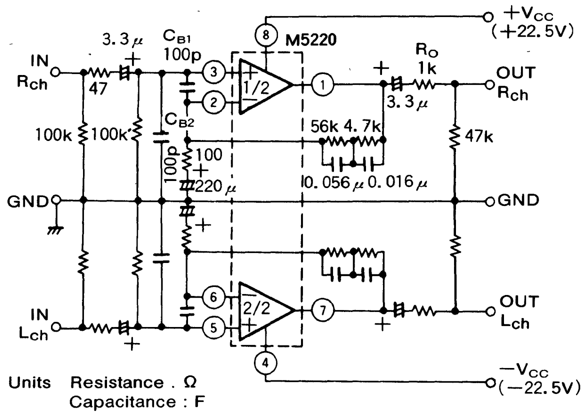


CIRCUIT CURRENT VS. AMBIENT TEMPERATURE



APPLICATION EXAMPLES

(1) Stereo equalizer amplifier circuit

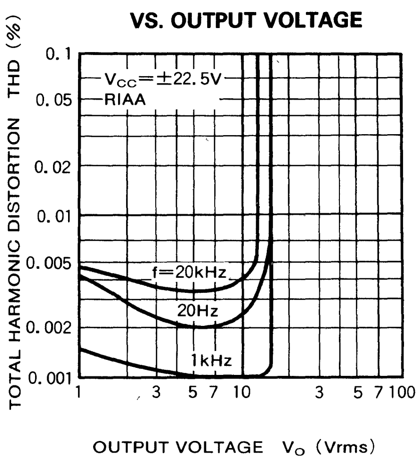


TYPICAL CHARACTERISTICS (V_{CC}=±22.5V, RIAA)

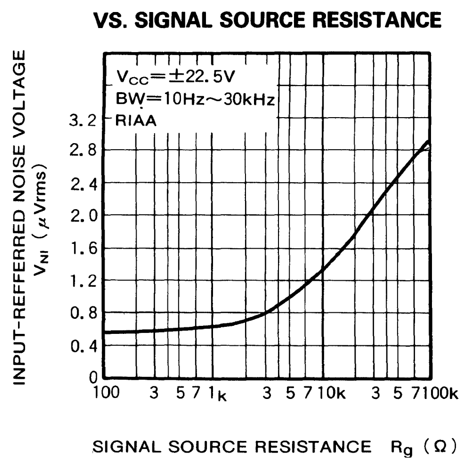
- G_V=35.6dB(f=1kHz)
- V_{NI}=0.75μVrms(R_g=2.2kΩ, BW=10Hz~30kHz)
- S/N=83dB (IHF-A network, shorted input, 2.5mVrms input sensitivity)
- THD=0.001%(f=1kHz, V_O=5Vrms)

L_{ch} circuit constants are identical to those of R_{ch}
C_{B1}, C_{B2} : Capacitors for buzz prevention, use if required.
R_O : Resistor used to prevent parasitic oscillation for capacitive loads and current limiting with shorted and other abnormal load conditions

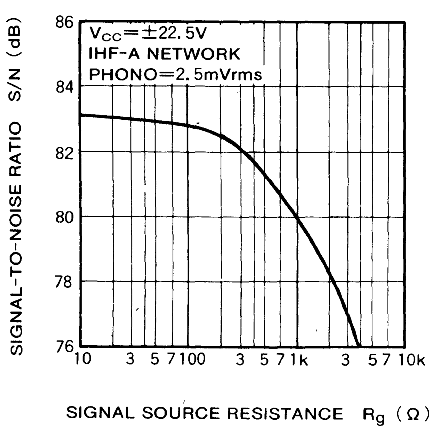
TOTAL HARMONIC DISTORTION VS. OUTPUT VOLTAGE



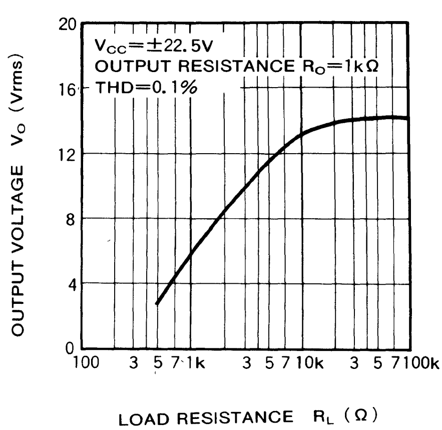
INPUT-REFERRED NOISE VOLTAGE VS. SIGNAL SOURCE RESISTANCE



SIGNAL-TO-NOISE RATIO VS. SIGNAL SOURCE RESISTANCE

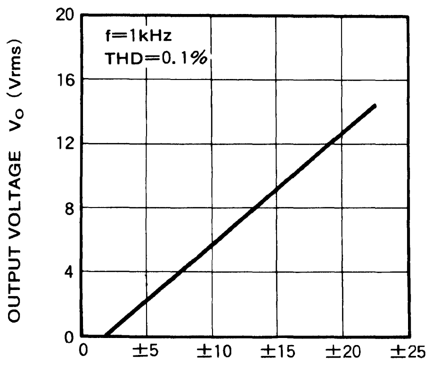


OUTPUT VOLTAGE VS. LOAD RESISTANCE

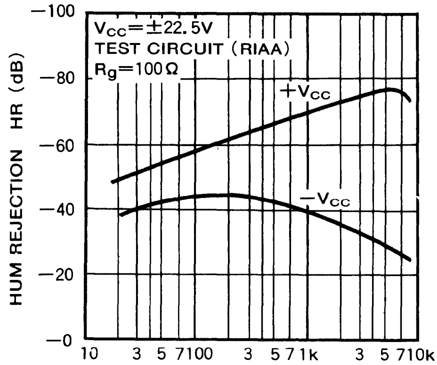


DUAL LOW-NOISE OPERATIONAL AMPLIFIERS(DUAL POWER SUPPLY TYPE)

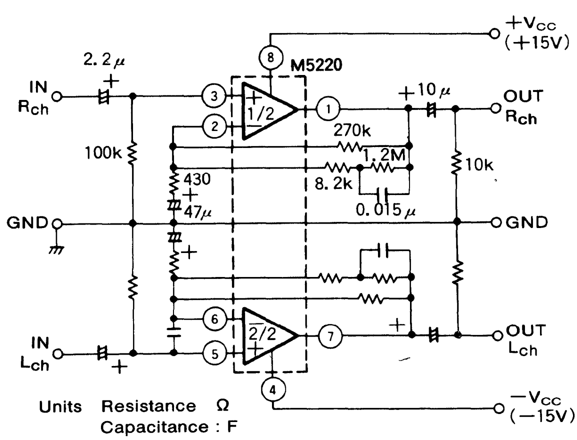
OUTPUT VOLTAGE VS. SUPPLY VOLTAGE



HUM REJECTION VS. FREQUENCY



(2) Stereo deck equalizer amplifier circuit



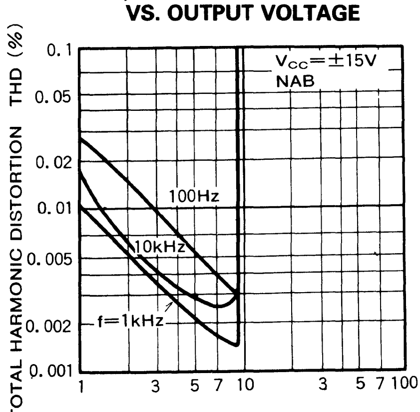
Units Resistance Ω
Capacitance : F

L_{ch} circuit constants are identical to those of R_{ch}

TYPICAL CHARACTERISTICS (V_{CC}=±15V, NAB)

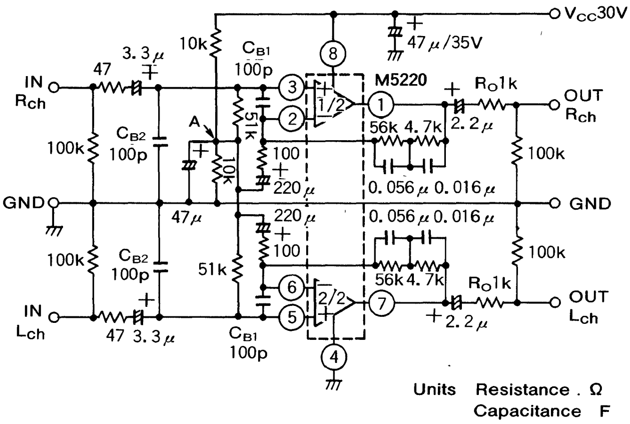
- G_V=29.9dB(f=1kHz)
- V_{NI}=1.0μVrms(R_g=2.2kΩ, BW=20Hz~15kHz) (−120dBv)

TOTAL HARMONIC DISTORTION VS. OUTPUT VOLTAGE



(3) Typical single power supply application

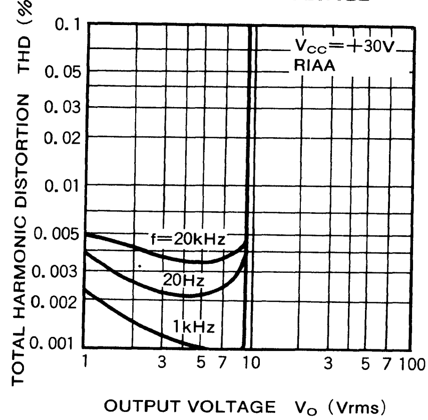
PHONO EQUALIZER AMPLIFIER (RIAA)



TYPICAL CHARACTERISTICS (V_{CC}=+30V, RIAA)

- G_V=35.6dB(f=1kHz)
- V_{NI}=0.75μVrms(R_g=2.2kΩ, BW=10Hz~30kHz)
- S/N=83dB (IHF-A network, shorted input, 2.5μVrms input sensitivity)

TOTAL HARMONIC DISTORTION VS. OUTPUT VOLTAGE



- → Point A is the $V_{CC}/2$ point in DC terms (virtual ground) when the device is used as a single power supply type.
- C_{B1}, C_{B2} : Capacitor for buzz prevention, used if required
- R_O : Resistor used to prevent parasitic oscillation for capacitive loads and current limiting with shorted and other abnormal conditions

M5221L, P, FP/M5T082P

DUAL J-FET INPUT OPERATIONAL AMPLIFIERS

DESCRIPTION

The M5221/M5T082P are semiconductor integrated circuits designed as high-performance dual operational amplifiers which adopt J-FETs in the input stage.

The devices come in an 8-pin SIP, DIP or FP and contain two circuits for yielding a high input impedance, high slew rate, low bias current and other excellent characteristics. They can be widely used as a general-purpose operational amplifiers in stereo equipment, tape decks, digital audio disc players and other similar products as well as in VTRs, video disc players and video related players.

FEATURES

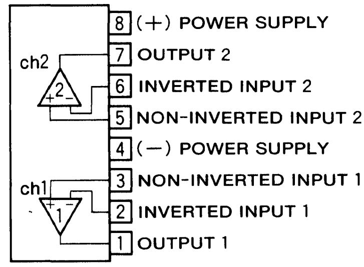
- High input impedance due to J-FET input ··········· R_i=1000MΩ (typ.)
- High slew rate ··········· SR=13V/μs(typ.)
- High gain, low distortion ········ G_{VO}=106dB, THD=0.007% (G_V=40dB @f=1kHz)(typ.)
- Large laod current and allowable current ··········· I_{LP}=±50mA, P_d=800mW(SIP) P_d=625mW(DIP) P_d=440mW(FP)

APPLICATION

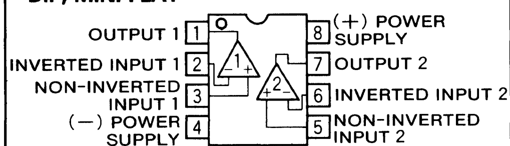
General-purpose preamplifier in stereo equipment, tape decks and digital audio disc players, VTRs and video disc players.

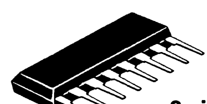
PIN CONFIGURATION (TOP VIEW)

SIP



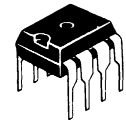
DIP, MINI FLAT





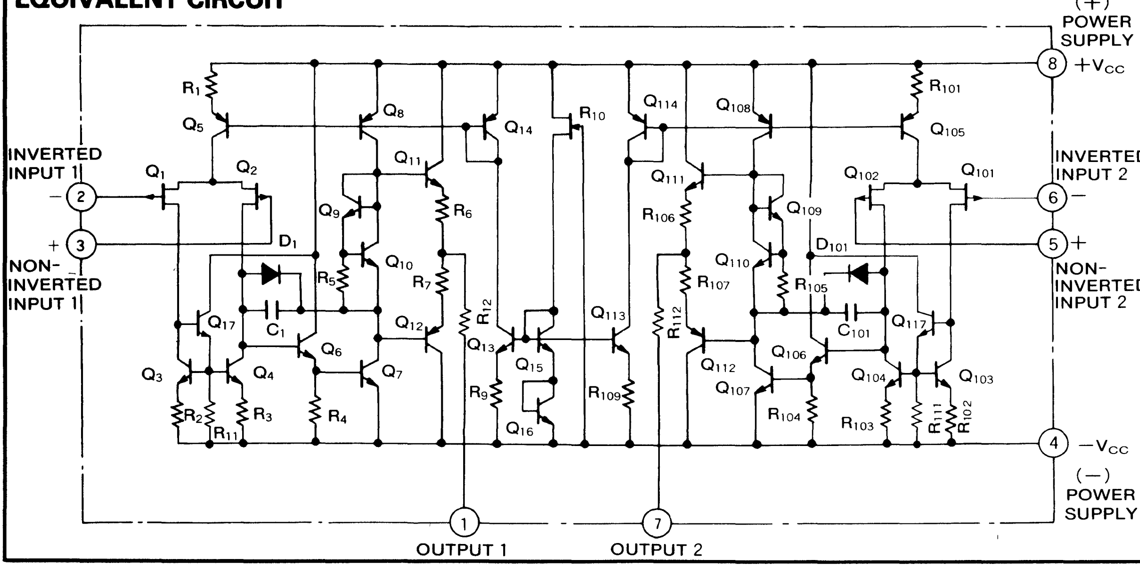
8-pin molded plastic SIP

8-pin molded plastic FP (MINI FLAT)



8-pin molded plastic DIP

EQUIVALENT CIRCUIT



ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

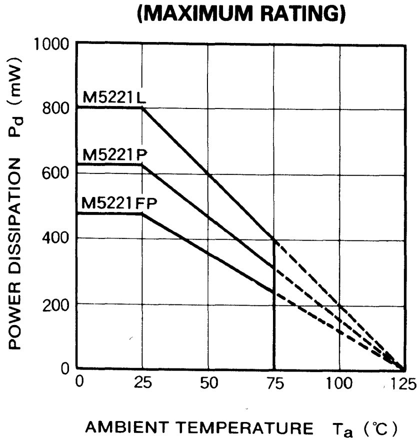
Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		±18	V
I_{LP}	Load current		±50	mA
V_{id}	Differential input voltage		±30	V
V_{ic}	Common input voltage		±15	V
P_d	Power dissipation		800(SIP)/625(DIP)/440(FP)	mW
K_θ	Thermal derating	T_a≧25℃	8(SIP)/6.25(DIP)/4.4(FP)	mW/℃
T_{opr}	Operating temperature		−20～+75	℃
T_{stg}	Storage temperature		−55～+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=±15V)

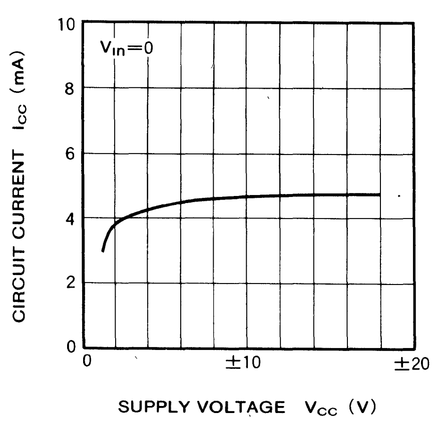
Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
I_{CC}	Circuit current	V_{in}=0		3.0	6.0	mA
V_{IO}	Input offset voltage	R_S≦10kΩ		5.0	15.0	mV
I_{IO}	Input offset current			5	200	pA
I_{IB}	Input bias current			30	400	pA
R_{in}	Input resistance			10^3		MΩ
G_{VO}	Open loop voltage gain	R_L≧2kΩ, V_O=±10V	86	106		dB
V_{OM}	Maximum output voltage	R_L≧10kΩ	±12	±14		V
		R_L≧2kΩ	±10	±13		
V_{CM}	Common input voltage width		±10	12		V
CMRR	Common mode rejection ratio	R_S≦10kΩ	70	76		dB
SVRR	Supply voltage rejection ratio	R_S≦10kΩ		30	150	μV/V
P_d	Power dissipation			90	180	mW
SR	Slew rate	G_V=0dB, R_L=2kΩ		13		V/μs
f_T	Gaing bandwidth product			3		MHz
V_{NI}	Input-referred noise voltage	R_S=100Ω, BW=10Hz～ 30kHz		2.2		μVrms

TYPICAL CHARACTERISTICS

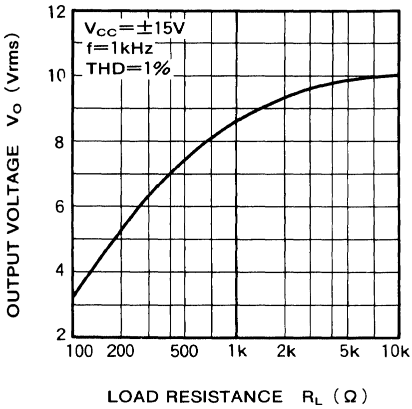
THERMAL DERATING (MAXIMUM RATING)



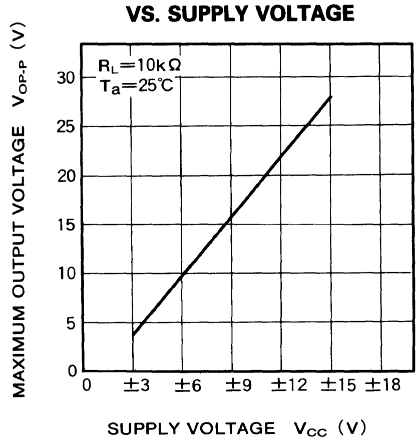
CIRCUIT CURRENT VS. SUPPLY VOLTAGE



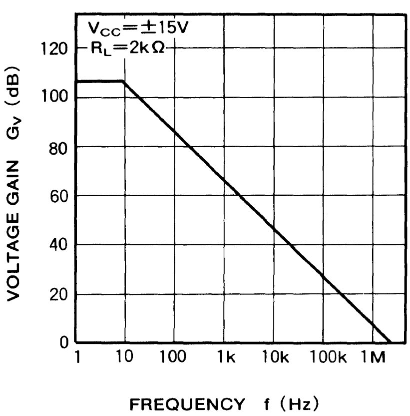
OUTPUT VOLTAGE VS. LOAD RESISTANCE



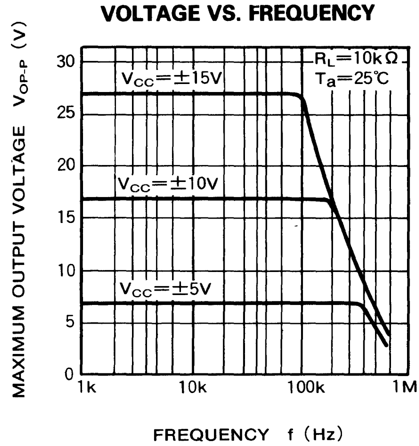
MAXIMUM OUTPUT VOLTAGE VS. SUPPLY VOLTAGE



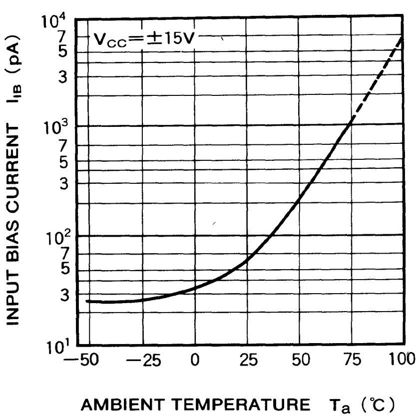
VOLTAGE GAIN VS. FREQUENCY RESPONSE



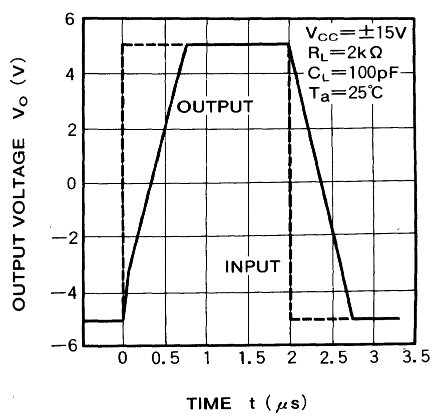
MAXIMUM OUTPUT VOLTAGE VS. FREQUENCY



INPUT BIAS CURRNET VS. AMBIENT TEMPERATURE

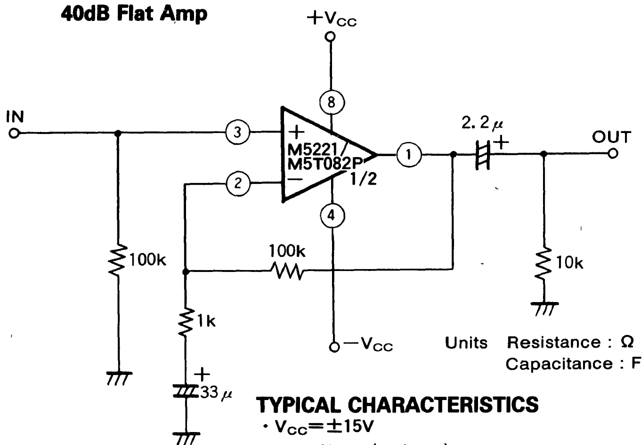


SLEW RATE (SR) CHARACTERISTICS



APPLICATION EXAMPLE

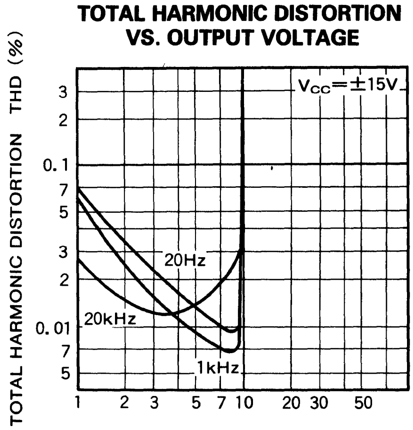
40dB Flat Amp



TYPICAL CHARACTERISTICS

- $V_{CC}=\pm15V$
- $G_V=40dB$ (f=1kHz)
- $V_O=9.5Vrms$ (f=1kHz, THD=0.1%)
- THD=0.007% (f=1kHz, $V_O=7Vrms$)

TOTAL HARMONIC DISTORTION VS. OUTPUT VOLTAGE



M5238L, P, FP

DUAL LOW-NOISE J-FET INPUT OPERATIONAL AMPLIFIERS

DESCRIPTION

The M5238 is a semiconductor integrated circuit designed as a low-noise Bi-FET operational amplifier which adopts J-FETs in the input stage. Noise reduction characteristic in the input stage has been improved by 3 - 4dB, when compared with the M5221 general-purpose Bi-FET operational amplifier, and two circuits for yielding a high input impedance, high slew rate and low bias current and other excellent characteristics, are housed in an 8-pin SIP, DIP or FP.

It can be widely used as a general-purpose operational amplifier in stereo equipment, tape decks, digital audio disc players and other similar products as well as in VTRs, video disc players and video related players.

FEATURES

- Low noise, input-referred noise ······· V_{NI}=1.9μVrms(typ.)
  (R_S=100kΩ BW10Hz~30kHz FLAT)
  S/N=73dB(typ.)
  (Shorted input, RIAA, IHF-A network, PHONO 2.5mVrms)
- High input impedance due to J-FET input ······ R_i=1000MΩ(typ.)
- High slew rate ······ S_R=20V/μs(typ.)
- High gain, low distortion ······ G_{VO}=100dB(typ.), THD=0.002%
  (G_V=35.6dB, RIAA, V_O=5Vrms)
- Large load current and allowable current ······ I_{LP}=±50mA, P_d=800mW(SIP)
  P_d=625mW(DIP), P_d=440mW(FP)

APPLICATION

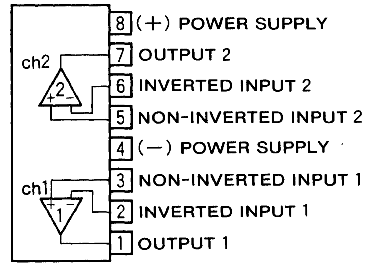
General purpose preamplifier in stereo equipment, tape decks and digital audio disc players, VTRs and video disc players.

RECOMMENDED OPERATING CONDITIONS

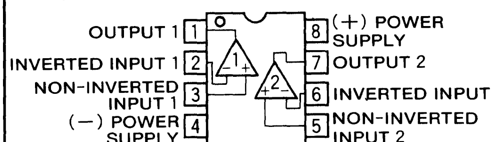
Supply voltage range ······ ±5~±15V
Rated supply voltage ······ ±15V

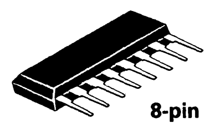
PIN CONFIGURATION (TOP VIEW)

SIP



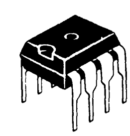
DIP, MINI FLAT





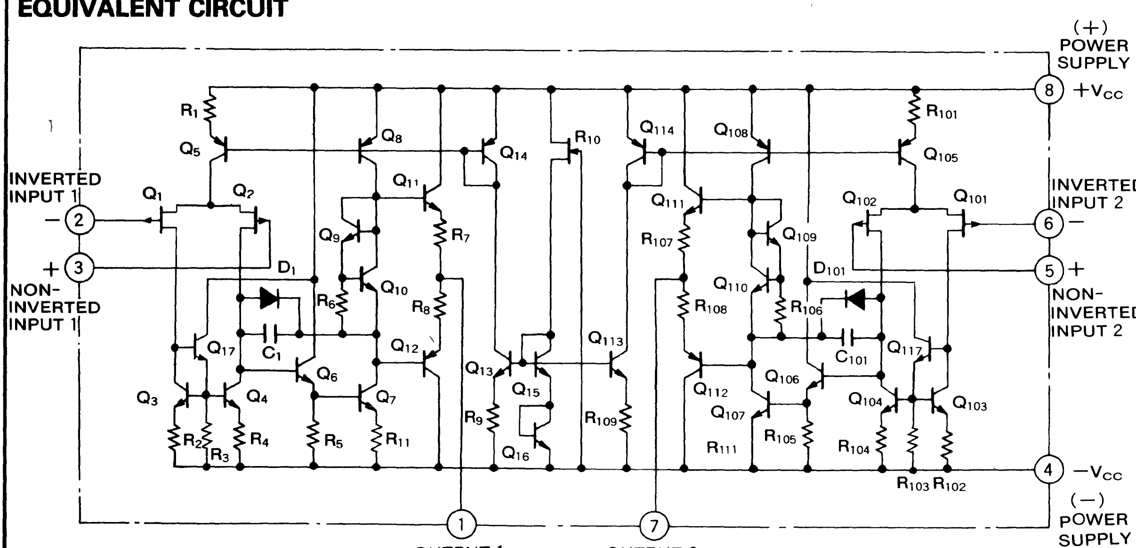
8-pin molded plastic SIP

8-pin molded plastic FP (MINI FLAT)



8-pin molded plastic DIP

EQUIVALENT CIRCUIT



DUAL LOW-NOISE J-FET INPUT OPERATIONAL AMPLIFIERS

ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

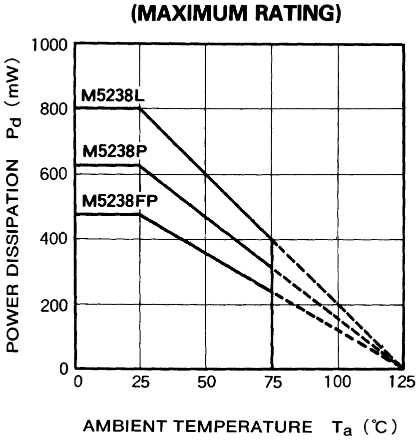
Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		±18	V
I_{LP}	Load current		±50	mA
V_{id}	Differential input voltage		±30	V
V_{ic}	Common input voltage		±15	V
P_d	Power dissipation		800(SIP)/625(DIP)/440(FP)	mW
K_θ	Thermal derating	$T_a \geqq 25$℃	8(SIP)/6.25(DIP)/4.4(FP)	mW/℃
T_{opr}	Ambient temperature		−20～+75	℃
T_{stg}	Storage temperature		−55～+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=±15V)

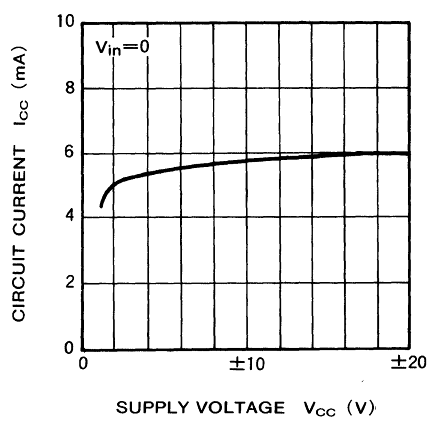
Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
I_{CC}	Circuit current	V_{in}=0		5.8	9.0	mA
V_{IO}	Input offset voltage	$R_S \leqq 10k\Omega$		2.0	10.0	mV
I_{IO}	Input offset current			5	200	pA
I_{IB}	Input bias current			30	400	pA
R_{in}	Input resistance			10^3		MΩ
G_{VO}	Open loop voltage gain	$R_L \geqq 2k\Omega$, V_O=±10V	86	106		dB
V_{OM}	Maximum output voltage	$R_L \geqq 10k\Omega$	±12	±14		V
		$R_L \geqq 2k\Omega$	±10	±13		
V_{CM}	Common input voltage width		±10	±12		V
CMRR	Common mode rejection ratio	$R_S \leqq 10k\Omega$	70	76		dB
SVRR	Supply voltage rejection ratio	$R_S \leqq 10k\Omega$		30	150	μV/V
P_d	Power dissipation			174	270	mW
SR	Slew rate	G_V=0dB, R_L=2kΩ		20		V/μs
f_T	Gain bandwidth product			6		MHz
V_{NI}	Input referred noise voltage	R_S=100Ω, BW=10Hz～30kHz		1.9		μVrms

TYPICAL CHARACTERISTICS

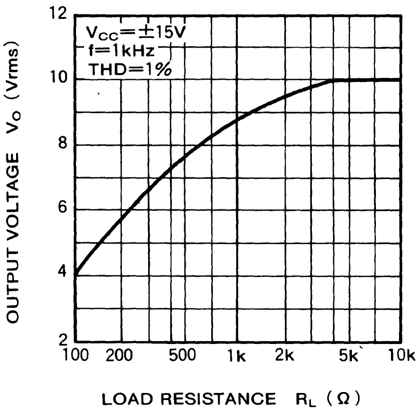
THERMAL DERATING (MAXIMUM RATING)



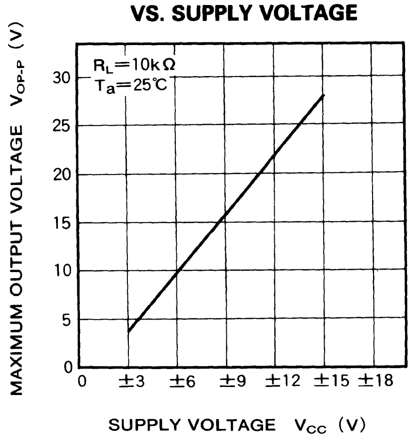
CIRCUIT CURRENT VS. SUPPLY VOLTAGE



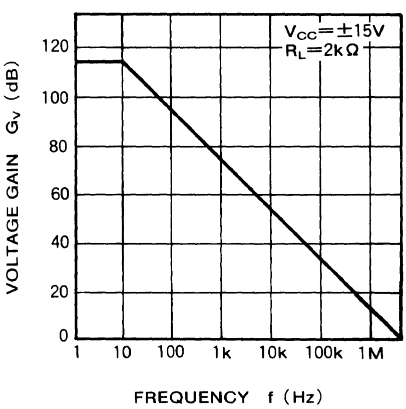
OUTPUT VOLTAGE VS. LOAD RESISTANCE



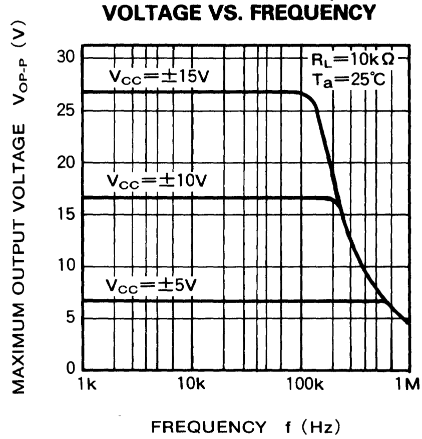
MAXIMUM OUTPUT VOLTAGE VS. SUPPLY VOLTAGE



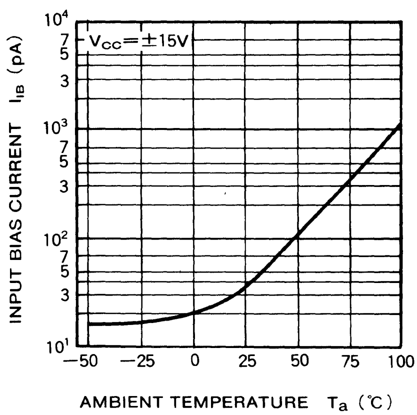
VOLTAGE GAIN VS. FREQUENCY RESPONSE



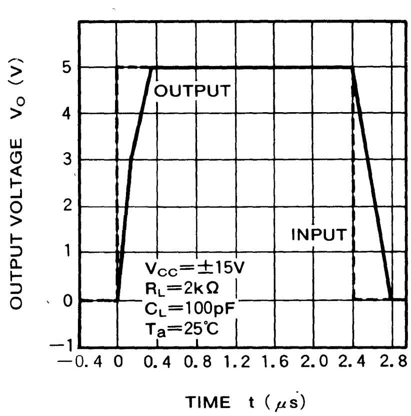
MAXIMUM OUTPUT VOLTAGE VS. FREQUENCY



INPUT BIAS CURRENT VS. AMBIENT TEMPERATURE

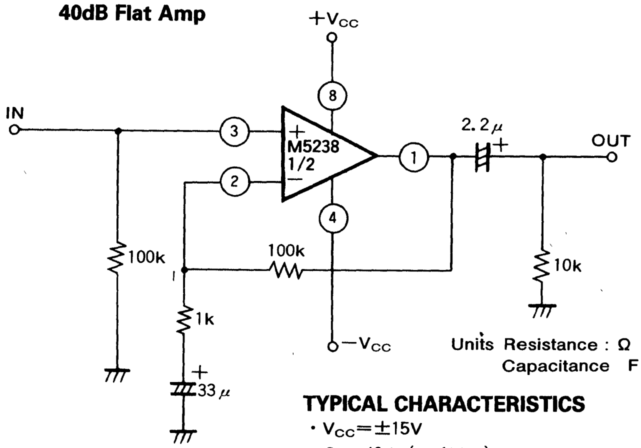


SLEW RATE (SR) CHARACTERISTICS

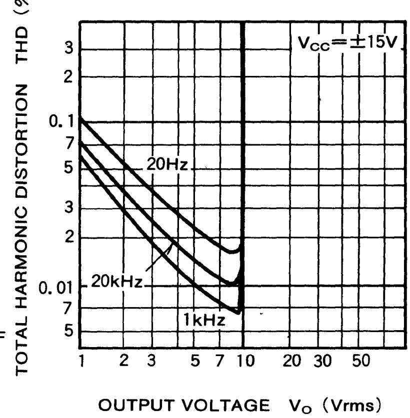


APPLICATION EXAMPLE

40dB Flat Amp



TOTAL HARMONIC DISTORTION VS. OUTPUT VOLTAGE

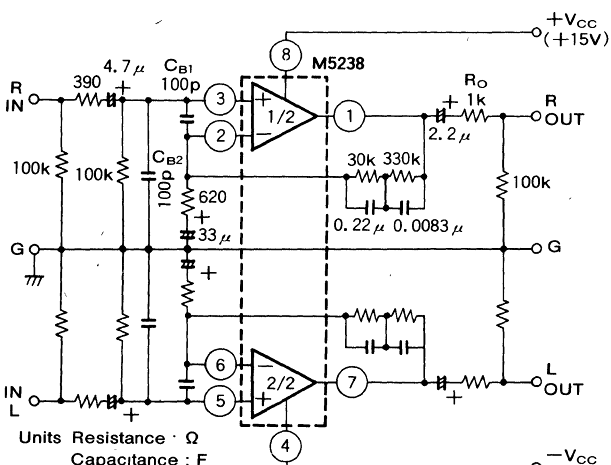


TYPICAL CHARACTERISTICS

- $V_{CC}=\pm15V$
- $G_V=40dB(f=1kHz)$
- $V_O=9.5Vrms(f=1kHz, THD=0.1\%)$
- $THD=0.007\%(f=1kHz, V_O=7Vrms)$

APPLICATION EXAMPLE

Stereo equalizer amplifier circuit



L_{ch} circuit constants are identical to those of R_{ch}

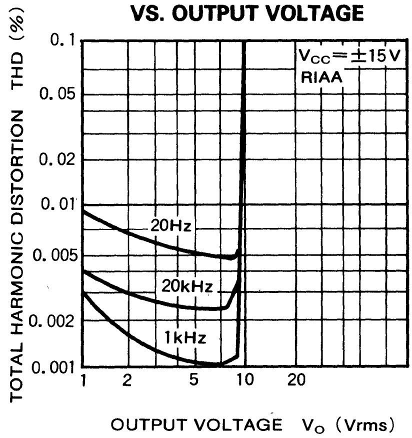
C_{B1}, C_{B2} : Capacitors for buzz prevention, use if required.

R_O : Resistor used to prevent parasitic oscillation for capacitive loads and current limiting with shorted and other abnormal load conditions.

TYPICAL CHARACTERISTICS ($V_{CC}=\pm15V$, RIAA)

- $G_V=35.6dB(f=1kHz)$
- $V_{NI}=1.9\mu Vrms(R_S=100\Omega, BW=20Hz\sim30kHz)$
- S/N=73dB (IHF-A network, shorted input, 2.5mVrms input sensitivity)
- $THD=0.001\%(f=1kHz, V_O=7Vrms)$

TOTAL HARMONIC DISTORTION VS. OUTPUT VOLTAGE



M5240P

DUAL LOW-NOISE J-FET INPUT OPERATIONAL AMPLIFIERS

DESCRIPTION

The M5240P is a semiconductor integrated circuit designed as a low-noise Bi-FET operational amplifier which adopts J-FETs in the input stage. The device comes in a 16-pin DIP and contains two circuits for yielding high sound quality, high input impedance, high slew rate and low distortion characteristics. It can be widely used as an operational amplifier in stereo equipment, tape decks, and as preamplifier for digital audio disc players and other similar products, mixer for public announcement or LM, high fidelity VTRs.

FEATURES

- Low noise ········· S/N=82dB(typ.) (shorted input, RIAA, IHF-A, PHONO 2.5mVrms)
- High slew rate ········· SR=40V/μs(typ.) (Variable by extermally connected RC due to external phase compensation type)
- High input impedance ········· R_i=1000MΩ (typ.)
- Low distortion rate ········· THD=0.001%(typ.) (f=1kHz, RIAA, V_O=5Vrms)
- Large load current and allowable current ········· I_{LP}=±50mA, P_d=1W

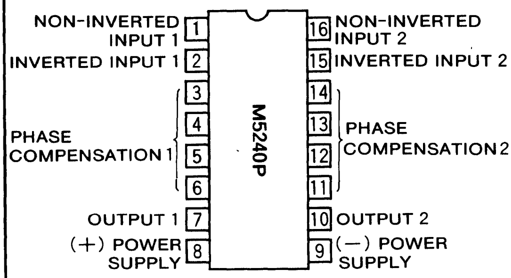
APPLICATION

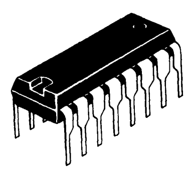
Amplifier in stereo equipment, tape decks and digital audio disc players, mixer.

RECOMMENDED OPERATING CONDITIONS

Supply voltage range ········· ±5~±15V
Rated supply voltage ········· ±15V

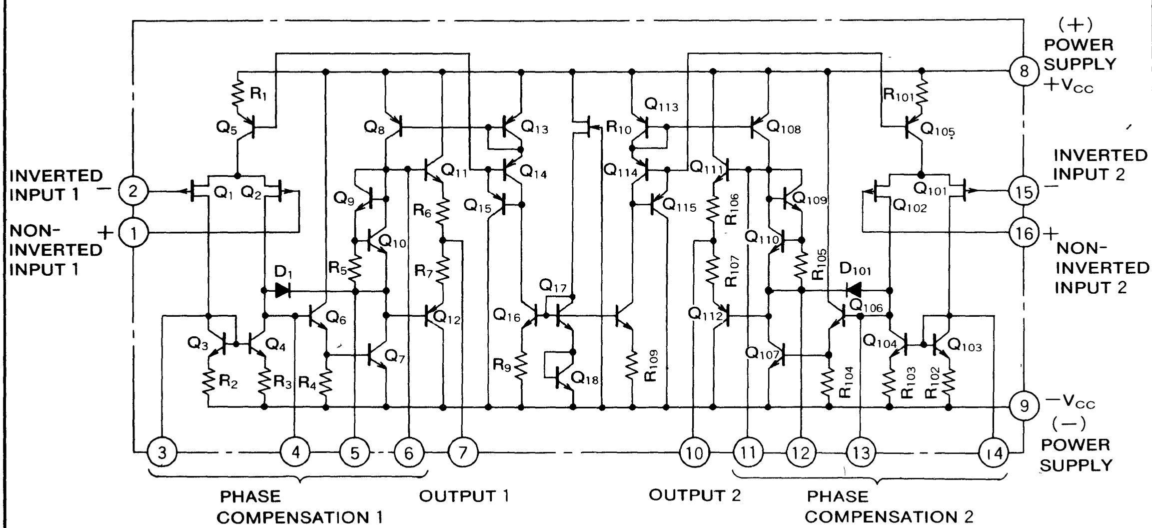
PIN CONFIGURATION (TOP VIEW)





16-pin molded plastic DIP

EQUIVALENT CIRCUIT



DUAL LOW-NOISE J-FET INPUT OPERATIONAL AMPLIFIERS

ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

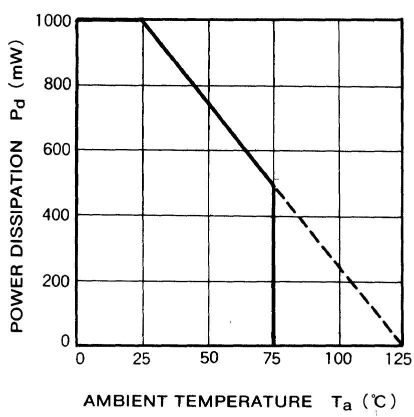
Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		±18	V
I_{LP}	Load current		±50	mA
V_{id}	Differential input voltage		±30	V
V_{ic}	Common input voltage		±15	V
P_d	Power dissipation		1000	mW
$K\theta$	Thermal derating	$T_a \geqq 25$℃	10	mW/℃
T_{opr}	Ambient temperature		−20～+75	℃
T_{stg}	Storage temperature		−55～+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=±15V)

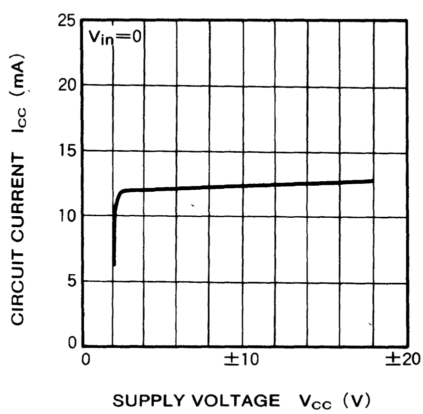
Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
I_{CC}	Circuit current	V_{in}=0		12.0	17.0	mA
V_{IO}	Input offset voltage	$R_S \leqq 10k\Omega$		5.0	15.0	mV
I_{IO}	Input offset current			25	1000	pA
I_{IB}	Input bias current			120	2000	pA
R_{in}	Input resistance			10^3		MΩ
G_{VO}	Open loop voltage gain	$R_L \geqq 2k\Omega$, V_O=±10V		110		dB
V_{OM}	Maximum output voltage	$R_L \geqq 10k\Omega$	±12	±14		V
		$R_L \geqq 2k\Omega$	±10	±13		
V_{CM}	Common input voltage width		±10	±12		V
CMRR	Common mode rejection ratio	$R_S \leqq 10k\Omega$	70	76		dB
SVRR	Supply voltage rejection ratio	$R_S \leqq 10k\Omega$		30	150	μV/V
P_d	Power dissipation			360	510	mW
SR	Slew rate	G_V=16.5dB		40		V/μs
f_T	Gain bandwidth product			18		MHz
e_n	Equivalent input refferred noise voltage	R_S=100Ω, BW=10Hz～30kHz		3.3		nV/√Hz
V_{NI}		R_g=2.2kΩ, RIAA EQ		1.2	2.5	μVrms
S/N	Signal-to-noise voltage ratio	R_g=47Ω, RIAA EQ, IHF-A		82		dB

TYPICAL CHARACTERISTICS

THERMAL DERATING (MAXIMUM RATING)



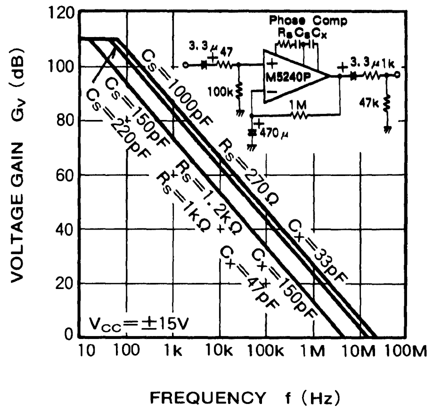
CIRCUIT CURRENT VS. SUPPLY VOLTAGE



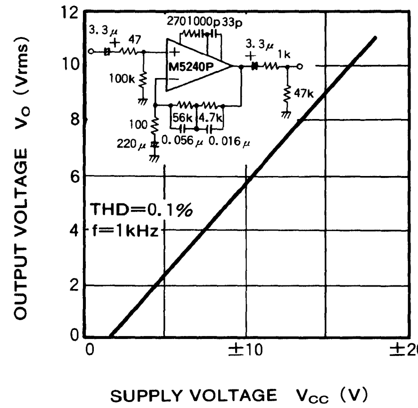
MITSUBISHI ELECTRIC

DUAL LOW-NOISE J-FET INPUT OPERATIONAL AMPLIFIERS

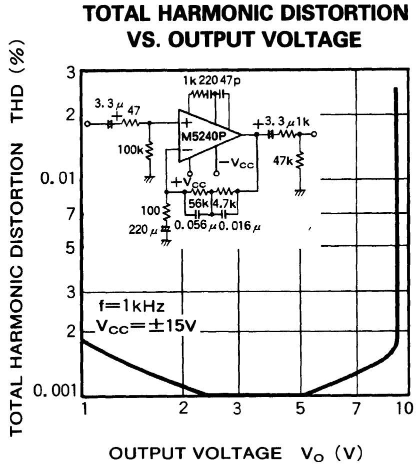
VOLTAGE GAIN VS. FREQUENCY RESPONSE



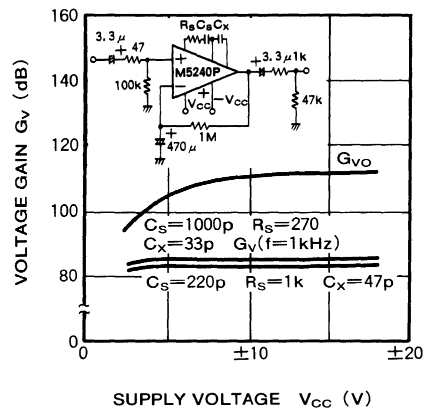
OUTPUT VOLTAGE VS. SUPPLY VOLTAGE



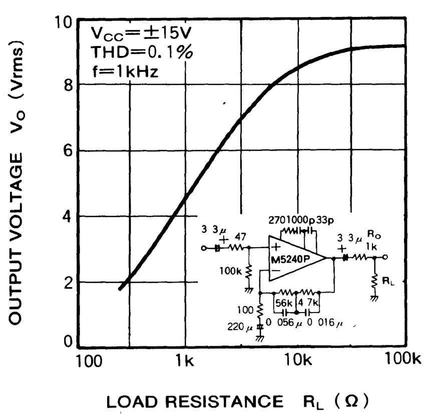
TOTAL HARMONIC DISTORTION VS. OUTPUT VOLTAGE



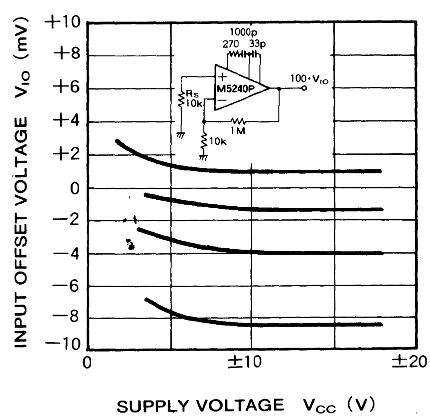
VOLTAGE GAIN VS. SUPPLY VOLTAGE



OUTPUT VOLTAGE VS. LOAD RESISTANCE

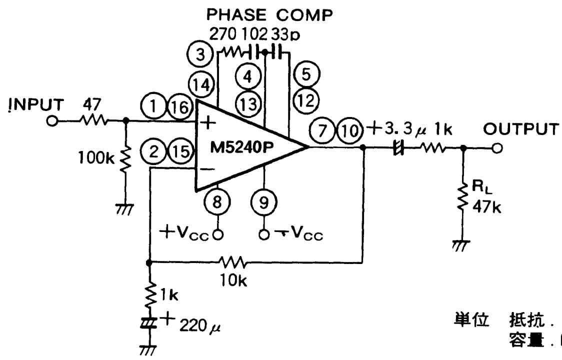


INPUT OFFSET VOLTAGE VS. SUPPLY VOLTAGE



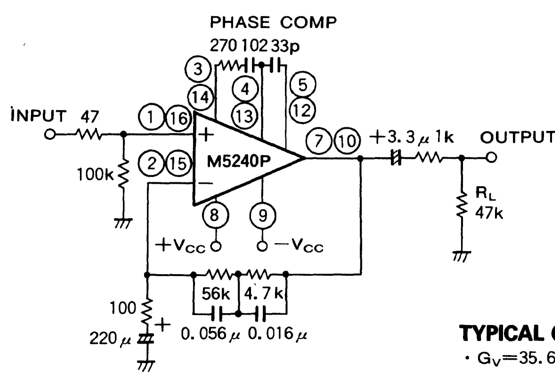
TYPICAL APPLICATION EXAMPLES

1. G_V=20dB FLAT AMP



単位　抵抗．Ω
容量．F

2. STEREO EQUALIZER AMP

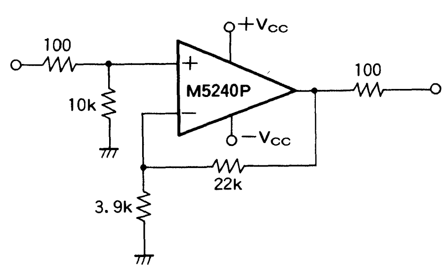


Unit　Resistance : Ω
Capacitance : F

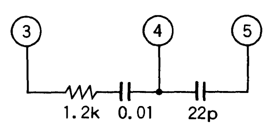
TYPICAL CHARACTERISTICS (V_{CC}=±15V, RIAA)

- G_V=35.6dB(f=1kHz)
- V_{NI}=1.2μVrms(R_g=2.2kΩ, BW=10Hz~30kHz)
- THD=0.001%(f=1kHz, V_O=5Vrms)
- S/N=82dB (IHF-A network, shorted input, 2.5mrms input sensitivity)

3. HIGH SLEW RATE FLAT AMP



V_{CC}=±15, FLAT
G_V=16.5dB
SR=40V/μs



Phase compensation
SR　+40V/μs
−40V/μs

Unit　Resistance : Ω
Capacitance : F

M5201L, P, FP

GENERAL PURPOSE SWITCHING OPERATIONAL AMPLIFIER (DUAL INPUT,SINGLE OUTPUT TYPE)

DESCRIPTION

The M5201 is a semiconductor integrated circuit designed for an operational amplifier which adopts analog switch function, having dual inputs of A and B and a single output. The device comes in an 8-pin SIP, DIP or FP and contains input differential circuits of A and B type, single output circuit and a switching circuit of an operational amplifier, and can be used as a convertional operational amplifier, turning on A or B inputs by externally setting the control pin at high or low level. For a voltage follower condition where $G_V = 0dB$, the device functions merely as an analog switch, but, for an amplifier with a switching function, gain can be set independently for A and B inputs. The M5201 operational amplifier has basic characteristics similar to those of the M5218/ M5R4558P and can be widely used as audio, video and musical instrument equipments.

FEATURES

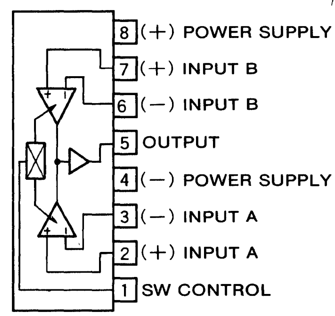
- Operational amplifier inputs of A and B type and gain can be set independently
- Applicable to both single and dual power supplies
- High gain, low distortion ·························· $G_{VO}=100dB$, THD=0.002%(typ.)
- High slew rate, high f_T ······· SR=2.2V/μs, f_T=7MHz(typ.)
- Low noise (R_S=1kΩ) FLAT ············· V_{NI}=2μVrms(typ.)
- Small switching shock noise
- Large-current, large allowable dissipation ······························ I_{LP}=±50mA, P_d=800mW(SIP)
  P_d=625mW(DIP)
  P_d=440mW(FP)

RECOMMENDED OPERATING CONDITIONS

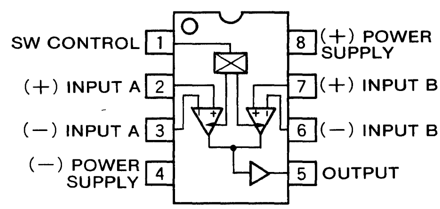
Supply voltage range ···························· ±2.5~±16V
Rated supply voltage ······································ ±15V

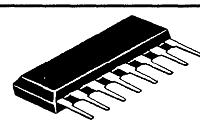
PIN CONFIGURATION (TOP VIEW)

SIP



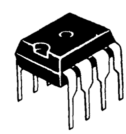
DIP, MINI FLAT





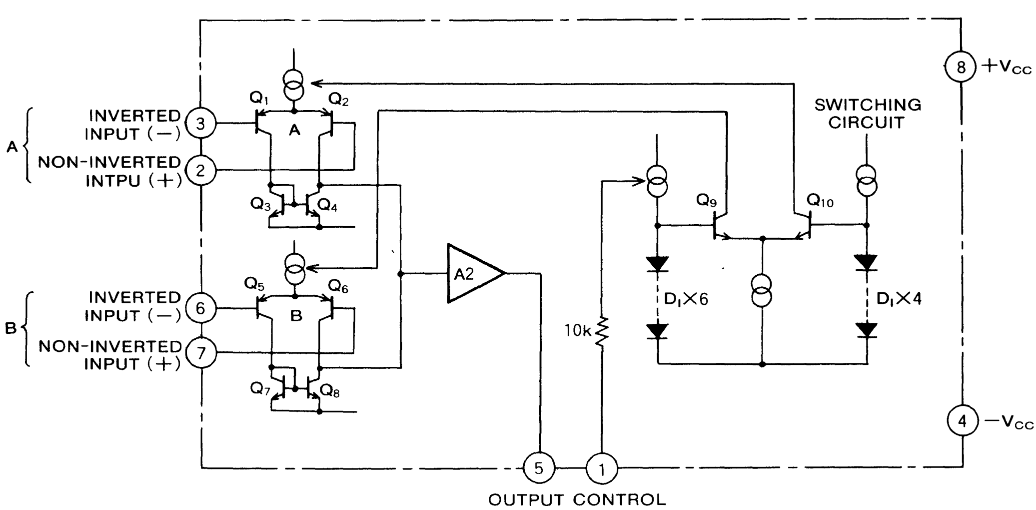
8-pin molded plastic SIP

8-pin molded plastic FP (MINI FLAT)



8-pin molded plastic DIP

EQUIVALENT CIRCUIT



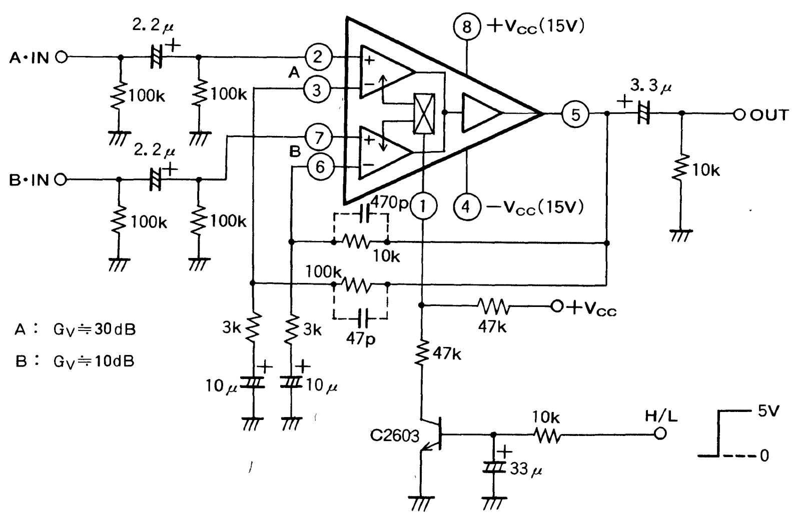
ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Ratings	Unit
V_{CC}	Supply voltage	±18(36)	V
V_{id}	Differential input voltage	±30	V
V_{IC}	Common phase input voltage	±15	V
I_{LP}	Load current	±50	mA
P_d	Power dissipation	800(SIP)/625(DIP)/440(FP)	mW
T_{opr}	Ambient temperature	−20～+75	℃
T_{stg}	Storage temperature	−55～+125	℃

ELECTRICAL CHARACTERISTICS (V_{CC}=±15V)

Symbol	Parameter	Test conditions		Limits Min	Limits Typ	Limits Max	Unit
I_{CC}	Circuit current	V_{in}	SW ON		2.3	6.0	mA
			SW OFF		2.1	6.0	
V_{IO}	Input offset voltage	R_S=10kΩ			0.8	6.0	mV
I_B	Input bias current				80	500	nA
G_{VO}	Open loop voltage gain	R_L=2kΩ			100		dB
V_{OM}	Maximum output voltage	R_L≧10kΩ		±12	±14		V
THD	Total harmonic distortion	f=1kHz, V_O=5Vrms, G_V=20dB			0.002		%
SVR	Supply voltage rejection ratio				20	150	μV/V
C·S	Channel separation	f=1kHz			82		dB
f_T	Gain bandwidth product	G_V=0dB			7		MHz
SR	Slew rate	G_V=0dB, R_L=2kΩ//100pF			2.2		V/μs
V_{NI}	Input refferred noise voltage	R_S=1kΩ, BW=10Hz～30kHz, Flat			2.0		μVrms

TYPICAL APPLICATION EXAMPLE



※ When current at the control pin 1 is on, ch. B is turned on and, when the current is off, ch B is turned on

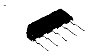
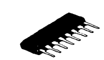
Units Resistance Ω
Capacitance : F

COMPARATOR

3

MITSUBISHI ELECTRIC

QUICK REFERENCE TABLE OF COMPARATORS

Application	Type No.	Function	Features	Maximum ratings: Operating supply voltage range V_{CC} (V)	Maximum ratings: Power dissipation P_d (mW)	Electrical characteristics (Typical characteristics): Circuit current I_{CC} (mA)	Output sink current I_{sink} (mA)	Input offset voltage V_{IO} (mV)	Input bias current I_B (nA)	Response time (μs)	Equivalent	Package outline
Single comparator	M51201	Single (built-in reference voltage circuit for comparision)	● Operates at low supply voltage ● Large output sink current	1.7~6.5	TL:180 FP:300	2	60 (at V_O=0.3V)	—	8	0.2 (Rise of output) 50 (Fall of output)	—	TL: 5-pin SIP  FP: 8-pin mini FLAT 
	M51203		● Wide supply voltage range ● Large output sink current	3.0~28		2	60 (at V_O=0.3V)	—	20	1.0 (Rise of output) 10 (Fall of output)	—	
	M51205		● Large output sink current	Including zener diode for shunt regulator		1.9	60 (at V_O=0.3V)	—	20	1.0 (Rise of output) 10 (Fall of output)	—	
	M51202	Single	● Operates at low supply voltage ● Large output sink current	1.7~6.5		1.7	60 (at V_O=0.3V)	2	8	0.2 (Rise of output) 50 (Fall of output)	—	
	M51204		● Wide supply voltage range ● Large output sink current	2.5~28		1.8	60 (at V_O=0.3V)	2	20	1.0 (Rise of output) 10 (Fall of output)	—	
	M51206		● Large output sink current	Including zener diode for shunt regulator		1.8	60 (at V_O=0.3V)	2	20	1.0 (Rise of output) 10 (Fall of output)	—	
Dual comparator	M51207L	Dual	● Wide supply voltage range ● Large output sink current	2.5~28	650	3.8	60 (at V_O=0.2V)	2	20	2.0 (Rise of output) 1.0 (Fall of output)	Functional equivalent of AN6916	L: 8-pin SIP 
	M51922L		● Wide supply voltage range ● Low power dissipation	2.5~28	650	1.5 (All output ON) 0.4 (All output OFF)	20 (at V_O=0.15V)	2	25	2.0 (Rise of output) 0.2 (Fall of output)	—	
	M51923		● Wide supply voltage range ● Low power dissipation	2.5~28	650 (M51923P) 300 (M51923FP)	1.5 (All output ON) 0.4 (All output OFF)	20 (at V_O=0.15V)	2	25	2.0 (Rise of output) 0.2 (Fall of output)	2903	L 8-pin SIP  FP: 8-pin mini FLAT 
	★ M5233	High output break down voltage dual	● Wide supply voltage range ● Low power dissipation ● Large output sink current	2~36	800 (M5233P) 625 (M5233L) 440 (M5233FP)	0.6	25	2	25	1.3	393 2903	L: 8-pin SIP  P: 8-pin DIP  FP: 8-pin mini FLAT 

★: New product

QUICK REFERENCE TABLE OF COMPARATORS (CONTINUED)

Application	Type No.	Function	Features	Maximum ratings: Operating supply voltage range V_{CC} (V)	Maximum ratings: Power dissipation P_d (mW)	Electrical characteristics (Typical characteristics): Circuit current I_{CC} (mA)	Output sink current I_{sink} (mA)	Input offset voltage V_{IO} (mV)	Input bias current I_B (nA)	Response time (μs)	Equivalent	Package outline
Quad comparator	M51209P	Quad	● Wide supply voltage range ● Large output sink current	2.5~28	900	6.8	60 (at V_O=0.2V)	2	20	2.0 (Rise of output) 1.0 (Fall of output)	Functional equivalent of AN6918	14-pin DIP
	M51924		● Wide supply voltage range ● Low power dissipation current	2.5~28	900 (M51924P) 350 (M51924FP)	3.0 (All output ON) 0.8 (All output OFF)	20 (at V_O=0.15V)	2	25	2.0 (Rise of output) 0.2 (Fall of output)	2901	P: 14-pin DIP FP: 14-pin mini FLAT
	★ M5234	High voltage quad	● Wide supply voltage range ● Low power dissipation current ● Large output sink current	2~36	700 (M5234P) 550 (M5234FP)	0.8	25	2	25	1.3	339 2901	P: 14-pin DIP FP: 14-pin mini FLAT

INDEX OF FUNCTIONAL EQUIVALENTS COMPARATORS

Application	Mitsubishi: Function	Mitsubishi: Type No.	Functional equivalents: JRC	NEC	Matsushita	Toshiba	Hitachi	Tokyo Sanyo	ROHm	TI	NSS	FC	MOTO
Comparator	High output break down voltage dual, general-purpose comparator	M5233L	NJM2903S(9L)		AN6913	TA75393S(9L)		LA69393S(9L)					
		M5233P	NJM2903D	μPC393C	AN1393 AN6914	TA75393P	HA17903PS	LA6393D	BA6993	LM393 LM2903	LM393 LM2903	μA393 μA2903	
		★ M5233FP	NJM2903M	μPC393G	AN1393S	TA75393F		LA6393M	BA6993F				
	High output break down voltage dual, general-purpose comparator	M5234P	NJM2901D	μPC339C	AN1339 AN6912	TA75339P	HA17901P	LA6339	BA10339	LM339 LM2901	LM339 LM2901	μA339 μA2901	MLM339P MLM2901P
		M5234FP	NJM2901M	μPC339G	AN1339NS	TA75339F		LA6339M	BA10339F				

L: SIP (8-pin), P: DIP (8-, 14-pin), (9L): SIP (9-pin), FP: mini FLAT (8-, 14-pin)

★: New product

MITSUBISHI ELECTRIC

M51201TL,FP

VOLTAGE COMPARATOR

DESCRIPTION

The M51201TL,FP is a semiconductor integrated circuit for a voltage comparator that operates from a single power supply. Especially the M51201TL,FP has superiority as to characteristics of input current (high input resistance) and fits to wide ranged applications, for example, CR timer, etc. M51201TL,FP's package is a mini SIP and FLAT package, therefore can use very easily.

FEATURES

- Low input current ··8nA(typ.)
- Capable of directly driving a relay or a lamp
- Operates at low supply voltage ························1.7~6.5V
- Low power dissipation ·················2mA typ. (V_{CC}=2.65V)
- Including reference voltage for comparison ··········· $V_{CC}/2$
- Including voltage surge absorbing zener diode for protection
- High output breakdown voltage ······················ 18V(max.)

APPLICATION

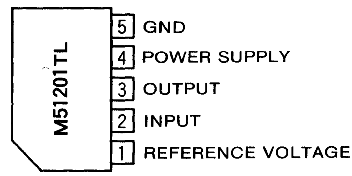
Electric shutter, CR timer, comparator, time delay circuit, oscillator (square wave)

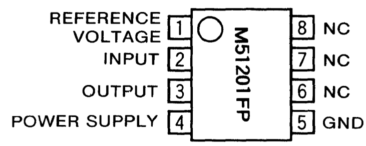
RECOMMENDED OPERATING CONDITIONS

Supply voltage range ··································1.7~6.5V

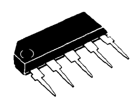
Rated supply voltage ··5.0V

PIN CONFIGURATION (TOP VIEW)

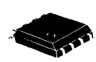




NC : NO CONNECTION

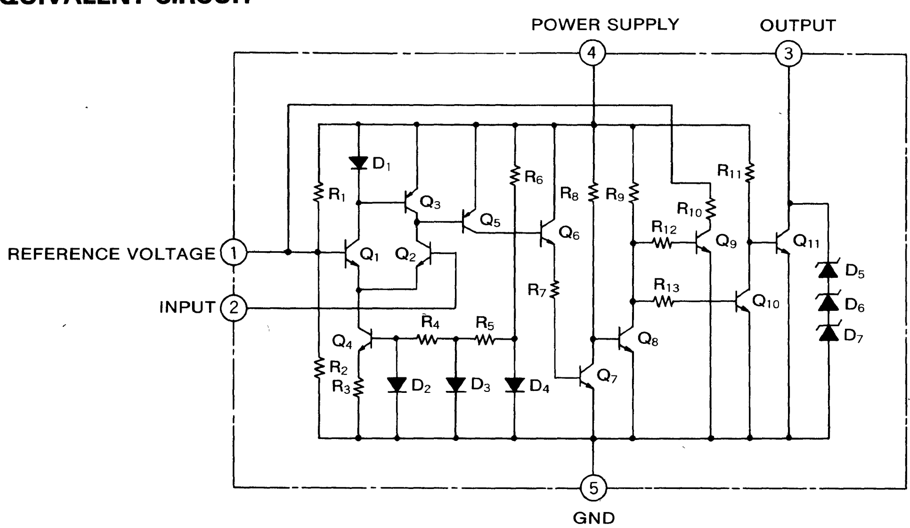


5-pin molded plastic SIP



8-pin molded plastic FP (MINI FLAT)

EQUIVALENT CIRCUIT



ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

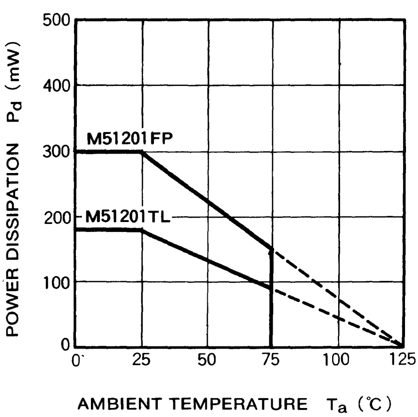
Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		6.5	V
I_{sink}	Output sink current		200	mA
V_{IN}	Input voltage		V_{CC}	V
P_d	Power dissipation		180(M51201TL)	mW
			300(M51201FP)	
K_θ	Thermal derating	$T_a \geq 25$℃	1.8(M51201TL)	mW/℃
			3.0(M51201FP)	
T_{opr}	Operating temperature		−20～+75	℃
T_{stg}	Storage temperature		−40～+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃)

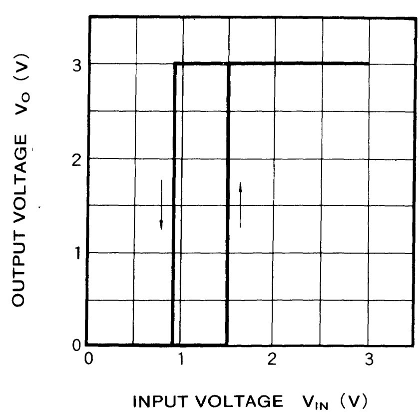
Symbol	Parameter	Test conditions		Limits			Unit
		V_{CC}(V)		Min	Typ	Max	
V_{CC}	Supply voltage range			1.7		6.5	V
I_{CC}	Circuit current	2.65			2.0	3.5	mA
		6.0			5.0	8.8	
I_{IN}	Input current	2.65			8	100	nA
V_{REF}	Reference voltage	6.0		2.55	3.0	3.45	V
V_{OL}	Output saturation voltage	6.0	I_{sink}=60mA		0.2	0.6	V
			I_{sink}=200mA		1		
V_Z	Zener voltage		I_Z=5mA	18	22	26	V
t_{PLH}	Output "L-H" propagation delay time	6.0			0.2		μs
t_{PHL}	Output "H-L" propagation delay time	6.0			50		μs
V_{IN}	Input voltage range			0.8		V_{CC}−0.2	V

TYPICAL CHARACTERISTICS (T_a=25℃, V_{CC}=3V, unless otherwise noted)

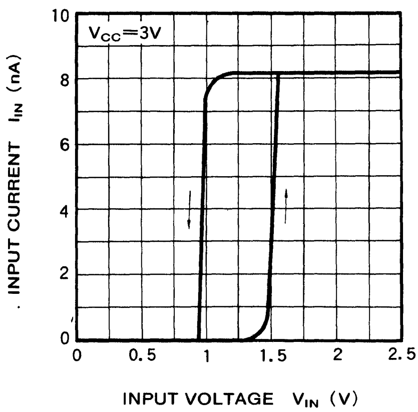
THERMAL DERATING (MAXIMUM RATING)



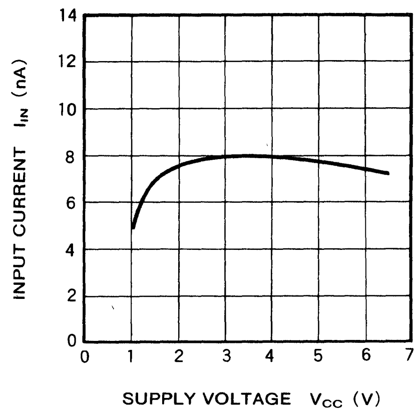
OUTPUT VOLTAGE VS. INPUT VOLTAGE



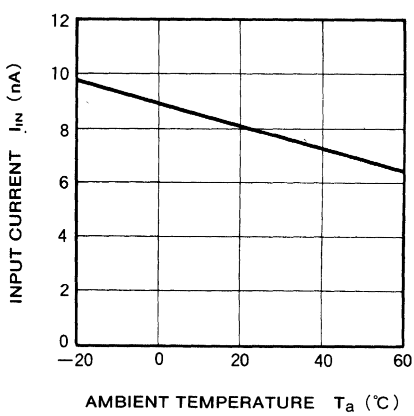
INPUT CURRENT VS. INPUT VOLTAGE



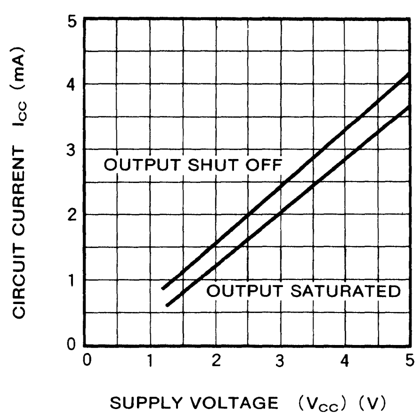
INPUT CURRENT VS. SUPPLY VOLTAGE



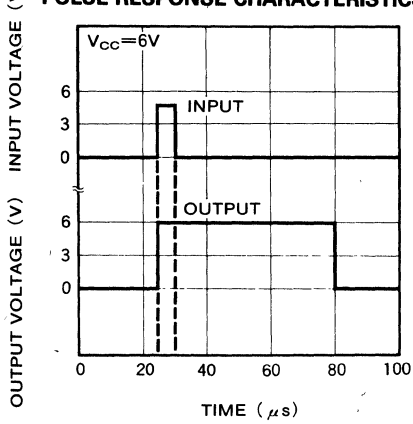
INPUT CURRENT VS. AMBIENT TEMPERATURE



CIRCUIT CURRENT VS. SUPPLY VOLTAGE

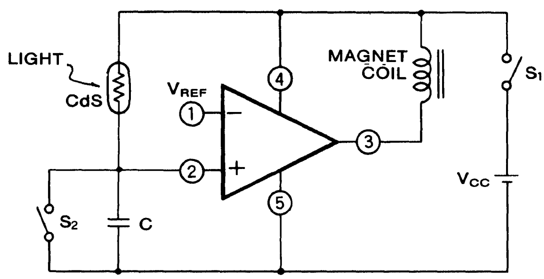


PULSE RESPONSE CHARACTERISTICS



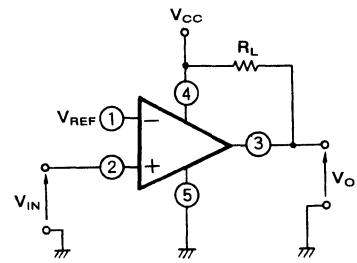
APPLICATION EXAMPLES

(1) Electric shutter

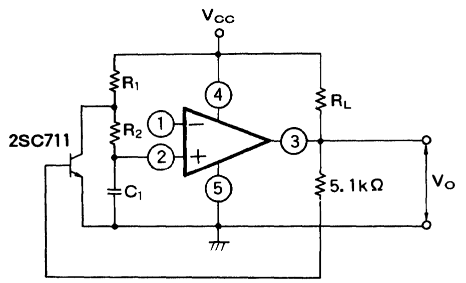


$t \approx 0.7CR_{cds}$

(2) Voltage comparator



(3) Oscillator



$$f = \frac{1}{C_1(0.337R_1 + 0.847R_2)} \text{ [Hz]}$$

PRECAUTIONS FOR USE

1. Paying much attention is necessary for fear that the M51201 TL,FP may flow large current and reach to destroy because of the structure when the terminals of V_{CC} and GND of the M51201 TL,FP is connected wrong position each other.
2. Reference voltage (V_{REF}) is adjustable for connecting external resistor, but adjustable voltage range is 0.8 to (V_{CC}−0.2)(V).
3. Output is "open collector" and a loading resistor is not included. Connect a loading resistor to stabilize operation, in case of driving a next stage.

M51203TL,FP

VOLTAGE COMPARATOR

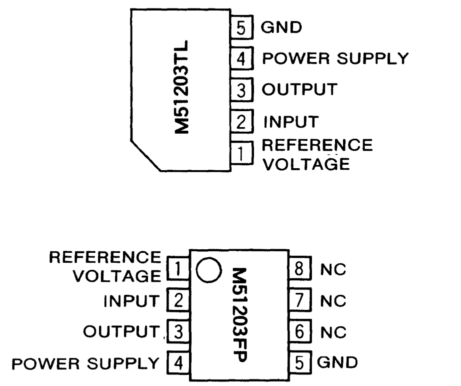
DESCRIPTION
The M51203TL,FP is a semiconductor integrated circuit for a voltage comparator that operates from a single power supply. Especially the M51203TL,FP has superiority as to characteristics of input current (high input resistance) and fits to wide ranged applications, for example CR timer, etc. M51203TL,FP's package is a mini SIP and FLAT package, therefore can use very easily.

FEATURES
- Low input current (high input resistance) ········ 20nA(typ.)
- Operates at low supply voltage ························ 3.0~28V
- Capable of directly driving a relay or a lamp
- Low power dissipation ······························2.5mA(max.)
- Including reference voltage for comparison
- Hysteresis characteristic between input and output
- High output breakdown voltage ····················· 30V(max.)

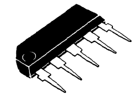
APPLICATION
Electric shutter, CR timer, voltage comparator, time delay circuit, oscillator (square wave)

RECOMMENDED OPERATING CONDITIONS
Supply voltage range ································· 3.0~28V
Rated supply voltage ···12V

PIN CONFIGURATION (TOP VIEW)



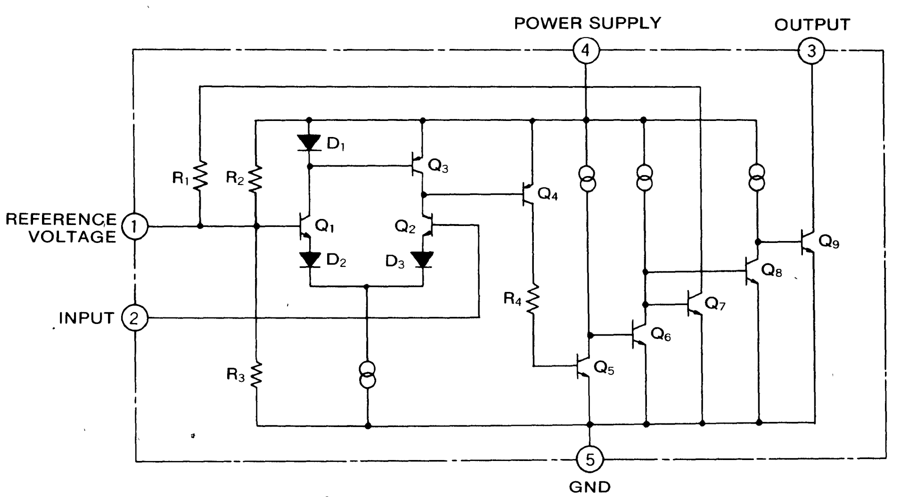
NC : NO CONNECTION



5-pin molded plastic SIP

8-pin molded plastic FLAT

EQUIVALENT CIRCUIT



MITSUBISHI ELECTRIC

ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

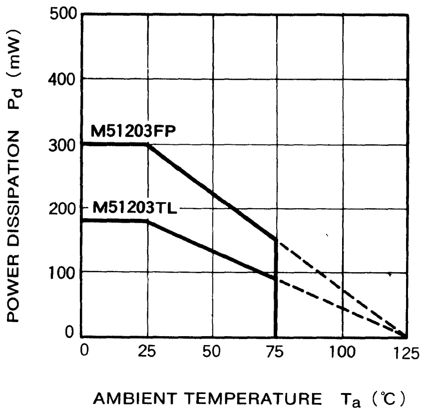
Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		28	V
V_{IN}	Input voltage		V_{CC}	V
I_{sink}	Output sink current		200	mA
V_{OH}	Output drive voltage		30	V
P_d	Power dissipation		180(M51203TL)	mW
			300(M51203FP)	
K_θ	Thermal derating	$T_a \geq 25$℃	1.8(M51203TL)	mW/℃
			3.0(M51203FP)	
T_{opr}	Operating temperature		−20～+75	℃
T_{stg}	Storage temperature		−40～+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃)

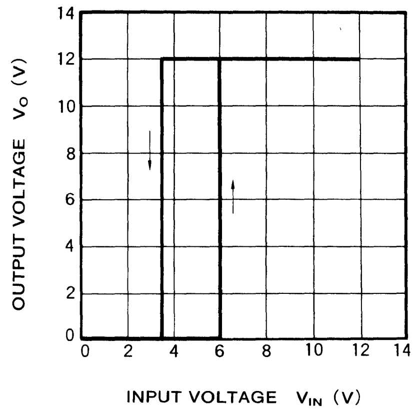
Symbol	Parameter	Test conditions		Limits			Unit
		V_{CC}(V)		Min	Typ	Max	
V_{CC}	Supply voltage range			3.0		28	V
I_{CC}	Circuit current	6.0			1.9	2.5	mA
		12.0			2.0		
		24.0			2.1		
V_{IN}	Input voltage			1.4		V_{CC}−0.2	V
I_{IN}	Input current	6.0			20	75	nA
		12.0					
		24.0					
V_{REF}	Reference voltage	6.0	V_{IN}=0V	2.7	3.0	3.3	V
		12.0		5.4	6.0	6.6	
		24.0		10.8	12.0	13.2	
ΔV_{hys}	Input/output hysteresis width voltage	6.0		1.0	1.2	1.4	V
		12.0		1.9	2.4	2.9	
		24.0		3.8	4.8	5.8	
V_{OL}	Output saturation voltage	6.0	I_{sink}=60mA		0.3	0.6	V
			I_{sink}=200mA		1		
t_{PLH}	Output "L-H" propagation delay time	12.0			1		μs
t_{PHL}	Output "H-L" propagation delay time				10		μs

TYPICAL CHARACTERISTICS (T_a=25℃, V_{CC}=12V, unless otherwise noted)

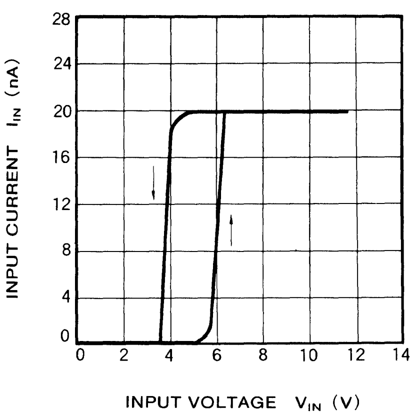
THERMAL DERATING (MAXIMUM RATING)



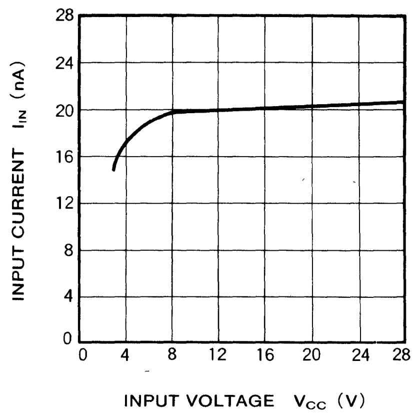
OUTPUT VOLTAGE VS. INPUT VOLTAGE



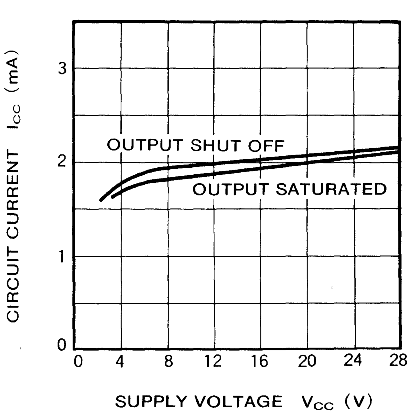
INPUT CURRENT VS. INPUT VOLTAGE



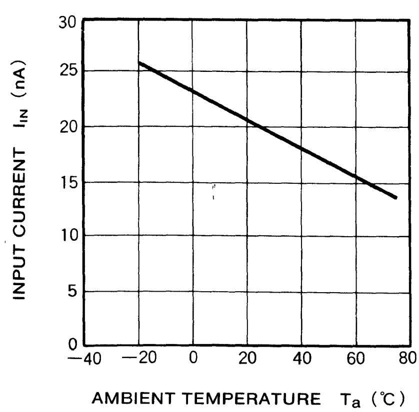
INPUT CURRENT VS. INPUT VOLTAGE



CIRCUIT CURRENT VS. SUPPLY VOLTAGE

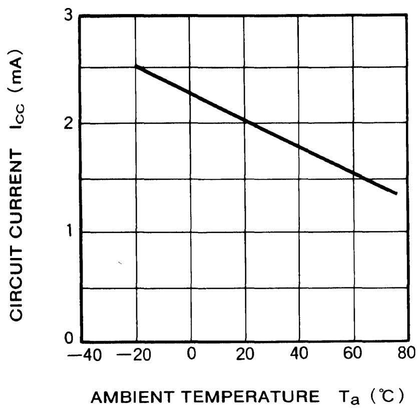


INPUT CURRENT VS. AMBIENT TEMPERATURE



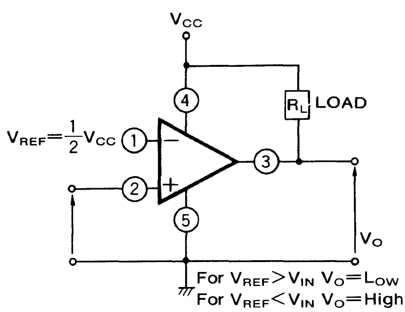
MITSUBISHI ELECTRIC

CIRCUIT CURRENT VS. AMBIENT TEMPERATURE

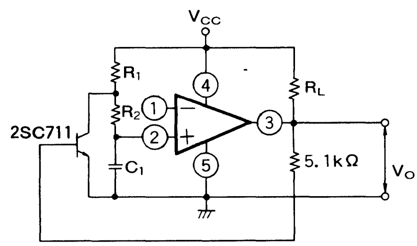


APPLICATION EXAMPLES

(1) Voltage comparator

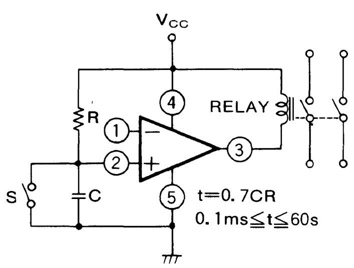


(2) Oscillator



$$f=\frac{1}{C_1(0.337R_1+0.847R_2)}\ [\mathrm{Hz}]$$

(3) CR Timer



PRECAUTIONS FOR USE

1. Paying much attention is necessary for fear that the M51203TL,FP may flow large current and reach to destroy because of the structure when the terminals of V_{CC} and GND of the M51203TL,FP is connected wrong position each other
2. Output is "open collector" and a loading resistor is not included. Connect a loading resistor to stabilize operation, in case of driving a next stage

M51205TL,FP

VOLTAGE COMPARATOR

DESCRIPTION

The M51205TL,FP is a semiconductor integrated circuit for a voltage comparator that operates from a single power supply. Especially the M51205TL,FP has superiority as to characteristics of input current (high input resistance) and fits to wide ranged applications, for example CR timer, etc. M51205TL,FP's package is a mini SIP and FLAT package, therefore can use very easily.

FEATURES

- Low input current (high input resistance) ········ 15nA(typ.)
- Built-in zener diode for stabilization of supply voltage between supply voltage terminal and GND terminal ························ 5.6V(typ.)
- Capable of directly driving a relay or a lamp
- Including reference voltage for comparison
- Hysteresis between input and output
- High output breakdown voltage ···················· 30V(max.)

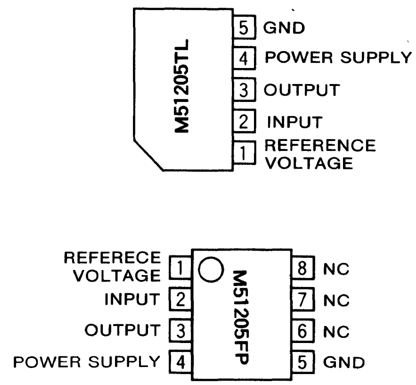
APPLICATION

Electric shutter, CR timer, voltage comparator, time delay circuit, oscillator (square wave)

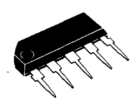
RECOMMENDED OPERATING CONDITIONS

Rated supply voltage ························ 12V(R_d=1kΩ)

PIN CONFIGURATION (TOP VIEW)



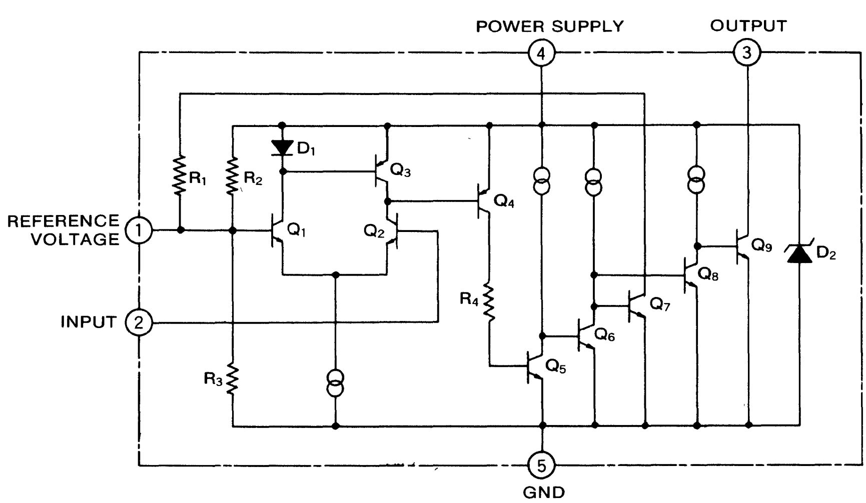
NC : NO CONNECTION



5-pin molded plastic SIP

8-pin molded plastic FLAT

EQUIVALENT CIRCUIT



MITSUBISHI ELECTRIC

ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
I_{CC}	Circuit current		20	mA
V_{IN}	Input voltage		$V_{(4)}$※	V
I_{sink}	Output sink current		200	mA
V_{OH}	Output drive voltage		30	V
P_d	Power dissipation		180(M51205TL)	mW
			300(M51205FP)	
K_θ	Thermal derating	T_a≧25℃	1.8(M51205TL)	mW/℃
			3.0(M51205FP)	
T_{opr}	Operating temperature		−20~+75	℃
T_{stg}	Storage temperature		−40~+125	℃

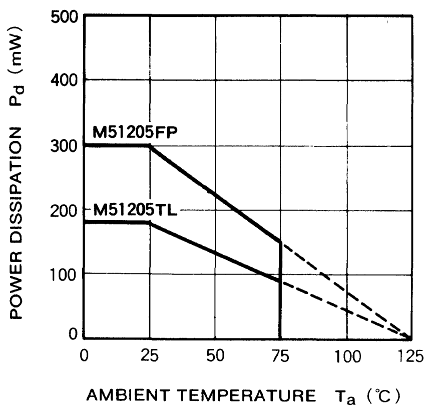
※ Voltage at pin ④

ELECTRICAL CHARACTERISTICS (T_a=25℃, R_d: dropper resistor)

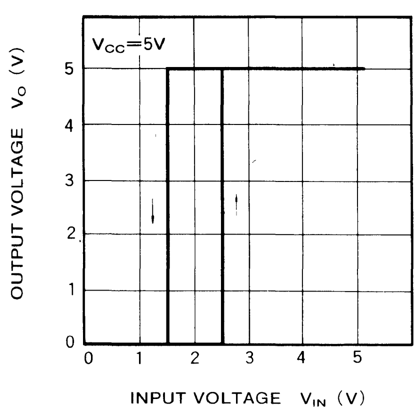
Symbol	Parameter	Test conditions		Limits			Unit
		V_{CC}(V)		Min	Typ	Max	
$V_{④}$	Zener voltage	12.0	R_d=1kΩ	5.0	5.6	7.0	V
V_{IN}	Input voltage	12.0	R_d=1kΩ	0.8		$V_{(4)}$−0.2	V
I_{IN}	Input current	12.0	R_d=1kΩ		15	75	nA
V_{REF}	Reference voltage	5.00	R_d=0Ω, V_{IN}=0V	2.25	2.50	2.75	V
ΔV_{hys}	Input/output hysteresis width voltage	5.00	R_d=0Ω, V_{IN}=3V	0.80	1	1.20	V
V_{OL}	Output saturation voltage	6.0	I_{sink}=60mA		0.2	0.6	V
			I_{sink}=200mA		1		
t_{PLH}	Output "L-H" propagation delay time	12.0	R_d=1kΩ		1		μs
t_{PHL}	Output "H-L" propagation delay time				10		μs
I_{CC}	Circuit current (V_{CC}≦$V_{④}$)	5.00	R_d=0Ω		1.9	2.4	mA

TYPICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

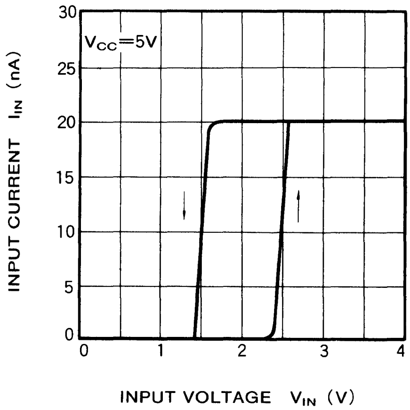
THERMAL DERATING (MAXIMUM RATING)



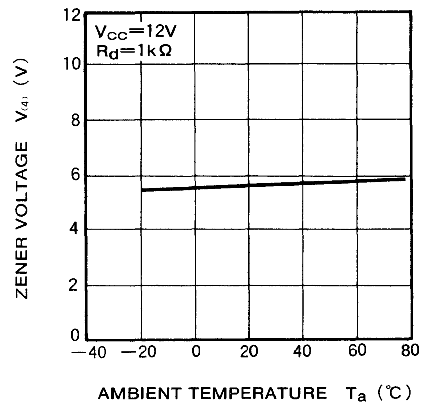
OUTPUT VOLTAGE VS. INPUT VOLTAGE



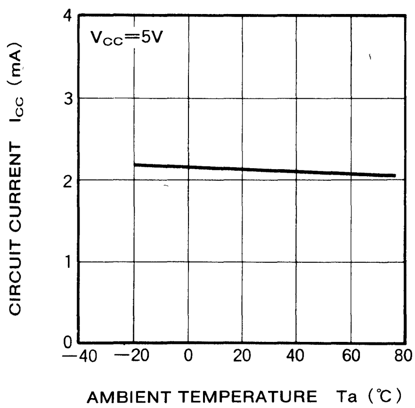
INPUT CURRENT VS. INPUT VOLTAGE



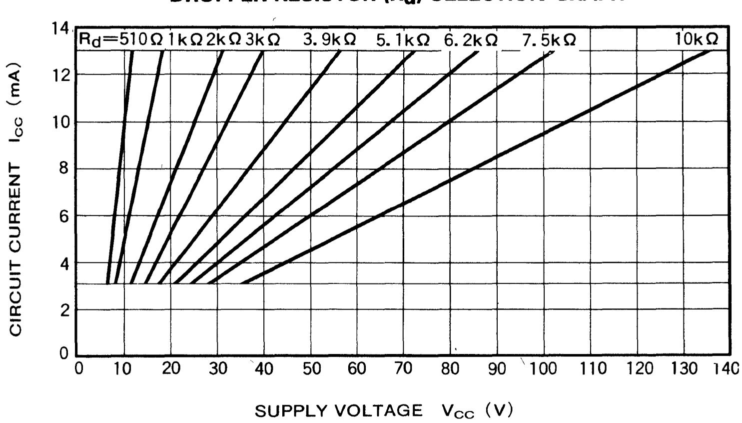
ZENER VOLTAGE VS. AMBIENT TEMPERATURE



CIRCUIT CURRENT VS. AMBIENT TEMPERATURE

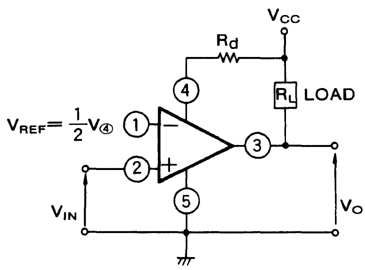


DROPPER RESISTOR (R_d) SELECTION GRAPH

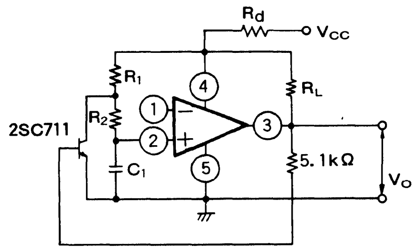


APPLICATION EXAMPLES

(1) Voltage comparator

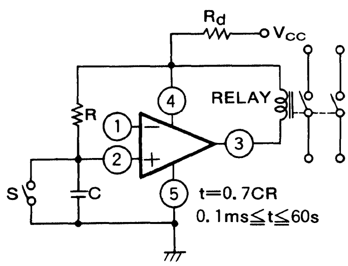


(2) Oscillator

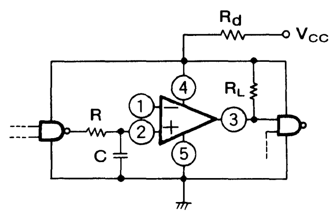


$$f = \frac{1}{C_1(0.337R_1 + 0.847R_2)} \text{ [Hz]}$$

(3) CR Timer



(4) Time delay circuit



Delay time t_S=0.7CR

PRECAUTIONS FOR USE

1. Paying much attention is necessary for fear that the M51205TL,FP may flow large current and reach to destroy because of the structure when the terminals of V_{CC} and GND of the M51205TL,FP is connected wrong position each other.
2. Output is "open collector" and a loading resistor is not included. Connect a loading resistor to stabilize operation, in case of driving a next stage.
3. Care should be taken not to apply over 5(V) directly to the terminals between Pin ④ and Pin ⑤. Connect a dropper resistor (R_d) in series to Pin ④, in case of applying over 5(V) between Pin ④ and Pin ⑤.

M51202TL,FP

VOLTAGE COMPARATOR

DESCRIPTION

The M51202TL,FP is a semiconductor integrated circuit for a voltage comparator that operates from a single power supply. Especially the M51202TL,FP has superiority as to characteristics of input current (high input resistance) and fits to wide ranged applications, for example CR timer, etc. M51202TL,FP's package is a mini SIP and FLAT package, therefore can use very easily.

FEATURES

- Low input current ············8nA(typ.)
- Operates at low supply voltage ············1.7~6.5V
- Capable of directly driving a relay or a lamp
- Including voltage surge absorbing zener diode for protection
- High output breakdown voltage ············18V(max.)

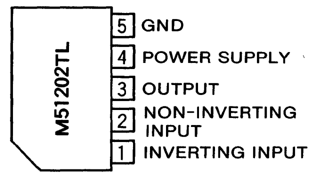
APPLICATION

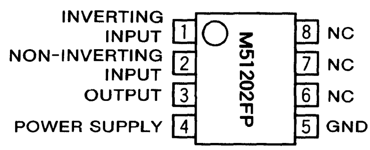
Voltage comparator, CR timer, electric shutter, time delay circuir, oscillator (square wave)

RECOMMENDED OPERATING CONDITIONS

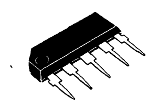
Supply voltage range ············1.7~6.5V
Rated supply voltage ············5.0V

PIN CONFIGURATION (TOP VIEW)

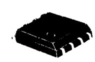




NC : NO CONNECTION

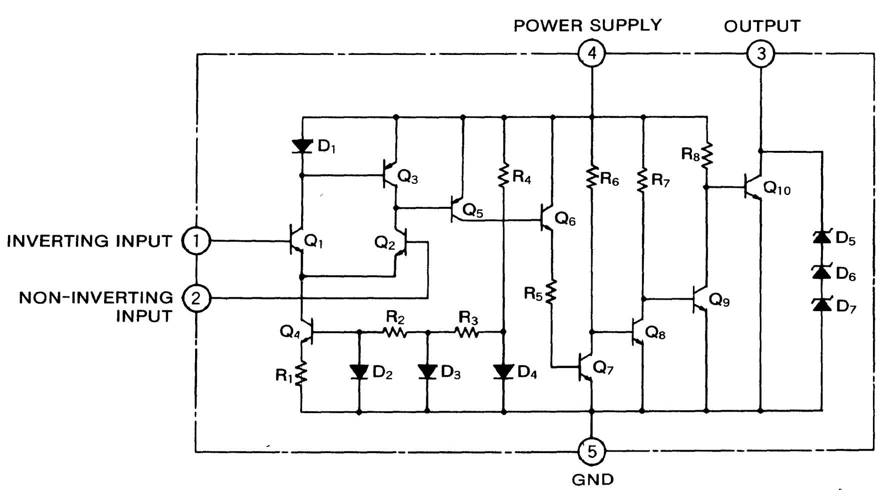


5-pin molded plastic SIP



8-pin molded plastic FLAT

EQUIVALENT CIRCUIT



MITSUBISHI ELECTRIC

ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

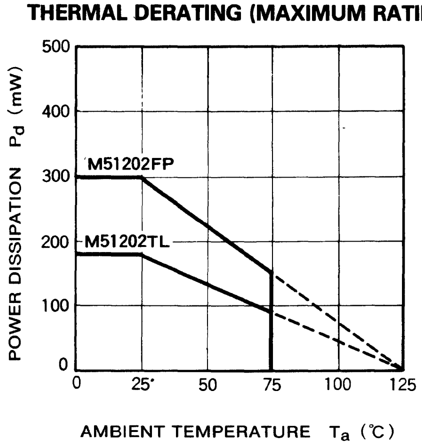
Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		6.5	V
I_{sink}	Output sink current		200	mA
V_{IN}	Input voltage		V_{CC}	V
P_d	Power dissipation		180(M51202TL)	mW
			300(M51202FP)	
K_θ	Thermal derating	$T_a \geq 25$℃	1.8(M51202TL)	mW/℃
			3.0(M51202FP)	
T_{opr}	Operating temperature		−20～+75	℃
T_{stg}	Storage temperature		−40～+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃)

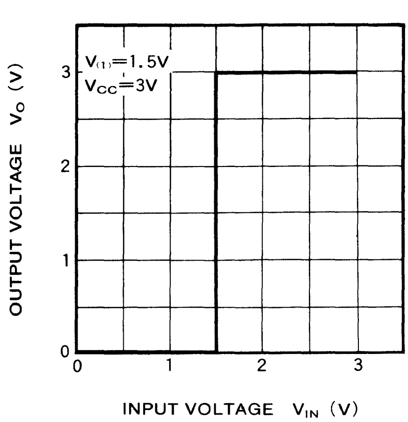
Symbol	Parameter	Test conditions		Limits			Unit
		V_{CC}(V)		Min	Typ	Max	
V_{CC}	Supply voltage range			1.7		6.5	V
I_{CC}	Circuit current	2.65			1.7	3.2	mA
		6.0			4.4	8.2	
I_{IN}	Input current	2.65			8	100	nA
V_{IO}	Input offset voltage	2.65			2	50	mV
V_{OL}	Output saturation voltage	6.0	I_{sink}=60mA		0.2	0.6	V
			I_{sink}=200mA		1		
V_Z	Zener voltage		I_Z=5mA	18	22	26	V
t_{PLH}	Output "L-H" propagation delay time	6.0	$V_{REF}=V_{CC}/2$		0.2		μs
t_{PHL}	Output "H-L" propagation delay time	6.0	$V_{REF}=V_{CC}/2$		50		μs
V_{IN}	Input voltage range			0.8		V_{CC}−0.2	V

TYPICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

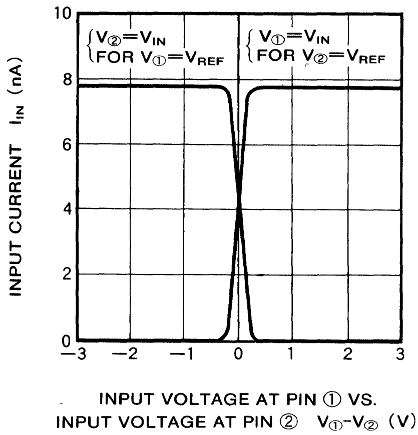
THERMAL DERATING (MAXIMUM RATING)



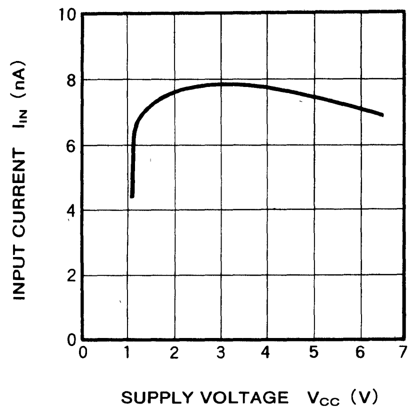
OUTPUT VOLTAGE VS. INPUT VOLTAGE



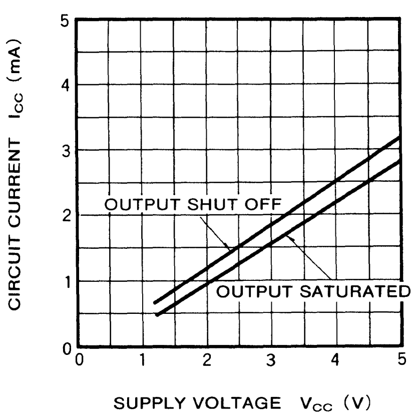
INPUT CURRENT VS. INPUT VOLTAGE



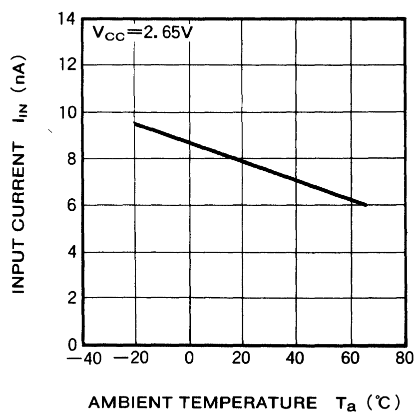
INPUT CURRENT VS. SUPPLY VOLTAGE



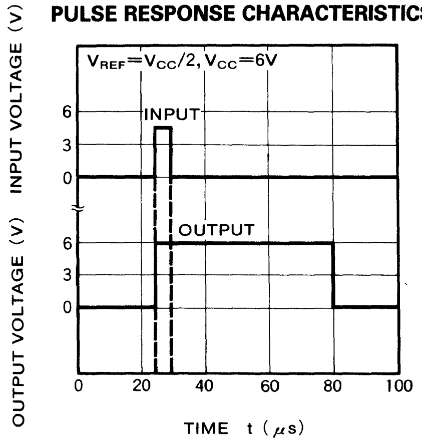
CIRCUIT CURRENT VS. SUPPLY VOLTAGE



INPUT CURRENT VS. AMBIENT TEMPERATURE

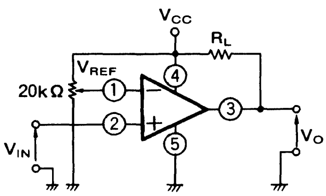


PULSE RESPONSE CHARACTERISTICS



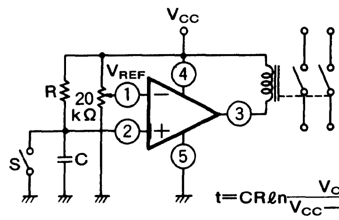
APPLICATION EXAMPLES

(1) Voltage comparator



If $V_{REF} > V_{IN}$ V_O=Low
If $V_{REF} < V_{IN}$ V_O=High

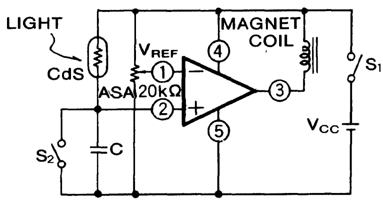
(2) CR Timer



$t = CR \ell n \frac{V_{CC}}{V_{CC} - V_{REF}}$

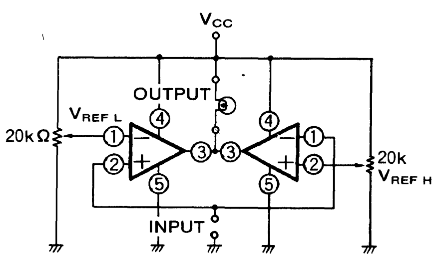
0.1ms≦t≦60s

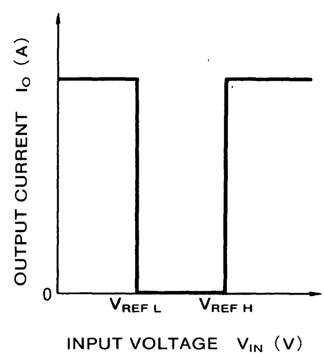
(3) Electric shutter



$t = CR_{cds} \ell n \frac{V_{CC}}{V_{CC} - V_{REF}}$

(4) Window comparator (alarm circuit)





PRECAUTIONS FOR USE

1. Paying much attention is necessary for fear that the M51202TL,FP may flow large current and reach to destroy because of the structure when the terminals of V_{CC} and GND of the M51202TL,FP is connected wrong position each other.
2. Output is "open collector" and a loading resistor is not included. Connect a loading resistor to stabilize operation, in case of driving a next stage.

M51204TL,FP

VOLTAGE COMPARATOR

DESCRIPTION

The M51204TL, FP is a semiconductor integrated circuit for a voltage comparator that operates from a single power supply. Especially the M51204TL,FP has superior characteristics as to input current (high input resistance) and fits to wide ranged applications, for example CR timer, etc. M51204TL,FP's package is a mini SIP and FLAT package, therefore can use very easily.

FEATURES

- Low input current ········· 20nA(typ.)
- Wide operating voltage range ········· 2.5~28V
- Low power dissipation ········· 2.5mA(max.)
- Capable of directly driving a relay or a lamp
- High output breakdown voltage ········· 30V(max.)

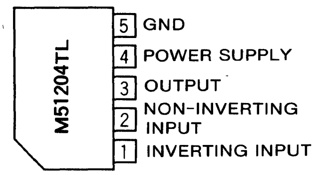
APPLICATION

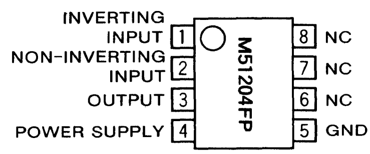
Voltage comparator, electric shutter, CR timer, time delay circuit, oscillator (square wave)

RECOMMENDED OPERATING CONDITIONS

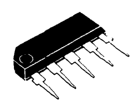
Supply voltage range ········· 2.5~28V
Rated supply voltage ········· 12V

PIN CONFIGURATION (TOP VIEW)





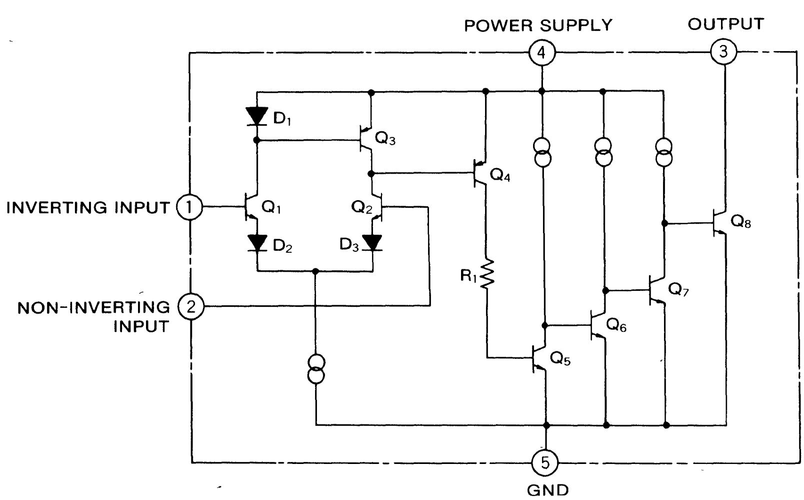
NC NO CONNECTION



5-pin molded plastic SIP

8-pin molded plastic FLAT

EQUIVALENT CIRCUIT



MITSUBISHI ELECTRIC

ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

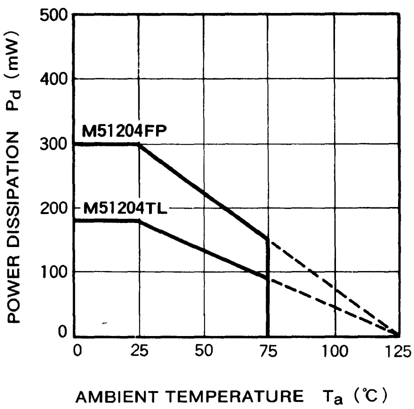
Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		28	V
V_{IN}	Input voltage		V_{CC}	V
I_{sink}	Output sink current		200	mA
V_{OH}	Output drive voltage		30	V
P_d	Power dissipation		180(M51204TL)	mW
			300(M51204FP)	
K_θ	Thermal derating	T_a≧25℃	1.8(M51204TL)	mW/℃
			3.0(M51204FP)	
T_{opr}	Operating temperature		−20～+75	℃
T_{stg}	Storage temperature		−40～+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃)

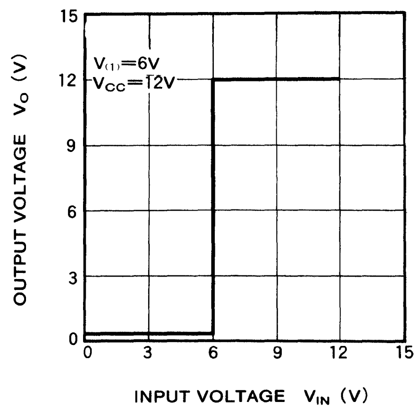
Symbol	Parameter	Test conditions		Limits			Unit
		V_{CC}(V)		Min	Typ	Max	
V_{CC}	Supply voltage range			2.5		28	V
I_{CC}	Circuit current	6.0			1.8	2.5	mA
		12.0					
		24.0					
$V_{IN①}$	Inverting input voltage	12.0		1.4		V_{CC}−0.2	V
$V_{IN②}$	Non-inverting input voltage	12.0					V
$I_{IN①}$	Inverting input current	6.0			20	75	nA
		12.0					
		24.0					
$I_{IN②}$	Non-inverting input current	6.0			20	75	nA
		12.0					
		24.0					
V_{IO}	Input offset voltage	6.0	Reference voltage at Pin ①	−7	2	12	mV
		12.0					
		24.0					
V_{OL}	Output saturation voltage	6.0	I_{sink}=60mA		0.2	0.6	V
			I_{sink}=200mA		1		
t_{PLH}	Output "L-H" propagation delay time	12.0			1		μs
t_{PHL}	Output "H-L" propagation delay time				10		μs

TYPICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

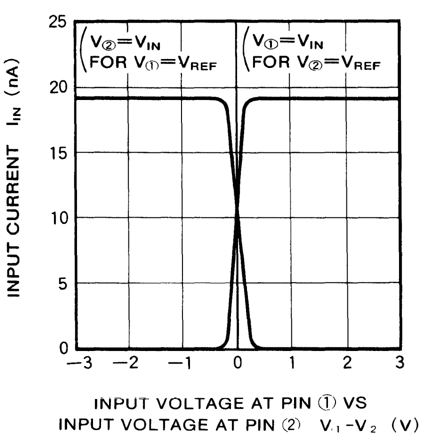
THERMAL DERATING (MAXIMUM RATING)



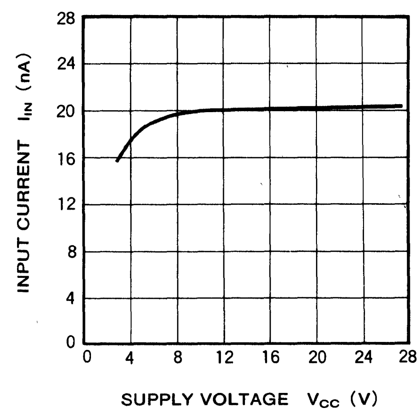
OUTPUT VOLTAGE VS. INPUT VOLTAGE



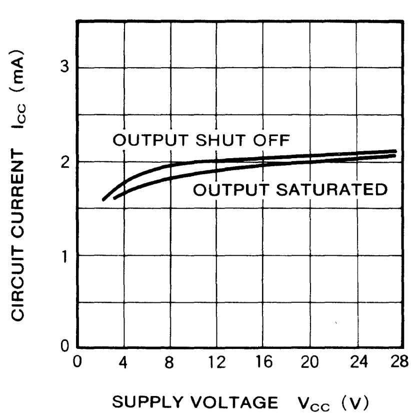
INPUT CURRENT VS. INPUT VOLTAGE



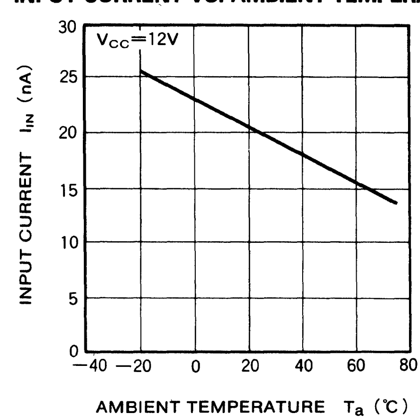
INPUT CURRENT VS. SUPPLY VOLTAGE



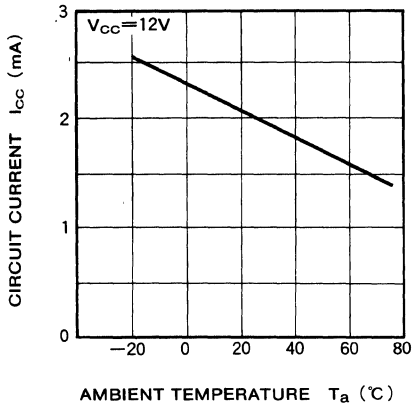
CIRCUIT CURRENT VS. SUPPLY VOLTAGE



INPUT CURRENT VS. AMBIENT TEMPERATURE

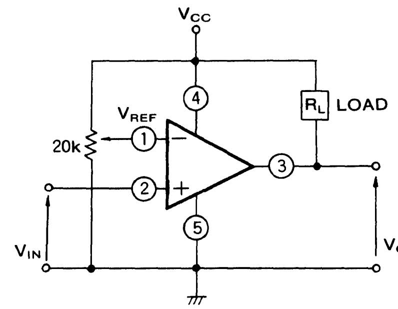


CIRCUIT CURRENT VS. AMBIENT TEMPERATURE

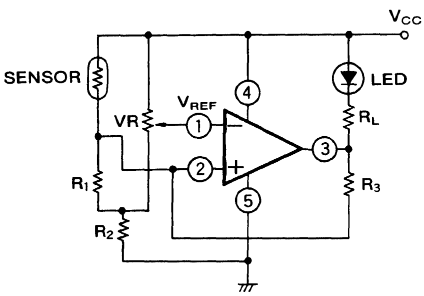


APPLICATION EXAMPLES

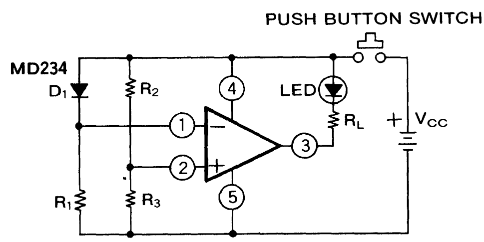
(1) Voltage comparator



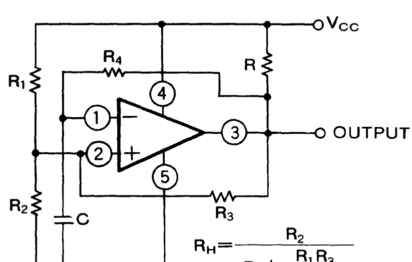
(2) Sensor detection circuit



(3) Battery check circuit



(4) Oscillator



$R_L \ll R_3, R_4$

$$R_H = \frac{R_2}{R_2 + \frac{R_1 R_3}{R_1 + R_3}}$$

$$f = \frac{1}{CR_4 \ln \frac{R_L}{R_H} \cdot \frac{1-R_L}{1-R_H}} \text{ [Hz]} \qquad R_L = \frac{\frac{R_2 R_3}{R_2 + R_3}}{R_1 + \frac{R_2 R_3}{R_2 + R_3}}$$

PRECAUTIONS FOR USE

1. Paying much attention is necessary for fear that the M51204TL,FP may flow large current and reach to destroy because of the structure when the terminals of V_{CC} and GND of the M51204TL,FP is connected wrong position each other.
2. Output is "open collector" and a loading resistor is not included. Connect a loading resistor to stabilize operation, in case of driving a next stage.

M51206TL,FP

VOLTAGE COMPARATOR

DESCRIPTION

The M51206TL,FP is a semiconductor integrated circuit for a voltage comparator that operates at a single power supply. Especially the M51206TL,FP has superiority as to characteristics of input current (high input resistance) and fits to wide ranged applications, for example CR timer, etc. M51206TL,FP's package is a mini SIP and FLAT package, therefore can use very easily.

FEATURES

- Low input current ········ 15nA(typ.)
- Built-in zener diode for stabilization of supply voltage between supply voltage terminal and GND terminal ········ 5.6V(typ.)
- Capable of directly driving a relay or lamp
- High output breakdown voltage ········ 30V(max.)

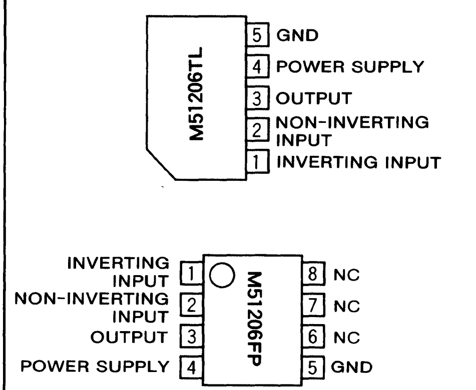
APPLICATION

Voltage comparator, CR timer, electric shutter, time delay circuit, oscillator (square wave).

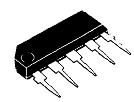
RECOMMENDED OPERATING CONDITIONS

Rated supply voltage ········ 12V(R_d=1kΩ)

PIN CONFIGURATION (TOP VIEW)



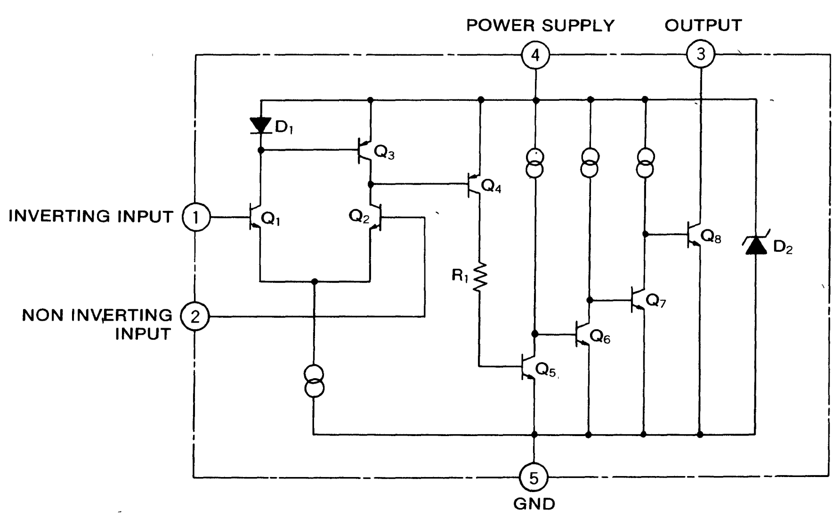
NC : NO CONNECTION



5-pin molded plastic SIP

8-pin molded plastic FLAT

EQUIVALENT CIRCUIT



ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
I_{CC}	Circuit current		20	mA
V_{IN}	Input voltage		V④※	V
I_{sink}	Output sink current		200	mA
V_{OH}	Output drive voltage		30	V
P_d	Power dissipation		180(M51206TL)	mW
			300(M51206FP)	
K_θ	Thermal derating	T_a≧25℃	1.8(M51206TL)	mW/℃
			3.0(M51206FP)	
T_{opr}	Operating temperature		−20~+75	℃
T_{stg}	Storage temperature		−40~+125	℃

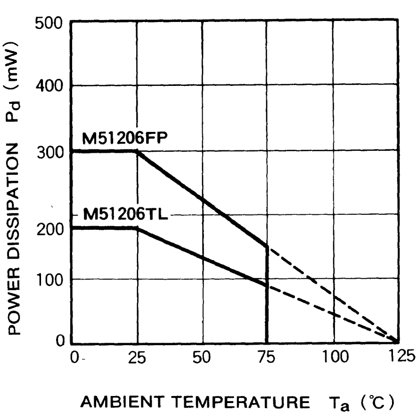
※Voltage at Pin ④

ELECTRICAL CHARACTERISTICS (T_a=25℃, R_d dropper resistor)

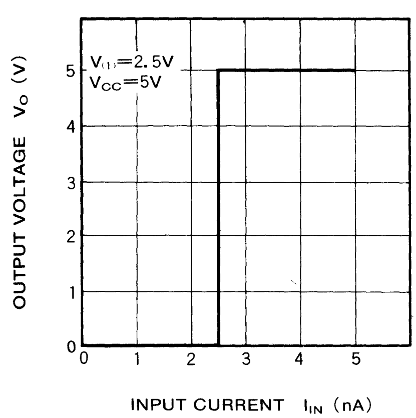
Symbol	Parameter	Test conditions		Limits			Unit
		V_{CC}(V)		Min	Typ	Max	
V④	Zener voltage range	12.0	R_d=1kΩ	5.0	5.6	7.0	V
V_{IN}	Input voltage range	12.0	R_d=1kΩ	0.8		V④−0.2	V
$I_{IN①}$	Input current at Pin ①	12.0	R_d=1kΩ		15	75	nA
$I_{IN②}$	Input current at Pin ②	12.0	R_d=1kΩ		15	75	nA
I_{CC}	Circuit current (V_{CC}<V④)	5.0	R_d=0Ω		1.8	2.4	mA
V_{IO}	Input offset voltage	12.0	R_d=1kΩ	−20	−1.4	20	mV
V_{OL}	Output saturation voltage	6.0	I_{sink}=60mA		0.2	0.6	V
			I_{sink}=200mA		1		
t_{PLH}	Output "L-H" propagation delay time	12.0	R_d=1kΩ		1		μs
t_{PHL}	Output "H-L" propagation delay time				10		μs

TYPICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

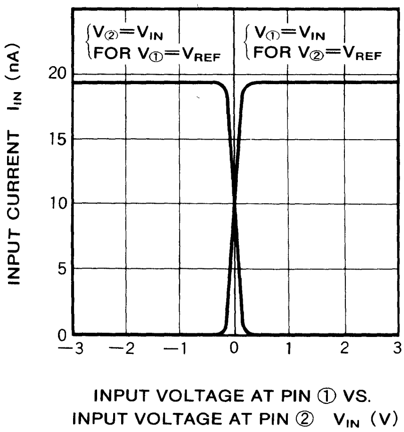
THERMAL DERATING (MAXIMUM RATING)



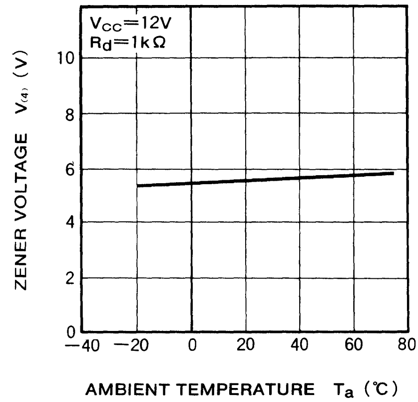
OUTPUT VOLTAGE VS. INPUT VOLTAGE



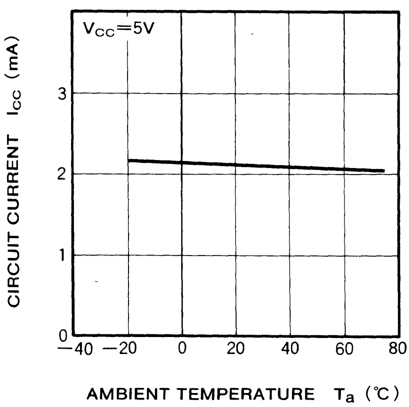
INPUT CURRENT VS. INPUT VOLTAGE



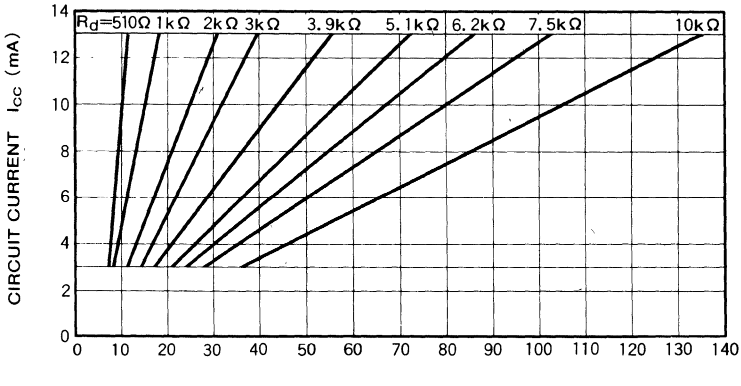
ZENER VOLTAGE VS. AMBIENT TEMPERATURE



CIRCUIT CURRENT VS. AMBIENT TEMPERATURE

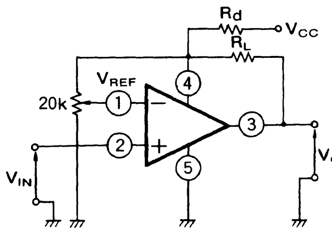


DROPPER RESISTOR (R_d) SELECTION GRAPH



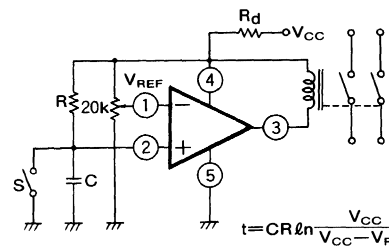
APPLICATION EXAMPLES

(1) Voltage comparator



If $V_{REF} > V_{IN}$ V_O=Low
If $V_{REF} < V_{IN}$ V_O=High

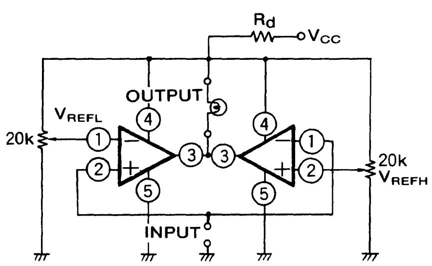
(2) CR Timer

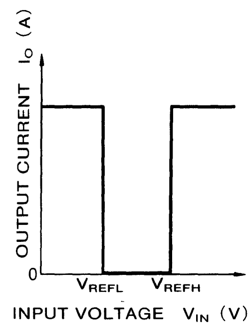


$t = CR\ell n \frac{V_{CC}}{V_{CC} - V_{REF}}$

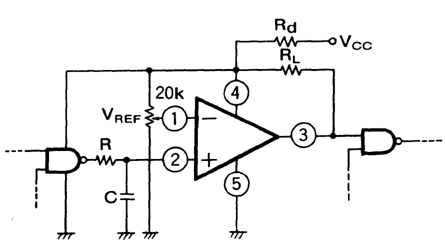
0.1ms≦t≦60s

(3) Window comparator (alarm circuit)





(4) Time delay circuit



$t_S = CR\ell n \frac{V_{CC}}{V_{CC} - V_{REF}}$

Unit
Resistance : Ω
Capacitance : F

PRECAUTIONS FOR USE

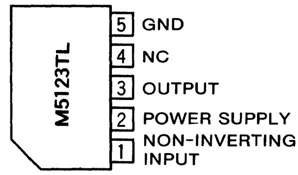
1. Paying much attention is necessary for fear that the M51206TL,FP may flow large current and reach to destroy because of the structure when the terminals of V_{CC} and GND of the M51206TL,FP is connected wrong position each other.
2. Output is "open collector" and a loading resistor is not included. Connect a loading resistor to stabilize operation, in case of driving a next stage.
3. Care should be taken not to apply over 5(V) directly to the terminals between Pin ④ and Pin ⑤. Connect a dropper resistor (R_d) in series to Pin ④ in case of applying over 5(V) between Pin ④ and Pin ⑤.

DESCRIPTION

The M5123TL is a semiconductor integrated circuit for a voltage comparator designed to operate from a single power supply. The comparator reference voltage is close to the supply voltage and, therefore, the M5123TL fits to the shaping of waveform of signal multiplied to power supply because the input voltage can be more than the supply voltage.

M5123TL's package is a mini SIP, making mounting of the component easy.

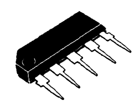
PIN CONFIGURATION (TOP VIEW)



NC . NO CONNECTION

FEATURES

- Operates at low supply voltage ························2.5~5.5V
- Including comparator reference voltage ························ V_{CC}−46mV(typ.)
- Low power dissipation in standby state ········ 150μA(typ.)
- Built-in protection resistor and diode for input surge current



5-pin molded plastic SIP

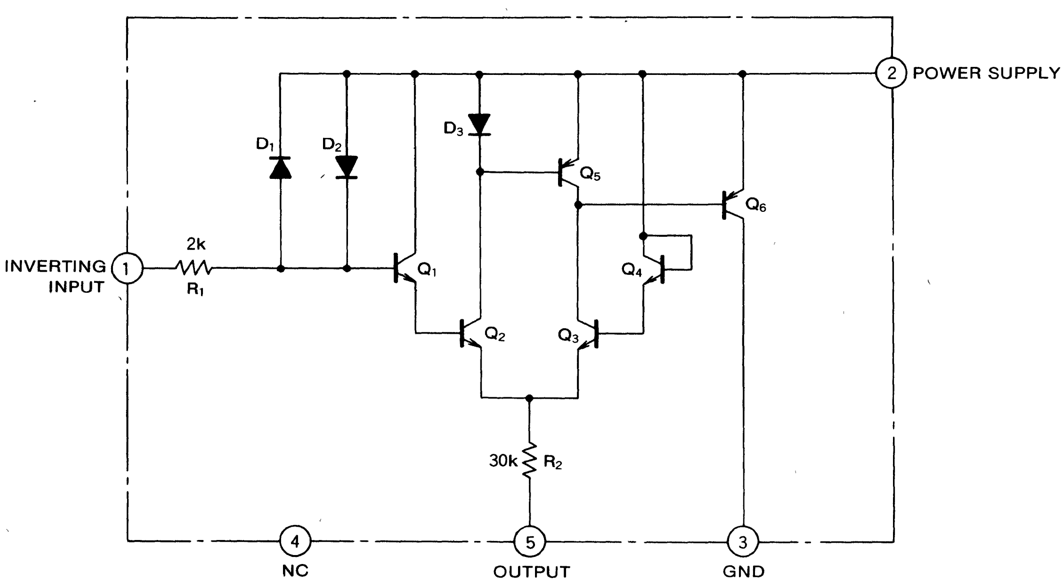
APPLICATION

Voltage comparator, general-purpose detection, alarm circuits.

RECOMMENDED OPERATING CONDITIONS

Supply voltage range ································2.5~5.5V
Rated supply voltage ·····································5.0V

EQUIVALENT CIRCUIT



MITSUBISHI ELECTRIC

ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

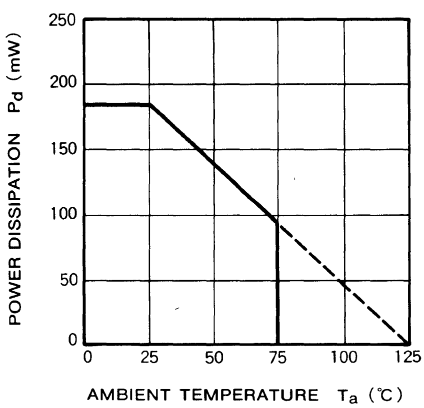
Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		6	V
V_I	Input voltage		−0.2~10	V
V_O	Output voltage		V_{CC}	V
P_d	Power dissipation		180	mW
T_{opr}	Operating temperature		−20~+75	℃
T_{stg}	Storage temperature		−40~+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

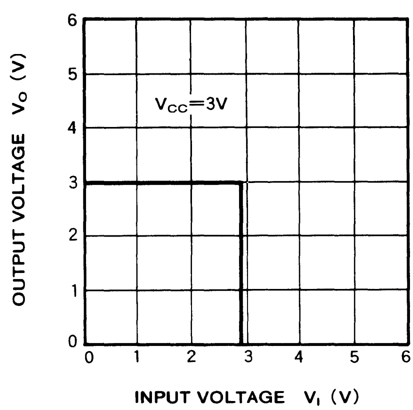
Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage range		2.5		5.5	V
I_{CC1}	Circuit current	V_{CC}=3.3V		100	170	μA
I_{CC2}	Circuit current	V_{CC}=5.5V		150	270	μA
V_{IO}	Input offset voltage	V_{CC}=2.5~5.5V, V_{CC} reference voltage	−100	−46	0	mV
V_{OS}	Output saturation voltage	V_{CC}=5.5V, R_L=27kΩ		50	300	mV
I_{OL}	Output leak current	V_{CC}=5.5V	−1			μA

TYPICAL CHARACTERISTICS (T_a=25℃, V_{CC}=5.5V, unless otherwise noted)

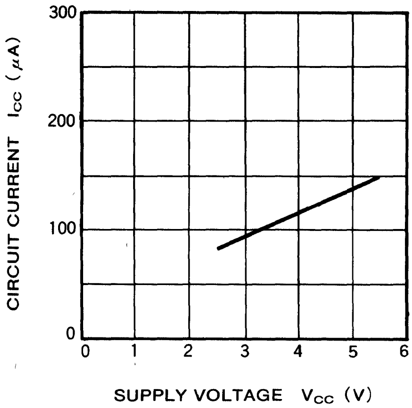
THERMAL DERATING (MAXIMUM RATING)



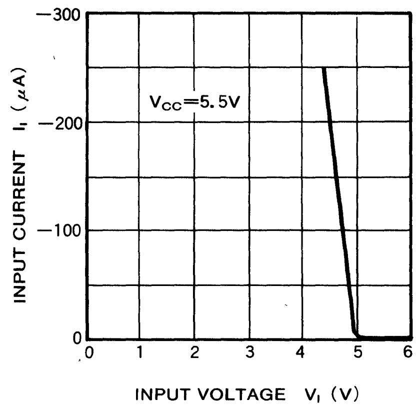
OUTPUT VOLTAGE VS. INPUT VOLTAGE



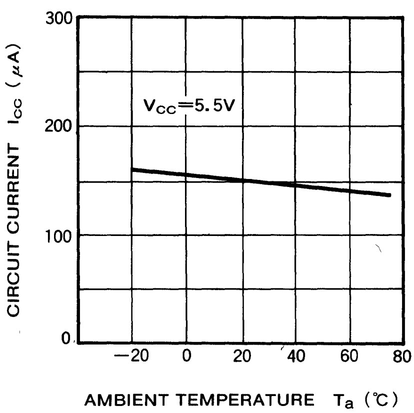
CIRCUIT CURRENT VS. SUPPLY VOLTAGE



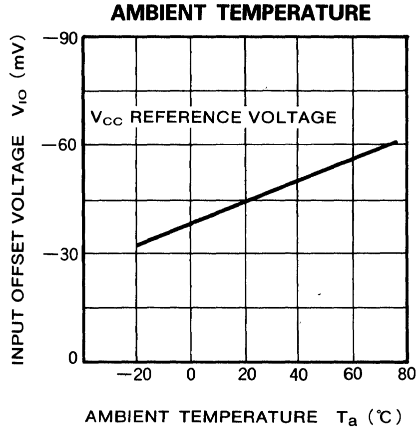
INPUT CURRENT VS. INPUT VOLTAGE



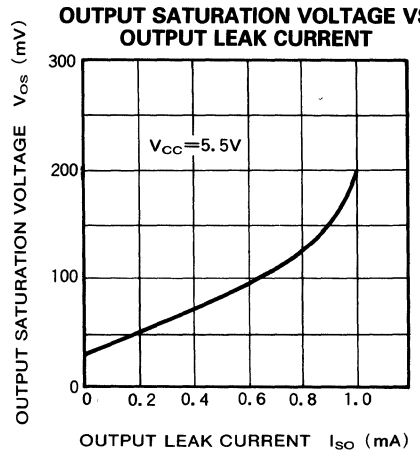
CIRCUIT CURRENT VS. AMBIENT TEMPERATURE



INPUT OFFSET VOLTAGE VS. AMBIENT TEMPERATURE



OUTPUT SATURATION VOLTAGE VS. OUTPUT LEAK CURRENT



MITSUBISHI ELECTRIC

M51207L

DUAL COMPARATOR

DESCRIPTION

The M51207L is a dual (two independent) comparator and operates over a wide voltage range from a single supply voltage. Especially the M51207L has superiority as to characteristics of input current (input resistance) and fits to wide ranged applications, for example CR Timer, oscillator, etc.

FEATURES

- Low input curret (high input resistance) ········ 20nA(typ.)
- Wide supply voltage range ························· 2.5V~28V
- Low dissipation current ···························· 3.8mA(typ.)
- Capable of driving a relay or a lamp directly ······ 60mA(max.)
- Includes voltage surge absorbing zener diodes
- High output breakdown voltage ···················· 30V(max.)
- Low output voltage ···································· 0.2V(typ.)
- Low input offset voltage ···························· 2mV(typ.)

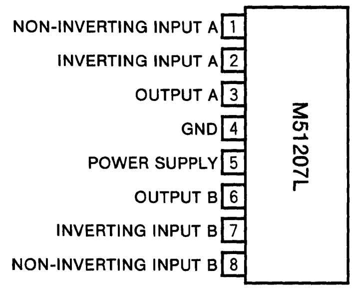
APPLICATION

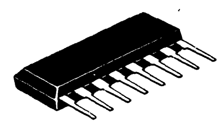
Voltage comparator, window comparator, CR Timer, time delay circuit, oscillator, etc

RECOMMENDED OPERATING CONDITIONS

Supply voltage range ································· 2.5~28V
Rated supply voltage ·· 12V

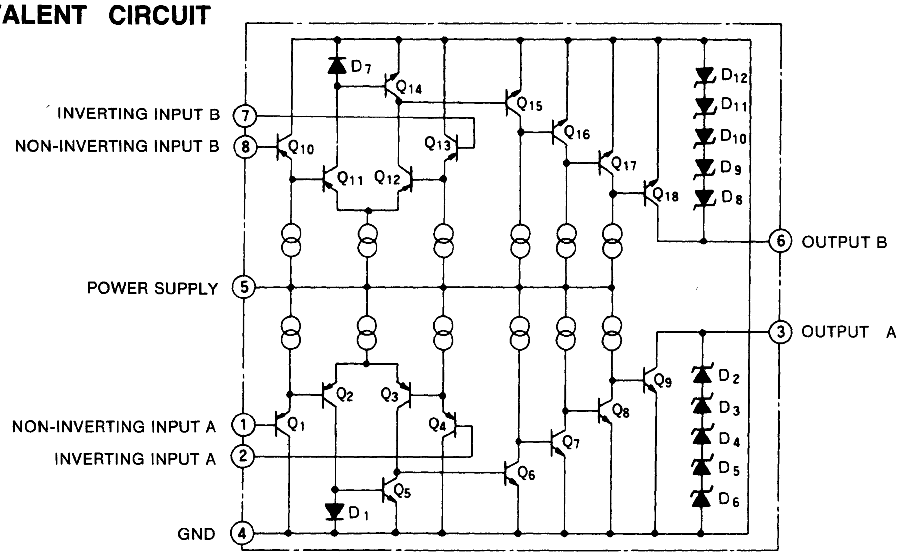
PIN CONFIGURATION (TOP VIEW)





8-pin molded plastic SIP

EQUIVALENT CIRCUIT



ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

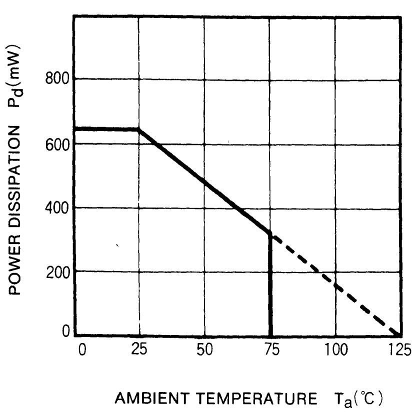
Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		28	V
V_{ID}	Differential input voltage		V_{CC}	V
V_{ICM}	Common mode input voltage range		$-0.3 \sim V_{CC}$	V
Isink	Output sink current		80	mA
V_{OH}	"H" output voltage		30	V
P_d	Power dissipation		650	mW
Topr	Operating temperature		−20～+75	℃
Tstg	Storage temperature		−40～+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=2.5～28V, unlese otherwise noted)

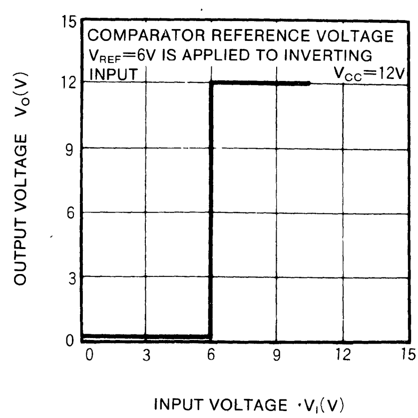
Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage range		2.5		28	V
I_{CC}	Circuit current			3.8	5.3	mA
$V_{I\ominus}$	Inverting input voltage range		0		$V_{CC}-1.5$	V
$V_{I\oplus}$	Non-inverting input voltage range		0		$V_{CC}-1.5$	V
V_{IO}	Input offset voltage			2	7	mV
$I_{I\ominus}$	Inverting input current			20	100	nA
$I_{I\oplus}$	Non-inverting input current			20	100	nA
I_{IO}	Input offset current			5	50	nA
V_{OL}	"L" output voltage	I_{sink}=60mA		0.2	0.4	V
		I_{sink}=200mA		1		
I_{LO}	Output leak current				0.1	μA
t_{PLH}	Output "L→H" propagation delay time			2		μs
t_{PHL}	Output "H→L" propagation delay time			1		μs

TYPICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

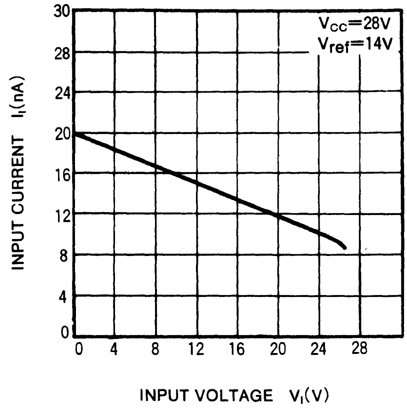
THERMAL DERATING (MAXIMUM RATING)



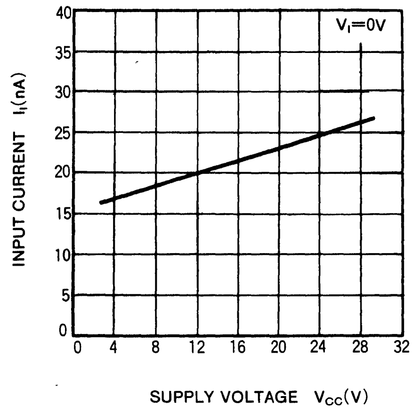
OUTPUT VOLTAGE VS INPUT VOTAGE



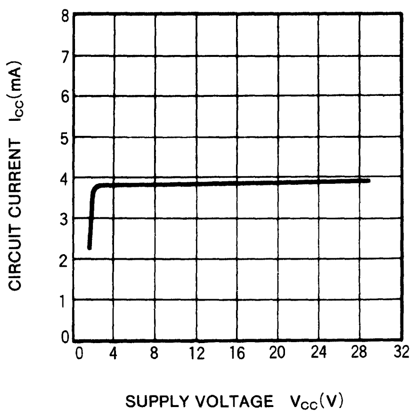
INPUT CURRENT VS INPUT VOLTAGE



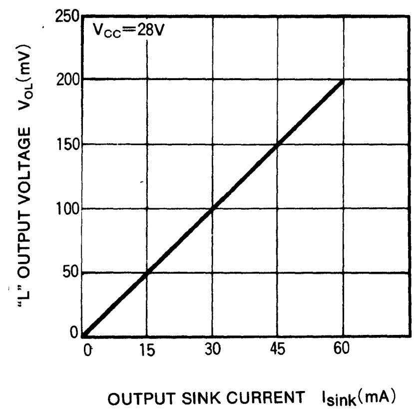
INPUT CURRENT VS SUPPLY VOLTAGE



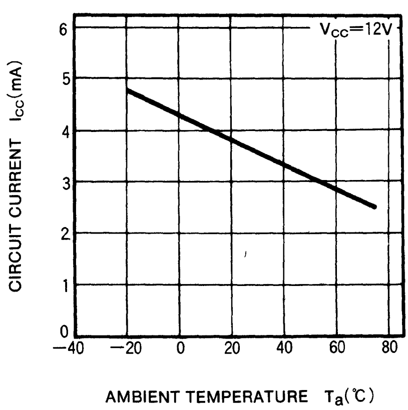
CIRCUIT CURRENT VS SUPPLY VOLTAGE



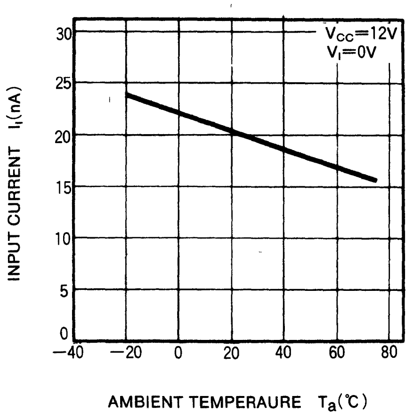
"L" OUTPUT VOLTAGE VS OUTPUT SINK CURRENT



CIRCUIT CURRENT VS AMBIENT TEMPERATURE



INPUT CURRENT VS AMBIENT TEMPERATURE

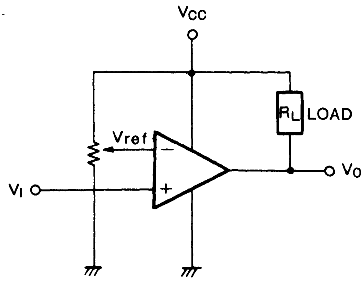


PRECAUTIONS FOR USE

1. Special care must be taken to protect the M51209P from large surges in current, such as may result from the in currect connection of the V_{CC} and GND terminals.
2. Output is "open collector" and a loading resistor is not included. Connect a loading resistor to stabilize operation, when driving another.

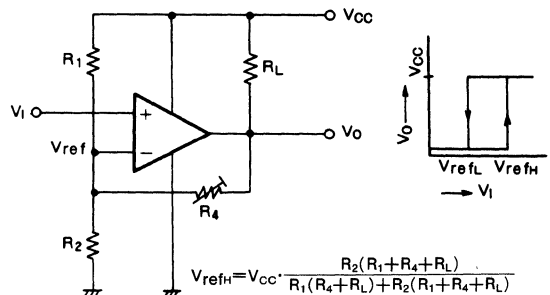
APPLICATION EXAMPLES

(1) Voltage comparator



If $V_{REF} > V_I$ V_O=Low
If $V_{REF} < V_I$ V_O=High

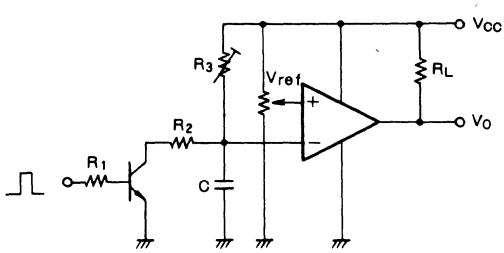
(2) Schmitt trigger circuit



$$V_{refH}=V_{CC}\cdot\frac{R_2(R_1+R_4+R_L)}{R_1(R_4+R_L)+R_2(R_1+R_4+R_L)}$$

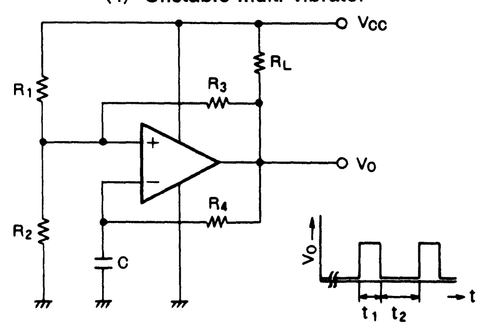
$$V_{refL}=V_{CC}\cdot\frac{R_2R_4}{R_2R_4+R_1(R_2+R_4)}$$

(3) Monostable multi-vibrator



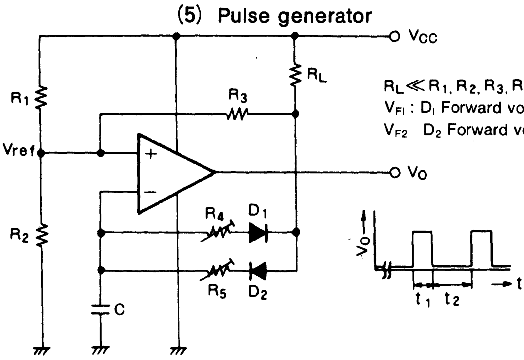
$$t=CR_3\cdot \ell n\frac{V_{CC}}{V_{CC}-V_{ref}}\text{(sec)}$$

(4) Unstable multi-vibrator



$$t_1=CR_4\,\ell n\frac{R_2+R_3}{R_3}\quad t_2=CR_4\,\ell n\frac{R_1+R_3}{R_3}\quad (R_L<R_1,R_2,R_3,R_4)$$

(5) Pulse generator

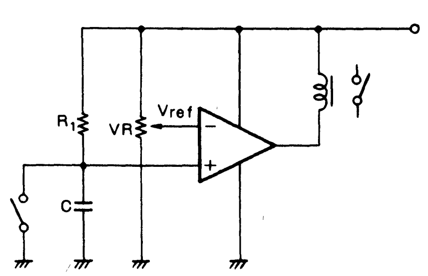


$R_L \ll R_1, R_2, R_3, R_4$
V_{F1} : D_1 Forward voltage
V_{F2} D_2 Forward voltage

$$V_{refH}=\frac{V_{CC}\cdot R_2(R_1+R_3)}{R_1R_2+R_2R_3+R_3R_1}\qquad t_1=CR_5\,\ell n\frac{V_{CC}-V_{refL}-V_{F2}}{V_{CC}-V_{refH}}$$

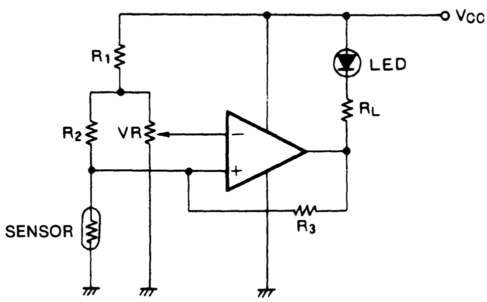
$$V_{refL}=\frac{V_{CC}\cdot R_2R_3}{R_1R_2+R_2R_3+R_3R_1}\qquad t_2=CR_4\,\ell n\frac{V_{refH}-V_{F1}}{V_{refL}}$$

(6) CR Timer

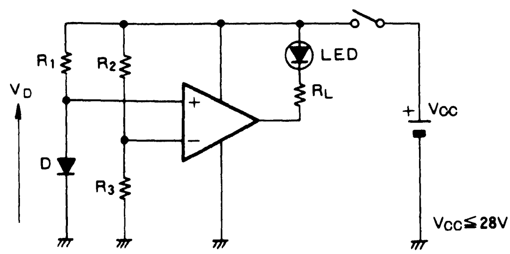


$$t=CR_1\cdot \ell n\frac{V_{CC}}{V_{CC}-V_{ref}}$$

(7) Sensor detector



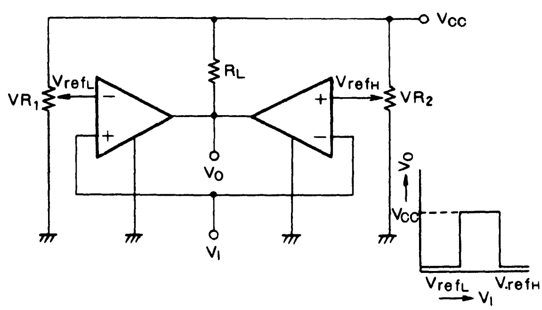
(8) Battery check circuit



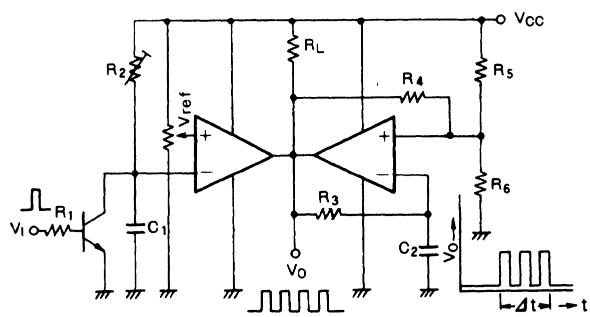
$V_D < V_{CC} \cdot \frac{R_3}{R_2+R_3}$, LED→ON

$V_D > V_{CC} \cdot \frac{R_3}{R_2+R_3}$, LED→OFF

(9) Window comparator

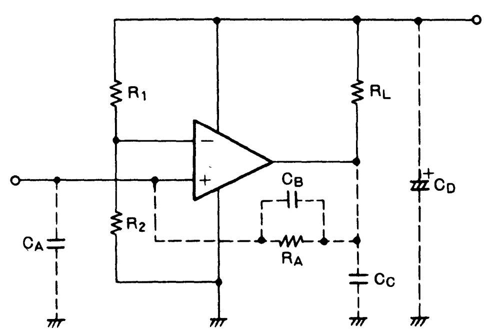


(10) Pulse train generator



$\Delta t = C_1 R_2 \cdot \ell n \frac{V_{CC}}{V_{CC} - V_{ref}}$

(11) Countermeaure against oscillation

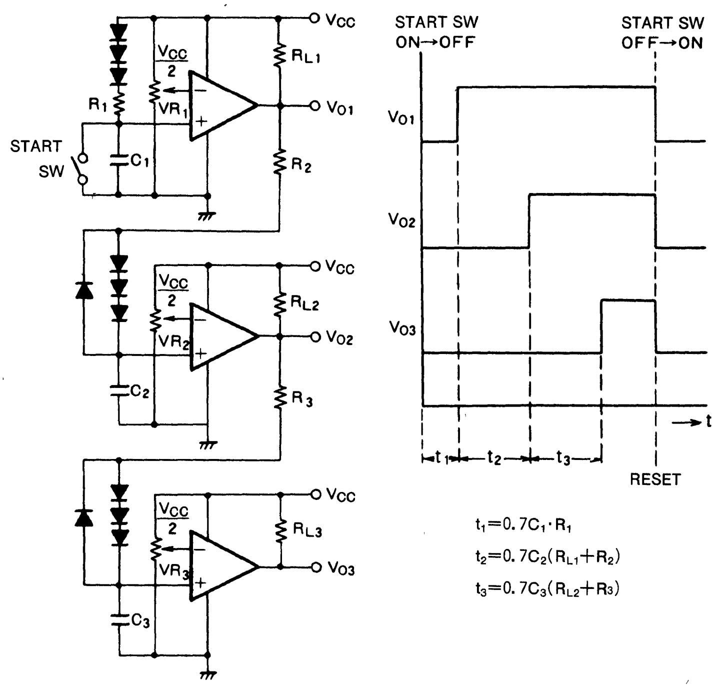


(Note) Taking steps against oscillation

The M51207L may oscillate according to input condition. If the M51207L should oscillate, the following countermeasures are applicable.

- In case of connecting input signal with chattering, connect a capcitor of small C_A. value.
- In case of oscillation with ordinary input, employ positive feedback inserting R_A (large registor) , C_B (no polar) or connect C_C.
- When the supply voltage is not stabilized, connect C_D (a large electrolytic capacitor) to absorb the supply voltage change.

(12) Sequential timer

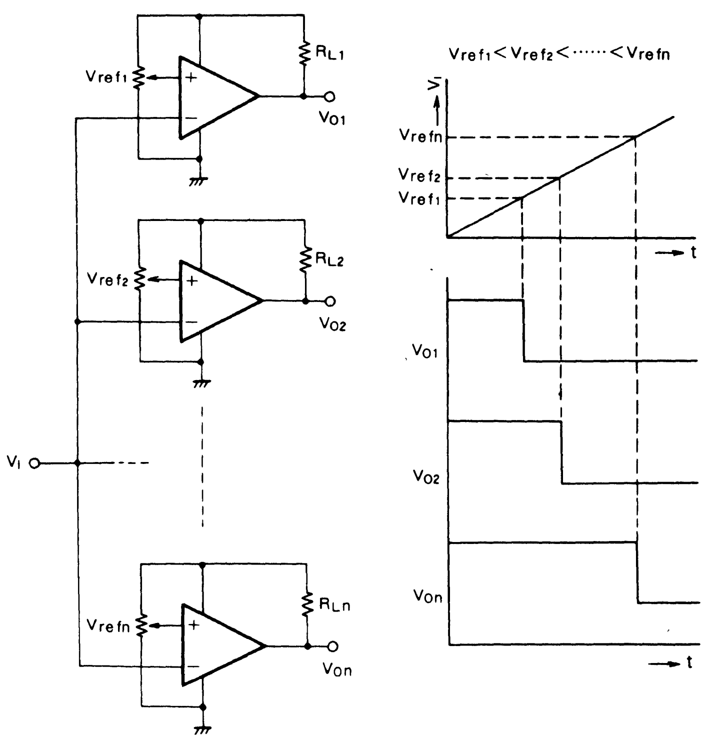


$t_1 = 0.7C_1 \cdot R_1$

$t_2 = 0.7C_2(R_{L1} + R_2)$

$t_3 = 0.7C_3(R_{L2} + R_3)$

(13) Analog/Digital converter



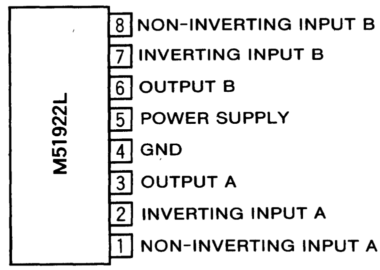
DESCRIPTION
The M51922L is a dual (two independent) comparator and operates over a wide voltage range from a single supply voltage. The M51922L has a low power dissipation characteristics but enables high output drive, and fits to wide ranged applications, for example CR timer, oscillator, etc.

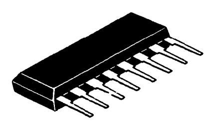
FEATURES
- Low input current .... 25nA(typ.)
- Wide supply voltage range .... 2.5V~28V
- Low dissipation current .... 0.4mA(typ.)(All output OFF)
  1.5mA(typ.)(All output ON)
- Enables high output drive .... V_{OL}=0.15V(typ.)
  (Output current 20mA)

APPLICATION
Voltage comparator, window comparator, CR Timer, time delay circuit, oscillator, etc.

RECOMMENDED OPERATING CONDITIONS
Supply voltage range .... 2.5~28V
Rated supply voltage 12V

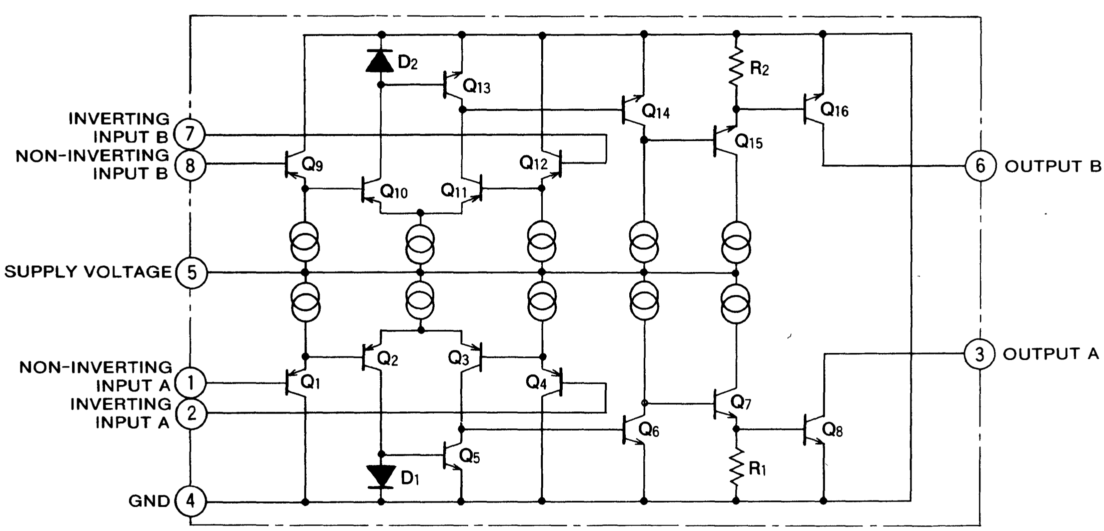
PIN CONFIGURATION (TOP VIEW)





8-pin molded plastic SIP

EQUIVALENT CIRCUIT



ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		28	V
V_{ID}	Differential input voltage		V_{CC}	V
V_{ICM}	Common mode input voltage range		−0.3~V_{CC}	V
I_{sink}	Output sink current		80	mA
V_{OH}	"H" output voltage		30	V
P_d	Power dissipation		650	mW
T_{opr}	Operating temperature		−20~+75	℃
T_{stg}	Storage temperature		−40~+125	℃

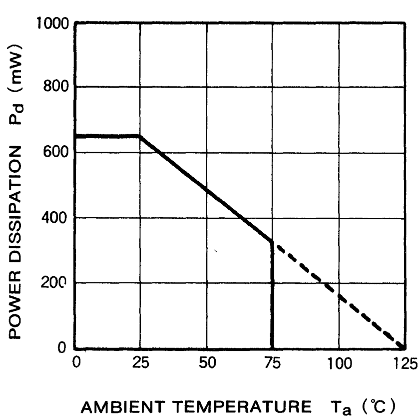
ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=2.5~28V, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage range		2.5		28	V
I_{CC1}	Circuit current 1	ALL OUTPUT ON		1.5	2.5	mA
I_{CC2}	Circuit current 2	ALL OUTPUT OFF		0.4	0.8	mA
$V_{I\ominus}$	Inverting input voltage range	NOTE	0		V_{CC}−1.5	V
$V_{I\oplus}$	Non-inverting input voltage range	NOTE	0		V_{CC}−1.5	V
V_{IO}	Input offset voltage			2	5	mV
$I_{I\ominus}$	Inverting input current			25	150	nA
$I_{I\oplus}$	Non-inverting input current			25	150	nA
I_{IO}	Input offset current			5	50	nA
V_{sat}	Output saturation voltage	I_{OL}=20mA		0.15	0.4	V
V_{OL}	"L" output voltage	I_{sink}=20mA		0.15	0.4	V
		I_{sink}=80mA		1		
I_{LO}	Output leak current				0.1	μA
t_{PLH}	Output "L→H" propagation delay time			2		μs
t_{PHL}	Output "H→L" propagation delay time			0.2		μs

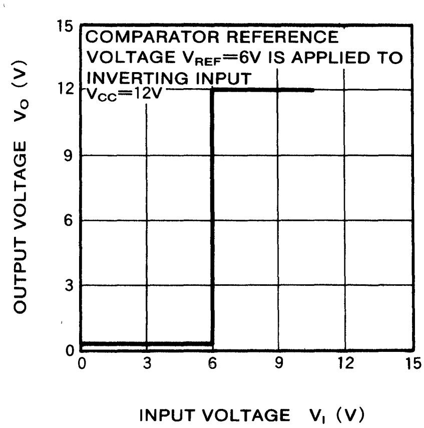
NOTE) Either inverting or non-inverting inputs (reference side) should be within this range. (Abnormal operation will not occur when the other is within the range of 0 to V_{CC}.)

TYPICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

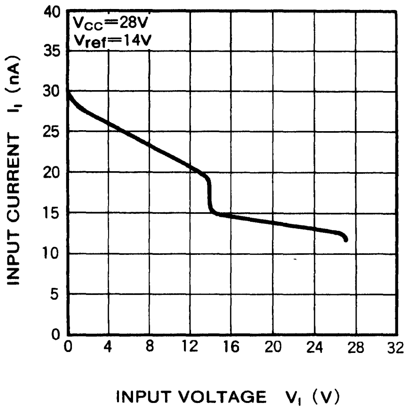
THERMAL DERATING (MAXIMUM RATING)



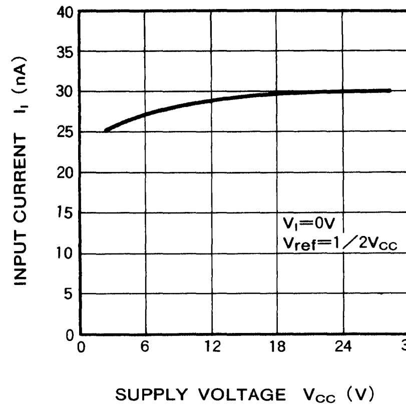
OUTPUT VOLTAGE VS. INPUT VOLTAGE



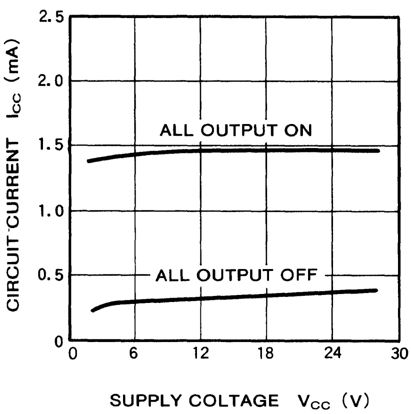
INPUT CURRENT VS. INPUT VOLTAGE



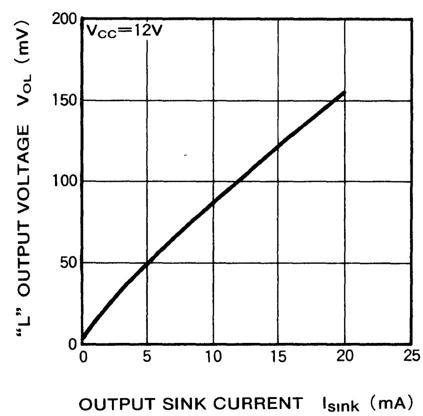
INPUT CURRENT VS. SUPPLY VOLTAGE



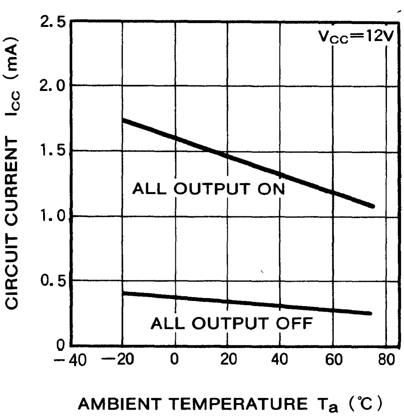
CIRCUIT CURRENT VS. SUPPLY VOLTAGE



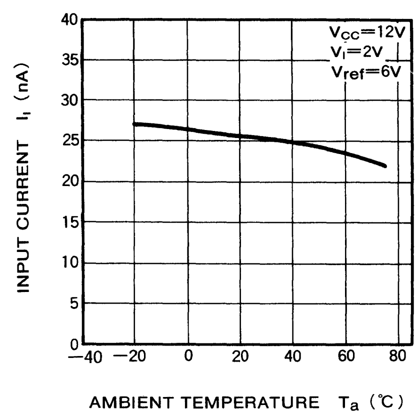
"L" OUTPUT VOLTAGE VS. OUTPUT SINK CURRENT



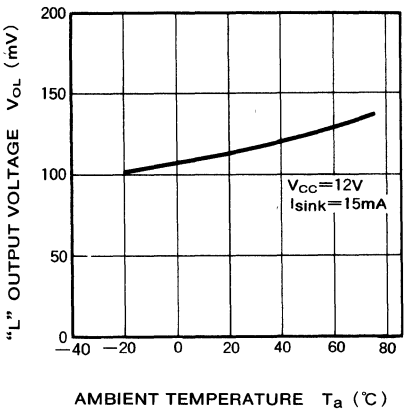
CIRCUIT CURRENT VS. AMBIENT TEMPERATURE



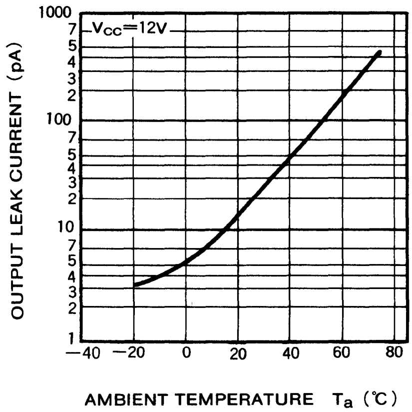
INPUT CURRENT VS. AMBIENT TEMPERATURE



"L" OUTPUT VOLTAGE VS. AMBIENT TEMPERATURE



OUTPUT LEAK CURRENT VS. AMBIENT TEMPERATURE



M51923P,FP

DUAL COMPARATOR

DESCRIPTION

The M51923P,FP is a dual (two independent) comparator and operates over a wide voltage range from a single supply voltage. The M51923P,FP has a characteristic of low power dissipation but enables high output drive, and fits to wide ranged applications, for example CR timer, oscillator, etc.

FEATURES

- Low input current ·· 25nA(typ.)
- Wide supply voltage range ····························· 2.5V～28V
- Low dissipation current ········ 0.4mA(typ.)(All output OFF)
  1.5mA(typ.)(All output ON)
- Enables high output drive ······················ V_{OL}=0.15V(typ.)
  (Output current 20mA)

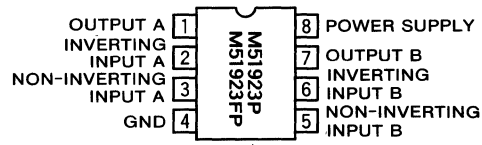
APPLICATION

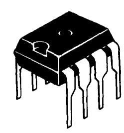
Voltage comparator, window comparator, CR timer, time delay circuit, oscillator, etc.

RECOMMENDED OPERATING CONDITIONS

Supply voltage range ··································· 2.5～28V
Rated supply voltage ··12V

PIN CONFIGURATION (TOP VIEW)

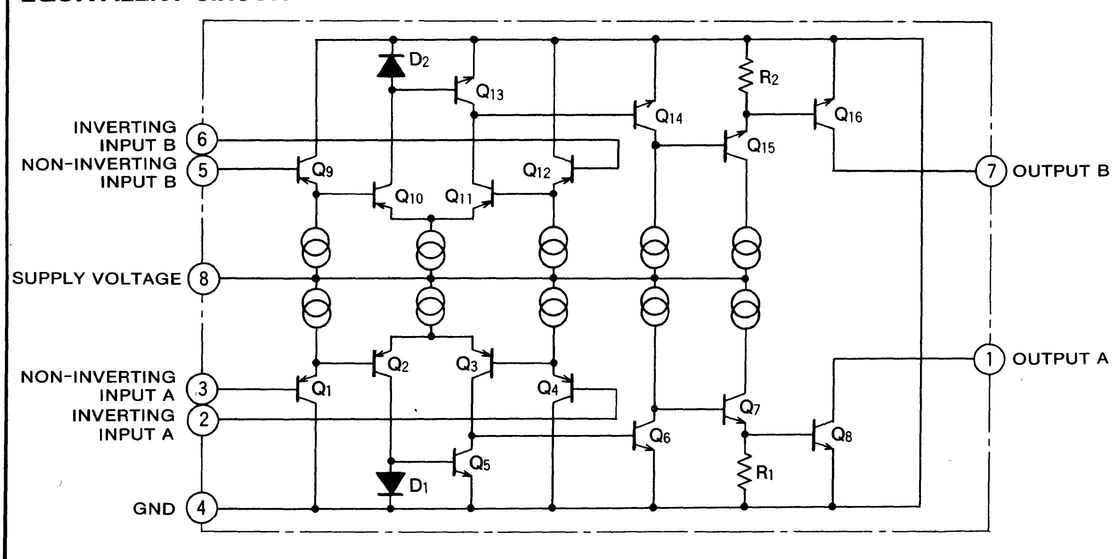




8-pin molded plastic DIP

8-pin molded plastic FLAT

EQUIVALENT CIRCUIT



ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		28	V
V_{ID}	Differential input voltage		V_{CC}	V
V_{ICM}	Common mode input voltage range		−0.3~V_{CC}	V
I_{sink}	Output sink current		80	mA
V_{OH}	"H" output voltage		30	V
P_d	Power dissipation		650 (M51923P) 300 (M51923FP)	mW
T_{opr}	Operating temperature		−20~+75	℃
T_{stg}	Storage temperature		−40~+125	℃

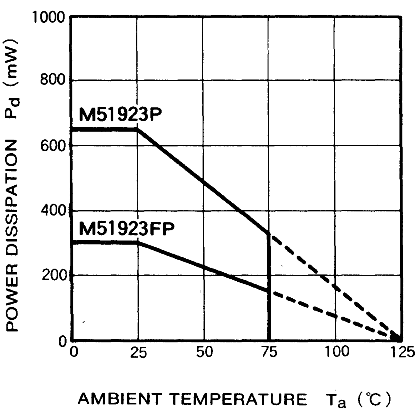
ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=2.5~28V, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage range		2.5		5.5	V
I_{CC1}	Circuit current 1	ALL OUTPUT ON		1.5	2.5	mA
I_{CC2}	Circuit current 2	ALL OUTPUT OFF		0.4	0.8	mA
$V_{I\ominus}$	Inverting input voltage range	NOTE	0		V_{CC}−1.5	V
$V_{I\oplus}$	Non-inverting input voltage range	NOTE	0		V_{CC}−1.5	V
V_{IO}	Input offset voltage			2	5	mV
$I_{I\ominus}$	Inverting input current			25	150	nA
$I_{I\oplus}$	Non-inverting input current			25	150	nA
I_{IO}	Input offset current			5	50	nA
V_{sat}	Output saturation voltage	I_{OL}=20mA		0.15	0.4	V
V_{OL}	"L" output voltage	I_{sink}=20mA		0.15	0.4	V
		I_{sink}=80mA		1		
I_{LO}	Output leak current				0.1	μA
t_{PLH}	Output "L→H" propagation delay time			2		μs
t_{PHL}	Output "H→L" propagation delay time			0.2		μs

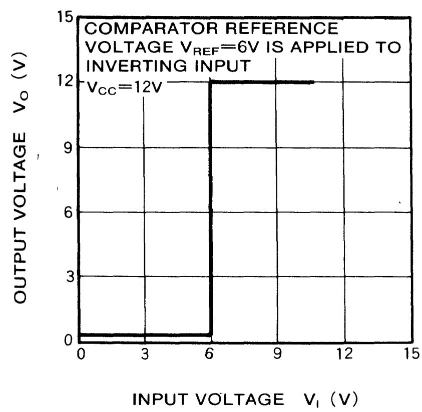
NOTE) Either inverting or non-inverting inputs (reference side) should be within this range. (Abnormal operation will not occur when the other is within the range of 0 to V_{CC})

TYPICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

THERMAL DERATING (MAXIMUM RATING)

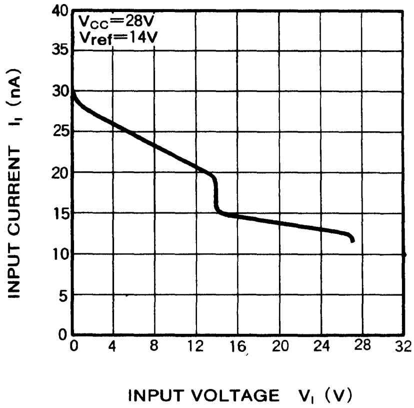


OUTPUT VOLTAGE VS. INPUT VOLTAGE

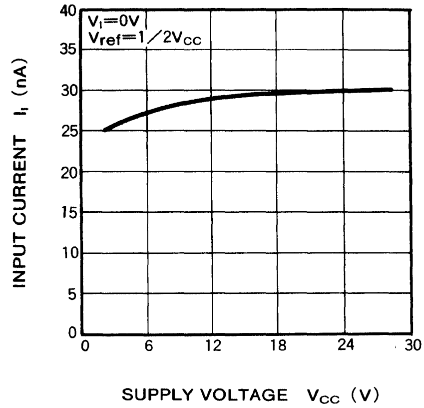


MITSUBISHI ELECTRIC

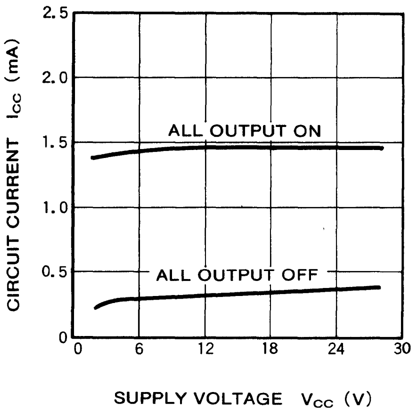
INPUT CURRENT VS. INPUT VOLTAGE



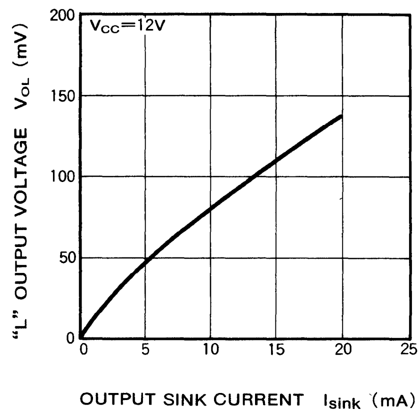
INPUT CURRENT VS. SUPPLY VOLTAGE



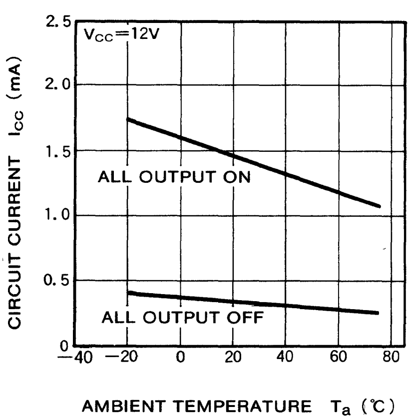
CIRCUIT CURRENT VS. SUPPLY VOLTAGE



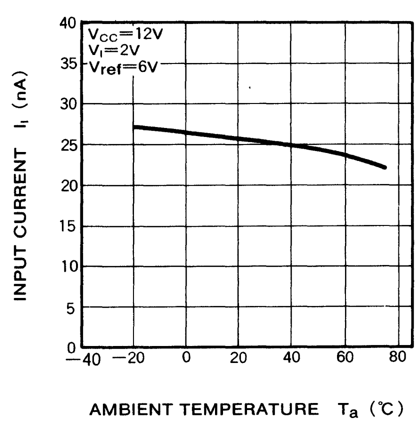
"L" OUTPUT VOLTAGE VS. OUTPUT SINK CURRENT



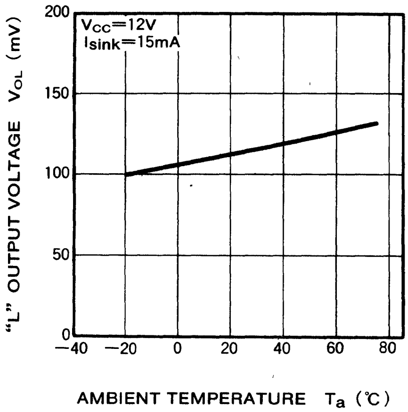
CIRCUIT CURRENT VS. AMBIENT TEMPERATURE



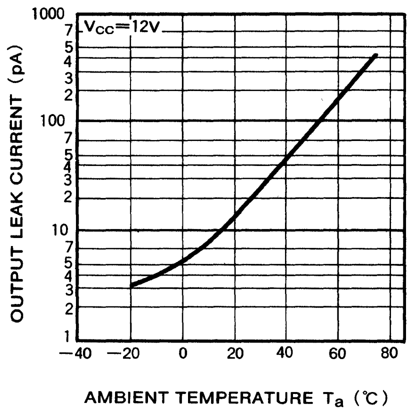
OUTPUT CURRENT VS. AMBIENT TEMPERATURE



"L" OUTPUT VOLTAGE AMBIENT TEMPERATURE



OUTPUT LEAK CURRENT VS. AMBIENT TEMPERATURE



M5233L, P, FP

DUAL COMPARATOR

DESCRIPTION

The M5223L,P,FP is a semiconductor circuit for a comparator designed to operate over a wide supply voltage range from 2 to 36V from a single power supply, with two circuits in each 8-pin SIP and 8-pin DIP and 8-pin mini flat package. A differential circuit which is equivalent to a conventional single power supply operational amplifier is used to enable operation from GND level to improve input characteristics. Power dissipation (circuit current) is low and output voltage is large. It fits to a general-purpose comparator for a variety fo electronic equipment.

FEATURES

- Wide operating supply voltage range ················ 2V～36V
  Dual power supplies: ±1V～±18V
- Low circuit current ···································· 0.6mA(typ.)
- Wide common mode input voltage range
  ····················· 0V～V_{CC}−1.5V (single power supply)
- Open collector output
- Output sink current ·· 25mA
- Response time ·· 1 3μsec
- Pin compatible with general-purpose comparators 393, 2930

APPLICATION

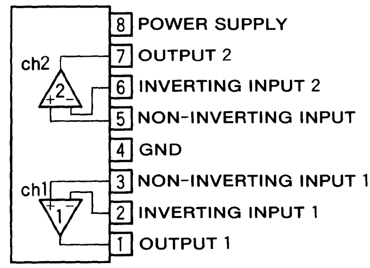
Voltage comparator, window comparator, CR timer, time delay circuit, oscillator, etc.

RECOMMENDED OPERATING CONDITIONS

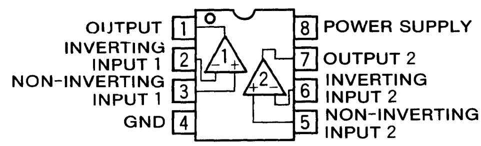
Supply voltage range ···································· 2～36V
Rated supply voltage ··12V

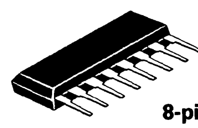
PIN CONFIGURATION (TOP VIEW)

SIP



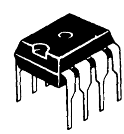
DIP, MINI FLAT





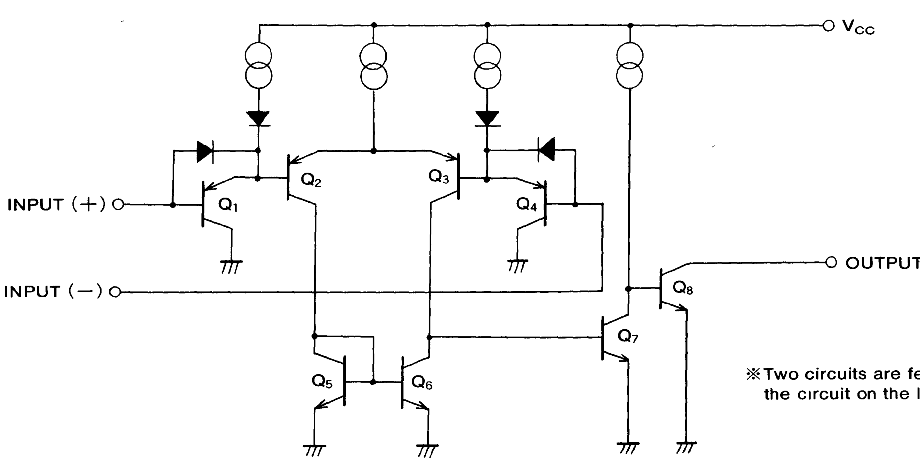
8-pin molded plastic SIP

8-pin molded plastic FP (MINI FLAT)



8-pin molded plastic DIP

EQUIVALENT CIRCUIT



※Two circuits are featured in the circuit on the left

ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

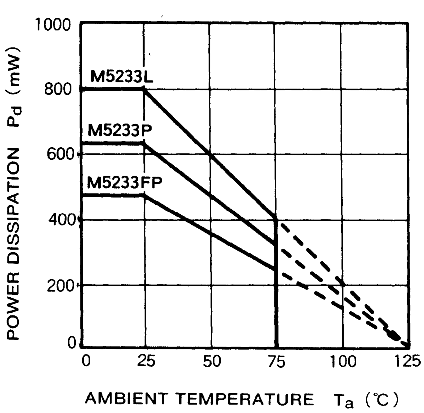
Symbol	Parameter	Ratings	Unit
V_{CC}	Supply voltage	36(±18)	V
V_{ID}	Differential input voltage	36	V
V_{ICM}	Common mode input voltage range	−0.3~+36	V
P_d	Power dissipation	800(SIP)/625(DIP)/440(FP)	mW
T_{opr}	Operating temperature	−20~+75	℃
T_{stg}	Storage temperature	−55~+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=5V)

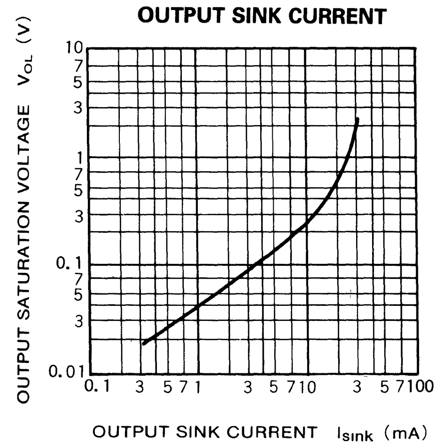
Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
V_{IO}	Input offset voltage	V_O=1.4V, V_{REF}=1.4V, R_S=0Ω		2	5	mV
I_{IO}	Input offset current			5	50	nA
I_B	Input bias current			25	250	nA
V_{ICM}	Common mode input voltage range		0		V_{CC}−1.5	V
G_V	Voltage gain	R_L=15kΩ		200		V/mV
I_{CC}	Circuit current	R_L=∞		0.6	1	mA
t_{PLH}	Response time	R_L=5.1kΩ, V_{RL}=5V		1.3		μsec
I_{sink}	Output sink current	$V_{IN(-)}$=1V, $V_{IN(+)}$=0V, $V_O \leqq 1.5$V	10	25		mA
V_{OL}	Output saturation voltage	$V_{IN(-)}$=1V, $V_{IN(+)}$=0V, I_{sink}=8mA		200	400	mV
I_{LO}	Output leak current	$V_{IN(+)}$=1V, $V_{IN(-)}$=0V, V_O=5V		0.1		nA

TYPICAL CHARACTERISTICS

THERMAL DERATING (MAXIMUM RATING)



OUTPUT SATURATION VOLTAGE VS. OUTPUT SINK CURRENT



MITSUBISHI ELECTRIC

M51200P

DUAL COMPARATOR

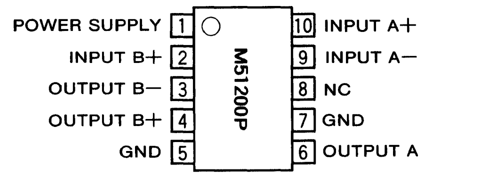
DESCRIPTION

The M51200P is a semiconductor integrated circuit for a dual voltage comparator designed to operate from a single power supply.

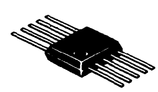
Comparator A has two inputs and one output while comparator B has one input and two outputs with half the supply voltage as its reference voltage. Especially the M51200P can operate at low supply voltage and has superiority as to input current (input resistance) and fits to wide ranged applications.

The M51200P's package is 10-pin FLAT package and makes mounting of components easy.

PIN CONFIGURATION (TOP VIEW)



NC : NO CONNECTION



10-pin molded plastic FLAT

FEATURES

- Operates over low supply voltage range ·········· 1.4~6.0V
- Low input current ······································ 3nA(typ.)
- Capable of directly driving a relay or a lamp ·· 40mA(max.)
- High breakdown voltage ································ 18V(max.)
- Includes voltage surge absorbing zener diode for protection

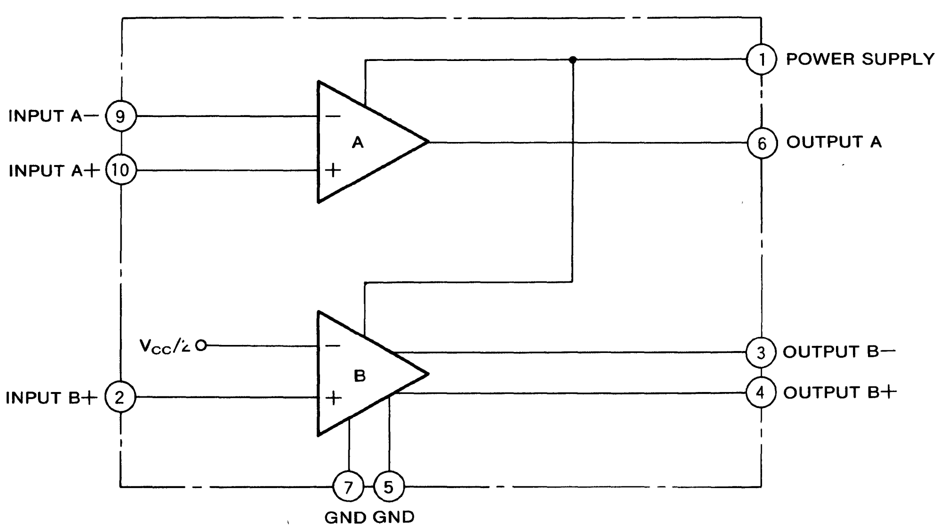
APPLICATION

Voltage comparator, electronic shutter, CR timer, time delay circuit, oscillator.

RECOMMENDED OPERATING CONDITIONS

Supply voltage range ···································· 1.4~6.0V
Rated supply voltage ······································ 3.0V

EQUIVALENT CIRCUIT



ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

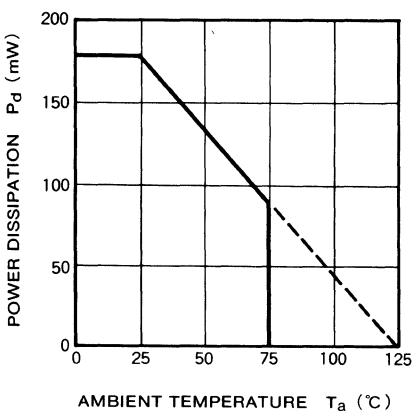
Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Power supply		6	V
V_{IN}	Input voltage		V_{CC}	V
$I_{⑥}$	Output sink current		40	mA
$I_{③}$			2	mA
$I_{④}$			25	mA
$V_{⑥}$	Output drive voltage		18	V
$V_{③}$			10	V
$V_{④}$			18	V
P_d	Power dissipation		180	mW
T_{opr}	Operating temperature		−20～+75	℃
T_{stg}	Storage temperature		−40～+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=3.0V, unless otherwise noted)

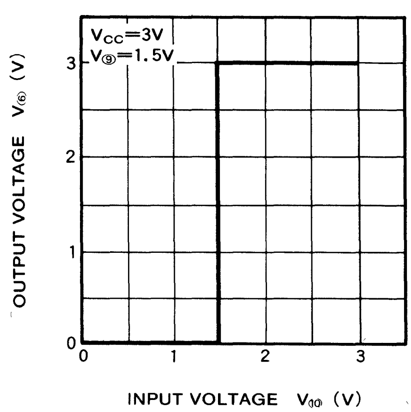
Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage range		1.4		6.0	V
I_{CC}	Circuit current	V_{CC}=3V		1.8	2.8	mA
		V_{CC}=6V		3.4	4.9	
$I_{IN⑩}$	Input current	V_{CC}=3V		3	10	nA
$I_{IN⑨}$				3	10	nA
$I_{IN②}$				8	100	nA
V_{REF}	Reference voltage of comparator B	V_{CC}=3V	1.35	1.5	1.65	V
$V_{S⑥}$	Output saturation voltage	$I_{⑥}$=20mA		0.18	0.3	V
$V_{S③}$		$I_{③}$=10μA		38	60	mV
$V_{S④}$		$I_{④}$=25mA		0.2	0.5	V
$V_{Z⑥}$	Output protection zener voltage	$I_{⑥}$=5mA	18	21	26	V
$V_{Z④}$		$I_{④}$=5mA	18	21	26	V
V_{IN}	Input voltage range	V_{CC}=3V	0.8		V_{CC}−0.2	V
t_{PLH}	Output "L→H" propagation delay time	V_{CC}=3V		20		μs
t_{PHL}	Output "H→L" propagation delay time			20		μs

TYPICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

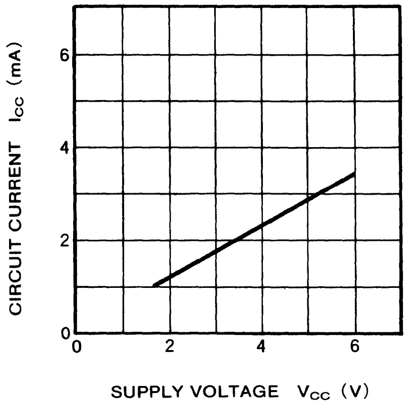
THERMAL DERATING (MAXIMUM RATING)



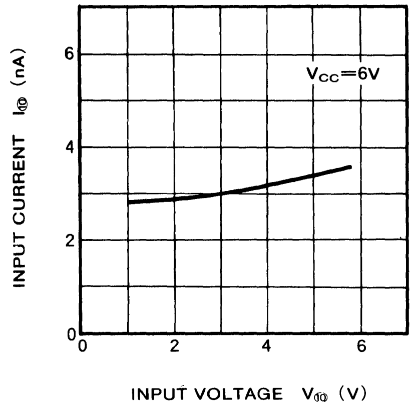
INPUT/OUTPUT PROPAGATION CHARACTERISTICS (COMPARATOR A)



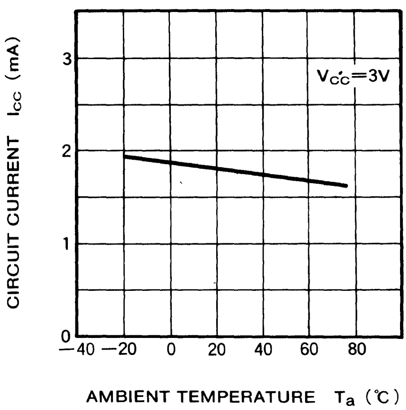
CIRCUIT CURRENT VS. SUPPLY VOLTAGE



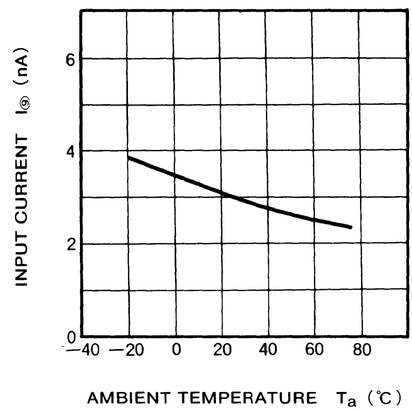
INPUT CURRENT AT PIN ⑩ VS. INPUT VOLTAGE



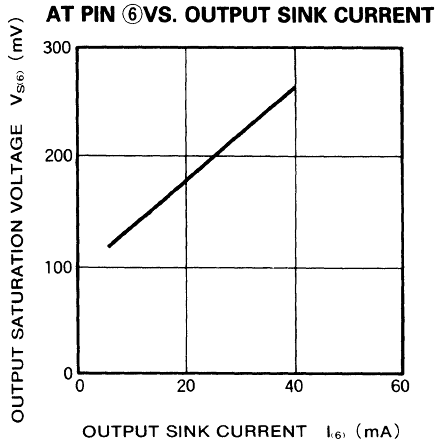
CIRCUIT CURRENT VS. AMBIENT TEMPERATURE



INPUT CURRENT AT PIN ⑨ VS. AMBIENT TEMPERATURE

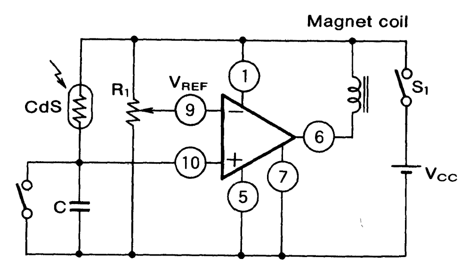


OUTPUT SATURATION VOLTAGE AT PIN ⑥VS. OUTPUT SINK CURRENT



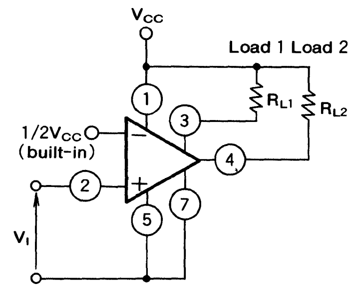
APPLICATION EXAMPLES

(1) Electronic shutter



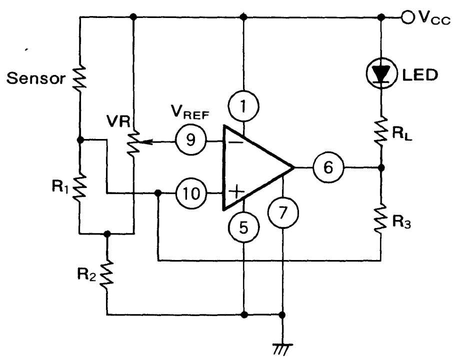
$$t = CR_{cds}\ \ell n \frac{V_{CC}}{V_{CC} - V_{REF}}$$

(2) Comparator

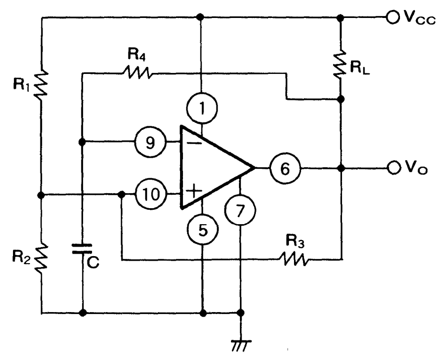


$V_I < 1/2V_{CC}$ · $V_④$=Low, $V_③$=High
$V_I < 1/2V_{CC}$: $V_④$=High, $V_③$=Low

(3) Detection circuit



(4) Oscillator



$R_L < R_3, R_4$

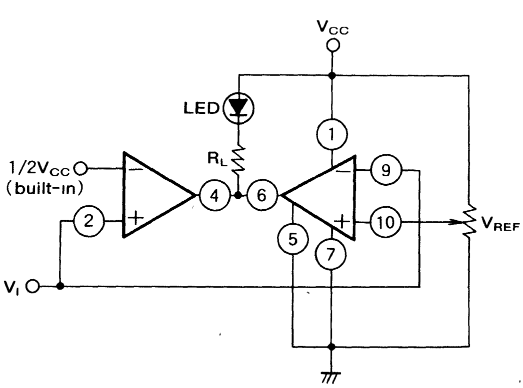
$$I = \frac{1}{CR_4\ \ell n \frac{R\ell}{Rh} \cdot \frac{1 - R\ell}{1 - Rh}} \text{[Hz]}$$

$$Rh = \frac{R_2}{R_2 + \frac{R_1 R_3}{R_1 + R_3}}$$

$$R\ell = \frac{\frac{R_2 R_3}{R_2 + R_3}}{R_1 + \frac{R_2 R_3}{R_2 + R_3}}$$

Note : Connect both pin ⑤ and pin ⑦ to GND

(5) Window comparator



M51209P

QUAD COMPARATOR

DESCRIPTION

The M51209P is a quad (four independent) comparator and operates over a wide voltage range from a single supply voltage. Especially the M51209P has superiority as to characteristics of input current (input resistance) and fits to wide ranged applications, for example CR Timer, oscillator, etc.

FEATURES

- Low input curret (high input resistance)········20nA(typ.)
- Wide supply voltage range························· 2.5V~28V
- Low dissipation current····························6.8mA(typ.)
- Capable of driving a relay or a lamp directly 200mA(max.)
- Includes voltage surge absorbing zener diodes
- High output breakdown voltage····················30V(max.)
- Low output voltage (I_{sink}=60mA) ················ 0.2V(typ.)
- Low input offset voltage ···························· 2mV(typ.)

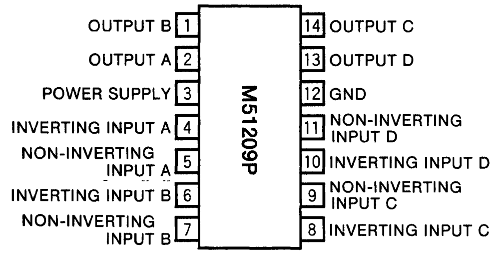
APPLICATION

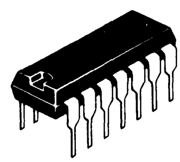
Voltage comparator, sequential timer, pulse generator, analog / digital converter, time delay circuit

RECOMMENDED OPERATING CONDITIONS

Supply voltage range································· 2.5~28V
Rated supply voltage·· 12V

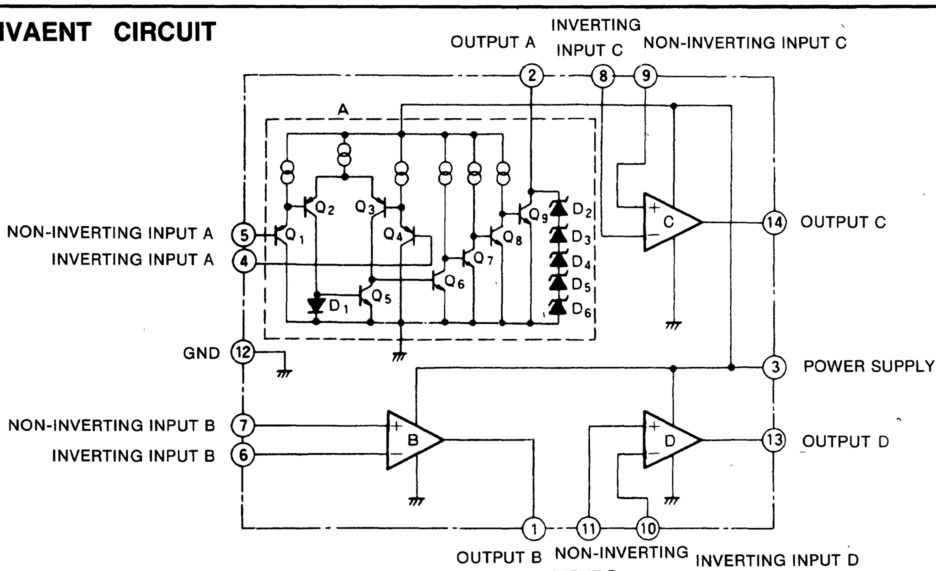
PIN CONFIGURATION (TOP VIEW)





14-pin molded plastic DIP

EQUIVAENT CIRCUIT



ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

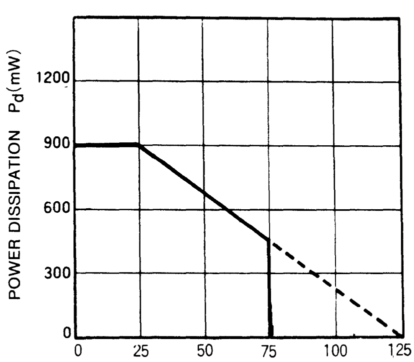
Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		28	V
V_{ID}	Differential input voltage		V_{CC}	V
V_{ICM}	Common mode input voltage range		−0.3~V_{CC}	V
Isink	Output sink current		200	mA
V_{OH}	"H" output voltage		30	V
P_d	Power dissipation		900	mW
Topr	Operating temperature		−20~+75	℃
Tstg	Storage temperature		−40~+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=2.5~28V, unlese otherwise noted)

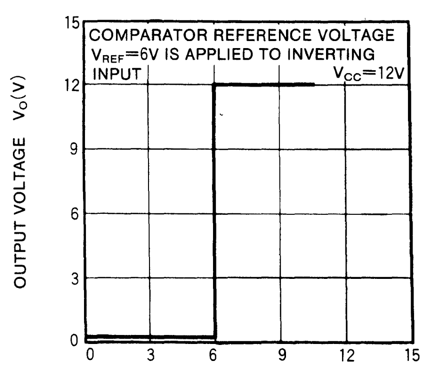
Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage range		2.5		28	V
I_{CC}	Circuit current			6.8	9.5	mA
$V_{I\ominus}$	Inverting input voltage range		0		V_{CC}−1.5	V
$V_{I\oplus}$	Non-inverting input voltage range		0		V_{CC}−1.5	V
V_{IO}	Input offset voltage			2	7	mV
$I_{I\ominus}$	Inverting input current			20	100	nA
$I_{I\oplus}$	Non-inverting input current			20	100	nA
I_{IO}	Input offset current			5	50	nA
V_{OL}	"L" output voltage	I_{sink}=60mA		0.2	0.4	V
		I_{sink}=200mA		1		
I_{LO}	Output leak current				0.1	μA
t_{PLH}	Output "L→H" propagation delay time			2		μs
t_{PHL}	Output "H→L" propagation delay time			1		μs

TYPICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

THERMAL DERATING
(MAXIMUM RATING)

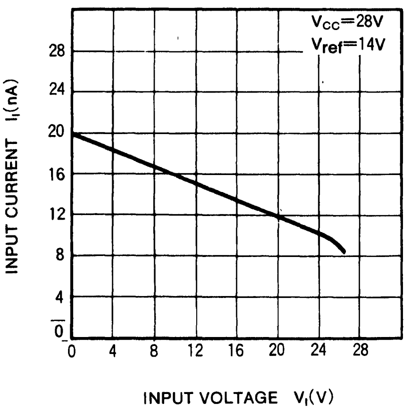


OUTPUT VOLTAGE VS
INPUT VOTAGE

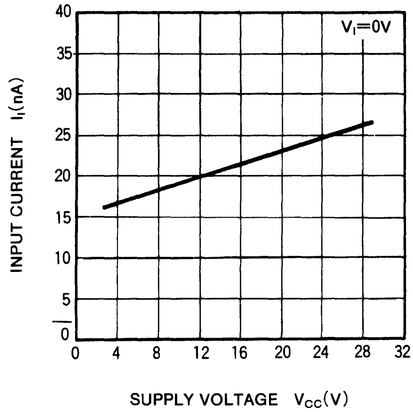


MITSUBISHI
ELECTRIC

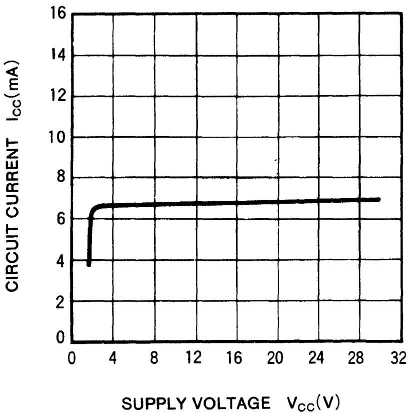
INPUT CURRENT VS INPUT VOLTAGE



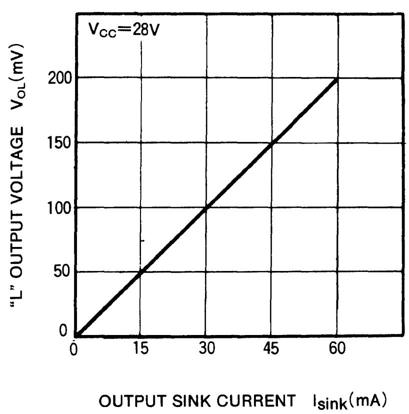
INPUT CURRENT VS SUPPLY VOLTAGE



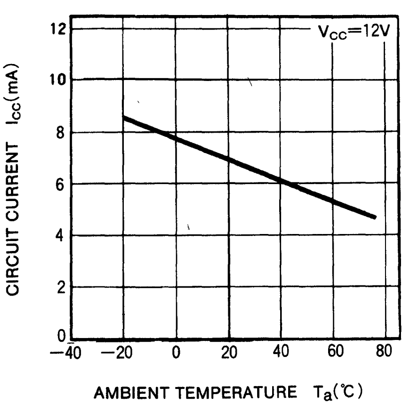
CIRCUIT CURRENT VS SUPPLY VOLTAGE



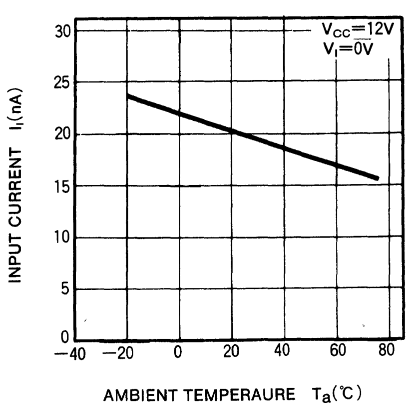
"L" OUTPUT VOLTAGE VS OUTPUT SINK CURRENT



CIRCUIT CURRENT VS AMBIENT TEMPERATURE



INPUT CURRENT VS AMBIENT TEMPERATURE

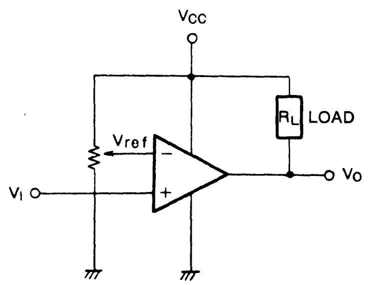


PRECAUTIONS FOU USE

1. Special care must be taken to protect the M51209P from large surges in current, such as may result from the incorrect connection of the V_{CC} and GND terminals.
2. Output is "open collector" and a loading resistor is not included. Connect a loading resistor to stabilize operation, when driving another.

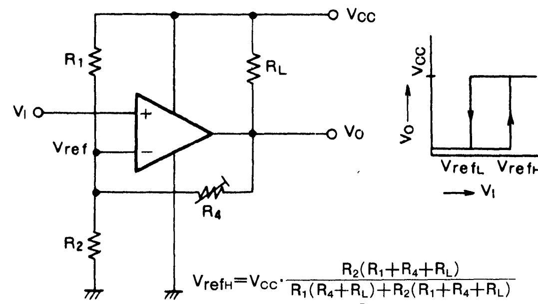
APPLICATION EXAMPLES

(1) Voltage comparator



If $V_{REF} > V_I$ V_O=Low
If $V_{REF} < V_I$ V_O=High

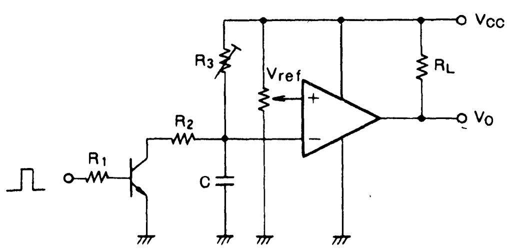
(2) Schmitt trigger circuit



$$V_{refH} = V_{CC} \cdot \frac{R_2(R_1+R_4+R_L)}{R_1(R_4+R_L)+R_2(R_1+R_4+R_L)}$$

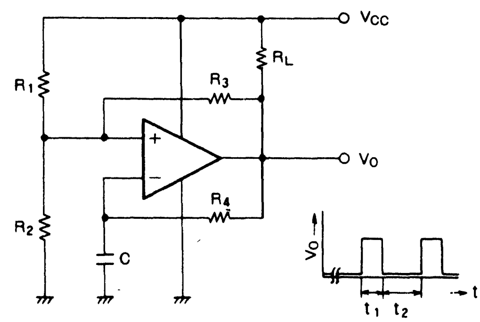
$$V_{refL} = V_{CC} \cdot \frac{R_2R_4}{R_2R_4+R_1(R_2+R_4)}$$

(3) Monostable multi-vibrator



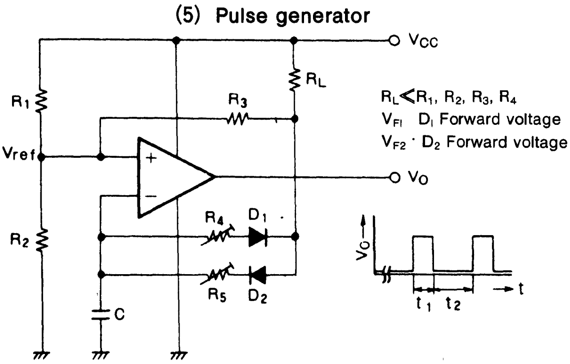
$$t = CR_3 \cdot \ell n \frac{V_{CC}}{V_{CC}-V_{ref}} \text{(sec)}$$

(4) Unstable multi-vibrator



$$t_1 = CR_4 \ell n \frac{R_2+R_3}{R_3} \quad t_2 = CR_4 \ell n \frac{R_1+R_3}{R_3} \quad (R_L < R_1, R_2, R_3, R_4)$$

(5) Pulse generator

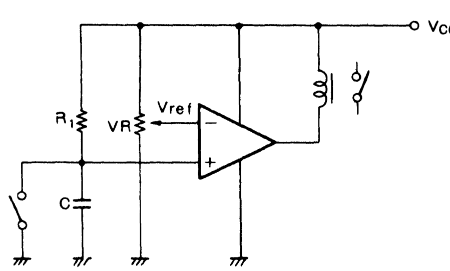


$R_L < R_1, R_2, R_3, R_4$
V_{F1} D_1 Forward voltage
V_{F2} · D_2 Forward voltage

$$V_{refH} = \frac{V_{CC} \cdot R_2(R_1+R_3)}{R_1R_2+R_2R_3+R_3R_1} \qquad t_1 = CR_5 \ell n \frac{V_{CC}-V_{refL}-V_{F2}}{V_{CC}-V_{refH}}$$

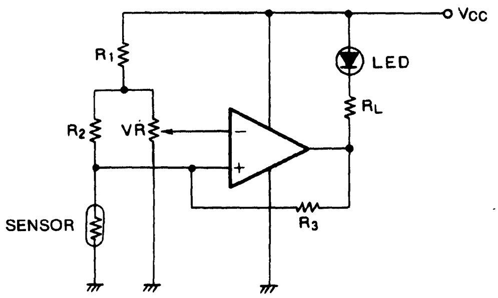
$$V_{refL} = \frac{V_{CC} \cdot R_2R_3}{R_1R_2+R_2R_3+R_3R_1} \qquad t_2 = CR_4 \ell n \frac{V_{refH}-V_{F1}}{V_{refL}}$$

(6) CR Timer

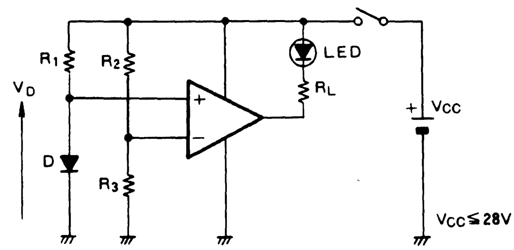


$$t = CR_1 \cdot \ell n \frac{V_{CC}}{V_{CC}-V_{ref}}$$

(7) Sensor detector



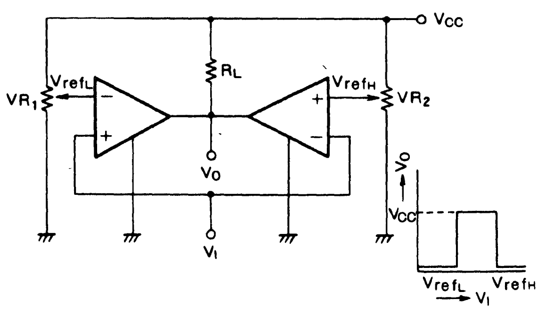
(8) Battery check circuit



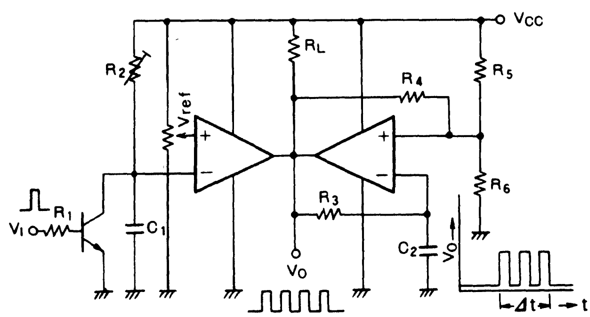
$V_D < V_{CC} \cdot \frac{R_3}{R_2+R_3}$; LED→ON

$V_D > V_{CC} \cdot \frac{R_3}{R_2+R_3}$; LED→OFF

(9) Window comparator

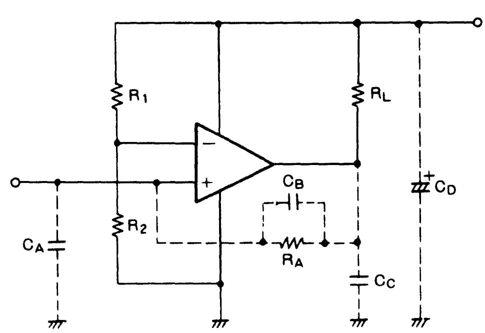


(10) Pulse train generator



$\Delta t = C_1 R_2 \cdot \ell n \frac{V_{CC}}{V_{CC} - V_{ref}}$

(11) Countermeaure against oscillation

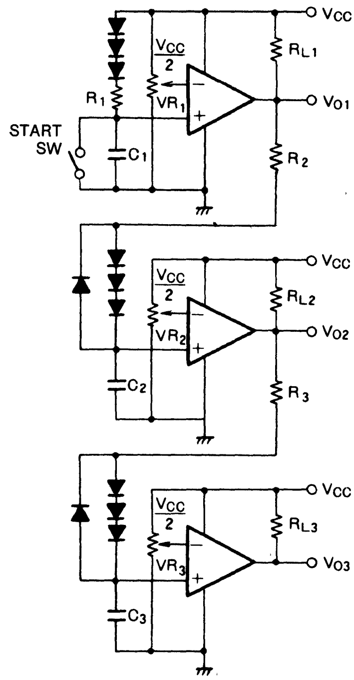


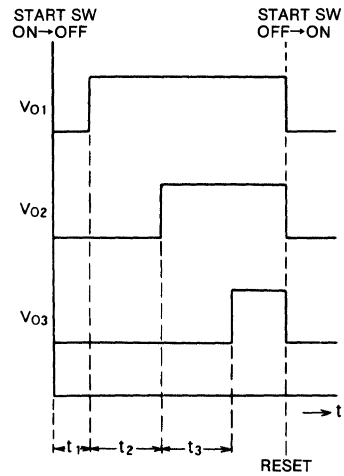
(Note) Taking steps against oscillation

The M51209P may oscillate according to input condition. If the M51209P should oscillate, the following countermeasures are applicable.

- In case of connecting input signal with chattering, connect a capcitor of small C_A. value.
- In case of oscillation with ordinary input, employ positive feedback inserting R_A (large resistor) , C_B (no polar) or connect C_C.
- When the supply voltage is not stabilized, connect C_D (a large electrolytic capacitor) to absorb the supply voltage change.

(12) Sequential timer



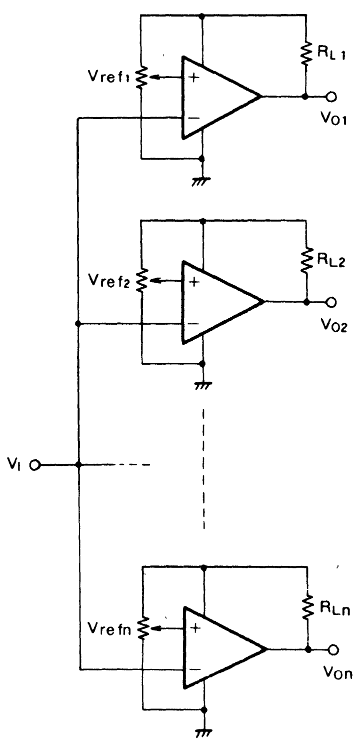


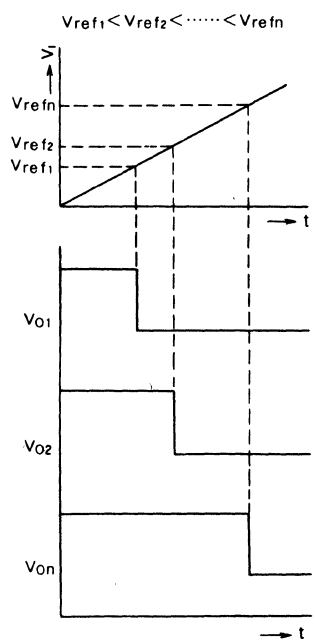
$t_1 = 0.7C_1 \cdot R_1$

$t_2 = 0.7C_2(R_{L1} + R_2)$

$t_3 = 0.7C_3(R_{L2} + R_3)$

(13) Analog/Digital converter





MITSUBISHI ELECTRIC

M51924P,FP

QUAD COMPARATOR

DESCRIPTION

The M51924P,FP is a quad (four independent) comparator and operates over a wide voltage range from a single supply voltage. Especially the M51924P,FP has superiority as to characteristics of input current (input resistance) and fits to wide ranged applications, for example CR timer, oscillator, etc.

FEATURES

- Low input current ········· 25nA(typ.)
- Wide supply voltage range ········· 2.5~28V
- Low dissipation current
  ········· 0.8mA(typ.)(All output OFF)
  3mA(typ.)(ALL output ON)
- Enable high output drive ········· V_{OL}=0.15V(typ.)
  (Output current 20mA)

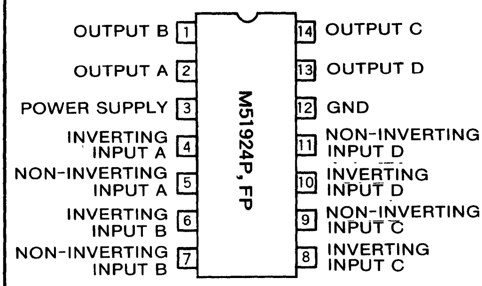
APPLICATION

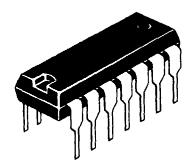
Voltage comparator, window comparator, CR timer, time delay circuit, oscillator.

RECOMMENDED OPERATING CONDITIONS

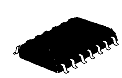
Supply voltage range ········· 2.5~28V
Rated supply voltage ········· 12V

PIN CONFIGURATION (TOP VIEW)



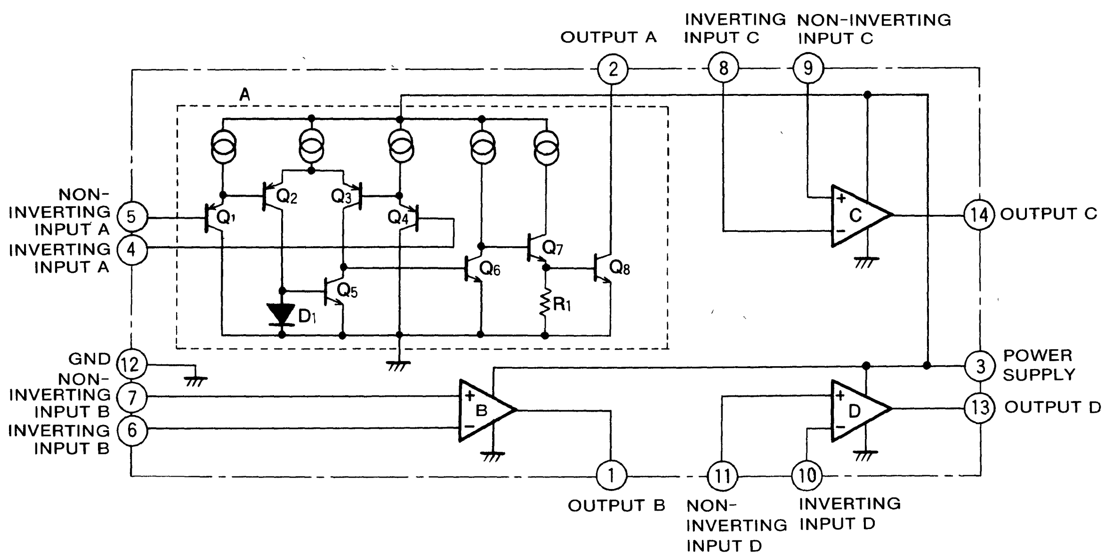


14-pin molded plastic DIP



14-pin molded plastic FLAT

EQUIVALENT CIRCUIT



ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		28	V
V_{ID}	Differential input voltage		V_{CC}	V
V_{ICM}	Common mode input voltage range		$-0.3 \sim V_{CC}$	V
I_{sink}	Output sink current		80	mA
V_{OH}	"H" output voltage		30	V
P_d	Power dissipation		900 (M51924P)	mW
			350 (M51924FP)	
T_{opr}	Operating temperature		$-20 \sim +75$	℃
T_{stg}	Storage temperature		$-40 \sim +125$	℃

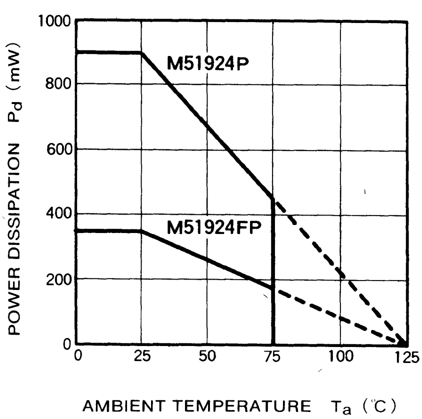
ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=2.5~28V, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage range		2.5		28	V
I_{CC1}	Circuit current 1	ALL OUTPUT ON		3.0	5.0	mA
I_{CC2}	Circuit current 2	ALL OUTPUT OFF		0.8	1.6	mA
$V_{I\ominus}$	Inverting input voltage range	NOTE	0		$V_{CC}-1.5$	V
$V_{I\oplus}$	Non-inverting input voltage range	NOTE	0		$V_{CC}-1.5$	V
V_{IO}	Input offset voltage			2	5	mV
$I_{I\ominus}$	Inverting input current			25	150	nA
$I_{I\oplus}$	Non-inverting input current			25	150	nA
I_{IO}	Input offset current			5	50	nA
V_{sat}	Output saturation voltage	I_{OL}=20mA		0.15	0.4	V
V_{OL}	"L" output voltage	I_{sink}=20mA		0.15	0.4	V
		I_{sink}=80mA		1		
I_{LO}	Output leak current				0.1	μA
t_{PLH}	Output "L→H" propagation delay time			2		μs
t_{PHL}	Output "H→L" propagation delay time			0.2		μs

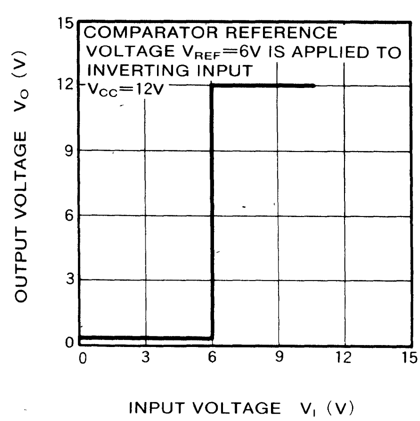
NOTE) Either inverting or non-inverting inputs (reference side) should be within this range (Abnormal operation will not occur when the other is within the range of 0 to V_{CC})

TYPICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

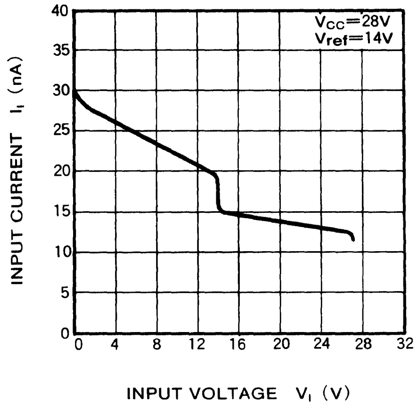
THERMAL DERATING (MAXIMUM RATING)



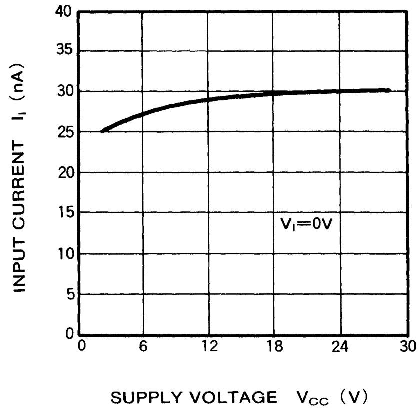
OUTPUT VOLTAGE VS. INPUT VOLTAGE



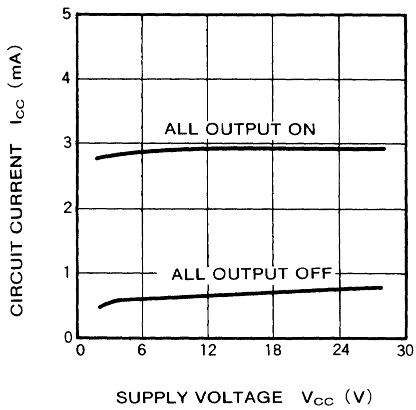
INPUT CURRENT VS. INPUT VOLTAGE



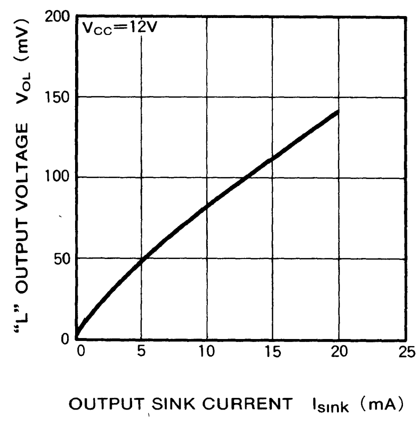
INPUT CURRENT VS. SUPPLY VOLTAGE



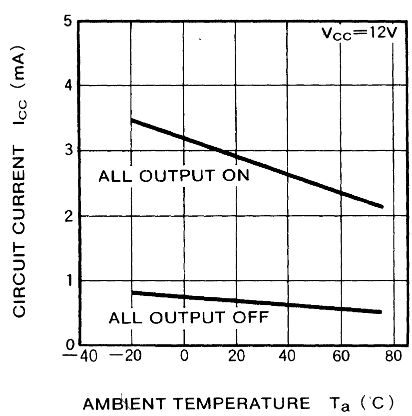
CIRCUIT CURRENT VS. SUPPLY VOLTAGE



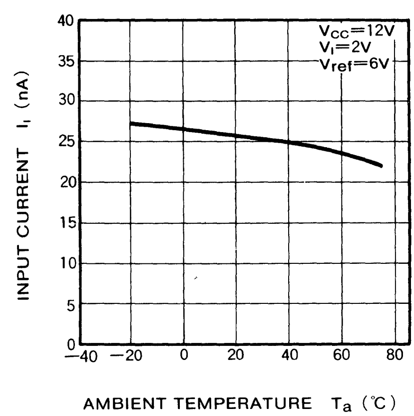
"L" OUTPUT VOLTAGE VS. OUTPUT SINK CURRENT



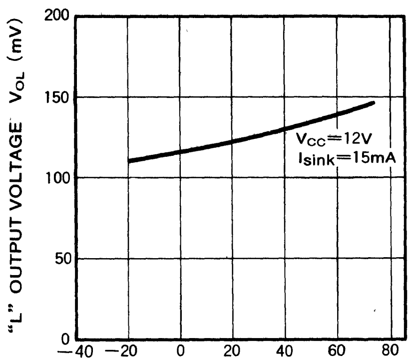
CIRCUIT CURRENT VS. AMBIENT TEMPERATURE



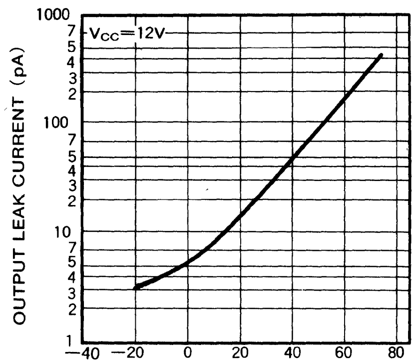
INPUT CURRENT VS. AMBIENT TEMPERATURE



"L" OUTPUT VOLTAGE VS. AMBIENT TEMPERATURE



OUTPUT LEAK CURRENT VS. AMBIENT TEMPERATURE



M5234P, FP

QUAD COMPARATOR

DESCRIPTION

The M5234P,FP is a semiconductor circuit for a comparator designed to operate over a wide supply voltage range from 2 to 36V from a single power supply, with four circuits in each 14-pin DIP and 14-pin mini flat package. A differential circuit which is equivalent to a conventional single power supply operational amplifier is used to enable operation from GND level to improve input characteristics. Power dissipation (circuit current) is low and output voltage is large. It is a general-purpose comparator suitable for a variety of electronic equipment.

FEATURES

- Wide operating supply voltage range ·················· 2V~36V
  Dual power supplies: ±1V~±18V
- Low circuit current ····································· 0.8mA(typ.)
- Wide common mode input voltage range
  ·······················0V~V_{CC}−1.5V (single power supply)
- Open collector output
- Output sink current ·· 25mA
- Response time ··· 1.3μsec
- Pin compatible with general-purpose comparators 339, 2901

APPLICATION

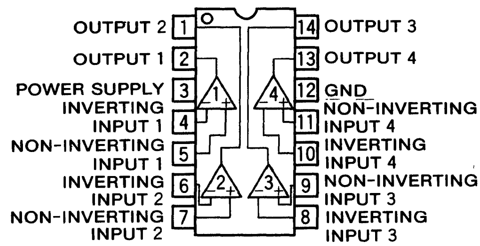
Voltage comparator, window comparator, CR timer, time delay circuit, oscillator, etc.

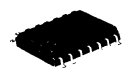
RECOMMENDED OPERATING CONDITIONS

Supply voltage range ······································· 2~36V
Rated supply voltage ··12V

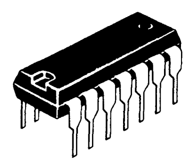
PIN CONFIGURATION (TOP VIEW)

DIP, MINI FLAT



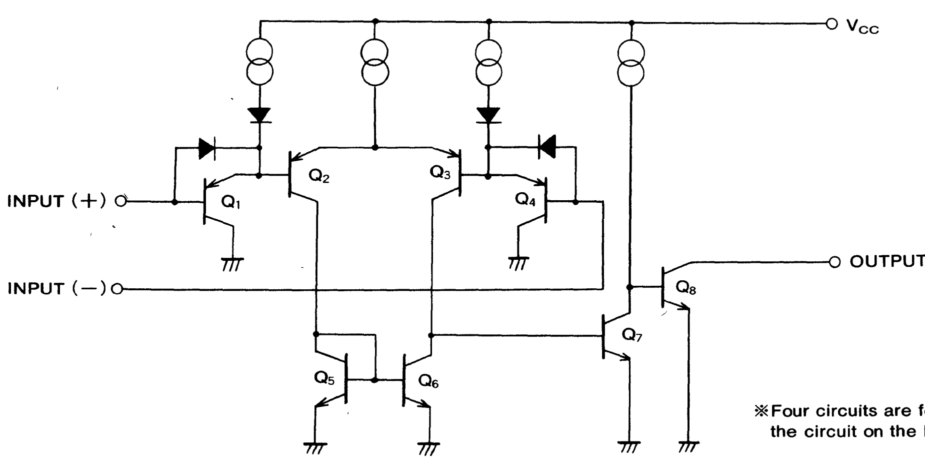


14-pin molded plastic FP (MINI FLAT)



14-pin molded plastic DIP

EQUIVALENT CIRCUIT



※Four circuits are featured in the circuit on the left.

ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

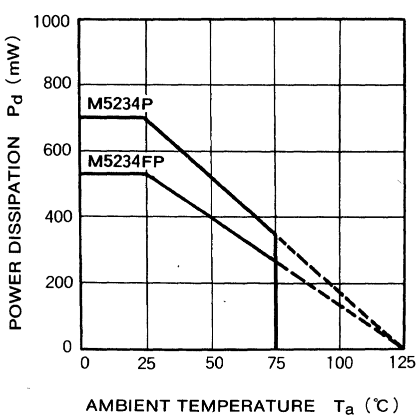
Symbol	Parameter	Ratings	Unit
V_{CC}	Supply voltage	36(±18)	V
V_{ID}	Differential input voltage	36	V
V_{ICM}	Common mode input voltage range	−0.3∼+36	V
P_d	Power dissipation	700(DIP)/550(FP)	mW
T_{opr}	Operating temperature	−20∼+75	℃
T_{stg}	Storage temperature	−55∼+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=±15V)

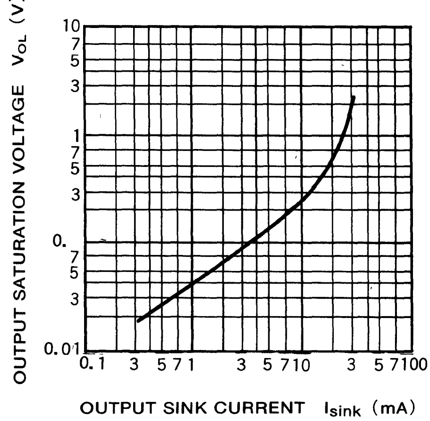
Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
V_{IO}	Input offset voltage	V_O=1.4V, V_{REF}=1.4V, R_S=0Ω		2	5	mV
I_{IO}	Input offset current			5	50	nA
I_B	Input bias current			25	250	nA
V_{ICM}	Common mode input voltage range		0		V_{CC}−1.5	V
G_V	Voltage gain	R_L=15kΩ		200		V/mV
I_{CC}	Circuit current	R_L=∞		0.8	2	mA
t_{PLH}	Response time	R_L=5.1kΩ, V_{RL}=5V		1.3		μsec
I_{sink}	Output sink current	$V_{IN(-)}$=1V, $V_{IN(+)}$=0V, V_O≦1.5V	10	25		mA
V_{OL}	Output saturation voltage	$V_{IN(-)}$=1V, $V_{IN(+)}$=0V, I_{sink}=8mA		200	400	mV
I_{LO}	Output leakage current	$V_{IN(+)}$=1V, $V_{IN(-)}$=0V, V_O=5V		0.1		nA

TYPICAL CHARACTERISTICS

THERMAL DERATING (MAXIMUM RATING)



OUTPUT SATURATION VOLTAGE VS. OUTPUT SINK CURRENT



MITSUBISHI ELECTRIC

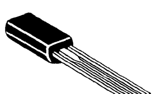
VOLTAGE REGULATOR

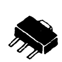
4

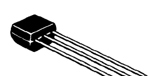
QUICK REFERENCE TABLE OF VOLTAGE REGULATORS

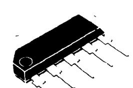
Application	Type No.	Function	Features	Maximum ratings: Input voltage range V_I (V)	Maximum ratings: load current I_L (mA)	Maximum ratings: Power dissipation P_d (mW)	Electrical characteristics (typ.): Input bias current I_B (mA)	Electrical characteristics (typ.): Ripple rejection ratio RR (dB)	Electrical characteristics (typ.): Reference voltage V_{REF} (V)	Electrical characteristics (typ.): Minimum I/O voltage differential V_{IO} (V)	Electrical characteristics (typ.): Output noise voltage V_{NO} (μVrms)	Equivalent	Package outline
Variable output	M5230L	Positive/negative variable voltage regulator (tracking type)	● Withstands high voltage, and has high ripple rejection ratio ● Capable of ON/OFF control and variable rising time constant of output voltage	±8～±35	30	800	1.3	68	1.8	2.5 (0.1 possible)	12	TA7179P	8-pin SIP
Variable output	M5231TL	Variable positive single power supply	● Withstands high voltage, and has high ripple rejection ratio ● Constant variable and ON/OFF control at the time of output voltage rise	8～70	30	300	1.2	62	1.8	2.5 (0.1 possible)	6	μPC141 μPC305 TA7089P	5-pin SIP
Low I/O voltage differential operation	M5235L	3-Terminal low voltage variable output voltage regulator (drive type)	● Very low input-output voltage differential operation ● Low operating voltage (V_{INmin}=1.3V) ● Small outline	V_{IN}1.3～7	20	300	1.6	56	0.79	0.1	18	—	Compack 3-pin SIP
Low I/O voltage differential operation	M5236	General-purpose 3-terminal variable output voltage regulator (driver type)	● Low input-output voltage differential operation ● High withstand voltage ● High ripple rejection ratio	V_{IN}3.5～36	30	900	1.7	68	1.26	0.2	33	—	L: 3-pin SIP ML: 3-pin mini FLAT
Fixed positive output	★M5278L05	5V 3-terminal regulator	● Internal fold-back protection circuit for load terminal short circuit ● High ripple rejection ratio ● High output-voltage accuracy	8～36	100	900	4.8	73	Output voltage Vo 5±0.25	2	49	78L	3-pin SIP (TO-92L)
Fixed positive output	★M5278L56	5.6V 3-terminal regulator		8.6～36				73	5.6±0.28		55		
Fixed positive output	★M5278L08	8V 3-terminal regulator		11～36				59	8±0.4		80		
Fixed positive output	★M5278L09	9V 3-terminal regulator		12～36				58	9±0.45		90		
Fixed positive output	★M5278L10	10V 3-terminal regulator		13～36				57	10±0.5		100		
Fixed positive output	★M5278L12	12V 3-terminal regulator		15～36				55	12±0.6		110		
Fixed positive output	★M5278L15	15V 3-terminal regulator		18～36				52	15±0.75		140		
Switching	M5T494	Switching regulator control	● Internal under voltage lock-out circuit ● Output voltage of reference voltage circuit········5V±5% ● Applicable to single-end, push-pull	7～40V	200	1000(P) 800(FP)	7		5V	—	—	TL494 MB3759 μPC494	P: 16-pin DIP FP: 16-pin mini FLAT

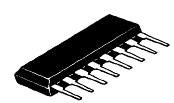
★: New product

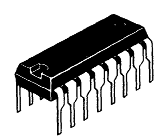

3-pin SIP (TO-92L)

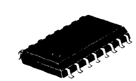

3-pin mini FLAT


Small 3-pin SIP


5-pin SIP


8-pin SIP


16-pin DIP

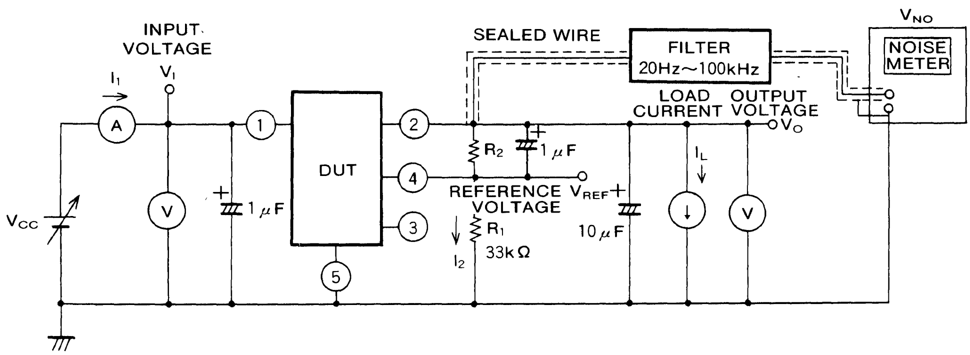

16-pin FLAT

TEST METHOD, APPLICATION EXAMPLE AND PRECAUTIONS FOR USE OF VOLTAGE REGULATOR

Methods of measuring various electric characteristics, applications and general precautions in the use of power-supply ICs are explained, with M5231, a general purpose variable-voltage positive power-supply IC as an example.

1. Test method

1-1. Test circuit 1



V_{REF}: Reference voltage

Reference voltage for variable output voltage regulator. Voltage between pins ④—⑤ and is 1.8V typ.

V_O: Output voltage

Voltage between pins ②—⑤. V_O is determined by the following equation.

$$V_O=V_{REF}\times(1+\frac{R_2}{R_1})(V)$$

V_{I-O}: Minimum input-output voltage differential

Voltage difference of input voltage (V_I) and output voltage (V_O) required for stable operation of the device.

Difference of input voltage and output voltage is measured when input voltage regulation (Reg-in) is reduced by 6dB.

Reg-in: Input regulation

Indicates ratio of output voltage regulation against input voltage regulation. When input voltage changes from V_{I1} to V_{I2}, and output voltage changes from V_{O1} to V_{O2}, the Reg-in is obtained in the following equation.

$$\text{Reg-in}=\frac{V_{O2}-V_{O1}}{V_{O1}}\times\frac{1}{V_{I2}-V_{I1}}\times100\ (\%/V)$$

Reg-L: Load regulation

Ratio of output voltage regulation against load current regulation. When load current (I_L) changes from I_{L1} to I_{L2}, Reg-L is obtained by the following equation.

$$\text{Reg-L}=\frac{V_{O1}-V_{O2}}{V_{O1}}\times100\ (\%)$$

I_B: Bias current

Circuit current (power dissipation current) required for stable operation of the device. If load current (I_L) is 0 and input current is I_1, the I_B is expressed by the following equation. Current in reference voltage pin ④ is minimum and can be distregarded.

$$I_B=I_1-I_2=I_1-\frac{V_{REF}}{R_1}$$

$$\doteqdot I_1-\frac{1.8V}{3.3k\Omega}\doteqdot I_1-0.55mA$$

V_{NO}: Output noise voltage

Noise at output pin is measured with a noise meter using band pass filter of 20Hz~100kHz.

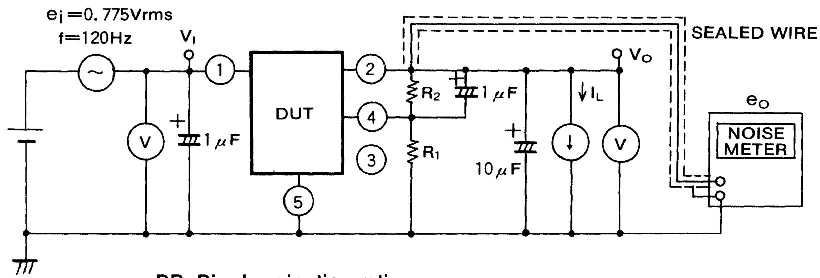
TCV_O: Temperature coefficient of output voltage

Output voltage regulation owing to ambient temperature change. When the device is placed in isothermal bath, and ambient temperature changes from T_{a1} to T_{a2}, and output voltage changes from V_{O1} to V_{O2}, TCV_O is expressed by the following equation.

$$TCV_O=\frac{V_{O2}-V_{O1}}{V_O(@Ta=25°C)}\times\frac{1}{T_{a1}-T_{a2}}\times100\ (\%/°C)$$

TEST METHOD, APPLICATION EXAMPLE PRECAUTIONS FOR USE OF VOLTAGE REGULATOR

1-2. Test circuit 2



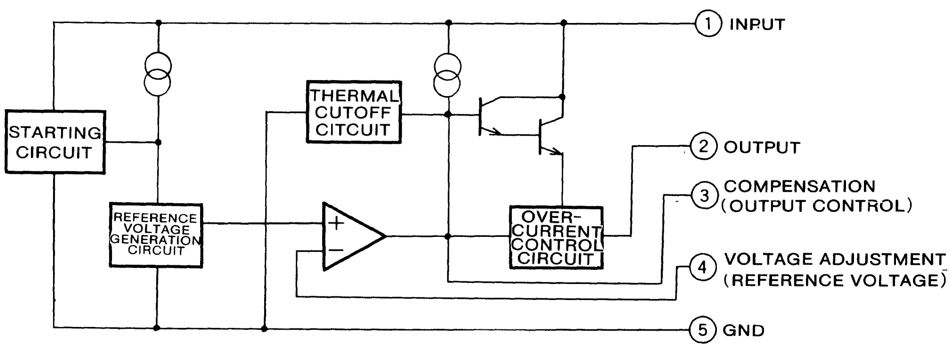
RR: Ripple rejection ratio

Ratio of output ripple (e_O) against input ripple (e_i) is expressed by the following equation.

$$RR=\log\frac{e_i}{e_O}\ (dB) \qquad \text{where, } V_I=V_O+5V$$

2. Application example

2-1. Block diagram (M5231TL)

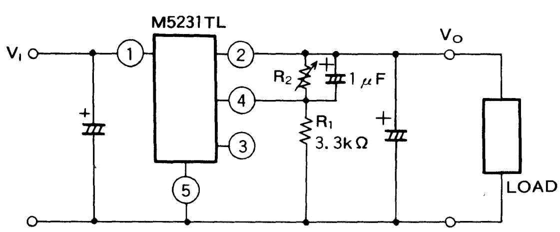


2-2. Input voltage range

Minimum input voltage required for stable operation and maximum input voltage (maximum rating) to prevent destruction of the device.

For the M5231TL, the minimum input voltage is 8V for generating internal reference voltage, and maximum input voltage is 70V.

2-3. Output voltage setting



Output voltage (V_O) can be set freely by externally connected resistors R_1, R_2 from the following equation.

$$V_O=V_{REF}\times(1+\frac{R_2}{R_1})$$

The R_2 is obtained from the following equation.

$$R_2=R_1\times(\frac{V_O}{V_{REF}}-1)$$

For the M5231TL, V_{REF}=1.8V typ.

R_1=3.3kΩ (recommended value)

output voltage setting range V_O=3V ~50V

2-4. Input-output voltage difference

Input voltage should be higher than output voltage for stable operation of the device. The minimum voltage difference is shown by V_{I-O}.

If the input voltage contains ripple element, the input voltage must be determined considering the ripple voltage.

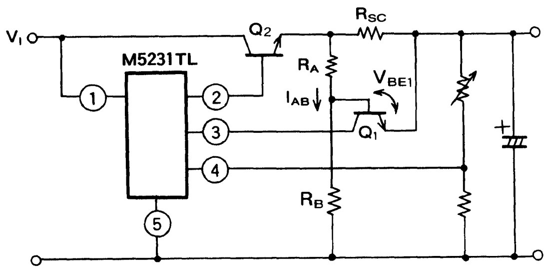
$$\text{Input voltage } V_I>V_O+(V_{I-O})+\frac{V_{RR\ P-P}}{2}$$

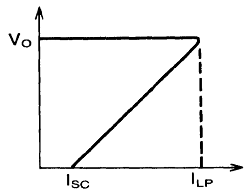
(V_O: Output voltage)

(V_{I-O}: Minimum input-output voltage difference)

$\frac{V_{RR\ P-P}}{2}$: 1/2 of ripple voltage (peak to peak)

TEST METHOD, APPLICATION EXAMPLE PRECAUTIONS FOR USE OF VOLTAGE REGULATOR





The design procedure is shown in the following. (V_I=18V, V_O=12V, I_{LP}=2A, $I_{SC} \doteqdot 0.4A$)

Control circuit consists of Q_1, R_A, R_B and R_{SC}.

To determine R_{SC},

when base-emitter voltage (V_{BE1}) of Q_1 is 0.6V,

$$R_{SC} > \frac{V_{BE1}}{I_{SC}} = \frac{0.6}{0.4} = 1.5 \rightarrow 1.8\Omega.$$

To determine R_A, R_B,

$$R_{SC} \cdot I_{LP} - \left(\frac{V_O + R_{SC} \cdot I_{LP}}{R_A + R_B}\right) \cdot RA = V_{BE1} \qquad (1)$$

when ( ) shows breeder current (I_{AB}) in resistors R_A, R_B and is 5mA,

$$R_A = \frac{R_{SC} \cdot I_{LP} - V_{BE1}}{I_{AB}} = \frac{R_{SC} \cdot I_{LP} - V_{BE1}}{5 \times 10^{-3}}$$

$$= 600 \rightarrow 680\Omega.$$

$$\text{From } \frac{V_O + R_{SC} \cdot I_{LP}}{R_A + R_B} = I_{AB}$$

$$R_B = \frac{V_O + R_{SC} \cdot I_{LP}}{I_{AB}} - R_A = \frac{12 + 1.8 \times 2}{5 \times 10^{-3}}$$

$$= 2440 \rightarrow 2.7k\Omega$$

With R_{SC}=1.5Ω, R_A=480Ω, R_B=5.1kΩ, I_{LP} and I_{SC} are calculated from equation 1 below.

$$I_{LP}(@I_{Lmax}) = \frac{V_{BE1}(R_A + R_B)}{R_{SC} \cdot R_B} + \frac{V_O \cdot R_A}{R_{SC} \cdot R_B}$$

$$= \frac{0.6(680 + 2.7 \times 10^3)}{1.8 \times 2.7 \times 10^3} + \frac{12 \times 680}{1.8 \times 2.7 \times 10^3}$$

$$= 0.417 + 1.68 = 2.09(A)$$

(Designed value 2A)

$$I_{SC}(@V_O = 0) = \frac{V_{BE1}(R_A + R_B)}{R_{SC} \cdot R_B} = 0.417$$

(Designed value 0.4A)

Power dissipation of each resistor

R_A; $Pd = (I_{AB})^2 \times R_A = 0.017$ (W)

R_B; $Pd = (I_{AB})^2 \times R_B = 0.067$ (W)

R_{SC}; $P_{d(max)} = I_{LP}^2 \times R_{SC} = 7.86$ (W)

(determined by load current)

To determine Q_1,

Maximum collector dissipation,

$$P_{C(max)} = (V_{③-⑤} + I_{SC} \cdot R_{SC}) \times I_O(max)$$

$$= 2.8V \times 60mA = 168(mW)$$

$V_{CEO} > V_{③-⑤} + I_{LP} + R_{SC} = 2.1 + 3.76 = 5.86(V)$

$I_C > I_{O(max)} = 60mA$

To determine Q_2,

Maximum collector dissipation,

$$P_{C(max)} = V_{CE} \cdot I_{LP}$$

$$= [V_I - (V_O + R_{SC} \cdot I_{LP})] \cdot I_{LP} = 4.67(W)$$

In shorted load condition,

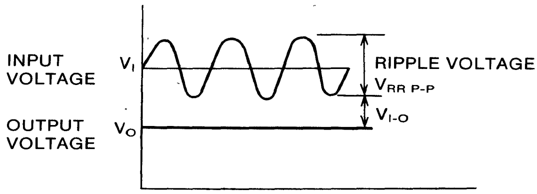
$P_C = (V_I - I_{SC} \cdot R_{SC}) \cdot I_{SC} = 7.19(W)$

$V_{CEO} > V_I = 18V \qquad I_C > I_{LP} = 2.09A$

If the output voltage of M5231TL I_O=10mA,

$$h_{FE(min)} > \frac{I_{LP}}{I_O} = \frac{2.09A}{10mA} = 209$$

TEST METHOD, APPLICATION EXAMPLE PRECAUTIONS FOR USE OF VOLTAGE REGULATOR



But the input voltage merely increases power dissipation if increased more than necessary, and should be set at the most suitable value.

2-5. Power dissipation

Power dissipation of the device in normal operating condition and in shorted output condition is shown below.

In normal operating condition,

$P_d = V_I \times I_B + (V_I - V_O) \times I_L$

In shorted output condition,

$P_d = V_I \times (I_{SC} + I_B)$ ·································· Note 1.

(V_I: Input voltage)

(I_B: Bias current)

(V_O: Output voltage)

(I_L: Load current)

(I_{SC}: Load current in shorted output condition)

The maximum power dissipation P_{dMAX} should be

$$P_{dMAX} < \frac{T_{jMAX} - T_a}{R_{th}}$$

(T_{jMAX}: Maximum junction temperature)

(T_a: Ambient temperature)

(R_{th}: Thermal resistance)

For the M5231TL, $V_{I\text{-}O}=3V$, $I_{SC} \fallingdotseq 50mA$, $T_{jMAX}=125℃$, $R_{th}=333℃/W$.

Note 1) The device contains an over-current control (protection) circuit to prevent large current when output is shorted. An application example to minimize the current is shown in section (2-9).

2-6. Output current range

I_L is the maximum rated output current of the device for itself. The M5231TL has the I_{MAX} of 30mA and can be used from 0 to 30mA. The output current over 30mA can be obtained, if required, by externally connected transistors at the value of h_{FE} times of the transistor. (Refer to application example.)

2-7. Phase compensation

If oscillation occurs owing to external wiring condition, a capacitor of 1000pF to 0.1 μ F must be connected between pins ③ and ⑤.

2-8. Input/output capacitors

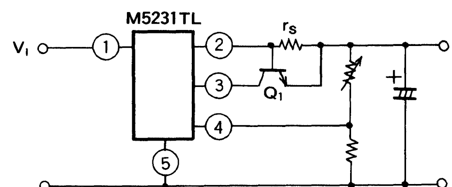
A capacitor of 0.33μF or over must be connected on the input side for stable operation of the device. An electrolytic capacitor of some tens of μ F or over and film capacitro of 0.1 μ F must be connected on the output side to prevent oscillation and reduce output impedance in high-frequency range. In both cases, capacitors should be mounted as close to the IC as possible.

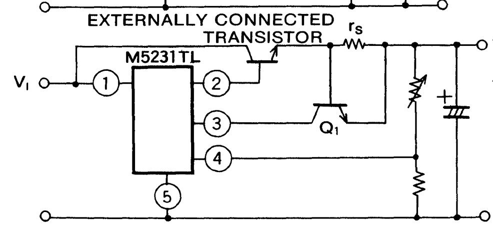
2-9. Output current control

The device contains an output current control circuit to prevent accidental destruction due to output short circuit.

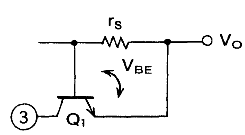
The M5231TL controls current over approximately 50~60mA. To minimize the control current value, the following method can be adopted. The over-current control circuit is recommended when externally connected transistors are used as shorted current is multiplied by h_{FE} times of transistors in shorted output condition.

2-9-1. Over-current control circuit (drooping type)



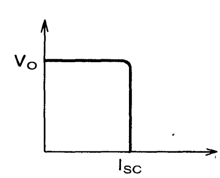


The control circuit consists of Q_1 and r_S. If the control current is I_{SC}, r_S is obtained from the equation below.



$$r_S = \frac{V_{BE}}{I_{SC}}$$

Care should be taken as V_{BE} is derated by $-2.3mV/℃$.



2-9-2. Over-current control circuit (fold-back protection circuit)

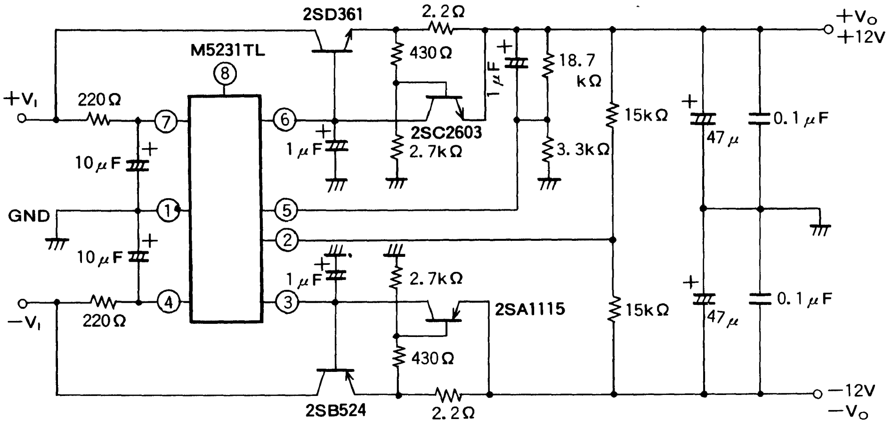
The fold-back protection circuit instantly reduces over-current generated by load short circuit as shown below and the name is derived from the fact that the curve in typical characteristic graph of output voltage V_O and load current I_L is folded back.

TEST METHOD, APPLICATION EXAMPLE PRECAUTIONS FOR USE OF VOLTAGE REGULATOR

2-9-3. Dual variable output voltage regulator M5231TL with fold-back protection circuit

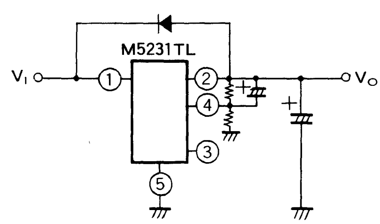
+ 12V/1A power supply with a fold-back protection circuit

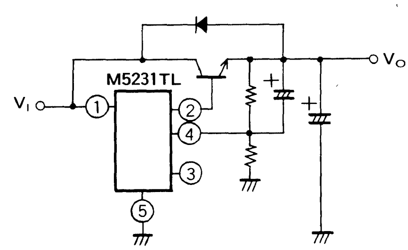
Specification I_{SC}=0.31A I_{LP}=1.18A



3. Precautions for use

- Application of supply voltage with the device mounted the wrong way or the pins not securely inserted may lead to deterioration of the characteristics or destruction of the device and should be avoided at all costs.
- Application of voltage to an output pin higher than the voltage in an input pin may destroy the element. If an input pin is shorted to GND under normal operating condition, the output pin voltage becomes higher than the input pin voltage and the electric load of an electrolytic capacitor connected to the output pin is reversed from the device or from externally connected transistors to the input side, causing destruction of the device. To prevent this, an ordinary silicon diode can be connected as shown below.
- Parasitic oscillation may be generated due to wiring condition. Proper capacitors should be connected between input pin and GND or output pin and GND. Capacitors with small capacitive change due to changes in ambient temperature should be used.





M5230L

VARIABLE OUTPUT VOLTAGE REGULATOR(DUAL TRACKING TYPE)

DESCRIPTION

The M5230L is a semiconductor integrated circuit which is designed for variable output voltage regulator of dual tracking type.

It is housed in an 8-pin SIP. The output voltage can be adjusted over a wide range from ±3~±30V by adjusting the value of the voltage setting external resistors. By adjusting the resistance of the external balance setting resistors the positive/negative output voltage ratio can also be set freely. Again by attaching power transistors high current gains can be achieved, making the device suitable for use in the power supplies of a wide variety of equipment.

FEATURES

- High input voltage ········ V_I=±35V
- Wide range of output voltage ········ V_O=±3~±30V
- Low output noise voltage ········ V_{NO}=12μVrms(typ.)
- Built-in current limiting and thermal shutdown circuit
- The output voltage rise time constant of the coefficients can be adjusted by the value of the external capacitor.
- Capability of operation control by the external control signal (Pin ⑧).

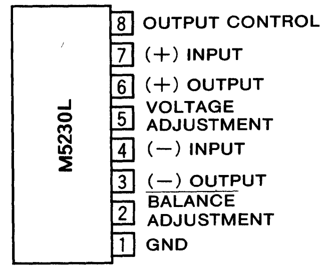
APPLICATION

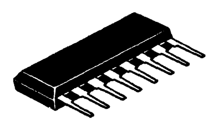
Dual voltage power supplies for stereo preamplifiers, for the power supplies of other equipment, including operational amplifiers.

RECOMMENDED OPERATING CONDITIONS

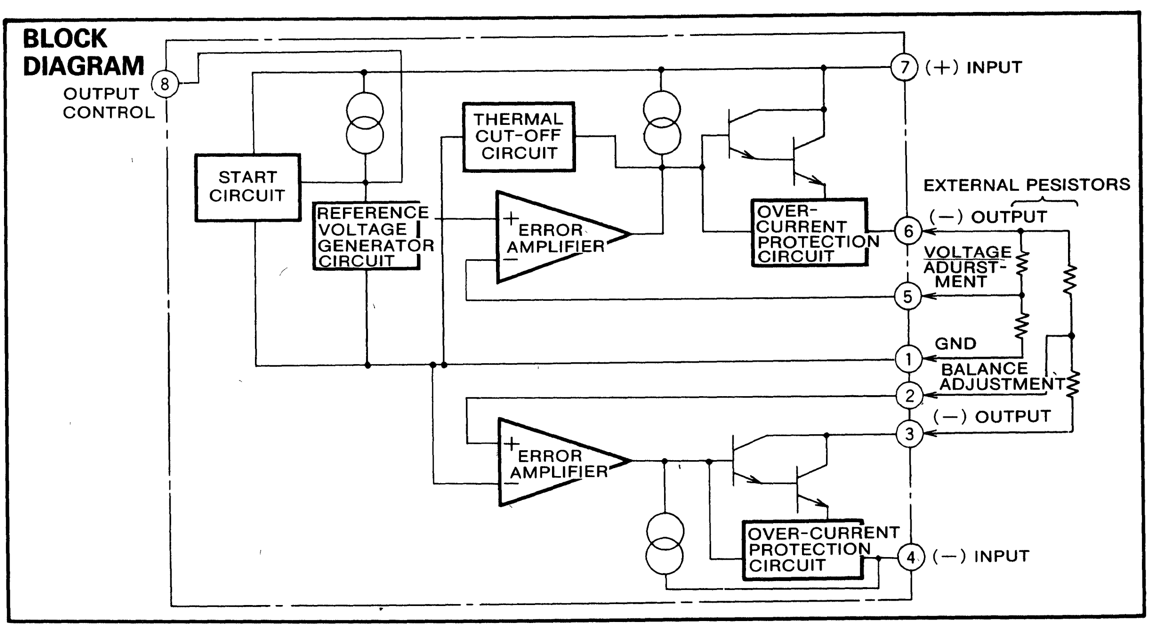
Supply voltage range ········ ±8~±35V
Rated supply voltage ········ ±20V

PIN CONFIGURATION (TOP VIEW)





8-pin molded plastic SIP



VARIABLE OUTPUT VOLTAGE REGULATOR(DUAL TRACKING TYPE)

ABSOLUTE MAXIMUM RATINGS (T_a=25℃)

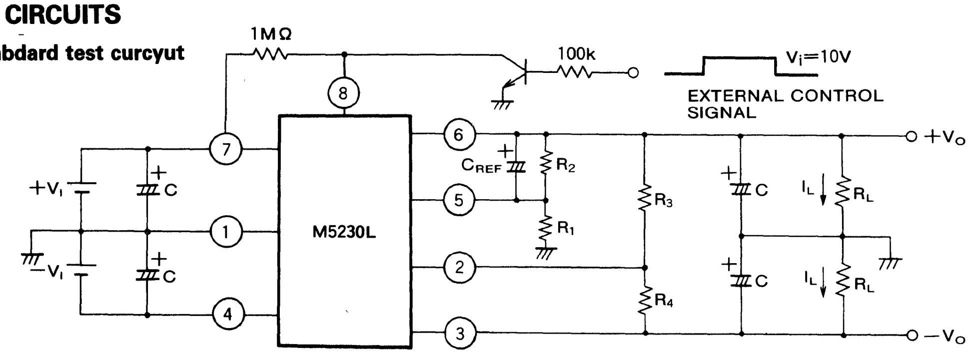
Symbol	Parameter	Ratings	Unit
V_I	Input voltage	±35	V
I_L	Load current	±30	mA
V_I-V_O	Input-output voltage difference	±32	V
Pd	Power dissipation	800	mW
Topr	Ambient temperature	−20～+75	℃
Tstg	Storage temperature	−55～+125	℃

ELECTTICAL CHARACTERISTICS (measurement circuit (a) is used with, T_a=25℃, V_I=±20V, V_O=±15V, I_L=10mA, C=10μF, C_{REF}=1μF, R_1=3.3kΩ)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
V_I	Input voltage		±8		±35	V
V_O	Output voltage	R_2≈1.5～55kΩ	±3		±30	V
V_{REF}	Reference voltage	(between pin ⑤ and pin ①)	(1.66)	1.8	(1.95)	V
V_I-V_O	Minimum input-output voltage difference			2.5	3	V
$\Delta V_O\pm$	Dual voltage tracking				1	%
$R_{eg\text{-}in}$	Input regulation	V_I=±18～±30V		0.02	0.1	%/V
$R_{eg\text{-}L}$	Load regulation	I_L=0～20mA		0.02	0.1	%
I_B	Bias current	I_L=0 (disregarding the current in resistors R_1, R_2, R_3, R_4)		1.3	3.0	mA
TC_{VO}	Temperature coefficient of output voltage	T_a=0～75℃, V_O=±3～±30V		0.01		%/℃
RR	Ripple rejection	f=120Hz(measured with circuit (b))		68		dB
V_{NO}	Output noise voltage	f=20Hz～100kHz (between the output terminal and ground)		12		μVrms
$V_{O(OFF)}$	Output cut-off voltage	V_I=10V			±0.1	V

TEST CIRCUITS

(a) Stabdard test curcyut



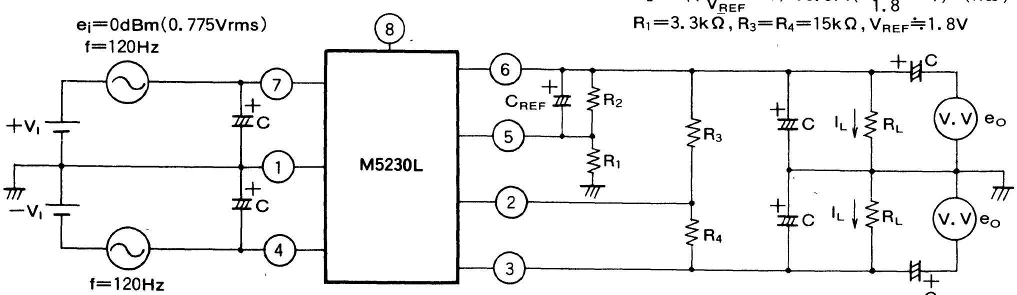
$$+V_O=V_{REF}(1+\frac{R_2}{R_1})\fallingdotseq 1.8\times(1+\frac{R_2}{3.3})\ \ (V)$$

$$-V_O=+V_O\cdot\frac{R_4}{R_3}(V)$$

$$R_2=R_1(\frac{V_O}{V_{REF}}-1)\fallingdotseq 3.3\times(\frac{+V_O}{1.8}-1)\ \ (k\Omega)$$

R_1=3.3kΩ, R_3=R_4=15kΩ, V_{REF}≒1.8V

(b) Ripple rejection test circuit

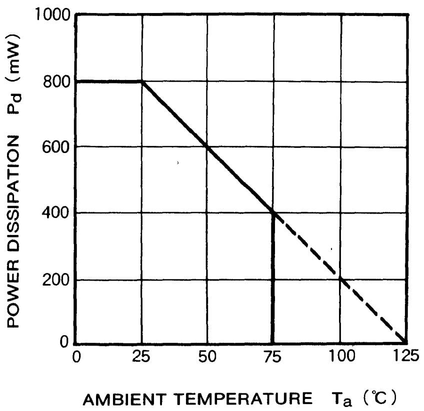


$$RR=20\log_{10}(\frac{e_I}{e_O})\ \ (dB)$$

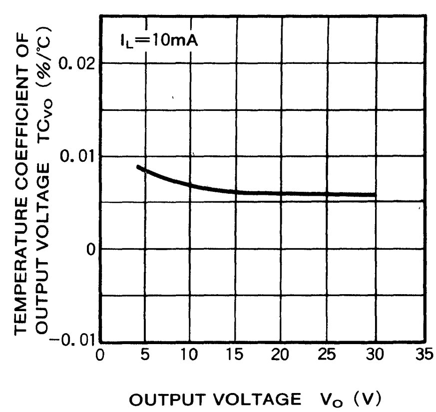
VARIABLE OUTPUT VOLTAGE REGULATOR(DUAL TRACKING TYPE)

TYPICAL CHARACTERISTICS

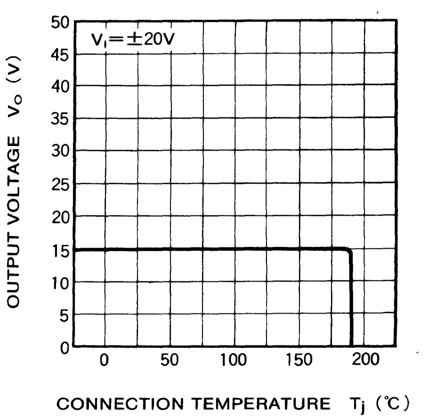
THERMAL DERATING (MAXIMUM RATING)



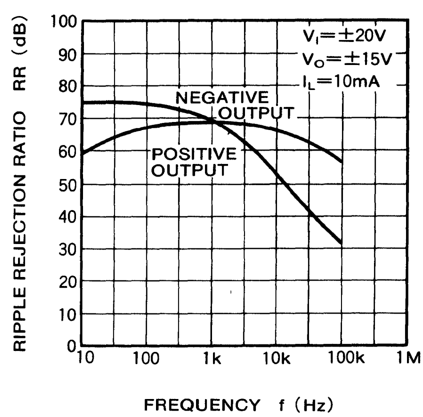
TEMPERATURE COEFFICIENT OF OUTPUT VOLTAGE VS. OUTPUT VOLTAGE CHARACTERISTICS



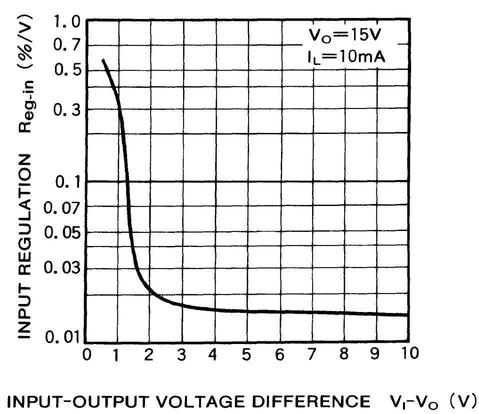
THERMAL CUTOFF



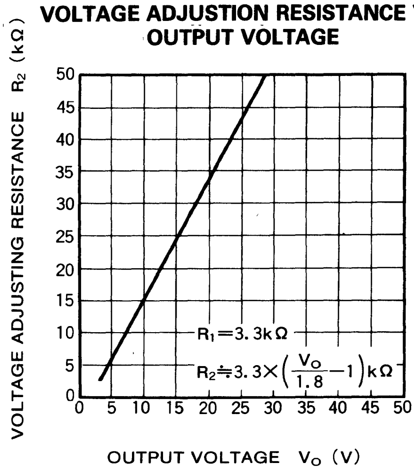
RIPPLE ERJECTION



INPUT REGULATION VS. INPUT-OUTPUT VOLTAGE DIFFERENCE

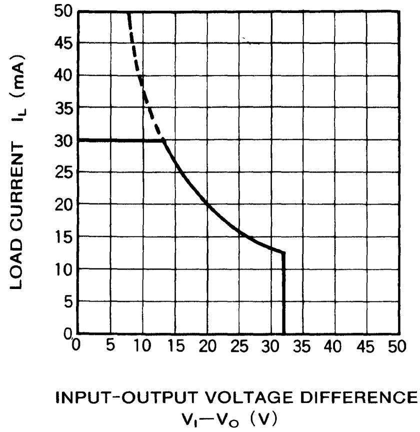


VOLTAGE ADJUSTION RESISTANCE VS. OUTPUT VOLTAGE

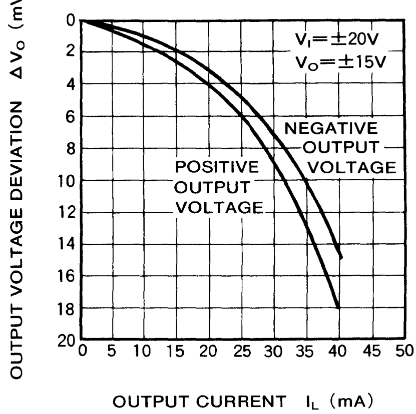


MITSUBISHI ELECTRIC

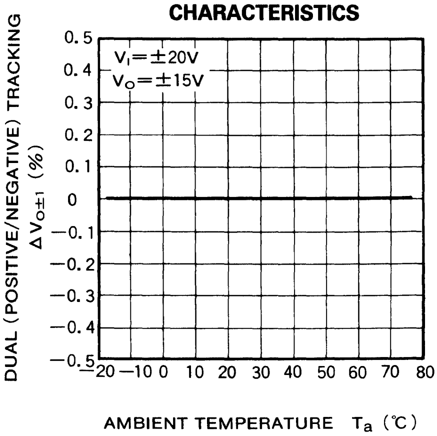
LOAD CURRENT VS. INPUT-OUTPUT VOLTAGE DIFFERENCE



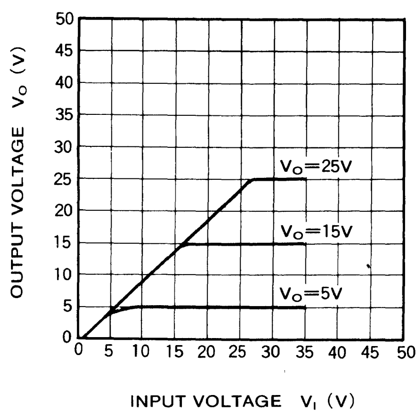
OUTPUT VOLTAGE REGULATION



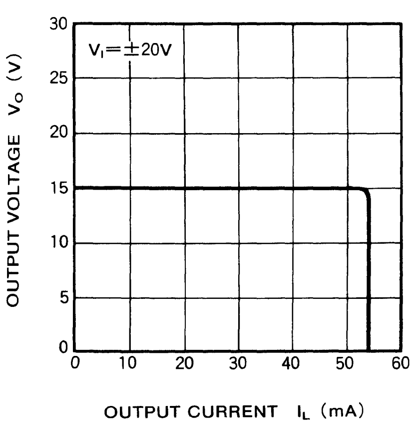
DUAL-TRACKING TEMPERATURE CHARACTERISTICS



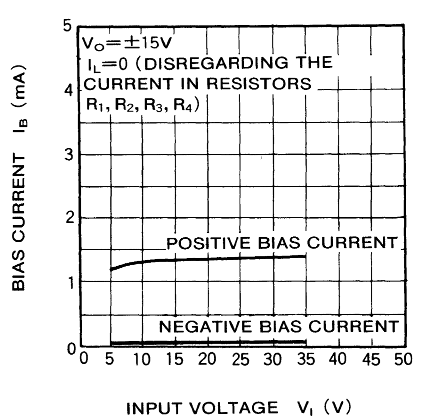
OUTPUT VOLTAGE CHARACTERISTICS



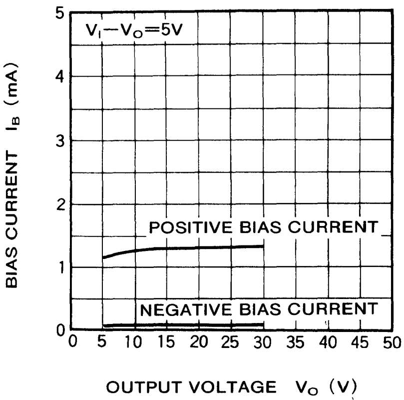
LOAD CHARACTERISTICS



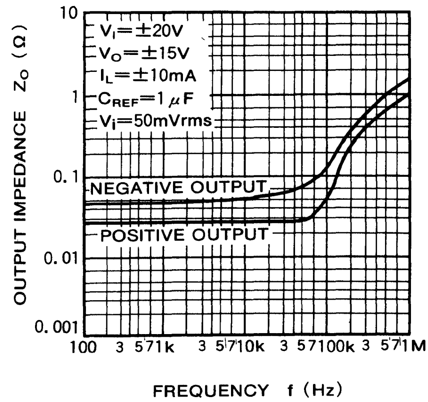
BIAS CURRENT VS. INPUT VOLTAGE



BIAS CURRENT VS. OUTPUT VOLTAGE

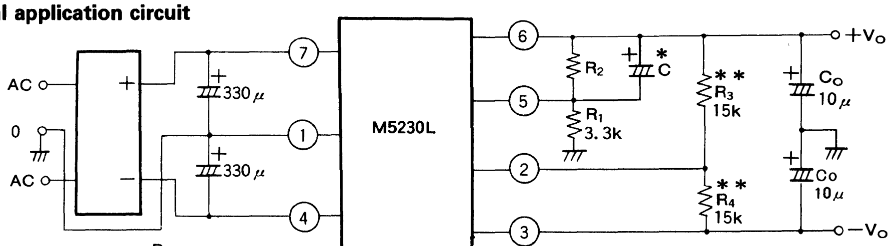


OUTPUT IMPEDANCE VS. FREQUENCY



APPLICATION EXAMPLES

(1) Typical application circuit



$+V_O \doteqdot 1.8 \times (1+\frac{R_2}{3.3})$ (V)

$R_2 \doteqdot 3.3 \times (\frac{V_O}{1.8}-1)$ (kΩ) $-V_O=(+V_O)\cdot\frac{R_4}{R_3}$ (V)

Note When the input power supply lines become long, a 0.1μF capacitor should be connected between input power supply pins ⑦ and ④ and ground.

Unit Resistance Ω
Capacitance F

∗C

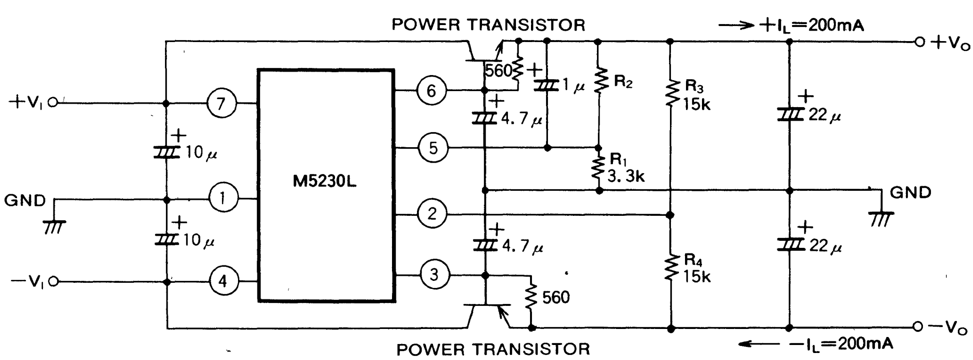
Connection of this capacitor gives the following characteristics.

1) The rise time constant of the output voltage can be adjusted (slowed) (See Fig. 1)
2) The ripple rejection ration is improvea.
3) Noise output voltage is reduced.

∗∗R_3, R_4

By changing the ratio of these two resistances the positive/negative voltage retio can also be set freely. (See Fig. 2)

(2) Typical application circuit with power transistors connected

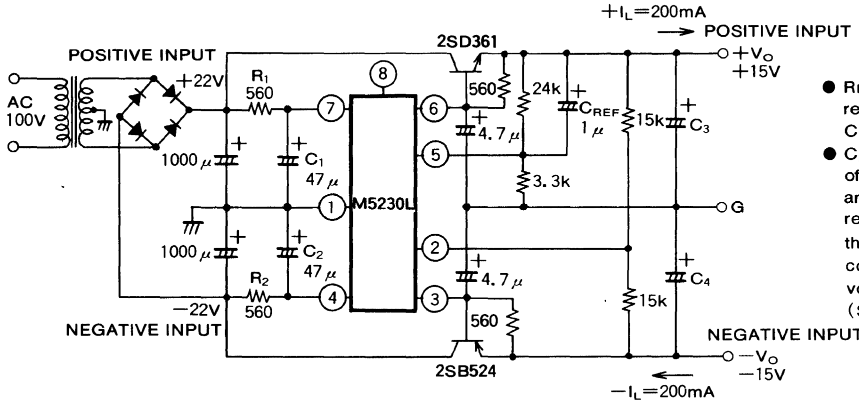


Unit Resistance : Ω
Capacitance : F

MITSUBISHI ELECTRIC

VARIABLE OUTPUT VOLTAGE REGULATOR (DUAL TRACKING TYPE)

(3) High ripple rejection circuit (80dB)

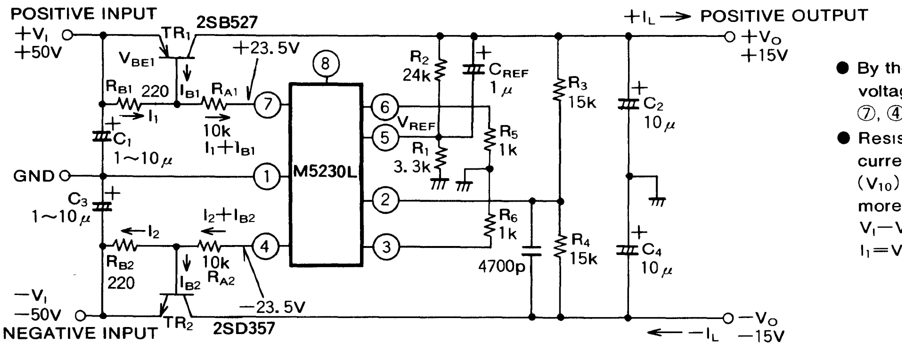


- Ripple regained by the input resistance R_1, (R_2), and capacitor C_1, (C_2).
- C_{REF} can reduce noise to the 1/10 of that of 3 Terminal regulator IC, and also can inprove the ripple rejection. In addition, by increasing the capacitance of the C_{REF}, the constant at set-up of the output voltage V_O can be adjusted (Soft set-up enable).

Unit Resistance : Ω
Capacitance : F

(4) High input voltage ($V_I=\pm50V$)

RIPPLE REJECTION 65dB

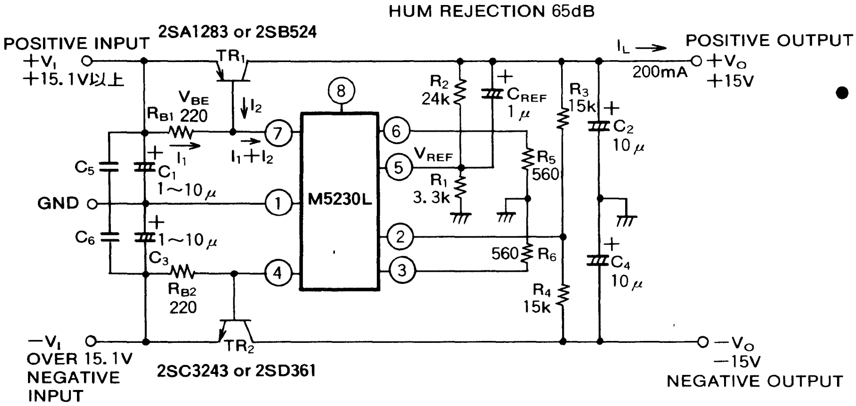


- By the resistance R_{A1}, (R_{A2}), the voltage that will be supplied to pins ⑦, ④ can be lower
- Resistanves R_5 and R_6 are for load current limit. Keep the I/O voltage (V_{IO}) difference between ⑦-⑥ more than 6V
  $V_I-V_{BE}-(I_1+I_{B1}-I_B)R_5>3V$
  $I_1=V_{BE}/R_{B1}$, $I_{B1}=I_L/h_{FE}$

Unit Resistance : Ω
Capacitance : F

(5) Low dropout regulator circuit (V_{IO}=100mV)

HUM REJECTION 65dB

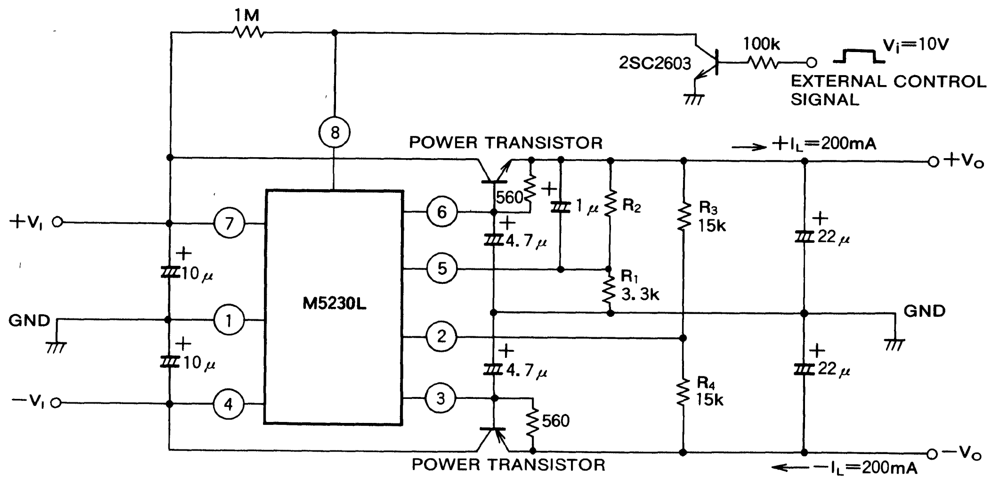


- Stable operations are expected even if the input-output voltage differnces are quite low as 0.1V. The heat sink of power TR can become small in size owing to the low dissipation

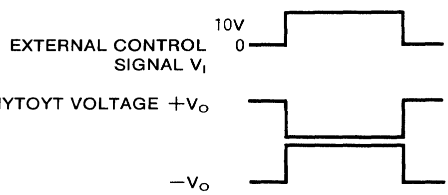
Unit Resistance Ω
Capacitance F

(Note) The load current can be over 1A by connecting the external power TR

(6) ON/OFF control of output voltage circuit



Unit Resistance : Ω
Capacitance : F



EXAMPLES OF THE CHARACTERISTICS ACHIEVED

Fig. 1 OUPUT VOLTAGE CHARACTERISTICS FOR EXTERNAL CAPACITORS (*C)

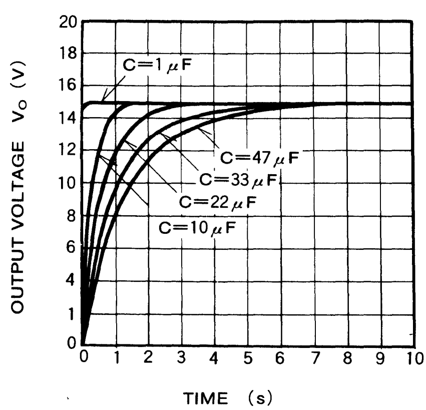
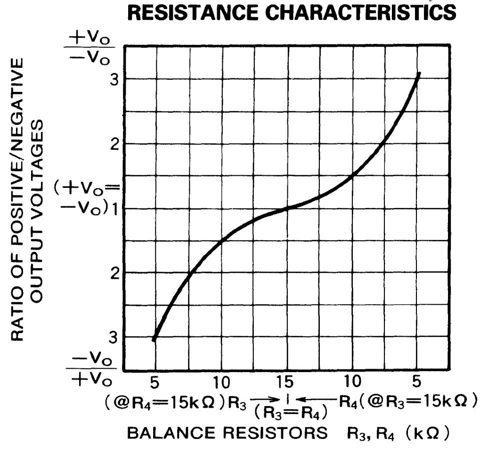


Fig. 2 OUTPUT VOLTAGE RATIO VS. BALNCE VOLTAGE ADJUSTING RESISTANCE CHARACTERISTICS



M5231TL

VARIABLE OUTPUT VOLTAGE REGULATOR

DESCRIPTION

The M5231TL is a semiconductor integrated circuit which is designed for variable output voltage regulator and is housed in a small 5-pin SIP.

The input range 8~70V, and the output voltage range 3~50V can be optionally adjusted by the external resistors. In addition, by attaching power transistors, high current gains can be achieved, making the device suitable for used in the power supplies of a wide variety of equipment.

FEATURES

- High input voltage ············ V_I=70V
- Wide range of output voltages ············ V_O=3V~50V
- Low output noise voltage ············ V_{NO}=6μVrms(typ.)
- Built-in current limiting and thermal shutdown circuits
- Capability of adjusting the output voltage rise time constant of the coefficients by the external capacitor
- Capability of the operating control by the external signal

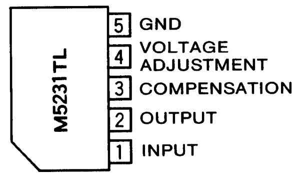
APPLICATION

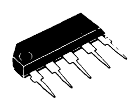
Audio, VTR equipment, and a variety of electronic musical instruments.

RECOMMENDED OPERATING CONDITIONS

Supply voltage range ············ 8~70V
Rated supply voltage ············ 35V

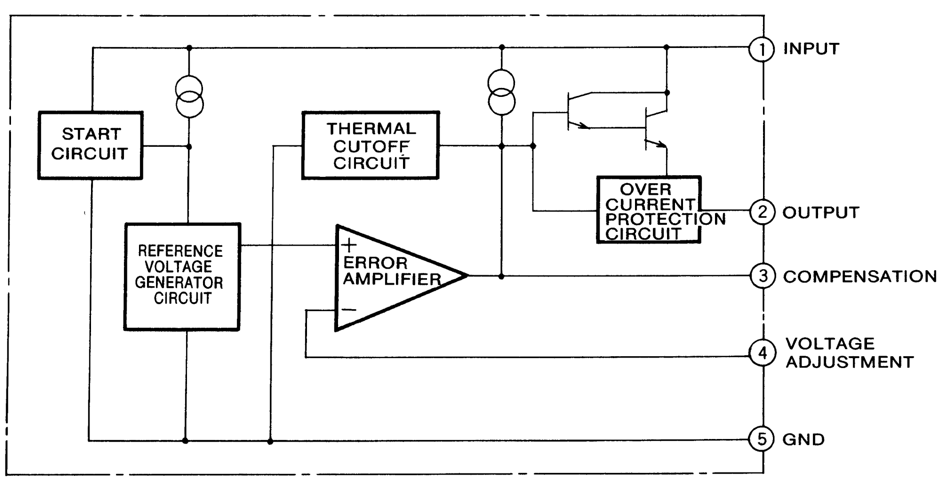
PIN CONFIGURATION (TOP VIEW)





5-pin molded plastic SIP

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS (T_a=25℃)

Symbol	Parameter	Ratings	Unit
V_I	Input voltage	70	V
I_L	Load current	30	mA
V_I-V_O	Input-output voltage difference	67	V
P_d	Power dissipation	300(L)/450(TL)	mW
T_{opr}	Operating temperature	−20～+75	℃
T_{stg}	Storage temperature	−55～+125	℃

ELECTRICAL CHARACTERISTICS (measurement circuit (a) is used with, T_a=25℃, V_I=40V, V_O=35V, I_L=10mA, C=10μF, C_{REF}=1μF, R_1=3.3kΩ, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
V_I	Input voltage		8		70	V
V_O	Output voltage	R_2≒1.5～88kΩ	3		50	V
V_I-V_O	Minimum input-output voltage differential			2.5	3.0	V
V_{REF}	Reference voltage	(between pin ④ and pin ⑤)	(1.66)	1.8	(1.90)	V
$R_{eg\text{-}in}$	Input regulation	V_I=38～60V		0.04	0.1	%/V
$R_{ge\text{-}L}$	Load regulation	I_L=0～20mA		0.03	0.1	%
I_B	Bias current	I_L=0 (disregarding the current in resistors R_1, R_2)		1.2	2.5	mA
TC_{VO}	Temperature coefficient of output voltage	T_a=0～75℃, V_O=3～50V		0.02		%/℃
RR	Ripple rejection	f=120Hz(measured with circuit (b))		62		dB
V_{NO}	Output noise voltage	f=20Hz～100kHz		6		μVrms

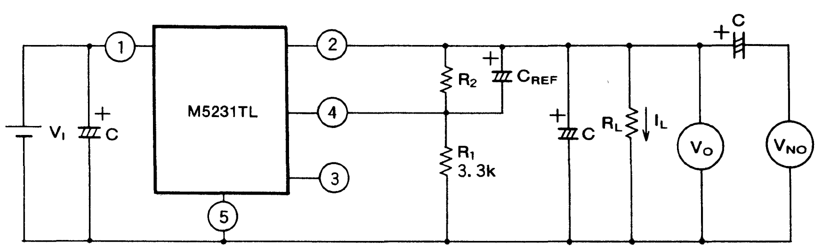
TEST CIRCUITS

(a) Standard test circuit

$$V_O = V_{REF}\left(1+\frac{R_2}{R_1}\right) \fallingdotseq 1.8\times\left(1+\frac{R_2}{3.3}\right) \text{ (V)}$$

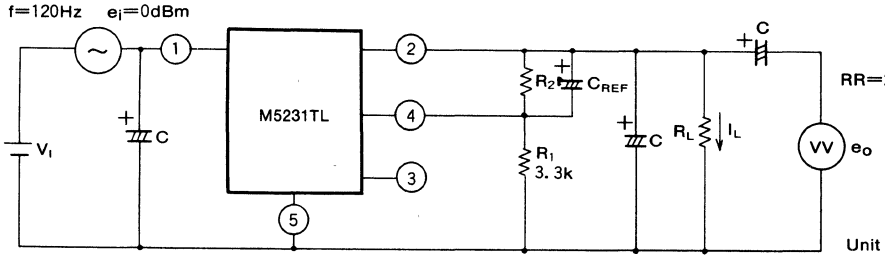
$$R_2 = R_1\left(\frac{V_O}{V_{REF}}-1\right) \fallingdotseq 3.3\times\left(\frac{V_O}{1.8}-1\right) \text{ (k}\Omega\text{)}$$

R_1=3.3kΩ, V_{REF}≒1.8V



Unit Resistance : Ω
Capacitance : F

(b) Ripple rejection test circuit

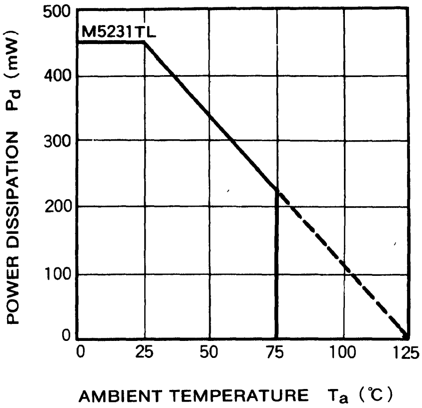


$$RR = 20\log\left(\frac{e_i}{e_o}\right) \text{ (dB)}$$

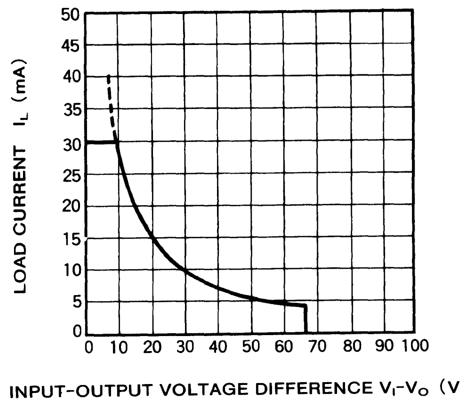
Unit Resistance : Ω
Capacitance : F

TYPICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

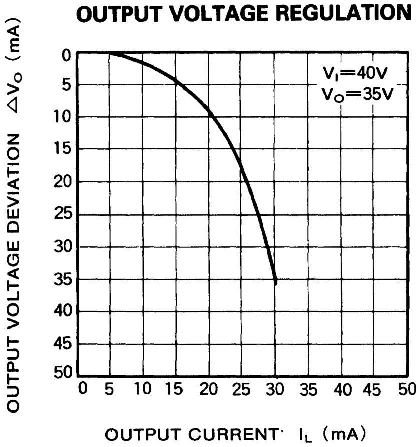
THERMAL DERATING (MAXIMUM RATINGS)



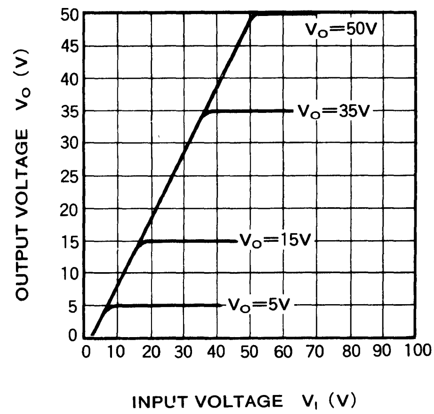
LOAD CURRENT VS. INPUT-OUTPUT VOLTAGE DIFFERENCE



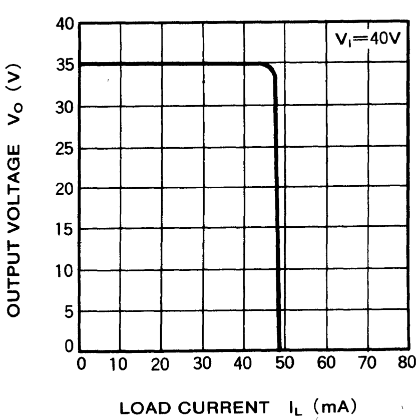
OUTPUT VOLTAGE REGULATION



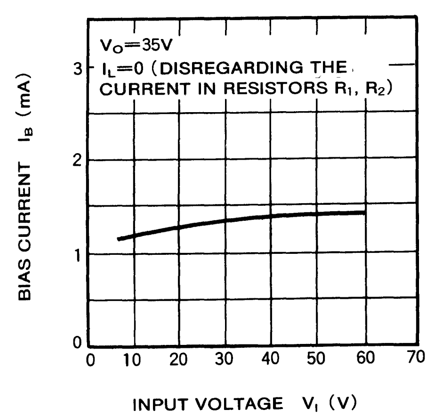
OUTPUT VOLTAGE CHARACTERISTICS



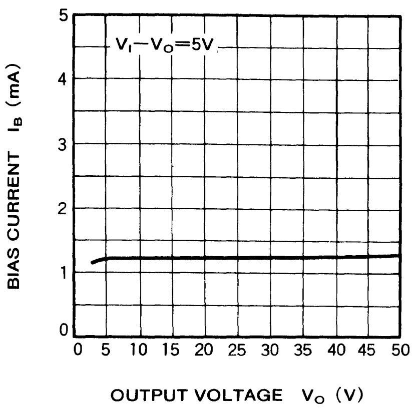
LOAD CHARACTERISTICS



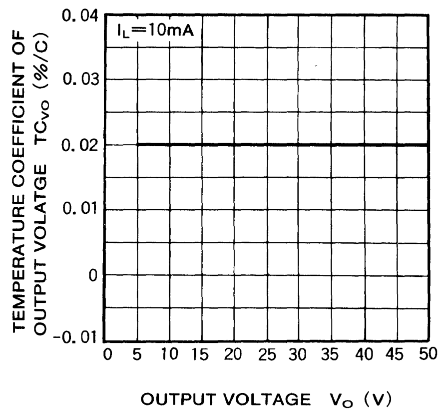
BIAS CURRENT VS. INPUT VOLTAGE



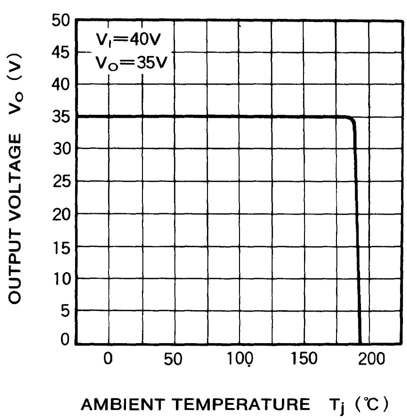
BIAS CURRENT VS. OUTPUT VOLTAGE



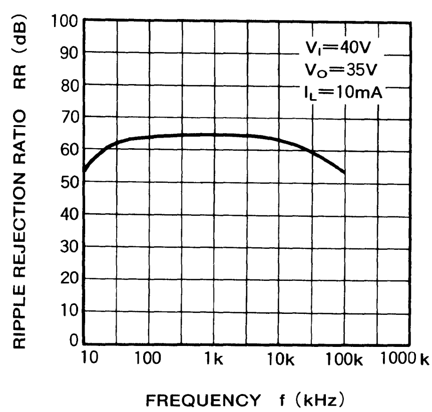
TEMPERATURE COEFFICIENT OF OUTPUT VOLTAGE VS. OUTPUT VOLTAGE CHARACTERISTICS



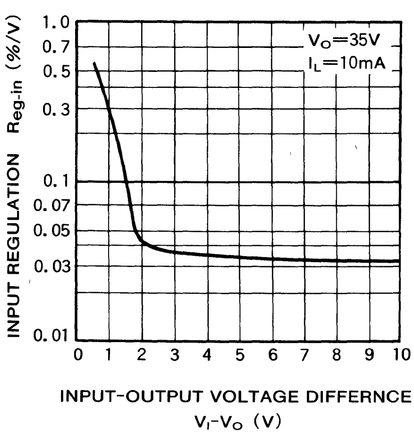
THERMAL CUTOFF



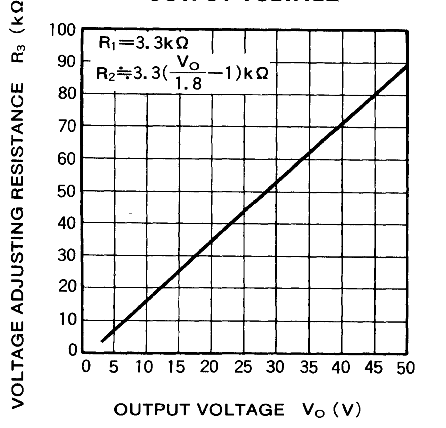
RIPPLE REJECTION



INPUT REGULATION VS. INPUT-OUTPUT VOLTAGE DIFFERENCE



VOLTAGE ADJUSTING RESISTANCE VS. OUTPUT VOLTAGE

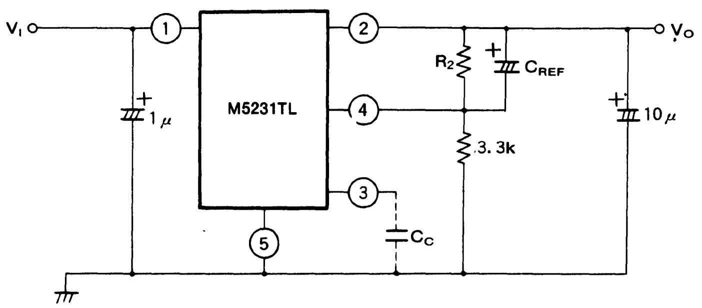


APPLICATION EXAMPLES

(1) Standard application example

$V_O \fallingdotseq 1.8 \times (1 + \frac{R_2}{3.3})$ (V)

$R_2 \fallingdotseq 3.3 \times (\frac{V_O}{1.8} - 1)$ (kΩ)



CREF

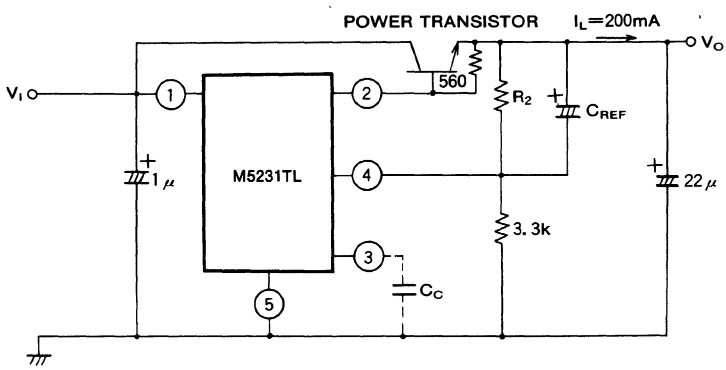
Connection of this capacitor gives the following characteristics.

1) The rise time of the output voltage can be adjusted (slowed).
2) The ripple rejection ratio is improved.
3) Output noise voltage is reduced down to 1/10 of three terminal regulator IC.

CC

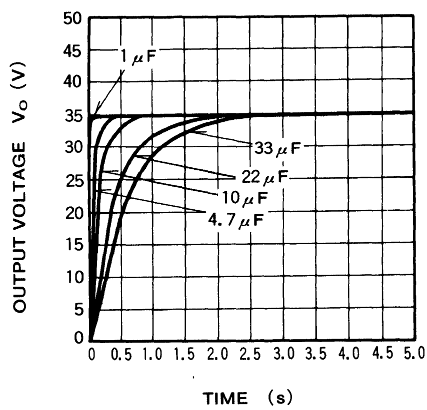
Compensation capability by connection of a capacitor.

(2) Current boost circuit with NPN external power TR

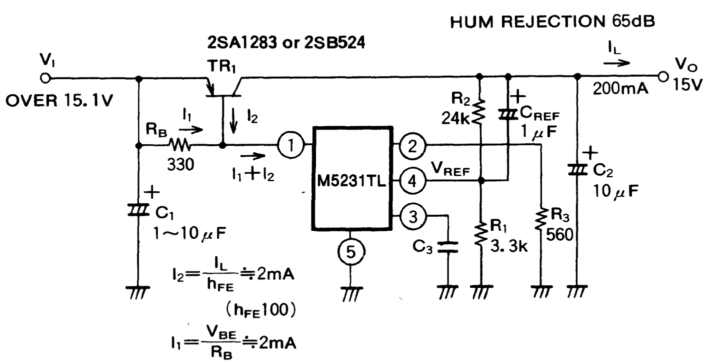


EXAMPLE 1 OF CHARACTERISTIC ACHIEVED

OUTPUT VOLTAGE CHARACTERISTICS FOR EXTERNAL CAPACITORS (C_{REF})

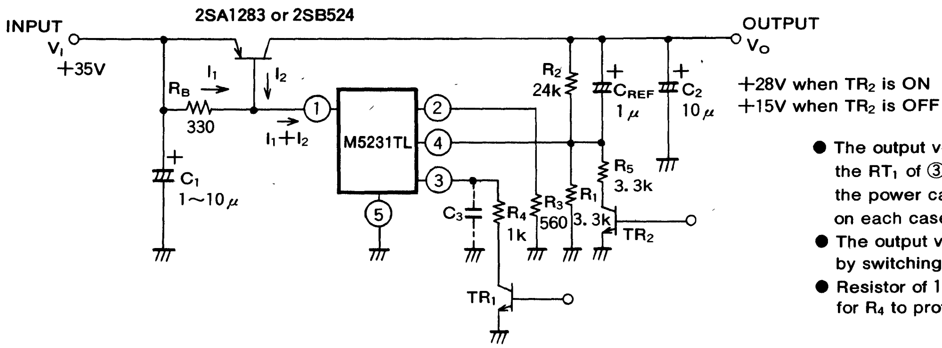


(3) Low dropout regulator circuits (V_{IO}=100mV)



- Stable operation is expected even if the input-output voltage differences are as low as 0.1V.
  The heat sink of power TR can become small in size owing to low dissipation.
  The R_3 is a load current limit resistor and the input-output voltage differences between ① and ② pins must be over 3V.
  $V_I - V_{RE} - (I_1 + I_2 - IB)R_3 > 3V$

(4) Output voltage ON/OFF controller, Step UP/DOWN controller



- The output voltage V_O IS 0V when the RT_1 of ③ pin is ON. Therefore, the power can be on/off depending on each case.
- The output voltage is changeable by switching the RT_2.
- Resistor of 1kΩ must be connected for R_4 to protect the integrated circuit

(Note) The load current can be over 1A by connection the external power TR.

M5235L

3V,3-TERMINAL VARIABLE VOLTAGE OUTPUT REGULATOR (FOR DRIVER)

DESCRIPTION

The M5235L is a semiconductor integrated circuit designed for 3V system output voltage regulator.

A high-performance low-voltage, 3-terminal output voltage regulator with small input-output voltage differences can be made in combination with externally connected PNP transistors. It is housed in a small 3-pin package, including a reference voltage circuit, error amplifier, and driver, and the output voltage can be set freely by externally connected resistors, and a smal, compact power supply circuit can be achieved, making the device suitable for use in small electronic equipment, such as headphone stereo, VTR camera, and radio cassette recorder.

FEATURES

- Operates at low input voltage ··················· $V_{IN(min)}=1.3V$
- Capable of operating with low input-output voltage for driver by externally connected power transistors
  [$V_{CE(sat)}$ state of T_R]
  $V_{I\text{-}O(min)} \fallingdotseq 0.1V$
- Output voltage can be set freely by externally connected resistors
- A compact device is possible due to small package
- Capable of taping (automated insertion) and lead forming

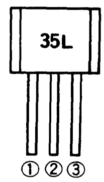
APPLICATION

For two dry-battery (3V) type headphone stereo (especially to stabilize recording bias circuit), portable VTR, small radio cassette recorder, radio-controlled and electronic toys, or electronic games, and for power supplies of other general battery-driven electronic equipment.

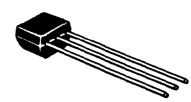
RECOMMENDED OPERATING CONDITIONS

Supply voltage range ··························· $V_{IN}=1.5V \sim 6V$
Rated supply voltage ························· $V_O=1.0V \sim 5.5V$

PIN CONFIGURATION

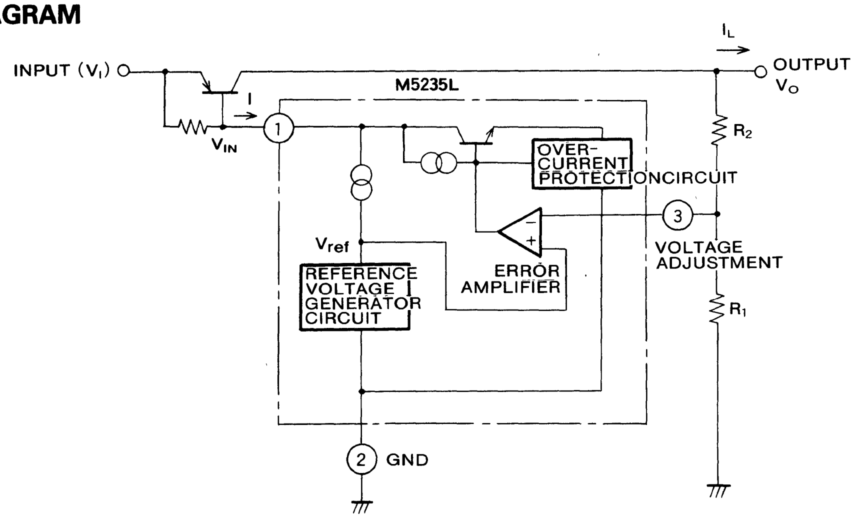


PIN CONNECTION
① INPUT
② GND
③ VOLTAGE ADJUSTMENT



Small 3-pin package

BLOCK DIAGRAM



3V,3-TERMINAL VARIABLE VOLTAGE OUTPUT REGULATOR (FOR DRIVER)

ABSOLUTE MAXIMUM RATINGS (T_a=25℃)

Symbol	Parameter	Ratings	Unit
V_{IN}	Input voltage	7(10)[Note 1]	V
I_D	Drive current	20	mA
V_I-V_O	Input-output voltage difference	6	V
P_d	Power dissipation	300	mW
T_{opr}	Operating temperature	−20～+75	℃
T_{stg}	Storage temperature	−55～+125	℃

Note 1. Refer to APPLICATION EXAMPLES

ELECTRICAL CHARACTERISTICS (measurement circuit (a) is used with, T_a=25℃, V_I=4.5V, V_O=3V, I_L=50mA, C=10μF, C_{REF}=1μF, R_1=5.1kΩ, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
V_{IN}	Input voltage	(between pin ① and pin ②)	1.3		7	V
V_O	Output voltage	R_2≒1.35kΩ～36.8kΩ	1.0		6.5	V
V_I-V_O	Minimum input-output voltage difference			0.1	0.5	V
V_{REF}	Reference voltage	(between pin ③ and pin ②)	0.75	0.79	0.83	V
R_{eg-in}	Input regulation	V_I=4～5V		0.3	0.8	%/V
R_{eg-L}	Load regulation	I_L=10～50mA		0.03	0.2	%
I_B	Bias current	I_L=0(disregarding the current in resistors R_1, R_2)		1.6	3.0	mA
TC_{VO}	Temperature coefficient of output voltage	T_a=0～75℃		−0.1		%/℃
RR	Ripple rejection ratio	f=120Hz(measured with circuit (b))		50		dB
V_{NO}	Output noise voltage	f=20Hz～100kHz		24		μVrms

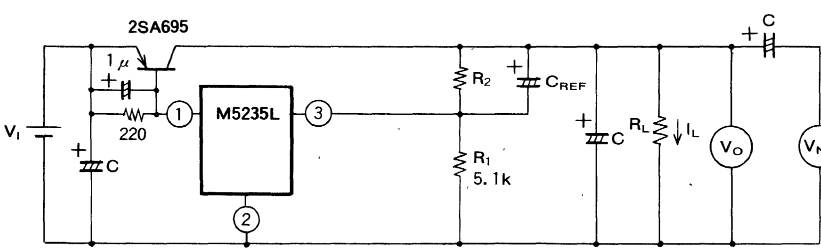
TEST CIRCUITS

(a) Standard test circuit

$V_O=V_{REF}(1+\frac{R_2}{R_1})≒0.79\times(1+\frac{R_2}{5.1})$ (V)

$R_2=R_1(\frac{V_O}{V_{REF}}-1)≒5.1\times(\frac{V_O}{0.79}-1)$ (kΩ)

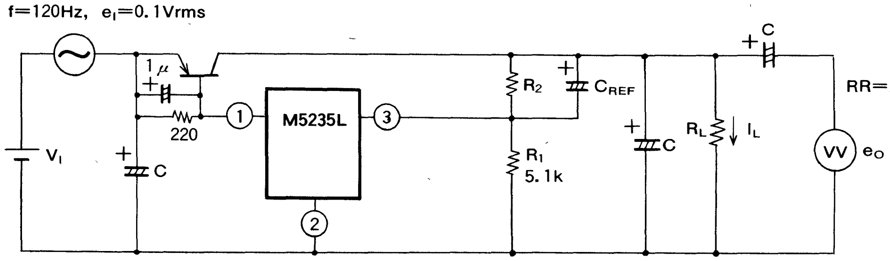
(R_1=5.1kΩ, V_{REF}≒0.79V)



Unit Resistance : Ω
Capacitance : F

(d) Ripple rejection test circuit

f=120Hz, e_I=0.1Vrms

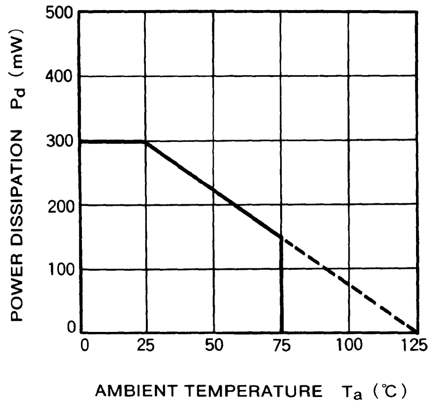


RR=20 log($\frac{e_I}{e_O}$) (dB)

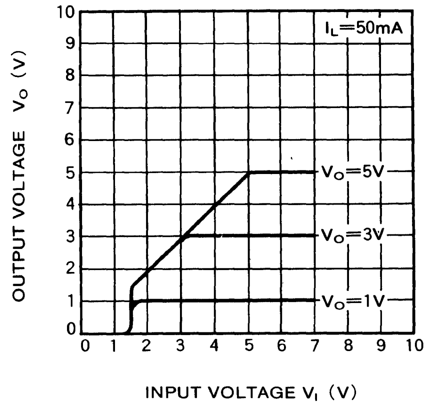
Unit Resistance : Ω
Capacitance : F

TYPICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

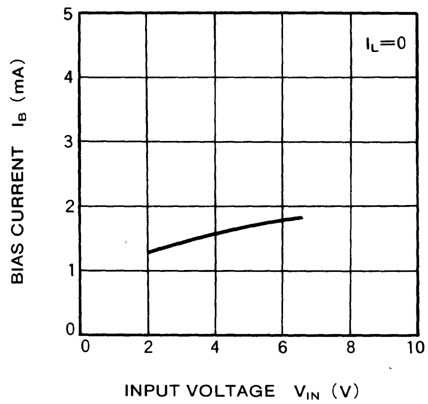
THERMAL DERATING (MAXIMUM RATINGS)



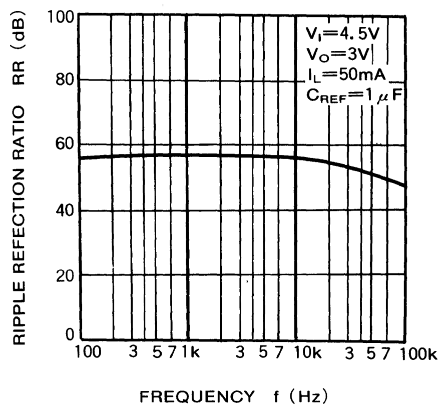
OUTPUT VOLTAGE CHARACTERISTICS



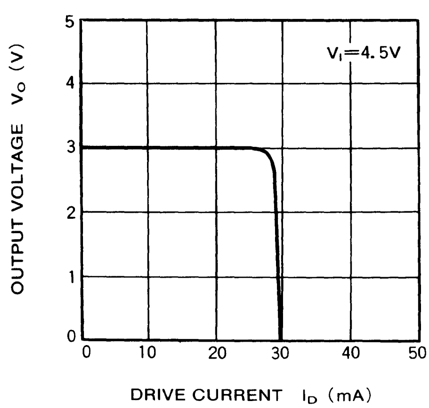
BIAS CURRENT VS. INPUT VOLTAGE



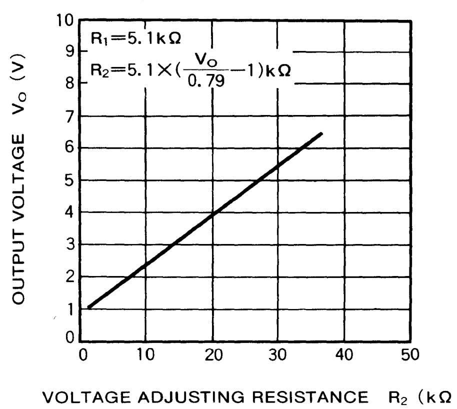
RIPPLE REJECTION



OUTPUT VOLTAGE VS. DRIVE CURRENT



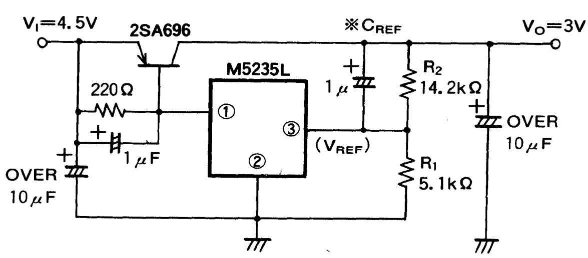
OUTPUT VOLTAGE VS. VOLTAGE ADJUSTING RESISTANCE



3V,3-TERMINAL VARIABLE VOLTAGE OUTPUT REGULATOR (FOR DRIVER)

APPLICATION EXAMPLES

1. Standard application circuit



$$V_O = V_{REF} \times \left(1 + \frac{R_2}{R_1}\right) V$$

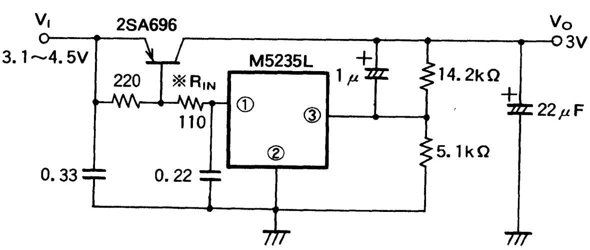
V_{REF}=0.79V(typ.)

※C_{REF}

Connection of this capacitor improves ripple rejection ratio, improves output noise voltage and adjusts the rise time constants of the output voltage. (Capacitor over 1000pF must be connected.)

Note. Capacitors displaying small capacity change with temperature should be used.

2. Control circuit for maximum drive current (I_P)



When the input voltage (V_I) is lower than the set output voltage (V_O) or when the output pin is shorted, drive current of approximately 20mA TO 35mA runs in Pin ① of the integrated circuit.

In this case, the current does no harm to the device, but the current can be limited by connecting a resistor R_{IN} if required due to input supply voltage (dry battery). (Fig. 1 shows relationship between control current vs. input voltage. In the application example, V_I controls the drive current approximately down to 10mA, when it reaches 3V.

Note1. Resistors ranging from 180Ω to 200Ω should be inserted between the emitter and base of externally connected PNP transistors.
Resistors from 100Ω to 120Ω should be used when the input voltage is 7V to 10V.

Fig.1 MAXIMUM DRIVE CURRENT CONTROL CHARACTERISTICS (I_{DM})

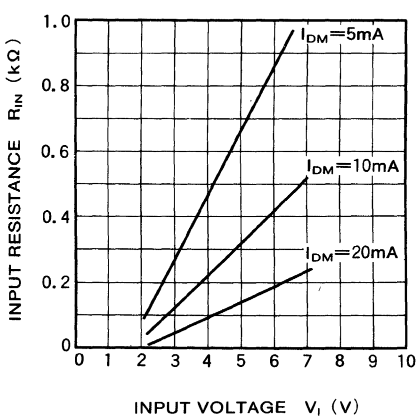
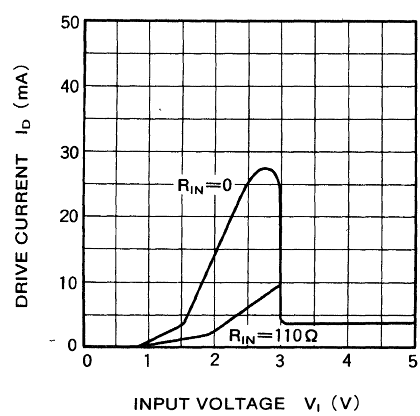
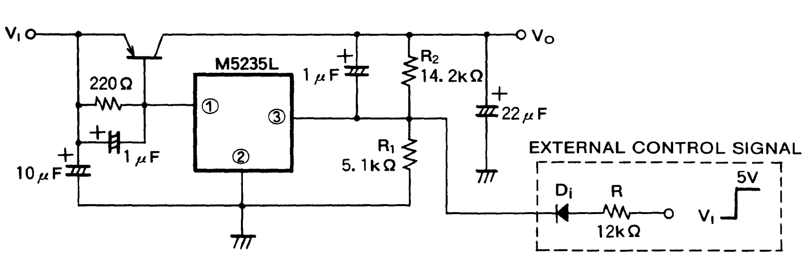
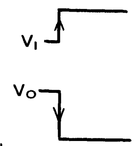


Fig.2 $I_D - V_{IN}$ CHARACTERISTICS IN APPLICATION EXAMPLE 2



3. ON/OFF control of output voltage circuit





Resistor R in the control circuit is determined by the following equation.

$$R \doteqdot \frac{V_i - V_F - V_{REF}'}{\frac{V_{REF}'}{R_1} + \frac{V_{REF}' - V_O'}{R_2}}$$

where, V_i: External control voltage
V_F: Forward voltage of diode (D_i)
V_{REF}: 0.9V Pin ③ voltage when V_{REF}' is $V_{O(OFF)}$
V_O': 0V output voltage when V_O' is $V_{O(OFF)}$

M5236L, ML

GENERAL PURPOSE 3-TERMINAL VARIABLE VOLTAGE OUTPUT REGULATOR (FOR DRIVER)

DESCRIPTION

The M5236 is a semiconductor integrated circuit designed for general-purpose output voltage regulator.

A high-performance variable output voltage regulator with small input-output voltage differences can be made in combination with externally connected PNP transistors.

It is housed in a small 3-pin package, including a reference voltage circuit, error amplifier, and driver, and the output voltage can be set freely by externally connected resistors, and a small, compact power supply circuit can be achieved, making the device suitable for use in small electronic equipment, such as car stereo, radio cassette recorder and portable stereo equipment.

FEATURES

- Wide operating voltage range ······························ V_{IN}=3.5V~36V, V_O=1.5V~33V
- Capable of operating at low input-output voltage for driver by externally connected power transistors [$V_{CE(sat)}$ state of TR] ······················· $V_{I-O(min)} \doteqdot 0.2V$
- Output voltage can be set freely by externally connected resistors
- Built-in ASO protection and thermal cutoff circuits
- Capable of taping (automated insertion) and lead forming

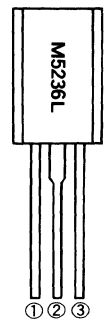
APPLICATION

For car stereo equipment, radio casette recorder, portable stereo and other general electronic equipment.

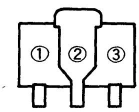
RECOMMENDED OPERATING CONDITIONS

Supply voltage range ························· V_{IN}=3.5V~30V
Rated supply voltage ·························· V_O=1.5V~25V

PIN CONFIGURATION

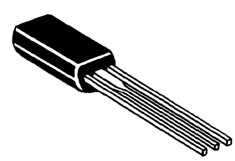


TO-92L

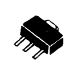


SOT-89

PIN CONNECTION
① INPUT
② GND
③ VOLTAGE ADJUSTMENT

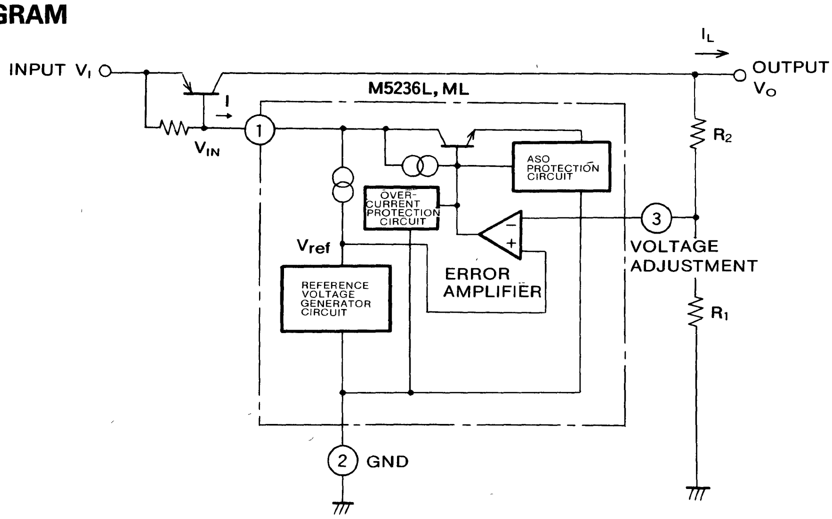


TO-92L package



SOT-89 package

BLOCK DIAGRAM



GENERAL PURPOSE 3-TERMINAL VARIABLE VOLTAGE OUTPUT REGULATOR (FOR DRIVER)

ABSOLUTE MAXIMUM RATINGS (T_a=25℃)

Symbol	Parameter	Ratings	Unit
V_{IN}	Input voltage	36	V
I_D	Drive current	30	mA
V_I-V_O	Input-output voltage difference	30	V
P_d	Power dissipation	900(SIP)/500(ML)	mW
T_{opr}	Operating temperature	−20～+75	℃
T_{stg}	Storage temperature	−55～+150	℃

ELECTRICAL CHARACTERISTICS (measurement circuit (a) is used with, T_a=25℃, V_I=15V, V_O=12V, I_L=200mA, C_{REF}=1μF, R_1=4.3kΩ, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
V_{IN}	Input voltage	(between pin ① and pin ②)	3.5		36	V
V_O	Output voltage	R_2≒0.82kΩ～108kΩ	1.5		33	V
V_I-V_O	Minimum input-output voltage difference			0.2		V
V_{REF}	Reference voltage	(between pin ③ and pin ②)	1.20	1.26	1.32	V
$R_{eg\text{-}in}$	Input regulation	V_I=15～20V		0.02	0.1	%/V
$R_{eg\text{-}L}$	Load regulation	I_L=10～200mA		0.02	0.1	%
I_B	Bias current	I_L=0(disregarding the current in resistors R_1, R_2)		1.7	3.0	mA
TC_{VO}	Temperature coefficient of output voltage	T_a=0～75℃		0.02		%/℃
RR	Ripple rejection ratio	f=120Hz(measured with circuit (b))		68		dB
V_{NO}	Output noise voltage	f=20Hz～100kHz		33		μVrms

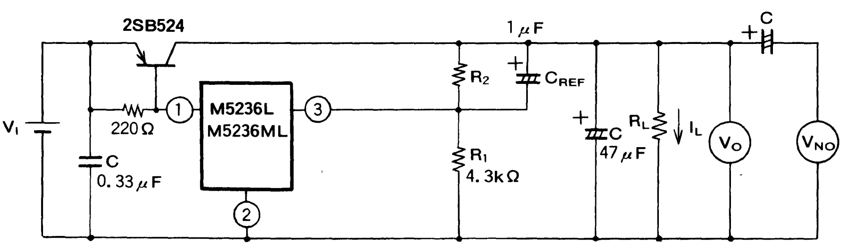
TEST CIRCUITS

(a) Standard test circuit

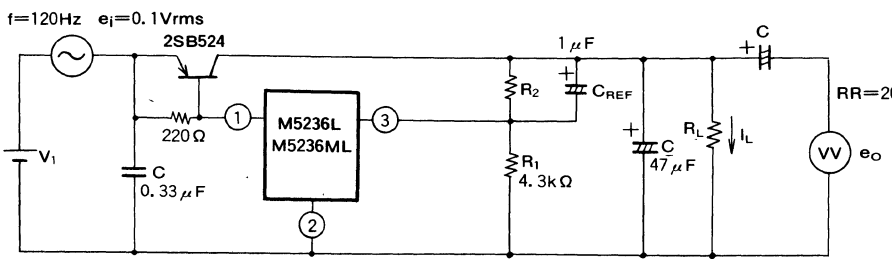
$$V_O=V_{REF}(1+\frac{R_2}{R_1})\fallingdotseq 1.26\times(1+\frac{R_2}{4.3})\ (V)$$

$$R_2=R_1(\frac{V_O}{V_{REF}}-1)\fallingdotseq 4.3\times(\frac{V_O}{1.26}-1)\ (k\Omega)$$

(R_1=4.3kΩ, V_{REF}≒1.26V)

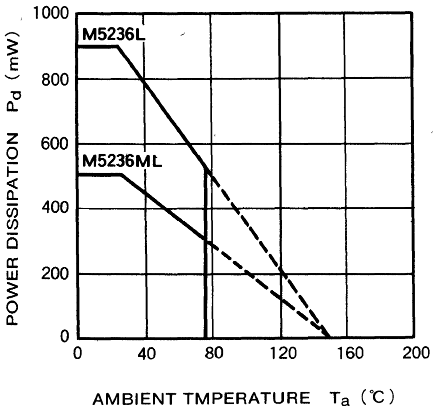


(b) Ripple rejection test circuit

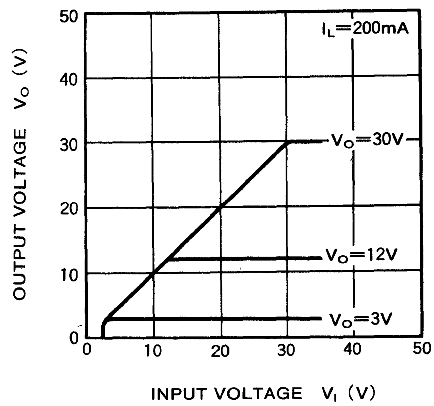


TYPICAL CHARACTERISTICS

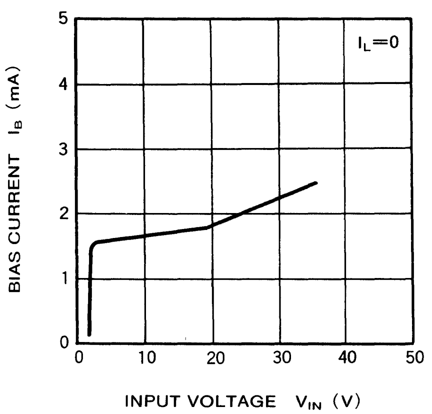
THERMAL DERATING (MAXIMUM RATINGS)



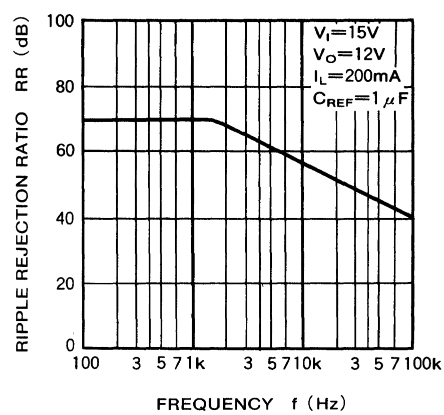
OUTPUT VOLTAGE CHARACTERISTICS



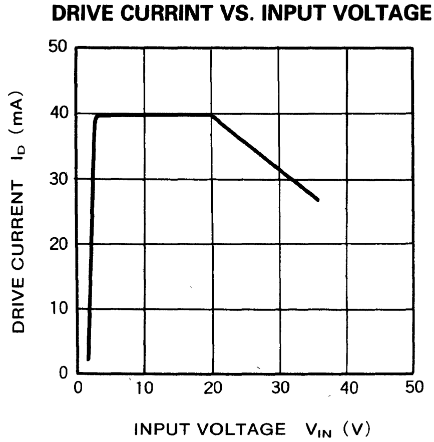
BIAS CURRENT VS. INPUT VOLTAGE



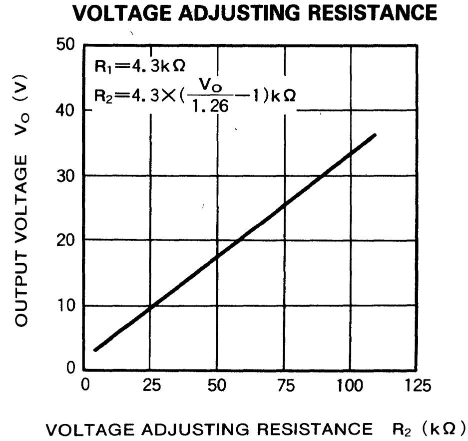
RIPPLE REJECTION



DRIVE CURRINT VS. INPUT VOLTAGE



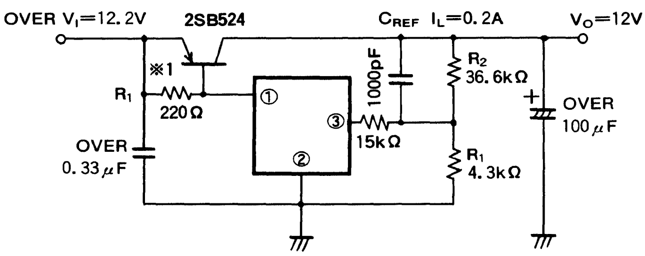
OUPUT VOLTAGE VS. VOLTAGE ADJUSTING RESISTANCE



GENERAL PURPOSE 3-TERMINAL VARIABLE VOLTAGE OUTPUT REGULATOR (FOR DRIVER)

APPLICATION EXAMPLES

1. Standard application circuit



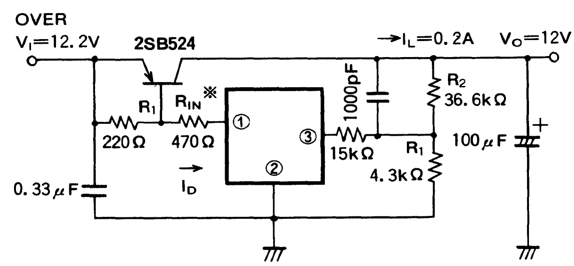
$$V_O = V_{REF} \times \left(1 + \frac{R_2}{R_1}\right) V$$

V_{REF}=1.26V(typ.)

※1. R_1 of 180~220Ω should be used.

Note) Capacitors displaying small capacity change with temperature should be used.

2. Control circuit for maximum drive current (I_{DM})



When the input voltage (V_I) is lower than the set output voltage (V_O), drive current of approximately 30mA to 45mA runs in Pin ① of the integrated circuit. (Refer to TYPICAL CHARACTERISTICS DRIVE CURRENT VS INPUT VOLTAGE. For example, when the input voltage V_I of 20V is higher than the fixed output voltage of 20V or above, and input and output are inverted, power dissipation in the circuit is P_d=20V×45mA=900mW, and reaches the maximum rating, making it necessary to control the drive current.) When the input power supply is supplied by batteries and the current needs to be controlled, a resistor R_{IN} can be inserted to control the drive current. (Fig. 1 shows input voltage dependency of the control current and input resistor R_{IN}.)

When the input voltage reaches 12V (=V_O), the current at Pin ① is limited to approximately to 20mA.

Fig. 2 shows I_D-V_I characteristics of the circuit.

Fig. 1 MAXIMUM DRIVE CURRENT CONTROL CHARACTERISTICS (I_{DM})

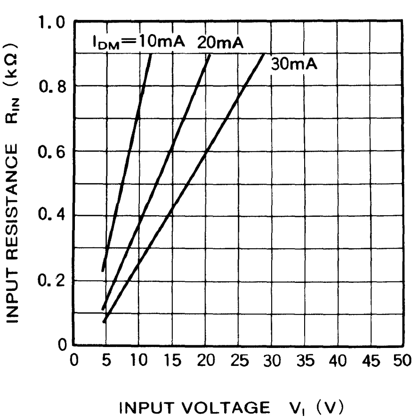
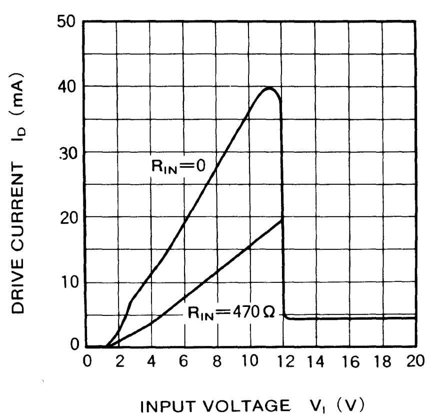
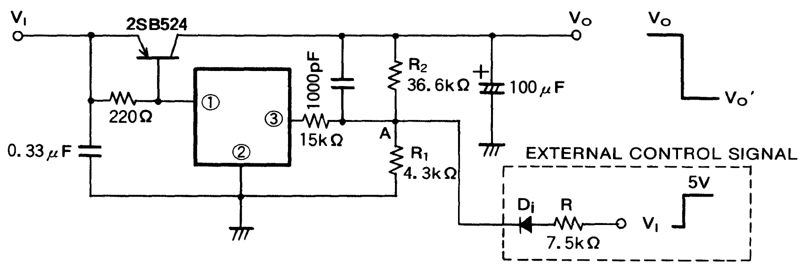


Fig. 2 I_D—V_I CHARACTERISTICS IN APPLICATION EXAMPLE 2



MITSUBISHI ELECTRIC

3. ON/OFF control of output voltage circuit



Resistor R in the control circuit is determined by the following equation.

$$R=\frac{V_i-V_F-V_{REF}'}{\frac{V_{REF}'}{R_1}+\frac{V_{REF}'-V_O'}{R_2}}$$

where, V_i: External control voltage
V_F: Forward voltage of diode (D_i)
V_{REF}: 1.4V Pin ③ voltage when V_{REF}' is $V_{O(OFF)}$
V_O': 0V output voltage when V_O' is $V_{O(OFF)}$

M5278LXX

(5V, 5.6V, 8V, 9V, 10V, 12V. 15V) 3-TERMINAL FIXED POSITIVE OUTPUT VOLTAGE REGULATOR (WITH FOLD-BACK PROTECTION CIRCUIT)

DESCRIPTION

The M5278L series consists of four monolithic integrated circuits, each a three-terminal regulator with maximum load capabilities of 100mA and featuring output voltages of 5, 5.6, 8, 9, 10, 12, or 15V. The high-performance, fixed-positive output power supply ICs are packaged in 3-pin TO-92L packages featuring fold-back protective circuits for limiting current when load short. They are especially appropriate for use in personal computers and general power supplies of electrical appliances.

FEATURES

- Interchangeable with other brand 78L series ········· $I_L$max=100mA
- Internal fold-back protection circuit limits current due to shorted loads.
  M5278L05 ····16.5mA(typ.)(1/10 that of other brands)
- High ripple division factor
  M5278L05 ········· 73dB(typ.)
- Low output voltage tolerancee ········· ±5%(max.)
- High level of permissible internal heat dissipation ········· 900mW(max.)

APPLICATION

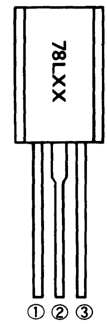
Power supply for microcomputer in VTR equipment, general power supply for electronic equipment of tape decks, car stereo equipment and radio cassette recorder.

FUNCTION CODE

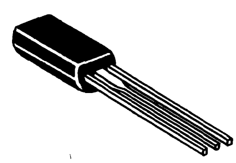
M5278LXX
└OUTPUT VOLTAGE VALUE

Type	Marking	Output voltage	Type	Marking	Output voltage
M5278L05	78L05	5V	M5278L10	78L10	10V
M5278L56	78L56	5. 6V	M5278L12	78L12	12V
M5278L08	78L08	8V	M5278L15	78L15	15V
M5278L09	78L09	9V			

PIN CONFIGURATION

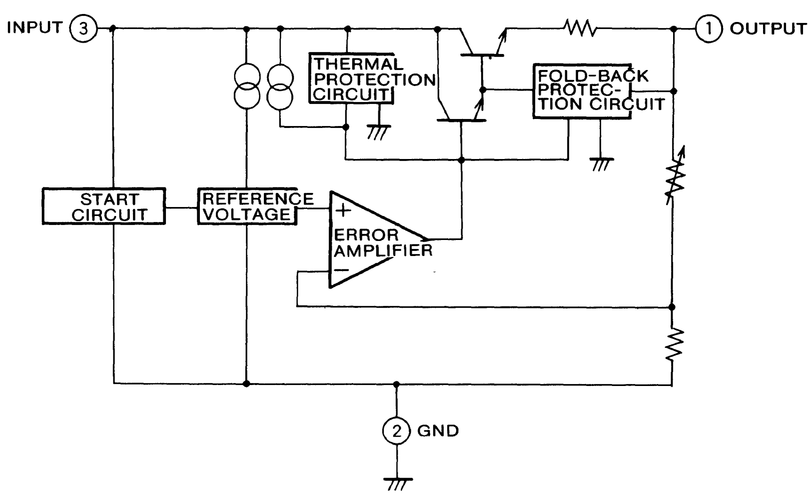


ELECTRODE CONNECTION
① OUTPUT EIAJ : TO-92L
② : GND
③ : INPUT



TO-92L package

BLOCK DIAGRAM

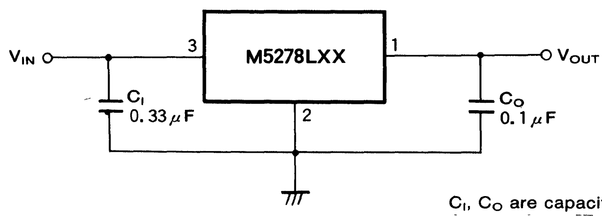


(5V, 5.6V, 8V, 9V, 10V, 12V, 15V) 3-TERMINAL FIXED POSITIVE OUTPUT VOLTAGE REGULATOR (WITH FOLD-BACK PROTECTION CIRCUIT)

ABSOLUTE MAXIMUM RATINGS (T_a=25℃)

Symbol	Parameter	Conditions	Ratings	Unit
V_I	Input voltage		36	V
I_L	Load current		100	mA
P_d	Power dissipation		900	mW
T_{opr}	Operating temperature		−20∼+75	℃
T_{stg}	Sotrage temperature		−55∼+150	℃

STANDARD CONNECTION



C_I, C_O are capacitors to prevent oscillation. Make connections as close to the IC as possible.

ELECTRICAL CHARACTERISTICS

M5278L05 (V_I=10V, I_L=40mA, T_a=25℃, C_I=0.33μF, C_O=0.1μF, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
V_O	Output voltage		4.75	5.0	5.25	V
R_{eg-in}	Input regulation	7.5V≦V_I≦20V		50	200	mV
		8V≦V_I≦20V		30	150	
R_{eg-L}	Load regulation	1mA≦I_L≦100mA		10	60	mV
		1mA≦I_L≦40mA		5	30	
V_O	Output voltage	7.5V≦V_I≦20V, 1mA≦I_L≦40mA	4.7	5.0	5.3	V
		V_I=10V, 1mA≦I_L≦70mA	4.7	5.0	5.3	
I_B	Bias current	I_L=0		4.8	6.7	mA
ΔI_B	Bias current variability	8V≦V_I≦20V, I_L=40mA		0.1	1.5	mA
		V_I=10V, 1mA≦I_L≦40mA			0.2	
V_{NO}	Output noise voltage	BW: 10Hz∼100kHz		49		μVrms
RR	Ripple rejection ratio	f=120Hz, V_{in}=0dBm	63	73		dB
V_I-V_O	Minimum input-output voltage difference			2.0		V
I_{LP}	Peak load current			130		mA
I_{OS}	Output short holding current			16.5		mA
TC_{VO}	Temperature coefficient of output voltage	I_L=5mA		−0.6		mV/℃

(5V, 5.6V, 8V, 9V, 10V, 12V, 15V) 3-TERMINAL FIXED POSITIVE OUTPUT VOLTAGE REGULATOR (WITH FOLD-BACK PROTECTION CIRCUIT)

M5278L56 (V_I=11V, I_L=40mA, T_a=25℃, C_I=0.33μF, C_O=0.1μF, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits Min	Limits Typ	Limits Max	Unit
V_O	Output voltage		5.32	5.6	5.88	V
$R_{eg\text{-}in}$	Input regulation	8.5V≦V_I≦21V		50	200	mV
		9V≦V_I≦21V		30	150	
$R_{eg\text{-}L}$	Load regulation	1mA≦I_L≦100mA		10	60	mV
		1mA≦I_L≦40mA		5	30	
V_O	Output voltage	8.5V≦V_I≦21V, 1mA≦I_L≦40mA	5.27	5.6	5.93	V
		V_I=11V, 1mA≦I_L≦70mA	5.27	5.6	5.93	
I_B	Bias current	I_L=0		4.8	6.7	mA
ΔI_B	Bias current differential	9V≦V_I≦21V, I_L=40mA		0.1	1.5	mA
		V_I=11V, 1mA≦I_L≦40mA			0.2	
V_{NO}	Output noise voltage	BW: 10Hz~100kHz		55		μVrms
RR	Ripple rejection ratio	f=120Hz, V_{in}=0dBm	63	73		dB
V_I-V_O	Minimum input-output voltage difference			2.0		V
I_{LP}	Peak load current			150		mA
I_{OS}	Output short circuit sustain current			16.5		mA
TC_{VO}	Temperature coefficient of output voltage	I_L=5mA		−0.65		mV/℃

M5278L08 (V_I=14V, I_L=40mA, T_a=25℃, C_I=0.33μF, C_O=0.1μF, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits Min	Limits Typ	Limits Max	Unit
V_O	Output voltage		7.6	8.0	8.4	V
$R_{eg\text{-}in}$	Input regulation	10.5V≦V_I≦23V		60	200	mV
		11V≦V_I≦23V		40	150	
$R_{eg\text{-}L}$	Load regulation	1mA≦I_L≦100mA		10	80	mV
		1mA≦I_L≦40mA		5	40	
V_O	Output voltage	10.5V≦V_I≦23V, 1mA≦I_L≦40mA	7.52	8.0	8.48	V
		V_I=14V, 1mA≦I_L≦70mA	7.52	8.0	8.48	
I_B	Bias current	I_L=0		4.8	6.7	mA
ΔI_B	Bias current differential	10.5V≦V_I≦23V, I_L=40mA		0.1	1.5	mA
		V_I=14V, 1mA≦I_L≦40mA			0.2	
V_{NO}	Output noise voltage	BW: 10Hz~100kHz		80		μVrms
RR	Ripple rejection ratio	f=120Hz, V_{in}=0dBm		59		dB
V_I-V_O	Minimum input-output voltage difference			2.0		V
I_{LP}	Peak load current			150		mA
I_{OS}	Output short circuit sustain current			12.5		mA
TC_{VO}	Temperature coefficient of output voltage	I_L=5mA		−0.7		mV/℃

(5V, 5.6V, 8V, 9V, 10V, 12V, 15V) 3-TERMINAL FIXED POSITIVE OUTPUT VOLTAGE REGULATOR (WITH FOLD-BACK PROTECTION CIRCUIT)

M5278L09 (V_I=16V, I_L=40mA, T_a=25℃, C_I=0.33μF, C_O=0.1μF, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits Min	Limits Typ	Limits Max	Unit
V_O	Output voltage		8.55	9.0	9.45	V
R_{eg-in}	Input regulation	12V≦V_I≦24V		70	225	mV
		13V≦V_I≦24V		40	170	
R_{eg-L}	Load regulation	1mA≦I_L≦100mA		10	90	mV
		1mA≦I_L≦40mA		5	40	
V_O	Output voltage	12V≦V_I≦24V, 1mA≦I_L≦40mA	8.46	9.0	9.54	V
		V_I=16V, 1mA≦I_L≦70mA	8.46	9.0	9.54	
I_B	Bias current	I_L=0		4.8	6.7	mA
ΔI_B	Bias current differential	13V≦V_I≦24V, I_L=40mA		0.1	1.5	mA
		V_I=16V, 1mA≦I_L≦40mA			0.2	
V_{NO}	Output noise voltage	BW: 10Hz~100kHz		90		μVrms
RR	Ripple rejection ratio	f=120Hz, V_{in}=0dBm		58		dB
V_I-V_O	Minumum input-output voltage difference			2.0		V
I_{LP}	Peak load current			150		mA
I_{OS}	Output short circuit sustain current			12.5		mA
TC_{VO}	Temperature coefficient of output voltage	I_L=5mA		−0.8		mV/℃

M5278L10 (V_I=17V, I_L=40mA, T_a=25℃, C_I=0.33μF, C_O=0.1μF, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits Min	Limits Typ	Limits Max	Unit
V_O	Output voltage		9.5	10.0	10.5	V
R_{eg-in}	Input regulation	12.5V≦V_I≦25V		70	230	mV
		13V≦V_I≦25V		50	170	
R_{eg-L}	Load regulation	1mA≦I_L≦100mA		10	90	mV
		1mA≦I_L≦40mA		5	45	
V_O	Output voltage	12.5V≦V_I≦25V, 1mA≦I_L≦40mA	9.4	10.0	10.6	V
		V_I=17V, 1mA≦I_L≦70mA	9.4	10.0	10.6	
I_B	Bias current	I_L=0		4.8	6.7	mA
ΔI_B	Bias current differential	13V≦V_I≦25V, I_L=40mA		0.1	1.5	mA
		V_I=17V, 1mA≦I_L≦40mA			0.2	
V_{NO}	Output noise voltage	BW: 10Hz~100kHz		100		μVrms
RR	Ripple rejection ratio	f=120Hz, V_{in}=0dBm		57		dB
V_I-V_O	Minumum input-output voltage difference			2.0		V
I_{LP}	Peak load current			130		mA
I_{OS}	Output short circuit sustain current			12.5		mA
TC_{VO}	Temperature coefficient of output voltage	I_L=5mA		−0.9		mV/℃

(5V, 5.6V, 8V, 9V, 10V, 12V, 15V) 3-TERMINAL FIXED POSITIVE OUTPUT VOLTAGE REGULATOR (WITH FOLD-BACK PROTECTION CIRCUIT)

M5278L12 (V_I=19V, I_L=40mA, Ta=25℃, C_I=0.33μF, C_O=0.1μF, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
V_O	Output voltage		11.4	12.0	12.6	V
$R_{eg\text{-}in}$	Input regulation	14.5V≦V_I≦27V		70	250	mV
		16V≦V_I≦27V		50	200	
$R_{eg\text{-}L}$	Load regulation	1mA≦I_L≦100mA		10	100	mV
		1mA≦I_L≦40mA		5	50	
V_O	Output voltage	14.5V≦V_I≦27V, 1mA≦I_L≦40mA	11.3	12.0	12.7	V
		V_I=19V, 1mA≦I_L≦70mA	11.3	12.0	12.7	
I_B	Bias current	I_L=0		4.8	6.7	mA
ΔI_B	Bias current differential	16V≦V_I≦27V, I_L=40mA		0.1	1.5	mA
		V_I=19V, 1mA≦I_L≦40mA			0.2	
V_{NO}	Output noise voltage	BW: 10Hz~100kHz		110		μVrms
RR	Ripple rejection ratio	f=120Hz, V_{in}=0dBm		55		dB
V_I-V_O	Minimum input-output voltage difference			2.0		V
I_{LP}	Peak load current			150		mA
I_{OS}	Output short circuit sustain current			12.5		mA
TC_{VO}	Temperature coefficient of output voltage	I_L=5mA		−1.0		mV/℃

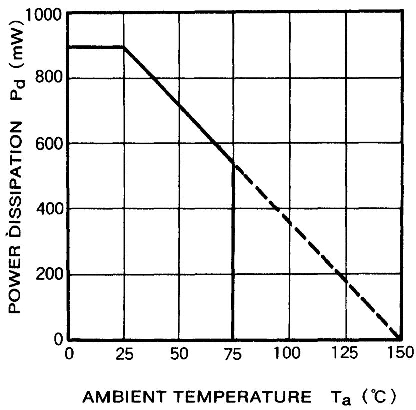
M5278L15 (V_I=23V, I_L=40mA, Ta=25℃, C_I=0.33μF, C_O=0.1μF, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
V_O	Output voltage		14.25	15.0	15.75	V
$R_{eg\text{-}in}$	Input regulation	17.5V≦V_I≦30V		80	300	mV
		20V≦V_I≦30V		60	250	
$R_{eg\text{-}L}$	Load regulation	1mA≦I_L≦100mA		10	150	mV
		1mA≦I_L≦40mA		5	75	
V_O	Output voltage	17.5V≦V_I≦30V, 1mA≦I_L≦40mA	14.1	15.0	15.9	V
		V_I=23V, 1mA≦I_L≦70mA	14.1	15.0	15.9	
I_B	Bias current	I_L=0		4.8	6.7	mA
ΔI_B	Bias current differential	23V≦V_I≦30V, I_L=40mA		0.1	1.5	mA
		V_I=23V, 1mA≦I_L≦40mA			0.2	
V_{NO}	Output noise voltage	BW: 10Hz~100kHz		140		μVrms
RR	Ripple rejection ratio	f=120Hz, V_{in}=0dBm		52		dB
V_I-V_O	Minimum input-output voltage difference			2.0		V
I_{LP}	Peak load current			150		mA
I_{OS}	Output short circuit sustain current			12.5		mA
TC_{VO}	Temperature coefficient of output voltage	I_L=5mA		−1.2		mV/℃

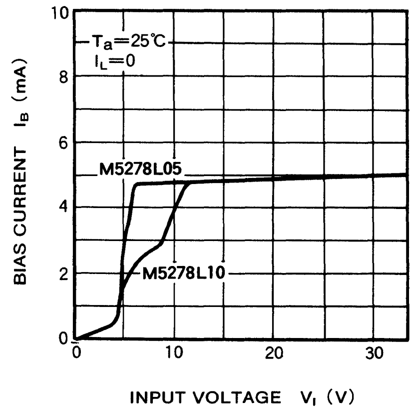
(5V, 5.6V, 8V, 9V, 10V, 12V. 15V) 3-TERMINAL FIXED POSITIVE OUTPUT VOLTAGE REGULATOR (WITH FOLD-BACK PROTECTION CIRCUIT)

TYPICAL CHARCTERISTICS

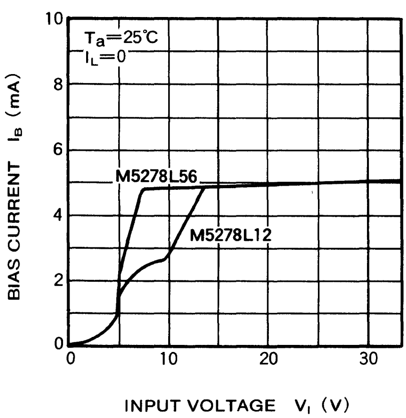
THERMAL DERATING (MAXIMUM RATING)



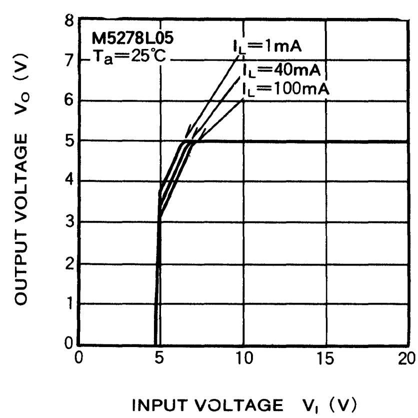
BIAS CURRENT VS. INPUT VOLTAGE



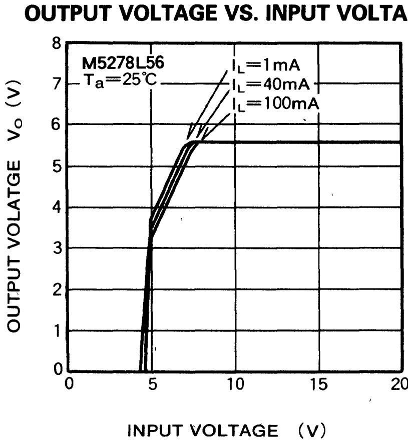
BIAS CURRENT VS. INPUT VOTAGE



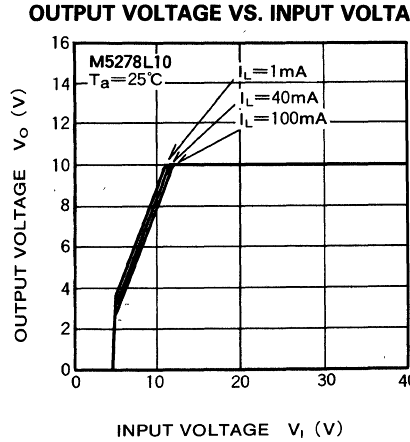
OUTPUT VOLTAGE VS. INPUT VOLTAGE



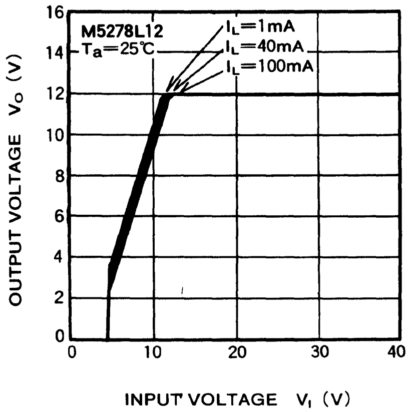
OUTPUT VOLTAGE VS. INPUT VOLTAGE



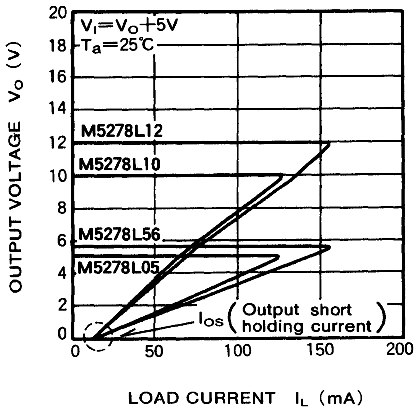
OUTPUT VOLTAGE VS. INPUT VOLTAGE



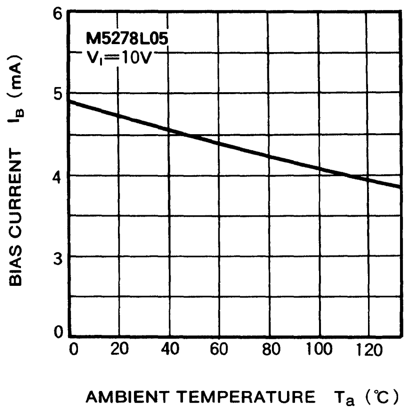
OUTPUT VOLTAGE VS. INPUT VOLTAGE



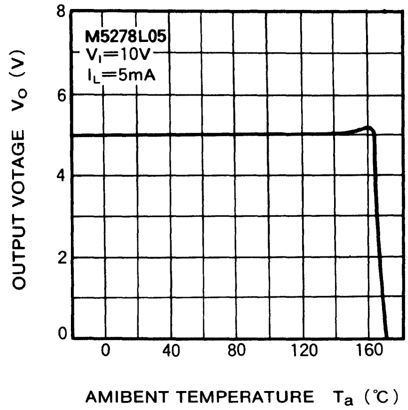
OUTPUT VOLTAGE VS. LOAD CURRENT



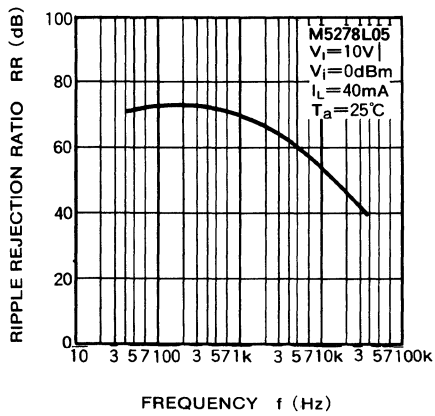
BIAS CURRENT VS. AMBIENT TEMPERATURE



OUTPUT VOLTAGE VS. AMBIENT TEMPERATURE

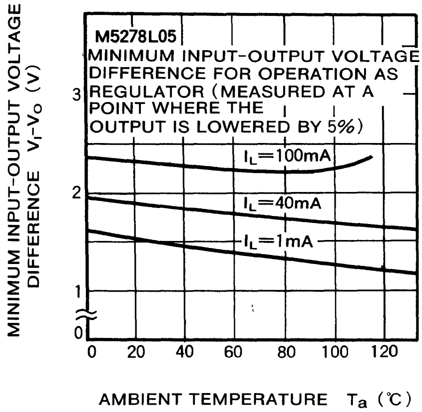


RIPPLE REJECTION VS. FREQUENCY



(5V, 5.6V, 8V, 9V, 10V, 12V, 15V) 3-TERMINAL FIXED POSITIVE OUTPUT VOLTAGE REGULATOR (WITH FOLD-BACK PROTECTION CIRCUIT)

MINIMUM INPUT-OUTPUT VOLTAGE DIFFERENCE VS. AMBIENT TEMPERATURE



FOLD-BACK PROTECTION CIRCUIT

The M5278L series has been designed to be complete with three-pin, 78L type regulators manufactured by other companies for applications with loading currents in the 100mA class. They additionally have an internalized fold-back protection circuit for protection against shorted loads.

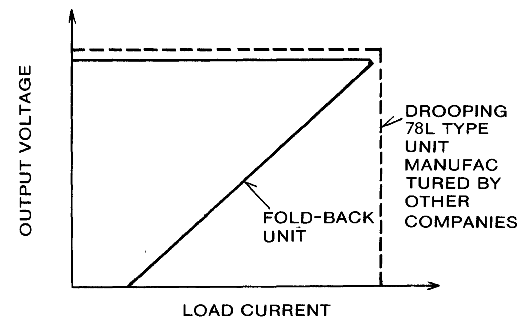
Other 78L units do have an internalized protection circuit known as a drooping type circuit that are rether simple, merely limiting maximum loading current. When large current begins to flow in these units due to a short circuit, abnormal temperatures are generated leading to breakdown and effective setting reliability.

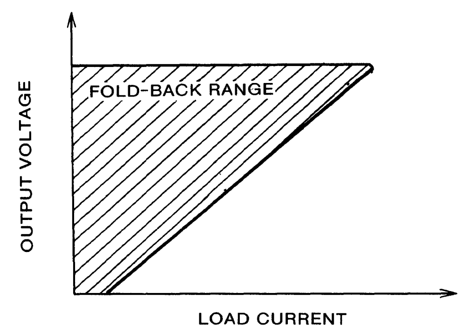
As shown in the diagram, the fold-back protection circuit employed in the M5278L decreases immediately excessive current caused by a short in the load. This not only improves set reliability but permits the elimination of such protection circuits as fuses in the protection circuit.

PRECAUTIONS FOR USE

The current-control circuit requires that, as an IC power supply, this device be operated within the fold-back operating range shown in the accompanying chart.

OUTPUT VOLTAGE VS. LOAD CURRENT





M5T494P, FP

SWITCHING REGULATOR CONTROL

DESCRIPTION

The M5T494P,FP is a monolithic IC designed for a pulse-width-modulation control circuit.

It contains all functions necessary to control a switching power supplies. It employs an on-chip reference voltage circuit, error amplifier, saw-teeth wave oscillator, dead-time control comparator, a flip-flop buffer capable of both sink and source.

It also contains an undervoltage-lockout (UVLO) function, which turns the output completely even in transit state due to the rising and falling of power supply.

FEATURES

- Built-in undervoltage lock-out circuit
- Buil-in reference regulator ································ 5V±5%
- Applicable to single-end and push-pull circuits
- Uncommitted outputs for 200mA sink or source outputs

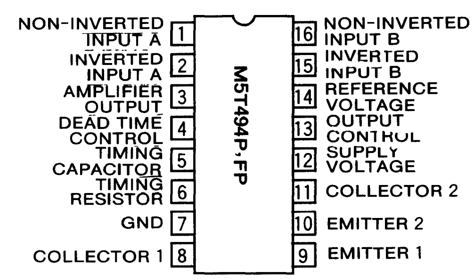
APPLICATION

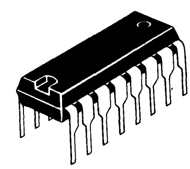
Switching regulator, step-up regulator, step-down regulator, voltage inversion regulator.

RECOMMENDED OPERATING CONDITIONS

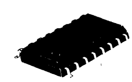
Supply voltage range ···································· 7~40V
Pin ③ current ···································· less than 0.3mA
Timing capacitor C_T ···························· 470pF~3.3μF
Timing resistor R_T ···································· 1.8~500kΩ
Oscillator frequency ······················ lower than 300kHz

PIN CONFIGURATION (TOP VIEW)



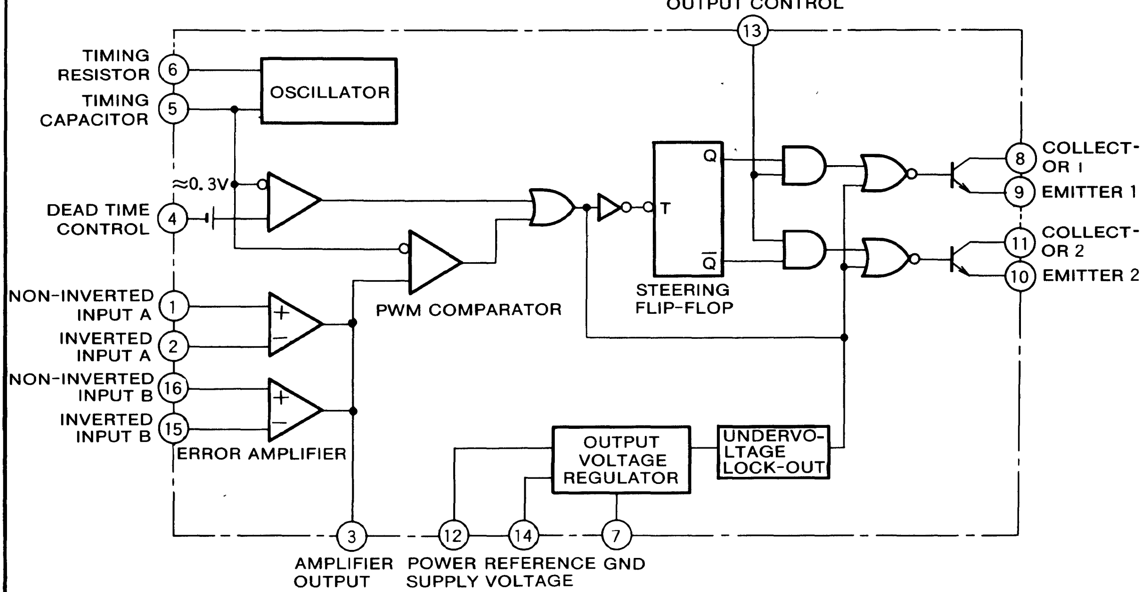


16-pin molded plastic DIP



16-pin molded plastic FLAT

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

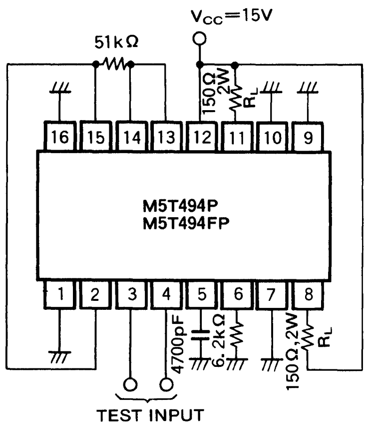
Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		41	V
V_{ICM}	Common phase input voltage range of error amplifier		−0.3～V_{CC}	V
V_{ID}	Differential input voltage of error amplifier		V_{CC}	V
V_O	Output voltage		41	V
I_O	Output current		200	mA
$V_{⑬}$	Pin ⑬ applied voltage range		−0.3～$V_{⑭}$+0.3	V
P_d	Power dissipation		1000(M5T494P)	mW
			800(M5T494FP)	
K_θ	Thermal derating	T_a≧25℃	8(M5T494P)	mW/℃
			6.4(M5T494FP)	
T_{opr}	Operating temperature		−20～+85	℃
T_{stg}	Storage temperature		−40～+125	℃

ELECTRICAL CHARACTERISTICS (V_{CC}=15V, f_{OSC}=40kHz, T_a=−20～+70℃, unless otherwise noted)

Symbol	Block	Parameter	Test conditions	Limits Min	Limits Typ	Limits Max	Unit
V_{ref}	REFERENCE	Output voltage	I_{ref}=−1mA, T_j=25℃	4.75	5	5.25	V
$\Delta V_{ref\ IN}$		Input stability	V_{CC}=7～40V I_{ref}=−1mA, T_j=25℃		1	10	mV
$\Delta V_{ref\ L}$		Load stability	I_{ref}=−1～−10mA, T_j=25℃		2	20	mV
$\Delta V_{ref}/\Delta T_a$		Output voltage temperature ragulaiton	T_a=−20～+85℃, I_{ref}=−1mA		0.01	0.03	%/℃
I_S		Output short current	V_{ref}=0	−50	−30	−15	mA
f_{OSC}	OSCILLATOR	Oscillation frequency setting value	C_T=4700pF, R_T=6.2kΩ	37	41	45	kHz
$\Delta f/f_S$		Oscillation frequency setting accuracy	V_{CC}=7～40V, T_a=25℃ C_T, R_T, within recommended ratings		10		%
$\Delta f/f_{IN}$		Frequency input stability	V_{CC}=7～40V, T_a=25℃ C_T=4700pF, R_T=6.2kΩ		0.5	1.5	%
$\Delta f/f_{Ta}$		Frequency thermal regulation	T_a=0～70℃ C_T=4700pF, R_T=6.2kΩ		1	2	%
$I_{④}$	DEAD-TIME CONTROL	Input bias current	$V_{④}$=0～5.25V	−7	−0.7		μA
D_{max}		Maximum duty (each output stage)	$V_{④}$=0V	42	45	48	%
$V_{④TH1}$		Input threshold voltage 1	Output pulse 0% duty		2.45	2.80	V
$V_{④TH2}$		Input threshold voltage 2	Output pulse maximum duty	0			V
V_{AMPIO}	ERROR AMPLIFIER	Input offset voltage	$V_{③}$=2.5V		1	7	mV
I_{AMPIO}		Input offset current	$V_{③}$=2.5V		5	200	nA
I_{AMPIB}		Input bias current	$V_{③}$=2.5V	−700	−100		nA
V_{AMPICM}		Common phase input voltage range	V_{CC}=7～40V	−0.3		V_{CC}−2	V
A_V		Open loop voltage gain	$V_{③}$=0.5～3.5V, T_a=25℃	70	110		dB
f_T		Unity gain frequency	T_a=25℃	500	900		kHz
CMRR		Common mode signal rejection ratio	V_{CC}=40V, T_a=25℃	65	85		dB
$I_{③sink}$		Output sink current	$V_{③}$=0.7V	0.3	0.7		mA
$I_{③source}$		Output source current	$V_{③}$=3.5V		−10	−2	mA
$V_{③RANGE}$		Output voltage range — Low level	$I_{③}$=0		0.1	0.3	V
		Output voltage range — High level		4.2	4.9		V
$V_{③TH}$	PWM COMPA-RATOR	Input threshold voltage	Output pulse 0% duty		3.4	3.8	V
$I_{③sink}$		Input sink current	$V_{③}$=0.7V	0.3	0.7		mA
I_{CL}	OUTPUT	Collector leak current	V_{CE}=40V, V_{CC}=40V Common emitter		0.01	100	μA
I_{EL}		Emitter leak current	V_{CC}=V_C=40V, V_E=0V Emitter follower	−100	−0.01		μA
V_{CESAT}		Collector saturation voltage (emitter grounded)	I_C=200mA, V_E=0V		0.95	1.3	V
V_{CEON}		Collector saturation voltage (emitter follower)	I_E=−200mA, V_C=15V		1.6	2.5	V

Symbol	Block	Parameter	Test conditions	Limits Min	Typ	Max	Unit
t_{r1}	OUTPUT	Output voltage rising time (common emitter)	V_{CC}=15V, R_L=150Ω		80	200	ns
t_{f1}		Output voltage falling time (common emitter)	I_C=100mA, T_a=25℃		30	100	ns
t_{r2}		Output voltage rising time (emitter follower)	V_{CC}=V_C=15V, R_L=150Ω		200	400	ns
t_{f2}		Output voltage falling time (emitter follower)	I_E=−100mA, T_a=25℃		30	100	ns
I⑬		Output control input bias current	V⑬=V_{ref}	270	550	1000	μA
V_{CCLO}	UNDER-VOLTAGE LOCK-OUT	Undervoltage lock-out voltage	Supply voltage at which output is OFF	3.8	5	5.7	V
ΔV_{CCLO}		UVLO hysteresis width		100	200	380	mV
I_{CCSB}	CONSUMED CURRENT	Standby current	V_{CC}=15V, other pins are open		6.7	11.5	mA
I_{CCBI}		Bias current	V④=2V		7.3	13	mA

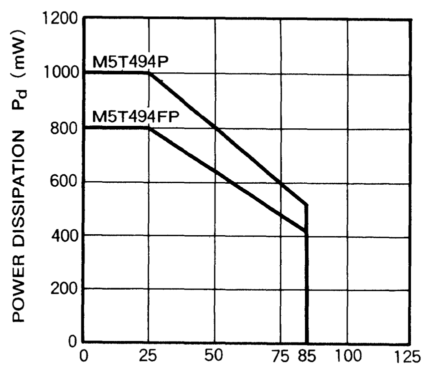
TEST CIRCUITS



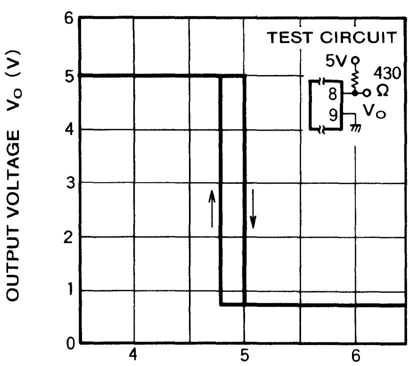
Note: Connect Pin ⑧ and Pin ⑪ to V_{CC} and connect Pin ⑨ and Pin ⑩ to GND via resistors R_L when emitter follower output is used.

TYPICAL CHARACTERISTICS

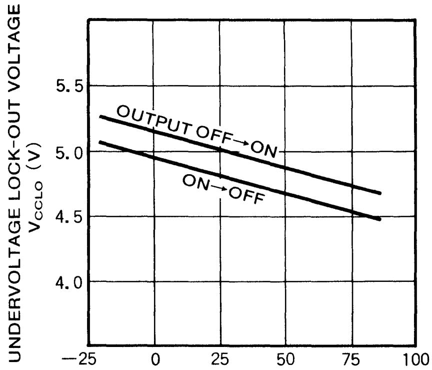
THERMAL DERATING (MAXIMUM RATING)



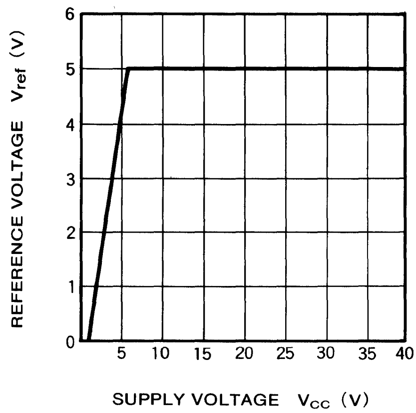
UNDERVOLTAGE LOCK-OUT OPERATION CHARACTERISTICS



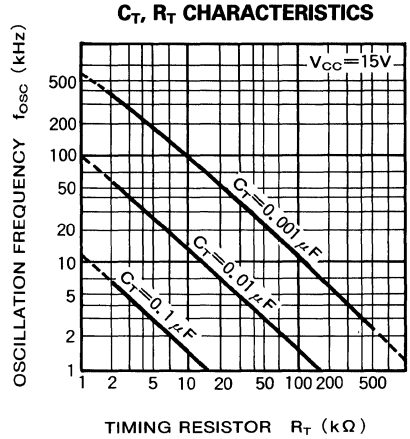
UNDERVOLTAGE LOCK-OUT VS. AMBIENT TEMPERATURE



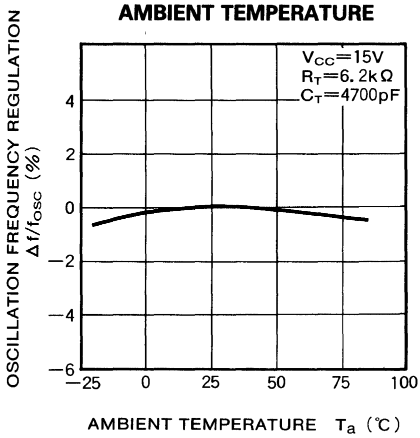
REFERENCE VOLTAGE VS. SUPPLY VOLTAGE



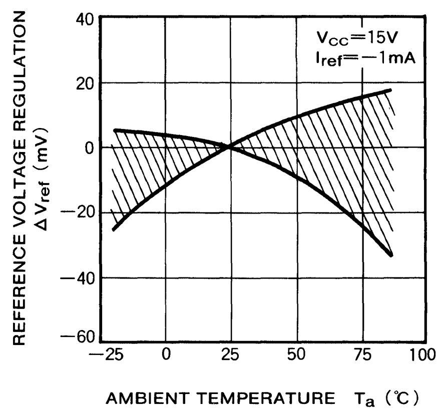
OSCILLATION FREQUINCY VS. C_T, R_T CHARACTERISTICS



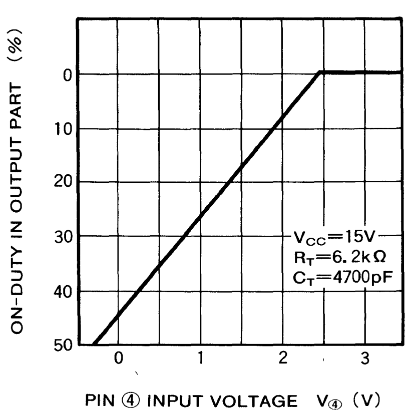
OSCILLATION FREQUINCY REGULATION VS. AMBIENT TEMPERATURE



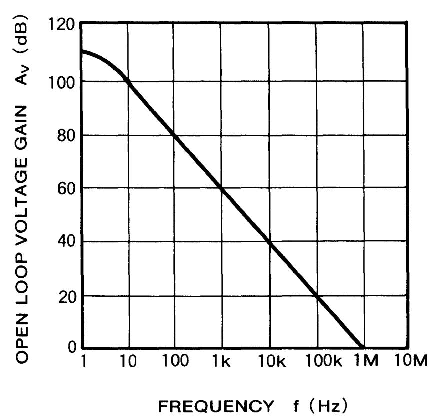
REFERENCE VOLTAGE REGULATION VS. AMBIENT TEMPERATURE

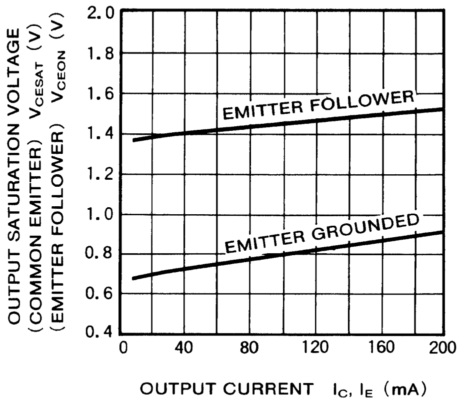


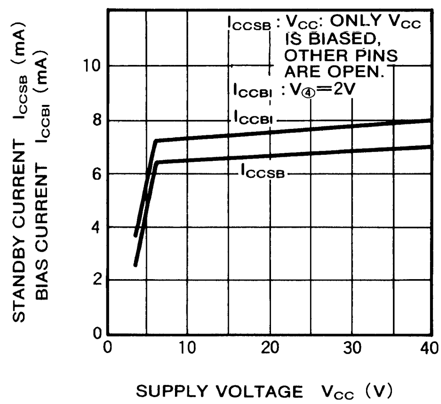
INPUT VOLTAGE AT ON-DUTY PIN ④ OF OUTPUT PART



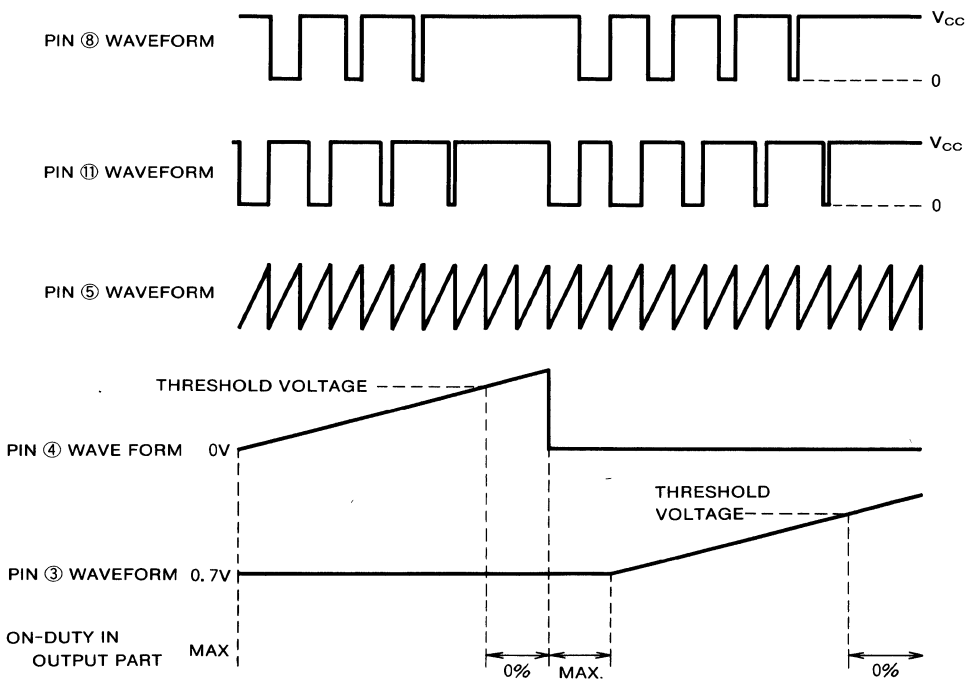
OPEN LOOP VOLTAGE GAIN OF ERROR AMPLIFIER VS. FREQUENCY







VOLTAGE WAVEFORMS



PIN ⑬ VOLTAGE AND OPERATION MODE

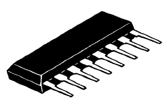
Pin ⑬ Voltage	Operational mode
V_{ref}	Push-pull operation
GND	Single-end or parallel operation

TIMER

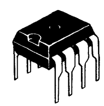
5

QUICK REFERENCE TABLE OF TIMERS

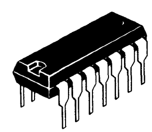
Application	Type No	Processing time	Features	Electrical characteristics			Package outline
				Supply voltage range	Output current (max.)	Circuit current (typ.)	
CR timer	M51841P	100μs~180sec	High output current 200mA	4.5~16V	200mA	10mA	8-pin DIP
	M51843P	10ms~180sec	Internal open collector and emitter outputs Built-in ON/OFF control and discharge circuit	4.5~16V	200mA	13mA	14-pin DIP
	M51848	10μs~180sec	Maximum operating frequency 100kHz Built-in supply voltage reset circuit	4~17V	200mA	7mA	8-pin DIP 8-pin SIP
Dual CR timer	M51847P	10μs~180sec	Maximum operating frequency 100kHz Built-in supply voltage reset circuit	4~17V	100mA	10mA	14-pin DIP
High-speed CR timer	M52051P	1μs~1sec	Maximum osccilator frequency 1MHz Built-in reset circuit	4.5~5.5V	5mA	11mA	8-pin DIP
IIL counter timer	M51849L	100ms~50hr	Built-in supply voltage reset circuit and stabilization zener Built-in 11 stage divider	5~V_Z	30mA	3.5mA	8-pin SIP
CMOS counter timer	M58479P	50ms~4800hr	Low pwoer dissipation Selection of division ratio	7.4~9V	1.6mA	0.25mA	14-pin DIP
	M58482P	50ms~4800hr	Low power dissipation Selection of division ratio	3~9V	1.6mA	25μA	14-pin DIP



8-pin DIP



8-pin SIP



14-pin DIP

DESCRIPTION

The M51841P monolithic timing circuit is highly stable controller capable of producing accurate time delays, or oscillation. Additional terminals are provided for two voltage comparators, triggering or resetting, if desired, applicable for a wide range of usage as monostable or astable multivibrators. The output can be directly connected to TTL or DTL circuits.

The M51841P is interchangeable with the Signetics NE555.

FEATURES

- Capable of forming a monostable multivibrator with one resistor and capacitor
- Capable of forming an astable multivibrator with two resistors and a capacitor
- Supply voltage rejection ratio ······ 0.01%V(typ.)
- Temperature coefficient ······ 50ppm/℃(typ.)
- High output current ······ 200mA(max.)

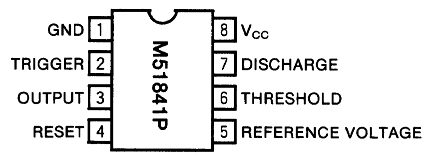
APPLICATION

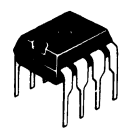
Time-delay generator monostable multivibrator) , pulse oscillator (astable multivibrator) , pulsewidth modulation, pulse position modulation, sequential timer, DC-DC converter

RECOMMENDED OPERATING CONDITIONS

Supply voltage range ······ 4.5~16V
Rated supply voltage ······ 5V, 12V, 15V

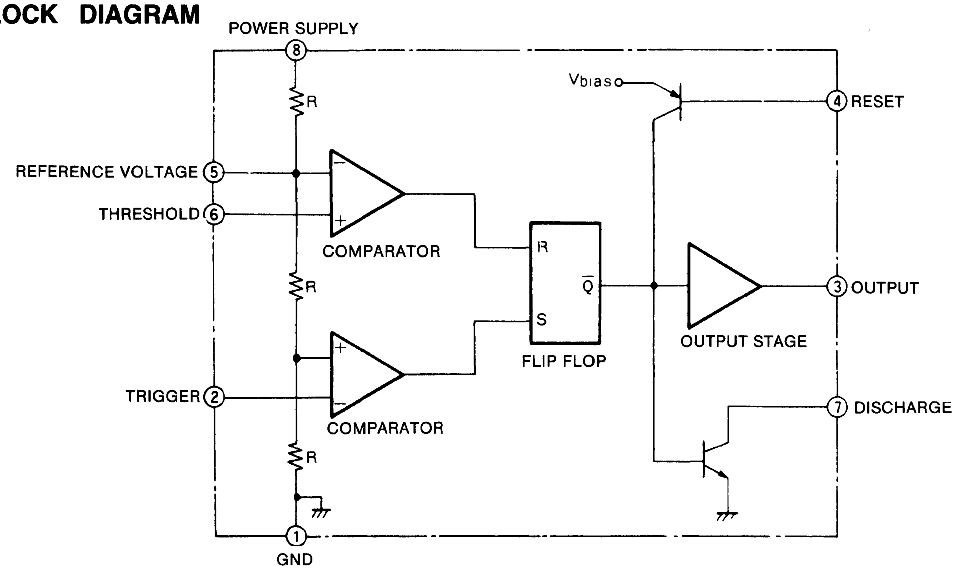
PIN CONFIGURATION (TOP VIEW)





8-pin molded plastic DIP

BLOCK DIAGRAM



ABOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

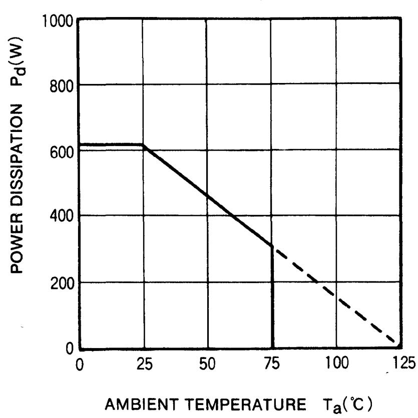
Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		18	V
$I_{O(peak)}$	Output current		200	mA
P_d	Power dissipation		625	mW
K_θ	Thermal derating	$T_a \geqq 25$℃	6.25	mW/℃
Topr	Operating ambient temperature		−20～+75	℃
Tstg	Storage temperature		−40～+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=5～15V, unless otherwise noted)

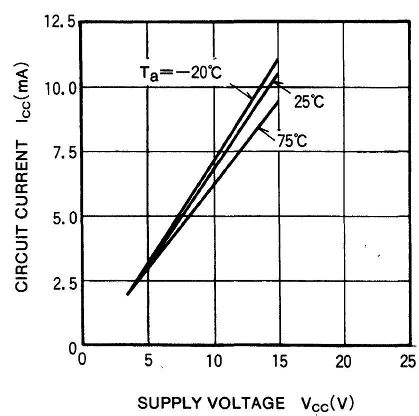
Symbol	Parameter	Test conditions		Limits			Unit
		V_{CC}(V)		Min	Typ	Max	
V_{CC}	Supply voltage			4.5		16	V
I_{CC}	Circuit current	5	$R_L=\infty$		3	6	mA
		15	$R_L=\infty$		10	15	
V_{REF}	Reference voltage	5		2.6	3.33	4.0	V
		15		9	10	11	
V_{TH}	Threshold voltage				$2/3V_{CC}$		V
I_{TH}	Threshold current				0.1	0.25	μA
V_T	Trigger voltage				$1/3V_{CC}$		V
I_T	Trigger current				0.5	1.0	μA
V_R	Reset voltage				0.7	1.0	V
I_R	Reset current				0.1		mA
V_{OL}	Low output voltage	5	I_{SINK}=5mA		0.25	0.35	V
		15	I_{SINK}=10mA		0.1	0.25	
		15	I_{SINK}=50mA		0.4	0.75	
		15	I_{SINK}=100mA		2.0	2.5	
V_{OH}	High output voltage	5	I_{SOURCE}=100mA	2.75	3.3		V
		15	I_{SOURCE}=100mA	12.75	13.3		
—	Timing error				0.5		%
—	Temperature coefficient				50		ppm/℃
—	Supply voltage rejection ratio				0.01		%/V

TYPICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

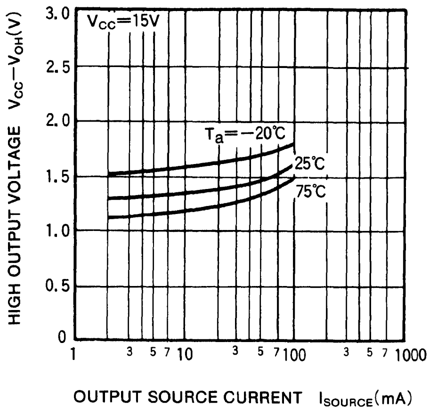
THERMAL DERATING (MAXIMUM RATING)



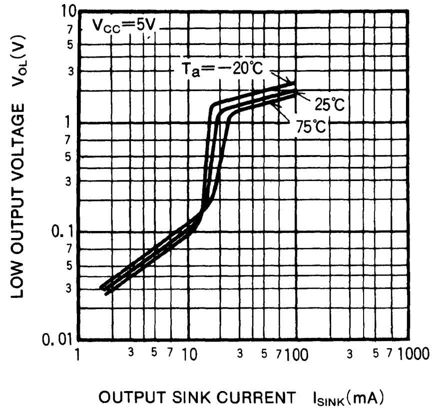
SUPPLY VOLTAGE VS. CIRCUIT CURRENT



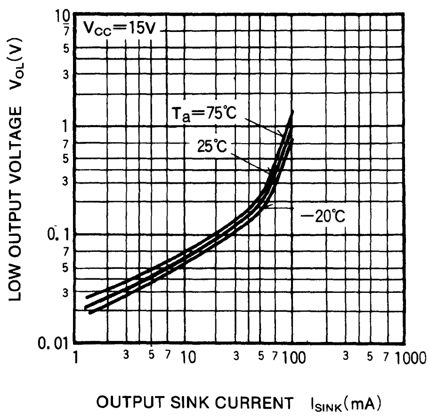
HIGH OUTPUT VOLAGE VS. OUTPUT SOURCE CURRENT



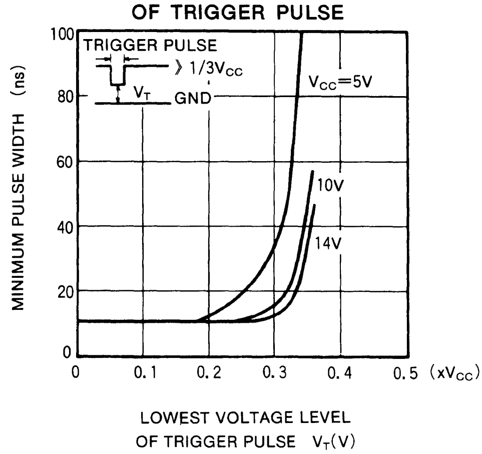
LOW OUTPUT VOLTAGE VS. OUTPUT SINK CURRENT



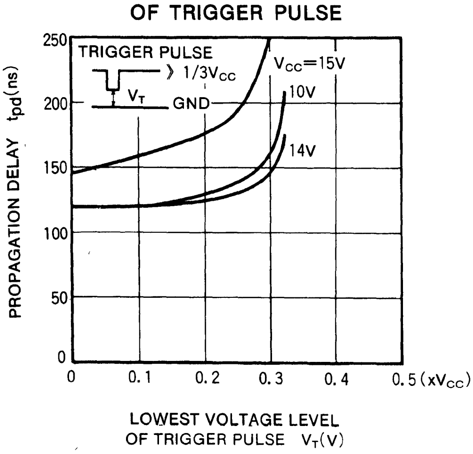
LOW OUTPUT VOLTAGE VS. OUTPUT SINK CURRENT



MINIMUM PULSE WIDTH VS. LOWEST VOLTAGE LEVEL OF TRIGGER PULSE



PROPAGATION DELAY VS. LOWEST VOLTAGE LEVEL OF TRIGGER PULSE

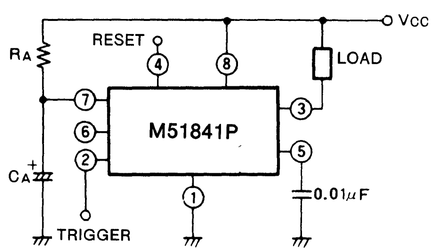


PIN DESCRIPTION

1. **Trigger pin (pin ②)**
   When the voltage at the trigger pin is reduced to lower than $1/3V_{CC}$, timing operation is started. Time of applying the trigger voltage "L" should be shorter than the time set by CR.
2. **Output pin (pin ③)**
   Logic output level is normally in the low state but is in the high state during timing operation. The output circuit is shaped like a totem-pole and withstands maximum load current of 200mA. The circuit can be directly connected to TTL or DTL circuits.
3. **Reset pin (pin ④)**
   Timing operation can be interrupted by applying the reset signal to a reset pin. (The voltage at this pin must be less than 1V.)
   If the reset signal is applied, the output is in the low state and the reset condition is maintained as long as the signal is applied. The output stays in the low state until the reset signal is replaced with the set signal (trigger signal at a trigger pin). Connect this pin to V_{CC} if not used.
4. **Reference voltage pin (pin ⑤)**
   The voltage at this pin is normally set at $2/3V_{CC}$. By applying reference voltage, delay-time or oscillation frequency can be changed. The control signal for pulse-width modulation is applied at this pin. Connect a capacitor of 0.01μF between this pin and GND as a noise filter, if the pin is not used.
5. **Threshold pin (pin ⑥)**
   The delay-time is determined by CR time constants connected to this pin. The delay-time of a monostable multivibrator t_d is expressed by the equation $t_d \doteqdot 1.1R_AC_A$.
6. **Discharge pin (pin ⑦)**
   The timed capacitor discharges at this pin. The discharge is enabled when a flip-flop in the device is ON and the reset signal is applied. In a monostable multivibrator, the capacitor is connected to pin ⑥

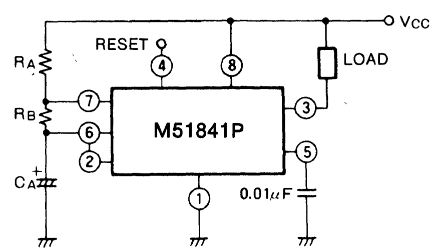
APPLICATION EXAMPLES

(1) Delay-timer
(monostable multivibrator)



DELAY-TIME
$t_d \doteqdot 1.1R_AC_A$

(2) Pulse oscillator
(astable multivibrator)



OSCILLATION FREQUENCY
$f \doteqdot 1.44/(R_A+2R_B)C_A$
duty cycle
$D=R_B/(R_A+2R_B)$

Precautions for use

1. Care must be taken not to connect the discharge pin (pin ⑦) directly to V_{CC}.Such connection causes a short circuit of V_{CC} and GND through a discharge transitor (built in to the device) and may destroy the integrated circuit.
2. Connect the reset pin (pin ④) to V_{CC}, if not used.
3. A capacitor connected to a reference voltage pin (pin ⑤) functions as a noise filter. Choose appropriate capacitance according to the noise induced. The M51843P is recommended for use in an environment where noise may cause misoperation.

M51843P

SINGLE TIMER

DESCRIPTION

The M51843P monolithic timing circuit is highly stable controller capable of producing accurate time delays, or oscillation. Additional terminals are provided for two voltage comparators, triggering or resetting, if desired, applicable for a wide range of usage as monostable or astable multivibrators. The circuit consists of noise filter pin, shutdown control circuit, and zener diode for supply voltage regulation, providing excellent anti-noise characteristics.

FEATURES

- Capable of forming a monostable multivibrator with a resistor and a capacitor
- Capable of forming an astable multivibrator with two resistors and a capacitor
- Supply voltage rejection ratio ·················· 0.01%V (typ.)
- Temperature coefficient ······················ 50ppm/℃ (typ.)
- High output current ······························ 100mA (max.)
- Noise filter pin provided
- Discharge control, and shutdown control pins
- Built-in zener diode for supply voltage regulation
- Emitter and collector outputs

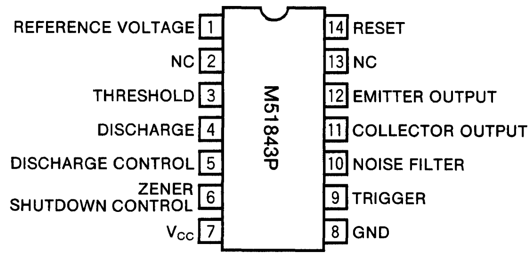
APPLICATION

Time delay generator (monostable multivibrator), pulse oscillator, pulsewidth modulation, pulse position modulation, sequential timer

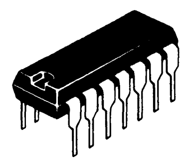
RECOMMENDED OPERATING CONDITIONS

Supply voltage range ································· 4.5~16V
Rated supply voltage ······························ 5V, 12V, 15V

PIN CONFIGURATION (TOP VIEW)

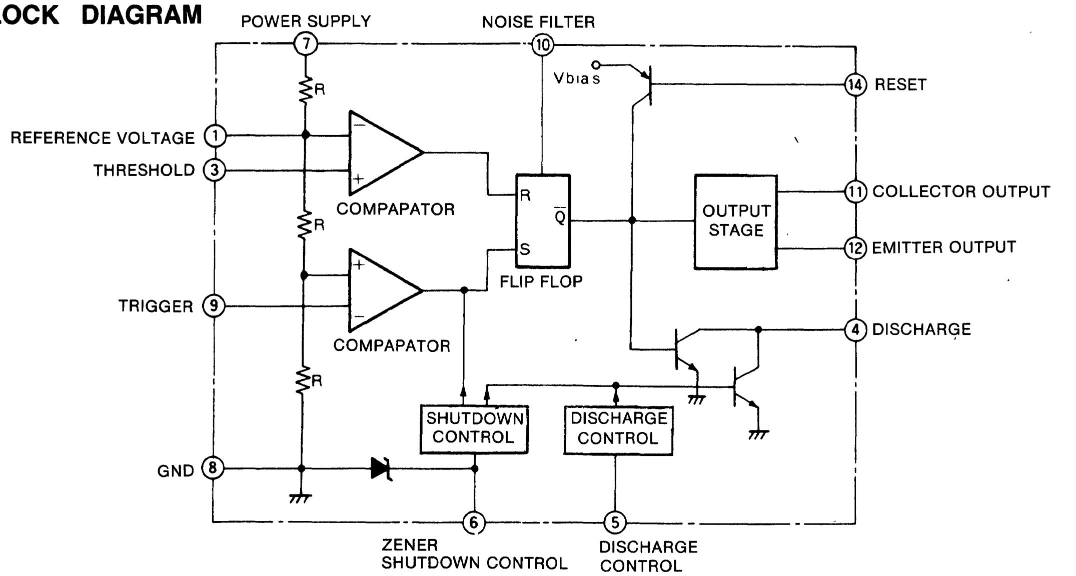


NC : NO CONNECTION



14-pin molded plastic DIP

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

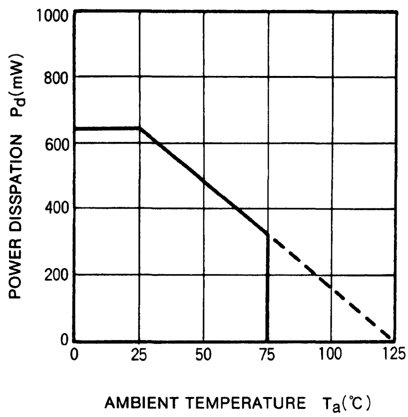
Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage (pin⑦)		18	V
I_Z	Zener Current (pin⑥)		10	mA
I_{OC}	Collector output current	Saturation	200	mA
BV⑪	Breakdown voltage (pin⑪)		27	V
P_d	Power dissipation		650	mW
K_θ	Thermal derating	T_a≧25℃	6.5	mW/℃
Topg	Operating temperature		−20～+75	℃
Tstg	Storage temperature		−40～+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃ V_{CC}=5～15V)

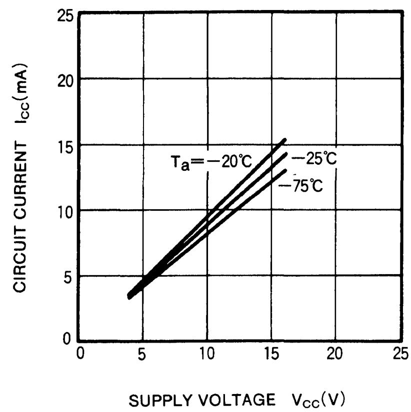
Symbol	Parameter	Test Conditions		Limits			Unit
		V_{CC}(V)		Min	Typ	Max	
V_{CC}	Supply voltage		Excluding pin R_L=∞	4.5		16	V
I_{CC}	Circuit current	5			4	10	mA
		15			13	22	
V_{REF}	Reference voltage	5		2.6	3.33	4.0	V
		15		9	10	11	
V_{TH}	Threshold voltage				2/3V_{CC}		V
I_{TH}	Threshold current				0.1	0.25	μA
V_T	Trigger voltage				1/3V_{CC}		V
I_T	Trigger current				0.5	1.0	μA
V_R	Reset voltage				0.7	1.0	V
I_R	Reset current				0.1		mA
V_Z	Zener voltage		I_Z=2mA	6.5	7.5	8.5	V
V_{SC}	Voltage range of shutdown control at pin⑥				2.4	4.0	V
V_{DCC}	Voltage range of discharge control				0.7+V_{CC}	1.0+V_{CC}	V
V_{OC}	Collector output voltage	5	I_{OC}=30mA		0.15	0.3	V
		15	I_{OC}=10mA		0.05	0.1	
		15	I_{OC}=100mA		0.3	1.0	
I_{OE}	Emitter output current	15		1	2		mA
—	Timing accuracy				0.5		%
—	Temperature coefficient				50		ppm/℃
—	Supply voltage rejection ratio				0.01		%/V

TYPICAL CARACTERISTICS (unless otherwise noted, T_a=25℃)

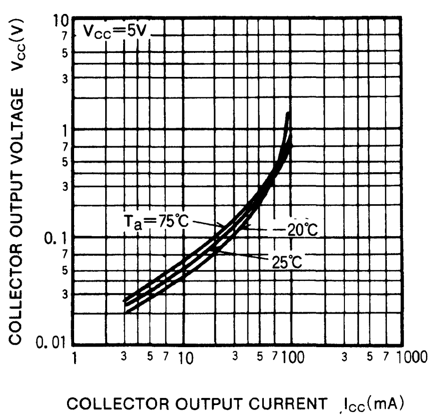
THERMAL DERATING (MAXIMUM RATING)



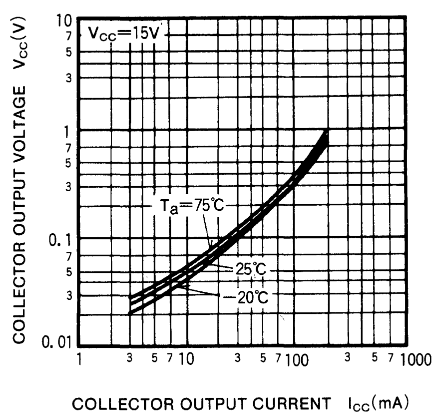
CIRCUIT CURRENT VS. SUPPLY VOLTAGE



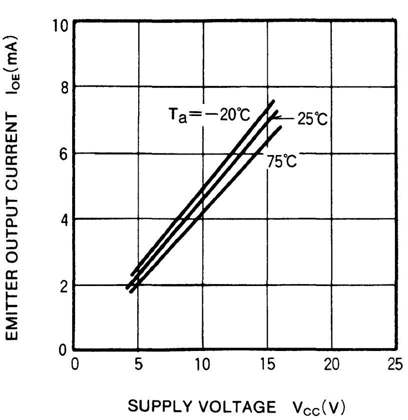
COLLECTOR OUTPUT VOLTAGE VS. OUTPUT CURRENT



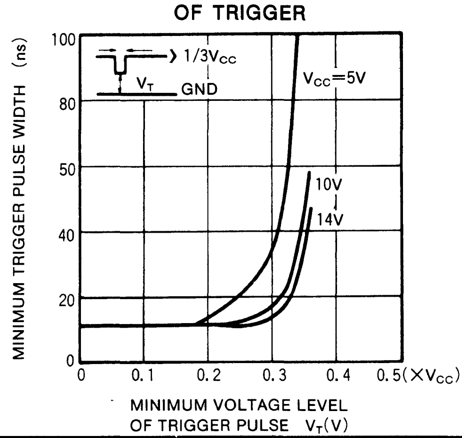
COLLECTOR OUTPUT VOLTAGE VS. OUTPUT CURRENT



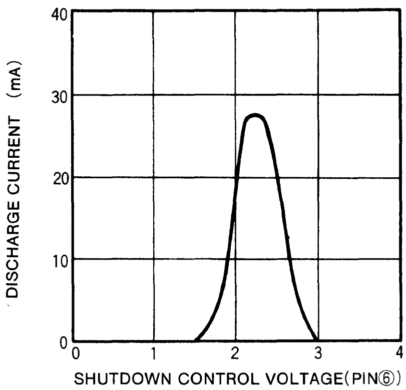
EMITTER OUTPUT CURRENT VS. SUPPLY VOLTAGE



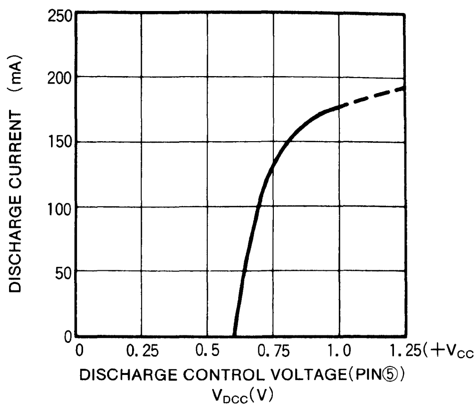
MINIMUM PULSE WIDTH VS. LOWEST VOLTAGE LEVEL OF TRIGGER



SHUTDOWN CONTROL CHARACTERISTICS



DISCHARGE CONTROL CHARACTERISTICS



PIN DESCRIPTION

1. Refernce voltage pin (pin ①)
The voltage at this pin is normally set at 2/3V_{CC}. By applying reference voltage, delay time or oscillation frequency can be changed. The control signal for pulse-width modulation is applied at this pin. Connect a capacitor of 0.01μF between this pin and GND as the noise filter, if the pin is not used.

2. Threshold pin (pin ③)
The delay time is determined by CR time constants connected to this pin. The delay time of a monostable multivibrator td is expressed by the equation $td \fallingdotseq 1.1 R_A C_A$.

3. Discharge pin (pin ④)
The timed capacitor discharges at this pin. The discharge is enabled when a flip flop in the device is ON and the reset signal, discharge control signal or shutdown signal are applied. In a monostable multivibrator, the capacitor is connected to pin ③

4. Discharge control pin (pin ⑤)
If a capacitor is connected between this pin and GND, the discharge pin (discharge transistor) is enabled by applying discharge control signal (approximately V_{CC} + 0.7V) to this pin. The timing capacitor can be automatically discharged when power supply drops. The capacitance should be 1/10-1/30 of that of the timing capacitor.

5. Zener/shutdown control pin (pin ⑥)
Supply voltage can be regulated (at approximately 8V) by connecting this pin to V_{CC} (pin⑦). By controlling the voltage at this pin as the shutdown control voltage (approximately 2.4V), discharge of timing capacitor and OFF of the output stage can be controlled.

6. Trigger pin (pin ⑨)
When the voltage level at trigger pin is reduced to lower than 1/3V_{CC}, timing operating is started.

7. Noise filter pin (pin ⑩)
Connect a capacitor between this pin and GND as the noise filter. Appropriate capacitance must be chosen according to the noise induced. (Normally less than 0.1μF)

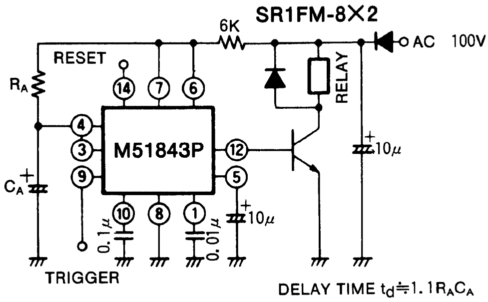
8. Collector output pin (pin ⑪)
The maximum load current of 200mA can be applied.
Logic output level is in the low state from the high state when the output stage is ON.

9. Emitter output pin (pin ⑫)
This pin drives externally connected transistors or thyristors. The load current is 2mA typ.

10. Reset pin (pin ⑭)
Timing operation can be interrupted by applying the reset signal to a reset pin. (The voltage at this pin must be less than IV.)
If the reset signal is applied, the output is in the low state and the reset condition is maintained as long as the signal is applied. The output stays in the low state until the reset signal is replaced with the set signal (trigger signal at a trigger pin). Connect this pin to V_{CC} if not used.

APPLICATION EXAMPLES

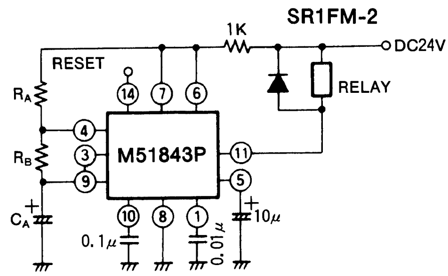
(1) DELAY TIMER



DELAY TIME $t_d \fallingdotseq 1.1 R_A C_A$

Unit :
Resistance : Ω
Capacitance : F

(2) ASTABLE OPERATION



FREE RUNNING FREQUENCY
$f \fallingdotseq 1.44/(R_A+2R_B)C_A$

duty cycle
$D=R_B(R_A+2R_B)$

M51848L,P

SINGLE TIMER

DESCRIPTION

The M51848L, P are semiconductor integrated circuits designed for producing accurate timing pulse and time delay.
The delay time can be set from microseconds through minutes by externally connected resistor and capacitor.
In an astable multivibrator, the maximum frequency is 100kHz.
The reset voltage is 1.4V typ. (T_a=25℃), and compatible with TTL level.

FEATURES

- Timing from microseconds through minutes
- Wide range of unage as monostable or astable multivibrators
- Maximum oscillation frequency ······················ 100kHz
- Reset voltage is compatible with TTL level
- Built-In supply voltage reset circuit for setting the output in the low state, when power is supplied

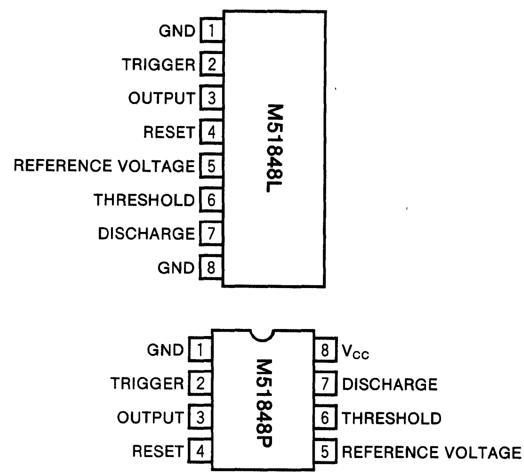
APPLICATION

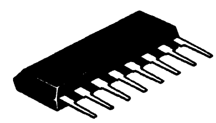
Monostable multivibrator, astable multivibrator, pulsewidth modulation

RECOMMENDED OPERATING CONDITIONS

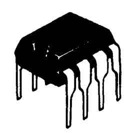
Supply voltage range ································· 4.5~17V

PIN CONFIGURATION (TOP VIEW)



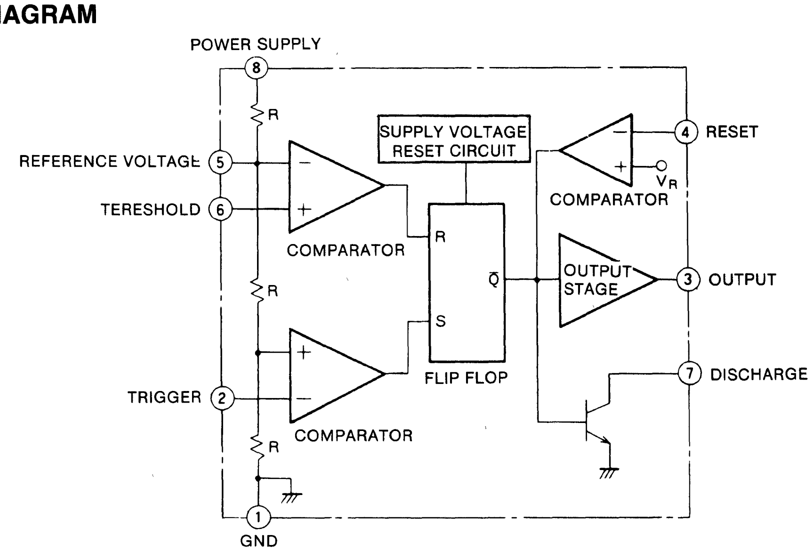


8-pin molded plastic DIP



8-pin molded plastic SIP

BLOCK DIAGRAM



MITSUBISHI ELECTRIC

ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

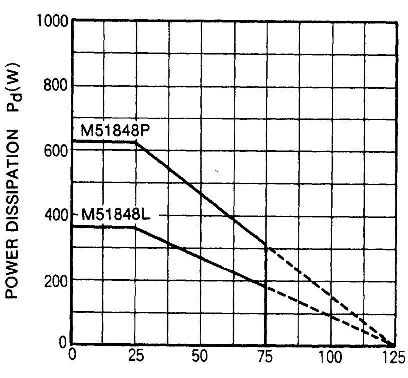
Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		18	V
$I_{O(peak)}$	Output current		200	mA
P_d	Power dissipation		360(M51848L)	mW
			625(M51848P)	
K_θ	Thermal derating	$T_a \geq 25$℃	3.6(M51848L)	mW/℃
			6.25(M51848P)	
Topr	Operating ambient temperature		−20~+75	℃
Tstg	Strage temperature		−48~+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=5~15V, unless otherwise noted)

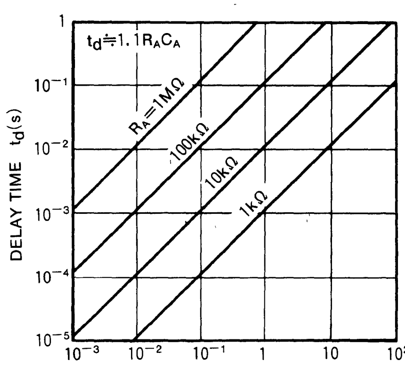
Symbol	Parameter	Test conditions	Limits			Units
			Min	Typ	Max	
V_{CC}	Supply voltage		4		17	V
I_{CC}	Curcuit current	V_{CC}=5V, $R_L=\infty$		3	5.5	mA
		V_{CC}=15V, $R_L=\infty$		7	10	
V_{REF}	Reference voltage	V_{CC}=5V	2.6	3.33	4.0	V
		V_{CC}=15V	9	10	11	
V_{TH}	Threshold voltage			2/3V_{CC}		V
I_{TH}	Threshold current			0.05	0.3	μA
V_T	Trigger voltage			1/3V_{CC}		V
I_T	Trigger current			0.1	0.5	μA
V_R	Reset voltage		1.0	1.4	2.0	V
I_R	Reset current			0.05	0.2	μA
V_{OL}	Low output voltage	V_{CC}=5V, I_{SINK}=5mA		0.05	0.2	V
		V_{CC}=15V, I_{SINK}=10mA		0.05	0.2	
		V_{CC}=15V, I_{SINK}=50mA		0.2	0.5	
		V_{CC}=15V, I_{SINK}=100mA		0.5	2.0	
V_{OH}	High output voltage	V_{CC}=5V, I_{SOURSE}=100mA	2.8	3.3		V
		V_{CC}=15V, I_{SOUSE}=100mA	12.8	13.3		
—	Supply voltage rejection ratio			0.01		%
f_{max}	Maximum operating frequency	$R_A=R_B$=2kΩ, C_A=200pF	100			kHz

TYPICAL CHARACTERISTTCS (T_a=25℃, unless otherwise noted)

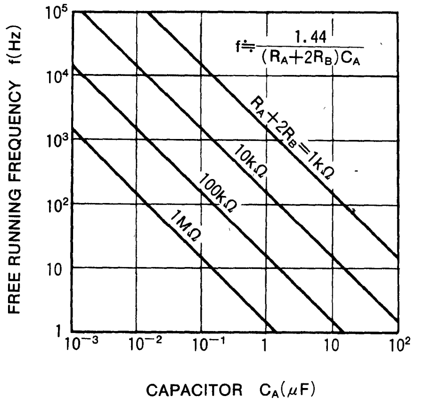
THERMAL DERATING
(MAXIMUM RATING)



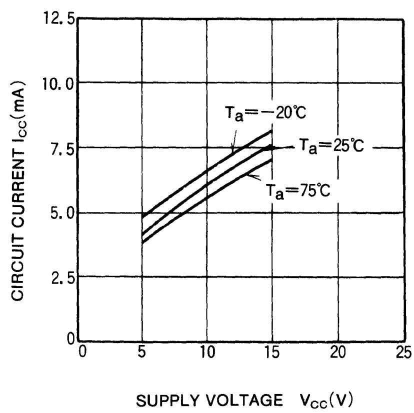
DELAY TIME VS.
TIMING RESISTOR, CAPACITANCE



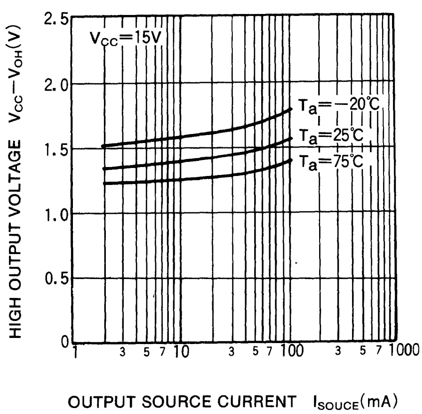
FREE RUNNING FREQUENCY VS. TIMING RESISTOR, CAPACITOR



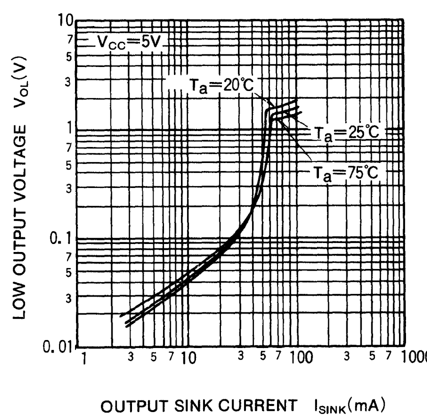
CIRCUIT CURRENT VS. SUPPLY VOLTAGE



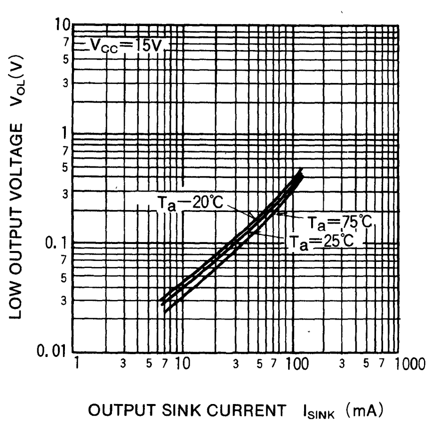
HIGH OUTPUT VOLTAGE VS. OUTPUT SOURCE CURRENT



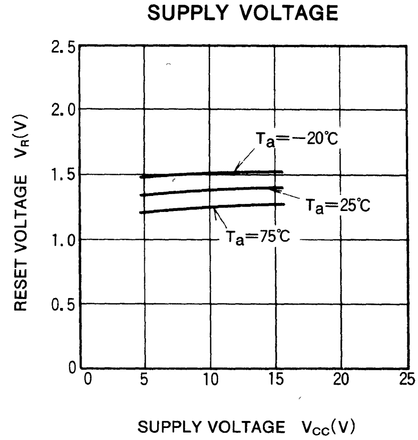
LOW OUTPUT VOLTAGE VS. OUTPUT SINK CURRENT



LOW OUTPUT VOLTAGE VS. OUTPUT SINK CURRENT



RESET VOLTAGE VS. SUPPLY VOLTAGE

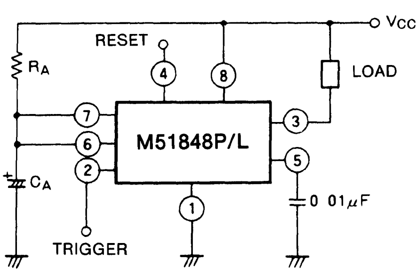


PIN DESCRIPTION

1. **Trigger pin (pin ②)**
   When the voltage at the trigger pin is reduced to lower than $1/3V_{CC}$, timing operation is started. Once triggered, the voltage is not affected during operation by the trigger voltage.
2. **Output pin (pin ③)**
   Logic output level is normally in the low state but is in the high state during timing operation. The output circuit is shaped like a totem-pole and withstands maximum load current of 200mA. The circuit can directly drive the TTL or DTL circuits.
3. **Reset pin (pin ④)**
   Timing operation can be interrupted by applying the reset signal to a reset pin. (The voltage at this pin must be less than 1.4V.)
   If the reset signal is applied, the output is in the low state and the reset condition is maintained as long as the signal is applied. The output stays in the low state until the reset signal is removed and the set signal (trigger signal at a trigger pin) is applied. Connect this pin to V_{CC} if not used.
4. **Recerence voltage pin (pin ⑤)**
   The voltage at this pin is normally set at $2/3V_{CC}$. By appling reference voltage, delay time or oscillation frequency can be changed. The control signal for pulse-width modulation is applied through this pin. Connect a capacitor of 0.01 μF between this pin and GND as noise filter, if the pin not used.
5. **Threshold pin (pin ⑥)**
   The delay time is determined by CR time constants connected to this pin. The delay time of a monostable multivibrator td is expressed by the equation $td \fallingdotseq 1.1 R_A C_A$.
6. **Discharge pin (pin ⑦)**
   The timing capacitor discharges at this pin. The discharge is enabled when a flip flop in the device is ON and the reset signal is applied. In a monostable multivibrator, the capacitor is connected to pin ⑥.

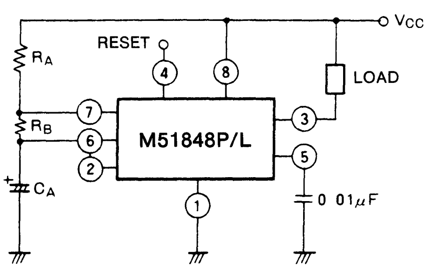
APPLICATION EXAMPLES

(1) Delay-timer (monostable multivibrator)



DELAY-TIME
$t_d \fallingdotseq 1.1 R_A C_A$

(2) Pulse oscillator (astable multivibrator)



FREOUENCY
$f \fallingdotseq 1.44/(R_A+2R_B)C_A$
duty cycle
$D=R_B/(R_A+2R_B)$

Precautions for us

1. Care must be taken not to connect the discharge pin (pin ⑦) directly to V_{CC}. Such connection causes short circuit of V_{CC} and GND through a discharge transistor (built into the device) and may destroy the integrated circuit.
2. Connect the reset pin (pin ④) to V_{CC}, if not used.
3. A capacitor connected to a reference voltage pin (pin ⑤) functions as the noise filter. Choose appropriate capacitance according to the noise induced. The M51843P is recommended for use in any environment where noise causes misoperation.

M51847P

DUAL TIMER

DESCRIPTTON

The M51847P is a semiconductor integrated circuit consisting of circuits of the M51848P timer. The two circuits operate independently.

In an astable multivibrator, the maximum frequency is 100kHz.

The reset voltage is 1.4V typ. (T_a=25℃), and compatible with TTL level.

FEATURES

- Timing from microseconds through minutes
- Wide range of usage as monostable or astable multivibrators
- Maximum oscillation frequency ························ 100kHz
- Reset voltage is compatible with TTL level
- Built-in supply voltage reset circuit for setting the output in the low state, when power is supplied

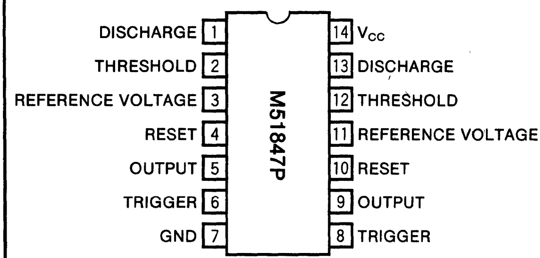
APPTCATION

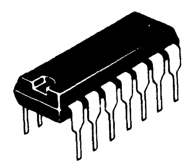
Monostable multivibrator, astable multivibrator, pulsewidth modulation

RECOMMENDED OPERATING CONDITIONS

Supply voltage range···································· 4.5~17V

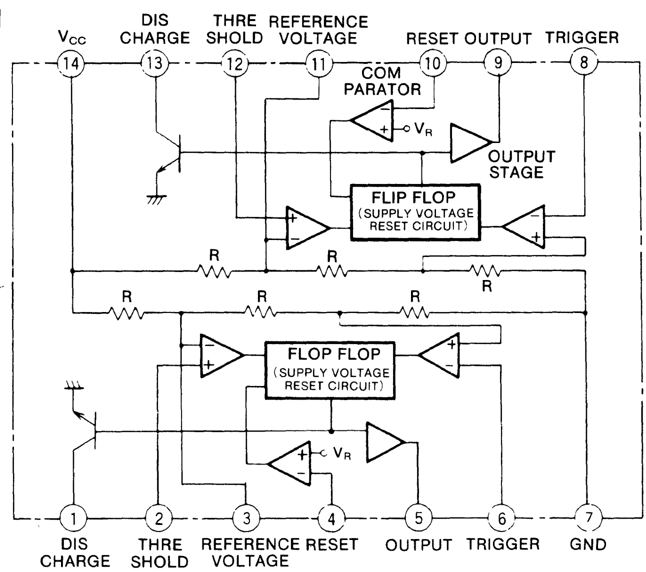
PIN CONFIGURATION (TOP VIEW)





14-pin molded plastic DIP

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

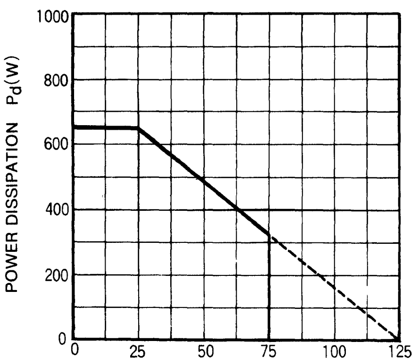
Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		18	V
$I_{OC(peak)}$	Collector output current		100	mA
P_d	Power disipation		650	mW
K_θ	Thermal derating	$T_a \geqq 25$℃	6.5	mW/℃
Topr	Operating ambient temperature		−20～+75	℃
Tstg	Storage temperature		−40～+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=5～15V, unless otherwise noted)

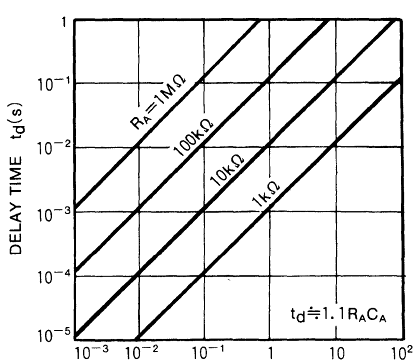
Symbol	Parameter	Test conditions	Limits			Units
			Min	Typ	Max	
V_{CC}	Supply voltage		4		17	V
I_{CC}	Curcuit current	V_{CC}=5V, $R_L=\infty$		5	9	mA
		V_{CC}=15V, $R_L=\infty$		10	19	
V_{REF}	Reference voltage	V_{CC}=5V	2.6	3.33	4.0	V
		V_{CC}=15V	9	10	11	
V_{TH}	Threshold voltage			2/3V_{CC}		V
I_{TH}	Threshold current			0.03	0.2	μA
V_T	Trigger voltage			1/3V_{CC}		V
I_T	Trigger current			0.05	0.4	μA
V_R	Reset voltage		1.0	1.4	2.0	V
I_R	Reset current			0.05	0.2	μA
V_{OL}	Low output voltage	V_{CC}=5V, I_{SINK}=5mA		0.05	0.2	V
		V_{CC}=15V, I_{SINK}=10mA		0.05	0.2	
		V_{CC}=15V, I_{SINK}=50mA		0.2	0.5	
		V_{CC}=15V, I_{SINK}=100mA		1.0	2.0	
V_{OH}	High output voltage	V_{CC}=5V, I_{SOURSE}=100mA	2.8	3.3		V
		V_{CC}=15V, I_{SOUSE}=100mA	12.8	13.3		
f_{max}	Maximum operating frequency	$R_A=R_B$=2kΩ, C_A=200pF	100			kHz

TYPICAL CHARACTERISTTCS (T_a=25℃, unless otherwise noted)

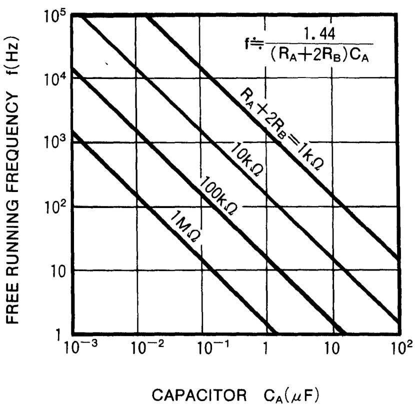
THERMAL DERATING
(MAXIMUM RATING)



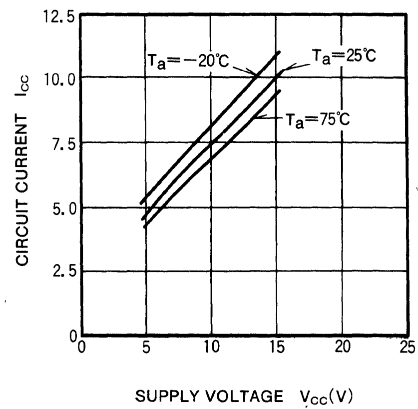
DELAY TIME VS. TIMING
RESISTOR, CAPACITANCE



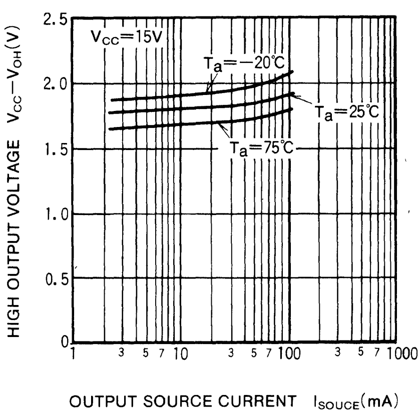
FREE RUNNING FREQUENCY VS. TIMING RESISTOR, CAPACITOR



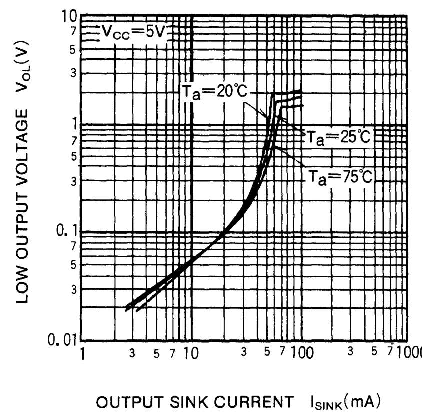
CIRCUIT CURRENT VS. SUPPLY VOLTAGE



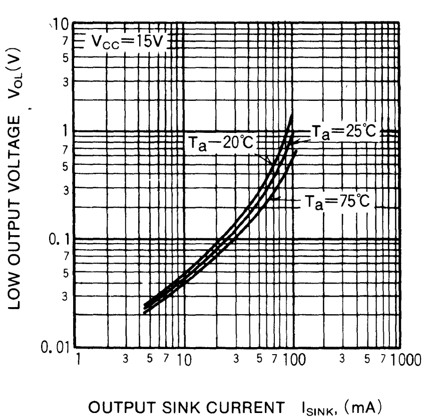
HIGH OUTPUT VOLTAGE VS. OUTPUT SOURCE CURRENT



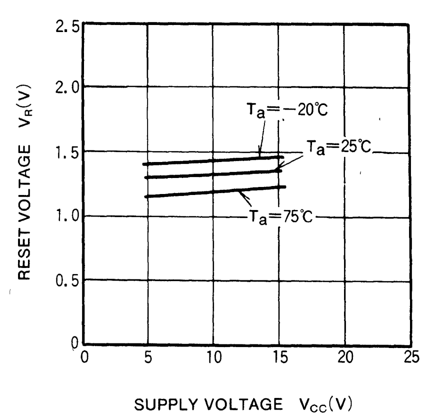
LOW OUTPUT VOLTAGE VS. OUTPUT SINK CURRENT



LOW OUTPUT VOLTAGE VS. OUTPUT SINK CURRENT



RESET VOLTAGE VS. SUPPLY VOLTAGE

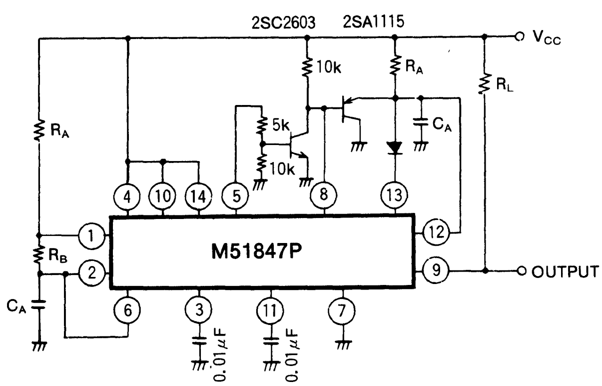


PIN DESCRIPTION

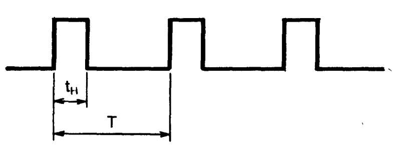
1. **Trigger pin (pin ⑥, ⑧)**
   When the voltage at the trigger pin is reduced to lower than $1/3V_{CC}$, timing operation is started. Once triggered, the voltage is not affected during operation by the trigger voltage.
2. **Output pin (pin ⑤, ⑨)**
   Logic output level is normally in the low state but is in the high state during timing operation. The output circuit is shaped like a totem-pole and withstands maximum load current of 200mA. The circuit can directly drive the TTL or DTL circuits.
3. **Reset pin (pin ④, ⑩)**
   Timing operation can be interrupted by applying the reset signal to a reset pin. (The voltage at this pin must be less than 1.4V.)
   If the reset signal is applied, the output is in the low state and the reset condition is maintained as long as the signal is applied. The output stays in the low state until the reset signal is removed and the set signal (trigger signal at a trigger pin) is applied. Connect this pin to V_{CC} if not used.
4. **Reference voltage pin (pin ③, ⑪)**
   The voltage at this pin is normally set at $2/3V_{CC}$. By applying reference voltage, delay time or oscillation frequency can be changed. The control signal for pulse-width modulation is applied through this pin. Connect a capacitor of 0.01 μF between this pin and GND as noise filter, if the pin not used.
5. **Threshold pin (pin ②, ⑫)**
   The delay time is determined by CR time constants connected to this pin. The delay time of a monostable multivibrator td is expressed by the equation $td \fallingdotseq 1.1 R_A C_A$.
6. **Discharge pin (pin①, ⑬)**
   The timing capacitor discharges at this pin. The discharge is enabled when a flip flop in the device is ON and the reset signal is applied. In a monostable multivibrator, the capacitor is connected to pin threshold pin.

APPLICATION EXAMPLE

DUTY CYCLE VARIABLE OSCILLATOR



OUTPUT WAVEFORM



t_H is variable by the R_A, having the T fixed

$$T = \frac{(R_A + 2R_B)C_A}{1.44}$$

$$t_H = -R'_A C'_A \ln \frac{\frac{V_{CC}}{3}}{V_{CC} - V_D}$$

(here, the V_D is a forward voltage of externally connected V_D.)

Precautions for use

1. Care must be taken not to connect the discharge pin (pin ①, ⑬) directly to V_{CC}. Such connection causes short circuit of V_{CC} and GND through a discharge transistor (built into the device) and may destroy the integrated circuit.
2. Connect the reset pin (pin ④, ⑩) to V_{CC}, if not used.
3. A capacitor connected to a recerence voltage pin (pin ③, ⑪) functions as the noise filter. Choose appropriate capacitance according to the noise induced.

M52051P

SINGLE TIMER

DESCRIPTION

The M52051P is a semiconductor integrated circuit designed to produce an accurate timing pulse and time delay. The delay time can be set from microseconds through minutes by an externally connected resistor and capacitor.

In an astable multivibrator, the maximum frequency is 1MHz.

The reset voltage is 1.4V typ. (T_a=25℃), and compatible with TTL level.

FEATURES

- Timing from microseconds through minutes
- Wide range of usage as monostable or astable multivibrators
- Maximum oscillation frequency 1MHz
- Reset voltage is compatible with TTL level
- Built-in supply voltage reset circuit for setting the output in the low state, when power is supplied

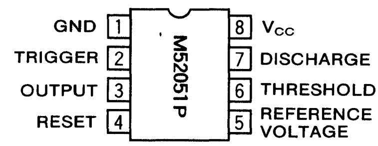
APPLICATION

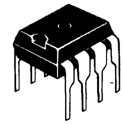
Monostable multivibrator, astable multivibrator, pulsewidth modulation.

RECOMMENDED OPERATING CONDITIONS

Supply voltage range .... 4.5~5.5V

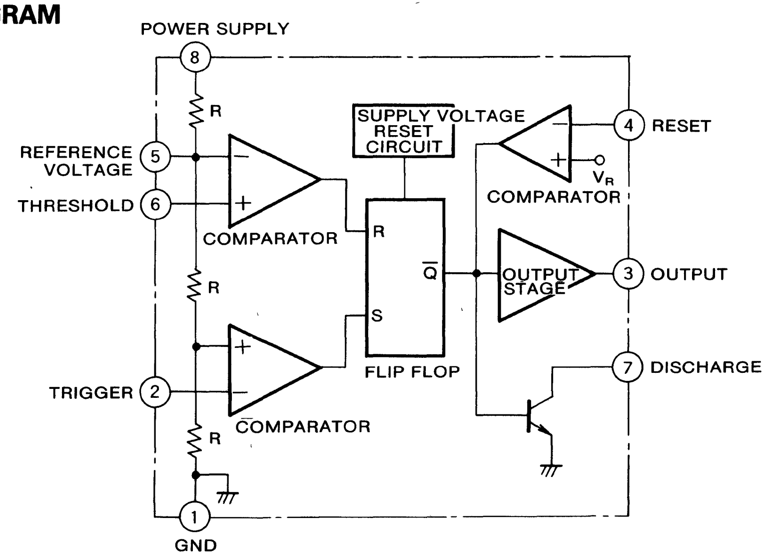
PIN CONFIGURATION (TOP VIEW)





8-pin molded plastic DIP

BLOCK DIAGRAM



MITSUBISHI ELECTRIC

ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

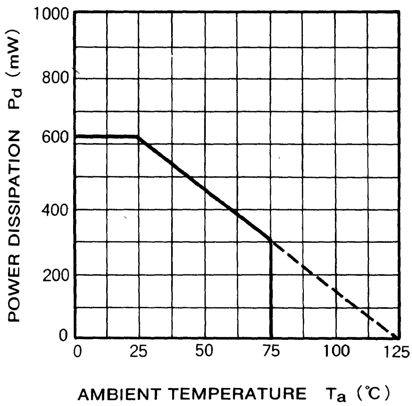
Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		5.5	V
I_O	Output current		10	mA
P_d	Power dissipation		625	mW
K_θ	Thermal derating	$T_a \geqq 25$℃	6.25	mW/℃
T_{opr}	Operating temperature		−20～+75	℃
T_{stg}	Storage temperature		−40～+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

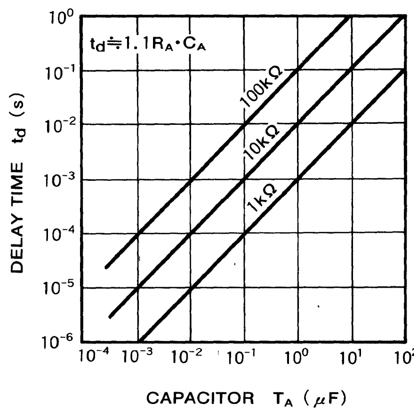
Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage		4.5		5.5	V
I_{CC}	Circuit current	V_{CC}=5V, $R_L=\infty$	6.0	11.0	16.0	mA
V_{REF}	Reference voltage	V_{CC}=5V	3.0	3.33	3.7	V
V_{TH}	Threshold voltage	V_{CC}=5V	3.0	3.33	3.7	V
I_{TH}	Threshold current			2.0	20	μA
V_T	Trigger voltage	V_{CC}=5V	1.4	1.67	2.0	V
I_T	Trigger current			4.0	40	μA
V_R	Reset voltage		1.0	1.4	2.0	V
I_R	Reset current			4.0	40	μA
V_{OL}	Low output voltage	V_{CC}=5V, I_{sink}=5mA		0.3	0.5	V
V_{OH}	High output voltage	V_{CC}=5V, I_{source}=10mA	2.2	2.7		V
f_{max}	Maximum operating frequency		1			MHz
R_A	Resistance range for timing setting	Monostable multivibrator	0.5		100	kΩ
R_A+2R_B	Resistance range for timing setting	Astable multivibrator	1		100	kΩ
C_A	Capacitance range for timing setting		3.3×10^{-4}		100	μF

TYPICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

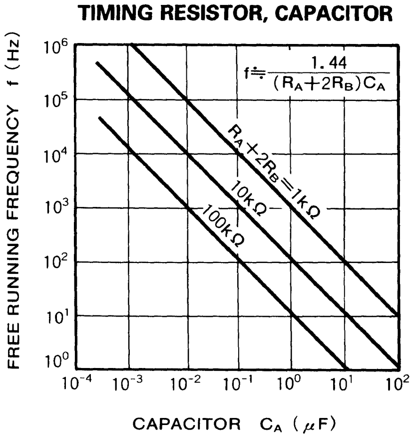
THERMAL DERATING (MAXIMUM RATING)



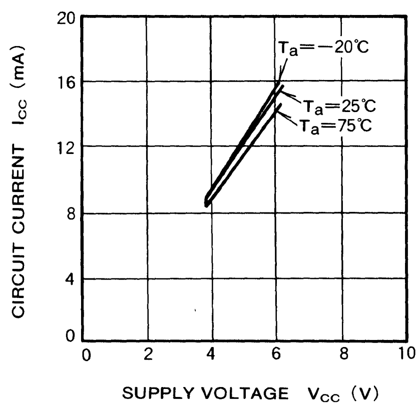
DELAY TIME VS. TIMING RESISTOR, CAPACITANCE



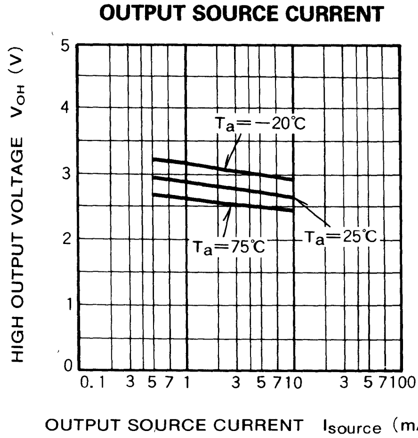
FREE RUNNING FREQUENCY VS. TIMING RESISTOR, CAPACITOR



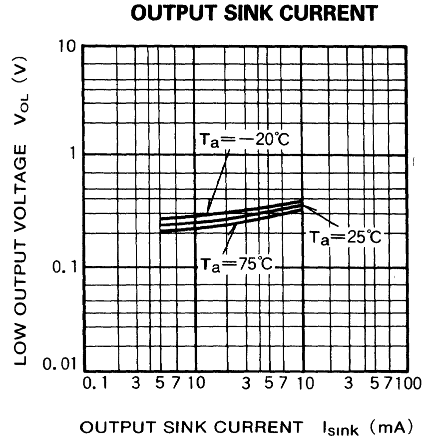
CIRCUIT CURRENT VS. SUPPLY VOLTAGE



HIGH OUTPUT VOLTAGE VS. OUTPUT SOURCE CURRENT



LOW OUTPUT VOLTAGE VS. OUTPUT SINK CURRENT



PIN DESCRIPTION

1. Trigger pin (Pin ②)
When the voltage at the trigger pin is reduced to lower than $1/3V_{CC}$, timing operation is started. Once triggered, the voltage is not affected during operation by the trigger voltage.

2. Output pin (Pin ③)
Logic output level is normally in the low state but is in the high state during timing operation. The output circuit is shaped like a totem-pole and withstands maximum load current of 10mA. The circuit can directly drive the TTL or DTL circuits.

3. Reset pin (Pin ④)
Timing operation can be interrupted by applying the reset signal to a reset pin. (The voltage at this pin must be less than 1.4V).
If the reset signal is applied, the output is in the low state and the reset condition is maintained as long as the signal is applied. The output stays in the low state until the reset signal is removed and the set signal (trigger signal at a trigger pin) is applied. Connect this pin to V_{CC} if not used.

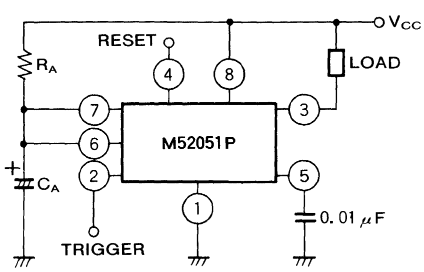
4. Reference voltage pin (pin ⑤)
The voltage at this pin is normally set at $2/3V_{CC}$. By applying reference voltage, delay time or oscillation frequency can be changed. The control signal for pulsewidth modulation is applied through this pin. Connect a capacitor of 0.01 μF between this pin and GND as the noise filter, if the pin is not used.

5. Threshold pin (Pin ⑥)
The delay time is determined by CR time constants connected to this pin. The delay time of a monostable multivibrator t_d is expressed by the equation $t_d \fallingdotseq 1.1R_AC_A$.

6. Discharge pin (Pin ⑦)
The timing capacitor discharges at this pin. The descharge is enabled when a flip flop in the device is ON and the reset signal is applied. In a monostable multivibrator, the capacitor is connected to Pin ⑥.

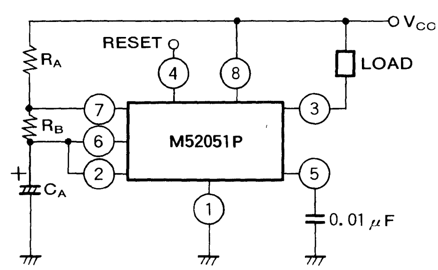
APPLICATION EXAMPLE

(1) Delay timer (monostable multivibrator)



DELAY TIME
$td \fallingdotseq 1.1R_AC_A$

(2) Pulse oscillator (astable multivibrator)



FREE RUNNING FREQUENCY
$f \fallingdotseq 1.44/(R_A+2R_B)C_A$
DUTY CYCLE
$D=R_B/(R_A+R_B)$

PRECAUTIONS FOR USE

1. Care must be taken not to connect the discharge pin (Pin ⑦) directly to V_{CC}. Such connection causes short circuit of V_{CC} and GND through a discharge transistor (built into the device) and may destroy the integrated circuit.
2. Connect the reset pin (Pin ④) to V_{CC}, if not used.
3. A capacitor connected to a reference voltage pin (Pin ⑤) functions as the noise filter. Choose appropriate capacitance according to the noise induced. The M51843P is recommended for use in an environment where the noise causes misoperation.

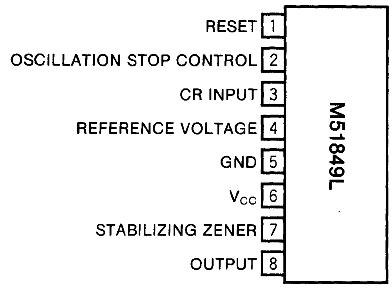
DESCRIPTION
The M51849L is a semiconductor integrated circuit designed for controller of long time delay, consisting of 11 stage divider by IIL. The time base period of oscillator is extended 1024 times, determing by the 11 stage divider by IIL, and the maximum output period is 50 hours.

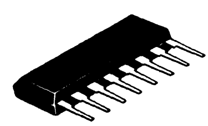
FEATURES
- Timing from 100ms through 50 hr
- High current output can sink 30mA(peak)
- Built-in stabilization zener
- Built-in power on reset

APPLICATION
- Precision timing, time delay generation, Ultra-low-frequency oscillator

RECOMMENDED OPERATING CONDITIONS
Supply voltage·········· $5V \sim V_Z$ (V_Z=pin ⑦ Zener voltage)
Rated supply voltage································· 6V±10%

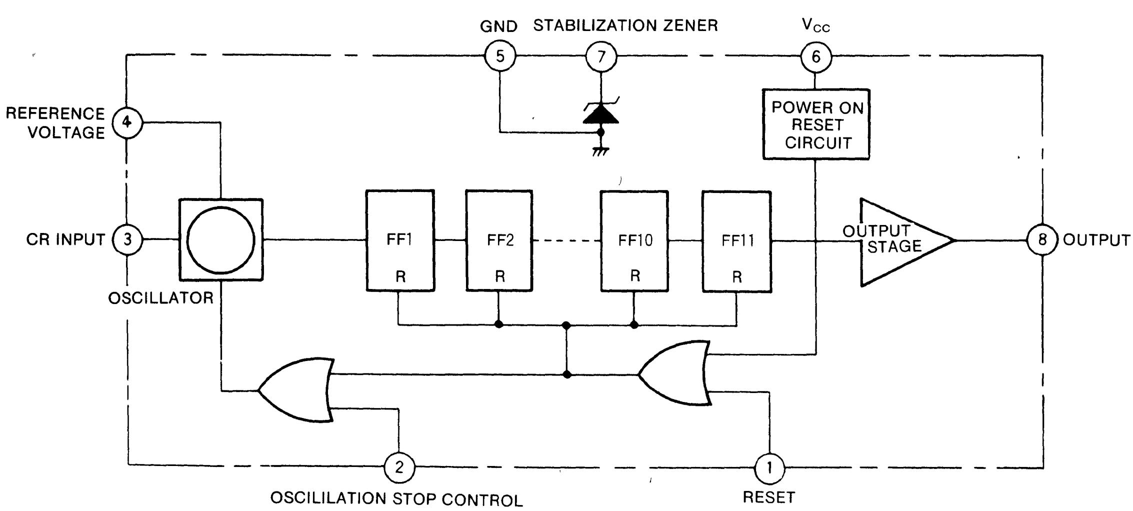
PIN CONFIGURATION (TOP VIEW)





8-pin molded plastic SIP

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless oterwise noted)

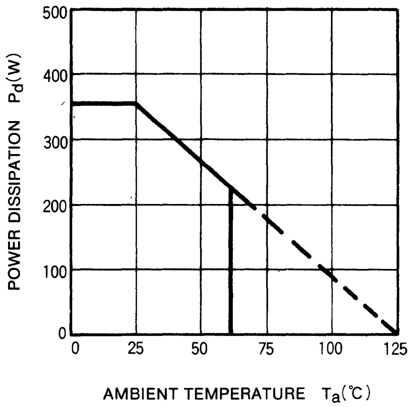
Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		7.0	V
I_Z	Zener current		20	mA
I_O	Output sink current		30	mA
P_d	Power dissipation		360	mW
K_θ	Thermal derating	$T_a \geqq 25$℃	3.6	mW/℃
Topr	Operating temperature		0～+60	℃
Tstg	Storage temperature		−40～+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=6V unless otherwise noted)

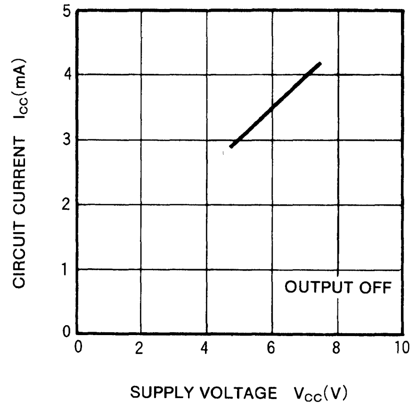
Symbol	Parameter	Test conditton	Limits			Unit
			Min	Typ	Max	
I_{CC}	Circuit current	V_{CC}=6.0V		3.5	6.0	mA
V_Z	Zener voltage	I_Z=1mA	6.0	6.4	6.8	V
V_R	Reset voltage			1.5	1.8	V
I_R	Reset current			0.1		mA
V_{OS}	Oscillation stop voltage			1.6	1.9	V
I_{OS}	Oscillation stop input current			0.1		mA
V_{OH}	High output voltage	I_{SOURSE}=10mA	4.0	4.5		V
V_{OL}	Low output voltage	I_{SINK}=10mA		0.2	0.6	V

TYPICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

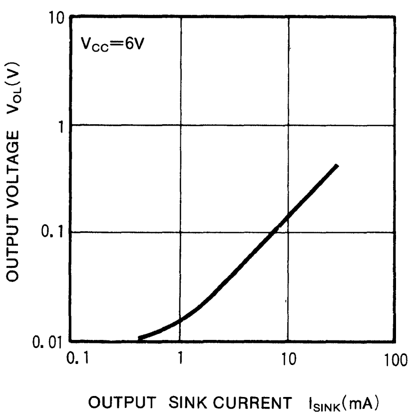
THERMAL DERATING
(MAXIMUM RATING)



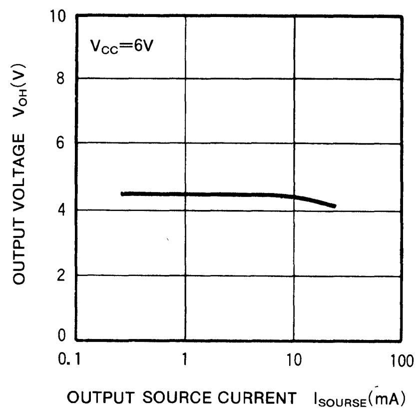
CIRCUIT CURRENT VS.
SUPPLY VOLTAGE



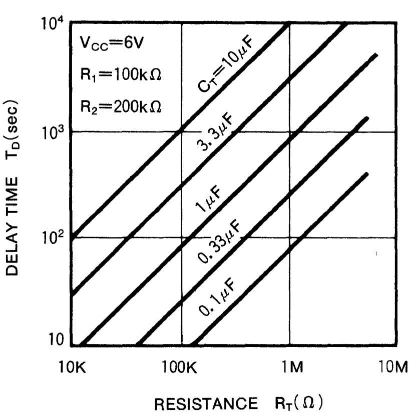
OUTPUT VOLTAGE VS.
OUTPUT SINK CURRENT



OUTPUT VOLTAGE VS.
OUTPUT SOURCE CURRENT



RESISTANCE VS. DELAY TIME



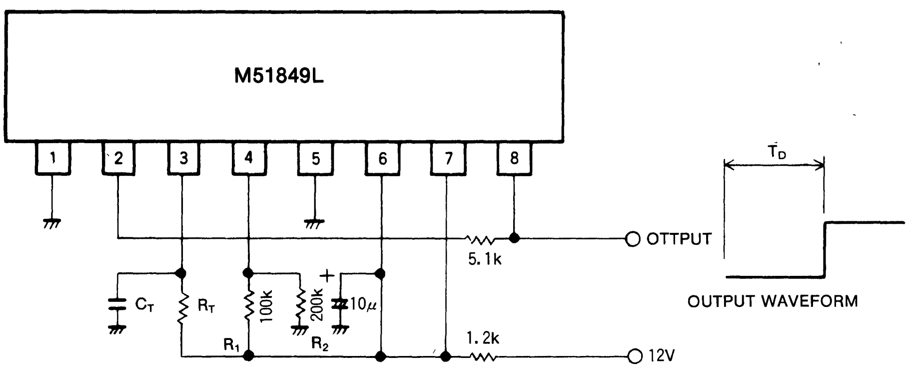
MITSUBISHI ELECTRIC

PIN DESCRIPTION

1. **Reset pin (pin ①)**
   This pin is used to stop counter operation. If the pin is in the high state, the counter is cleared and oscillation is stopped. Connect this pin to GND, if not used.
2. **Oscillation stop control pin (pin ②)**
   If the pin is in the high state, the oscillation stops. But the status of counter is not maintained, and therefore, if the pin is reset to the low state, timing operation is resumed. Connect the pin to GND, if not used.
3. **CR input pin (pin ③)**
   The capacitor C_T and resistor R_T are connected to this pin. The oscillation period is given in the following equation. The resistor R_T should be 1kΩ or above.
4. **Reference voltage pin (pin ④)**
   The highest voltage for the oscillation level is supplied at this pin. The voltage should be set at approximately 2/3 V_{CC} by a variable resistor or resistor division (R_1, R_2). The capacitor C_T is corrected by minutely adjusting this voltage by a variable resistor. The voltage can be set between 0.4V to 0.8V. The oscillator may not function if the voltage is outside this range.
5. **Stabilization zener pin (pin ⑦)**
   A zener diode of approximately 6.4V is connected between this pin and pin ⑤ (GND). Set the resistance so that the zener current is 5mA.
6. **Output pin (pin ⑧)**
   The output voltage changes from the low state to the high state when the oscillation period is 1024 times of T_0, and the voltage returns from the high state to the low state when the period is 2048 times for one cycle. The voltage can sink or source up to 10mA(typ.). Care must be taken in power supply variation in the integrated circuit when the output load current is large.

APPLICATION EXAMPLE

Monostable operation



The delay time in the above application example is given by :

$T_D \fallingdotseq 900 C_T \cdot R_T$(sec)

The timing resistor R_T should be 1kΩ or above

Precautions for use

1. CR input pin (pin ③) must not be directly connected to V_{CC} to avoid destruction of the integrated circuit .
2. The voltage at the reference voltage pin (pin ④) should be set between 0.4V to 0.8V. The oscillator may not function if the voltage is outside this range.
3. This integrated operates at ultra-low supply voltage. Therefore it is very sensitive to external noise and is subject to misoperation.
   A capacitor must be connected near the V_{CC} pin (pin ⑥) to avoid noise.
4. The specifications are subject to change.

M58479P/M58482P

CMOS COUNTER/TIMERS

DESCRIPTION

The M58479P and M58482P are electronic timer ICs developed by aluminum-gate CMOS technology. Use of these ICs makes possible timer devices without mechanical elements, which have reduced power dissipation, superior reliability, and higher noise immunity. The M58479P is specifically designed for high noise immunity, while the M58482P particularly features low power dissipation.

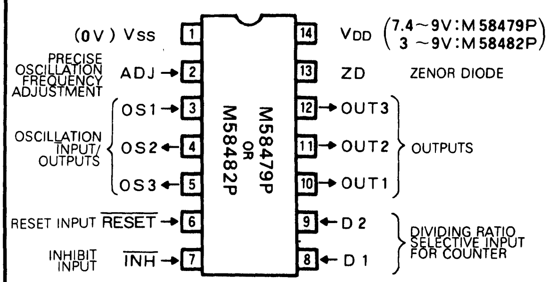
FEATURES

- Low power dissipation
  M58479P: 2mW (typ.), 7.5mW (max.)
  M58482P: 200μW (typ.), 750μW (max.)
- Superior noise immunity
- Single power supply with a zenor diode
- Internal RC oscillator
- Precise oscillation frequency regulating capability
- Extremely broad time-delay range (50ms~4800h)
- Time-delay settable to 10, 60, or 600 times fundamental time (1024 times oscillation period)
- M58479P has automatic-reset function during power engagement
- Built-in reset and inhibit functions
- Residual time display possible by adding Mitsubishi's M53290P and M53242P IC

APPLICATION

- Electronic timer or counter with broad time-delay range (50ms~4800h)

PIN CONFIGURATION (TOP VIEW)



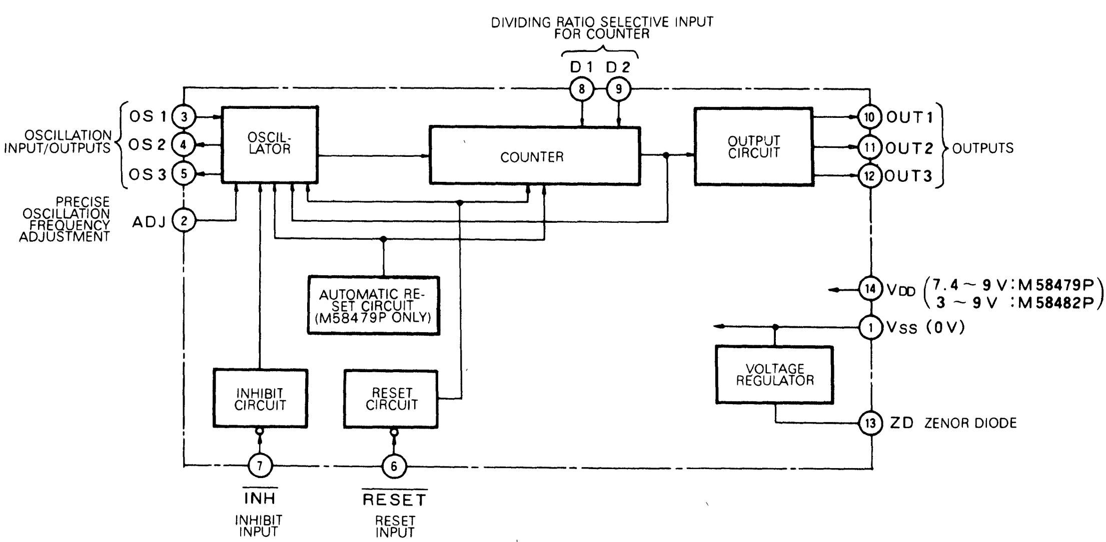
Outline 14P4

FUNCTIONAL DESCRIPTION

These devices make possible extremely long clock performance, by counting pulse signals from the RC oscillator. It has precise oscillation frequency adjustment, automatic-reset, reset, and inhibit functions.

There are three outputs. When the time duration is up, OUT1 turns from low to high and OUT2 from high to low. OUT3 can be connected to M53290P and M53242P TTLs for residual time display.

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Conditions	Ratings	Unit
V_{DD}	Supply voltage	With respect to V_{SS}	−0.3～9.5	V
V_I	Input voltage		$V_{SS} \leqq V_I \leqq V_{DD}$	V
Pd	Maximum power dissipation	Ta＝25°C	250	mW
Topr	Operating free-air temperature range		−30～75	°C
Tstg	Storage temperature range		−40～125	°C

RECOMMENDED OPERATING CONDITIONS (Ta＝−30～75°C, unless otherwise noted)

Symbol	Parameter		Limits			Unit
			Min	Typ	Max	
V_{DD}	Supply voltage	M58479P	7.4		9	V
		M58482P	3		9	V
I_{ZD}	Zenor current				10	mA
R_{FC}	Feedback resistance		0.005		10	MΩ
C_{FC}	Oscillation capacitance		0.001		1	μF
R_{FC}	Resistance for fine-adjustment of oscillation frequency		0		100	kΩ
V_{IH}	High-level input voltage, $\overline{RESET}$, $\overline{INH}$, D_1, D_2		0.7×V_{DD}	V_{DD}	V_{DD}	V
V_{IL}	Low-level input voltage, $\overline{RESET}$, $\overline{INH}$, D_1, D_2		0	0	0.3×V_{DD}	V

ELECTRICAL CHARACTERISTICS (Ta＝25°C, unless otherwise noted)

Symbol	Parameter		Test conditions	Limits			Unit
				Min	Typ	Max	
V_{ZD}	Zenor voltage		I_{ZD}＝2mA	7.4	8.2	9	V
			I_{ZD}＝10mA	7.5	8.2	9	V
I_{DD}	Supply current	M58479P	V_{DD}＝7.5V, C_{FC}＝0.01μF, R_{FC}＝1MΩ R_{ADJ}＝0Ω, Input/output open		0.25	1	mA
		M58482P	V_{DD}＝7.5V, C_{FC}＝0.01μF, R_{FC}＝1MΩ R_{ADJ}＝0Ω, Input/output open		25	100	μA
V_{RE}	Supply voltage at the time of automatic-reset release	M58479P		3 1		5.4	V
V_{TR}	Transition voltage of first inverter in the oscillator		V_{DD}＝7 5V, R_{ADJ}＝0Ω	2 9		4.8	V
R_I	Pull-up resistance RESET INH D1 D2 inputs	M58479P		10	20	30	kΩ
		M58482P		25	50	75	kΩ
I_{OH}	High-level output current OUT1 and OUT2 outputs		V_{DD}＝7.5V, V_O＝0V	−5	−10		mA
I_{OL}	Low-level output current OUT1 OUT2 and OUT3 outputs		V_{DD}＝7 5V, V_O＝7.5V	10	20		mA
I_{OZH}	Off-state output current OUT3 output		V_{DD}＝7.5V, V_O＝7.5V			1	μA
I_{OL}	Low-level output current OUT1 OUT2 and OUT3 outputs		V_{DD}＝7.5V, V_O＝0.4V	1.6			mA
I_{OL}	Low-level output current OUT1 OUT2 and OUT3 outputs	M58482P	V_{DD}＝4 5V, V_O＝0 4V	1.6			mA
V_{OL}	Low level output voltage OUT1 OUT2 and OUT3 outputs		V_{DD}＝7.5V			0.1	V

FUNCTIONAL DESCRIPTION

Voltage Regulator

A zenor diode is on-chip, making it easy to obtain a constant voltage regulator circuit. Since the zenor diode terminal (ZD) is independent of the power terminal (V_{DD}), it can be used as a constant voltage power supply for the total system.

Oscillator

Oscillation is obtained by connecting an external resistor (feedback resistor R_{FC}) between terminals OS1 and OS3 and an external capacitor (oscillation capacitor C_{FC}) between terminals OS1 and OS2. The values of the external resistor and capacitor can then be changed to vary the oscillation period and thus change the time delay. Oscillation period T_0 is obtained by the following equation:

$$T_0 = -R_{FC} \cdot C_{FC} \left\{ \ln \frac{V_{TR}}{V_{DD}+V_{BE}} + \ln \frac{V_{DD}-V_{TR}}{V_{DD}+V_{BE}} \right\} \cdots (1)$$

Where,

R_{FC} : Resistance of external resistor

C_{FC} : Capacitance of external capacitor

V_{TR} : Transition voltage of the first inverter in the oscillation circuit

V_{DD} : Supply voltage

V_{BE} : Forward rising voltage of the diode in terminal OS1 (0.3~0.7V)

Automatic-Reset Function

The M58479P has a power-supply voltage-detection circuit on-chip, so that the counter is automatically reset by the rising edge of the supply voltage when power is turned on. The reset is then released, making the oscillator ready to function and the counter ready to start counting.

The M58482P can also be provided with the same automatic-reset function by connecting capacitor between terminals $\overline{\text{RESET}}$ and V_{SS}.

Reset Function

When the $\overline{\text{RESET}}$ input turns low (V_{SS}), oscillation of the oscillator can be stopped and the counter reset.

Inhibit Function

When terminal $\overline{\text{INH}}$ turns low (V_{SS}) while the timer is in action, the oscillation halts. When input $\overline{\text{INH}}$ is turned high or returned to OPEN afterwards, it starts to count residual time.

Counter

This counter consists of an 11-stage 1/2 frequency divider, a 2-stage 1/10 frequency divider and a 1-stage 1/6 frequency divider. As shown in the table below, timer duration can be changed by varying the number of pulses counted according to the combination of the input levels on terminals D1 and D2.

D1	D2	Number of pulses counted	Time delay	Typical time delay applied
H	H	1024	T_1	1 min
L	H	1024×10	$T_1 \times 10$	10 min
H	L	$1024 \times 10 \times 6$	$T_1 \times 10 \times 6$	1h
L	L	$1024 \times 10 \times 6 \times 10$	$T_1 \times 10 \times 6 \times 10$	10h

Where, $T_1 = T_0 \times 1024$

T_0 is the value obtained from equation (1)

Output Circuits

The chips have three outputs: OUT1 changes from low to high and OUT2 from high to low as soon as the time duration is up. Either can be used to drive a transistor by connecting it to the transistor base. OUT1 can drive a thyristor when connected to the thyristor gate.

OUT3 is an open-drain output with period 1/8 of the time delay, and can be used to drive a TTL in a separate (5V) power supply line. Thus, if a M53290P counter and a M53242P binary-to-decimal decoder are connected to OUT3, with their output connected to a light-emitting diode, residual time will be displayed on the LED. When not in use, OUT3 should be connected to V_{SS}.

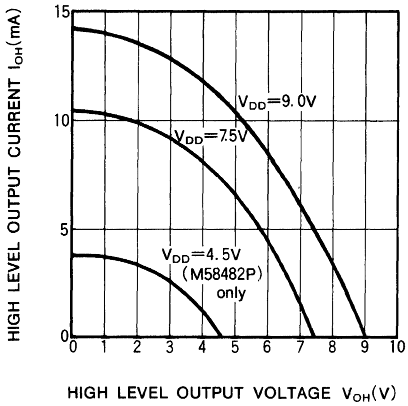
Fine Adjustment of Oscillation Period

A variable resistor can be connected between terminals ADJ and V_{SS}, enabling precise adjustment of the period of the oscillator. However, when not used for fine adjustment, ADJ should be connected to V_{SS}.

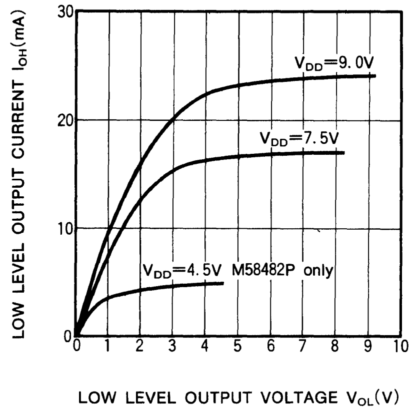
TYPICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

See "9. ELECTRICAL CHARACTERISTICS" for absolute values

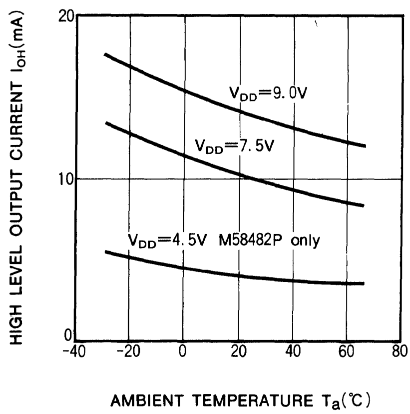
$I_{OH}-V_{OH}$ (OUT 1, OUT 2)



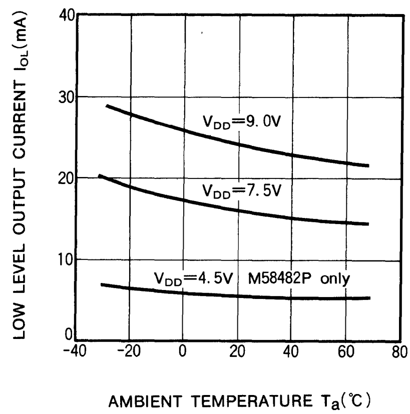
$I_{OH}-V_{OL}$ (OUT 1, OUT 2, OUT 3)



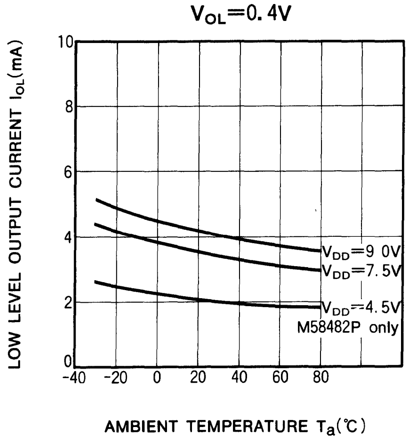
$I_{OH}-T_a$ (OUT 1, OUT 2) $V_{OH}=0$ V



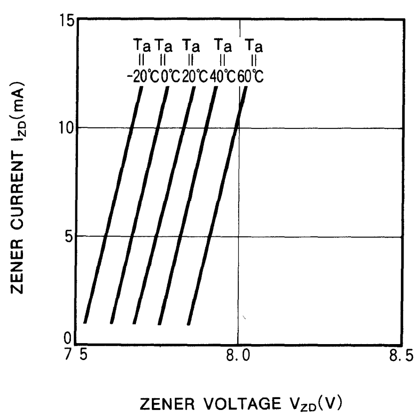
$I_{OL}-T_a$ (OUT 1, OUT 2, OUT 3) $V_{OL}=V_{DD}$



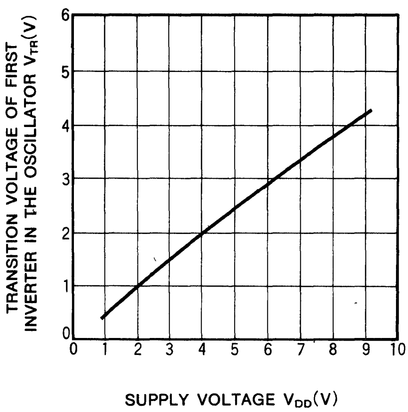
$I_{OL}-T_a$ (OUT 1, OUT 2, OUT 3) $V_{OL}=0.4$V



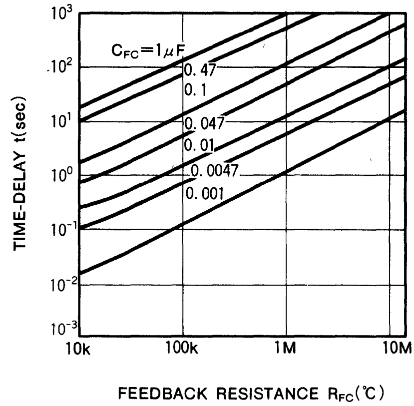
I_{ZD} V_{ZD}



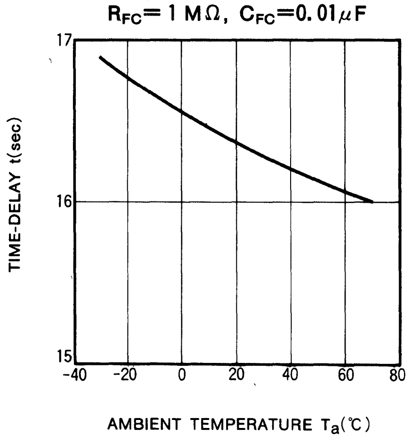
V_{TR}—V_{DD}



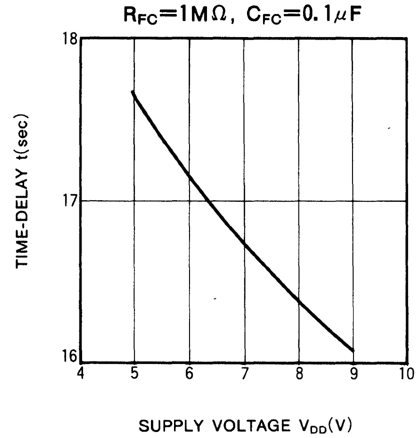
t=R_{FC}
V_{DD}=7.5V, ADJ: SHORTED WITH V_{SS},
D1~D2: OPEN OR "H",
C_{FC}=0.001~1μF



t—Ta
V_{DD}=7.5V ADJ: SHORTED WITH V_{SS},
D1, D2: OPEN OR "H",
R_{FC}= 1 MΩ, C_{FC}=0.01μF



t—V_{DD}
ADJ: SHORTED WITH V_{SS},
D1, D2:OPEN OR "H"
R_{FC}=1MΩ, C_{FC}=0.1μF



OSCILLATION FREQUENCY

The oscillation period of M58479P and M58482P are formularized as follows.

$$T_O=-R_{FC}C_{FC}\left\{\ell n\frac{V_{TR}}{V_{DD}+V_{BE}}+\ell n\frac{V_{DD}-V_{TR}}{V_{DD}+V_{BE}}\right\} \quad (1)$$

The value in { } of (1) takes the maximum value at $V_{TR}=V_{DD}/2$. For example, under the condition of $V_{DD}=7.5V$, the relation of the V_{TR} and the value in { } is shown in Figure 1.

Regarding the Figure 1, the value in { } of (1) at $V_{DD}=7.5V$ is, in a range of $V_{BE}=0.3\sim0.7V$ and $V_{TR}=2.9\sim4.8V$, $-1.647\sim-1.464$.

The oscillation period can be figured out theoretically by the (1) formula; however, as 'the oscillation is executed by the charge and discharge of R_{FC}, C_{FC}, the correction parameter R_{FC} by the output impedence of OS 2 and OS 3 is added in the (1) formula as:

$$T_O=-(R_{FC}+\Delta R_{FC})C_{FC}\left\{\ell n\frac{V_{TR}}{V_{DD}+V_{BE}}+\ell n\frac{V_{DD}-V_{TR}}{V_{DD}+V_{BE}}\right\} \quad (2)$$

At this time, the value of the correction parameter ΔR_{FC} will be around $5.5\pm2.5k\Omega$.

For the circuit designing, set the oscillation constant regarding to the above matters.

TIMER ADJUSTMENT

Following is the method of adjusting time-delay keeping the external resistance R_{FC} and capacitor C_{FC} fixed.

(1) The method to verify R_{ADJ} value with inserting the parallelly connected R_{ADJ} and C_{ADJ} into ADJ-VSS

As described already, the oscillation period To is calculated with (1) formula, as the relation of V_{TR} and the minimum value when $V_{TR}=V_{DD}/2$. This means the To can be varied by changing the V_{TR} value. This method is performed by adjusting the time-delay by the V_{TR}.

The ADJ is connected to a N-Channel-FET source of the first inverter of oscillator as Figure 3 illustrates. When the parallelly connected resistance R_{ADJ} and capacitance C_{ADJ} are inserted between ADJ and V_{SS} and the R_{ADJ} changes its value, the voltage of the ADJ varies by the current in the R_{ADJ}, and this results the change of V_{TR}.

As the R_{ADJ} value gets larger, the value of the V_{TR} is increased from that at $R_{ADJ}=0\Omega$. The value of V_{TR} at $R_{ADJ}=0\Omega$ is in the range of $2.9\sim4.8V$ ($V_{DD}=7.5V$). Therefore, as Figure 2 indicates, the variation way and the variation rate of the oscillation period To when the resistance R_{ADJ} gets larger are found according to the V_{TR} value at $R_{ADJ}=0\Omega$ and are not constant.

The capacitance C_{ADJ} to be parallelly inserted into the resistance R_{ADJ} has a function of making a variation rate of the To toward R_{ADJ} large.

On the resistance R_{ADJ} and the capacitance C_{ADJ}, please follow the ranges below.

$R_{ADJ}=0\sim100k\Omega$

$C_{ADJ}=100\sim1000pF$

When the ADJ is not used for the oscillation period adjustment, short to the V_{SS}.

Fig. 1. V_{TR} VS $\ell n\frac{V_{TR}}{V_{DD}+V_{BE}}+\ell n\frac{V_{DD}-V_{TR}}{V_{DD}+V_{BE}}$

TRANSITION VOLTAGE OF FIRST INVERTER IN THE OSCILLATOR

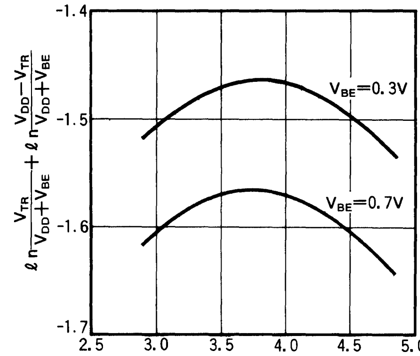


Fig. 2. Oscillation period (T_O) VS Transition Voltage (V_{TR})

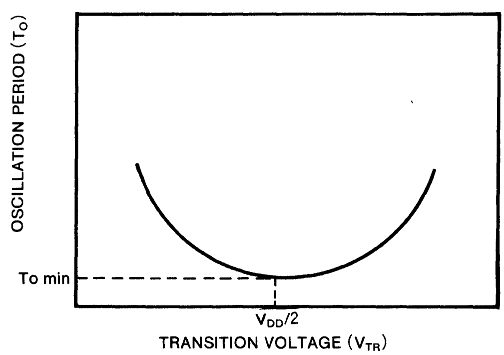
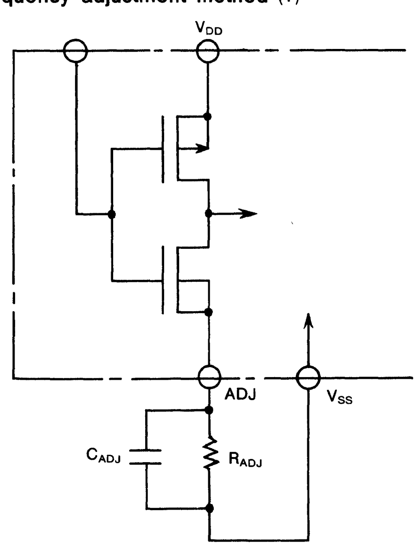


Fig.3 External connection diagram of oscillation frequency adjustment method (1)



(2) The method to verify resistance R_B value with inserting the resistance R_B and capacitance C_B connected in series between OS 1 and OS 2.

The oscillation period To is found by the same method as the (1) formula in principle, but a little more complicated

In principle, the variation way, and the variation rate of the oscillation period To with the resistance R_B are constant, and not be different by process parameter (V_{TR} etc).

Figure 4 illustrates the external connection diagram of resistances R_{FC}, R_B and capacitance C_{FC}, C_B. In addition, the Figure 5 shows the relation of the time-delay T ($=T_O$ x 1024) with R_B at $C_{FC}=C_B$, $R_{FC}=1$ MΩ, and the time-delay variation rate ΔT at $R_B=250$k Ω. As shown in Figure 6, the To takes the maximum value near $R_B=250$kΩ according to $C_{FC}=C_B=10^3$, 10^4, 10^5pF.

The change of the time-delay T with the resistance R_{FC} keeping the R_B constant will take poor linearity as the value of R_B increases. Therefore, try to keep the resistance R_B in a range of 0 ~150kΩ.

For that, take the $R_B=50$kΩ first and change its value in the range of 0 ~150kΩ to adjust the time-delay at the maximum value of R_{FC}, so the adjustment of ±7% becomes possible.

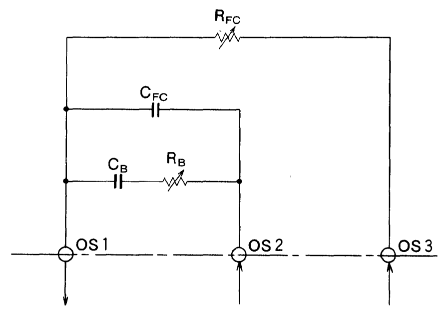


Fig. 4. External connection diagram of oscillation frequency adjustment method (2)

Fig. 5. (a) R_B—T (Method 2)
$C_{FC}=C_B=10^3$pF
$R_{FC}=1$MΩ
ADJ is shorted with V_{SS}

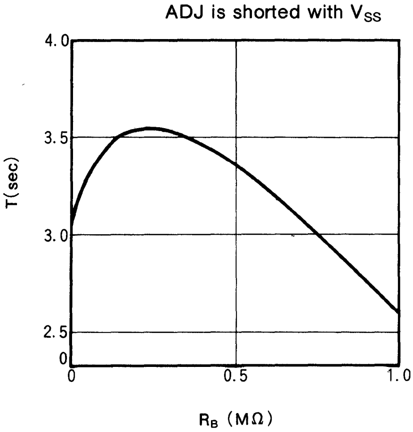


Fig. 5. (b) R_B—T (Method 2)
$C_{FC}=C_B=10^4$pF
$R_{FC}=1$ MΩ
ADJ is shorted with V_{SS}

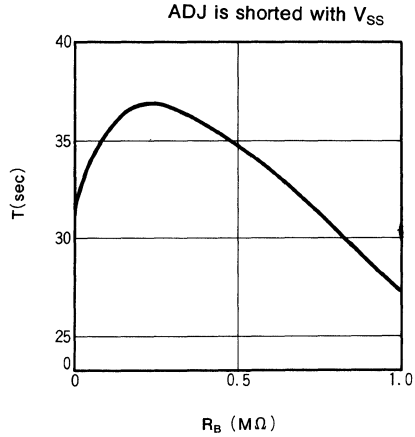


Fig. 5. (c) R_B—T (Method 2)
$O_{FC}=C_H=10^5$pF
$R_{FC}=1M\Omega$
ADJ is shorted with V_{SS}

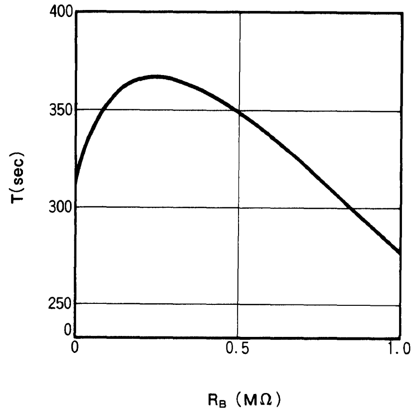
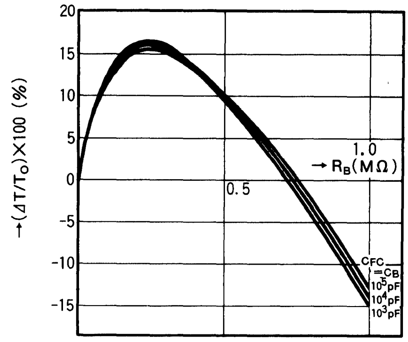


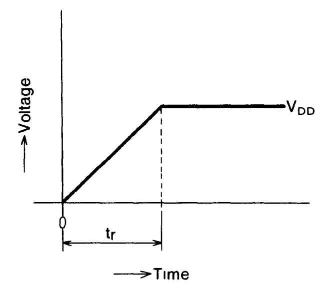
Fig. 6. R_B—$(\Delta T/T_O)\times100$(Method 2)
$R_{FC}=1M\Omega$
$\Delta T=T-T_O$
$T_O=T(Rb-0\Omega)$



POWER-ON RESET FUNCTION

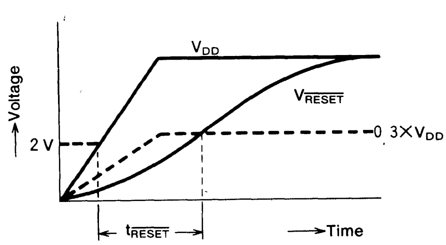
(1) M58479P

The power-on reset function will start when the power is on since the M58479P builts the supply voltage detection circuit in it; however, it is necessary to keep the rising time of power (tr) more than 1 ms as shown below.

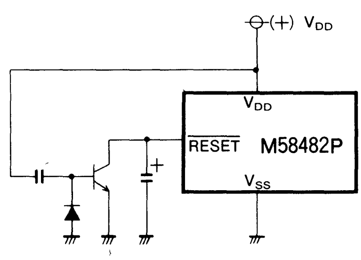


(2) M58482P

The power-on reset function will start by inserting the capacitance between the $\overline{\text{RESET}}$ and V_{SS} when the power is on as same as the M58479P. In order to have an accurate performance on the power-on reset function, keep $t_{\overline{RESET}}$ over 1msec on the condition of $V_{\overline{RESET}} \leqq 0.3 \times V_{DD}$ when V_{DD} is over 2 V, as illustrated below.

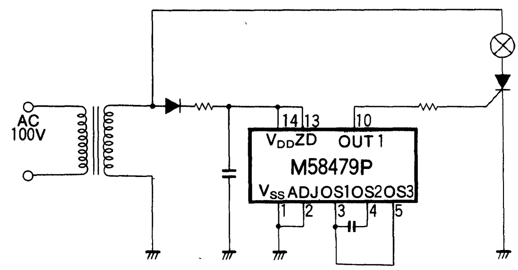


In case the power is on again after it is off and the voltage of $\overline{\text{RESET}}$ $V_{\overline{RESET}}$ is not perfectly down, the $t_{\overline{RESET}}$ must be also kept in over 1msec, which was mentioned in the above diagram. When the prescribed condition is not satisfied, add the circuit illustrated below to the $\overline{\text{RESET}}$and make the power-on reset function accurately. In this case, make sure to select an external capacitance to satisfy the $V_{\overline{RESET}} \geqq$ 1 msec.

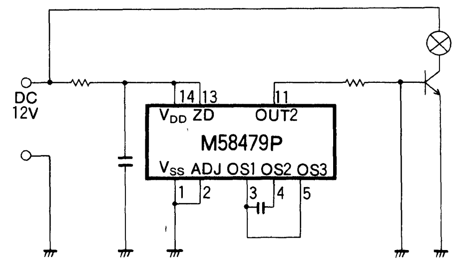


APPLICATION CIRCUITS

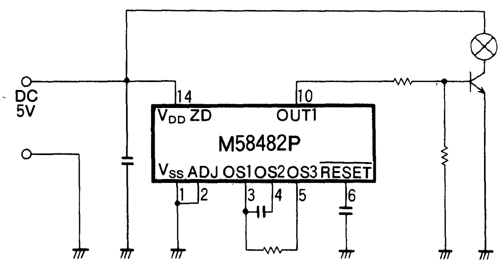
(1) Use of AC supply



(2) Use of DC supply



(3) Use of DC supply (low supply voltage)

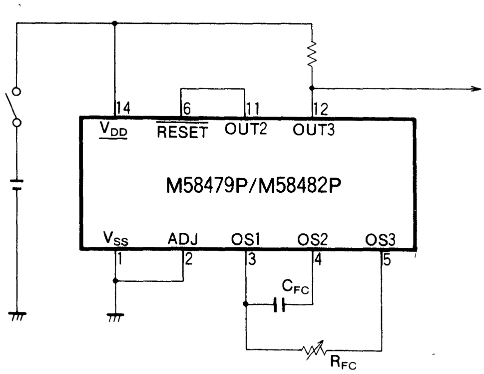


Both M58479P and M58483P build zenor diodes in them so that they can adopt AC supply (100V), DC supply (12V) according to external circuits.

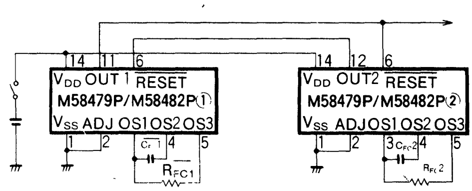
If the supply voltage is relatively high, when a power-on reset is required without an external circuit, employ the M58479P.

On the other hand, if a low supply voltage or low power dissipation is required, or if a power supply with a heavy fluctuation on lower voltage is used, employ the M58482P (M58479P may have a reset when V_{DD} is below 5.4V).

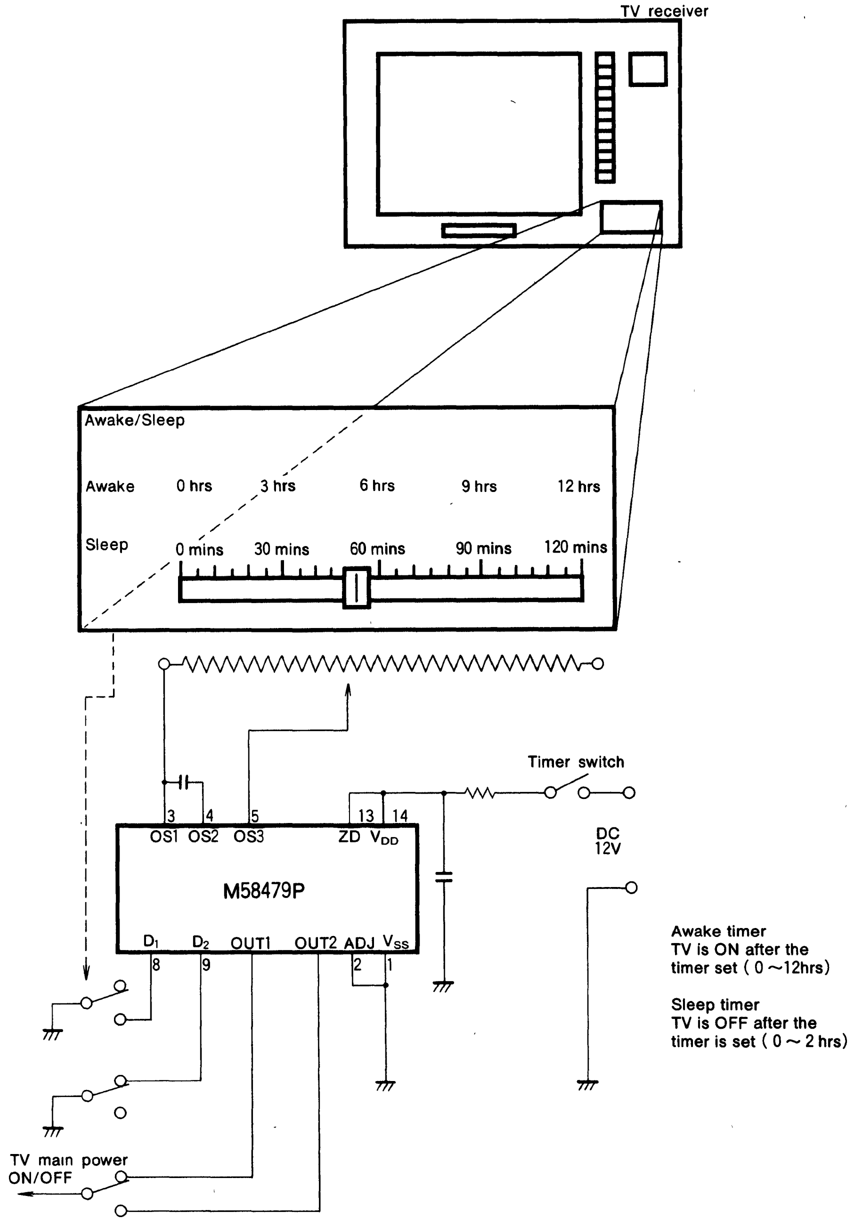
(4) While power is being on,
A pulse of 50% duty of which period is defined by R_{FC} and C_{FC}, is output from OUT 3.



(5) While power is being on,
a (duty changeable) pulse of which a "L" period is defined by R_{FC1}, C_{FC1}, and a "H" period is by R_{FC2}, C_{FC2}, is output from OUT 1 of M58479P/M58482P①.



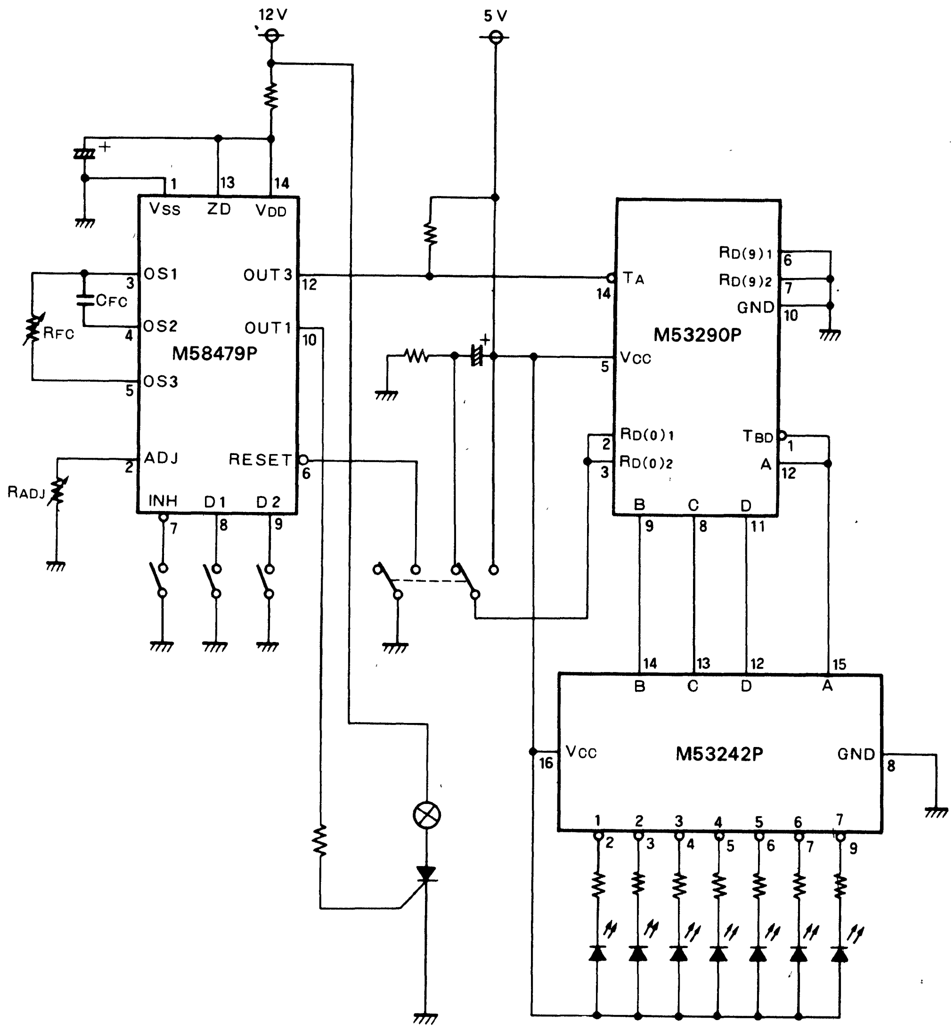
(6) An example of awake/sleep timer



Only one M58479P/M58482P is needed to have one switchover for awake/sleep timer

The application above is just a one example and the M58479P/M58482P can be widely used for home entertainment and industry.

(8) Circuit to display a timer in process



DESCRIPTION

The M51845L is a semicoducor integrated circuit designed for controller of long time delay, consisting of 11 stage divider by IIL. The time base period of oscillator is extended by 1024 times, determined by the the 11 stage divider by IIL, and the maximum output period is 50 hours.

FEATURES

- Timing from 100ms through 50 hr
- Timing can be set by one resistor and capacitor
- Built-in IIL divider with low power dissipation
- Built-in stabilization zener
- Built-in power on reset
- Direct drive of TTL possible

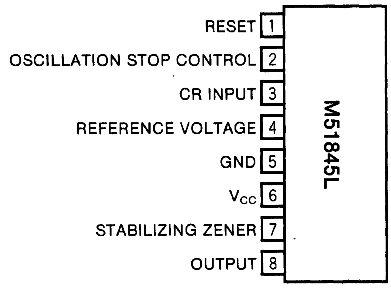
APPLICATION

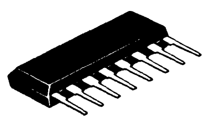
- Precision timer for consumer and home-use equipments, time delay generation for measuring instruments, Ultra-low-frequency oscillator

RECOMMENDED OPERATNG CONDITIONS

Supply voltage range
.... 4.5V~V_Z(V_Z=pin⑦ Zener voltage)
Rated supply voltage··· 5V±10%(No zener diode used)
9V, 12V(Stabilization zener diode used)

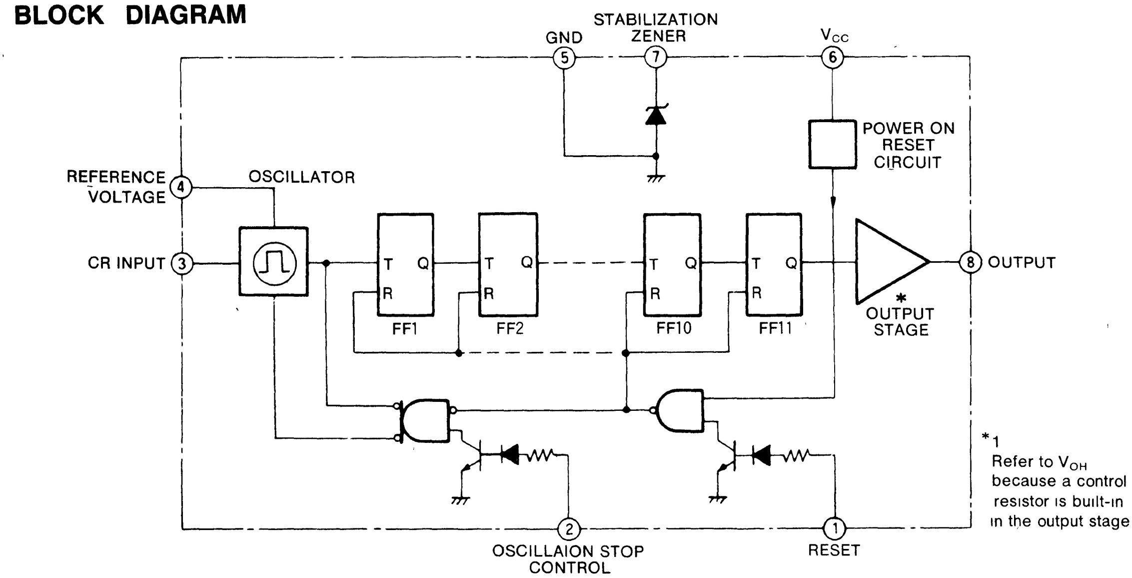
PIN CONFIGURATION





8-pin molded plastic SIP

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
$V_{CC⑥}$	Supply voltage		6.5	V
I_Z	Zener current		20	mA
I_O	Output sink current		15	mA
P_d	Power dissipation		360	mW
K_θ	Thermal derating	$T_a \geq 25$℃	3.6	mW/℃
Topr	Operating temperature		0～+60	℃
Tstr	Storage temperature		−40～+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=5V, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
$I_{CC⑥}$	Circuit current at pin⑥	No load t_a pin⑧		6.5	9.0	mA
V_Z	Zener voltage	I_Z=1mA	5.3	5.8	6.3	V
$I_{IH①}$	Input current at pin①	Pin① voltage 1=3V		0.8	2.3	mA
$I_{IL①}$		Pin① voltage 1=0.4V			1.0	μA
$I_{IH②}$	Input current at pin②	Pin② voltage 2=3V		0.8	2.3	mA
$I_{IL②}$		Pin② voltage 2=0.4V			1.0	μA
V_{OH}	Output voltage	I_{SOURCE}=2mA	2.0	2.65		V
V_{OL}		I_{SINK}=5mA		0.1	0.4	V
f_{max}	Maximum oscillation frequency	CR oscillation part	10	100		kHz

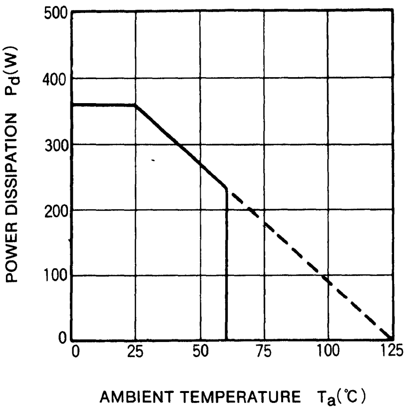
FUNCTION TABLE

Input conditions		Operating and output conditions		
RESET	OSCILLATION STOP CONTROL	OSCILLATOR	11 STAGE DIVIDER	OUTPUT
H	H	STOP	CLEAR (LOW LEVEL)	L
	L			
L	H	STOP	MAINTAIN PREVIOUS CONDITION	MAINTAIN PREVIOUS CONDITION
	L	OSCILLATION	COUNT	COUNT

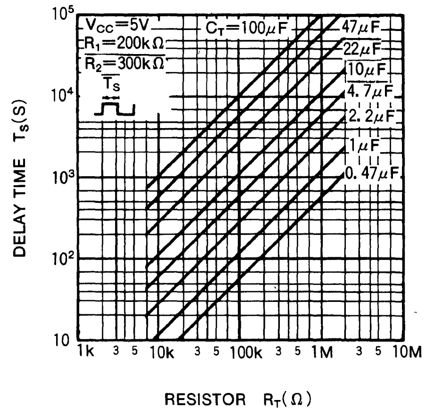
H≧1.4V, L≦0.4V

TYPICAL CHACTERICS (Ta=25℃, unless otherwise noted)

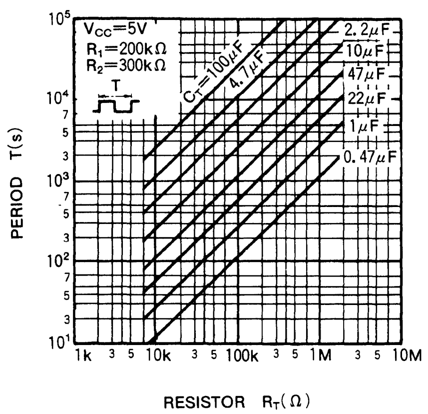
THERMAL DERATING (MAXIMUM RATING)



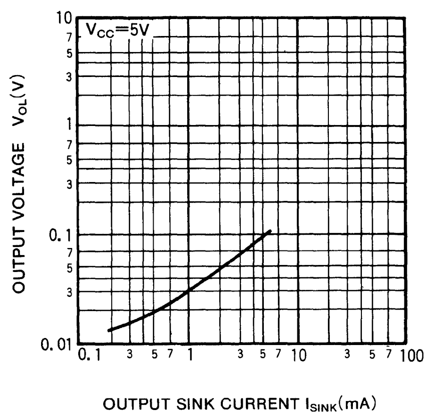
RESISTOR VS. DELAY TIME



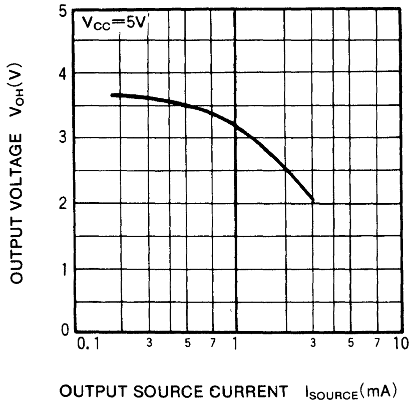
RESISTOR VS. PERIOD



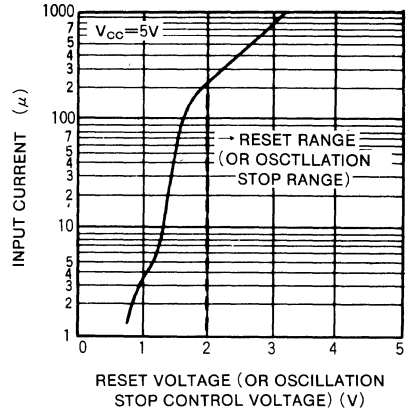
OUTPUT VOLTAGE VS. OUTPUT SINK CURRENT



OUTPUT VOTAGE VS. OUTPUT SOURCE CURRENT



INPUT CURRENT VS. RESET VOLAGE (OR OSCIIATION STOP CONTROL VOLTAGE CHARACTERISTICS)



PIN DESCRIPTION

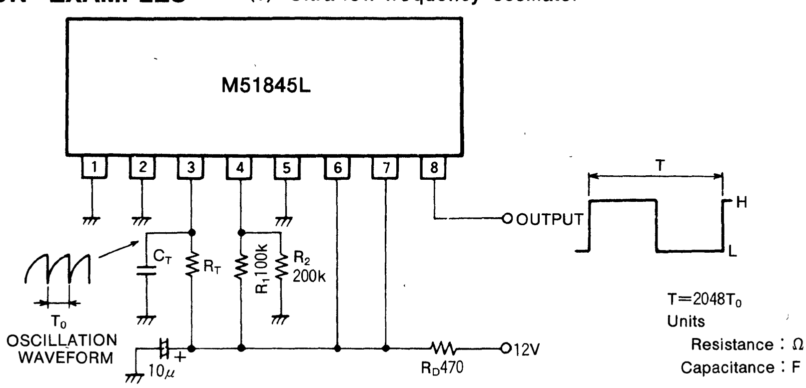
1. **Reset pin (pin ①)**
   This pin is used to stop counter operation. If the pin is in the high state, the counter is cleared and oscillation is stopped. Connect this pin to GND, if not used.
2. **Oscillation stop control pin (Pin ②)**
   If the pin is in the low state, oscillation is enabled and if the pin is in the high state, oscillation stops. If the feedback is applied to this pin from the output, the output stays in the high state, when it changes from the low to high state. (The function of monostable multivibrator is obtained.) Connect this pin to GND, if not used.
3. **CR input pin (pin ③)**
   The capacitor C_T and resistor R_T are connected to this pin.
   The oscillator period To is given in the following equation.

   $$T_O \fallingdotseq -C_T R_T \ln \frac{R_1 V_{CC} - 0.6(R_1+R_2)}{(V_{CC}-1.2)(R_1+R_2)}$$

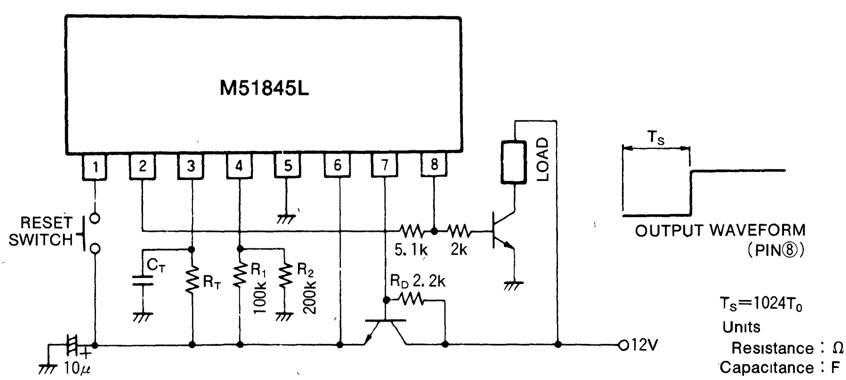
   (The V_{CC} is pin 6 voltage.)
   The period To given in the equation changes depending on the elements. Therefore, a resistor R_T must be connected in serial for fine adjustment if the required setting accuracy is ±25%.
4. **Reference voltage pin (pin ④)**
   The highest voltage for the oscillation level is supplied at this pin. The voltage should be set at approximately 2/3 V_{CC} by a variable resistor or resistor division (R_1, R_2) The capcitor C_T is corrected by minutely adjusting this voltage by a variable resistor.
5. **Supply voltage pin (pin ⑥)**
   Connect a capacitor (0.1μ to 10μF depending on the noise) between this pin and GND to avoid external noise from the power supply. The internal power on reset circuit resets the device whenever power is turned on.
6. **Stabilization zener pin (pin ⑦)**
   A zener diode of approximately 5.8V is connected between this pin and pin ⑤ (GND). Connection of this pin to pin ⑥ stabilizes power supply of the device and forms 5V supply voltage regulator with externally connected transistors.
7. **Output pin (pin ⑧)**
   The output voltage changes from the low state to high state when oscillation period is 1024 times To, and the voltage returns from the high state to the low state when the period is 2048 times for one cycle. Use oscillation stop control pin ② to form a monostable multivibrator.

APPLICATION EXAMPLES

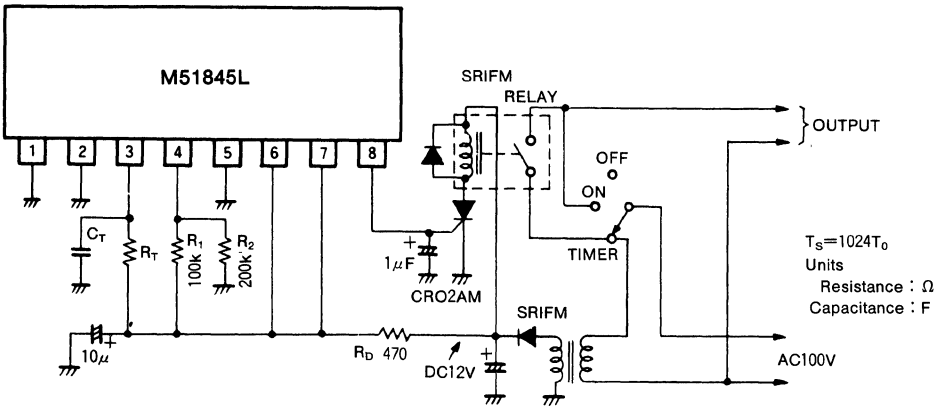
(1) Ultra-low-frequency oscillator



(2) Self-preserving timer



(3) Sleep timer



Precautions for use

1. CR input pin (pin③) must not be directly connected to V_{CC} to avoid destruction of the integrated circuit.
2. The voltage at the reference voltage pin (pin④) should be set to less than 3.5V. If it reaches 3.5V or above, the oscillator may not function.
3. This integrated circuit consisting of a divider by IIL and gate circuit operates at low supply voltages.
   Therefore it is extremely sensitive to external noise and is subject to misoperation. Care should be taken to the following items.
   1) Place the device away from any electromagnetic noise generaor or protect it with a shield wire.
   2) A capacitor must be connected near the V_{CC} pin (pin ⑥) to avoid noise.
4. V_{OH} changes according to load because output current control resistor varies depending on the load. Therefore, if the high output current is required, an external output transistor or the M51849L must be used.
5. The minimum resistance for timing resistor R_T is 7kΩ
   Use the M51849L to have a wide variable range of the timing resistor.
   As an improved version of the M51845L, the M51849L has superior characteristics in following.
   (compatible in pin configuration)
   1. Large output current (I_{OH} is approximately $10mA_{max}$)
   2. A timing resistor can be set by a wide range of resistance. (R_{Tmin}=1kΩ)
   3. Excellent temperature stability for timer setting

MOTOR DRIVER

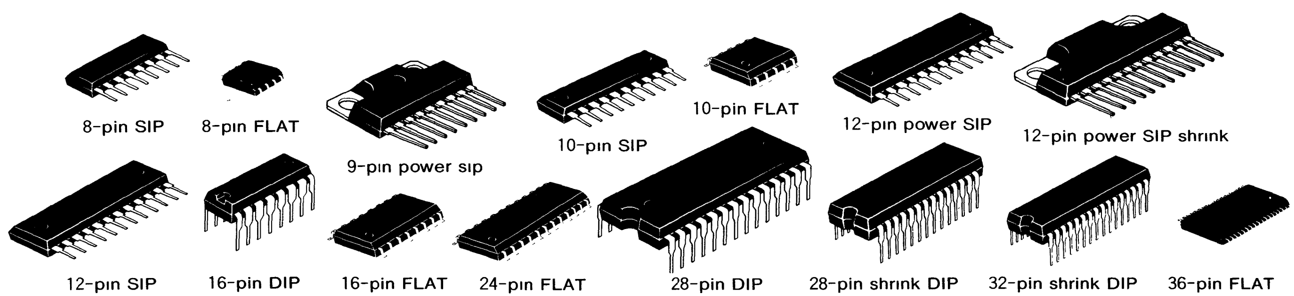
6

QUICK REFERENCE TABLE OF MOTOR DRIVERS

Application	Type No.	Applicable motor	Speed control method	Function			Features	Supply voltage range	Maximum ratings		Package outline
				FG input circuit	Hall amplifier gain	Motor drive transistor			Output current	Power dissipation	
Speed control	M51722P, FP	DC motor with FG	Sample and hold	PNP input operational amplifier	—	External	● Built-in multiplexer ● Built-in FG amplifier	10V	12mA	770mW 430mW	16-pin DIP 16-pin FLAT
Speed control	M51723P, FP	DC motor with FG	Sample and hold	PNP input voltage comparator	—	External	● Voltage/current outputs possible ● Start/stop	20V	6mA	770mW 430mW	16-pin DIP 16-pin FLAT
Speed control	M51728L, FP	DC motor with FG	PLL	NPN input voltage comparator	—	External	● Built-in zener diode (supply voltage clamp≈6.9V) ● Regulation against load ·············· Null	—	2mA	700mW 350mW	8-pin SIP 8-pin FLAT
Speed control	M51970L	DC motor with FG	Integration	PNP input voltage comparator	—	External	● Supply voltage regulation ······················ ±0.1% typ. ● Load regulation ··········· ±0.1% typ. ● Temperature coefficient of revolution ················ ±10ppm/℃ typ.	2.5~18V	40mA	550mW	8-pin SIP
Speed control	M51971L, FP	DC motor with FG	Integration	PNP input operational amplifier	—	External	● Supply voltage regulation ············· ±0.005%/V typ. ● Load regulation ········· ±0.01% typ. (full load) ● Temperature coefficient of revolution ··················· 7ppm/℃ typ.	4~17.5V	20mA	880mW 450mW	10-pin SIP 10-pin FLAT
Hall motor driver	M51712P, SP, FP	3-phase hall motor	—	—	40dB	Built-in	● Low noise, low torque ripple due to linear drive	26V	1.2A	2.1W 2.0W 1.2W	28-pin DIP 28-pin shrink DIP 36-pin FLAT
Hall motor driver	M51719P	1-phase hall motor	—	PNP input operational amplifier	—	Built-in	● Low cost system possible with a single sensor ● Build-in FG amplifier	7V 26V	1.5A	2.5W	16-pin DIP
Hall motor driver	M51724P, FP	3-phase hall motor	—	—	—	External	● Balanced current distribution	20V	10mA	900mW 540mW	16-pin DIP 16-pin FLAT
Hall motor driver	M51718FP	3-phase hall motor	—	—	—	External	● Designed for low power dissipation and low voltage ● Applicable to both spindle and access motor ● F/R, start/stop	7V 16V	25mA	650mW	24-pin FLAT
Speed control + Hall motor driver	M51781SP, FP	2-phase hall motor with FG	Sample and hold	PNP input operational amplifier	—	Built-in	● Current drive (low W/F) ● F/R	18V	1.2A	2.0W 1.2W	32-pin shrink DIP 36-pin FLAT
Speed control + Hall motor driver	M51785P, FP	3-phase hall motor with FG	Digital servo	PNP input operational amplifier	—	Built-in	● Voltage drive (high speed response) ● Adjustment free	15V	1.2A	3.0W 1.2W	32-pin shrink DIP 36-pin FLAT

QUICK REFERENCE TABLE OF MOTOR DRIVERS

Application	Type No.	Package outline	Speed	Additional function		Features	Maximum ratings			Supply voltage range
							Output current		Power dissipation	
				Brake	Thermal shut down		Continuous	Peak		
Bi-directional motor driver	M51714P	16-pin DIP	4	○		2 bi-directional motor drive	400mA	1.2A	2.5W	5~25V
	M54540AL	8-pin SIP	1			Small mounting space	100mA	0.6A	0.8W	6~11V
	M54541L	9-pin power SIP	1			Built-in clamp diode	200mA	0.8A	0.9W	6~15V
	M54542L	9-pin power SIP	1			High current drive	300mA	1.2A	1.0W	6~15V
	M54543L	9-pin power SIP	1	○		Low output saturation voltage	300mA	1.2A	1.15W	4~15V
	M54543AL	9-pin power SIP	1	○	○	Low power dissipation	300mA	1.5A	1.15W	4~15V
	M54544L	9-pin power SIP	1	○		Low output saturation voltage	300mA	1.2A	1.15W	4~15V
	M54544AL	9-pin power SIP	1	○	○	Low power dissipation	300mA	1.5A	1.15W	4~15V
	M54545L	9-pin power SIP	1	○		Low power dissipation	300mA	1.2A	1.15W	3~15V
	M54546L	10-pin SIP	1	○		Small mounting space	100mA	0.7A	0.6W	4~15V
	M54547P	16-pin DIP	1	○		Built-in operational amplifier, transistor array	100mA	0.6A	1.06W	4~15V
	M54548L	12-pin power SIP	1	○		Built-in operational amplifier for output voltage control	300mA	1.2A	1.2W	4~16V
	M54548AL	12-pin power SIP shrink	1	○		The M54548L equivalent in shrink package	300mA	1.2A	1.1W	4~16V
	M54549L	12-pin power SIP	2	○	○	2 motor drive	300mA	2A	1.2W	4~16V
	M54549AL	12-pin SIP	1	○	○	The M54549L equivalent in small package	100mA	0.8A	0.83W	4~16V
	M54640P	16-pin DIP	1	○	○	Bipolar stepper motor drive with chopper control	—	1A	1.2W	4.75~5.25V
	M54641L	8-pin SIP	1	○	○	Small mounting space	150mA	0.8A	0.58W	4~10V
	M54642L	10-pin SIP	1	○	○	Small mounting space	150mA	0.8A	0.58W	4~10V
	M54643L	10-pin SIP	1	○	○	Low output satulation voltage by externally PNP transistors	200mA	0.8A	0.7W	4~16V
	M54644BL	9-pin power SIP	1	○	○	Small control current	600mA	2A	1.15W	4~16V
	M54648L	12-pin power SIP	1	○	○	The M54548L equivalent of 3A output	300mA	3A	1.1W	4~18V
	M54648AL	12-pin power SIP shrink	1	○	○	The M54648L equivalent in shrink package	300mA	3A	1.1W	4~18V
	M54649L	10-pin SIP	2	○	○	Small package for 2 motor drive	600mA	1.6A	0.7W	4~18V



M51722P,FP

F-V CONVERTER WITH MULTIPLEXER

DESCRIPTION

The M51722P,FP are semiconductor integrated circuits developed for frequency-voltage (F-V) converter.

In combination with predriver ICs, the devices constitute high-accuracy 2-phase, 3-phase, F-servo motor control system.

FEATURES

- Built-in frequency multiplexer controls motors with high accuracy.
- Operates at a low supply voltage (supply voltage range 4.5~10V)
- Built-in FG amplifier circuit enables operation by weak signals
- Large final stage output current (current source and current sink)

APPLICATION

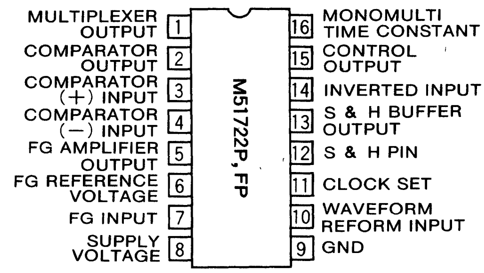
VTRs, floppy-disk drive, etc.

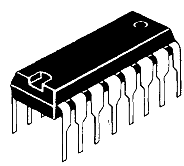
RECOMMENDED OPERATING CONDITIONS

Supply voltage range ································ 4.5~10V

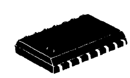
Rated supply voltage ·· 9V

PIN CONFIGURATION (TOP VIEW)



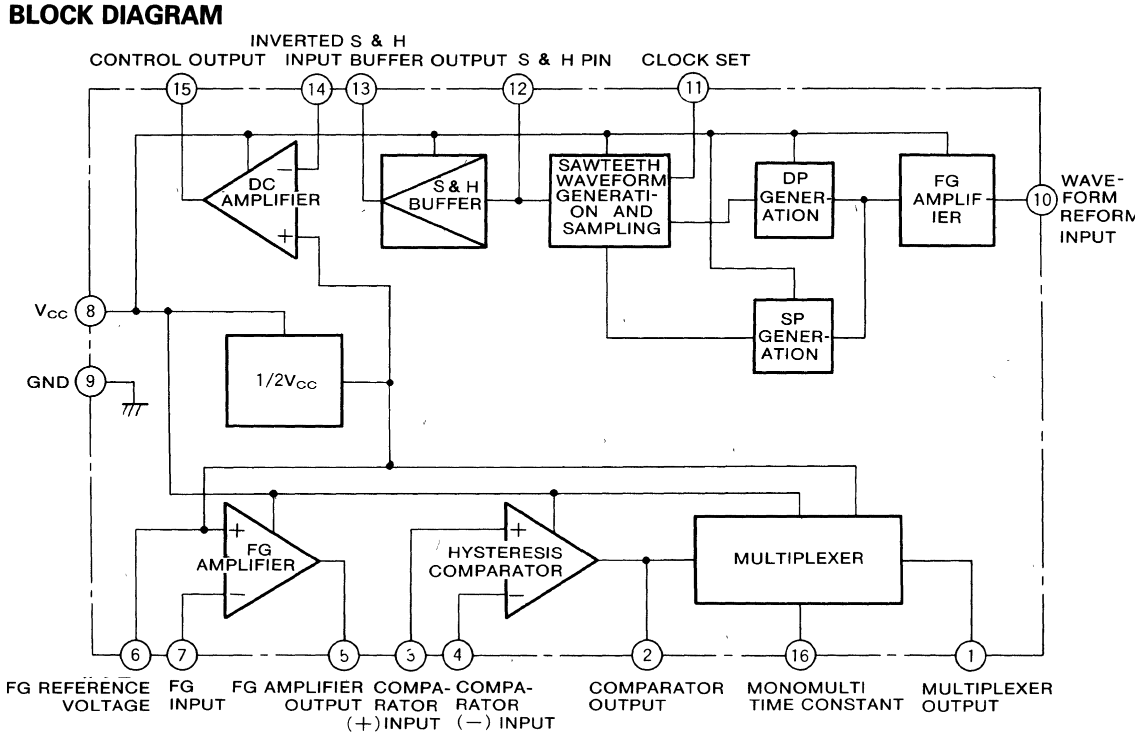


16-pin molded plastic DIP



16-pin molded plastic FLAT (C type)

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		10	V
$I_{②}$	Pin ② output current		8	mA
$I_{⑤}$	Pin ⑤ output current		2	mA
$I_{①}$	Pin ① source current		8	mA
$I_{⑮}$	Pin ⑮ sink current		12	mA
$I_{⑬}$	Pin ⑬ output current		1	mA
$V_{⑦}$	Pin ⑦ input voltage		1.5～V_{CC}	V
$V_{⑩}$	Pin ⑩ input voltage		0～V_{CC}	V
P_{dF}	Power dissipation		770(430)	mW
K_{θ}	Thermal derating		7.7(4.3)	mW/℃
T_{opr}	Operating temperature		−20～+75	℃
T_{stg}	Storage temperature		−40～+125	℃

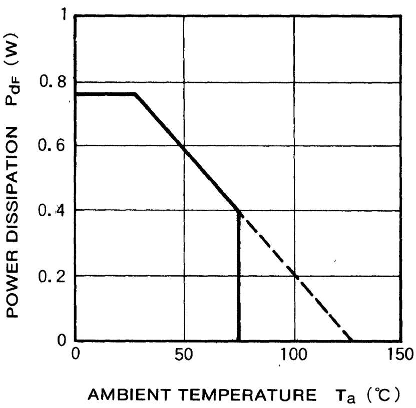
Note ( )=M51722FP

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=9V, unless otherwise noted)

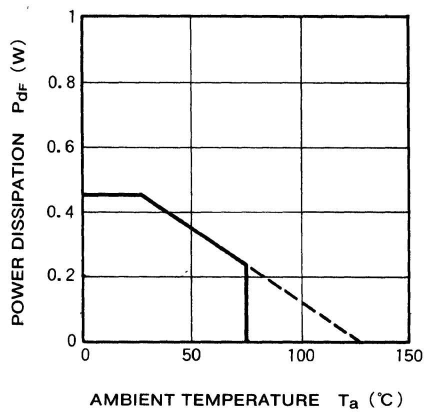
Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
$I_{CC(1)}$	Circuit current (1)	V_{CC}=4.5V		4.5	9	mA
$I_{CC(2)}$	Circuit current (2)	V_{CC}=10V		4.5	9	mA
$V_{ref(1)}$	Reference voltage of output voltage (1)	Pin ⑥ Open	4.4	4.5	4.6	V
$V_{ref(2)}$	Reference voltage of output voltage (2)	10kΩ between pin ⑥ and GND	4.4	4.5	4.6	V
$V_{OH⑤}$	Pin ⑤ high-level output	3.9kΩ between pin ⑤ and GND	6.0	6.8		V
$V_{OL⑤}$	Pin ⑤ low-level output	3.9kΩ between V_{CC} and pin ⑤		1.0	1.5	V
$V_{OH②}$	Pin ② high-level output	2kΩ between pin ② and GND	7.5	8.0		V
$V_{OL②}$	Pin ② low-level output	2kΩ between V_{CC} and pin ②		1.0	1.5	V
$V_{OH⑮}$	Pin ⑮ high-level output	1.5kΩ between pin ⑮ and GND	6.6	7.5		V
$V_{OL⑮}$	Pin ⑮ low-level output	1.5kΩ between V_{CC} and pin ⑮		1.0	1.5	V
$V_{offset⑥-⑦}$	Pin ⑥ - pin ⑦ offset voltage				±6	mV
$V_{offset③-④}$	Pin ③ - pin ④ offset voltage				±6	mV
$V_{offset⑫-⑬}$	Pin ⑫ - pin ⑬ offset voltage				±6	mV
$T_{①}$	Pin ① pulse width	Pin ⑯ time constant 100kΩ+820pF	45	55	65	μs

THERMAL DERATING (MAXIMUM RATING) (T_a=25℃, unless otherwise noted)

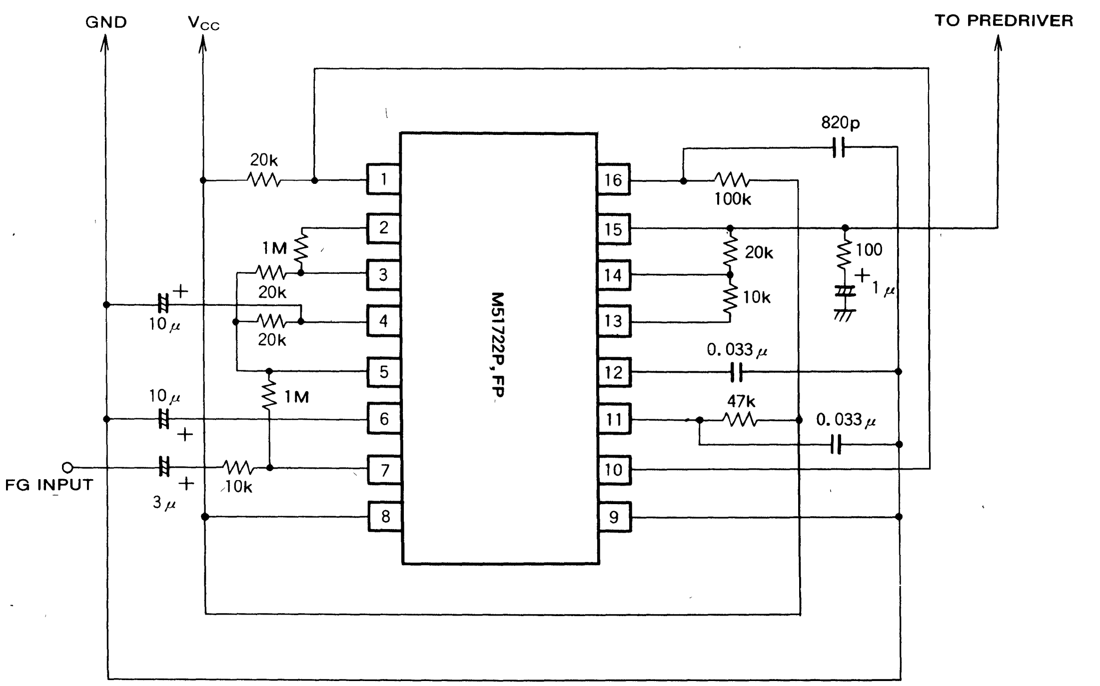
M51722P



M51722FP



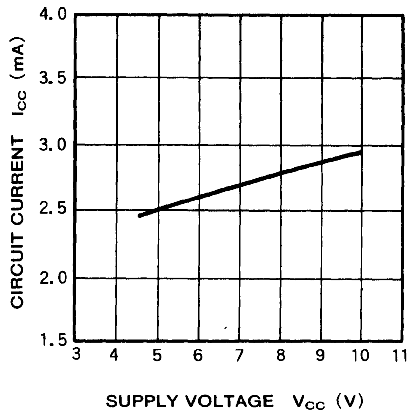
APPLICATION EXAMPLE



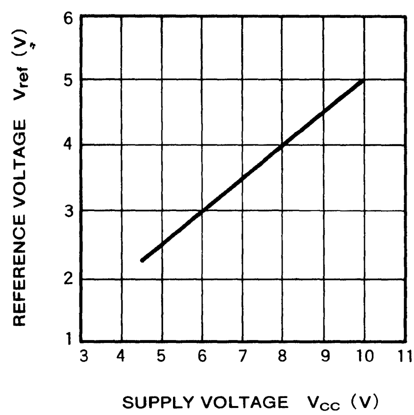
Unit Resistance : Ω
Capacitance · F

TYPICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

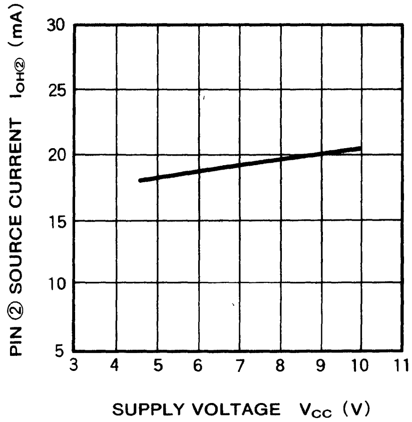
CIRCUIT CURRENT VS. SUPPLY VOLTAGE



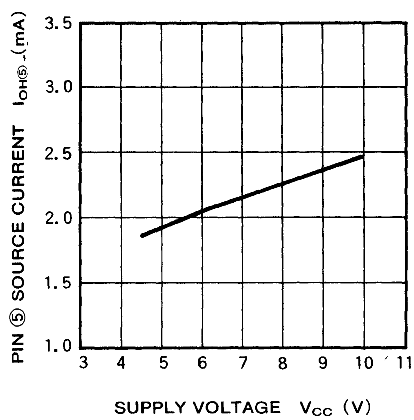
REFERENCE VOLTAGE VS. SUPPLY VOLTAGE



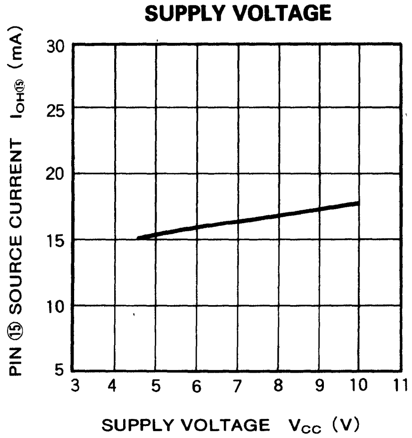
PIN ② SOURCE CURRENT VS. SUPPLY VOLTAGE



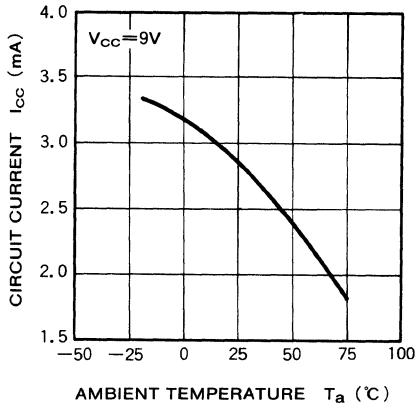
PIN ⑤ SOURCE CURRENT VS. SUPPLY VOLTAGE



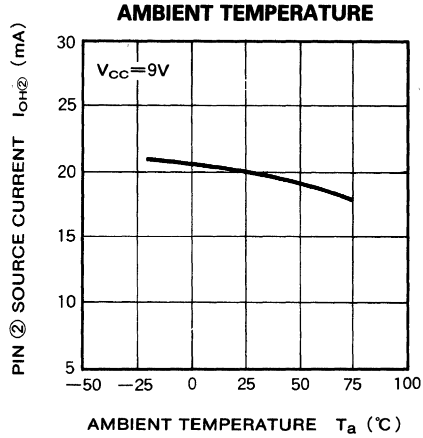
PIN ⑮ SOURCE CURRENT VS. SUPPLY VOLTAGE



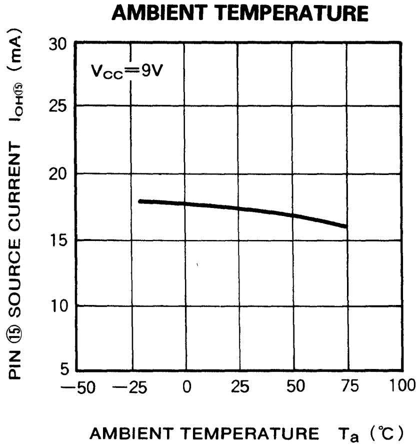
CIRCUIT CURRENT VS. AMBIENT TEMPERATURE



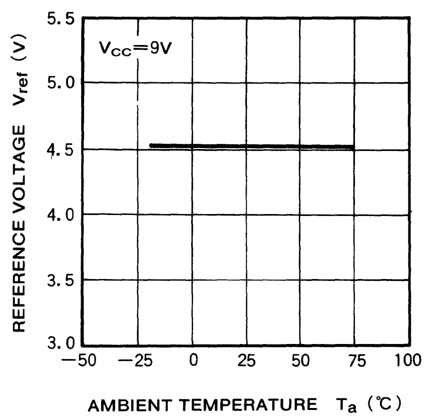
PIN ② SOURCE CURRENT VS. AMBIENT TEMPERATURE



PIN ⑮ SOURCE CURRENT VS. AMBIENT TEMPERATURE



REFERENCE VOLTAGE VS. AMBIENT TEMPERATURE



M51723P,FP

FREQUENCY-VOLTAGE(F-V)CONVERTER

DESCRIPTION

The M51723P,FP are semiconductor integrated circuits designed for use in frequency-voltage (F-V) converting.

The devices consist of an FG amplifier, sample and hold circuit, error amplifier and sawteeth-wave generating circuits.

The M51723P,FP constitute frequency-servo motor control system in combination with the brushless motor pre-driver, M51724P,FP or other pre-driver ICs.

FEATURES

- Low power dissipation
- Suitable for both current output (current source or current sink) and voltage output
- Start/stop changeover terminal

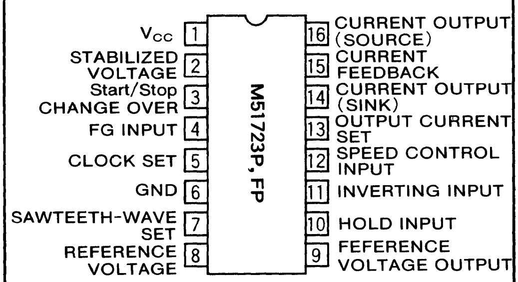
APPLICATION

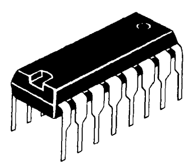
VTR, floppy disk drive, etc.

RECOMMENDED OPERATING CONDITIONS

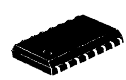
Supply voltage range ································ 7.2~20V
Rated supply voltage ··12V

PIN CONFIGURATION (TOP VIEW)



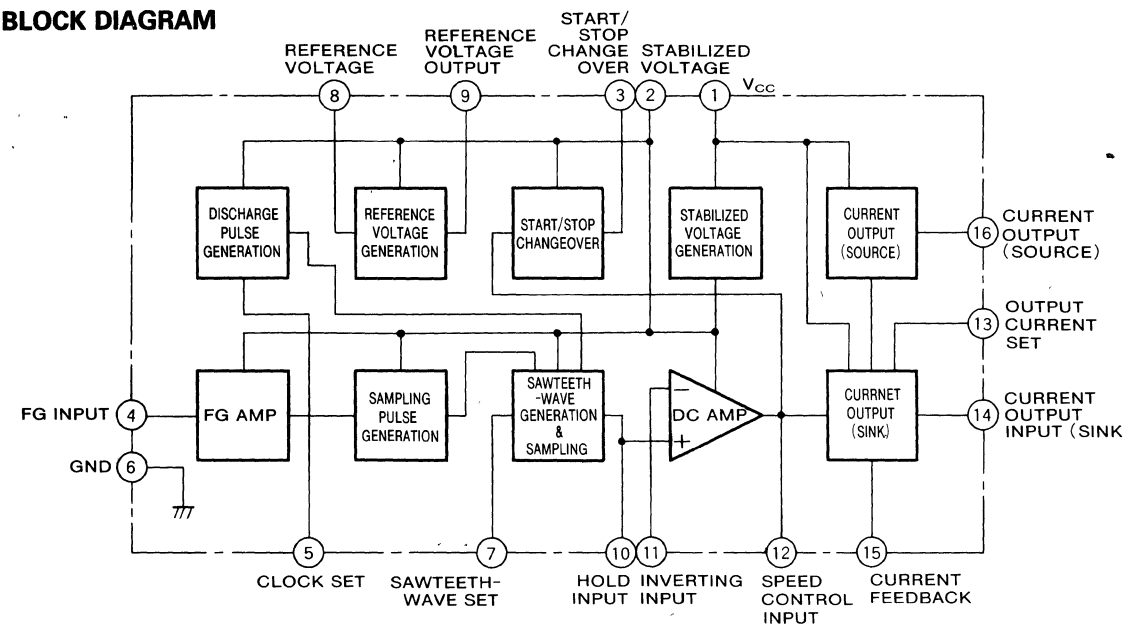


16-pin molded plastic DIP



16-pin molded plastic FLAT (C type)

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		20	V
I_{stb}	Pin ② output current		20	mA
$V_{④}$	Pin ④ input voltage		−0.2~V_{stb}	V
$I_{OL⑭}$	Pin ⑭ source current		6	mA
$I_{OL⑯}$	Pin ⑯ sink current		6	mA
P_{dF}	Power dissipation		770(430)	mW
T_{opr}	Operating temperature range		−20~+75	℃
T_{stg}	Storage temperature		−40~+125	℃

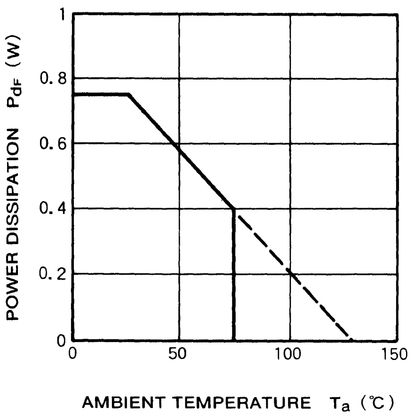
Note ( )=M51723FP

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=12V, unless otherwise noted)

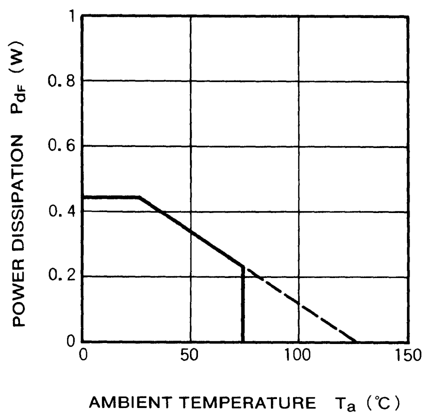
Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
I_{CC}	Circuit current		2	3	5	mA
V_{stb}	Stabilized output voltage		5.3	5.8	6.3	V
V_{ref}	Reference voltage	V_{CC}=V_{stb}=5.6V	2.70	2.81	2.94	V
$V_{TH(1)}$	Clock threshold voltage (1)	V_{CC}=V_{stb}=5.6V	1.78	1.90	2.00	V
$V_{TH(2)}$	Clock threshold voltage (2)	V_{CC}=V_{stb}=5.6V	2.67	2.81	2.95	V
$V_{TH(3)}$	Clock threshold voltage (3)	V_{CC}=V_{stb}=5.6V	3.01	3.17	3.33	V
$V_{TH(4)}$	Clock threshold voltage (4)	V_{CC}=V_{stb}=5.6V	3.95	4.17	4.37	V
V_{STOP}	Stop circuit operating voltage	V_{CC}=V_{stb}=5.6V		2.6	3.0	V
$V_{offset④}$	Pin ④ input offset voltage	V_{CC}=V_{stb}=5.6V		0	±6	mV
$V_{offset⑦-⑩}$	Pin ⑦ - pin ⑩ offset voltage	V_{CC}=V_{stb}=5.6V		0	±10	mV
$V_{offset⑧-⑨}$	Pin ⑧ - pin ⑨ offset voltage	V_{CC}=V_{stb}=5.6V		0	±10	mV
$V_{offset⑩-⑪}$	Pin ⑩ - pin ⑪ offset voltage	V_{CC}=V_{stb}=5.6V		0	±10	mV
$I_{SI⑭}$	Pin ⑭ sink current	20kΩ between V_{CC} and pin ⑬	440	550	660	μA
$I_{SO⑯}$	Pin ⑯ source current	20kΩ between V_{CC} and pin ⑬	570	720	860	μA

THERMAL DERATING (MAXIMUM RATING) (T_a=25℃, unless otherwise noted)

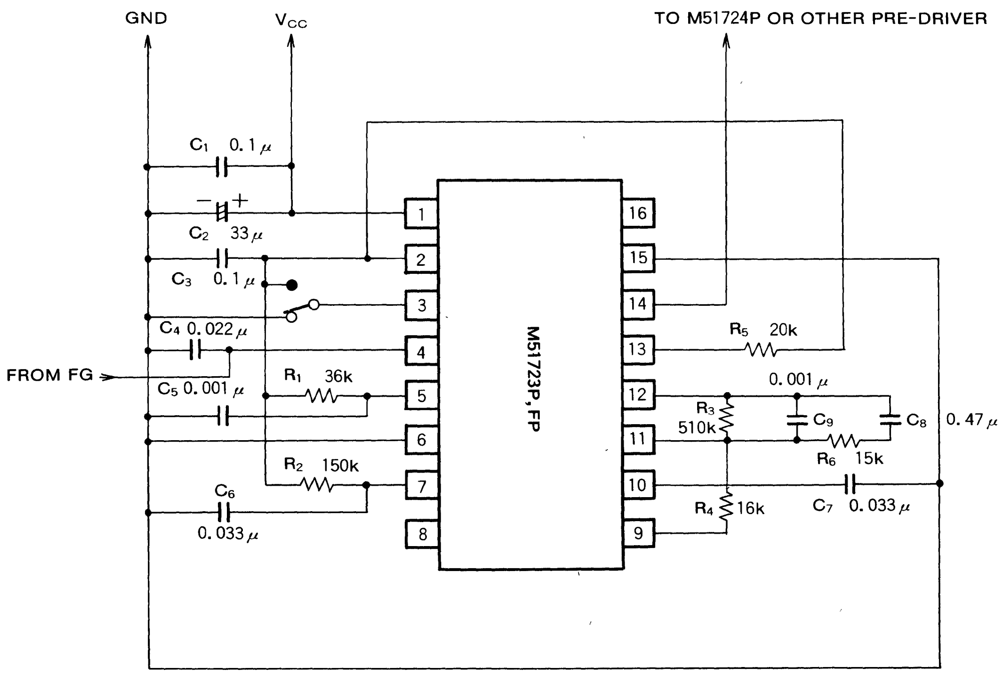
M51723P

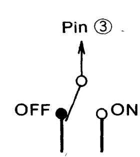


M51723FP



APPLICATION EXAMPLE



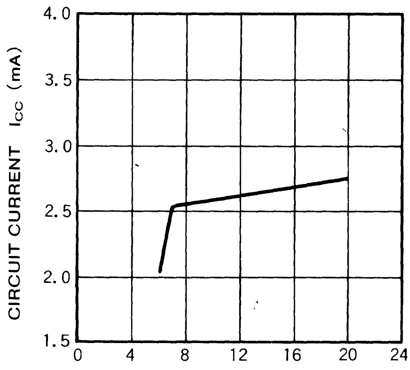


ON . Operation start
OFF : Operation stop

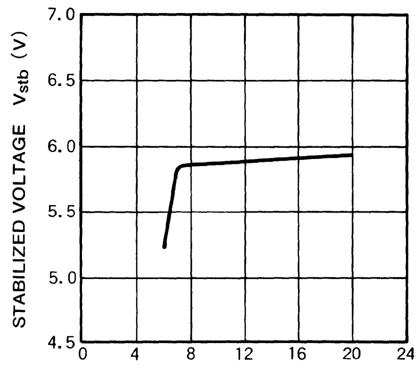
Unit Resistance Ω
Capacitance : F

TYPICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

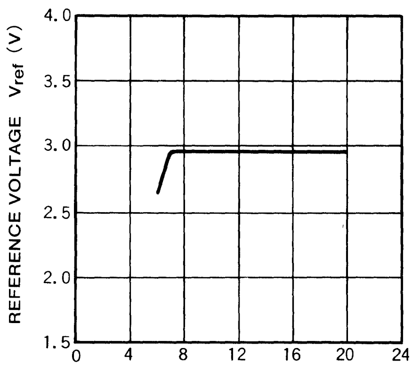
CIRCUIT CURRENT VS. SUPPLY VOLTAGE



STABILIZED VOLTAGE VS. SUPPLY VOLTAGE

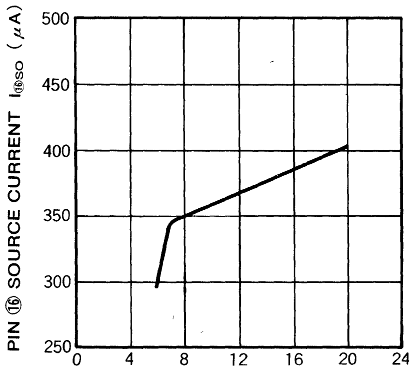


REFERENCE VOLTAGE VS. SUPPLY VOLTAGE

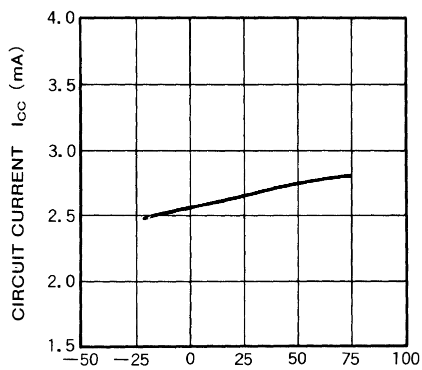


PIN ⑭ SINK CURRENT VS. SUPPLY VOLTAGE

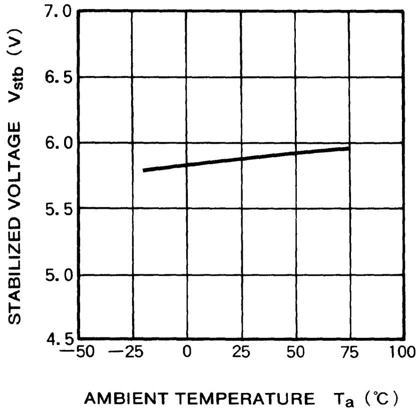
PIN ⑯ SOURCE CURRENT VS. SUPPLY VOLTAGE



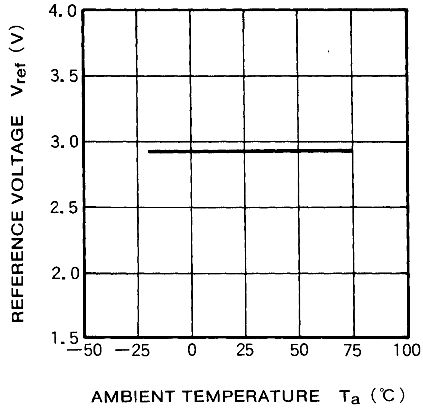
CIRCUIT CURRENT VS. AMBIENT TEMPERATURE



STABILIZED VOLTAGE
VS. AMBIENT TEMPERATURE



REFERENCE VOLTAGE
VS. AMBIENT TEMPERATURE



M51728L,FP

PLL MOTOR SPEED CONTROL

DESCRIPTION

The M51728L,FP are semiconductor integrated circuits designed for motor speed control circuit.

The precision speed control can be obtained because of the PLL circuit.

It controls DC motors with a TG (tacho generator).

FEATURES

- Built-in zener diode ······························6.9V(typ.)
- Supply voltage regulation (oscillating frequency) ······················ ±0.01%(typ.)(9~18V, R_S=910Ω)
- Load regulation of motor speed ······························ Nil
- Temperature coefficient (oscillating frequency) ······················ ±50ppm/℃(typ.)(−20~+75℃)
- Motor speed can be easily set

APPLICATION

Speed control of motors in audio equipment or terminals.

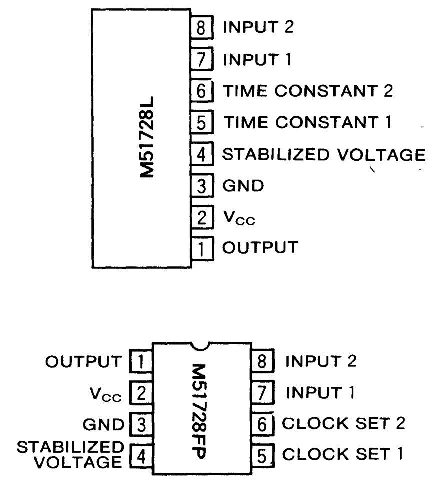
RECOMMENDED OPERATING CONDITIONS

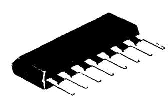
(V_S when dropper resistor R_S=910Ω)

Supply voltage range ······························9~18V

Rated supply voltage ······························13V

PIN CONFIGURATION (TOP VIEW)

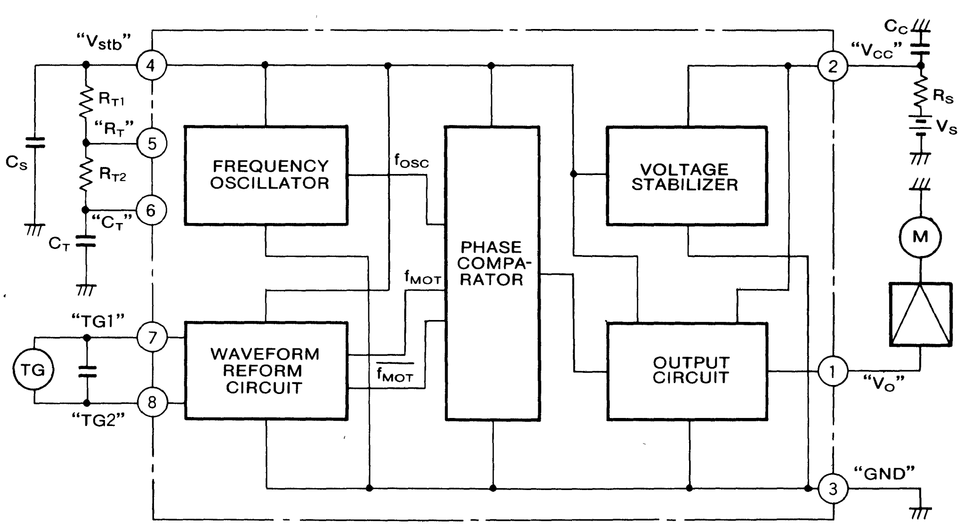




8-pin molded plastic SIP

8-pin molded plastic FLAT (MINI FLAT)

BLOCK DIAGRAM



MITSUBISHI ELECTRIC

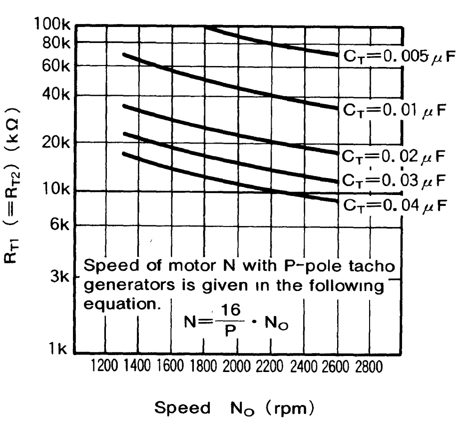
ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
I_{CC}	Circuit current	Source current at Pin ②	20	mA
$V_{in⑦-⑧}$	Pin ⑦—⑧ applied voltage		5.7	V_{P-P}
$I_{⑤}$	Pin ⑤ source current		2	mA
I_O	Output current		Note ±2	mA
$V_{⑤}$	Pin ⑤ applied voltage		7	V
$V_{⑥}$	Pin ⑥ applied voltage		2.7	V
$V_{①}$	Pin ① applied voltage		7	V
P_d	Power dissipation		500(400)	mW
K_θ	Thermal derating		200(250)	℃/W
T_{opr}	Operating temperature		−20～+75	℃
T_{stg}	Storage temperature		−40～+125	℃

Note 1. "+" indicated sink current to Pin ① and "−" indicates source current from Pin ①.
2. ( )=M51728FP

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_S=13V, R_S=910Ω, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
V_{CC}	Circuit voltage	Pin ② voltage	6.2	6.9	7.6	V
I_{CC}	Circuit current	V_{CC}=6V	2.0	3.7	6.0	mA
V_{stb}	Stabilized output voltage	V_{CC}=6V	2.4	2.7	3.0	V
V_{OH}	Pin ① high level output	I_O=−1mA	4.2	5.5		V
V_{OL}	Pin ① low level output	I_O=+1mA		0.04	0.3	V
$V_{⑦}(V_{⑧})$	Pin ⑦ (Pin ⑧) voltage	$V_{stb}=V_{CC}$=3V	1.0	1.3	1.5	V
$I_{⑦-⑧}$	Current between Pin ⑦ and Pin ⑧	5V applied between Pin ⑦ and Pin ⑧	1.6	2.5	3.6	mA
ΔT_{in}	Difference of TG amplifier output period	Measured under conditions of 5kHz, 150mV_{P-P}SIN input between Pin ⑦ and Pin ⑧, and 10kHz rectangular wave input at Pin ⑥ and output at Pin ①	−20	0	+20	μsec
f_{OSC}	Oscillating output frequency	$R_{T1}=R_{T2}$=47kΩ, C_T=0.01μF	975	1025	1075	Hz
$\Delta f_{(V_S)}$	Oscillating frequency supply voltage regulation	V_S=9～18V		±0.01		%
$\Delta f_{(t)}$	Oscillating frequency supply voltage regulation	T_a=−20～+75℃, IC only		±50		ppm/℃
$\Delta f_{(T_a)}$	Oscillating frequency time regulation	t=0.5sec～30min		±0.02		%
$V_{in(min)}$	Minimum operating voltage between Pin ⑦ and Pin ⑧	Voltage satisfying ΔT_{in} when f_{in} (between Pin ⑦ and Pin ⑧=0.1～5kHz)		150		mV_{P-P}
$V_{in(N)}$	Input sensitivity between Pin ⑦ and Pin ⑧	Measure existence of Pin ① output for the input between Pin ⑦ and Pin ⑧		3		mV_{P-P}



The fig. shows relationship between oscillator time constants (T_{T1}, R_{T2}, C_T) and speed N_O of a motor with sixteen-pole tachometer generator. The limits in the above are ontained when $R_{T1}=R_{T2}$=47kΩ, C_T=0.01μF.

A trimmer resistor can be added in serial with R_{T1} or R_{T2} for fine adjustment.

The calsulating equation is as follows;

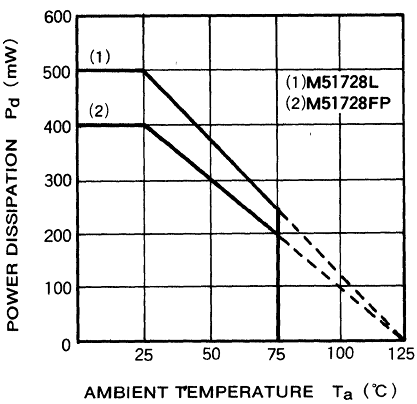
$$f_{OSC} \doteqdot \frac{1}{0.693\cdot C_T(R_{T1}+2R_{T2})}$$

$$N=\frac{60\cdot f_{TG}}{P}=\frac{60\cdot f_{OSC}/2}{P}=\frac{30}{P}f_{OSC}$$

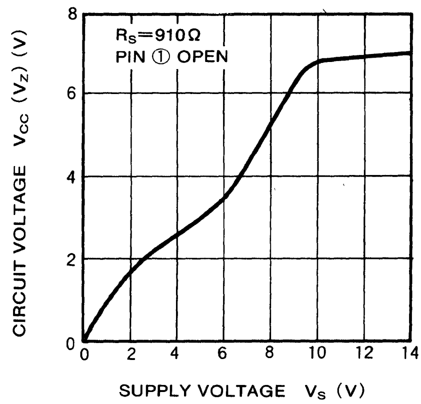
where N: Speed
P: number of poles of tacho generator
f_{TG}: output frequency of tacho generator

TYPICAL CHARACTERISTICS (T_a=25℃, V_S=13V, R_S=910Ω, unless otherwise noted)

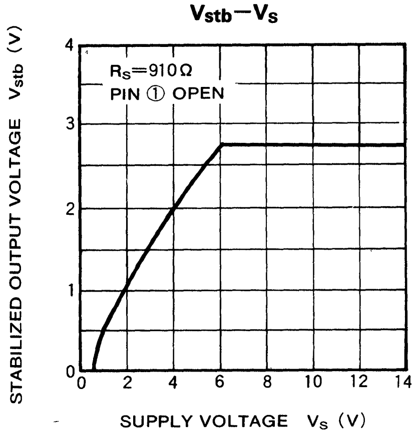
THERMAL DERATING (MAXIMUM RATING)



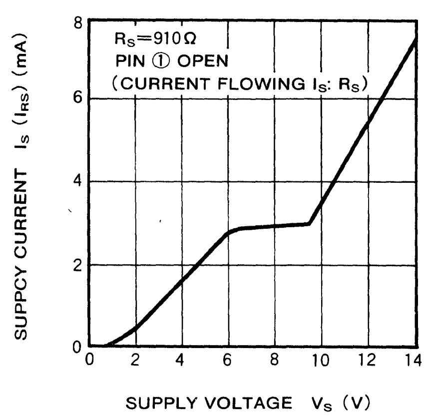
Vcc—Vs



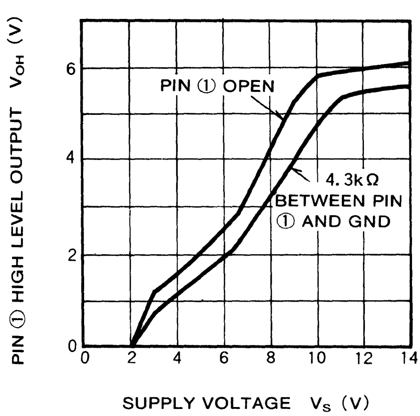
Vstb—Vs



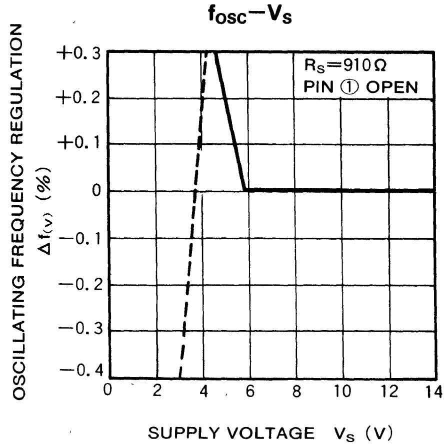
Is—Vs



VOH—Vs (PIN ① OUTPUT)

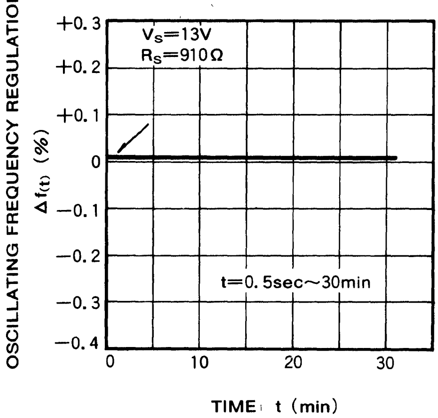


fosc—Vs

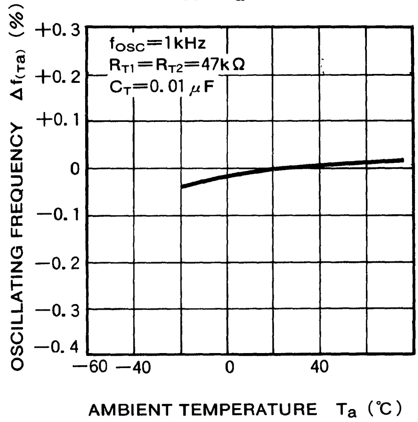


MITSUBISHI ELECTRIC

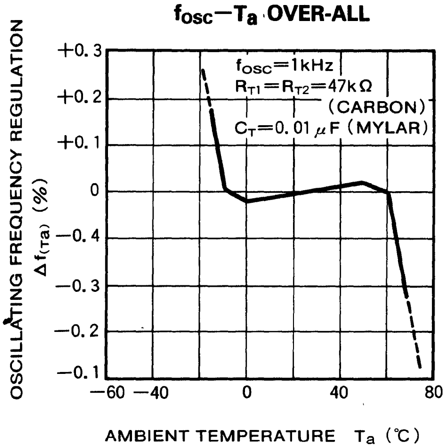
f_{OSC}—t (DRIFT CHARACTERISTICS)



f_{OSC}—T_a IC ONLY

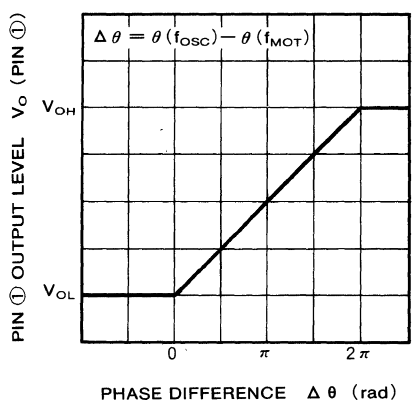


f_{OSC}—T_a OVER-ALL

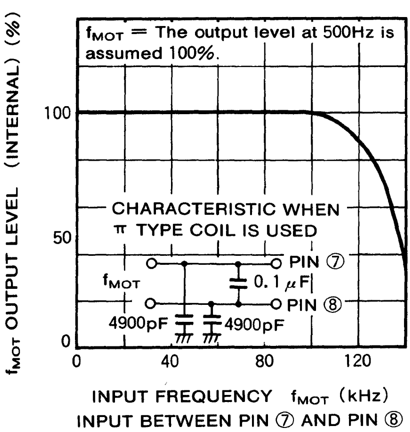


OUTPUT CHARACTERISTICS OF PHASE COMPARATOR (PIN ①)

(Note: The Y-axis indicates the integrated output.)

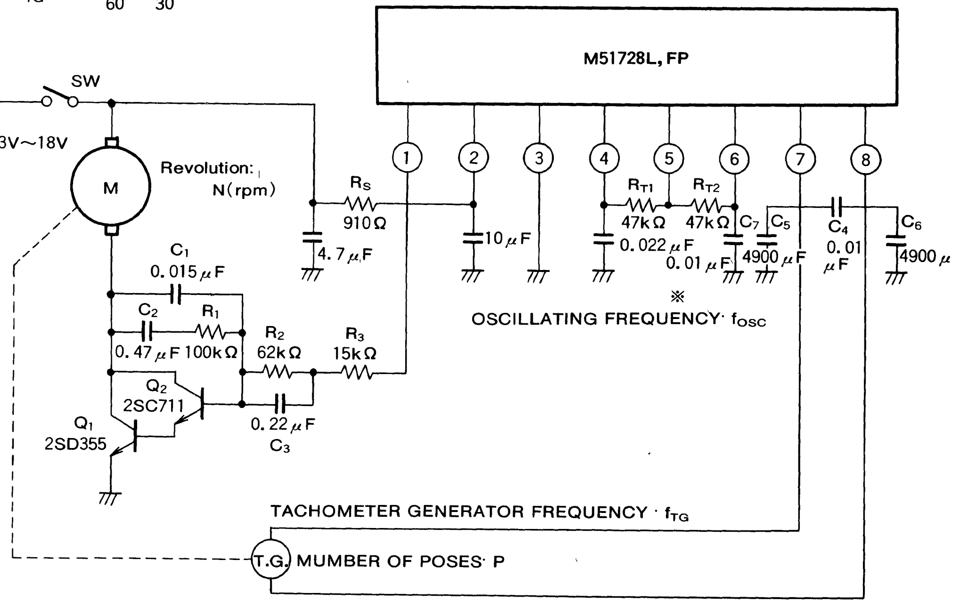


OUTPUT CHARACTERISTICS OF WAVEFORM REFORM CIRCUIT (INTERNAL)



APPLICATION EXAMPLE

Note. $f_{OSC}=2 \cdot f_{TG}=2 \cdot P\frac{N}{60}=\frac{PN}{30}$

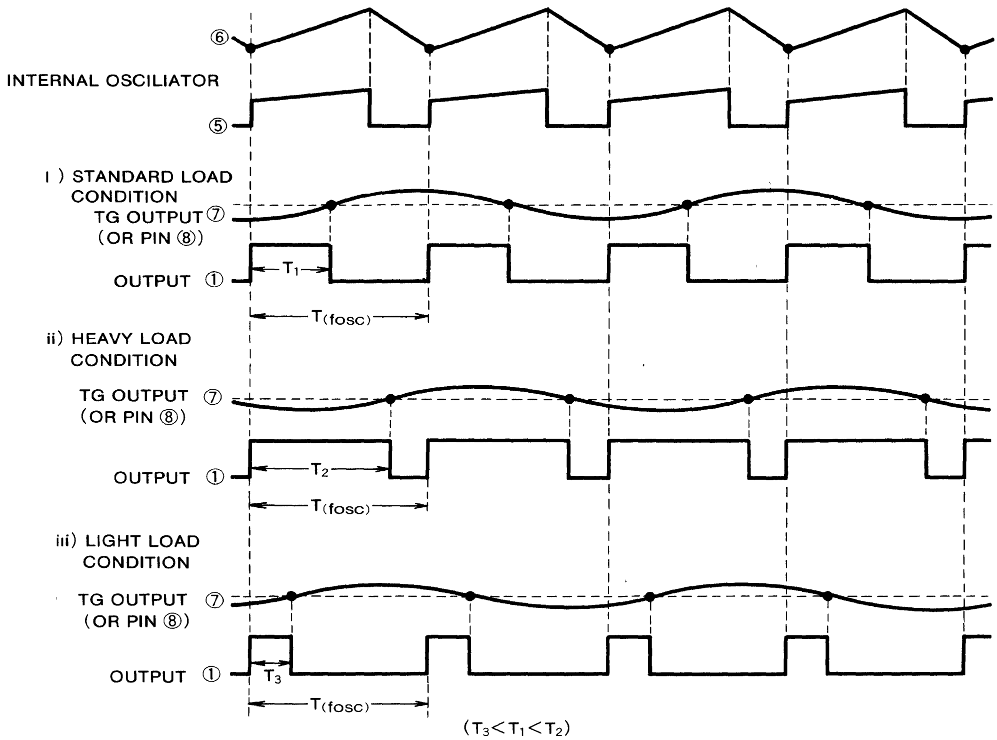


※ External signals of crystal oscillator can be input at Pin ⑥ as oscillating frequency. The input threshold value is as follows.

$V_{ref(H)}=\frac{2}{3}V_{stb}$

$V_{ref(L)}=\frac{1}{3}V_{stb}$

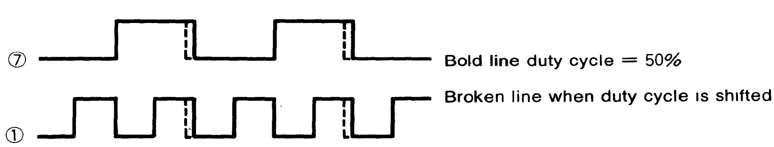
TIMING CHART OF THE M51728L,FP



1. Differential type of input is used for tacho generator frequency input Pin ⑦ and Pin ⑧. Trigger signal is generated for phase comparator when the AC frequency width of the input signal crosses at near zero.
2. Pulse feedback signal generated by encoder must be input to Pin ⑦. The high input level should be less than $V_{stb}-0.3V$. ($V_{stb}=2.7V$ typ.)
3. The duty of phase comparator output at Pin ① differs for every cycle if the duty of input signal at Pin ⑦ and Pin ⑧ is less than 50%.
4. An external oscillator, such as crystal oscillator instead of internal oscillator of oscillating frequency, should be connected to Pin ⑥. The input level must be less than the level shown below;

for high level $V_{in(H)}$ $\frac{2}{3}V_{stb}<V_{in(H)}<(V_{stb}-0.3V)$

and for low level $V_{in(L)}$ $0<V_{in(L)}<\frac{1}{3}V_{stb}$



M51970L

SPEED CONTROL FOR DC MICRO MOTOR

DESCRIPTION

The M51970L is a monolithic IC designed for use of speed control for DC micro motor. It controls constantly speed of DC micro motor, connecting the signal of frequency-generation detector to the IC. It consists of an input signal amplifier, a monostable multivibrator, an integrator, an output current amplifier with current limiter, an overshoot protector and an internal voltage regulator.

FEATURES

- Wide supply voltage range ······· 2.5~18V (−20~+75℃)
- High stability vs supply voltage ············ ±0.01%/V (typ.)
- High stability vs temperature ············ ±10ppm/℃ (typ.)
- High stability vs load ······························ ±0.1%(typ.)
- Provides DC output drive for minimum RFI.
- Includes overshoot protection circuit for quick start response of motor with less overshoot.

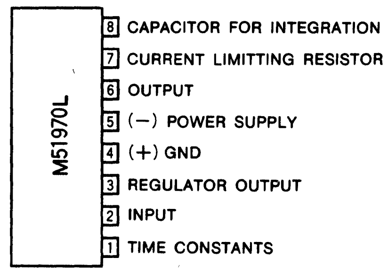
APPLICATIONS

8m/m movie camera, Floppy disk driver, Record player, Tape recorder, Car stereo, Motor driven equipment

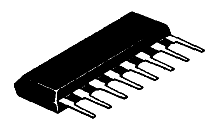
RECOMMENDED OPERATING CONDITIONS

Supply voltage range ···································· 2.5~17V
Rated supply voltage ··· 9V

PIN CONFIGURATION (TOP VIEW)

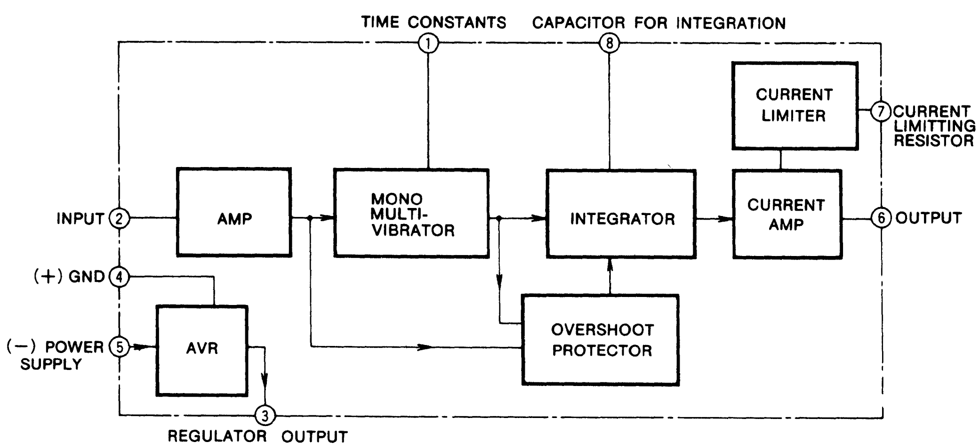


Outline 8P5



8-pin molded plastic SIL

BLOCK DIAGRAM



MITSUBISHI ELECTRIC

SPEED CONTROL FOR DC MICRO MOTOR

ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

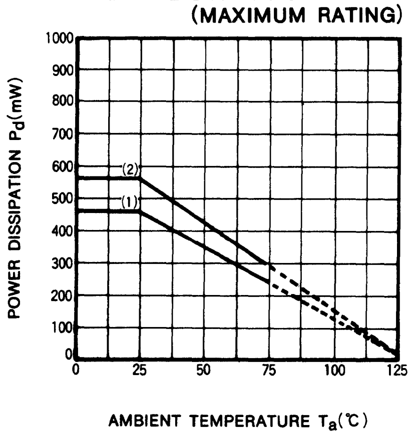
Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		18	V
$I_{⑥}$	Sink current into ⑥		40	mA
$I_{③}$	Issued current from ③		−3	mA
P_d	Power dissipation	Mounted on the P-C board (Cu foil area 4.5X5.5cm, t=35μ, thickness of the P-C board 2mm)	550	mW
K_θ	Derating		5.5	mW/℃
T_{opr}	Operating temperature		−20~+75	℃
T_{stg}	Storage temperature		−40~+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=9V, unles otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage range	T_a=−20~+75℃	2.5		18	V
I_{CC}	Circuit current	Except output current	3	4.5	8	mA
V_S	Regulated output voltage	Between ④ and ③	1.8	2.0	2.2	V
$V_{TH②}$	Input threshold voltage		−50	0	50	mV
$R_{IN②}$	Input impedance		4.2	7.9	12	kΩ
$I_{SC⑥}$	Limitted output current	R_{SC}=27Ω	20	27	35	mA
T_τ	Pulse width of mono. -multi.	R_τ=75k, C_τ=4700pF	375	395	415	μs
Reg-V_{CC}	Motor speed stability for V_{CC}	V_{CC}=4~15V		±0.1		%
Reg-L	Motor speed stability for load			±0.1		%
TC_N	Motor speed stability for temperature	T_a=−20~+75℃		±10		ppm/℃

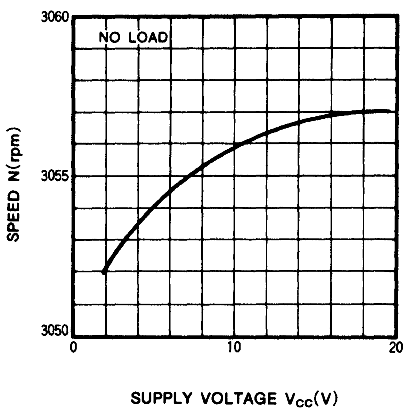
TYPICAL CHARACTERISTICS

THERMAL DERATING
(MAXIMUM RATING)

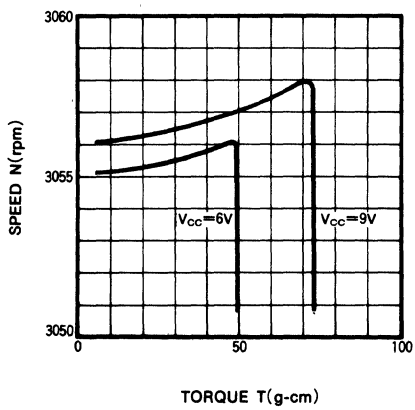


(1) IC only
(2) With printed circuit board of 2mm thick cover with Cu area of 4.5cmWX5.5cmLX35μt
Following datas come from the "APPLICATION CIRCUIT" applying the following components.
R_1=100kΩ, R_2=30kΩ, C_{F1}=1μF, C_{F2}=4.7μF, R_F=4.7kΩ, R_τ=75kΩ, C_τ=22,000pF, R_{SC}=56Ω, No. of tachogeneratorpoles=10. Components R, C, were located outside of the temperature test chamber in case of measuring "Speed VS ambient temperature".

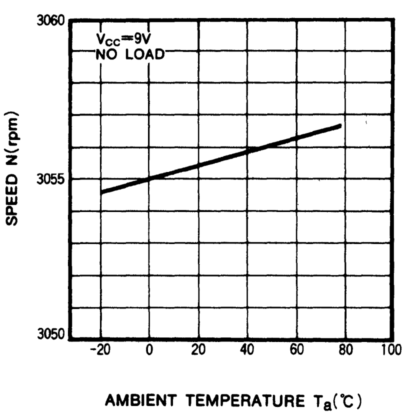
SPEED VS SUPPLY VOLTAGE



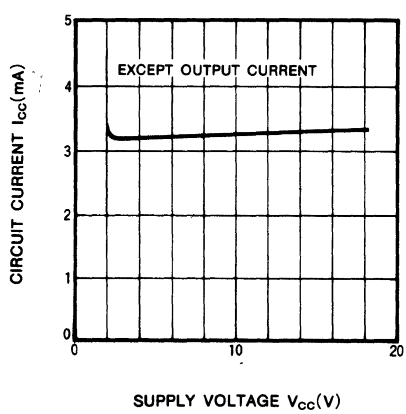
SPEED VS MOTOR TORQUE



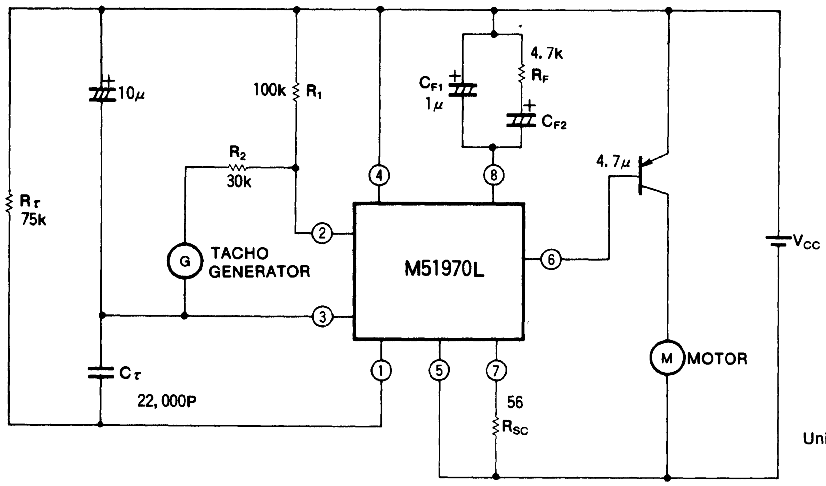
SPEED VS AMBIENT TEMPERATURE



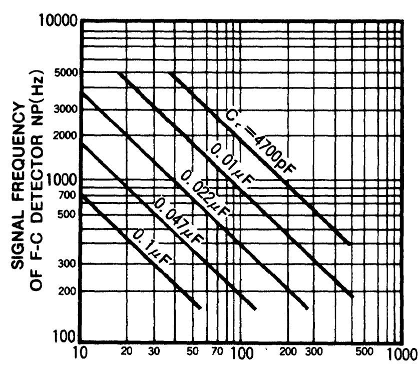
CIRCUIT CURRENT VS POWER SUPPLY



APPLICATION EXAMPLE



- **HOW TO DETERMINE Rτ. Cτ**



Rτ. Cτ. determine the speed of motor

$$NP \fallingdotseq \frac{1}{1.17R_\tau C_\tau}$$

where N; the speed of motor
P; number of pole pair of F-G detector.
The desiarable range of Rτ is usually 10k to 500kΩ.

APPLICATION HINTS

(1) HOW TO DECIDE THE CONSTANTS OF FILTER AT ⑧ PIN

The dynamic characteristics of a motor is determined by the relationships between the constants which a motor originally has, (such as, mechanical constant or inertia and tacho generator frequency) and circuit constants (C_{F1}, C_{F2}, RF in the typical application circuit)

The following relationships will be recommendable to choose circuit constants when a cycle of tacho generator is $T_G (=1/f_G)$, and the mechanical time constant of a motor is τ_M.

1. C_{F1} should be a smaller value in order to improve the circuit response. (But if the value is too small, peak to peak value of ramp shaped driving wave increases and becomes pulsive driven).

$$F_G \times C_{F1} = 50 \sim 150\text{Hz} \cdot \mu\text{F}$$

2. The relationship between the time period of a tacho generator, and the motor constant should be following, because the control is more unstable if speed information is less,

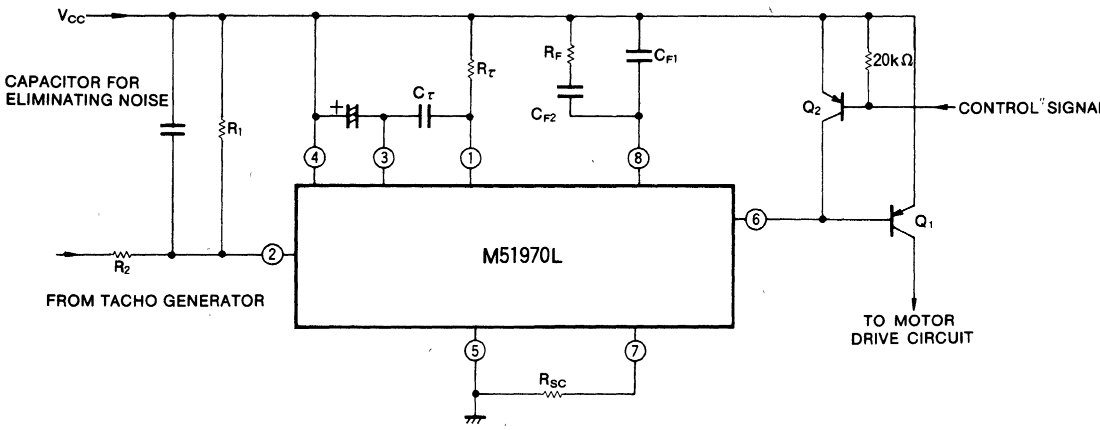
$$T_G/\tau_M << 1 (T_G < \tfrac{1}{6}\tau_M \text{ at least})$$

3. Relationship between R_F, C_{F2} and τ_M

$$\tau_M \sim R_F \times C_{F2}$$

(2) HOW TO GET A MOTOR ON OR OFF BY THE CONTROL SIGNAL.

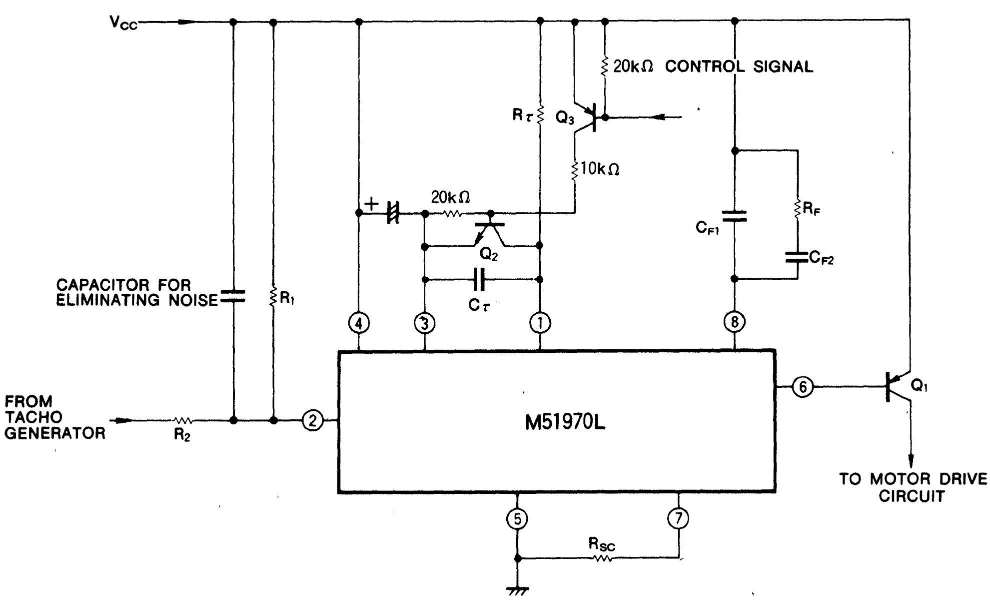
Example 1



The motor is off when Q_2 is on.

Choose the constants as the current driving ability of $Q_2 \geqq V_{BE}/R_{SC} \sim 0.7V/R_{SC}$

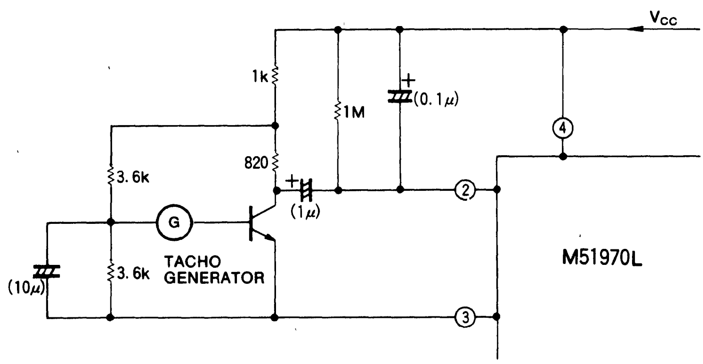
Example 2



The motor is off when Q_2 and Q_3 are on.

Use example 2 in case overshoot is large in example 1.

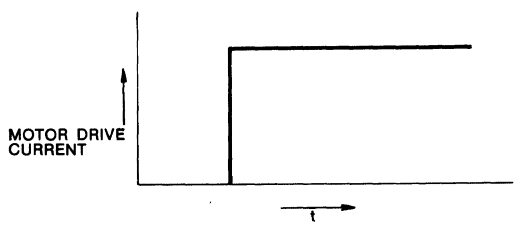
(3) HOW TO AMPLIFY THE SIGNAL FROM TACHO GENERATOR WHEN IT IS SMALL.

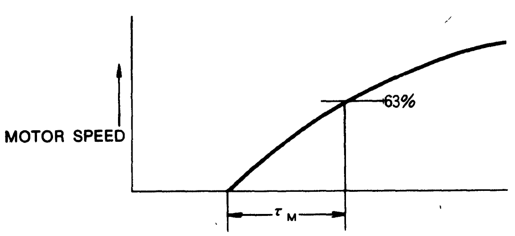


Unit Resistance : Ω
Capacitance : F

The above constants of capacitors are example in case F_G=500Hz.

(4) HOW TO GET THE APPROXIMATE VALUE OF THE MECHANICAL CONSTANT OF A MOTOR, τ_M.
First, drive the stationary motor by the step current. Then measure the time until the motor speed reachs 63% of the final value as following.





M51971L, FP

SPEED CONTROL FOR MOTOR

DESCRIPTION

The M51971L,FP are semiconductor integrated circuits designed for use as speed controls for motors.

They include a high-gain F-G amplifier and can be sued for a speed detector (F-G detector) for a side range of speeds.

They control the speed of DC motors with high-precision, using few externally connected components.

FEATURES

- Wide supply voltage range ···························· 4~17.5V
- Supply voltage regulation ······················ 0.005%/V(typ.)
- Load regulation ···················· 0.01%(typ. full load range)
- Temperature coefficient of speed ············ 7ppm/℃(typ.)
- Including a high-performance F-G amplifier

APPLICATION

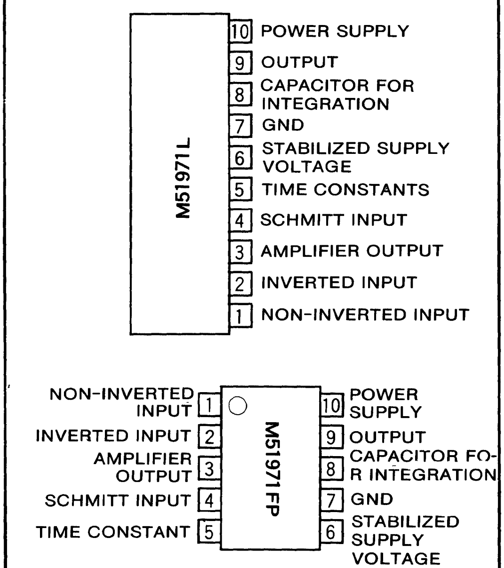
Speed control of motors for floppy-disk drives, players, tape recorders, car stereo.

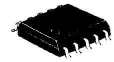
RECOMMENDED OPERATING CONDITIONS

Supply voltage range ································ 4~17.5V
Rated supply voltage ·· 9V
Pin ① input voltage range ············· 0.4V~V_{CC}(Note 1)
Pin ④ input voltage range ························ 0.4V~V_{CC}
Maximum tacho generator frequency ··············· 2.5kHz
Minimum trigger pulse width (Pin ④ input pulse)
··· 40μs(Note 2)

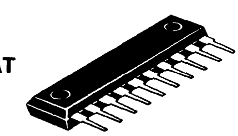
Note 1. Liner operation range −0.4~+0.4V
Note 2. This condition is applicable to both the periods from rise-time to fall-time and from fall-time to rise-time.

PIN CONFIGURATION (TOP VIEW)



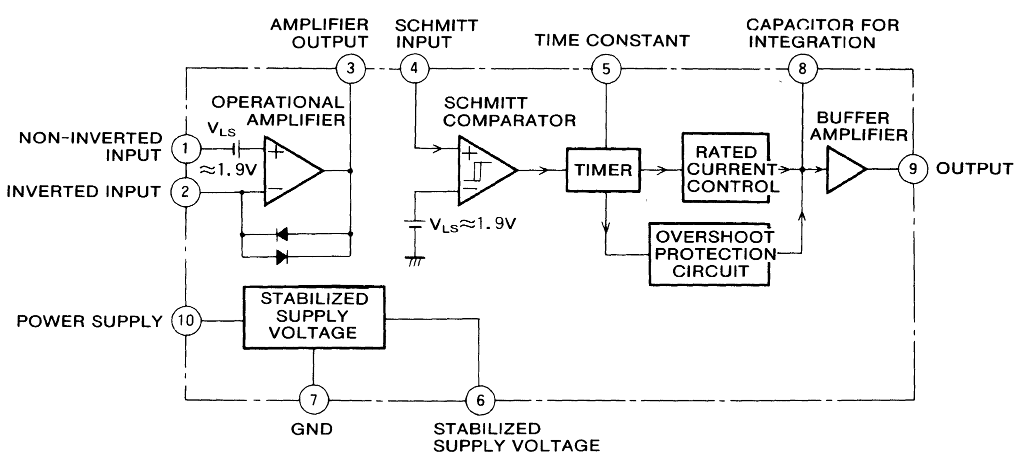


10-pin molded plastic FLAT



10-pin molded plastic SIP

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

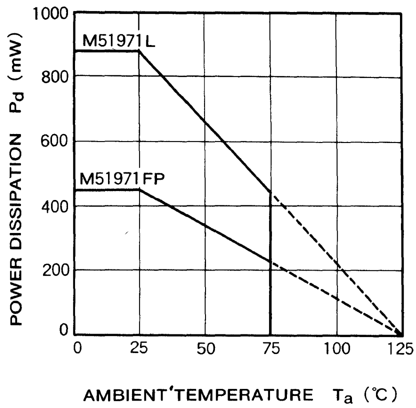
Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		18	V
$V_{①}$	Pin ① applied voltage		−3～V_{CC}	V
$I_{③}$	Pin ③ sink current		−5	mA
$I_{⑥}$	Pin ⑥ sink current		−5	mA
$V_{④}$	Pin ④ applied current		0～V_{CC}	V
$I_{⑨}$	Pin ⑨ sink current		−20	mA
P_{dF}	Power dissipation		880(M51971L)	mW
			450(M51971FP)	
$K_{\theta F}$	Thermal derating	T_a≧25℃	8.8(M51971L)	mW/℃
			4.5(M51971FP)	
T_{opr}	Operating temperature		−20～+75	℃
T_{stg}	Storage temperature		−40～+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=9V, unless otherwise noted)

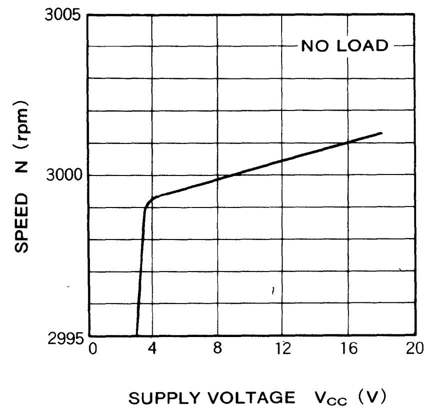
Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage range		4.0		17.5	V
I_{CC}	Circuit current			3.2	6.0	mA
V_S	Stabilized supply voltage	Pin ⑥ voltage	2.44	2.71	2.98	V
$I_{①}$	Pin ① input current	$V_{①}$=0V	−3.0	−0.5		μA
$I_{②}$	Pin ② input current	$V_{①}$=0V	−180	−30		nA
$V_{①LS}$	Pin ① level shift voltage	$V_{①}$=0V	1.51	1.89	2.27	V
A_V	FG amplifier voltage gain	$V_{①}$=0.2mVrms, f=500Hz, externally set gain=60dB	54	59	64	dB
$I_{④}$	Pin ④ input current	$V_{④}$=2.5V		0.4	2.0	μA
$V_{④TH}$	Pin ④ threshold voltage	Reference is the Pin ① level shift voltage	0	16	40	mV
$V_{④HY}$	Pin ④ hysteresis width		20	37	55	mV
$V_{⑤S}$	Pin ⑤ saturation voltage	R_τ=75kΩ		3	20	mV
T_τ	One-shot pulse width	R_τ=75kΩ, C_τ=4700pF	375	395	415	μsec
$I_{⑧C}$	Pin ⑧ charge current	$V_{⑧}$=1V	−260	−190	−140	μA
r_{cd}	Pin ⑧ charge/discharge current	$V_{⑧}$=1V	−14.5	−11.6	−9.0	
$R_{⑨}$	Pin ⑨ output protection resistor	$I_{⑨}$=−20mA	65	100	150	Ω
$V_{⑨max}$	Pin ⑨ maximum voltage		2.9	3.2		V
$V_{⑨min}$	Pin ⑨ minimum voltage			50	200	mV
V_{BO}	Buffer amplifier offset voltage	$V_{⑧}$=1V, $V_{⑧}$−$V_{⑨}$	0	100	200	mV
R_{eg}-V_{CC}	Supply voltage regulation	V_{CC}=4～17.5V		0.07		%
R_{eg}-L	Supply voltage load	full load range		0.01		%
TC_N	Temperature coefficient of speed	T_a=−20～+75℃		7		ppm/℃

TYPICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

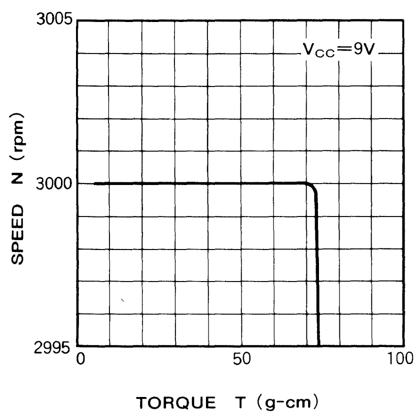
THERMAL DERATING (MAXIMUM RATING)



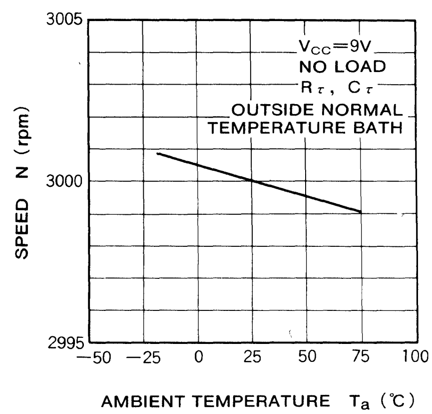
SPEED VS. SUPPLY VOLTAGE



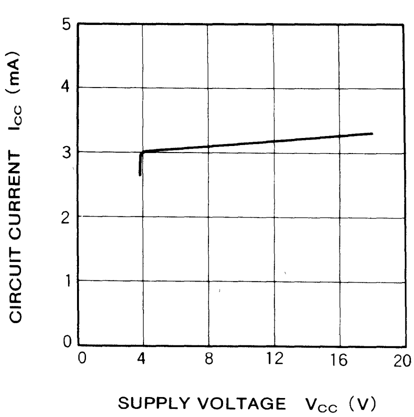
SPEED VS. TORQUE



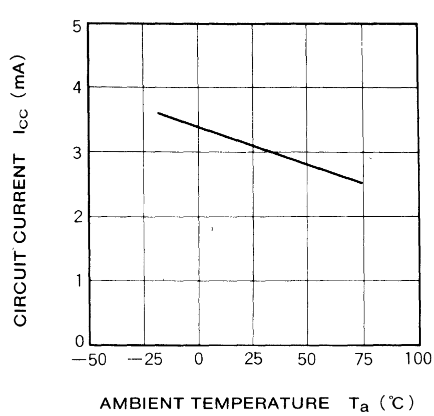
SPEED VS. AMBIENT TEMPERATURE



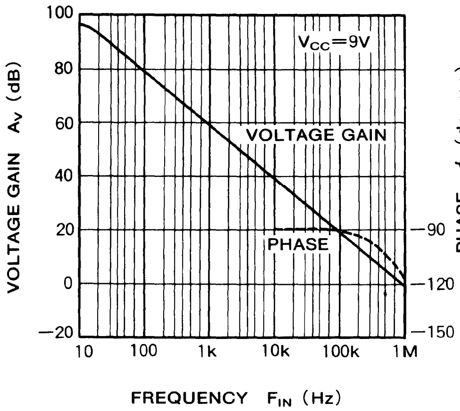
CIRCUIT CURRENT VS. SUPPLY VOLTAGE



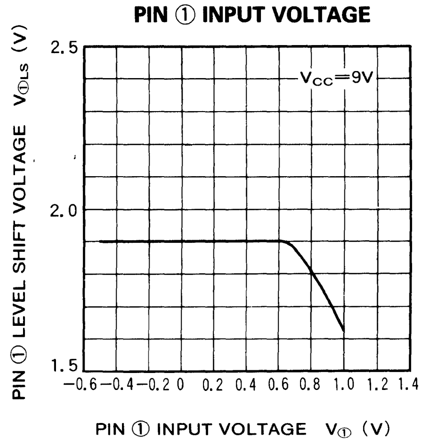
CIRCUIT CURRENT VS. AMBIENT TEMPERATURE



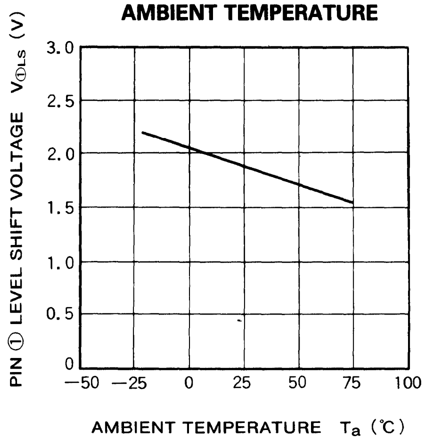
FG AMPLIFIER OPEN LOOP VOLTAGE GAIN VS. PHASE SHIFT



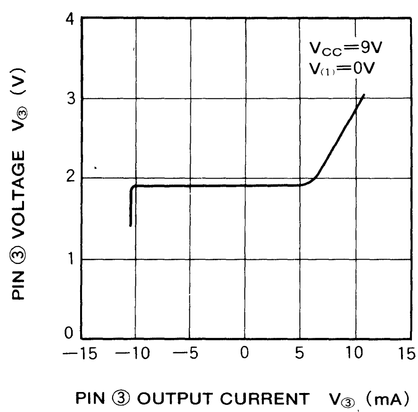
PIN ① LEVEL SHIFT VOLTAGE VS. PIN ① INPUT VOLTAGE



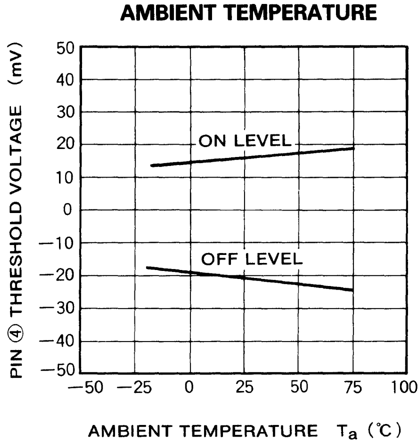
PIN ① LEVEL SHIFT VOLTAGE VS. AMBIENT TEMPERATURE



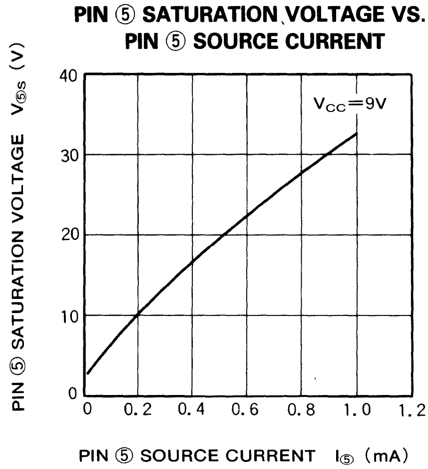
PIN ③ VOLTAGE VS. PIN ③ OUTPUT CURRENT



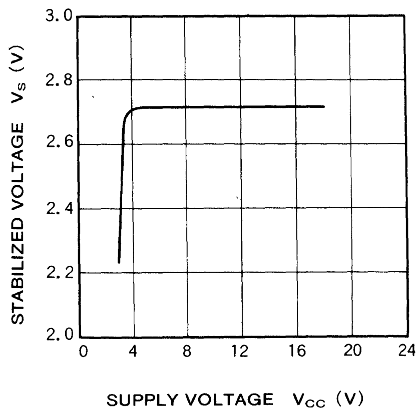
PIN ④ THRESHOLD VOLTAGE VS. AMBIENT TEMPERATURE



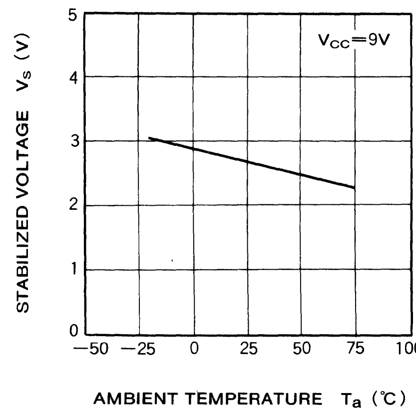
PIN ⑤ SATURATION VOLTAGE VS. PIN ⑤ SOURCE CURRENT



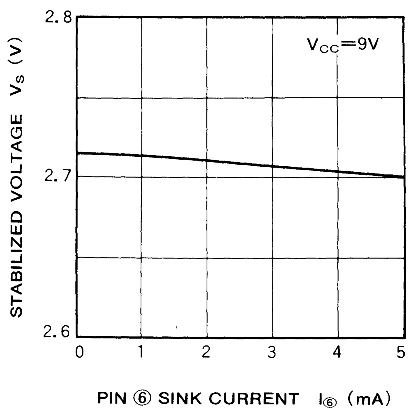
STABILIZED VOLTAGE VS. SUPPLY VOLTAGE



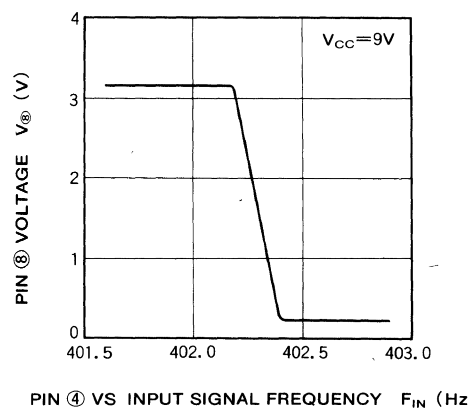
STABILIZED VOLTAGE VS. AMBIENT TEMPERATURE



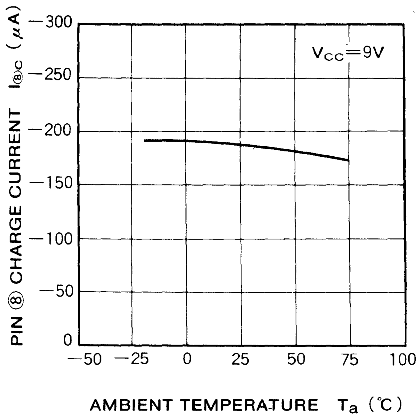
STABILIZED VOLTAGE VS. PIN ⑥ SINK CURRENT



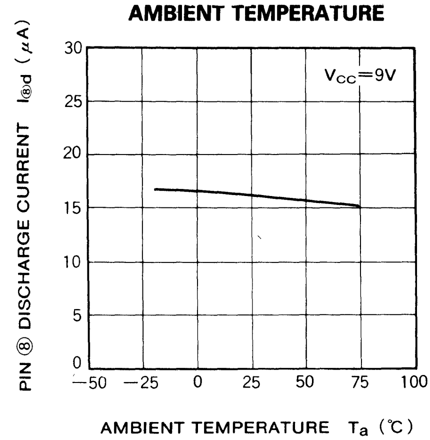
PIN ⑧ VOLTAGE VS. INPUT SIGNAL FREQUENCY



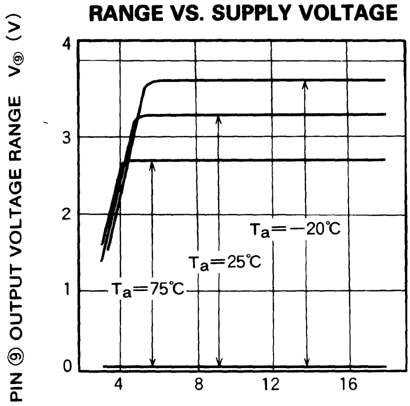
PIN ⑧ CHARGE CURRENT VS. AMBIENT TEMPERATURE



PIN ⑧ DISCHARGE CURRENT VS. AMBIENT TEMPERATURE

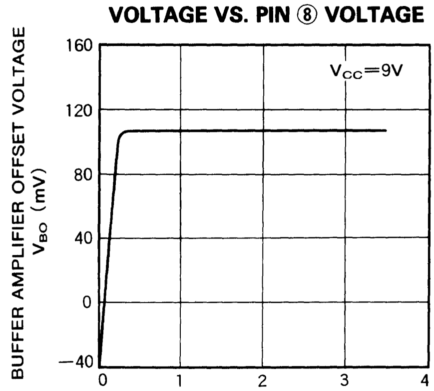


PIN ⑨ OUTPUT VOLTAGE RANGE VS. SUPPLY VOLTAGE



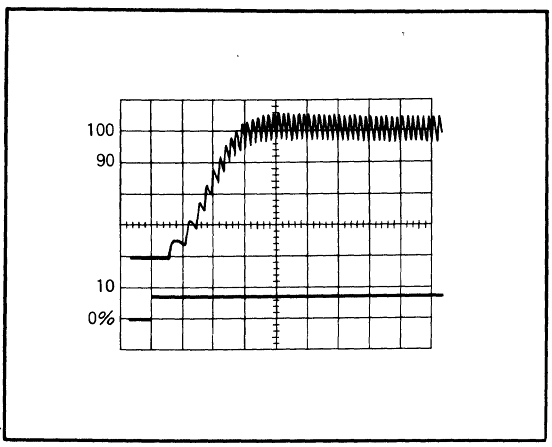
SUPPLY VOLTAGE V_{CC} (V)

BUFFER AMPLIFIER OFFSET VOLTAGE VS. PIN ⑧ VOLTAGE



PIN ⑧ VOLTAGE V⑧ (V)

RESPONSE CHARACTERISTICS



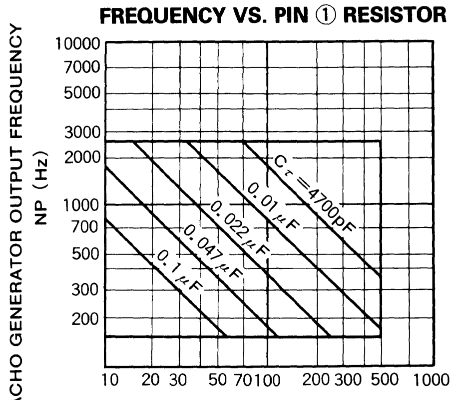
Upper : Motor speed (IF/V converting waveform of tacho generator frequency)
Lower : Supply voltage
X-axis : 20ms/div
Time constant of motor≈100ms

R_τ, C_τ

R_τ , C_τ determine the speed of motor. The following equation is obtained where N is the speed of motor and P is the number of pole pairs of tacho generator. The desirable range of R_τ is 10kΩ to 500kΩ. Care should be taken for leak current on the surface of printed circuit board when a large resistor is used.

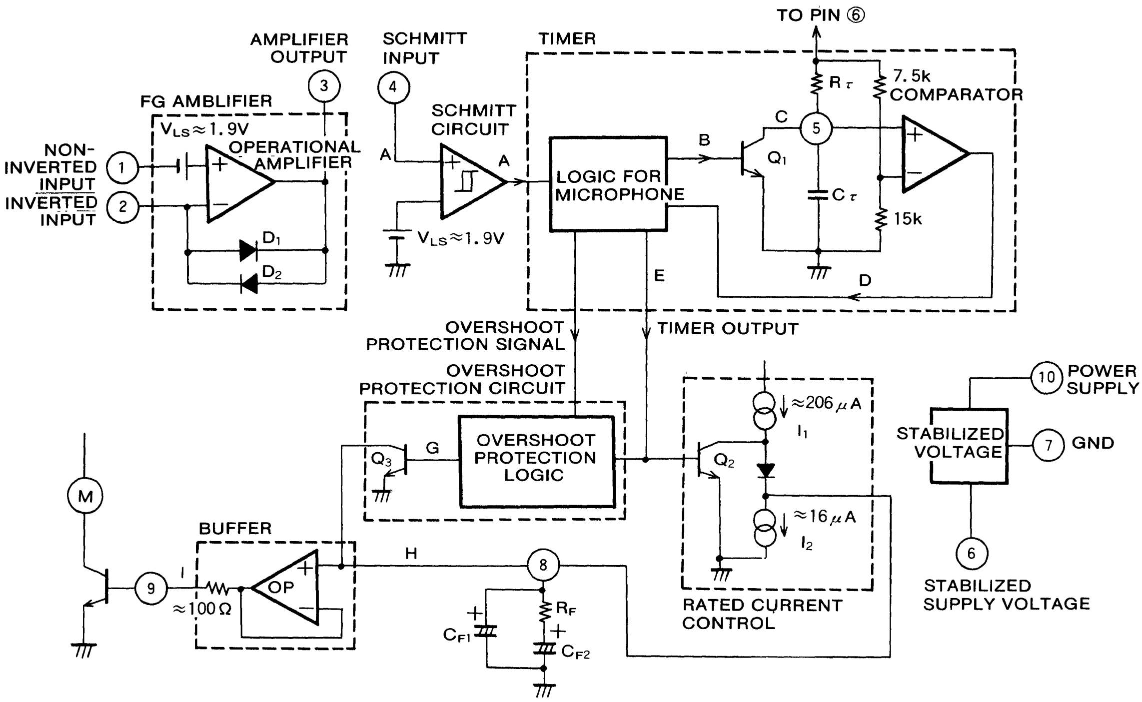
$$NP \approx \frac{1}{1.20 \cdot R_\tau \cdot C_\tau}$$

TACHO GENERATOR OUTPUT FREQUENCY VS. PIN ① RESISTOR



PIN ① RESISTOR R_τ (kΩ)

OPERATIONAL DESCRIPTION OF THE M51971
DESCRIPTION OF EACH BLOCK



F-G amplifier
The F-G amplifier consists of an operational amplifier, level shift circuit and diode for waveform clipping.

The output DC voltage at Pin ③ is increased from the DC voltage at Pin ① by the V_{LS} (≈1.9V≈3V_{BE}) when a DC protection capacitor is connected to Pin ②.

AC singals near the GND can be easily amplified. The clipper diode can limit the output signal width within ± 0.7V(V_{BE}), and rapidly charges a capacitor for DC protection at power on.

Schmitt Circuit
The schmitt circuit is a comparator with hysteresis, and has the ON level of V_{LS}+20mV, and the OFF level of V_{OS}−20mV.

Timer
The timer circuit generates reference time required for speed control of motor. The timer consists of a one-shot circuit, triggered by the input signal, and generates pulse with pulse width of $1.1C_\tau R_\tau$.

Rated Current Limiting Circuit
The rated current limiting circuit is controlled by the output from the timer circuit and generates source current of I_1-I_2 (≈190μA) when one-shot pulse is not generated and generates source current of I_2 (≈ 190μA) when one-shot pulse is generated. The ratio of I_1 against I_2 is unique for each IC and the tacho generator frequency to be set is determined by the one-shot pulse width and this ratio of currents (I_1/I_2≈12.6),

$$T_G=T_\tau\times\frac{I_1}{I_1-I_2}\approx1.09\times T_\tau$$

where T_G: Tacho generator frequency period (set value)

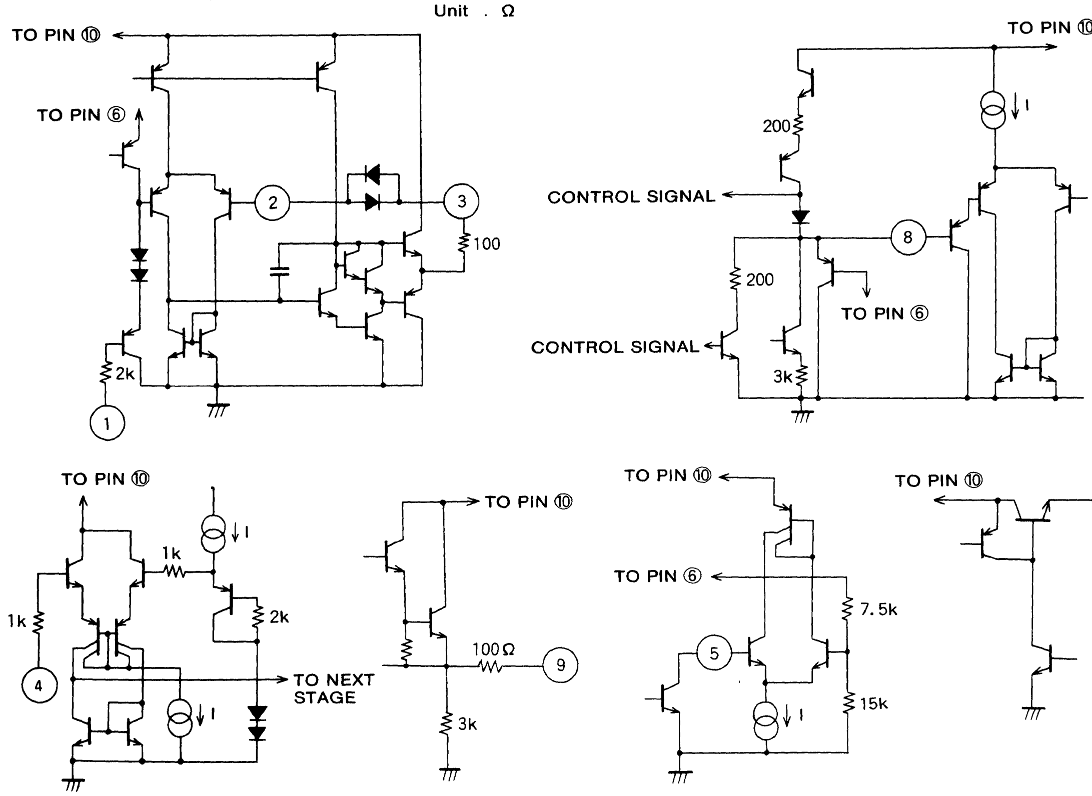
T_τ: One-shot pulse width

Overshoot Protection Circuit
The overshoot protection circuit operates when the overshoot is exceptionally large, for example, when motor is released from locked condition.

The Q_3 is turned ON for approximately the period of one-shot pulse width (T_τ), when the signal period of tacho generator becomes shorter than one-shot pulse width. C_{F1} is discharged because usually $R_F \cdot C_{F2} \gg T_\tau$.

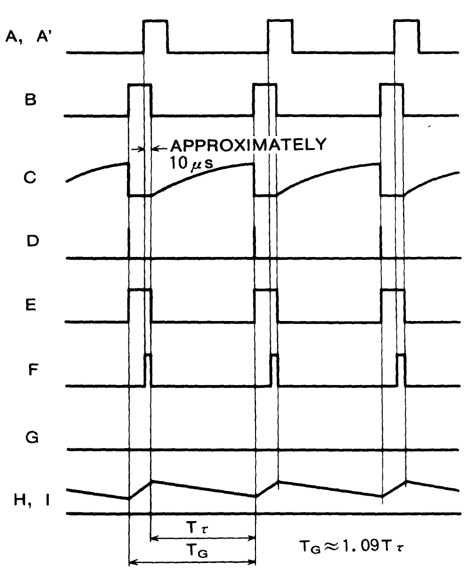
Buffer Amplifier
The buffer amplifier circuit consists of a voltage-follower circuit using operational amplifier. The input current is very low (within 10nA), and the driven output current is 20mA.

INPUT/OUTPUT CIRCUITS

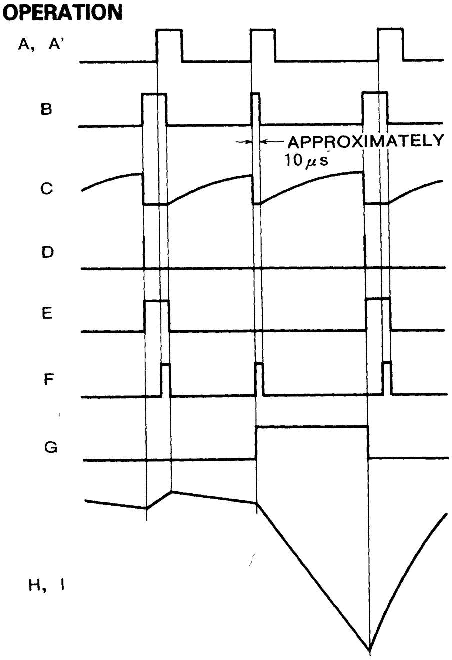


TIMING CHARTS

I. NORMAL OPERATION

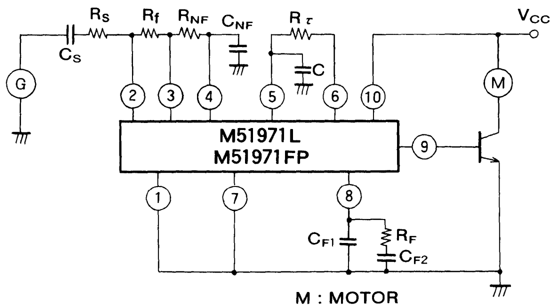


II. NORMAL OPERATION TO QUICK DISCHARGE OPERATION



APPLICATION EXAMPLES

I. When output impedance of tacho generator is low



M : MOTOR
G . TACHO GENERATOR

C_S : Coupling capacitor for AC amplifier
R_S, R_f : Resistor for setting FG amplifier gain
R_{NF}, C_{NF} : Filter for eliminating noise
R_τ, C_τ : Time constants for setting speed of motor
C_{F1}, C_{F2}, R_F Capacitor and resistor for phase compensation to stabilize integration and speed control systems

Note

1. The tacho generator signal width of set speed of motor should be less than $1mV_{P-P}$.
2. FG amplifier gain $\approx \sqrt{\dfrac{1+\omega_G^2 C_S^2 (R_S+R_f)^2}{1+\omega_G^2 C_S^2 R_S^2}}$

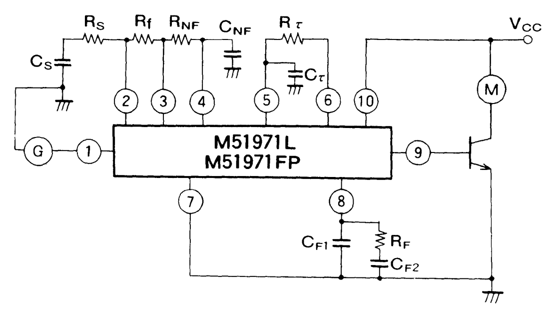
   ω_G: Tacho generator width angle frequency
3. The desirable values for C_S, R_S, R_{NF}, C_{NF} are as follows.

   $C_S \leqq 4.7\mu F$

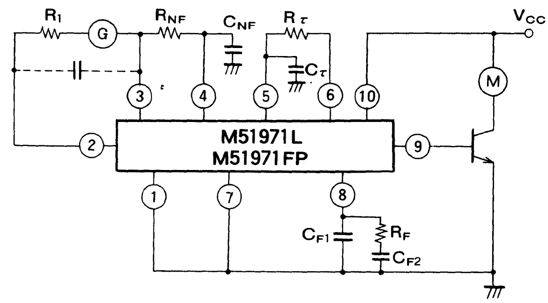
   $\dfrac{2}{\omega_G} \geqq C_S R_S \geqq \dfrac{1}{\omega_G}$

   $R_{NF} \cdot C_{NF} \leqq \dfrac{1}{\omega_G}$

II. When the output impedance of tacho generator is high and the signal width is small

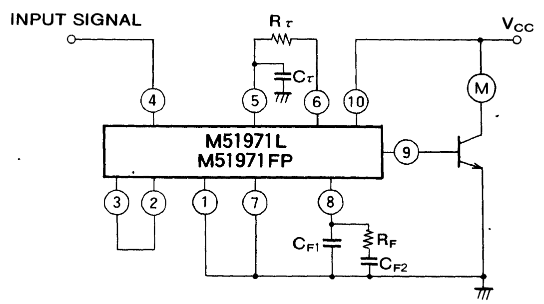


III. When the signal width of tacho generator is large



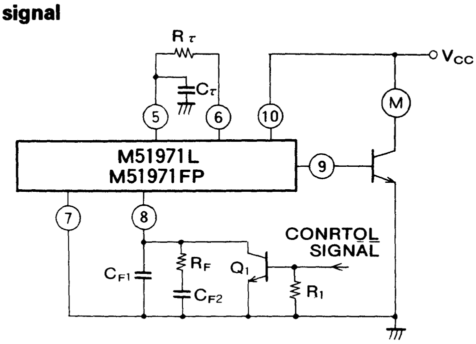
The output waveform exceeding the value of V_f(0.7V) in the above three examples are clipped by an internal waveform clipping diode.

IV. When the input waveform is pulsive



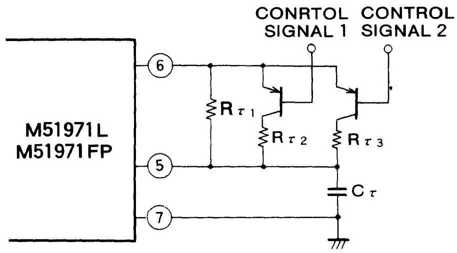
NOTE. The Pin ④ threshold voltage to GND is approximately 1.9V.

V. When a motor is turned ON/OFF by the control signal

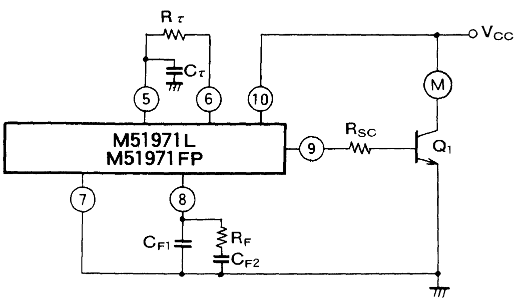


The motor is off when Q_1 is ON.
The speed control is on when Q_1 is OFF.

VI. When the set speed needs to be changed gradually by the control signal



VII. To limit the Pin ⑨ output current to suppress the hear of the IC

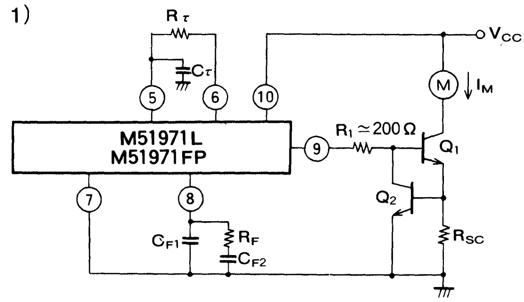


$$I_{(9)}max = \frac{V_{(9)}max}{R_{(9)}+R_{SC}} \quad V_{(9)}max \approx 3.2V, \ R_{(9)} \approx 100\Omega$$

(Refer to ELECTRICAL CHARACTERISTICS and TYPICAL CHARACTERISTICS)

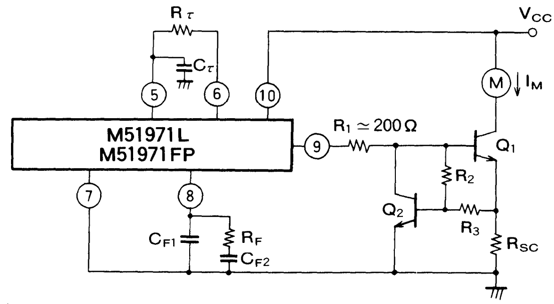
VIII. To limit the drive current of motor

1)



$$I_{Mmax} = \frac{V_{BE2}}{R_{SC}} \approx \frac{0.7V}{R_{SC}}$$

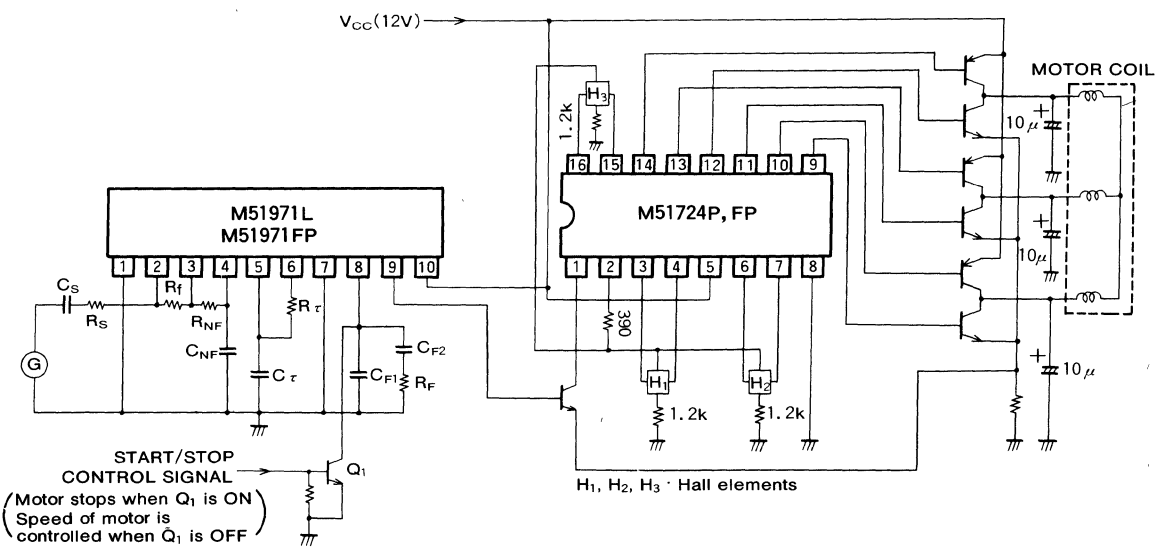
2) To minimize the power loss of current limiting resistor



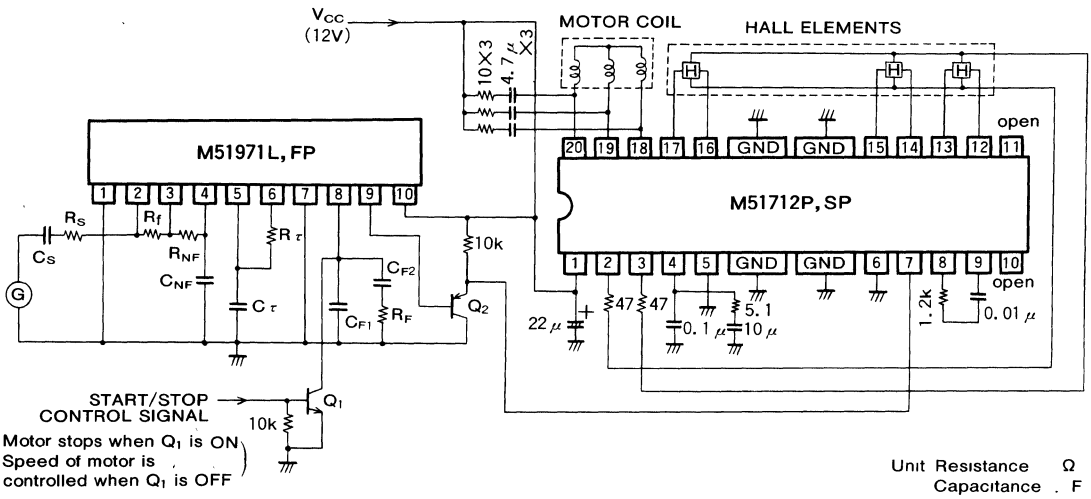
$$I_{Mmax} = (V_{BE2} - V_{BE1} \times \frac{R_3}{R_2+R_3})/R_{SC}$$

$$\approx \frac{0.7V \times R_2}{(R_2+R_3)\cdot R_{SC}}$$

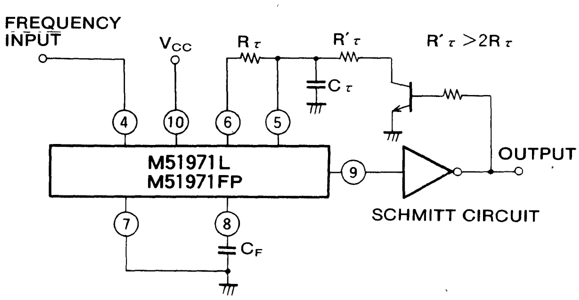
IX. Speed control drive circuit for 3-phase brushless motor, using the M51971 and M51924



X. Speed control drive circuit for 3-phase brushless motor, using the M51971 and M51712

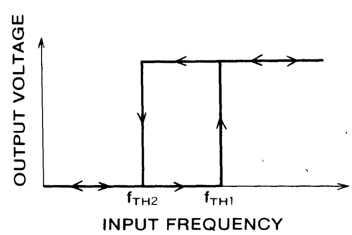


XI. Frequency comparator



Note. The hysteresis of Schmitt circuit should be higher than repple voltage at Pin ⑧ (to prevent chattering)

Input/output transfer characteristics



$$f_{TH1} \approx \frac{1}{1.20 \times R_\tau \cdot C_\tau}$$

$$f_{TH2} \approx \frac{1}{1.09 \times R_\tau // R'_\tau \times C_\tau \times \ln\left\{\frac{3(R_\tau + R'_\tau)}{R'_\tau - 2R_\tau}\right\}}$$

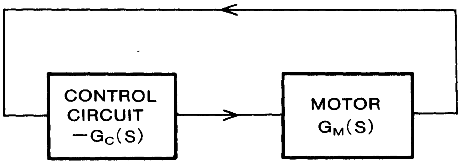
MITSUBISHI ELECTRIC

SOME HINTS TO DESIGN STABLE SPEED CONTROL SYSTEM

(How to determine filter constants at Pin ⑧ (C_{F1}, C_{F2}, R_F))

The filter constants at Pin ⑧ must be determined to satisfy the stability of the system.

1. Transfer function of speed control system for motor



SPEED CONTROL SYSTEM FOR MOTOR

The speed control system for the motor is a negative feedback system, including control citcuit and motor.

To achieve stable negative feedback, the phase stays 180° or less in the frequency range in which the gain of cyclic transfer function ($G_C(S) \cdot G_M(S)$) is greater than 1.

2. Transfer function of motor

With the armature current of motor as I_a and angle speed as ω_V, the following equation is obtained.

$$\Delta T_g = K_T \cdot \Delta I_a = (SJ + D) \cdot \Delta \omega_V \quad \cdots\cdots (1)$$

where T_g: torque generated by motor
K_T: proportional constant between torque generated by motor and armature current
J: inertia moment of motor and load
D: viscous friction coefficient

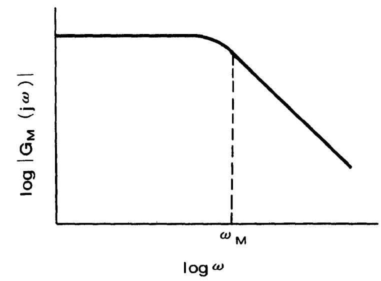
As the relationship between tacho generator angle frequency ω and motor angle speed ω_V, with number of pole pairs of tacho generator ad P, is expressed as $\omega = P \cdot \omega_V$, the transfer function of motor (transfer function including motor and tacho generator) $G_M(S)$ is a single-pole transfer function, and is given by

$$G_M(S) = \frac{\Delta \omega}{\Delta I_a} = \frac{P \cdot K_T}{D \cdot (1 + S \cdot \frac{J}{D})} \quad \cdots\cdots (2)$$

$$= \frac{K_M}{1 + \frac{S}{\omega_M}} \quad \cdots\cdots (3)$$

where $K_M = \frac{P \cdot K_T}{D} \quad \cdots\cdots (4)$

$$\omega_M = \frac{D}{J} \quad \cdots\cdots (5)$$



Simulated transfer function of the motor

3. Transfer function of control circuit using the M51971

Under the assumption that input information is continuously given, (tacho generator frequency is assumed to be infinitely high), the transfer function from the input at Pin ④ to the output at Pin ⑨ is given as follows;

$$G_{C(M51971)}(S) = \frac{\Delta(\text{PIN ⑨ OUTPUT VOLTAGE})}{\Delta(\text{PIN ④ INPUT FREQUENCY})}$$

$$= \frac{T_\tau (|I_{⑧c}| + |I_{⑧d}|)}{C_{F1} + C_{F2}} \times \frac{1 + S/\omega_{F1}}{S(1 + S/\omega_{F2})} \quad \cdots\cdots (6)$$

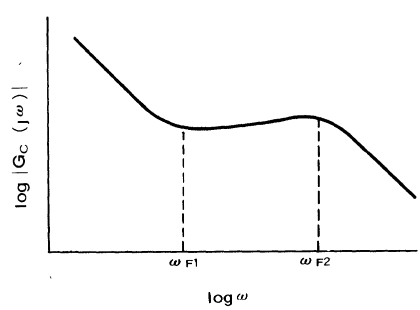
where T_τ: pulse width of timer $\approx 1.10 \times R_\tau \times C_\tau$
$I_{⑧c}$: charge current at Pin⑧
$I_{⑧d}$: discharge current at Pin ⑧

$$\omega_{F1} = \frac{1}{R_F \cdot C_{F2}}$$

$$\omega_{F2} = \frac{C_{F1} + C_{F2}}{R_F \cdot C_{F1} \cdot C_{F2}}$$

With the gain of the circuit connected after Pin ⑨ of the M51971 as K_{CP}, the transfer function of the whole circuit $G_C(S)$ is given in the following;

$$G_C(S) = K_{CP} \times \frac{T_\tau (|I_{⑧c}| + |I_{⑧d}|)}{C_{F1} + C_{F2}} \times \frac{1 + S/\omega_{F1}}{S(1 + S/\omega_{F2})} \quad \cdots (7)$$



Simulated transfer function of the control circuit

4. Requirement for stable control

For stable control of motor, the phase characteristics must be less than 180 in the frequency fange where the gain of $G_C(S) \cdot G_M(S)$ is greater than 1.

The relationship between phase and gian is determined by the Baud's theorem when all the poles and zero pints of transfer function are on the left of the complex sphere.

If the $G_C(j\omega) \cdot G_M(j\omega)$ follows the Baud's theorem, the inclination of gain of $G_C(j\omega) \cdot G_M(j\omega)$ should be more than -12dB/oct in the frequency range of $|G_C(j\omega) \cdot G_M(j\omega)| \geqq 1$ to ensure stable control.

When circuits constants are chosen so that $\omega_{F1} \approx \omega_M$, the following equation must be established in the frequency range where the inclination of gain of $G_C(j\omega)$ and $G_M(j\omega)$ are both -6dB/oct, in other words, the inclination of gain of $G_C(j\omega) \cdot G_M(j\omega)$ becomes -12dB/oct.

For precision control, the gain of one cycle transfer function must be large in all frequency ranges.

Fluctuation of speed of motor due to external disturbance is reduced if the inclination is -6dB/oct in the frequency range higher than ω_M.

Therefore, capacity of speed control in the frequency range from ω_{F1} to ω_{F2} is determined by the gain of one cycle transfer function when ω_{F1} ($\approx \omega_{F2}$). The following equation is established as $|G_C(j\omega_{F2}) \cdot G_M(j\omega_{F2})| < 1$ and the inclination of gain of $G_C(j\omega) \cdot G_M(j\omega)$ is approximately -6dB in the frequency range of ω_{F2} or less.

$$|G_C(j\omega_M) \cdot G_M(j\omega_M)| < \frac{\omega_{F2}}{\omega_{F1}} \approx \frac{\omega_{F2}}{\omega_M} \quad \cdots\cdots (9)$$

Therefore, the following conditions are required to improve accuracy of control in the frequency range from ω_{F1} to ω_{F2}.

$$\omega_{F1} \approx \omega_M \quad \cdots\cdots (10)$$

$$\frac{\omega_{F2}}{\omega_{F1}} \gg 1 \quad \cdots\cdots (11)$$

Then, the values of K_{CP} or $C_{F1}+C_{F2}$ must be set to satisfy the equations (4) and (5).

5. Influence of tacho generator frequency on stability

The tacho generator frequency, which is a system controlled by period, is basically a kind of sample hold system controlled by discrete information on the time axis.

The sample hold operation only adds an extra phase delay only to make the system unstable.

$$H^*(j\omega) = \frac{\sin \pi (\omega/\omega_G)}{\pi (\omega/\omega_G)} e^{-j\frac{2\pi\omega}{\omega_G}} \sum_{n=-\infty}^{\infty} H(j\omega + jn\omega_G) \quad \cdots\cdots (12)$$

Here, ω_G: Set value of tacho generator frequency

Additional phase delay of $2\pi\,\omega/\omega_G$(rad.) need to be considered.

Therefore, for the angle frequency where $|G_C^*(j\omega) \cdot G_M^*(j\omega)| = 1$ is ω_{odB}, the following equation must be established.

$$\omega_G > 4 \cdot \omega_{odB} \quad \cdots\cdots (13)$$

With this, if the ω_G is determined, the gain value of one cycle transfer function can be obtained.

$$|G_C(j\omega_M) \cdot G_M(j\omega_M)| < 0.357 \times \frac{\omega_G}{\omega_M} \quad \cdots\cdots (14)$$

This equation (14) must be satisfied in any control systems using tacho generator frequency irrespective of control method, and, it can be noted that, once the motor and tacho generator are determined, the upper limit value of the control gain in ω_M is determined.

To improve the accuracy of speed control, it is necessary that $|G_C(j\omega_M) \cdot G_M(j\omega_M)| \gg 1$ and, therefore, the following equation must be established.

$$0.357 \cdot \frac{\omega_G}{\omega_M} \gg 1 \quad \cdots\cdots (15)$$

6. Summary

The following is the method of designing speed control system, making the maximum use of characteristics of motors, based on the above-mentioned theoretical considerations.

$$(1)\quad \omega_{F1} = \frac{1}{R_F \cdot C_{F2}} \approx \omega_M \quad \cdots\cdots (16)$$

It is desirable that the circuit constant is set closed to the minimum value of ω_M, if the ω_M changes greatly when motor load is changed.

$$(2)\quad \omega_{F2} = \frac{C_{F1}+C_{F2}}{R_F \cdot C_{F1} \cdot C_{F2}} \geqq \frac{1}{4}\omega_G \quad \cdots\cdots (17)$$

The smaller the value of C_{F1}, the less is the influence of ω_{F2}, but the greater the peak-to peak value of output pin waveform and the drive waveforms becomes more pulsive.

Therefore, both arms of the equation should be equal in most cases of system designing.

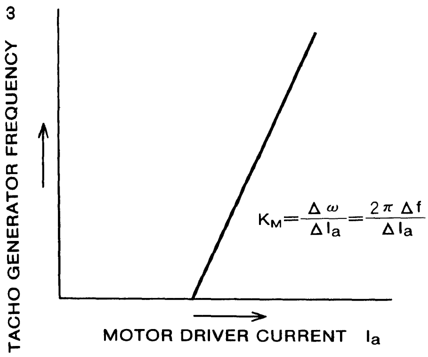
(3) Selection of gain

Obtain the value for stable control, changing the values of K_{CP}, C_{F1} or C_{F2}, satisfying at the same time the relationship described in the above (16) and (17).

When setting the stepping motor speed, the speed is usually unstable at slow speed, ad therefore, experiments should be made at the slowest speed.

How to obtain approximate value of transfer function of motor

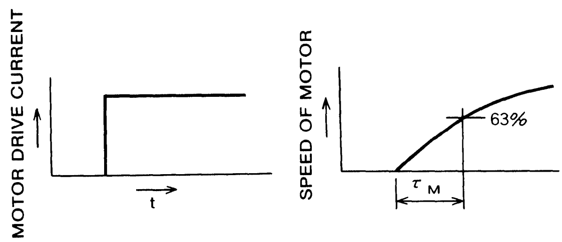
(1) How to obtain K_M



Plot the relationship between motor drive current and tacho generator frequency and obtain the inclination.

(2) How to obtain ω_M

The ω_M can be obtained by measuring frequency response of motor but usually this method takes long time. In stead, the approximate value can be simply obtained by measuring the step response.



The method is to apply stepping current to halted motor and measure the time τ_M when the speed of motor reaches 63% of the final speed and the τ_M is obtained from the following equation.

$$\tau_M = \frac{1}{\tau_M} \quad \cdots\cdots (18)$$

M51724P,FP

3-PHASE BRUSHLESS MOTOR PRE-DRIVER

DESCRIPTION

The M51724P,FP are semiconductor integrated circuits designed for use in 3-phase DC brushless motor.

FEATURES

- Suitable for various kind of motor system by selecting the external power transistors
- Internal current distribution circuit
- Good balance in output current between each phase
- Few externally connected parts

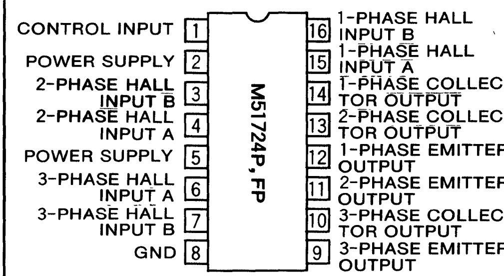
APPLICATION

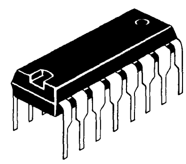
Brushless motor driver for VTR, cassette tape deck, floppy-disk drive.

RECOMMENDED OPERATING CONDITIONS

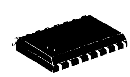
Supply voltage range ································· 10V～20V
Rated supply voltage ··15V

PIN CONFIGURATION (TOP VIEW)



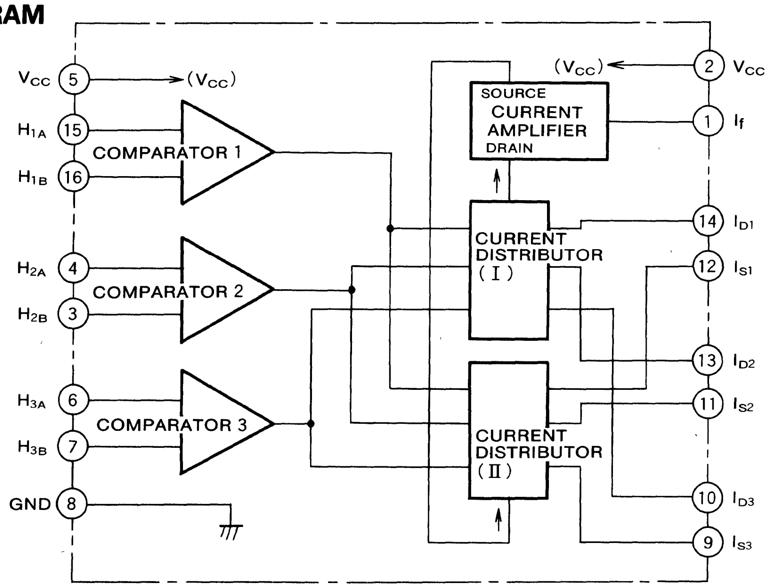


16-pin molded plastic DIP



16-pin molded plastic FLAT

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

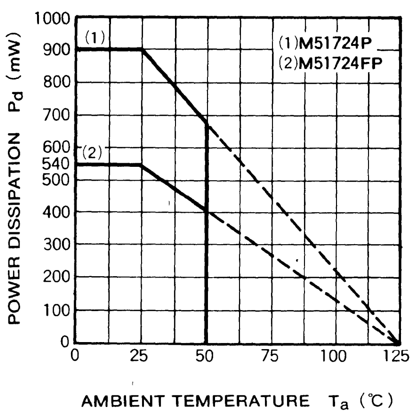
Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		20	V
I_f	Control input current		1	mA
V_D	Applied voltage at collector output pin		24	V
V_S	Applied voltage at emitter output pin		6.5	V
V_H	Applied voltage at hall output pins		6.5	V
f_{in}	Hall input frequency		DC~1	kHz
P_d	Power dissipation	( )=M51724FP	900(540)	mW
K_θ	Thermal derating(T≧25℃)	( )=M51724FP	110(185)	℃/W
T_{opr}	Operating temperature		−10~+50	℃
T_{stg}	Storage temperature		−40~+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=15V, unless otherwise noted)

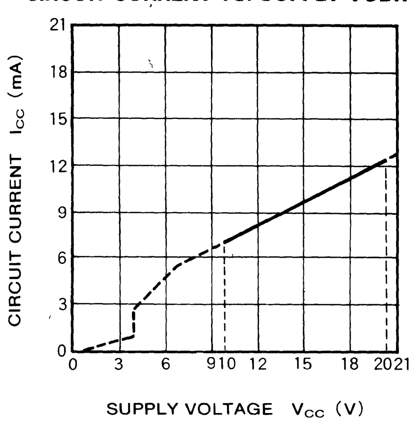
Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
I_{CC}	Circuit current		5	12	27	mA
V_{offset}	Comparator input offset voltage			5	20	mV
K_D	Collector output current gain		10	15	20	A/A
K_S	Emitter output current gain		11	16	21	A/A
$I_{D(max1)}$	Maximum output current of collector output (1)		3	4		mA
$I_{D(max2)}$	Maximum output current of collector output (2)		5.5	7		mA
$I_{S(max1)}$	Maximum output current of emitter output (1)		3	4		mA
$I_{S(max2)}$	Maximum output current of emitter output (2)		5	7		mA
M_D	Current gain ratio between collector output phases		0.75	1	1.33	A/A
M_S	Current gain ratio between emitter output phases		0.75	1	1.33	A/A
I_{in}	Comparator input current		0.1	1.5	6	μA
I_{LD}	Collector output leak current				200	nA
I_{LS}	Emitter output leak current				200	nA

TYPICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

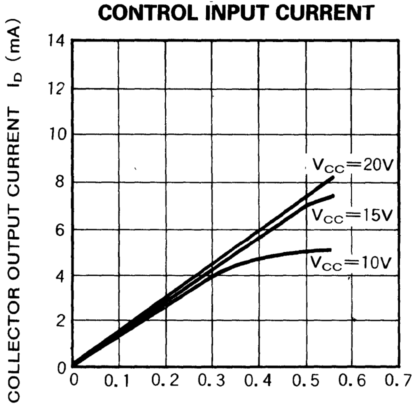
THERMAL DERATING (MAXIMUM RATING)



CIRCUIT CURRENT VS. SUPPLY VOLTAGE

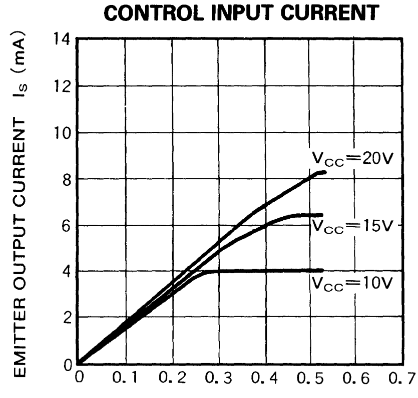


COLLECTOR OUTPUT CURRENT VS. CONTROL INPUT CURRENT



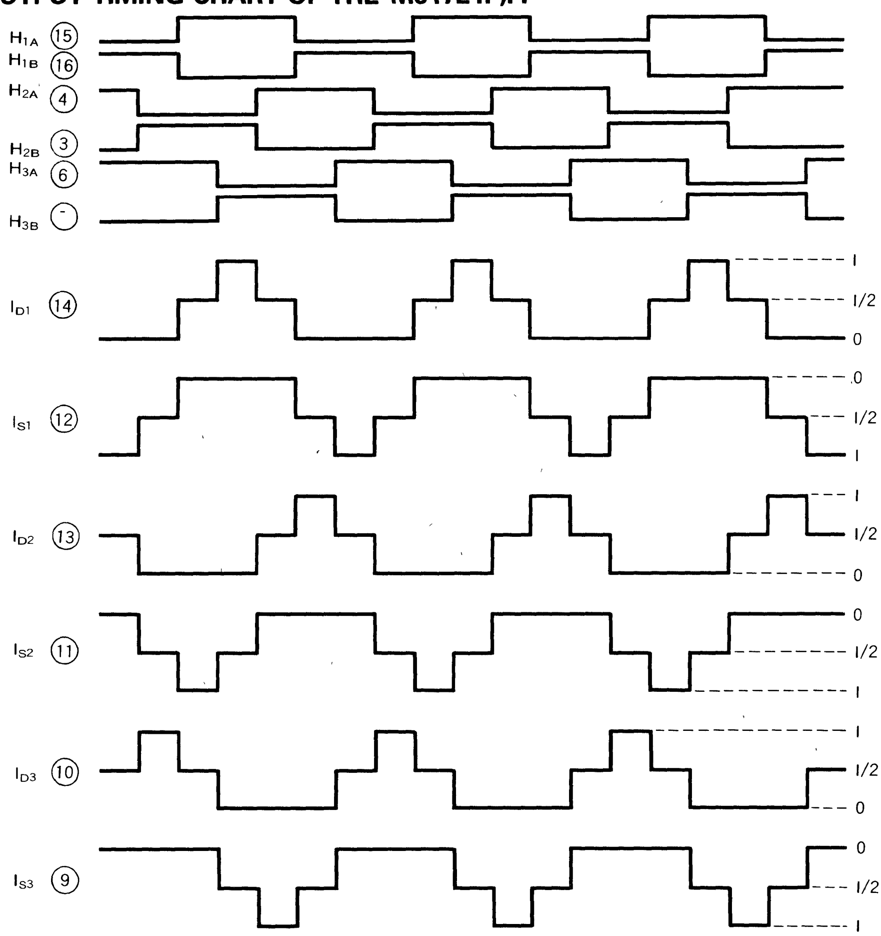
Note. when collector output 1 system and emitter output 2 system are ON

EMITTER OUTPUT CURRENT VS. CONTROL INPUT CURRENT



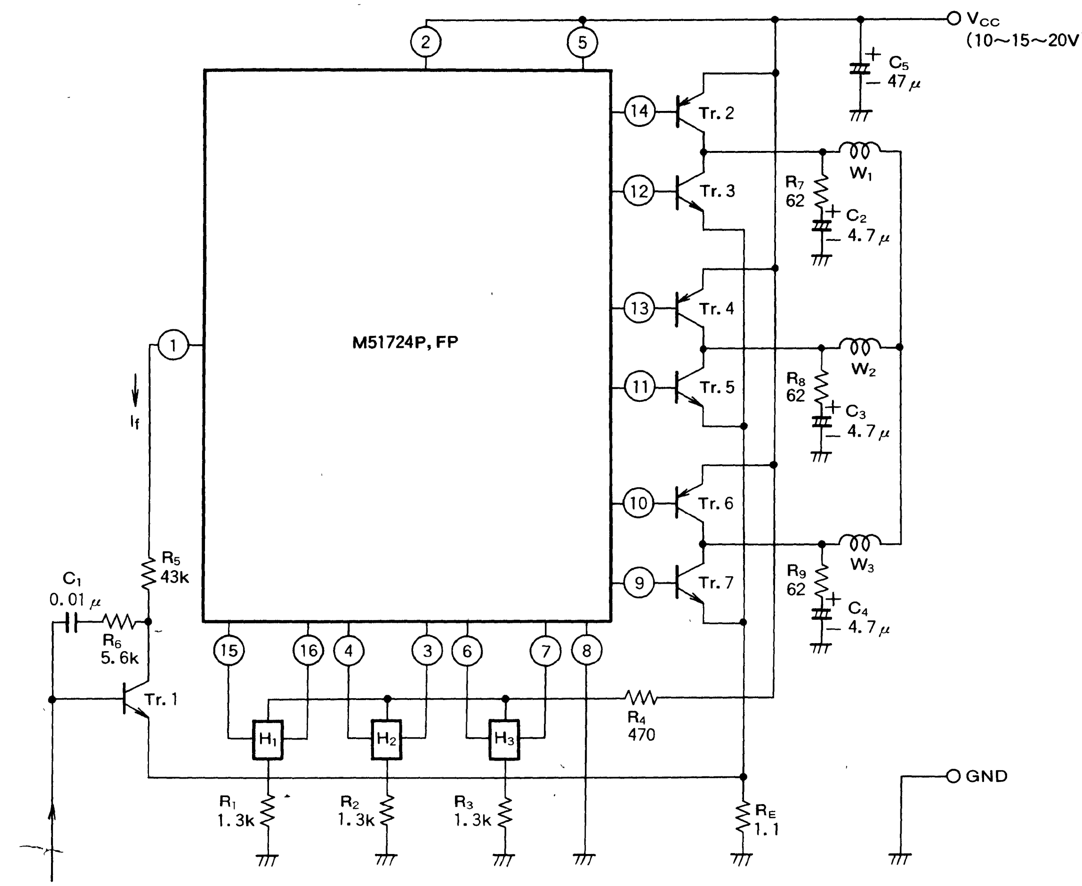
Note when collector output 2 system and emitter output 1 system are ON

INPUT/OUTPUT TIMING CHART OF THE M51724P,FP



Note : 1. In the output current value (I_D, I_S) , + indicates source current and — indicates sink current
2. All the input pins are biased.
3. Care must be taken to connect a load (low impedance) to all the output pins according to the current at the control input Pin ①

APPLICATION EXAMPLE



※All constants are tentative.

Unit Resistance : Ω
Capacitance : F

NOTE :

1. R_1~R_4 : For hall element bias
2. R_5 : For output (input) current limiting
3. R_6, C_1 : For oscillation prevention
4. R_7-R_9, C_2, C_4 : For reduction of driver noise
5. C_5 : For power supply stabilizing
6. R_E : For current feedback
7. Tr. 1 : Control transistor (S. S.)
8. Tr. 2-Rr. 7 : Power transistors
9. H_1-H_3 : Hall elements for position detection
10. The same power supply (V_{CC}) must be connected to Pin ② and Pin ⑤

SPEED CONTROL AND DRIVER FOR 2-PHASE BRUSHLESS MOTOR

DESCRIPTION

The M51781SP is a semiconductor integrated circuit developed for use in controlling 2-phase DC brushless motor. Both control and driver systems are contained in a single chip. It employs hall elements for position detection and consists of an FG amplifier, F-V converter, sample and hold circuit, constituting a complete circuit of F-serve motor driver system in a single chip.

FEATURES

- Includes both control system and driver system in a single chip
- Drives all waves of 2-phase motors
- High output current
- Including FG amplifier, hysteresis comparator, F-V converter, sample and hold circuit
- Gain adjustment of control amplifier of the final stage of servo system possible
- Internal reference voltage generator
- Built-in output current limiter circuit
- Including forward/reverse direction control pins
- Start/stop control pins provided

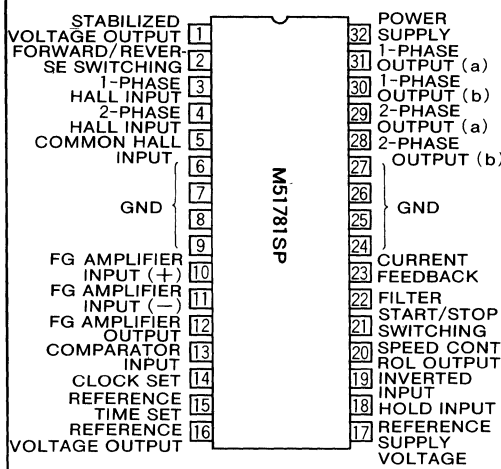
APPLICATION

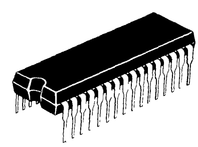
FDD, etc.

RECOMMENDED OPERATING CONDITIONS

Supply voltage range ································ 7.2V~18V
Rated supply voltage ··12V

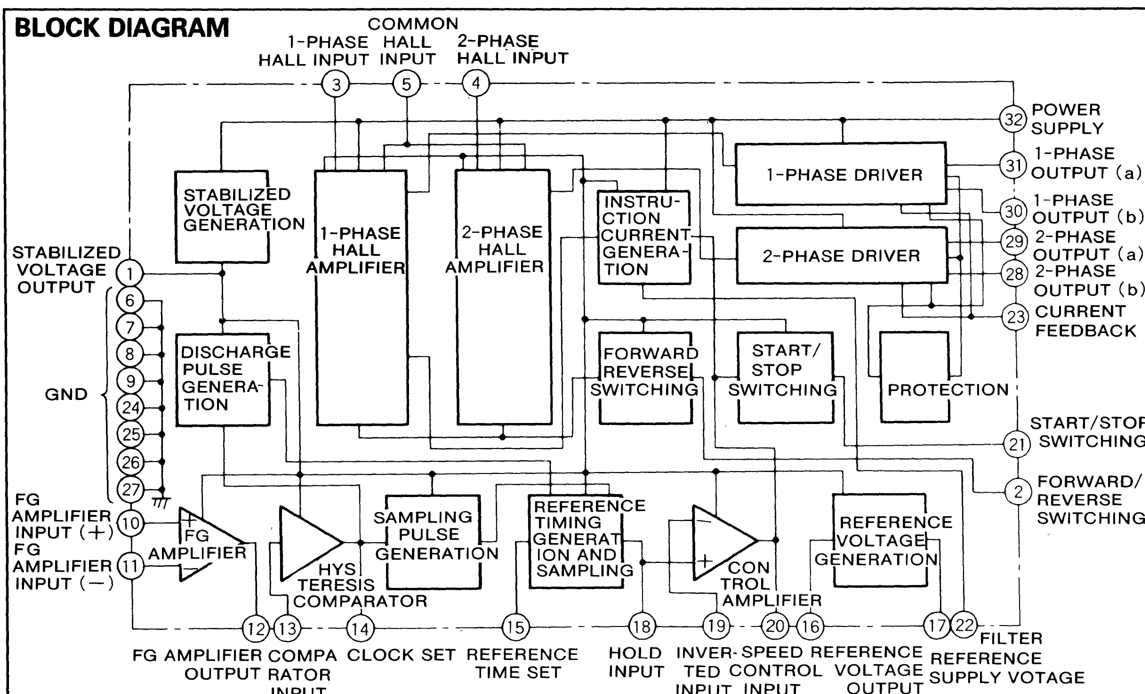
PIN CONFIGURATION (TOP VIEW)





32-pin molded plastic DIP shrink

BLOCK DIAGRAM



MITSUBISHI ELECTRIC

SPEED CONTROL AND DRIVER FOR 2-PHASE BRUSHLESS MOTOR

ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

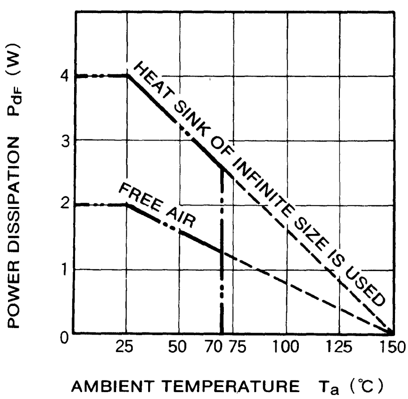
Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		18	V
I_{Lmax}	Charge current		1.2	A/PHASE
I_L	Output current		0.4	A/PHASE
I_{stb}	Pin ① output current		20	mA
$I_{OL⑭}$	Pin ⑭ source current	When discharge of time constant capacitor is finished	10	mA
$I_{OL⑮}$	Pin ⑮ source current	When discharge of time constant capacitor is finished	10	mA
V_H	Applied voltages between pins ③—⑤ and pins ④—⑤		5	V_{P-P}
$V_{⑱-⑲}$	Applied current between pin ⑱ and pin ⑲		±0.7	V
$V_{H(C)}$	Hall input common phase voltage	Between pins ③—⑤ and pins ④—⑤	1～V_{stb}−1	V
P_{dF}	Power dissipation	Heat sink of infinite size is used	4	W
T_{opr}	Operating temperature		−20～+70	℃
T_{stg}	Storage temperature		−40～+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=12V, unless otherwise noted)

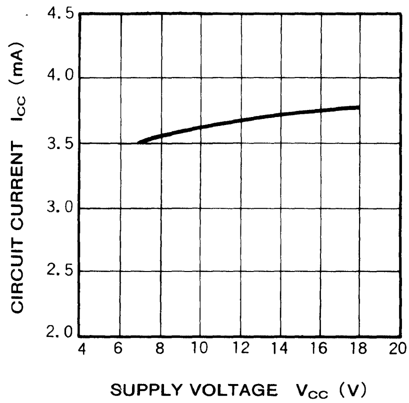
Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
$I_{CC(1)}$	Circuit current (1)		2.2	3.5	5.5	mA
$I_{CC(2)}$	Circuit current (2)	V_{CC}=18V	2.4	3.9	6.6	mA
$V_{stb(1)}$	Stabilized output voltage (1)		5.4	5.8	6.2	V
$V_{stb(2)}$	Stabilized output voltage (2)	270Ω between V_{stb} and GND	5.2	5.8	6.2	V
V_{ref}	Output voltage of reference voltage		2.72	2.90	3.02	V
$I_{⑩}$	Pin ⑩ input current	V_{CC}=V_{stb}=5.8V, $V_{⑩}$=0V		0.5	3.0	μA
$I_{⑪}$	Pin ⑪ input current	V_{CC}=V_{stb}=5.8V, $V_{⑩}$=0V		30	180	nA
$V_{OL⑭}$	Pin ⑭ low level voltage	V_{CC}=V_{stb}=5.8V, 10kΩ between V_{stb} and pin ⑭		80	120	mV
$V_{OL⑮}$	Pin ⑮ low level voltage	V_{CC}=V_{stb}=5.8V, 10kΩ between V_{stb} and pin ⑮		50	90	mV
$V_{TH(1)}$	Clock threshold voltage (1)	V_{CC}=V_{stb}=5.8V	1.83	1.95	2.05	V
$V_{TH(2)}$	Clock threshold voltage (2)	V_{CC}=V_{stb}=5.8V	2.75	2.90	3.05	V
$V_{TH(3)}$	Clock threshold voltage (3)	V_{CC}=V_{stb}=5.8V	3.12	3.28	3.44	V
$V_{TH(4)}$	Clock threshold voltage (4)	V_{CC}=V_{stb}=5.8V	4.10	4.32	4.54	V
$V_{OL⑳}$	Pin ⑳ low level voltage	V_{CC}=V_{stb}=5.8V, 5.1kΩ between V_{stb} and pin ⑳		0.75	1.00	V
$V_{offset⑮-⑱}$	Offset voltage between pin ⑮ and pin ⑱	V_{CC}=V_{stb}=5.8V			±10	mV
$V_{offset⑱-⑲}$	Offset voltage between pin ⑱ and pin ⑲	V_{CC}=V_{stb}=5.8V			±10	mV
$I_{Ba(max)}$	Maximum bias current of a output	Measured at pin ㉓	9	13		mA
$I_{Bb(max)}$	Maximum bias current of b output	Measured at pin ㉓	9	13		mA
$KI_{B(max)}$	Maximum current bias ratio	Calculated by $I_{Ba(max)}/I_{Bb(max)}$	0.9	1.0	1.1	A/A
$V_{sat(U)}$	Output saturation voltage (upper)	I_O=0.8A, applicable to pins ㉘～㉛		1.5	2.2	V
$V_{sat(D)}$	Output saturation voltage (lower)	I_O=0.8A, applicable to pins ㉘～㉛		1.0	1.5	V

TYPICAL CHARACTERISTICS

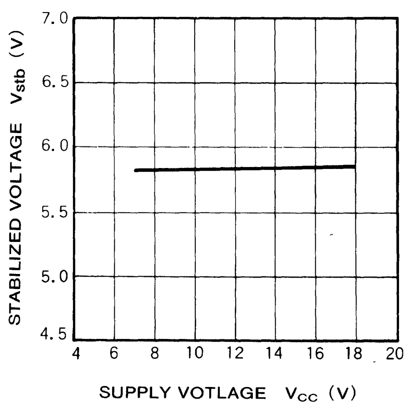
THERMAL DERATING (MAXIMUM RATING)



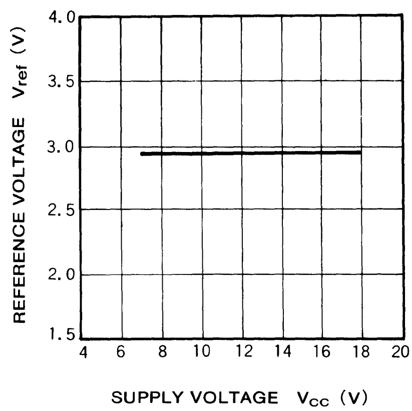
CIRCUIT CURRENT VS. SUPPLY VOLTAGE



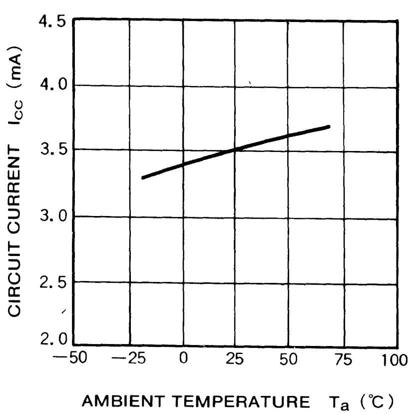
STABILIZED VOLTAGE VS. SUPPLY VOTAGE



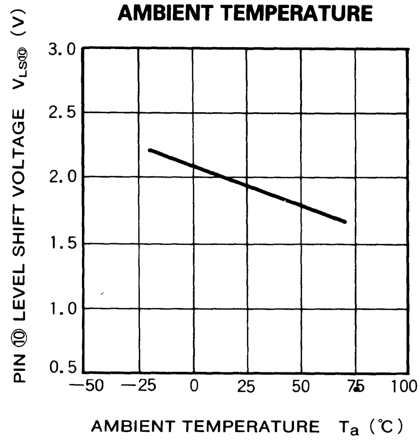
REFERENCE VOLTAGE VS. SUPPLY VOLTAGE



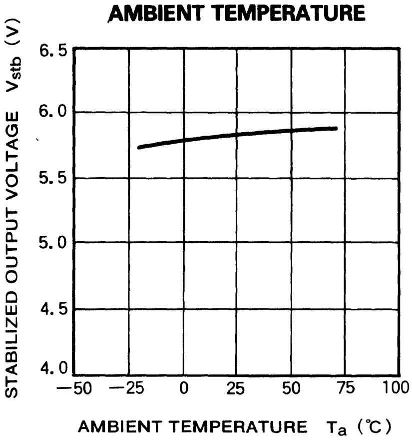
CIRCUIT CURRENT VS. AMBIENT TEMPERATURE



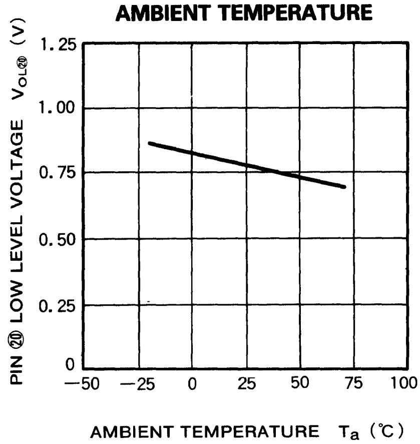
PIN ⑩ LEVEL SHIFT VOLTAGE VS. AMBIENT TEMPERATURE



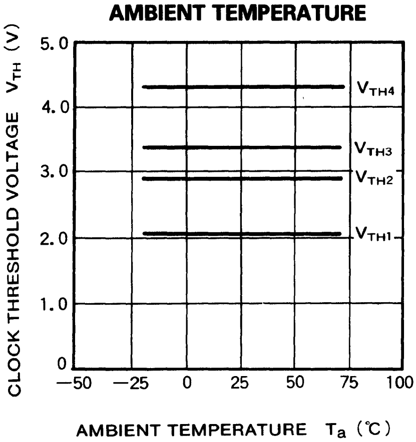
STABILIZED OUTPUT VOLTAGE VS. AMBIENT TEMPERATURE



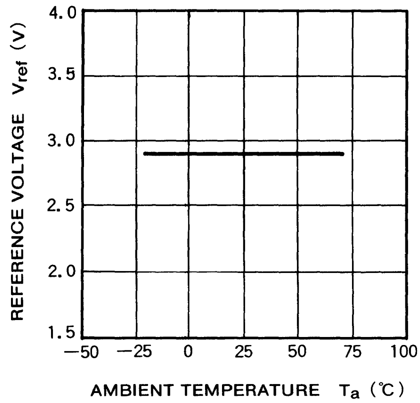
PIN ⑳ LOW LEVEL VOLTAGE VS. AMBIENT TEMPERATURE



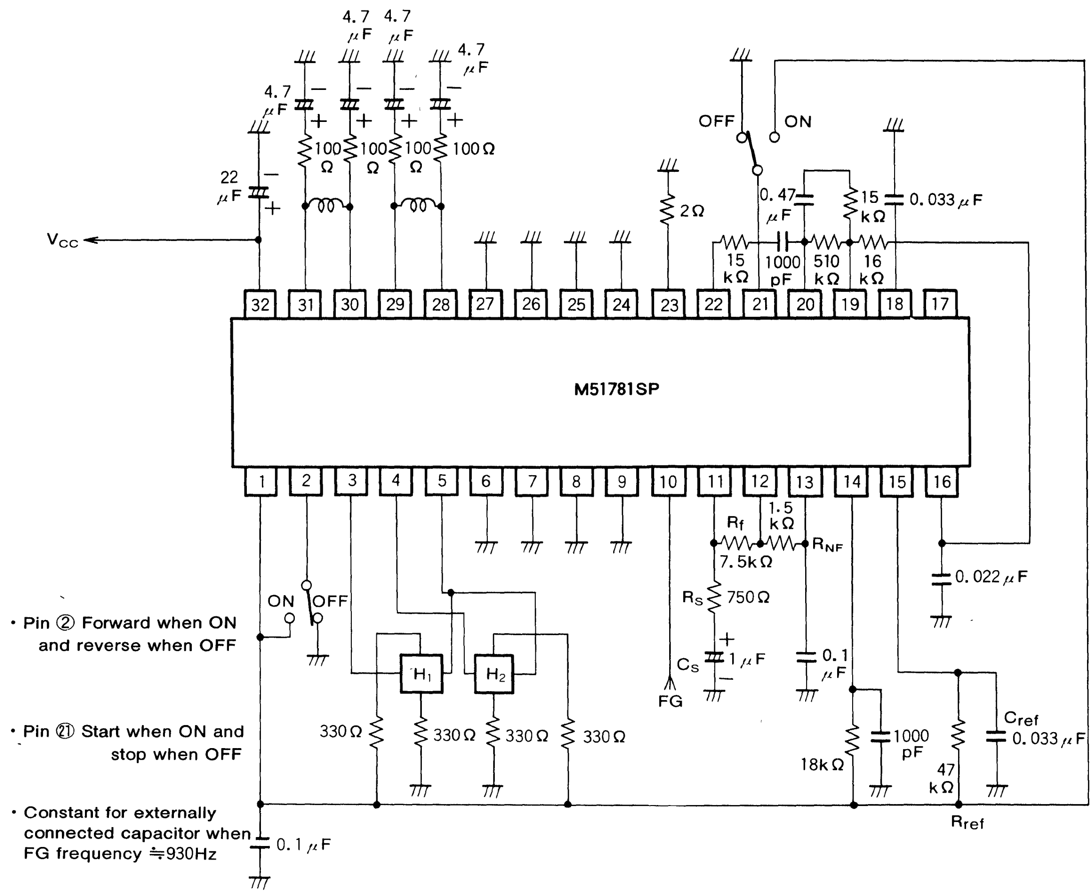
CLOCK THRESHOLD VOLTAGE VS. AMBIENT TEMPERATURE



REFERENCE VOLTAGE VS. AMBIENT TEMPERATURE



APPLICATION EXAMPLE



Note 1. The signal amplitude for the input tacho generator should be $1mV_{P-P}$ or more.

First stage amplifier gain $\sim \frac{1+\omega_G{}^2 C_S{}^2 (R_S+R_f)^2}{1+\omega_G{}^2 C_S{}^2 R_S{}^2}$

where ω_G: input tacho generator angle frequency

C_S must be chosen $4.7\mu F$ or less. The disireable range of R_S is obtained in the following.

$$\frac{2}{\omega_G} \geqq C_S \cdot R_S \geqq \frac{1}{\omega_G}$$

Note 2. R_{NF} and C_{NF} are resistor and capacitor for noise filtering. If the time constant is too large, the input signal is weakened. R_{NF} and C_{NF} should be chosen as follows;

$$R_{NF} \cdot C_{NF} \leqq \frac{1}{\omega_G}$$

Note 3. R_{ref} and C_{ref} are resistor and capacitor for setting speed of motor. R_{ref} and C_{ref} should be chosen as follows;

$$R_{ref} \cdot C_{ref} = \frac{1}{0.693 \cdot f_G}$$

where f_G: input tacho generator frequency

MITSUBISHI ELECTRIC

M51781FP

SPEED CONTROL AND DRIVER FOR 2-PHASE BRUSHLESS MOTOR

DESCRIPTION

The M51781FP is a semiconductor integrated circuit developed for use in controlling 2-phase DC brushless motor. Both control and driver systems are contained in a single chip. It employs hall elements for position detection and consists of an FG amplifier, F-V converter, sample and hold circuit, constituting a complete circuit of F-serve motor driver system in a single chip.

FEATURES

- Includes both control system and driver system in a single chip
- Drives all waves of 2-phase motors
- High output current
- Including FG amplifier, hysteresis comparator, F-V converter, sample and hold circuit
- Gain adjustment of control amplifier of the final stage of servo system possible
- Internal reference voltage generator
- Built-in output current limiter circuit
- Including forward/reverse direction control pins
- Start/stop control pins provided

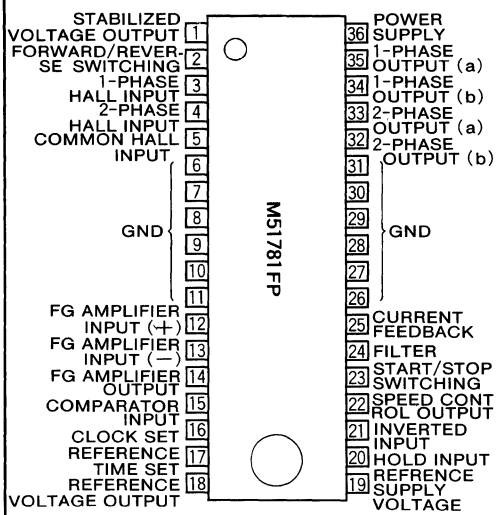
APPLICATION

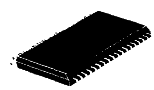
FDD, etc.

RECOMMENDED OPERATING CONDITIONS

Supply voltage range ································ 7.2V~18V
Rated supply voltage ···12V

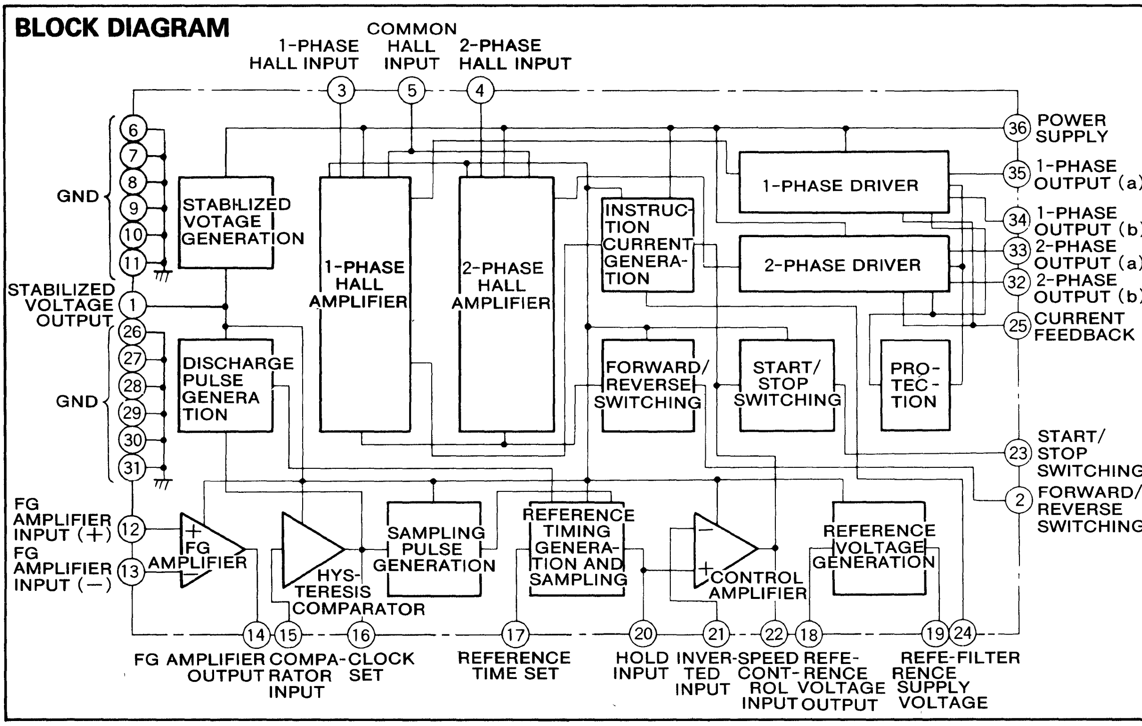
PIN CONFIGURATION (TOP VIEW)





36-pin molded plastic FLAT (A type)

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

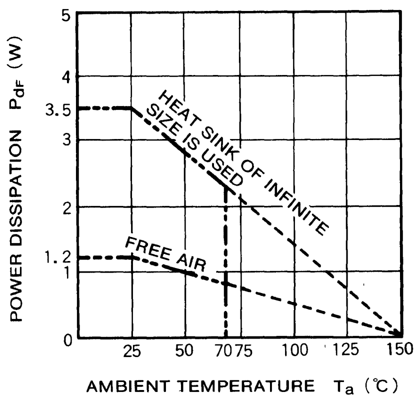
Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		18	V
I_{Lmax}	Charge current		1.2	A/PHASE
I_L	Output current		0.4	A/PHASE
I_{stb}	Pin ① output current		20	mA
I_{OL}⑯	Pin ⑯ source current	When discharge of time constant capacitor is finished	10	mA
I_{OL}⑰	Pin ⑰ source current	When discharge of time constant capacitor is finished	10	mA
V_H	Applied voltages between pins ③—⑤ and pins ④—⑤		5	V_{P-P}
V⑳-㉑	Applied current between pin ⑳ and pin ㉑		±0.7	V
$V_{H(C)}$	Hall input common phase voltage	Between pins ③—⑤ and pins ④—⑤	1～V_{stb}−1	V
P_{dF}	Power dissipation	Heat sink of infinite size is used	3.5	W
T_{opr}	Operating temperature		−20～+70	℃
T_{stg}	Storage temperature		−40～+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=12V, unless otherwise noted)

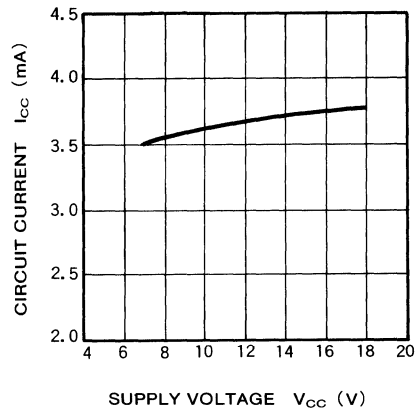
Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
$I_{CC(1)}$	Circuit current (1)		2.2	3.5	5.5	mA
$I_{CC(2)}$	Circuit current (2)	V_{CC}=18V	2.4	3.9	6.6	mA
$V_{stb(1)}$	Stabilized output voltage (1)		5.4	5.8	6.2	V
$V_{stb(2)}$	Stabilized output voltage (2)	270Ω between V_{stb} and GND	5.2	5.8	6.2	V
V_{ref}	Output voltage of reference voltage		2.72	2.90	3.02	V
I⑫	Pin ⑫ input current	V_{CC}=V_{stb}=5.8V, V⑫=0V		0.5	3.0	μA
I⑬	Pin ⑬ input current	V_{CC}=V_{stb}=5.8V, V⑬=0V		30	180	nA
V_{OL}⑯	Pin ⑯ low level voltage	V_{CC}=V_{stb}=5.8V, 10kΩ between V_{stb} and pin ⑯		80	120	mV
V_{OL}⑰	Pin ⑰ low level voltage	V_{CC}=V_{stb}=5.8V, 10kΩ between V_{stb} and pin ⑰		50	90	mV
$V_{TH(1)}$	Clock threshold voltage (1)	V_{CC}=V_{stb}=5.8V	1.83	1.95	2.05	V
$V_{TH(2)}$	Clock threshold voltage (2)	V_{CC}=V_{stb}=5.8V	2.75	2.90	3.05	V
$V_{TH(3)}$	Clock threshold voltage (3)	V_{CC}=V_{stb}=5.8V	3.12	3.28	3.44	V
$V_{TH(4)}$	Clock threshold voltage (4)	V_{CC}=V_{stb}=5.8V	4.10	4.32	4.54	V
V_{OL}㉒	Pin ㉒ low level voltage	V_{CC}=V_{stb}=5.8V, 5.1kΩ between V_{stb} and pin ㉒		0.75	1.00	V
V_{offset}⑰-⑳	Offset voltage between pin ⑰ and pin ⑳	V_{CC}=V_{stb}=5.8V			±10	mV
V_{offset}⑳-㉑	Offset voltage between pin ⑳ and pin ㉑	V_{CC}=V_{stb}=5.8V			±10	mV
$I_{Ba(max)}$	Maximum bias current of a output	Measured at pin ㉕	9	13		mA
$I_{Bb(max)}$	Maximum bias current of b output	Measured at pin ㉕	9	13		mA
$KI_{B(max)}$	Maximum current bias ratio	Calculated by $I_{Ba(max)}/I_{Bb(max)}$	0.9	1.0	1.1	A/A
$V_{sat(U)}$	Output saturation voltage (upper)	I_O=0.8A, applicable to pins ㉜～㉟		1.5	2.2	V
$V_{sat(D)}$	Output saturation voltage (lower)	I_O=0.8A, applicable to pins ㉜～㉟		1.0	1.5	V

TYPICAL CHARACTERISTICS

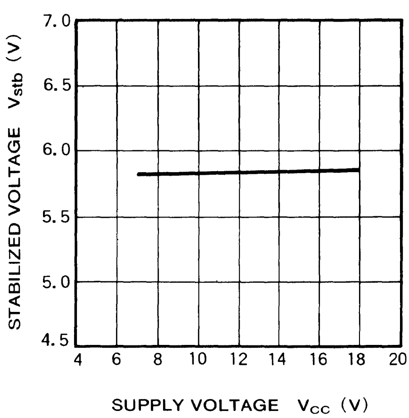
THERMAL DERATING (MAXIMUM RATING)



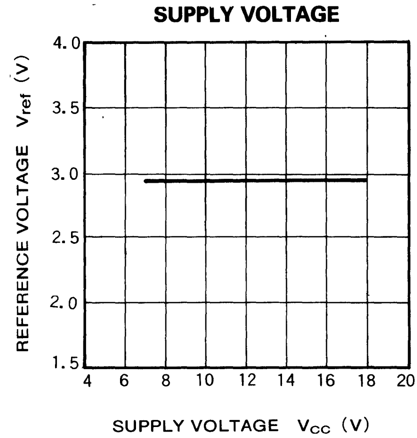
CIRCUIT CURRENT VS. SUPPLY VOLTAGE



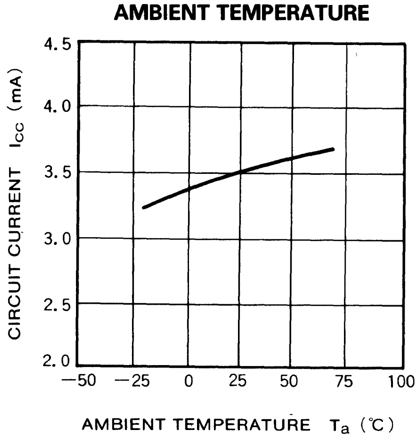
STABILIZED VOLTAGE VS. SUPPLY VOLTAGE



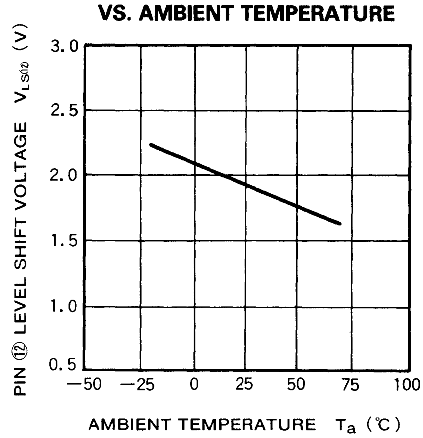
REFERENCE VOLTAGE VS. SUPPLY VOLTAGE



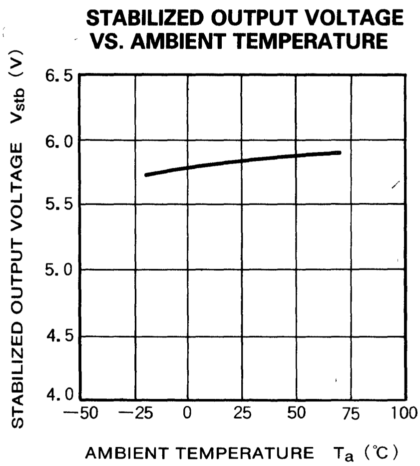
CIRCUIT CURRENT VS. AMBIENT TEMPERATURE

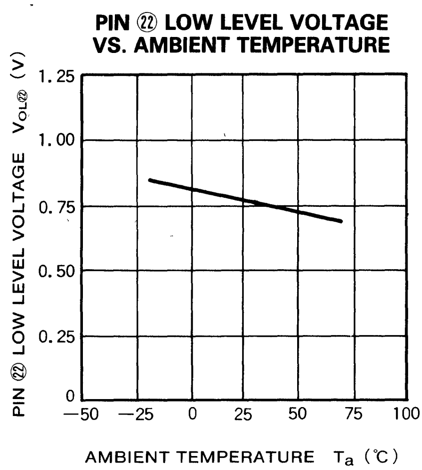


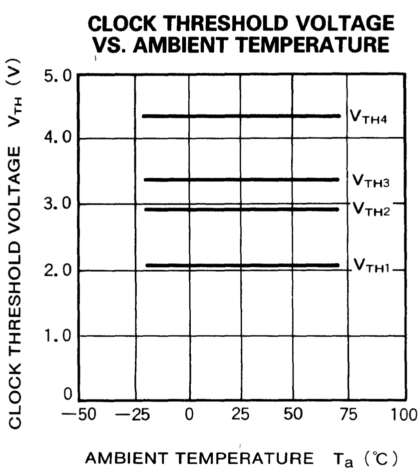
PIN ⑫ LEVEL SHIFT VOLTAGE VS. AMBIENT TEMPERATURE

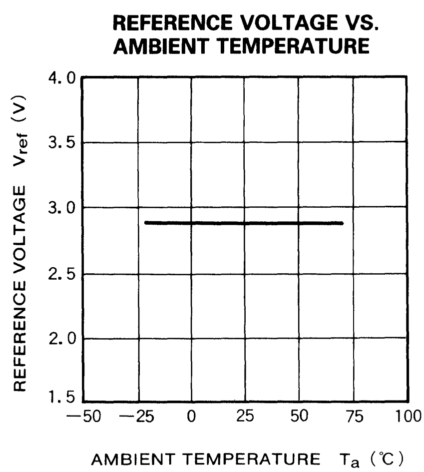


SPEED CONTROL AND DRIVER FOR 2-PHASE BRUSHLESS MOTOR

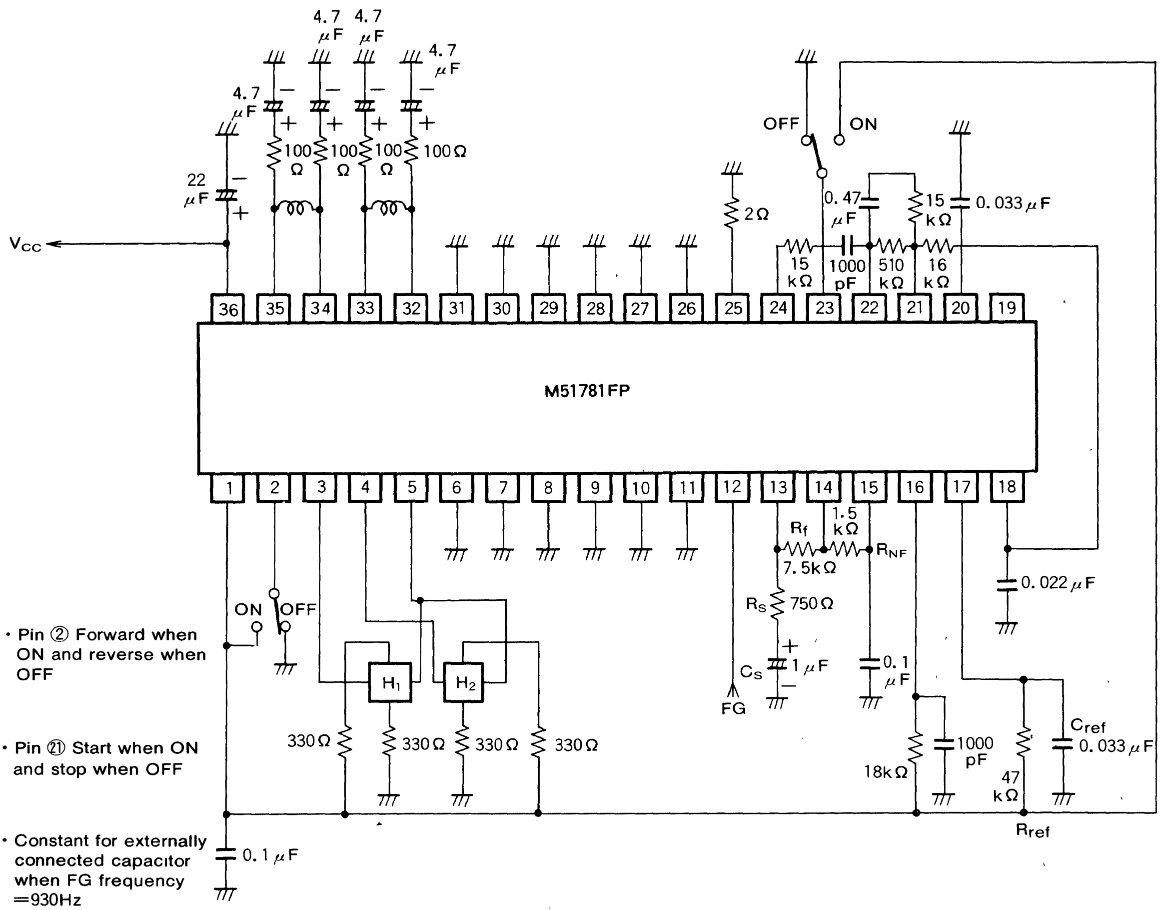








APPLICATION EXAMPLE



Note 1. The signal amplitude for the input tacho generator should be $1mV_{P\text{-}P}$ or more.

First stage amplifier gain $\sim \dfrac{1+\omega_G^2 C_S^2 (R_S+R_f)^2}{1+\omega_G^2 C_S^2 R_S^2}$

where ω_G: input tacho generator angle frequency

C_S must be chosen 4.7 μF or less. The disireable range of R_S is obtained in the following.

$$\frac{2}{\omega_G} \geq C_S \cdot R_S \geq \frac{1}{\omega_G}$$

Note 2. R_{NF} and C_{NF} are resistor and capacitor for noise filtering. If the time constant is too large, the input signal is weakened. R_{NF} and C_{NF} should be chosen as follows;

$$R_{NF} \cdot C_{NF} \leq \frac{1}{\omega_G}$$

Note 3. R_{ref} and C_{ref} are resistor and capacitor for setting speed of motor. R_{ref} and C_{ref} should be chosen as follows;

$$R_{ref} \cdot C_{ref} = \frac{1}{0.693 \cdot f_G}$$

where f_G: input tacho generator frequency

DESCRIPTION

The M51785P/SP is a semiconductor integrated circuit designed for a single-chip controller for FDD spindle motor, consisting of power amplifier, Hall ajplifier, FG amplifier, oscillator and speed discriminator and various protection circuits.

The device shows superiority in speed switching function of 1 : 1.2 which enables miniaturization of motor sets and cost reduction.

FEATURES

- High-accuracy, high-stability, and adjustment-free controller is possible by digital servo
- Speed switch of 1 : 1.2 possible ························· MOD
- $I_{O(peak)}$=1.2A
- 2 ENABLE systems ······································· EN, $\overline{EN}$

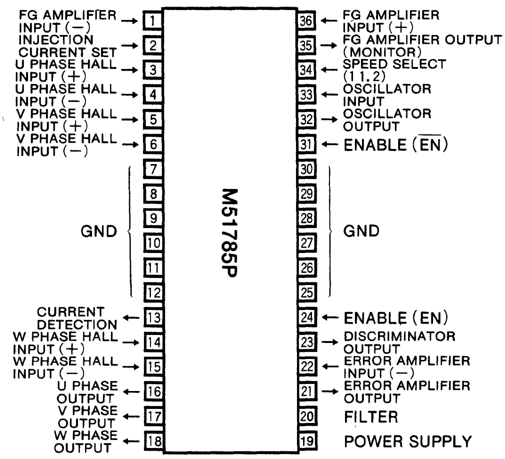
APPLICATION

FDD spindle motor (5″, 3.5″)

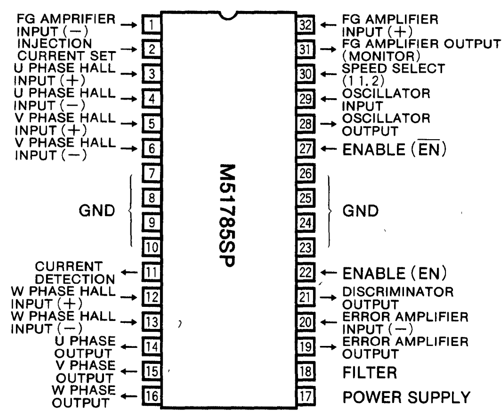
RECOMMENDED OPERATING CONDITIONS

Supply voltage ··· 10.8-12-13.2V
Oscillating frequency ··································· 400-650kHz
Ingector current ·· 2.5-3-7mA
Maximum output current ································ 800mA
FG OUT Load resistance ································ 100kΩ
FG amplifier input signal level ··················· 5 or above mV_{P-P}
Hall amplifier input signal level ················ 50-100-150 mV_{P-P}

PIN CONFIGURATION (TOP VIEW)

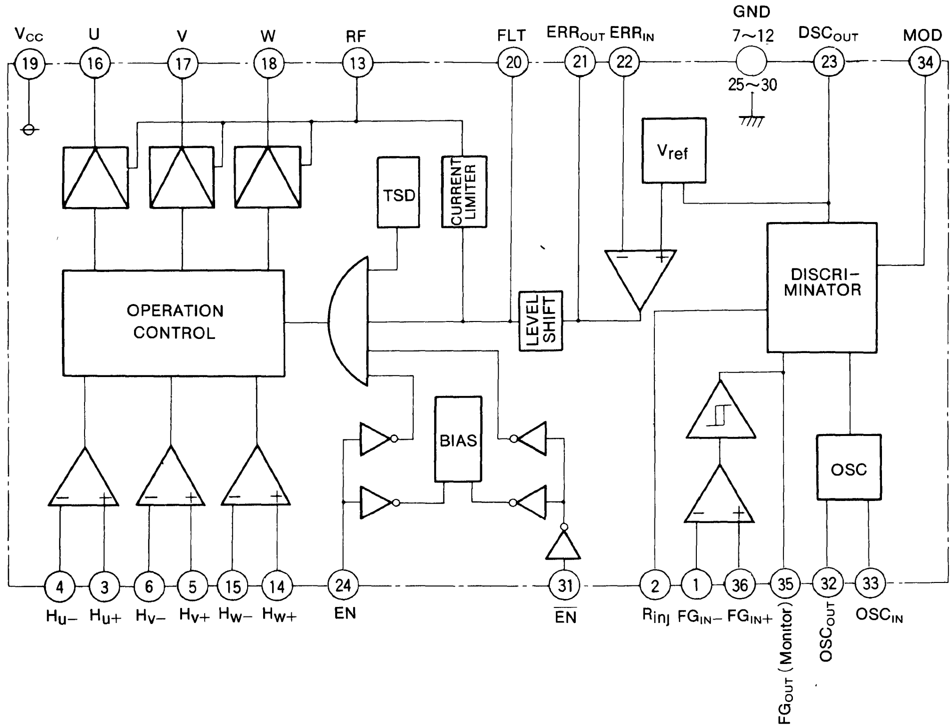


36-pin molded plastic FLAT (shrink)



32-pin molded plastic DIP (shrink) with fin

BLOCK DIAGRAM



Note Pin No = M51785P.

ABSOLUTE MAXIMUM RATINGS (T_a=25℃)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CCA}	Operating supply voltage		15	V
I_O	Output current		1.2	A
V_{HD}	Hall amplifier differential input voltage	3−4, 5−6, 14−15(Pin no).	5	V
I_{SS}	Source/sink current	20, 21, 23, 32, 33, 36(Pin no.)	±3	mA
V_{IN}	Pin applied voltage	1, 3, 4, 5, 6, 14, 15, 22, 24, 31, 34(Pin no)	0~V_{CC}	V
Iinj	Injection current		20	mA
V_{RF}	⑬ pin applied voltage		1	V
Pt	Power dissipation	Heatsink of infinite size used	4.5(8)	W
Kθ	Thermal derating	Heatsink of infinite size used	27.8(15.6)	℃/W
Tj	Junction temperature		150	℃
Topr	Operating temperature		−20~+75	℃
Tstg	Storage temperature		−40~+125	℃
V_{CCB}	Quiescent supply voltage	EN-Lo, EN-Hi.	16	V

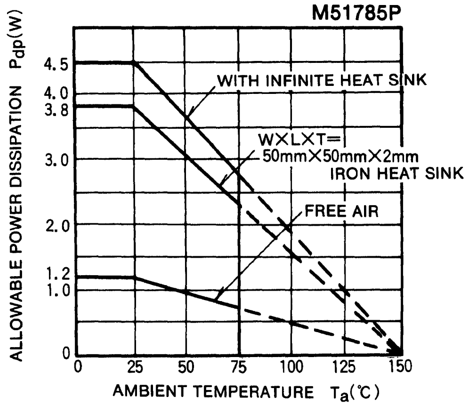
( ) Shows the value of M51785SP

ELECTRICAL CHARACTERISTICS (V_{CC}=12V, T_a=25℃, unless otherwise noted)

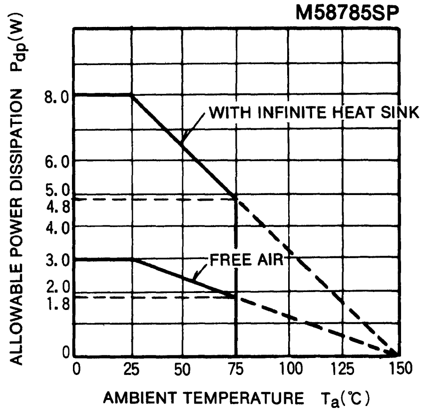
Symbol	Parameter	Test conditions	Limits Min	Limits Typ	Limits Max	Unit
$I_{CC}(H)$	Circuit current (EN ON)	EN=2.5V, MOD=EN=0.8V, excluding injection current and FG monitor pin current. No load	9	18	28	mA
$I_{CC}(L)$	Circuit current (EN OFF)	Connect injection setting pin and FG monitor pin directly to V_{CC} No load, EN=0.8V, EN=2.5V	—	90	300	μA
$V_{CC}(OP)$	Operating supply voltage		9	12	15	V
I_{inHA}	Hall amplifier input current		—	0.4	4	μA
V_N	Phase output middle point voltage		5.3	6.5	7.3	V
$\triangle V_N$	Difference of middle point voltage between phases		—	—	0.2	V
V_{sat}	Output saturation voltage	Current flow U→V, V→W, W→U. Total of V_{sat} of T_r on both sides, Io=0.7A	—	2.3	3.3	V
V_{TH}	Control input reference voltage	FLT pin voltage producing output	1.0	1.1	1.2	V
G_V	Voltage gain between contol input and output	Source	16.65	18.06	26.81	dB
		Sink	20.82	23.80	26.81	
$\triangle G_V$	Difference of voltage gain between phases		—	—	2	dB
V_{ref}	Error amplifier recerence voltage	Measure middle level of discriminator output	2.0	2.2	2.4	V
I_{inEA}	Error amplifier input current		−2.0	−0.02	—	μA
V_{OEA}	Error amplifier output level	Hi	2.2	2.5	3.1	V
		Lo	0.6	0.8	1.05	
V_{CL}	Current limiter reference voltage	R_F pin voltage when FLT pin voltage is reduced to less than 1 5V	0.36	0.40	0.44	V
V_{IN}	Function input threshold value	Hi 24, 31, 34	2.5	—	—	V
		Lo	—	—	0.8	
I_{IN}	Input current at function input pin	V_{IN}=12V 24, 34	500	700	1000	μA
		V_{IN}=0V 31	−150	−100	−70	
Vinj	Injection pin voltage	I_{inj}=6mA	0.6	0.9	1.5	V
V_{ODSC}	Discriminator output level	Hi	4.1	4.8	5.3	V
		Lo	0.5	0.8	1.2	
$\triangle T$	Discriminator count error	+ for deceleration, −for acceleration f_{OSC}=610.2kHz	−6	1	6	μsec
f_{OSC}	Oscillating frequency	f_{OSC}=610.2kHz	−0.2	—	+8.2	%
$I_{inj}MAX$	Maximum injection operationg current	f_{OSC}=610.2kHz.	17	—	—	mA
$I_{inj}MIN$	Minimum injection operating current	f_{OSC}=610.2kHz	—	—	4	mA
$V_{OL}(FG)$	FG amplifier output low level (monitor)	I_L=200μA	—	0.1	0.2	V
Il(FG)	Leak current at FG amplifier output (monitor) pin	12V is applied	—	—	1.0	μA
$V_{CC(SD)}$	Over-voltage protection operating voltage			16.3		V
$T_{(SD)}$	Thermal shutdown protection operating temperature			150		℃
$\triangle T_{(SD)}$	Thermal shutdown protection hysteresis			25		℃
$V_{in(FG)}MIN$	FG amplifier operating minimum input voltage	Measure at FG monitor pin		2.5		mV_{P-P}
$V_{FG(NM)}$	FG amplifier input noise margin			1.0		mV_{P-P}
N_{CLK}	Discriminator count no	MOD=Lo Count error is specified in section 19 of ELECTRICAL CHARACTERISTICS		1695		—
		MOD=Hi		2034		
f_{FGL1}	Synchronous frequency 1	MOD=Hi, fosc=610.2kHz		300.0		Hz
f_{FGL2}	Synchronous frequency 2	MOD=Lo, fosc=610.2kHz		360.0		Hz

MITSUBISHI ELECTRIC

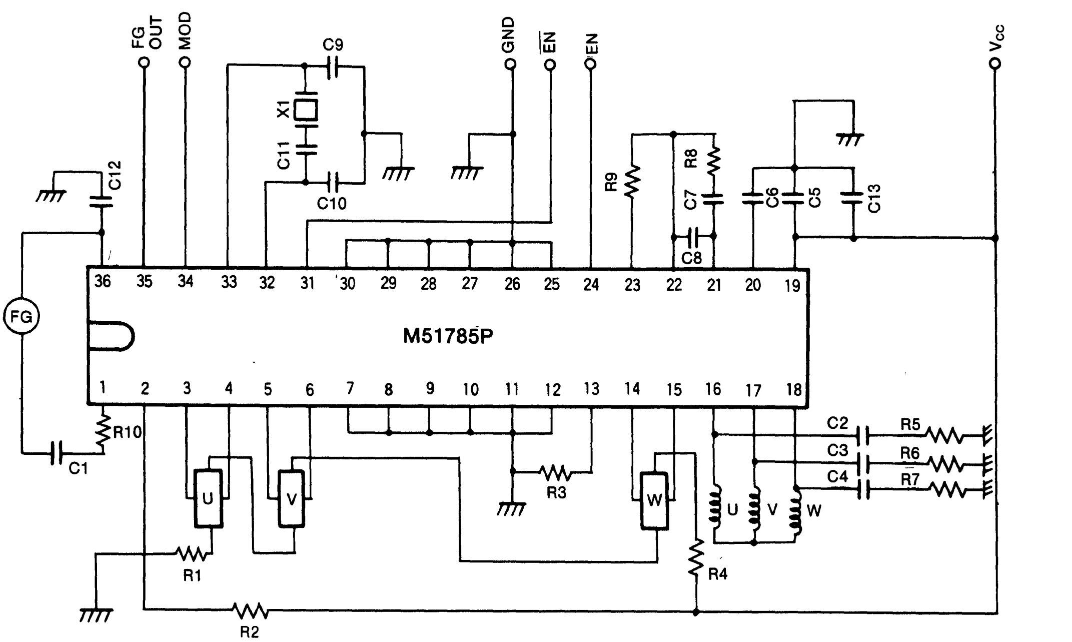
THERMAL DERATING (MAXIMUM RATING)



THERMAL DERATING (MAXIMUM RATING)



APPLICATION EXAMPLE

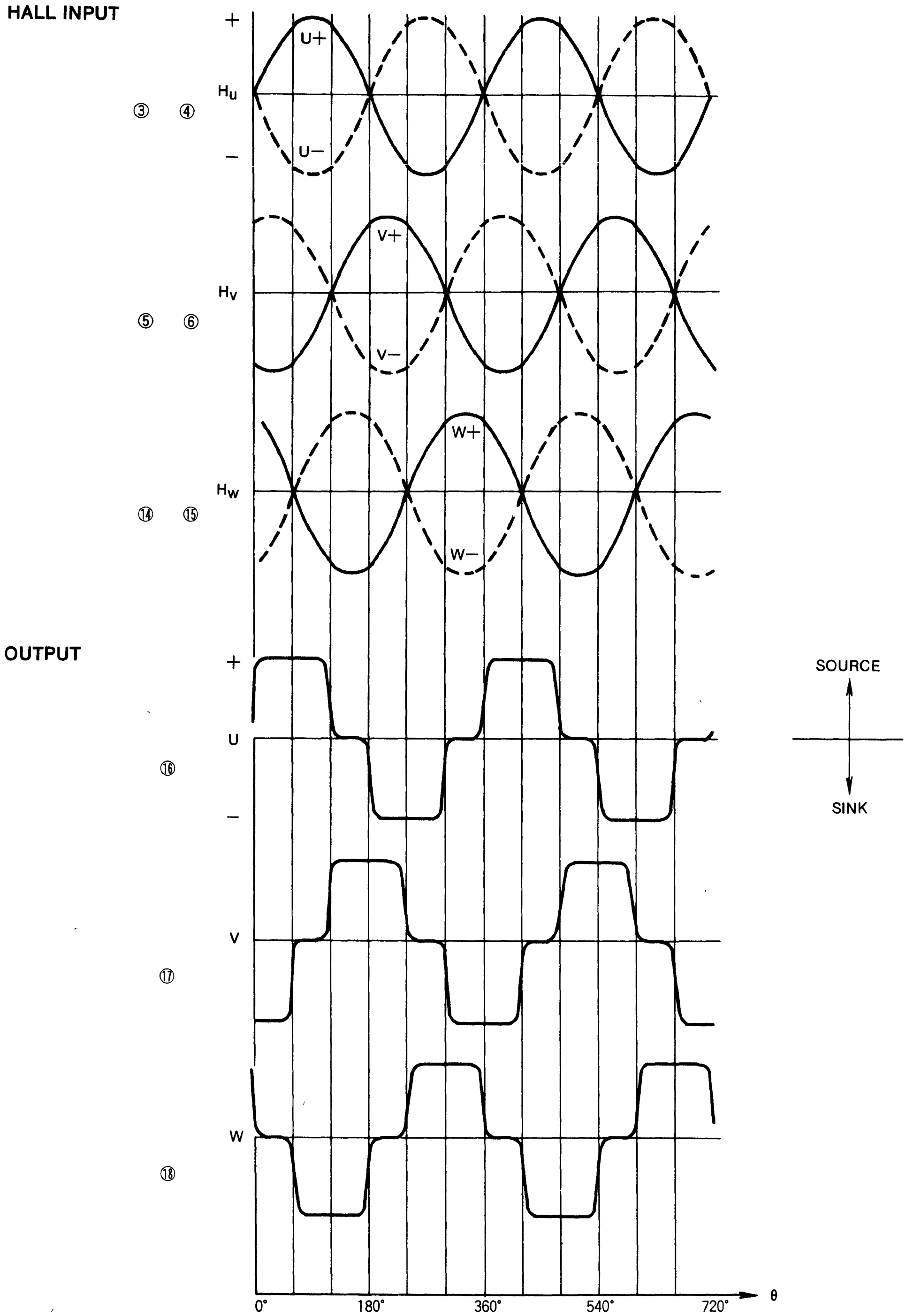


CONSTANTS

R1	330Ω	C1	4.7μF	X1	610.2kHz
R2	3.6kΩ	C2	0.1μF		
R3	0.5Ω	C3	0.1μF		
R4	330Ω	C4	0.1μF		
R5	4.7Ω	C5	0.1μF		
R6	4.7Ω	C6	0.22μF		
R7	4.7Ω	C7	0.33μF		
R8	75kΩ	C8	0.033pF		
R9	22kΩ	C9	220pF		
R10	330Ω	C10	220pF		
		C11	100pF		
		C12	0.1μF		
		C13	33μF		

Note : Open collector output at FG OUT pin

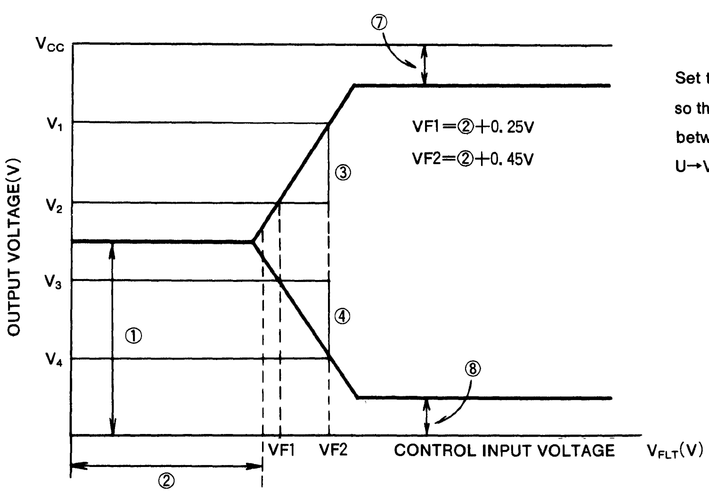
TIMING CHART



Note 1. The waveforms shown above are different from those at actual motor operation
Note 2. Pin No. =M51785P

TEST DESCRIPTION

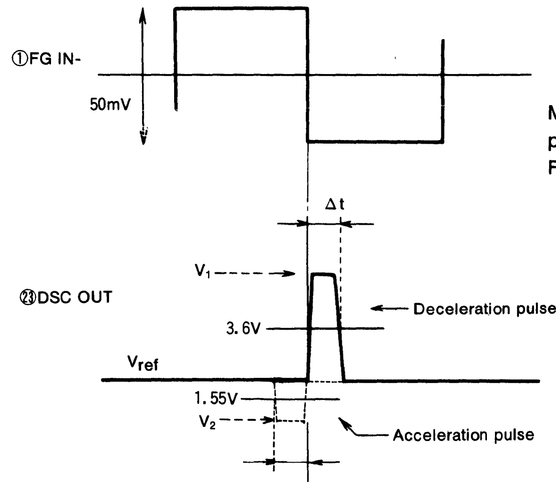
Phase output middle point voltage	→①
Difference of middle point voltage between phase	; Measure voltage 1 for each phase and $\triangle V_N$ is given in, $\triangle V_N=\triangle V_{UV}=V_U-V_V$ $=\triangle V_{VW}=V_V-V_W$ $=\triangle V_{VU}=V_W-V_U$
Output saturation voltage	→⑦+⑧ Load current 0.7A Control input voltage 2.2V
Control input reference voltage	→② Control input voltage value (V_{FLT}) when the output voltage is ①+100mV.
Voltage gain between control input and output	→③(source) ④(sink) ③=20 log $\{(V_1-V_2)/0.2\}$ ④=20 log $\{(V_3-V_4)/0.2\}$
Difference of voltage gain between phase	; Measure ③ and ④ for each phase, and $\triangle G_V$ is given in, (source and sink) $\triangle G=\triangle G_{UV}=G_{V(U)}-G_{V(V)}$ $=\triangle G_{VW}=G_{V(V)}-G_{V(W)}$ $=\triangle G_{WU}=G_{V(W)}-G_{V(U)}$



Set the values of ② to ⑧ so that the output current flows between phases U→V, V→W, W→U.

DISCRIMINATOR COUNT ERROR

Measure the pulsewidth at 23 pin DSC OUT. The test value is negative for accelerating pulse.



Measure acceleration or deceleration pulse at DOS_{OUT} output, applying pulse (synchronous with Fosc) divided by Fosc to FG_{IN}-in each mode.

☆Refer to table 1 for the frequency given to FG_{IN}.

Fig. 1

f_{FG} ; FG_{IN} INPUT FREQUENCY

Fosc ; oscillating frequency

Table 1

㉞MOD	①FG_{IN} input frequency
L 1665 division	$F_{OSC}/1695$
H 2034 division	$F_{OSC}/2034$

DISCRIMINATOR OUTPUT LEVEL

Measure V_1 and V_2 in Fig. 1. $Vo_{DSC}(Hi) \rightarrow V_1$

$(Lo) \rightarrow V_2$

But, for Low(V_2)level, measure Lo level of $f_{FG}=250Hz$(acceleration pulse),
and for High(V_1)level, measure Hi level of $f_{FG}=400Hz$ (deceleration pulse).

ENABLE FUNCTION

Table 2

EN (top) / $\overline{EN}$ (left)	Lo	Hi
Lo	DISABLE	ENABLE
Hi	DISABLE	DISABLE

☆EN pin=circuit is operated only when EN pin=Hi and $\overline{EN}$ pin=Lo

☆EN pin→open=Lo

$\overline{EN}$ pin→open=Hi

(But anti-noise characteristics may deteriorate if used with EN. • $\overline{EN}$=open after mounting on the equipment.)

M51714P

DUAL BI-DIRECTIONAL DRIVER

DESCRIPTION

The M51714P is a semiconductor integrated circuit for use in dual bi-directional micro motor.

FEATURES

- Superiority in mounting
- Can be controlled by TTL level interface
- 2-ENABLE facility
- 1.2A maximum output current

APPLICATION

General home-use equipment

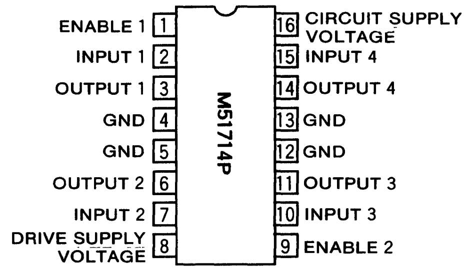
FUNCTIONAL DESCRIPTION

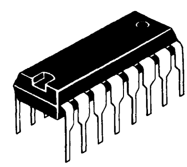
The M51714P has 4 internal amplifiers, and each amplifier operates as current source type when the input is in the high level and as current sink type when the input is in the low level.

Two ENABLE are provided, and $\overline{EN_1}$ functions in amplifiers 1 and 2 and $\overline{EN_2}$, in amplifiers 3 and 4. When the ENABLE input is in the high level, the system output is off and when the input is in the low level, and input-related output is produced.

The circuit power supply and drive power supply are independently provided for power supply of the device, facilitating free equipment design.

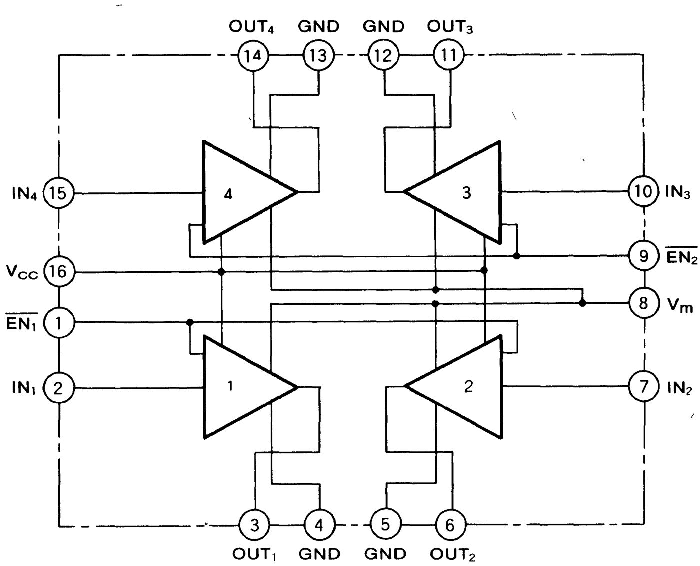
PIN CONFIGURATION (TOP VIEW)





16-pin molded plastic DIP

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_m	Drive supply voltage		V_{CC}~26	V
V_{CC}	Circuit supply voltage		V_m	V
$V_{i(IN)}$	Input voltage		−0.3~7	V
$V_{i(EN)}$	Enable input voltage		−0.3~7	V
$I_{o(max)}$	Ruch current		1.2	A
I_o	Output current		0.4	A
P_d	Allowable power dissipation		2.5	W
T_{opr}	Operating temperature		−20~+75	℃
T_{stg}	Storage temperature		−40~+125	℃

RECOMMENDED OPERATING CONDITIONS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
V_m	Drive supply voltage		5	12	24	V
V_{CC}	Circuit supply voltage	Should be less than V_m		5	12	V
I_O	Output current				300	mA
V_{IH}	High-level input voltage	For both input and enable input	2.8		V_{CC}−1.5	V
V_{IL}	Low-level input voltage	For both input and enable input	0		1.5	V

Note. It is desirable that enable input is in the high level and the output is off when the motor is stopped.

ELECTRICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Test conditions		Limits			Unit
				Min	Typ	Max	
I_{CC}	Circuit current	V_{CC}=5V bi-derectional mode	All enable input="H"		4	8	mA
			All enable input="L"		10	20	
I_m	Drive supply voltage current	V_m=12V, no-load bi-directional mode	All enable input="H"		0		mA
			All enable input="L"		25	50	
$V_{TH(IN)}$	Input threshold value	V_{CC}=5V		1.6	2.2	2.7	V
$V_{TH(EN)}$	Enable input threshold value	V_{CC}=5V		1.6	2.2	2.7	V
$I_{in(IN)}$	Input current	V_{CC}=5V(flowing to the pin)			3.5	20	μA
$I_{in(EN)}$	Enable input current	V_{CC}=5V(flowing from the pin)			0.5	10	μA
$V_{sat(U)}$	Output saturation voltage (source)	I_O=0.2A			1.0	1.6	V
		I_O=0.4A			1.3	1.9	
$V_{sat(D)}$	Output saturation voltage (sink)	I_O=0.2A			0.9	1.5	V
		I_O=0.4A			1.0	1.6	

REFERENCE DATA (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Reference value	Unit
t_r	Rise time	Output 10%→90%	150	ns
t_f	Fall time	Output 90%→10%	550	ns
t_{PLH}	Output low-level to high-level propagation delay time	Input 50%→Output 50%	350	ns
t_{PHL}	Output high-level to low-level propagation delay time	Input 50%→Output 50%	400	ns

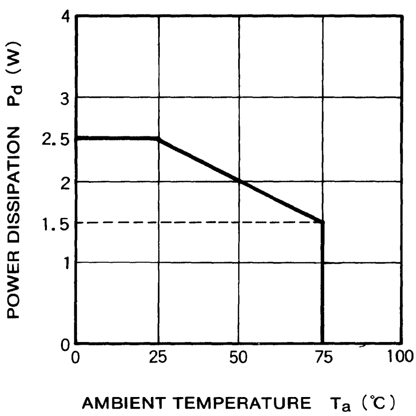
TRUTH TABLE

Input	Enable	Output
"H"	"L"	"H"
"L"	"L"	"L"
"H"	"H"	OFF
"L"	"H"	OFF

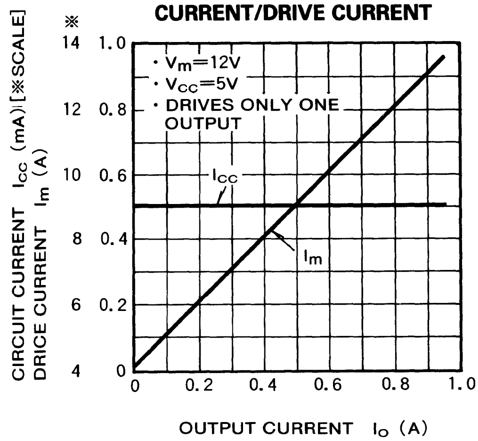
Note 1. ENABLE 1 functions in amplifiers 1 and 2, and ENABLE 2 functions in amplifiers 3 and 4.
2. OFF means high impedance.

TYPICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

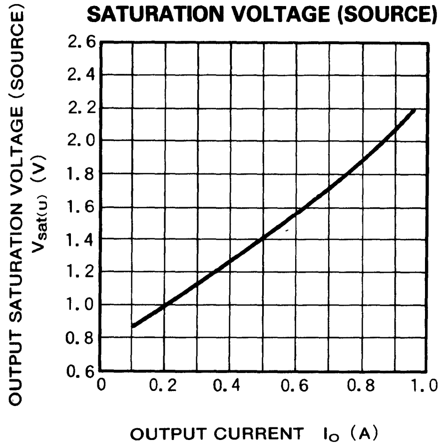
THERMAL DERATING (MAXIMUM RATING)



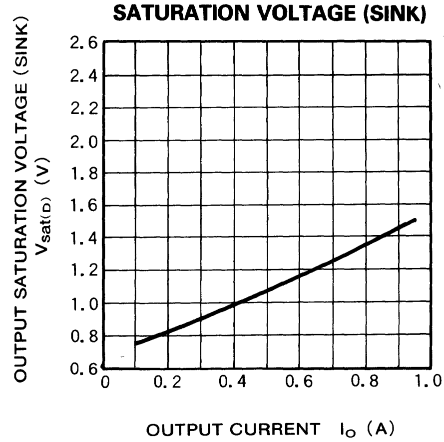
OUTPUT CURRENT VS. CIRCUIT CURRENT/DRIVE CURRENT



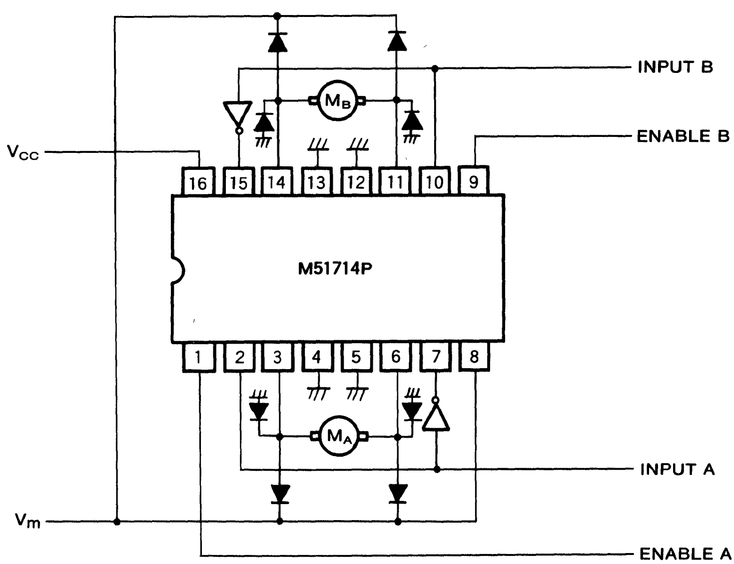
OUTPUT CURRENT VS. OUTPUT SATURATION VOLTAGE (SOURCE)



OUTPUT CURRENT VS. OUTPUT SATURATION VOLTAGE (SINK)



APPLICATION EXAMPLE



Note. A diode of small V_F is used between clamps. (For example, Schottky diode)

MITSUBISHI ELECTRIC

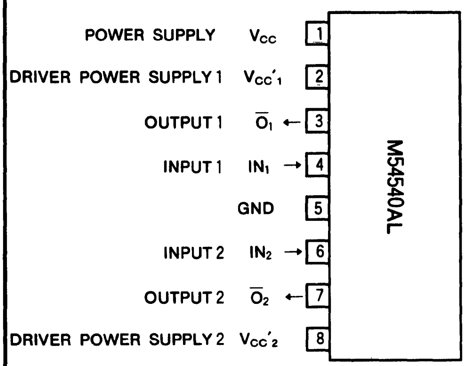
DESCRIPTION
The M54540AL, BI-DIRECTIONAL MOTOR DRIVER, consists of a full bridge power driver designed for a low power D-C motor control.

FEATURES
- Small single-in-line package
- Integral diodes for transient suppression
- PMOS compatible input

APPLICATION
Audio cassette tape recorder

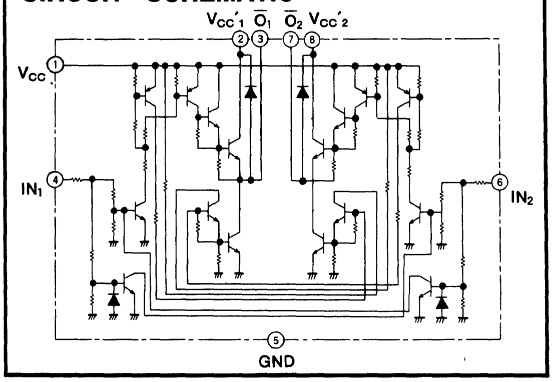
FUNCTION
The M54540AL, full bridge motor driver, has the logic circuitry and non-darlington power drivers for bidirection control of D-C motors operating at currents of up to 600mA.
The power supplies for the logic circuitry and the drivers are separated so that the applied voltage to the motor can be controlled by the V_{CC}' of the driver supply voltage.

PIN CONFIGURATION (TOP VIEW)



Outline 8P5

CIRCUIT SCHEMATIC



LOGIC TRUTH TABLE

Input		Output		Note
IN_1	IN_2	$\overline{O}_1$	$\overline{O}_2$	
L	L	"OFF" state	"OFF" state	Open
H	L	H	L	↻
L	H	L	H	↺
H	H	"OFF" state	"OFF" state	Open

ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		−0.3～+12	V
V_{CC}'	Driver supply voltage		−0.3～V_{CC}	V
V_I	Input voltage		−0.3～V_{CC}	V
V_O	Output voltage		−0.3～V_{CC}+2.5	V
$I_{O(max)}$	Peak output current	t_{op}=10ms, Repetitive cycle 0.2Hz max	±600	mA
I_O	Continuous output current		±120	mA
P_d	Power dissipation	T_a=60℃	850	mW
T_{opr}	Operating ambient temperature range		−10～+60	℃
T_{stg}	Storage temperature range		−55～+125	℃

RECOMMENDED OPERATING CONDITIONS (Ta=25℃, unless otherwise noted)

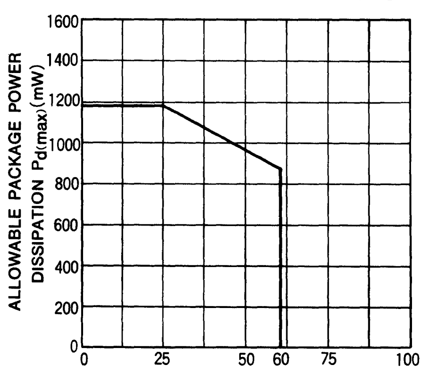
Symbol	Parameter	Conditions	Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage		6	10	11	V
I_O	Continuous output current				±100	mA
V_{IH}	"H" Input voltage		3	5	V_{CC}	V
V_{IL}	"L" Input voltage			0	0.4	V
T_{off}	Input switching interval	It is prohibited to switch the inputs at the same time.	10	300		ms

ELECTRICAL CHARACTERISTICS (Ta=25℃, unless otherwise noted)

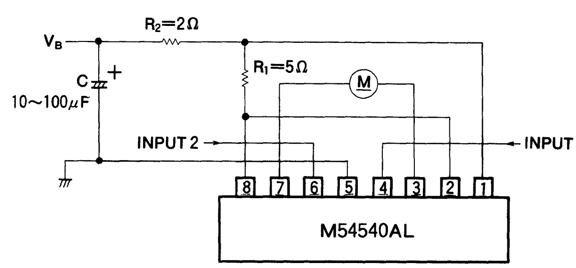
Symbol	Parameter	Test conditions		Limits			Unit
				Min	Typ	Max	
$I_{O(leak)}$	Output leakage current	$V_{CC}=V_{CC}'=20V$	$V_O=12V$			100	μA
		$V_{I1}=V_{I2}=3V$	$V_O=0V$			−100	
V_{OH}	"H" Output saturation voltage	$V_{CC}=V_{CC}'=10V$	$V_{I1}=3V$, $V_{I2}=0V$	8			V
		$I_{OH}=-100mA$	$V_{I1}=0V$, $V_{I2}=3V$				
V_{OL}	"L" Output saturation voltage	$V_{CC}=V_{CC}'=10V$	$V_{I1}=3V$, $V_{I2}=0V$			0.6	V
		$I_{OL}=100mA$	$V_{I1}=0V$, $V_{I2}=3V$				
I_{IH}	"H" Input current	$V_{CC}=V_{CC}'=10V$	$V_{I1}=3V$			500	μA
			$V_{I2}=3V$				
I_{CC}	Supply current	$V_{CC}=V_{CC}'=12V$	$V_{I1}=3V$, $V_{I2}=0V$		28	40	mA
			$V_{I1}=0V$, $V_{I2}=3V$				
			$V_{I1}=0V$, $V_{I2}=0V$		0		
			$V_{I1}=3V$, $V_{I2}=3V$				

TYPICAL CHARACTERISTICS

ALLOWABLE AVERAGE POWER DISSIPATION



APPLICATION EXAMPLE



Note

1. It is prohibited to switch the both inputs simultaneously. The inputs should be driven separately to avoid high crossover current.
2. The pins 1, 2 and 8 are separated and shall be connected externally.

M54541L

BI-DIRECTIONAL MOTOR DRIVER

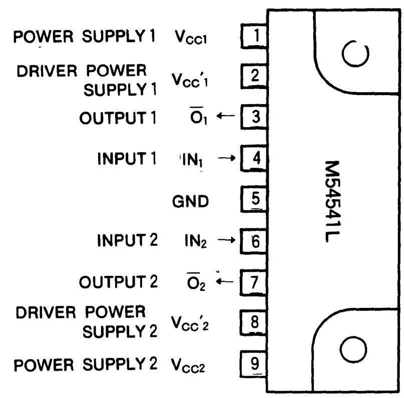
DESCRIPTION
The M54541L, BI-DIRECTIONAL MOTOR DRIVER, consists of a full bridge power driver designed for D-C motor control.

FEATURES
- 9-pin single-in-line power tab package
- Integral diodes for transient suppression
- 800mA output current
- PMOS compatible input

APPLICATIONS
- Audio cassette tape recorder
- Video cassette recorder

FUNCTION
The M54541L, full bridge motor driver, has the logic circuitry and darlington-pair power drivers for bidirectional control of D-C motors operating at currents up to 800mA. The power supplies for the logic circuitry and the drivers are separated so that the applied voltage to the motor can be controlled by the V_{CC}' of the driver power supply voltage.

PIN CONFIGURATION (TOP VIEW)

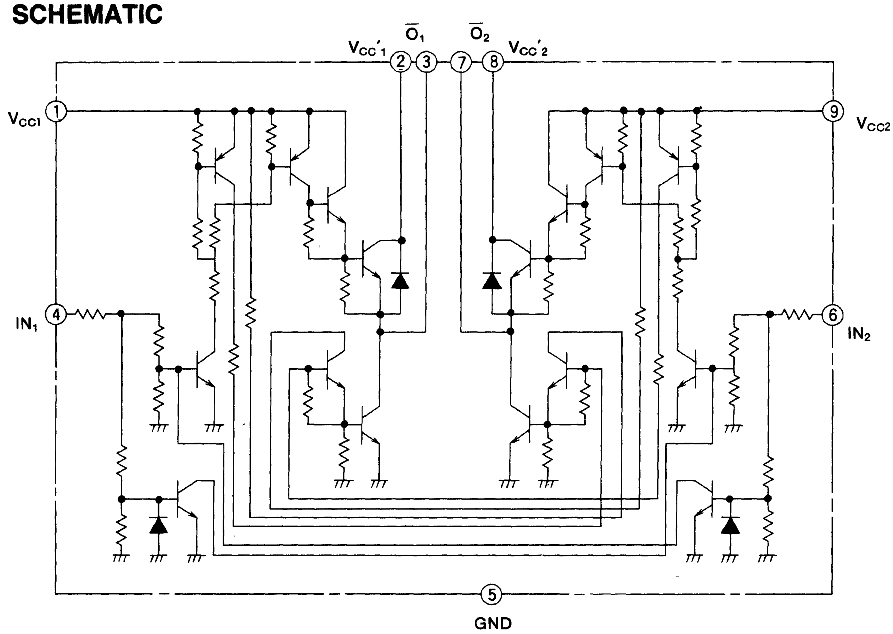


Outline 9P9

LOGIC TRUTH TABLE

Input		Output		Note
IN_1	IN_2	$\overline{O}_1$	$\overline{O}_2$	
L	L	"OFF" state	"OFF" state	Open
H	L	H	L	↻
L	H	L	H	↺
H	H	"OFF" state	"OFF" state	Open

CIRCUIT SCHEMATIC



ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		−0.5~+16	V
V_{CC}'	Driver supply voltage		−0.5~V_{CC}	V
V_I	Input voltage		−0.5~V_{CC}	V
V_O	Output voltage		−0.5~V_{CC}+2.5	V
$I_{O(max)}$	Peak output current	t_{op}=10ms, Repetitive cycle 0.2Hz max	±800	mA
I_O	Continuous output current		±220	mA
P_d	Power dissipation	T_a=60℃	900	mW
T_{opr}	Operating ambient temperature range		−10~+60	℃
T_{stg}	Storage temperature range		−55~+125	℃

RECOMMENDED OPERATING CONDITIONS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage		6	14	15	V
I_O	Continuous output current				±200	mA
V_{IH}	"H" Input voltage		3	5	V_{CC}	V
V_{IL}	"L" Input voltage			0	0.4	V
T_{off}	Input switching interval	It is prohibited to switch the inputs at the same time	10	300		ms

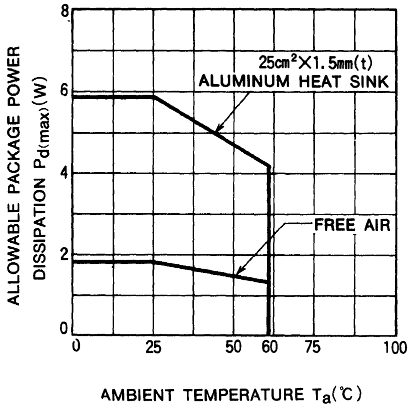
ELECTRICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Test conditions		Limits			Unit
				Min	Typ*	Max	
$I_{O(leak)}$	Output leakage current	$V_{CC}=V_{CC}'$=20V, $V_{I1}=V_{I2}$=3V	V_O=20V			100	μA
			V_O=0V			−100	
V_{OH}	"H" Output saturation voltage	$V_{CC}=V_{CC}'$=12V, I_{OH}=−200mA	V_{I1}=3V, V_{I2}=0V	9.9	10.4		V
			V_{I1}=0V, V_{I2}=3V				
V_{OL}	"L" Outuput saturation voltage	$V_{CC}=V_{CC}'$=12V, I_{OL}=200mA	V_{I1}=3V, V_{I2}=0V		0.3	0.7	V
			V_{I1}=0V, V_{I2}=3V				
I_{IH}	"H" Input current	$V_{CC}=V_{CC}'$=12V	V_{I1}=3V			500	μA
			V_{I2}=3V				
I_{CC}	Supply current	$V_{CC}=V_{CC}'$=16V	V_{I1}=3V, V_{I2}=0V		35	50	mA
			V_{I1}=0V, V_{I2}=3V				
			V_{I1}=0V, V_{I2}=0V		0		
			V_{I1}=3V, V_{I2}=3V				

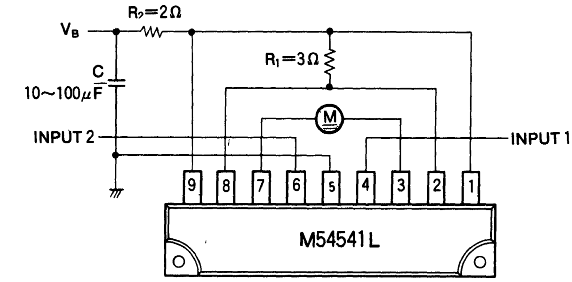
* : The all typical values are at T_a=25℃.

TYPICAL CHARACTERISTICS

ALLOWABLE AVERAGE POWER DISSIPATION



APPLICATION EXAMPLE



Note

1. It is prohibited to switch the both input simultaneously The inputs should be driven separately to avoid high crossover current.
2. The pins 1 , 9 and 2 , 8 are separated and shall be connected externally.

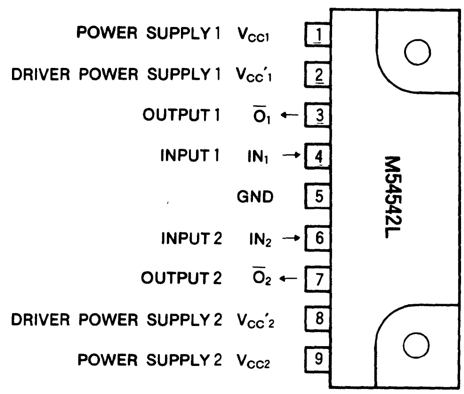
DESCRIPTION
The M54542L, BI-DIRECTIONAL MOTOR DRIVER, consists of a full bridge power driver designed for D-C motor control.

FEATURES
- 9-pin single-in-line power tab package
- Integral diodes for transient suppression
- 1.2A output current
- PMOS compatible input

APPLICATIONS
- Audio, video cassette recorders
- Floppy disk driver

FUNCTION
The M54542L, full bridge motor driver, has the logic circuitry and darlington-pair power drivers for bidirectional control of D-C motors operating at currents up to 1.2A.
The power supplies for the logic circuitry and the drivers are separated so that the applied voltage to the motor can be controlled by the V_{CC}' of the driver power supply voltage.

PIN CONFIGURATION (TOP VIEW)

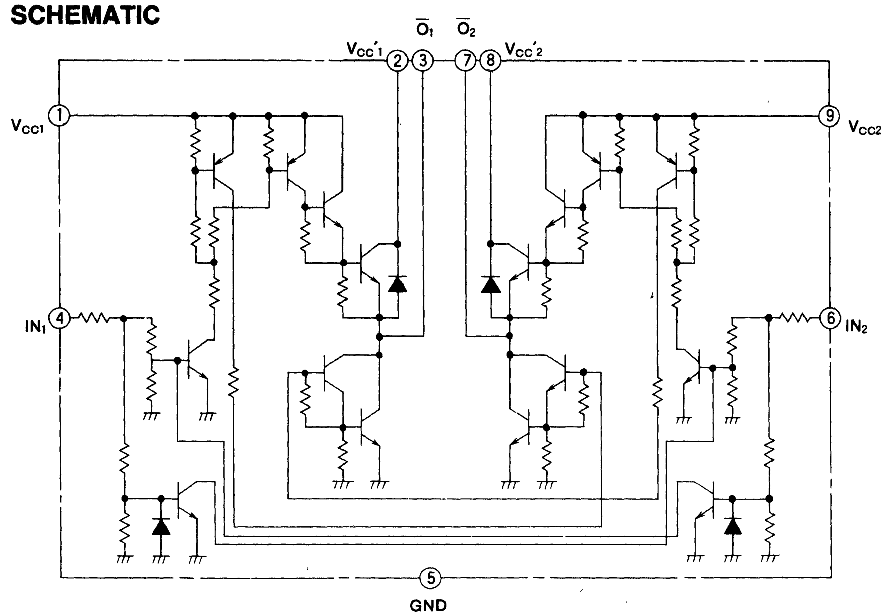


Outline 9P9

LOGIC TRUTH TABLE

INPUT		OUTPUT		NOTE
IN_1	IN_2	$\overline{O}_1$	$\overline{O}_2$	
L	L	"OFF" state	"OFF" state	Open
H	L	H	L	↻
L	H	L	H	↺
H	H	"OFF" state	"OFF" state	Open

CIRCUIT SCHEMATIC



ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		−0.5～+16	V
V_{CC}'	Driver voltage		−0.5～V_{CC}	V
V_I	Input voltage		−0.5～V_{CC}	V
V_O	Output voltage		−0.5～V_{CC}+2.5	V
$I_{O(max)}$	Peak output current	t_{op}=10ms Repetitive cycle 0.2Hz max	±1200	mA
I_O	Continuous output current		±330	mA
P_d	Power dissipation	T_a=60℃	1000	mW
T_{opr}	Operating ambient temperature range		−10～+60	℃
T_{stg}	Storage temperature range		−55～+125	℃

RECOMMENDED OPERATING CONDITIONS (T_a=25℃, unless otherwise noted)

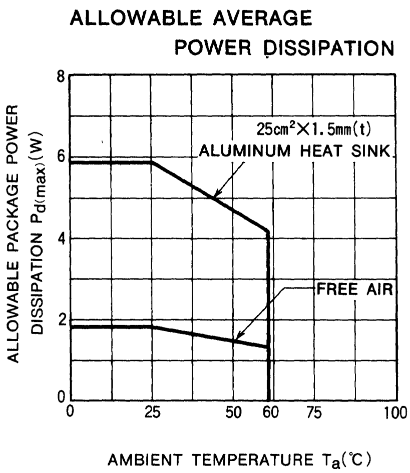
Symbol	Parameter	Conditions	Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage		6	14	15	V
I_O	Continuous output current				±300	mA
V_{IH}	"H" Input voltage		3	5	V_{CC}	V
V_{IL}	"L" Input voltage			0	0.4	V
T_{OFF}	Input switching interval	It is prohibited to switch the inputs at the same time.	10	300		ms

ELECTRICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

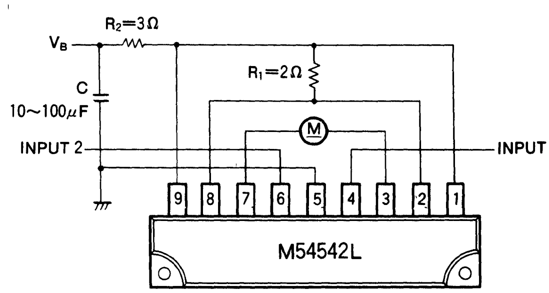
Symbol	Parameter	Test conditions		Limits			Unit
				Min	Typ*	Max	
$I_{O(leak)}$	Output leakage current	$V_{CC}=V_{CC}'$=20V $V_{I1}=V_{I2}$=3V	V_O=20V			100	μA
			V_O=0V			−100	
V_{OH}	"H" Output saturation voltage	$V_{CC}=V_{CC}'$=12V I_{OH}=−300mA	V_{I1}=3V, V_{I2}=0V V_{I1}=0V, V_{I2}=3V	9.7	10.2		V
V_{OL}	"L" Output saturation voltage	$V_{CC}=V_{CC}'$=12V I_{OL}=300mA	V_{I1}=3V, V_{I2}=0V V_{I1}=0V, V_{I2}=3V		0.9	1.4	V
I_{IH}	"H" Input current	$V_{CC}=V_{CC}'$=12V	V_{I1}=3V V_{I2}=3V			500	μA
I_{CC}	Supply current	$V_{CC}=V_{CC}'$=16V	V_{I1}=3V, V_{I2}=0V V_{I1}=0V, V_{I2}=3V		7	10	mA
			V_{I1}=0V, V_{I2}=0V V_{I1}=3V, V_{I2}=3V		0		

* : The all typical values are at T_a=25℃

TYPICAL CHARACTERISTICS



APPLICATION EXAMPLE



Note

1. It is prohibited to switch the both inputs simultaneously. The inputs should be driven separately to avoid high crossover current.
2. The pins 1 , 9 and 2 , 8 are separated and shall be connected externally.

MITSUBISHI ELECTRIC

M54543L

BI-DIRECTIONAL MOTOR DRIVER

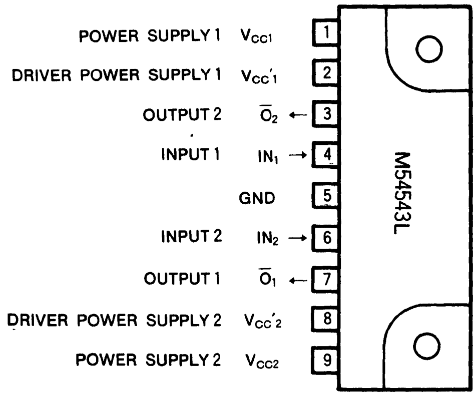
DESCRIPTION
The M54543L, BI-DIRECTIONAL MOTOR DRIVER, consists of a full bridge power driver designed for D-C motor control.

FEATURES
- Wide operating voltage range ($V_{CC} = 4 \sim 16V$)
- TTL, PMOS and CMOS compatible input
- Low output saturation voltage
- Integral diodes for transient suppression
- 1.2A output current
- Braking mode input

APPLICATION
Audio, video cassette recorder

FUNCTION
The M54543L, full bridge motor driver, has the logic circuitry and non-darlington power drivers for bidirectional control of D-C motors operating at currents up to 1.2A. A braking mode by switching the both inputs high may make easier to control the motor. The both of the separated power supplies for the logic circuitry and the drivers are usable for motor speed control.

PIN CONFIGURATION (TOP VIEW)

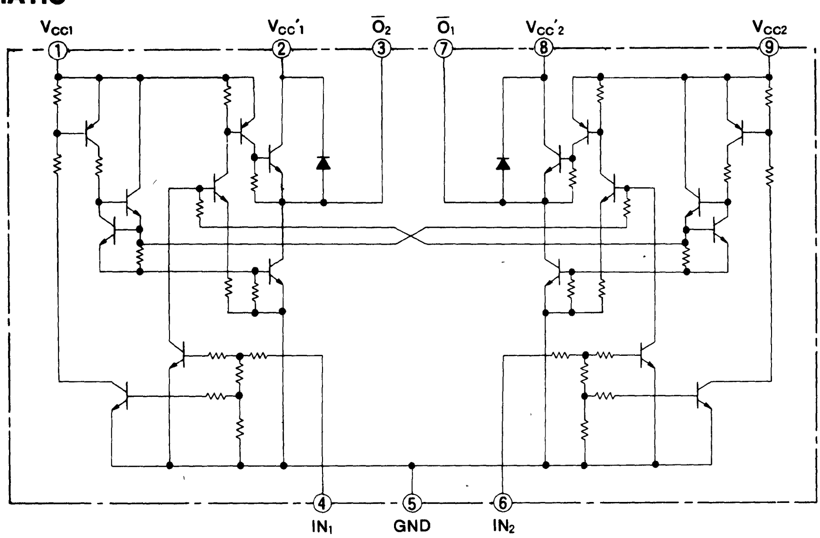


Outline 9P9

LOGIC TRUTH TABLE

INPUT		OUTPUT		NOTE
IN_1	IN_2	$\overline{O}_1$	$\overline{O}_2$	
L	L	"OFF" state	"OFF" state	Open
H	L	H	L	○
L	H	L	H	○
H	H	L	L	Braking

CIRCUIT SCHEMATIC



ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
$V_{CC(1)}$	Supply voltage (1)		−0.5~+16	V
$V_{CC(2)}$	Supply voltage (2)	With an external heat sink (3000mm²×1.5mm)	−0.5~+20	V
V_{CC}'	Driver supply voltage		−0.5~+16	V
V_I	Input voltage		0~V_{CC}	V
V_O	Output voltage		−0.5~V_{CC}'+2.5	V
$I_{O(max)}$	Peak output current	t_{op}=10ms: Repetitive cycle 0.2Hz max	±1.2	A
$I_{O(1)}$	Continuous output current (1)		±330	mA
$I_{O(2)}$	Continuous output current (2)	With an external heat sink (3000mm²×1.5mm)	±600	mA
P_d	Power dissipation	T_a=75℃	1.15	W
T_{opr}	Operating ambient temperature range		−10~+75	℃
T_{stg}	Storage temperature range		−55~+125	℃

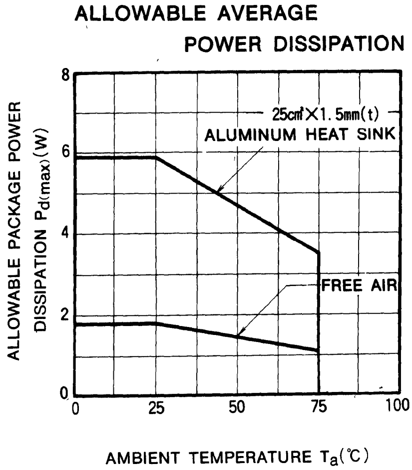
RECOMMENDED OPERATING CONDITIONS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage		4	12	15	V
I_O	Continuous output current				±300	mA
V_{IH}	"H" Input voltage		2		V_{CC}	V
V_{IL}	"L" Input voltage		0		0.4	V
t_B	Motor braking interval		100			ms

ELECTRICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Test conditions			Limits			Unit
					Min	Typ	Max	
$I_{O(leak)}$	Output leakage current	$V_{CC}=V_{CC}'$=20V		V_O=20V			100	μA
		$V_{I1}=V_{I2}$=0V		V_O=0V			−100	
$V_{OH(1)}$	"H" Output saturation voltage (1)	$V_{CC}=V_{CC}'$=12V	V_{I1}=2V	$I_{OH(1)}$=−300mA	10.8			V
			V_{I2}=0V	$I_{OH(1)}$=−500mA	10.7			
$V_{OH(2)}$	"H" Output saturation voltage (2)	$V_{CC}=V_{CC}'$=12V	V_{I1}=0V	$I_{OH(2)}$=−300mA	10.8			V
			V_{I2}=2V	$I_{OH(2)}$=−500mA	10.7			
$V_{OL(1)}$	"L" Output saturation voltage (1)	$V_{CC}=V_{CC}'$=12V	V_{I1}=0V	$I_{OL(1)}$=300mA			0.5	V
			V_{I2}=2V	$I_{OL(1)}$=500mA			0.65	
			$V_{I1}=V_{I2}$=2V				0.65	
$V_{OL(2)}$	"L" Output saturation voltage (2)	$V_{CC}=V_{CC}'$=12V	V_{I1}=2V	$I_{OL(2)}$=300mA			0.5	V
			V_{I2}=0V	$I_{OL(2)}$=500mA			0.65	
			$V_{I1}=V_{I2}$=2V				0.65	
$I_{IH(1)}$	"H" Input current (1)	$V_{CC}=V_{CC}'$=12V, V_{I1}=2V, V_{I2}=0V			70		200	μA
$I_{IH(2)}$	"H" Input current (2)	$V_{CC}=V_{CC}'$=12V, V_{I1}=0V, V_{I2}=2V			70		200	μA
I_{CC}	Supply current	$V_{CC}=V_{CC}'$=16V		V_{I1}=2V, V_{I2}=0V			40	mA
				V_{I1}=0V, V_{I2}=2V				
				$V_{I1}=V_{I2}$=2V			60	
				$V_{I1}=V_{I2}$=0V		0		

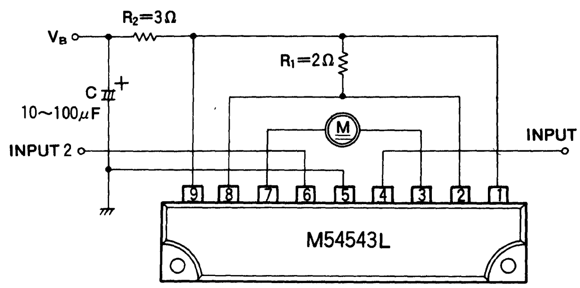
TYPICAL CHARACTERISTICS



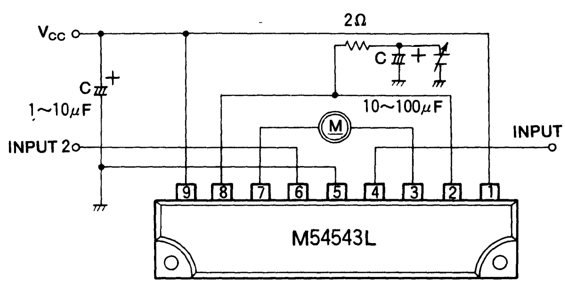
Note
When the V_{CC}' is lower than the V_{CC}, the current will flow from the V_{CC} to the V_{CC}' and may drive the motor.
The M54544L may be recommended to have the wider control voltage range of the V_{CC}'.

APPLICATION EXAMPLES

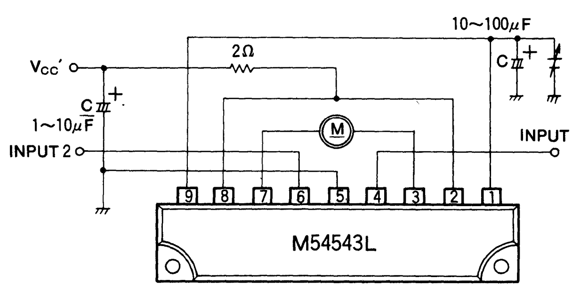
1) Motor speed control by V_{CC} and V_{CC}'



2) Motor speed control by the V_{CC}'



3) Motor speed control by the V_{CC}



M54543AL

BI-DIRECTIONAL MOTOR DRIVER

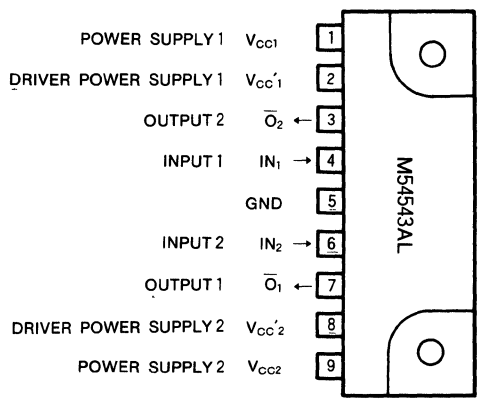
DESCRIPTION
The M54543AL, BI-DIRECTIONAL MOTOR DRIVER, consists of a full bridge power driver designed for D-C motor control.

FEATURES
- Wide operating voltage range ($V_{CC}=4\sim16V$)
- TTL, PMOS and CMOS compatible input
- Low output saturation voltage
- Integral diodes for transient suppression
- 1.2A output current
- Braking mode input
- Internal thermal shutdown protection

APPLICATION
Audio, video cassette recorder

FUNCTION
The M54543AL, full bridge motor driver, has the logic circuitry and non-darlington power drivers for bidirectional control of D-C motors operating at currents up to 1.2A. A braking mode by switching the both inputs high may make easier to control the motor. The both of the separated power supplies for the logic circuitry and the drivers are usable for motor speed control.

PIN CONFIGURATION (TOP VIEW)

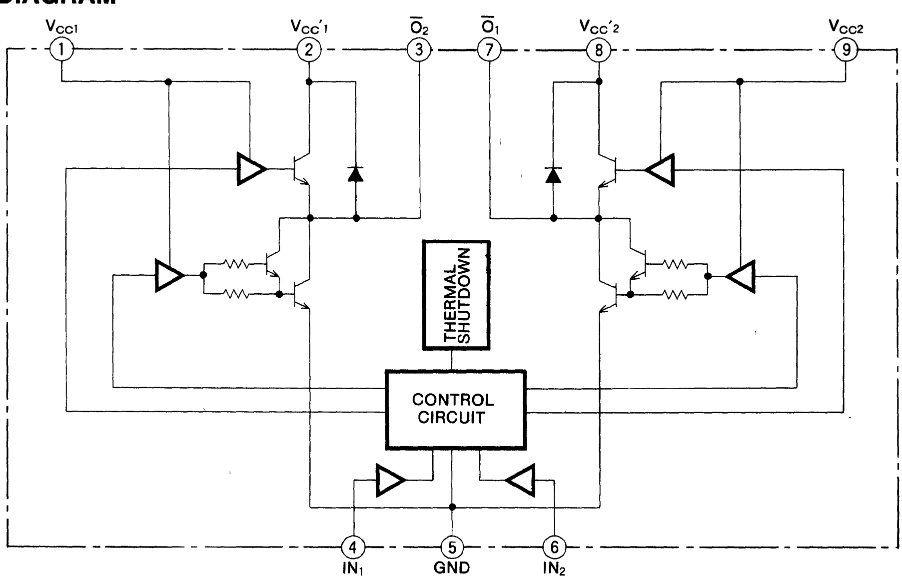


Outline 9P9

LOGIC TRUTH TABLE

INPUT		OUTPUT		NOTE
IN_1	IN_2	$\overline{O_1}$	$\overline{O_2}$	
L	L	"OFF" state	"OFF" state	Open
H	L	H	L	↻
L	H	L	H	↺
H	H	L	L	Braking

BLOCK DIAGRAM



MITSUBISHI ELECTRIC

ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
$V_{CC(1)}$	Supply voltage (1)		−0.5～+16	V
$V_{CC(2)}$	Supply voltage (2)	With an external heat sink (3000mm²X1.5mm)	−0.5～+20	V
V_{CC}'	Driver supply voltage		−0.5～+16	V
V_I	Input voltage		0～V_{CC}	V
V_O	Output voltage		−0.5～V_{CC}'+2.5	V
$I_{O(max)}$	Peak output current	t_{op}=10ms: Repetitive cycle 0.2Hz max	±2	A
$I_{O(1)}$	Continuous output current (1)		±330	mA
$I_{O(2)}$	Continuous output current (2)	With an external heat sink (3000mm²X1.5mm)	±600	mA
P_d	Power dissipation	T_a=75℃	1.15	W
T_{opr}	Operating ambient temperature range		−10～+75	℃
T_{stg}	Storage temperature range		−55～+125	℃

RECOMMENDED OPERATING CONDITIONS (T_a=25℃, unless otherwise noted)

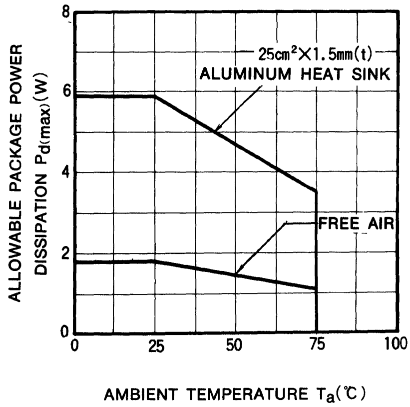
Symbol	Parameter	Conditions	Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage		4	12	15	V
I_O	Continuous output current				±300	mA
V_{IH}	"H" Input voltage		2		V_{CC}	V
V_{IL}	"L" Input voltage		0		0.4	V
t_B	Motor braking interval		100			ms
$T_{j(shut)}$	Thermal shutdown temperature	Junction temperature		150		℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Test conditions			Limits			Unit
					Min	Typ	Max	
$I_{O(leak)}$	Output leakage current	V_{CC}=V_{CC}'=20V, V_{I1}=V_{I2}=0V	V_O=20V				100	μA
			V_O=0V				−100	
$V_{OH(1)}$	"H" Output saturation voltage (1)	V_{CC}=V_{CC}'=12V	V_{I1}=2V, V_{I2}=0V	$I_{OH(1)}$=−200mA	10.8			V
				$I_{OH(1)}$=−500mA	10.7			
$V_{OH(2)}$	"H" Output saturation voltage (2)	V_{CC}=V_{CC}'=12V	V_{I1}=0V, V_{I2}=2V	$I_{OH(2)}$=−200mA	10.8			V
				$I_{OH(2)}$=−500mA	10.7			
$V_{OL(1)}$	"L" Output saturation voltage (1)	V_{CC}=V_{CC}'=12V	V_{I1}=0V, V_{I2}=2V	$I_{OL(1)}$=200mA			0.5	V
				$I_{OL(1)}$=500mA			1.35	
			V_{I1}=V_{I2}=2V				1.35	
$V_{OL(2)}$	"L" Output saturation voltage (2)	V_{CC}=V_{CC}'=12V	V_{I1}=2V, V_{I2}=0V	$I_{OL(2)}$=200mA			0.5	V
				$I_{OL(2)}$=500mA			1.35	
			V_{I1}=V_{I2}=2V				1.35	
$I_{IH(1)}$	"H" Input current (1)	V_{CC}=V_{CC}'=12V, V_{I1}=2V, V_{I2}=0V			50		120	μA
$I_{IH(2)}$	"H" Input current (2)	V_{CC}=V_{CC}'=12V, V_{I1}=0V, V_{I2}=2V			50		120	μA
I_{CC}	Supply current	V_{CC}=V_{CC}'=16V	V_{I1}=2V, V_{I2}=0V				20	mA
			V_{I1}=0V, V_{I2}=2V					
			V_{I1}=V_{I2}=2V				20	
			V_{I1}=V_{I2}=0V				4	

TYPICAL CHARACTERISTICS

ALLOWABLE AVERAGE POWER DISSIPATION



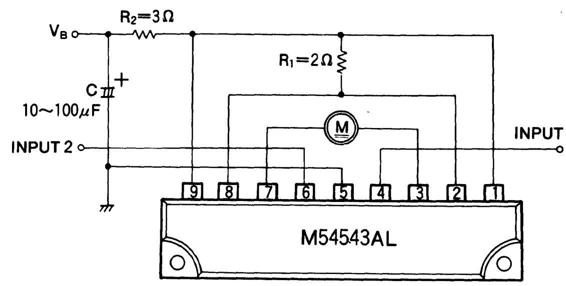
Note

When the V_{CC}' is lower than the V_{CC}, the current will flow from the V_{CC} to the V_{CC}' and may drive the motor.

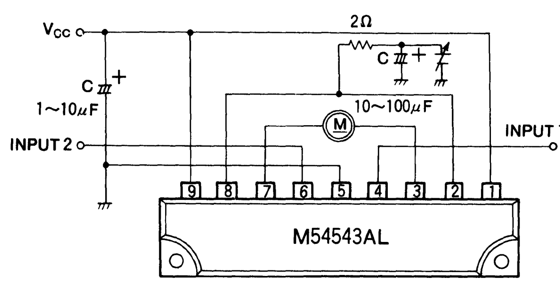
The M54544AL may be recommended to have the wider control voltage range of the V_{CC}.

APPLICATION EXAMPLES

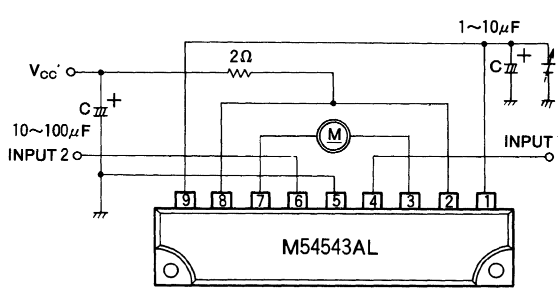
1) Motor speed control by V_{CC} and V_{CC}'



2) Motor speed control by the $V_{CC'}$



3) Motor speed control by the V_{CC}



M54544L

BI-DIRECTIONAL MOTOR DRIVER

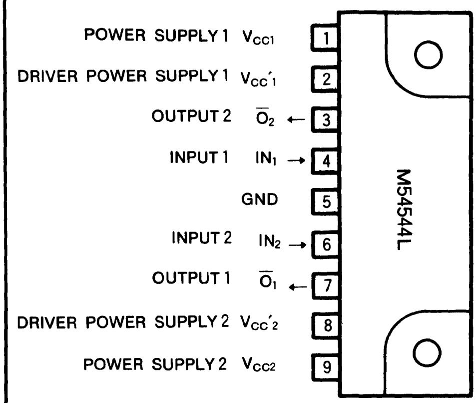
DESCRIPTION
The M54544L, BI-DIRECTIONAL MOTOR DRIVER, consists of a full bridge power driver designed for D-C motor control.

FEATURES
- Wide operating voltage range (V_{CC}= 4 ~16V)
- TTL, PMOS and CMOS compatible input
- Low output saturation voltage
- Integral diodes for transient suppression
- 1.2A output current
- Braking mode input

APPLICATION
Audio, video cassette recorders

FUNCTION
The M54544L, full bridge motor driver, has the logic circuitry and non-darlington power drivers for bidirectional control of D-C motors operating at currents up to 1.2A. A braking mode by switching the both inputs high may make easier to control the motor. The both of the separated power supplies for the logic circuitry and the drivers are usable for motor speed control. The power supply for the predriver is connected with the driver power supply to have a wider control range of motor supply voltage.

PIN CONFIGURATION (TOP VIEW)

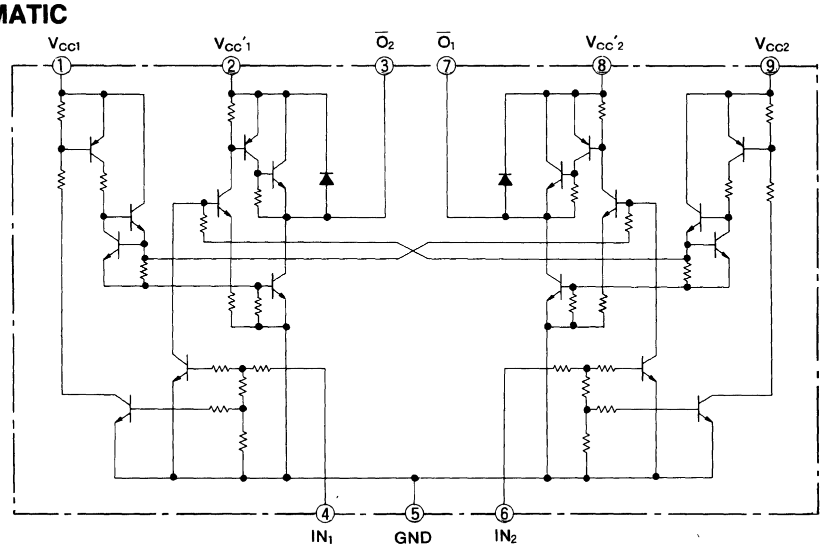


Outline 9P9

LOGIC TRUTH TABLE

Input		Output		Note
IN_1	IN_2	$\overline{O}_1$	$\overline{O}_2$	
L	L	"OFF" state	"OFF" state	Open
H	L	H	L	↻
L	H	L	H	↺
H	H	L	L	Braking

CIRCUIT SCHEMATIC



ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
$V_{CC(1)}$	Supply voltage (1)		−0.5～+16	V
$V_{CC(2)}$	Supply voltage (2)	With an external heat sink (3000mm^2×1.5mm)	−0.5～+20	V
V_{CC}'	Driver supply voltage		−0.5～+16	V
V_I	Input voltage		0～V_{CC}	V
V_O	Output voltage		−0.5～V_{CC}'+2.5	V
$I_{O(max)}$	Peak output current	t_{op}=10ms: Repetitive cycle 0.2Hz max	±1.2	A
$I_{O(1)}$	Continuous output current (1)		±330	mA
$I_{O(2)}$	Continuous output current (2)	With an external heat sink (3000mm^2×1.5mm)	±600	mA
Pd	Power Dissipation	T_a=75℃	1.15	W
Topr	Operating ambient temperature range		−10～+75	℃
Tstg	Storage temperature range		−55～+125	℃

RECOMMENDED OPERATING CONDITIONS (T_a=25℃, unless otherwise noted)

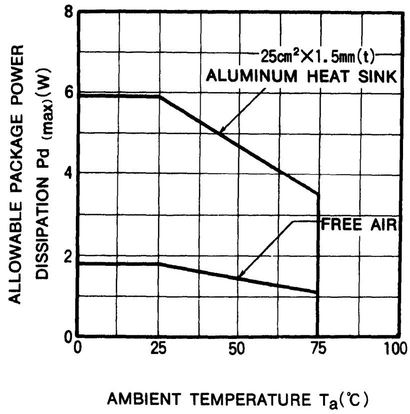
Symbol	Parameter	Conditions	Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage		4	12	15	V
I_O	Continuous output current				±300	mA
V_{IH}	"H" Input voltage		2		V_{CC}	V
V_{IL}	"L" Input voltage		0		0.4	V
t_B	Motor braking interval		100			ms

ELECTRICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Test conditions			Limits			Unit
					Min	Typ	Max	
$I_{O(leak)}$	Output leakage current	$V_{CC}=V_{CC}'$=20V, $V_{I1}=V_{I2}$=0V	V_O=20V				100	μA
			V_O=0V				−100	
$V_{OH(1)}$	"H" Output saturation voltage (1)	$V_{CC}=V_{CC}'$=12V	V_{I1}=2V, V_{I2}=0V	$I_{OH(1)}$=−300mA	10.8			V
				$I_{OH(1)}$=−500mA	10.7			
$V_{OH(2)}$	"H" Output saturation voltage (2)	$V_{CC}=V_{CC}'$=12V	V_{I2}=2V	$I_{OH(2)}$=−300mA	10.8			V
				$I_{OH(2)}$=−500mA	10.7			
$V_{OL(1)}$	"L" Output saturation voltage (1)	$V_{CC}=V_{CC}'$=12V	V_{I1}=0V, V_{I2}=2V	$I_{OL(1)}$=300mA			0.5	V
				$I_{OL(1)}$=500mA			0.65	
			$V_{I1}=V_{I2}$=2V				0.65	
$V_{OL(2)}$	"L" Output saturation voltage (2)	$V_{CC}=V_{CC}'$=12V	V_{I1}=2V, V_{I2}=0V	$I_{OL(2)}$=300mA			0.5	V
				$I_{OL(2)}$=500mA			0.65	
			$V_{I1}=V_{I2}$=2V				0.65	
$I_{IH(1)}$	"H" Input current (1)	$V_{CC}=V_{CC}'$=12V, V_{I1}=2V, V_{I2}=0V			70		200	μA
$I_{IH(2)}$	"H" Input current (2)	$V_{CC}=V_{CC}'$=12V, V_{I1}=0V, V_{I2}=2V			70		200	μA
I_{CC}	Supply current	$V_{CC}=V_{CC}'$=16V	V_{I1}=2V, V_{I2}=0V				30	mA
			V_{I1}=0V, V_{I2}=2V					
			$V_{I1}=V_{I2}$=2V				60	
			$V_{I1}=V_{I2}$=0V			0		

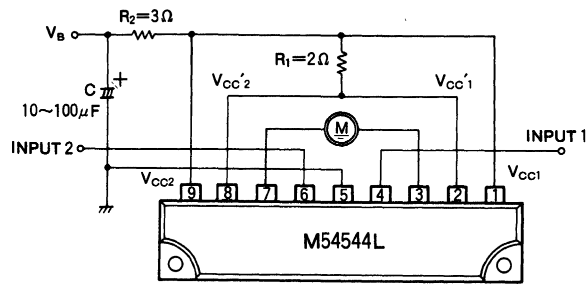
TYPICAL CHARACTERISTICS

ALLOWABLE AVERAGE POWER DISSIPATION

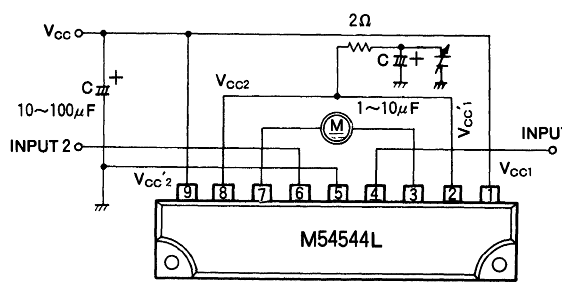


APPLICATION EXAMPLES

1) Motor speed control by V_{CC} and V_{CC}'



2) Motor speed control by the V_{CC}'



BI-DIRECTIONAL MOTOR DRIVER

DESCRIPTION

The M54544AL, BI-DIRECTIONAL MOTOR DRIVER, consists of a full bridge power driver designed for D-C motor control.

FEATURES

- Wide operating voltage range (V_{CC}= 4 ~16V)
- TTL, PMOS and CMOS compatible input
- Low output saturation voltage
- Integral diodes for transient suppression
- 1.2A output current
- Braking mode input
- Internal thermal shutdown protection

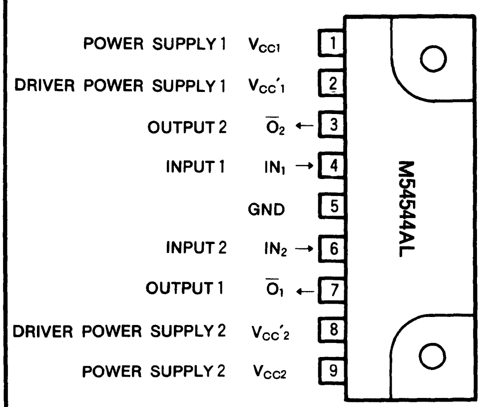
APPLICATION

Audio, video cassette recorders

FUNCTION

The M54544AL, full bridge motor driver, has the logic circuitry and non-darlington power drivers for bidirectional control of D-C motors operating at currents up to 1.2A. A braking mode by switching the both inputs high may make easier to control the motor. The both of the separated power supplies for the logic circuitry and the drivers are usable for motor speed control. The power supply for the predriver is connected with the driver power supply to have a wider control range of motor supply voltage.

PIN CONFIGURATION (TOP VIEW)

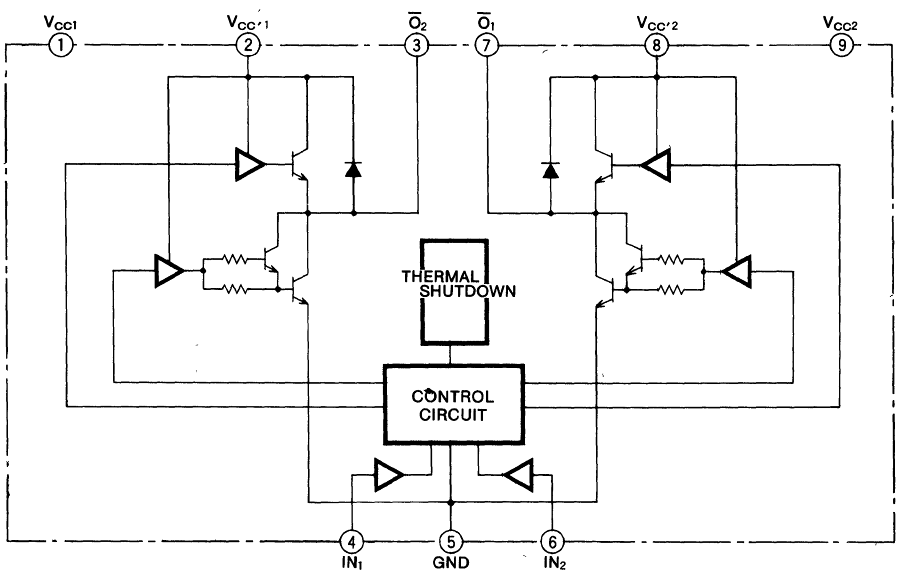


Outline 9P9

LOGIC TRUTH TABLE

Input		Output		Note
IN_1	IN_2	$\overline{O}_1$	$\overline{O}_2$	
L	L	"OFF" state	"OFF" state	Open
H	L	H	L	↻
L	H	L	H	↺
H	H	L	L	Braking

BLOCK DIAGRAM



MITSUBISHI ELECTRIC

ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
$V_{CC(1)}$	Supply voltage (1)		−0.5～+16	V
$V_{CC(2)}$	Supply voltage (2)	With an external heat sink (3000mm^2×1.5mm)	−0.5～+20	V
V_{CC}'	Driver supply voltage		−0.5～+16	V
V_I	Input voltage		0～V_{CC}	V
V_O	Output voltage		−0.5～V_{CC}'+2.5	V
$I_{O(max)}$	Peak output current	Repetitive cycle 0.2Hz max	±2	A
$I_{O(1)}$	Continuous output current (1)		±330	mA
$I_{O(2)}$	Continuous output current (2)	With an external heat sink (3000mm^2×1.5mm)	±600	mA
Pd	Power Dissipation	T_a=75℃	1.15	W
T_{opr}	Operating ambient temperature range		−10～+75	℃
T_{stg}	Storage temperature range		−55～+125	℃

RECOMMENDED OPERATING CONDITIONS (T_a=25℃, unless otherwise noted)

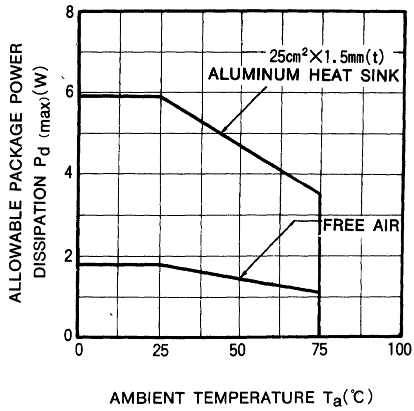
Symbol	Parameter	Conditions	Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage		4	12	15	V
I_O	Continuous output current				±300	mA
V_{IH}	"H" Input voltage		2		V_{CC}	V
V_{IL}	"L" Input voltage		0		0.4	V
t_B	Motor braking interval		10	100		ms
$T_{j(shut)}$	Thermal shutdown temperature	junction temperature		150		℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Test conditions			Limits			Unit
					Min	Typ	Max	
$I_{O(leak)}$	Output leakage current	$V_{CC}=V_{CC}'$=20V		V_O=20V			100	μA
		$V_{I1}=V_{I2}$=0V		V_O=0V			−100	
$V_{OH(1)}$	"H" Output saturation voltage (1)	$V_{CC}=V_{CC}'$=12V	V_{I1}=2V	$I_{OH(1)}$=−200mA	10.8			V
			V_{I2}=0V	$I_{OH(1)}$=−500mA	10.7			
$V_{OH(2)}$	"H" Output saturation voltage (2)	$V_{CC}=V_{CC}'$=12V	V_{I1}=0V	$I_{OH(2)}$=−200mA	10.8			V
			V_{I2}=2V	$I_{OH(2)}$=−500mA	10.7			
$V_{OL(1)}$	"L" Output saturation voltage (1)	$V_{CC}=V_{CC}'$=12V	V_{I1}=0V	$I_{OL(1)}$=200mA			0.5	V
			V_{I2}=2V	$I_{OL(1)}$=500mA			1.35	
			$V_{I1}=V_{I2}$=2V				1.35	
$V_{OL(2)}$	"L" Output saturation voltage (2)	$V_{CC}=V_{CC}'$=12V	V_{I1}=2V	$I_{OL(2)}$=200mA			0.5	V
			V_{I2}=0V	$I_{OL(2)}$=500mA			1.35	
			$V_{I1}=V_{I2}$=2V				1.35	
$I_{IH(1)}$	"H" Input current (1)	$V_{CC}=V_{CC}'$=12V, V_{I1}=2V, V_{I2}=0V			50		120	μA
$I_{IH(2)}$	"H" Input current (2)	$V_{CC}=V_{CC}'$=12V, V_{I1}=0V, V_{I2}=2V			50		120	μA
I_{CC}	Supply current	$V_{CC}=V_{CC}'$=16V		V_{I1}=2V, V_{I2}=0V			15	mA
				V_{I1}=0V, V_{I2}=2V				
				$V_{I1}=V_{I2}$=2V			20	
				$V_{I1}=V_{I2}$=0V			4	

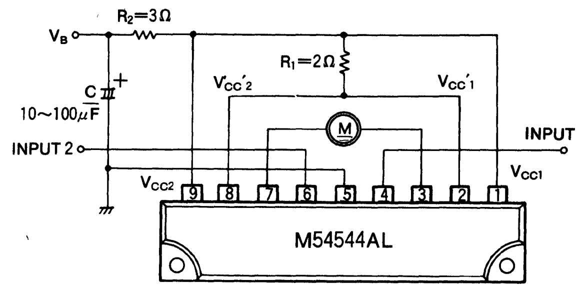
TYPICAL CHARACTERISTICS

ALLOWABLE AVERAGE POWER DISSIPATION

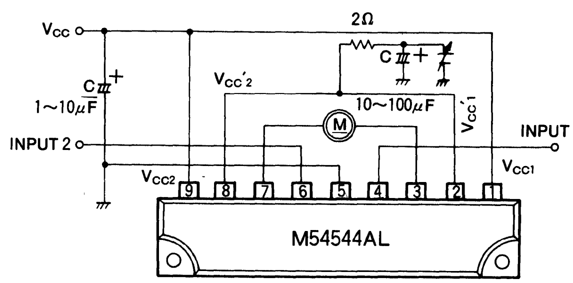


APPLICATION EXAMPLES

1) Motor speed control by V_{CC} and V_{CC}'



2) Motor speed control by the V_{CC}'



M54545L

BI-DIRECTIONAL MOTOR DRIVER

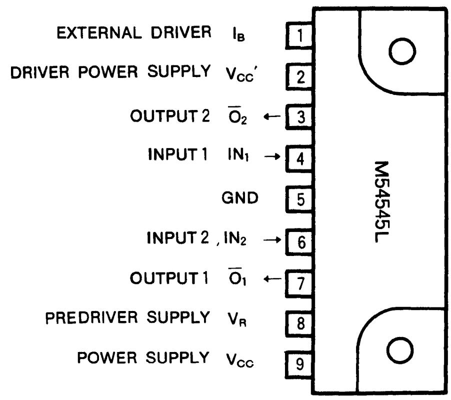
DESCRIPTION
The M54545L, BI-DIRECTIONAL MOTOR DRIVER, consists of a full bridge power driver designed for D-C motor control.

FEATURES
- Wide operating voltage range (V_{CC} = 3 ~16V)
- Low output saturation voltage
- Integral diodes for transient suppression
- 1.2A output current
- Braking mode input
- Low standby current

APPLICATION
Audio, video cassette recorder

FUNCTION
The M54545L, full bridge motor driver, has the logic circuitry and the quasi-darlington power driver for bidirectional control of D-C motors operating at currents up to 1.2A. A braking mode by switching the both inputs high may make easier to control the motor. The power supplies for the logic circuitry, the predrivers and the power drivers are separated so that the application circuit with the M54545L can be easily optimized for lower power consumption.

PIN CONFIGURATION (TOP VIEW)

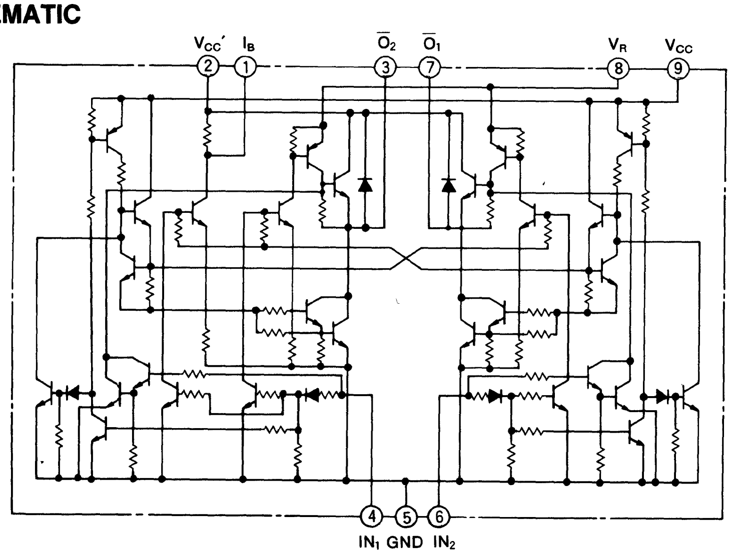


Outline 9P9

LOGIC TRUTH TABLE

Input		Output			Note
IN_1	IN_2	$\overline{O}_1$	$\overline{O}_2$	I_B	
L	L	"OFF" state	"OFF" state	H	Off
H	L	H	L	H	↻
L	H	L	H	L	↺
H	H	L	L	H	Braking

CIRCUIT SCHEMATIC



ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		−0.5～+16	V
V_R	Predriver supply voltage		−0.5～+16	V
V_{CC}'	Driver supply voltage		−0.5～+16	V
V_I	Input voltage		0～V_{CC}	V
V_O	Output voltage		−0.5～V_{CC}'+2.5	V
$I_{O(max)}$	Peak output current	t_{op}=10ms V_{CC}≧5V : Repetitive cycle 0.2Hz max	±1.2	A
I_O	Continuous output current		±330	mA
P_d	Power dissipation	T_a=75℃	1.15	W
T_{opr}	Operating ambient temperature range		−10～+75	℃
T_{stg}	Storage temperature range		−55～+125	℃

RECOMMENDED OPERATING CONDITIONS (T_a=25℃, unless otherwise noted)

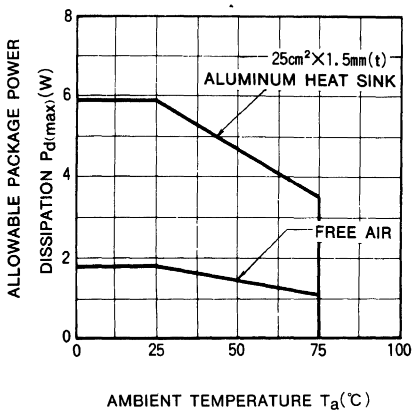
Symbol	Parameter	Conditions	Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage		3	12	15	V
I_O	Continuous output current				±200	mA
V_{IH}	"H" Input voltage		3		V_{CC}	V
V_{IL}	"L" Input voltage		0		0.4	V
t_B	Motor braking interval		100			ms

ELECTRICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Test conditions		Limits			Unit
				Min	Typ	Max	
$I_{O(leak)}$	Output leakage current	$V_{CC}=V_R=V_{CC}'$=16V	V_O=16V			100	μA
		$V_{I1}=V_{I2}$=0V	V_O=0V			−100	
$V_{OH(1)}$	"H" Output saturation voltage (1)	$V_{CC}=V_R=V_{CC}'$=12V	V_{I1}=3V, V_{I2}=0V	10.8			V
$V_{OH(2)}$	"H" Output saturation voltage (2)	I_{OH}=−200mA	V_{I1}=0V, V_{I2}=3V	10.8			V
$V_{OL(1)}$	"L" Output saturation voltage (1)	$V_{CC}=V_R=V_{CC}'$=12V	V_{I1}=0V, V_{I2}=3V			0.4	V
		$I_{OL(1)}$=200mA	V_{I1}=3V, V_{I2}=3V				
$V_{OL(2)}$	"L" Output saturation voltage (2)	$V_{CC}=V_R=V_{CC}'$=12V	V_{I1}=3V, V_{I2}=0V			0.4	V
		$I_{OL(2)}$=200mA	V_{I1}=3V, V_{I2}=3V				
$I_{IH(1)}$	"H" Input current (1)	$V_{CC}=V_R=V_{CC}'$=12V	V_{I1}=3V, V_{I2}=0V			700	μA
$I_{IH(2)}$	"H" Input current (2)	$V_{CC}=V_R=V_{CC}'$=12V	V_{I1}=0V, V_{I2}=3V			700	μA
I_{CC}	Supply current	$V_{CC}=V_R=V_{CC}'$=12V	V_{I1}=0V, V_{I2}=0V			5	mA
			V_{I1}=3V, V_{I2}=0V			10	
			V_{I1}=0V, V_{I2}=3V				
I_B	I_B Output current	$V_{CC}=V_R=V_{CC}'$=12V, V_{IB}=12V, V_{I1}=0V, V_{I2}=3V		1.0		15.0	mA

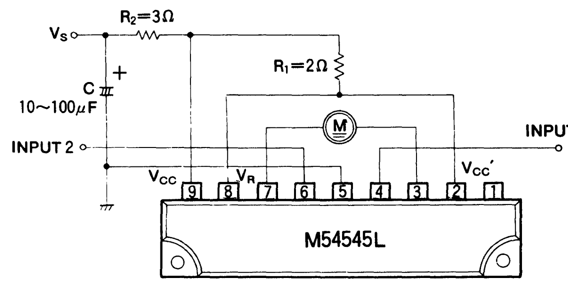
TYPICAL CHARACTERISTICS

ALLOWABLE AVERAGE POWER DISSIPATION

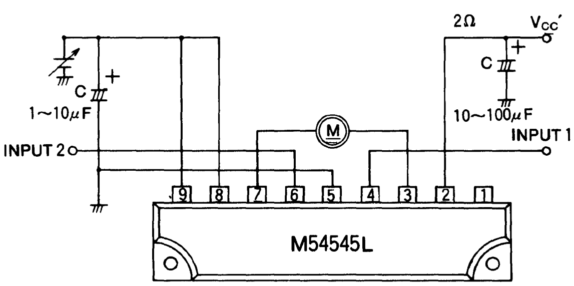


APPLICATION EXAMPLES

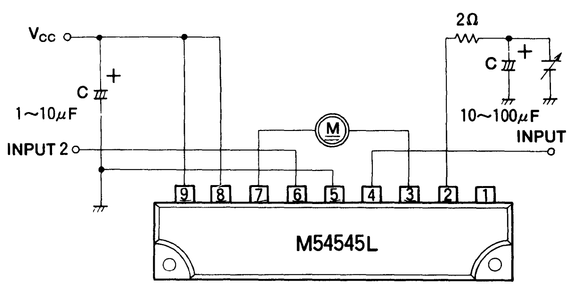
1) Motor speed control by V_{CC} and V_{CC}'



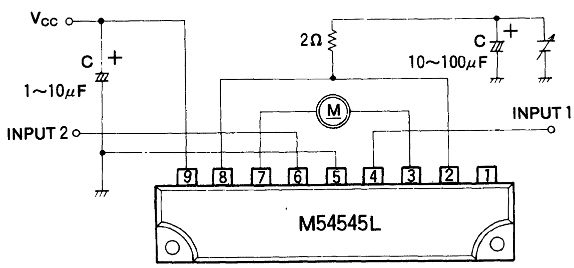
2) Motor speed control by the V_R and V_{CC}



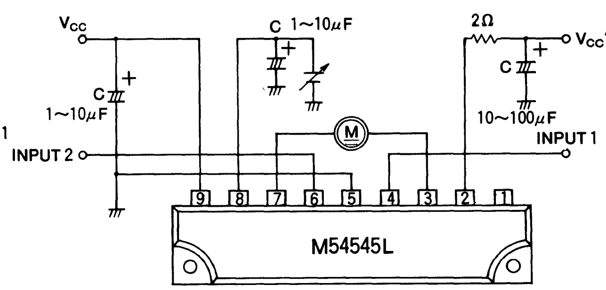
3) Motor speed control by the V_{CC}'



4) Motor speed control by the V_R and V_{CC}'



5) Motor speed control by the V_R



DESCRIPTION
The M54546L, BI-DIRECTIONAL MOTOR DRIVER, consists of a full bridge power driver designed for D-C motor control.

FEATURES
- Wide operating voltage range (V_{CC}= 4 ~16V)
- TTL, PMOS and CMOS compatible input
- Low output saturation voltage
- Integral diodes for transient suppression
- Small single-in-line package
- Braking mode input

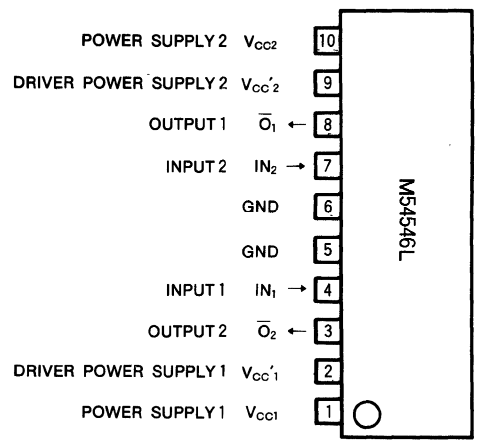
APPLICATION
Audio, video cassette recorder

FUNCTION
The M54546L, full bridge motor driver, has the logic circuitry and non-darlington power drivers for bidirectional control of D-C motors operating at currents up to 700mA. A braking mode by switching the both inputs high may make easier to control the motor. The both of the separated power supplies for the logic circuitry and the drivers are usable for motor speed control. The power supply of the predriver is connected with the driver power supply to have a wider control range of motor supply voltage.

LOGIC TRUTH TABLE

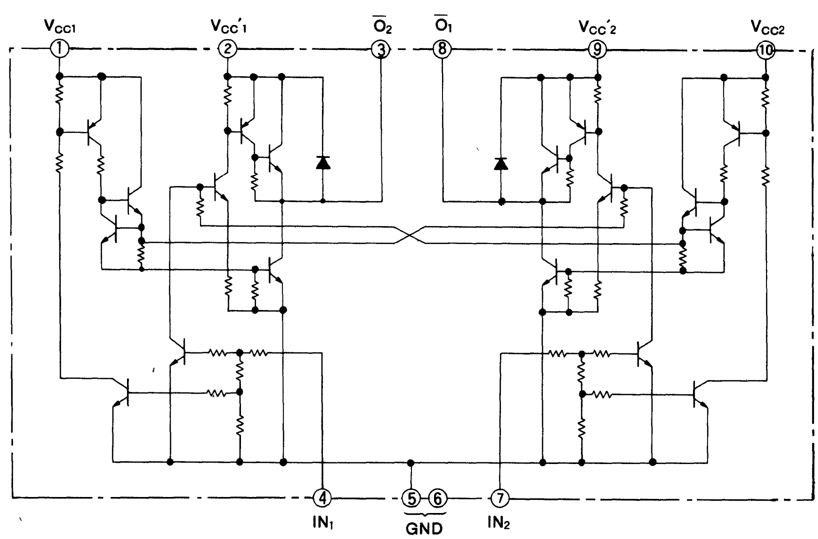
INPUT		OUTPUT		NOTE
IN_1	IN_2	$\overline{O_1}$	$\overline{O_2}$	
L	L	"OFF" state	"OFF" state	Open
H	L	H	L	↻
L	H	L	H	↺
H	H	L	L	Braking

PIN CONFIGURATION (TOP VIEW)



Outline 10P5

CIRCUIT SCHEMATIC



ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		−0.5∼+16	V
V_{CC}'	Driver supply voltage		−0.5∼+16	V
V_I	Input voltage		0∼V_{CC}	V
V_O	Output voltage		−0.5∼V_{CC}'+2.5	V
$I_{O(max)}$	Peak output current	t_{op}=10ms Repetitive cycle 0.2Hz max	±700	mA
I_O	Continuous output current		±150	mA
P_d	Power dissipation	T_a=75℃	600	mW
T_{opr}	Operating ambient temperature range		−10∼+75	℃
T_{stg}	Storage temperature range		−55∼+125	℃

RECOMMENDED OPERATING CONDITIONS (T_a=25℃, unless otherwise noted)

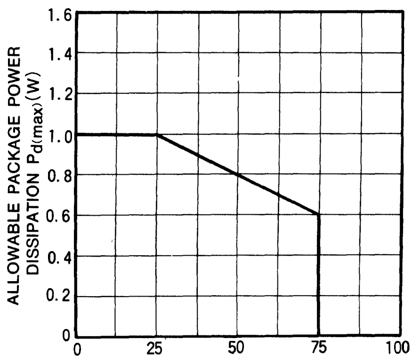
Symbol	Parameter	Conditions	Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage		4	12	15	V
I_O	Continuous output current				±300	mA
V_{IH}	"H" Input voltage		2		V_{CC}	V
V_{IL}	"L" Input voltage		0		0.4	V
t_B	Motor braking interval		100			ms

ELECTRICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Test conditions			Limits			Unit
					Min	Typ	Max	
$I_{O(leak)}$	Output leakage current	V_{CC}=V_{CC}'=20V, V_{I1}=V_{I2}=2V		V_O=20V			100	μA
				V_O=0V			−100	
$V_{OH(1)}$	"H" Output saturation voltage (1)	V_{CC}=V_{CC}'=12V	V_{I1}=2V, V_{I2}=0V	$I_{OH(1)}$=−50mA	11.0			V
				$I_{OH(1)}$=−100mA	10.9			
$V_{OH(2)}$	"H" Output saturation voltage (2)	V_{CC}=V_{CC}'=12V	V_{I1}=0V, V_{I2}=2V	$I_{OH(2)}$=−50mA	11.0			V
				$I_{OH(2)}$=−100mA	10.9			
$V_{OL(1)}$	"L" Output saturation voltage (1)	V_{CC}=V_{CC}'=12V	V_{I1}=0V, V_{I2}=2V	$I_{OL(1)}$=50mA			0.3	V
				$I_{OL(1)}$=100mA			0.35	
			V_{I1}=V_{I2}=2V	$I_{OL(1)}$=100mA			0.35	
$V_{OL(2)}$	"L" Output saturation voltage (2)	V_{CC}=V_{CC}'=12V	V_{I1}=2V, V_{I2}=0V	$I_{OL(2)}$=50mA			0.3	V
				$I_{OL(2)}$=100mA			0.35	
			V_{I1}=V_{I2}=2V	$I_{OL(2)}$=100mA			0.35	
$I_{IH(1)}$	"H" Input current (1)	V_{CC}=V_{CC}'=12V, V_{I1}=2V, V_{I2}=0V			70		200	μA
$I_{IH(2)}$	"H" Input current (2)	V_{CC}=V_{CC}'=12V, V_{I1}=0V, V_{I2}=2V			70		200	μA
I_{CC}	Supply current	V_{CC}=V_{CC}'=16V		V_{I1}=2V, V_{I2}=0V			30	mA
				V_{I1}=0V, V_{I2}=2V				
				V_{I1}=V_{I2}=2V			60	
				V_{I1}=V_{I2}=0V		0		

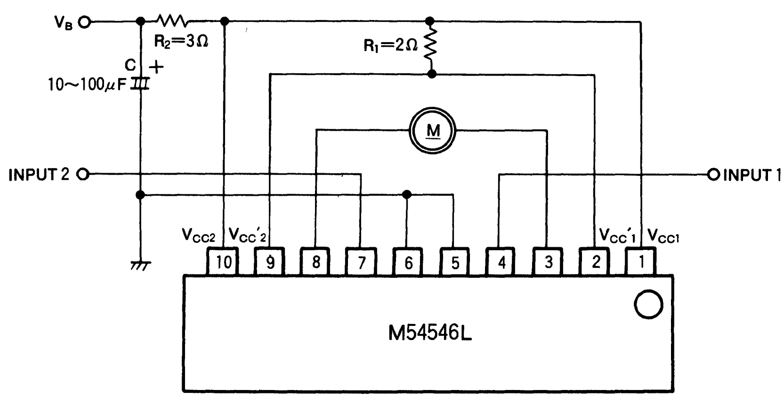
TYPICAL CHARACTERISTICS

ALLOWABLE AVERAGE POWER DISSIPATION

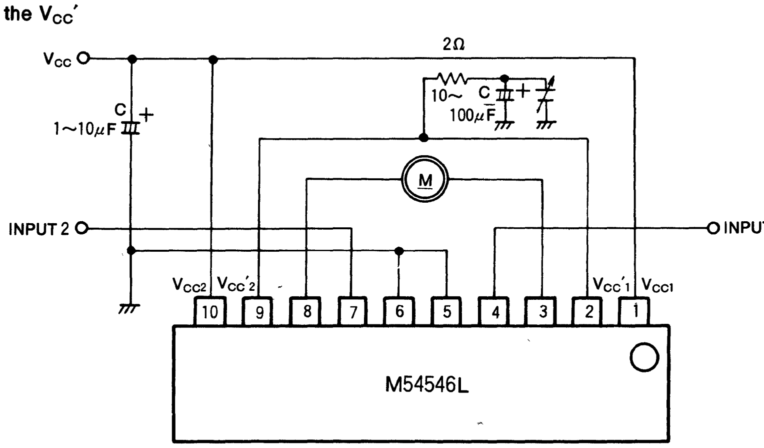


APPLICATION EXAMPLES

1) Motor speed control by V_{CC} and V_{CC}'



2) Motor speed control by the V_{CC}'



M54547P

BI-DIRECTIONAL MOTOR DRIVER WITH OP AMP AND TRANSISTOR ARRAY

DESCRIPTION

The M54547P, BI-DIRECTIONAL MOTOR DRIVER, consists of a full bridge power driver and dual general purpose NPN darlington pairs.

FEATURES

- 600mA output current
- Braking mode input
- Integral operational amplifier at direction control input
- Output transient suppression

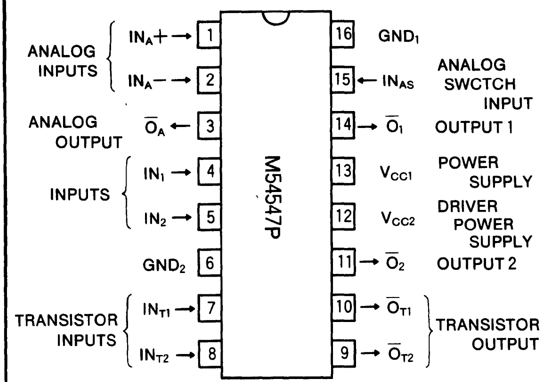
APPLICATION

Audio, video cassette recorder

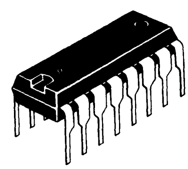
FUNCTION

The M54547P, full bridge motor driver, has the logic circuitry and darlington power drivers for bidirectional control of D-C motors operating at currents up to 600mA. The operational amplifier is connected to the direction control input through an analog switch controlled by pin 15 input. By switching the IN_{AS} input high and the IN_1 input low, the output of the amplifier appears at the output $\overline{O}_1$ so that the voltage across the bridge output is altered linearly by the amplifier input. The internal NPN darlington pairs are capable of sinking 300mA and will withstand 20V in the OFF state.

PIN CONFIGURATION (TOP VIEW)

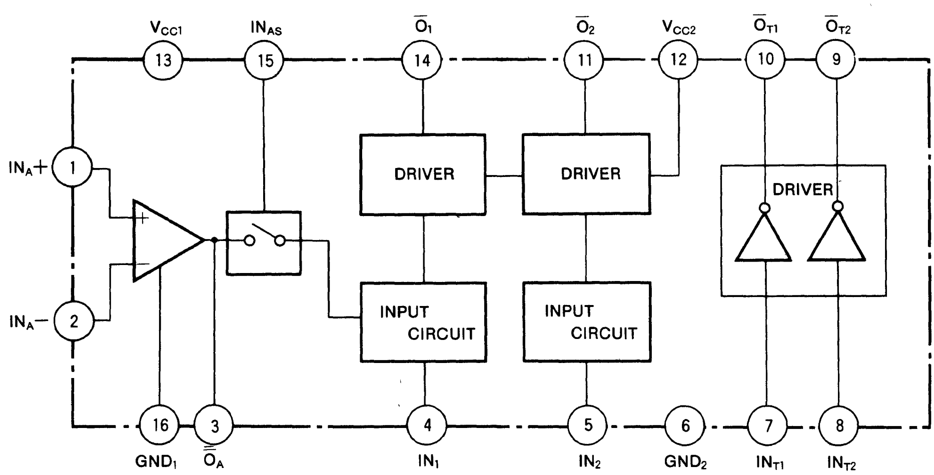


Outline 16P4



16-pin molded plastic DIP

BLOCK DIAGRAM



BI-DIRECTIONAL MOTOR DRIVER WITH OP AMP AND TRANSISTOR ARRAY

LOGIC TRUTH TABLE

Input			Output		Note
IN_{SW}	IN_1	IN_2	$\overline{O}_1$	$\overline{O}_2$	
L	L	L	H	H	Braking
L	L	H	H	L	↻
L	H	L	L	H	↺
L	H	H	L	L	Braking
H	L	L	A*	H	Analog ↻
H	L	H	A*	L	Analog ↺
H	H	L	L	H	↺
H	H	H	L	L	Braking

A* : The output voltage is controlled by the amplifier output.

ABSOLUTE MAXIMUM RATINGS (T_a=25℃,unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC1}	Supply voltage		−0.5~+16	V
V_{CC2}	Driver supply voltage		−0.5~+16	V
V_I,V_{IAS}	Input voltage		0~V_{CC}	V
V_O	Output voltage		−0.5~V_{CC2}+2.5V	V
I_{OP}	Peak output current	t_{op}=10ms : Repetitive cycle 0.2Hz max	±600	mA
I_O	Continuous output current		±150	mA
V_{CEO}	Collector-emitter applied voltage(transistor array)		20	V
I_C	Collector current(transistor array)		300	mA
V_I	Input voltage(Transistor array)		10	V
P_d	Power dissipation	T_a=25℃	1.47	W
		T_a=60℃	1.06	
T_{opr}	Operating ambient temperature range		−10~+60	℃
T_{stg}	Storage temperature range		−55~+125	℃

RECOMMENDED OPERATING CONDITIONS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Limits			Unit
			Min	Typ	Max	
V_{CC1}	Supply voltage		4	12	15	V
I_O	Continuous output current				±100	mA
V_{IH}	Input voltage(motor driver)		3		V_{CC}	V
V_{IL}	(IN_1, IN_2, IN_{AS})		0		0.6	V
t_B	Motor braking interval		100			ms
V_{IH}	Transistor array input voltage		4		10	V
V_{IL}	(IN_{T1}, IN_{T2})		0		0.6	V

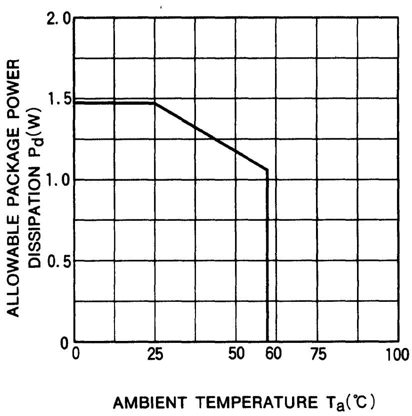
BI-DIRECTIONAL MOTOR DRIVER WITH OP AMP AND TRANSISTOR ARRAY

ELECTRICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

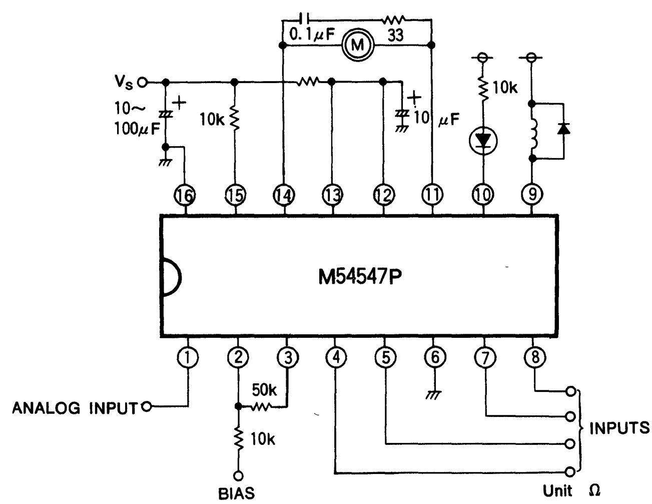
Symbol	Parameter	Test conditions		Limits Min	Limits Typ	Limits Max	Unit
$I_{O(leak)}$	Output leakage current($\overline{O}_1$, $\overline{O}_2$)	$V_{CC1}=V_{CC2}$=16V $V_{IN1}=V_{IN2}=V_{IAS}$=0V	V_O=0V V_O=16V			±100	μA
V_{OH}	"H"Output saturation voltage($\overline{O}_1$, $\overline{O}_2$)	$V_{CC1}=V_{CC2}$=12V I_O=−150mA	V_{IN1}=0V, V_{IN2}=3V V_{IN1}=3V, V_{IN2}=0V	10.3			V
V_{OL}	"L"Output saturation voltage($\overline{O}_1$, $\overline{O}_2$)	$V_{CC1}=V_{CC2}$=12V I_O=150mA	V_{IN1}=0V, V_{IN2}=3V V_{IN1}=3V, V_{IN2}=0V			1.2	V
I_I	Input current(IN_1, IN_2, IN_{AS})	V_{CC1}=12V, V_I=3V				0.3	mA
$I_{O(leak)}$	Output leakage current($\overline{O}_{T1}$, $\overline{O}_{T2}$)	V_O=30V, V_I=0.6V				100	μA
V_{OC}	"L"Output saturation voltage	V_I=4V	I_C=100mA			1.3	V
			I_C=200mA			1.5	
I_I	Input current	V_I=4V				0.8	mA
A_O	OP Amp open-loop-gain			40			dB
I_{CC1}	Supply current	V_{CC1}=12V, $V_{IN1}=V_{IN2}=V_{IAS}$=3V				6	mA

TYPICAL CHARACTERISTICS

ALLOWABLE AVERAGE POWER DISSIPATION



APPLICATION EXAMPLE



M54548L

BI-DIRECTIONAL MOTOR DRIVER WITH MOTOR SPEED CONTROL

DESCRIPTION

The M54548L, BI-DIRECTIONAL MOTOR DRIVER, consists of a full bridge power driver designed for use in a D-C motor control circuit. The internal operational amplifier is capable for controlling the voltage across the bridge outputs.

FEATURES

- Wide operating voltage range
- NMOS and CMOS compatible input
- 1.2A output current
- Integral operational amplifier for output source voltage
- Output transient suppression
- Braking mode input

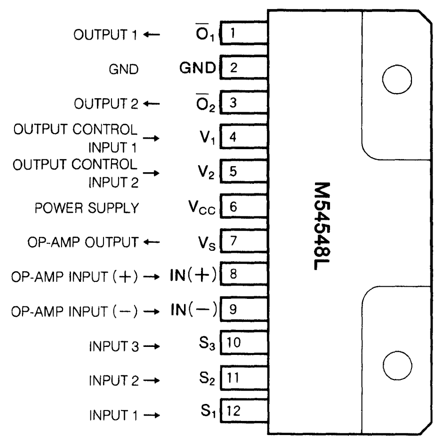
APPLICATION

Audio, video cassette recorder

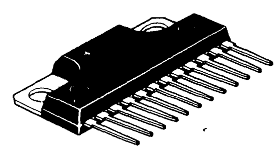
FUNCTION

The M54548L, full bridge motor driver, has the logic circuitry and the quasi-darlington power driver for bidirectional control of D-C motors operating at current up to 1.2A. The inputs, S_1, S_2 and S_3, are capable to control the bridge output polarity and also to select the supply voltage of the predriver from the voltages drived by V_1, V_2 or the output of the operational amplifier.

PIN CONFIGURATION (TOP VIEW)



Outline 12P9

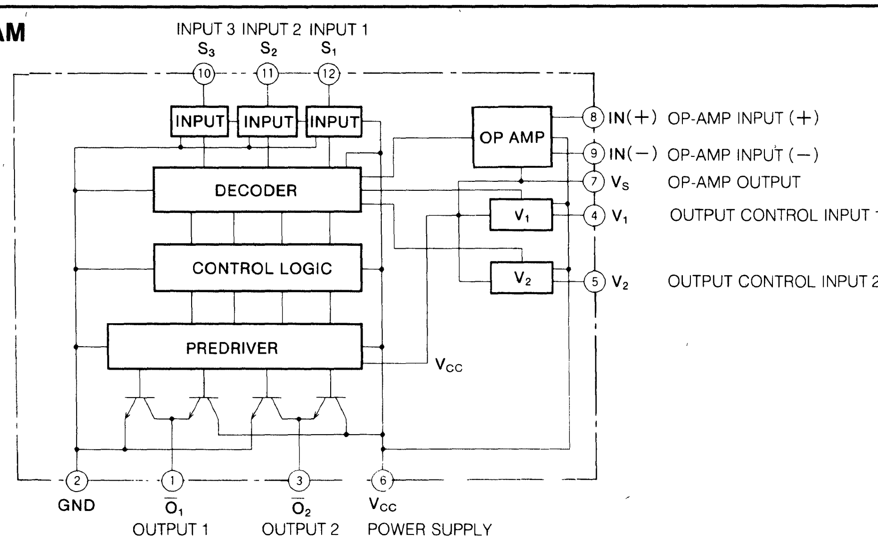


12-pin molded plastic SIP

LOGIC TRUTH TABLE

Input			Output		Driver power supply	Note
S_1	S_2	S_3	$\overline{O}_1$	$\overline{O}_2$		
L	L	L	"OFF" state	"OFF" state	−	STOP
L	L	H	H	L	OP AMP OUTPUT	PLAY(+)
L	H	L	L	H	OP AMP OUTPUT	PLAY(−)
L	H	H	H	L	V_2	FF(2)
H	L	L	L	H	V_2	REW(2)
H	L	H	H	L	V_1	FF(1)
H	H	L	L	H	V_1	REW(1)
H	H	H	L	L	V_S	BRAKING

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS (T_a =25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage	With an external heat sink (3000mm²×1.5mm^t)	−0.5〜+18	V
V_I	Input voltage	4 Pin, 5 Pin	−0.5〜+14or V_{CC}	V
			−0.5〜V_{CC}	
V_O	Output voltage		−0.5〜V_{CC}+2.5	V
$I_{O(max)}$	Peak output current	t_{op}=10ms; Repetitive cycle 0.2Hz max	±1.2	A
$I_{O(1)}$	Continuous output current (1)		±300	mA
$I_{O(2)}$	Continuous output current (2)	With an external heat sink (3000mm²×1.5mm^t)	±600	mA
Pd	Power dissipation	T_a =75℃	1.2	W
Topr	Operating ambient temperature range		−10〜+75	℃
Tstg	Storage temperature range		−55〜+125	℃

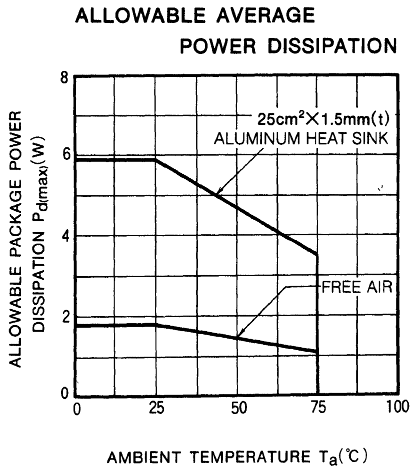
RECOMMENDED OPERATING CONDITIONS (T_a =25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage		4	12	16	V
I_O	Continuous output current				±200	mA
V_{IH}	"H" Input voltage		3			V
V_{IL}	"L" Input voltage				1	V
t_S	Motor braking interval		100			ms

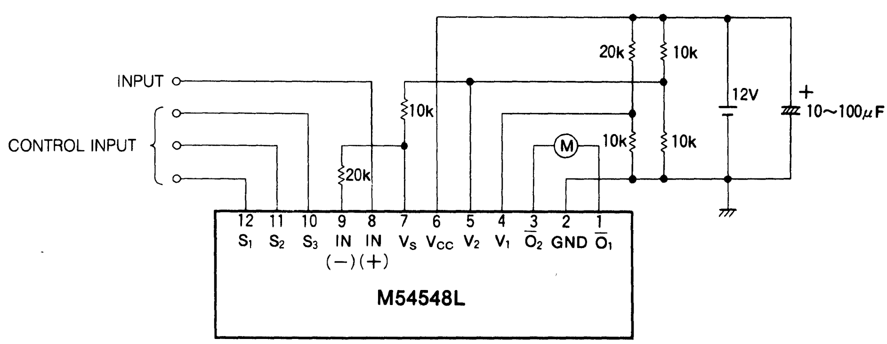
ELECTRICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Test conditions			Limits			Unit
					Min	Typ	Max	
$I_{O(leak)}$	Output leakage current	V_{S1}=0V, V_{S2}=0V, V_{S3}=0V		V_O=0V, V_{CC}=V_S=20V			−100	μA
				V_O=14V, V_{CC}=V_S=14V			+100	
$V_{OH(1)}$	"H" Output saturation voltage (1)	V_{CC}=16V, $V_{IN(-)}$=0V, $V_{IN(+)}$=3V	V_{S1}=V_{S2}=0V, V_{S3}=3V	I_{OH}=−200mA	13			V
				I_{OH}=−500mA	12.8			
$V_{OH(2)}$	"H" Output saturation voltage (2)	V_{CC}=16V, $V_{IN(-)}$=0V, $V_{IN(+)}$=3V	V_{S1}=V_{S3}=0V, V_{S2}=3V	I_{OH}=−200mA	13			V
				I_{OH}=−500mA	12.8			
$V_{OL(1)}$	"L" Output saturation voltage (1)	V_{CC}=16V, $V_{IN(-)}$=0V, $V_{IN(+)}$=3V	V_{S1}=V_{S3}=0V, V_{S2}=3V	I_{OL}=200mA			0.5	V
				I_{OL}=500mA			1.4	
$V_{OL(2)}$	"L" Output saturation voltage (2)	V_{CC}=16V, $V_{IN(-)}$=0V, $V_{IN(+)}$=3V	V_{S1}=V_{S2}=0V, V_{S3}=3V	I_{OL}=200mA			0.5	V
				I_{OL}=500mA			1.4	
I_{IH}	"H" Input current	V_{CC}=16V, V_{IS}=3V (S_1, S_2, S_3)					10	μA
I_{IL}	"L" Input current	V_{CC}=16V, V_{IS}=0V (S_1, S_2, S_3)					−20	μA
I_{CC}	Supply current	V_{CC}=16V, V_{S1}=V_{S2}=V_{S3}=3V					25	mA
A	Op amp open-loop-gain				50			dB

TYPICAL CHARACTERISTICS



APPLICATION EXAMPLE



Unit Ω

M54549L

DUAL BI-DIRECTIONAL MOTOR DRIVER WITH THERMAL SHUT DOWN FUNCTION

DESCRIPTION

The M54549L, BI-DIRECTIONAL MOTOR DRIVER, consists of the two full bridge power designed for use in are two D-C motors control circuit.

FEATURES

- Two separated full bridge driver (only one circuit can be switched by the SE input)
- Wide operating voltage range (V_{CC}=4~16V)
- TTL, PMOS, CMOS outputs, capable of direct drive
- Low output saturation voltage
- Built-in clamp diode
- Large output drive current ($I_{O(max)}=\pm 2A$)
- Braking mode input
- Internal thermal shutdown protection

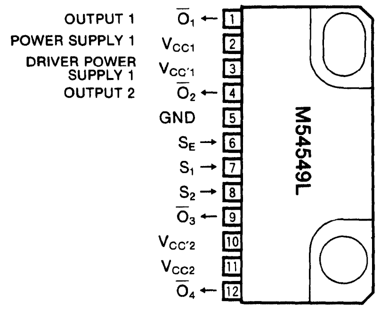
APPLICATION

- Audio tape-deck player, radio/cassette player
- VTR
- Home-use equipment

FUNCTION

The M54549L, two-full bridge motor driver, has the logic circuitry and the darlington power driver for bi-directional control of two D-C motors operating at current up to 2.0A. The input SE selects one of the bridges and S_1, S_2 determine the output polarity.

PIN CONFIGURATION (TOP VIEW)

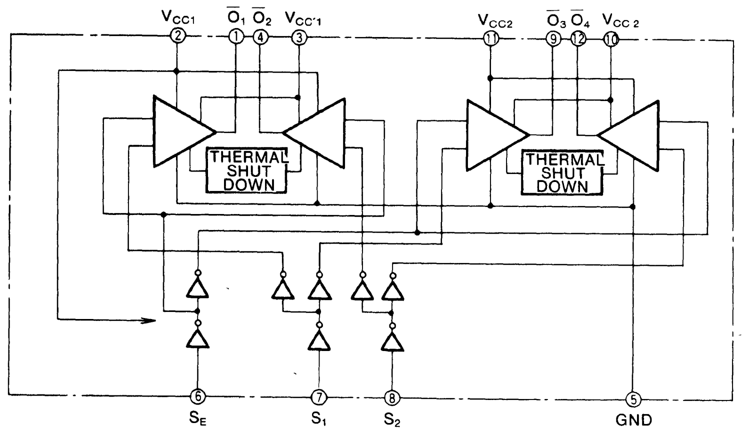


Outline 12P9

LOGIC TRUTH TABLE

Input			Output				Note	
S_E	S_1	S_2	$\overline{O}_1$	$\overline{O}_2$	$\overline{O}_3$	$\overline{O}_4$	Output $\overline{O}_1$, $\overline{O}_2$	Output $\overline{O}_3$, $\overline{O}_4$
0	0	0	OFF	OFF	OFF	OFF	OPen	Open
0	1	0	1	0	OFF	OFF	↻	Open
0	0	1	0	1	OFF	OFF	↺	Open
0	1	1	0	0	OFF	OFF	Braking	Open
1	0	0	OFF	OFF	OFF	OFF	Open	Open
1	1	0	OFF	OFF	1	0	Open	↻
1	0	1	OFF	OFF	0	1	Open	↺
1	1	1	OFF	OFF	0	0	Open	Braking

BLOCK DIAGRAM



DUAL BI-DIRECTIONAL MOTOR DRIVER WITH THERMAL SHUT DOWN FUNCTION

ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
$V_{CC(1)}$	Supply voltage (1)		−0.5～+18	V
$V_{CC(2)}$	Supply voltage (2)	With an external sink (3000mm^2×1.5mm)	−0.5～+18	V
$V_{CC'}$	Driver supply voltage		−0.5～+18	V
V_I	Input voltage		0～V_{CC}	V
V_O	Output voltage		−2～$V_{CC'}$+2.5	V
$I_{O(max)}$	Peak output current	t_{op}=10ms, retitive cycle 0.2Hz max	±2.0	A
$I_{O(1)}$	Continuous output current (1)		±330	mA
$I_{O(2)}$	Continuous output current (2)	With an external sink (3000mm^2×1.5mm)	±600	mA
P_d	Power dissipation	T_a=75℃	1.20	W
Topr	Operating ambient temperature range		−10～+75	℃
Tstg	Storage temperature range		−55～+125	℃

RECOMMNDED OPERATING CONDITIONS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage		4	12	16	V
I_O	Output current				±300	mA
V_{IH}	"H" Input voltage	Input S_1, S_2, S_E	2		V_{CC}	V
V_{IL}	"L" Input voltage	Input S_1, S_2, S_E	0		0.4	V
t_S	Motor braking interval		10	100		ms
$t_{j(shut)}$	Thermal shut down temperature	V_{CC}≧7V		150		℃

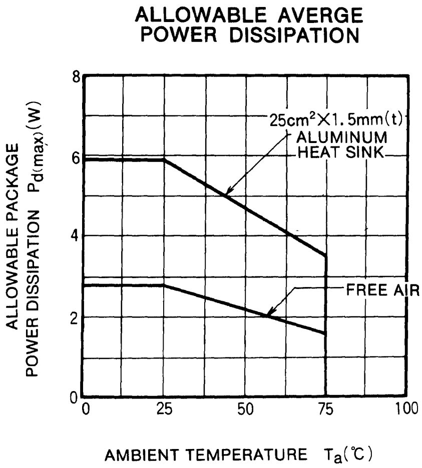
ELCTRICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Test conditions		Limits			Unit
				Min	Typ	Max	
$I_{O(leak)}$	Output leakage	V_{CC}=$V_{CC'}$=18V, V_{S1}=V_{S2}=0V, V_{SE}=0V or 2V	V_O=18V			100	μA
			V_O=0V			−10	
V_{OH}	"H" output voltage	V_{CC}=$V_{CC'}$=12V	$I_{OH(1)}$=−200mA	10.8			V
			$I_{OH(1)}$=−500mA	10.7			
V_{OL}	"L" output voltage	V_{CC}=$V_{CC'}$=12V	I_{OL}=200mA			0.5	V
			$I_{OL(1)}$=500mA			1.35	
I_{IH}	"H" input current	V_{CC}=$V_{CC'}$=12V, V_I=2V		70		200	μA
I_{IL}	"L" input current	V_{CC}=$V_{CC'}$=12V, V_I=0V		70		200	μA
I_{CC}	Supply current	V_{CC}=V_{CC}=$V_{CC'}$=12V	V_{SE}=0V, V_{S1}=V_{S2}=0V			10	mA
			V_{SE}=0V, V_{S1}=V_{S2}=0V				
			V_{SE}=0V, V_{S1}=0V, V_{S2}=2V			20	

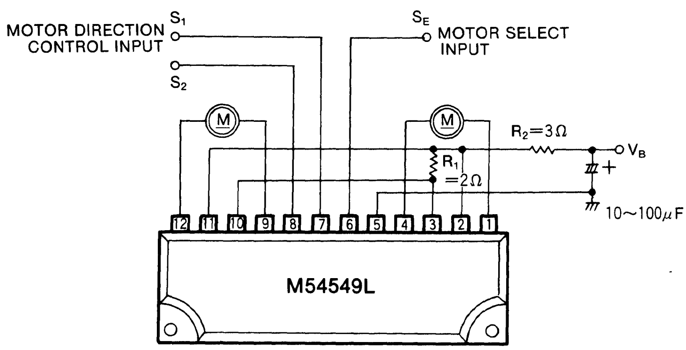
MITSUBISHI ELECTRIC

DUAL BI-DIRECTIONAL MOTOR DRIVER WITH THERMAL SHUT DOWN FUNCTION

TYPICAL CHARACTERTICS



APPLICATION EXAMPLE



M54549AL

BI-DIRECTIONAL MOTER DRIVER

DESCRIPTION

The M54549AL, BI-DIRECTIONAL MOTOR DRIVER, consists of the two full bridge power designed for use in are two D-C motors control circúit.

FEATURES

- Two separated full-bridge drivers (only one circuit can be switched by the SE input)
- Wide operating voltage range (V_{CC}=4~16V)
- TTL, PMOS, CMOS outputs, capable of direct drive
- Low output saturation voltage
- Built-in clamp diode
- Large drive current ($I_{O(max)}=\pm 1.2A$)
- Braking mode input
- Internal thermal shutdown protection

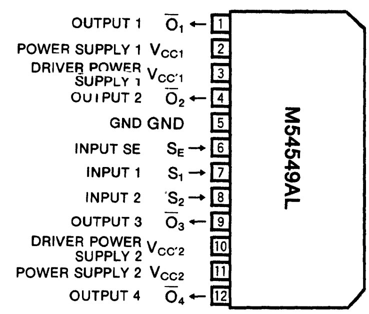
APPLICATION

- Audio tape-deck player, radio cassette player
- VTR
- Home-use equipment

FUNCTION

The M54549AL, two-full bridge motor driver, has the logic circuitry and the darlington power driver for bi-directional control of two D-C motors operating at current up to 2.0A. The input SE selects one of the bridges and S_1, S_2 determine the output polarity.

PIN CONFIGURATION (TOP VIEW)

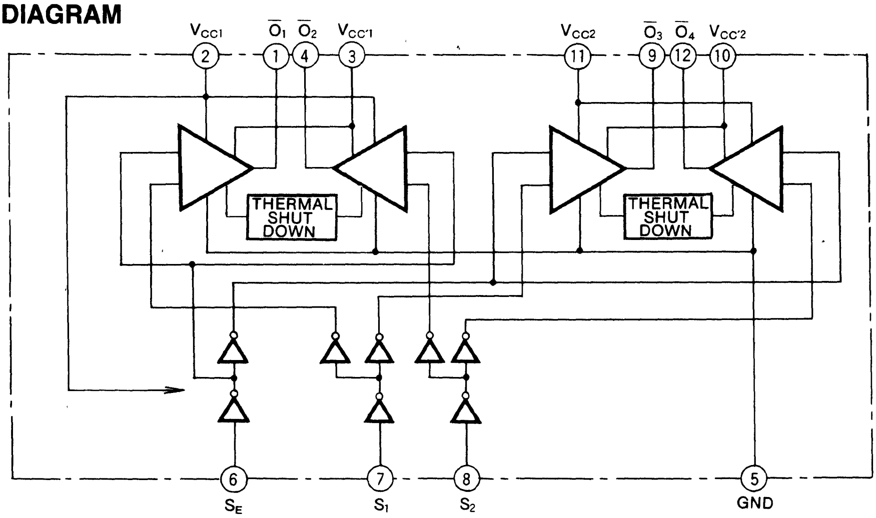


Outline 12P5

LOGIC TRUTH TABLE

Input			Output				Note	
S_E	S_1	S_2	$\overline{O_1}$	$\overline{O_2}$	$\overline{O_3}$	$\overline{O_4}$	Output $\overline{O_1}$, $\overline{O_2}$	Output $\overline{O_3}$, $\overline{O_4}$
0	0	0	OFF	OFF	OFF	OFF	OPen	Open
0	1	0	1	0	OFF	OFF	↻	Open
0	0	1	0	1	OFF	OFF	↺	Open
0	1	1	0	0	OFF	OFF	Braking	Open
1	0	0	OFF	OFF	OFF	OFF	Open	Open
1	1	0	OFF	OFF	1	0	Open	↻
1	0	1	OFF	OFF	0	1	Open	↺
1	1	1	OFF	OFF	0	0	Open	Braking

BLOCK DIAGRAM



MITSUBISHI ELECTRIC

ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		−0.5～+18	V
$V_{CC'}$	Driver supply voltage		−0.5～+18	V
V_I	Input voltage		0～V_{CC}	V
V_O	Output voltage		−2～$V_{CC'}$+2.5	V
$I_{O(max)}$	Peak output current	t_{op}=10ms, retitive cycle 0.2Hz max	±1.2	A
$I_{O(1)}$	Continuous output current (1)		±330	mA
P_d	Power dissipation	T_a=75℃	830	mW
Topr	Operating ambient temperature		−20～+75	℃
Tstg	Storage temperature range		−55～+125	℃

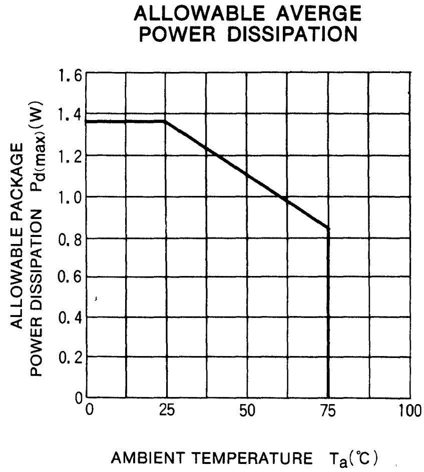
RECOMMNDED OPERATING CONDITIONS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage		4	12	16	V
I_O	Output current				±300	mA
V_{IH}	"H" input voltage		2		V_{CC}	V
V_{IL}	"L" input voltage		0		0.4	V
t_B	Motor braking interval		100			ms
$t_{j(shut)}$	Thermal shutdown temperature			150		℃

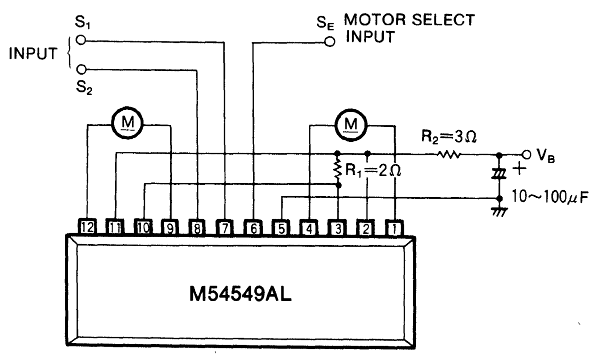
ELECTRICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Test conditions		Limits			Unit
				Min	Typ	Max	
$I_{O(leak)}$	Output leakage current	V_{CC}=$V_{CC'}$=18V	V_O=18V			100	μA
		V_{S1}=V_{S2}=0.4V, V_{SE}=0.4V or 2V	V_O=0V			−100	
V_{OH}	"H" output saturation voltage	V_{CC}=$V_{CC'}$=12V	$I_{OH(1)}$=−200mA	10.8			V
			$I_{OH(1)}$=−500mA	10.7			
V_{OL}	"L" output saturation voltage	V_{CC}=V_{CC} =12V	I_{OL}=200mA			0.5	V
			$I_{OL(1)}$=500mA			1.35	
I_{IH}	"H" input current	V_{CC}=$V_{CC'}$=12V, V_I=2V		50		120	μA
I_{CC1}	Supply current (1)	V_{CC}=V_{CC} =12V	V_{SEO}=V_{S1}=V_{S2}=0.4V			10	mA
			V_{SE}=V_{S1}=0.4V, V_{S2}=2V			20	
I_{CC2}	Supply current (2)	V_{CC}=$V_{CC'}$=12V	V_{SE}=2V, V_{S1}=V_{S2}=0.4V			10	mA
			V_{SE}=V_{S1}=2V, V_{S2}=2V			20	

TYPICAL CHARACTERTICS



APPLICATION EXAMPLE



M54641L

BI-DIRECTIONAL MOTOR DRIVER

DESCRIPTION

The M54641L, BI-DIRECTIONAL MOTOR DRIVER, consists of a full bridge power driver designed for D-C motor control.

FEATURES

- Wide operating voltage range (V_{CC}=4~10V, $V_{CC'}$(max) =20V)
- Low output saturation voltage in continuos output motor circuit (High voltage between motors)
- Built-in clamp diode
- Output voltage control pin (V_Z)
- Internal thermal shutdown protector ($T_{j(shut)}$=120°C$_{TYP}$)

APPLICATION

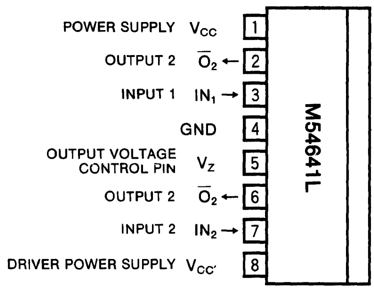
- Audio tape deck, radio cassette player, VTR

FUNCTION

The M54641L, full bridge motor driver, has the logic circuitry and darlington-per power drivers for bidirectional control of D-C motors operating at currents up to 800mA.

The power supplies for the logic circuitry and the drivers are separated so that the applied voltage to the motor can be controlled by the V_Z or $V_{CC'}$ of the driver power supply voltage.

PIN CONFIGURATION (TOP VIEW)

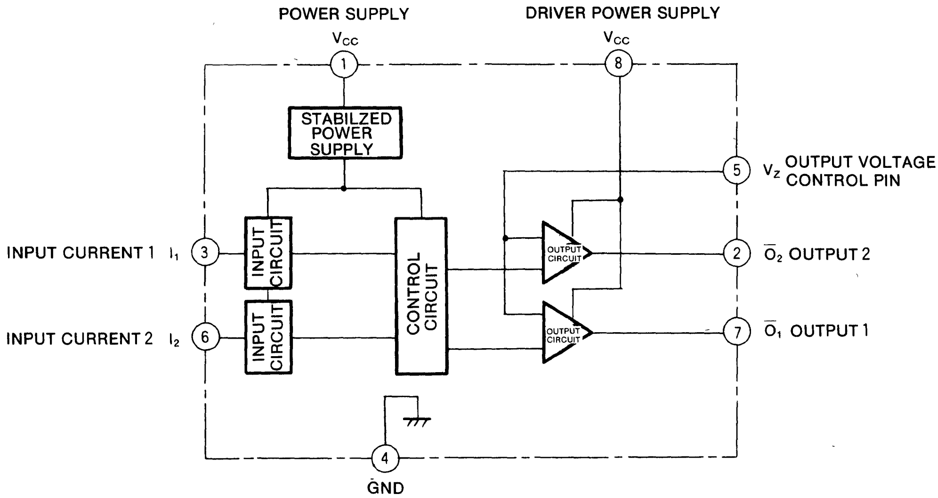


Outline 8P5

LOGIC TRUTH TABLE

Input		Output		Note
IN_1	IN_2	$\overline{O}_1$	$\overline{O}_2$	
L	L	"OFF" state	"OFF" state	Open
H	L	H	L	Clockwise
L	H	L	H	Anti-clockwise
H	H	L	L	Braking

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		−0.5~+12	V
$V_{CC'}$	Driver power supply		−0.5~+20	V
V_I	Input voltage		0~V_{CC}	V
V_O	Output voltage		−0.5~$V_{CC'}$+2.5	V
$I_{O(max)}$	Peak output current	top=10ms top=10ms · repetitive cycle 0.2Hz max	±800	mA
I_O	Continuous output current		±150	mA
P_d	Power dissipation	T_a=60℃	570	mW
Tj	Junction temperature		100	℃
Topr	Operating ambient temperature		−10~+60	℃
Tstg	Storage temperature range		−55~+125	℃

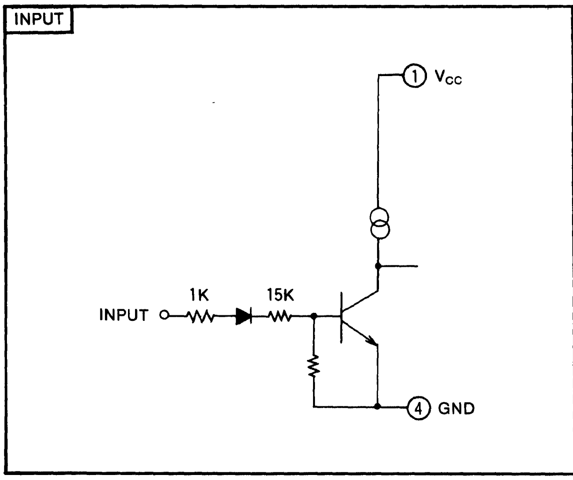
RECOMMENDED OPERATING CONDITIONS (T_a=25℃, unless otherwise noted)

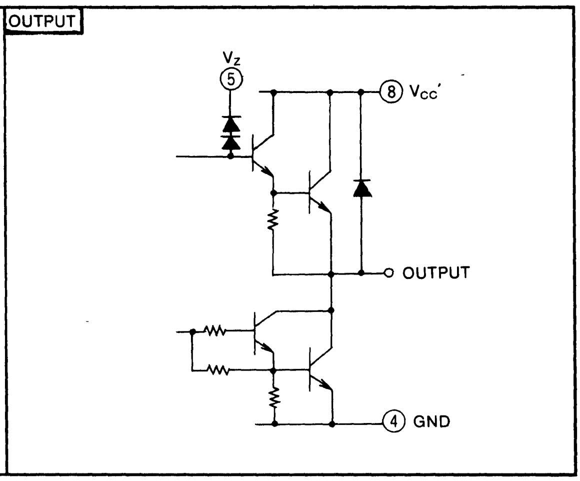
Symbol	Parameter	Conditions	Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage		4	5	10	V
I_O	Output current				±100	mA
V_{IN}	"H" input voltage		3.0		V_{CC}	V
V_{IL}	"L" input voltage		0		0.6	V
t_S	Motor braking interval		10	100		ms
T_S	Thermal shutdown protector operating temperature (Junction temperature)		100	120		℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=5V, unless otherwise noted)

Symbol	Parameter	Test conditions			Limits			Unit
					Min	Typ	Max	
$I_{O(leak)}$	Output lekage current	$V_{CC'}$=20V Vz · open		V_O=20V			100	μA
				V_O=0V			−100	
V_{OH}	"H" output voltage	$V_{CC'}$=12V Vz . open		I_{OH}=−50mA	10.2	10.5		V
				I_{OH}=−100mA	10.0	10.4		
V_{OL}	"L" output voltage	$V_{CC'}$=12V Vz open		I_{OH}=50mA		0.1	0.3	V
				I_{OH}=100mA		0.2	0.4	
V_{O1-O2}	Voltage between output(1) and output(2) (voltage between motors)	$V_{CC'}$=12V Vz=7V		I_O=±100mA	6.3	7.0	7.7	V
I_I	Input current	$V_{CC'}$=12V	V_I=3V	Output open		100	180	μA
			V_I=5V			240	380	
I_{CC}	Supply current	V_{CC}=10V $V_{CC'}$=12V		"OFF" state		1.2	3.0	mA
				Clockwise or anti-clockwise		4.5	8.0	
				Braking		7.5	12.0	

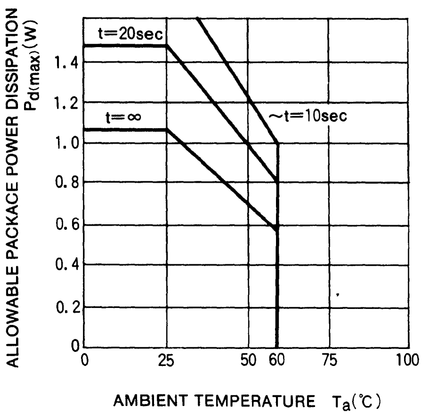
INPUT/OUTPUT CIRCUIT





TYPICAL CHARACTERISTICS

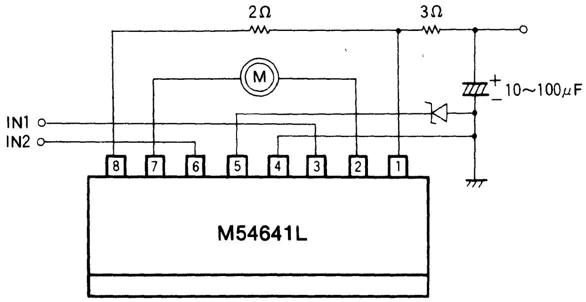
ALLOWABLE AVERAGE POWER DISSIPATION



Note 1 : Mounted on an epoxy PC board with Cu cover on one side (5cm×5cm×0.8mmt)

2 : t · time for power application

APPLICATION EXAMPLE



M54642L

BI-DIRECTIONAL MOTOR DRIVER

DESCRIPTION

The M54642L is a semiconductor integrated circuit, capable of directly driving bi-directional micro motor.

FEATURES

- Wide operating voltage range (V_{CC}=4~10V, $V_{CC'(max)}$ =20V)
- Low output saturation voltage in continuous output motor circuit (High voltage between motors)
- Built-in clamp diode
- Output voltage control pin (V_Z)
- Internal thermal shutdown protector ($T_{j(shut)}$=120℃$_{TYP}$)
- Additional interrupt input I_1', I_2'

APPLICATION

- Audio tape deck, radio cassette player, VTR

FUNCTION

The M54642L is a driver for bi-directional micro motor. The input pin has inputs I_1 and I_2 which are identical to those inputs of the M54641L and interrupt inputs of I_1' and I_2'. The I_1 functions to the I_1' and the I_2, to the I_2'. The I_1' and the I_2', if they are "H", operate just like the I_1 and the I_2 input signals in the M54641L. If the "H" signal is input to the input pin I_1, and the "L" signal is input t_0, the input pin I_2, output $\overline{O}_1$ is "H" and output $\overline{O}_2$ is "L". If a motor is connected between the output pins of $\overline{O}_1$ and $\overline{O}_2$, the output power supply is current source and the $\overline{O}_2$ is current sink and the motor is driven. If the reverse signals are input to the I_1, I_2, the $\overline{O}_1$ becomes "L" and the $\overline{O}_2$ becomes "H", then the motor is driven backward. But, if the I_1 and the I_2 are both "H", and the $\overline{O}_1$ and the $\overline{O}_2$ are "L", then the motor is quickly halted. (Braking mode input)

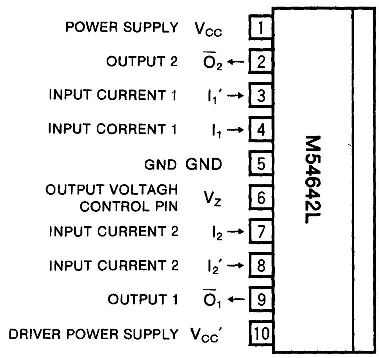
The interrupt input I_1' and I_2' are "L" active inputs and, when the I_1 is "H" and I_2 is "L", the motor is driven, but, if the I_2' is "L", then the outputs $\overline{O}_1$ and the $\overline{O}_2$ are both "L" and becomes brake mode.

The speed of motor becomes constant if a zener diode of a certain voltage is added to the Vz pin, because the output "H" voltage never exceeds this zener voltage. If the Vz pin is connected to the driver power supply V_{CC}', the speed of motor can be changed by changing the V_{CC}'.

The peak output current is $I_{OP(max)}$ = 800mA, and continuous output current is $I_{O(max)}$=150mA.

Threshold temperature of the internal thermal shutdown protector is min 100℃, and the drive current must be set so that the thermal shutdown protector will not operate.

PIN CONFIGURATION (TOP VIEW)



Outline 10P5

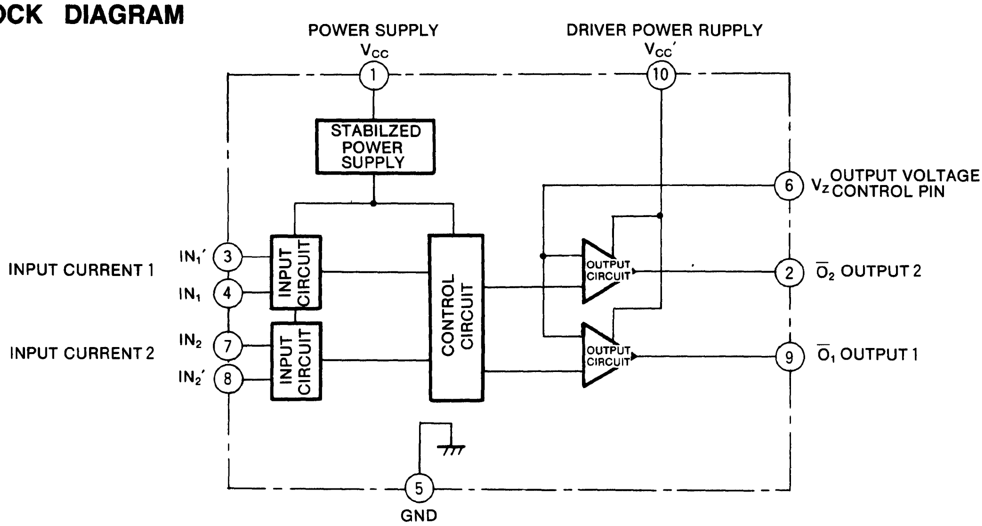
LOGIC TRUTH TABLE

Input				Output		Note
I_1	I_1'	I_2	I_2'	O_1	O_2	
L	H	L	H	"OFF" state	"OFF" state	Open
L	L	L	H	H	L	Clockwise
L	H	L	L	L	H	Anti-clockwise
L	L	L	L	L	L	Braking
H	H	L	H	H	L	Clockwise
H	L	L	H	H	L	Clockwise
H	H	L	L	L	L	Braking
L	H	H	H	L	H	Ahti-clockwise
L	H	H	L	L	H	Anti-clockwise
L	L	H	H	L	L	Braking
H	*	H	*	L	L	Braking

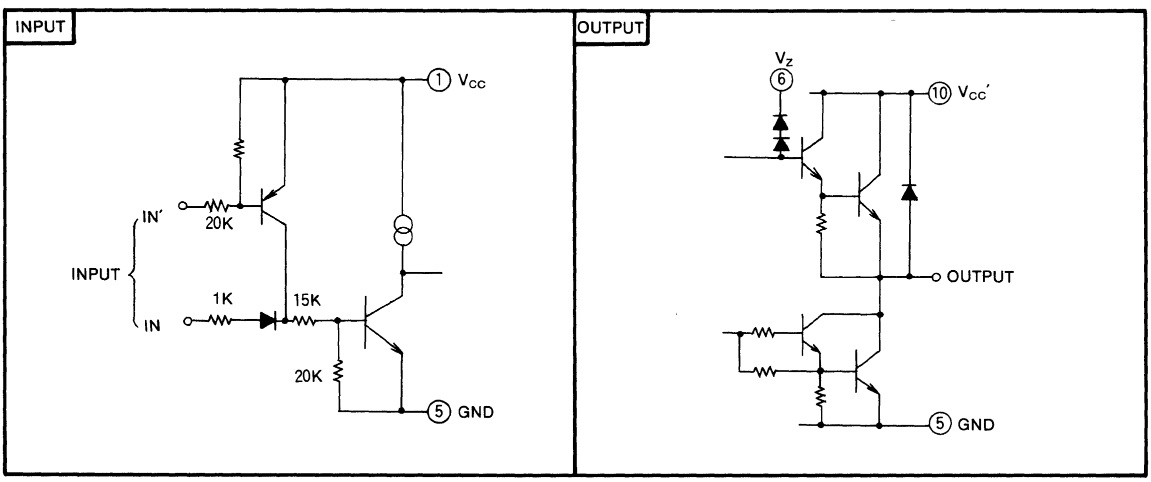
* : Irrelevant

MITSUBISHI ELECTRIC

BLOCK DIAGRAM



INPUT/OUTPUT CIRCUIT



ABSOLUTE MAXIMUM RAINGS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		−0.5∼+12	V
$V_{CC'}$	Driver power supply		−0.5∼+20	V
V_I	Input voltage		0∼V_{CC}	V
V_O	Output voltage		−0.5∼$V_{CC'}$+2.5	V
$I_{O(max)}$	Peak output current	top=10ms top=10ms : repetitive cycle 0.2Hz max	±800	mA
I_O	Continuous output current		±150	mA
P_d	Power dissipation	T_a=60℃	570	mW
Tj	Junction temperature		100	℃
Topr	Operating ambient temperature		−10∼+60	℃
Tstg	Storage temperature range		−55∼+125	℃

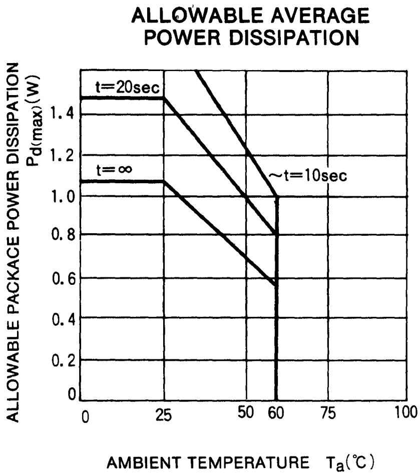
RECOMMENDED OPERATING CONDITIONS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage		4	5	10	V
I_O	Output current				±100	mA
V_{IH}	"H" input voltage	I_1, I_2 input pins	3.0		V_{CC}	V
$V_{I'H}$	"H" input voltage	I_1, I_2 input pins	V_{CC}−0.5		V_{CC}	V
V_{IL}	"L" input voltage	I_1, I_2 input pins	0		0.6	V
$V_{I'L}$	"L" input voltage	I_1, I_2 input pins	0		V_{CC}−3.6	V
t_s	Motor braking interval		10	100		ms
T_s	Thermal shutdown protector operating temperature (Junction temperature)		100	120		℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=5V, unless otherwise noted)

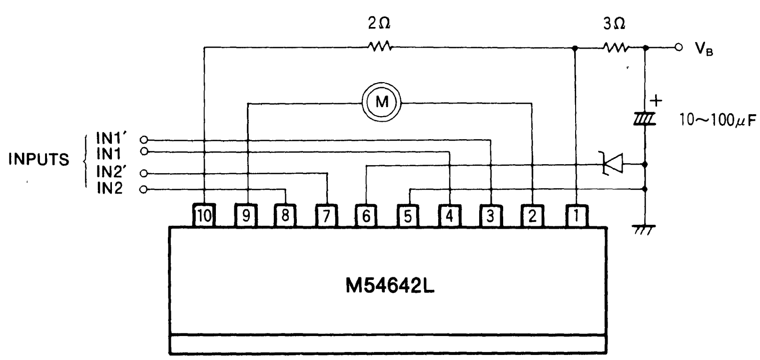
Symbol	Parameter	Test conditions			Limits			Unit
					Min	Typ	Max	
$I_{O(leak)}$	Output lekage current	V_{CC}=20V		V_O=20V			100	μA
		Vz . open		V_O=0V			−100	
V_{OH}	"H" output voltage	V_{CC}=12V		I_{OH}=−50mA	10.2	10.5		V
		Vz · open		I_{OH}=−100mA	10.0	10.4		
V_{OL}	"L" output voltage	$V_{CC'}$=12V		I_{OH}=50mA		0.1	0.3	V
		Vz · open		I_{OH}=100mA		0.2	0.4	
V_{O1-O2}	Voltage between output (1) and output (2) (voltage between motors)	$V_{CC'}$=12V Vz=7V		I_O=±100mA	6.3	7.0	7.7	V
I_I	Input current	$V_{CC'}$=12V	V_1=3V, V_1'=4.5V	Output open		100	180	μA
			V_1=5V, V_1'=4.5V			240	380	
I_I'	Input current	$V_{CC'}$=12V	V_1=0.4V, V_1'=4.5V	Output open		−200	−250	μA
			V_1'=1.4V, V_1=0.6V			−145	−190	
I_{CC}	Supply current	V_{CC}=10V $V_{CC'}$=12V		"OFF" state		1.2	3.0	mA
				Clockwise or anti-clockwise		4.5	8.0	
				Braking		7.5	12.0	

TYPICAL CHARACTERISTICS



Note 1 : Mounted on an epoxy PC board with Cu cover on one side (5cm×5cm×0.8mmt)
2 : t : time for power application

APPLICATION EXAMPLE



M54648L

BI-DIRECTIONAL MOTOR DRIVER WITH MOTOR SPEED CONTROL

DESCRIPTION

The M54648L is a semiconductor integrated circuit, capable of directly driving bi-directional micro motor, with a built in speed control circuit.

FEATURES

- Wide operating voltage range (V_{CC}=4~18V)
- N MOS, C MOS IC output for direct drive
- Large drive current ($I_{O(max)}$=±3.0A)
- Built-in operational amplifier for "H" output voltage control
- Built-in clamp diode
- Braking mode input

APPLICATION

- Audio tape deck player, radio cassette player
- VTR
- Home use equipment

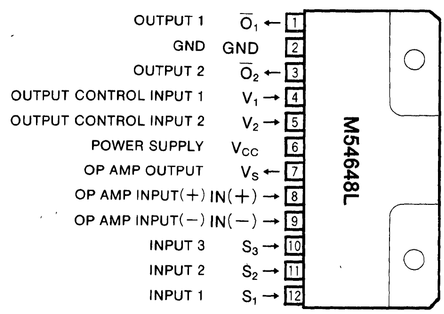
FUNCTION

The M54648L consists of a decoder, operational amplifier and bi-directional motor driver.

The output polarity shown in the logic truth table can be selected by inputs. S_1, S_2, and S_3, and the supply voltage of the predriver can also be selected from the voltages driven by V_1, V_2 or the output of the operational amplifier for the variable speed of motor. The motor driver has darlington output, capable of driving peak output voltage of $I_{OP(max)}$= 3.0A.

The internal thermal shutdown circuit protects the IC from thermal destruction due to blocking of motor, etc.

PIN CONFIGURATION (TOP VIEW)

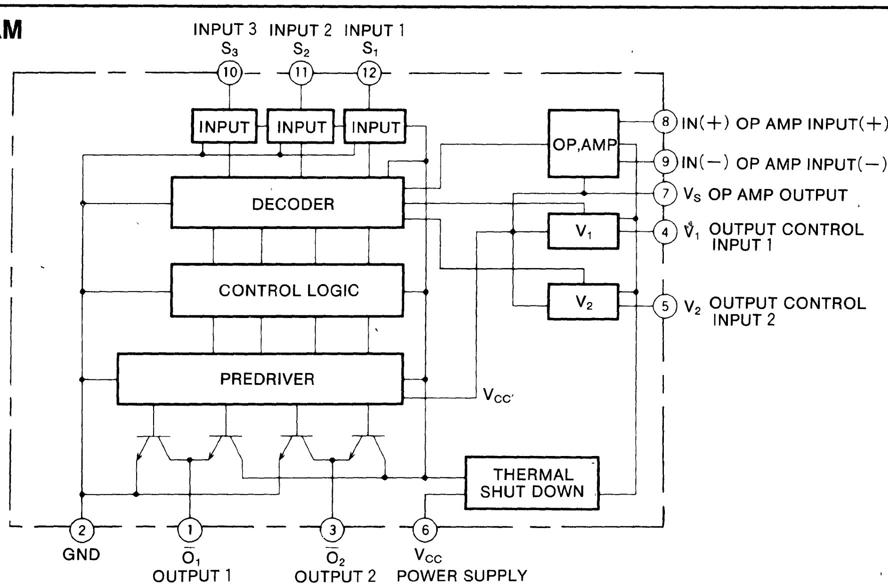


Outline 12P9

LOGIC TRUTH TABLE

Input			Output		Driver power supply (V_{CC})	Note
S_1	S_2	S_3	$\overline{O}_1$	$\overline{O}_2$		
L	L	L	"OFF" state	"OFF" state	—	STOP
L	L	H	H	L	OP AMP OUTPUT	PLAY(+)
L	H	L	L	H	OP AMP OUTPUT	PLAY(−)
L	H	H	H	L	V_2	FF(2)
H	L	L	L	H	V_2	REW(2)
H	L	H	H	L	V_1	FF(1)
H	H	L	L	H	V_1	REW(1)
H	H	H	L	L	V_S	BRAKE

BLOCK DIAGRAM



BI-DIRECTIONAL MOTOR DRIVER WITH MOTOR SPEED CONTROL

ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage	With an external heat sink ($3000mm^2$×1.5mmt)	−0.5～+20	V
V_I	Input voltage	4Pin, 5Pin	−0.5～+14 or V_{CC}	V
		Inputs pin other than the above	−0.5～V_{CC}	
V_O	Output voltage		−2.0～V_{CC}+2.5	V
$I_{O(max)}$	Peak output current	top=10ms ; repetive cycle 0.2Hz max	±3.0	A
$I_{O(1)}$	Continuous output current (1)		±300	mA
$I_{O(2)}$	Continuous output current (2)	With an external hbat sink ($3000mm^2$×1.5mmt)	±800	mA
P_d	Power dissipation	T_a=75℃	1.1	W
Topr	Operating ambient temperature		−10～+75	℃
Tstg	Storge temperature range		−55～+125	℃

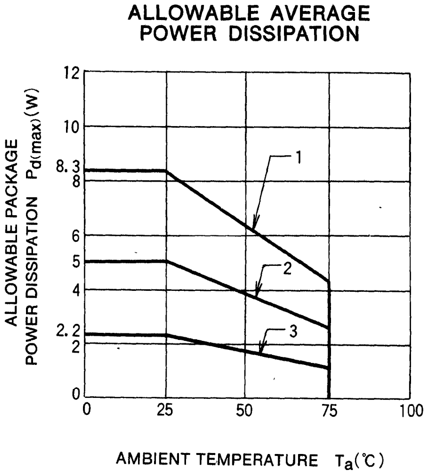
RECOMMENDED OPERATING CONDITIONS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage		4	12	18	V
I_O	Output current				±300	mA
V_{IH}	"H" input voltage		3		V_{CC}	V
V_{IL}	"L" input voltage		0		1	V
t_B	Moter braking interval		100			ms
$tj_{(shut)}$	Thermal shutdown temperature		125	150		℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

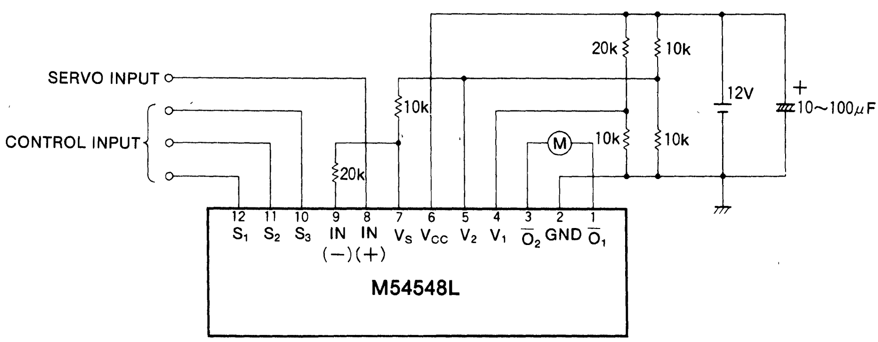
Symbol	Parameter	Test conditions			Limits			Unit
					Min	Typ	Max	
$I_{O(leak)}$	Output leakage current	V_{S1}=0V, S_{S2}=0V, V_{S3}=0V	V_O=0V, V_{CC}=V_S=20V				−100	μA
			V_O=14V, V_{CC}=V_S=14V				+100	
$V_{OH(1)}$	"H" output voltage	V_{CC}=16V, $V_{IN(-)}$=0V, $V_{IN(+)}$=3V	V_{S1}=V_{S2}=0V, V_{S3}=3V	I_{OH}=−200mA	13			V
				I_{OH}=−500mA	12.8			
$V_{OH(2)}$	"H" output voltage (2)	V_{CC}=16V, $V_{IN(-)}$=0V, $V_{IN(+)}$=3V	V_{S1}=V_{S3}=0V, V_{S2}=3V	I_{OH}=−200mA	13			V
				I_{OH}=−500mA	12.8			
$V_{OL(1)}$	"L" output voltage (1)	V_{CC}=16V, $V_{IN(-)}$=0V, $V_{IN(+)}$=3V	V_{S1}=V_{S3}=0V, V_{S2}=3V	I_{OL}=200mA			1.1	V
				I_{OL}=500mA			1.2	
$V_{OL(2)}$	"L" output voltage (2)	V_{CC}=16V, $V_{IN(-)}$=0V, $V_{IN(+)}$=3V	V_{S1}=V_{S2}=0V, V_{S3}=3V	I_{OL}=200mA			1.1	V
				I_{OL}=500mA			1.2	
I_{IH}	"H" input current	V_{CC}=16V, V_{IS}=3V(S_1, S_2, S_3)					10	μA
I_{IL}	"L" input current	V_{CC}=16V, V_{IS}=0V(S_1, S_2, S_3)					−20	μA
I_{CC}	Supply current	V_{CC}=16V, V_{S1}=V_{S2}=V_{S3}=3V					30	mA
A	Op amp open-loop-gain				50			dB

TYPICAL CHARACTERISTICS



1) WITH HEAT SINK OF INFINITE SIZE
2) $25cm^2 \times 1.5mmt$ ALUMINUM HEAT SINK
3) FREE AIR

APPLICATION EXAMPLE



Unit : Ω

M54648AL

BI-DIRECTIONAL MOTOR DRIVER WITH MOTOR SPEED CONTROL

DESCRIPTION

The M54648AL is a semiconductor integrated circuit, capable of directly driving bi-directional micro motor, with a built in speed control circuit.

FEATURES

- Wide operating voltage range (V_{CC}=4~18V)
- N MOS, C MOS IC output for direct drive
- Large output sink current ($I_{O(max)}=\pm3.0A$)
- Built-in operational amplifier for "H" output voltage control
- Built-in clamp diode
- Braking mode input
- Compact power package requiring small space

APPLICATION

- Audio tape deck player, radio cassette player
- VTR
- Home-use equipment

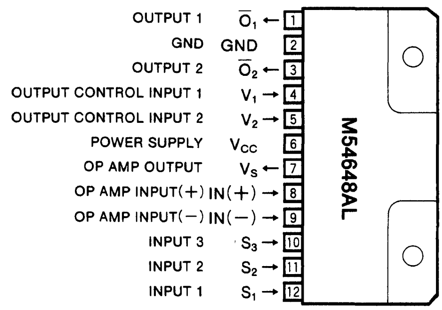
FUNCTION

The M54648AL consists of a decoder, operational amplifier and bi-directional motor driver.

The output polarity shown in the logic truth table can be selected by inputs. S_1, S_2, and S_3, and the supply voltage of the predriver can also be selected from voltages driven by V_1, V_2 or the output of the operational amplifier for the variable speed of motor. The motor driver has darlington output, capable of driving peak output voltage of $I_{OP(aax)}$ = 3.0A.

The internal thermal shutdown protector protects the IC from thermal destruction due to blocking of motor, etc.

PIN CONFIGURATION (TOP VIEW)

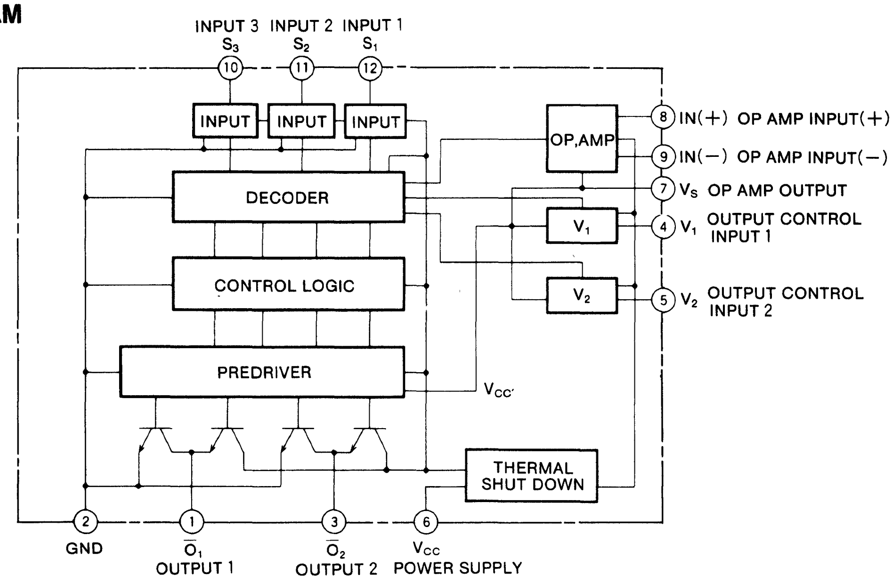


Outline 12P9B

LOGIC TRUTH TABLE

Input			Output		Driver power supply (V_{CC})	Note
S_1	S_2	S_3	$\bar{O}_1$	$\bar{O}_2$		
L	L	L	"OFF" state	"OFF" state	—	STOP
L	L	H	H	L	OP AMP OUTPUT	PLAY(+)
L	H	L	L	H	OP AMP OUTPUT	PLAY(−)
L	H	H	H	L	V_2	FF(2)
H	L	L	L	H	V_2	REW(2)
H	L	H	H	L	V_1	FF(1)
H	H	L	L	H	V_1	REW(1)
H	H	H	L	L	V_S	BRAKE

BLOCK DIAGRAM



BI-DIRECTIONAL MOTOR DRIVER WITH MOTOR SPEED CONTROL

ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage	With an external heat sink (3000mm^2×1.5mmt)	−0.5～+20	V
V_I	Input voltage	4Pin, 5Pin	−0.5～+14 or V_{CC}	V
		Inputs pin other than the above	−0.5～V_{CC}	
V_O	Output voltage		−2.0～V_{CC}+2.5	V
$I_{O(max)}$	Peak output current	top=10ms , repetive cycle 0.2Hz max	±3.0	A
$I_{O(1)}$	Continuous output current (1)		±300	mA
$I_{O(2)}$	Continuous output current (2)	With an external hbat sink (3000mm^2×1.5mmt)	±800	mA
P_d	Power dissipation	T_a=75℃	0.8	W
Topr	Operating ambient temperature		−10～+75	℃
Tstg	Storage temperature range		−55～+125	℃

RECOMMENDED OPERATING CONDITIONS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Limits Min	Limits Typ	Limits Max	Unit
V_{CC}	Supply voltage		4	12	18	V
I_O	Output current				±300	mA
V_{IH}	"H" input voltage		3		V_{CC}	V
V_{IL}	"L" input voltage		0		1	V
t_B	Moter braking interval		100			ms
$t_{j(shut)}$	Thermal shutdown temperature		125	150		℃

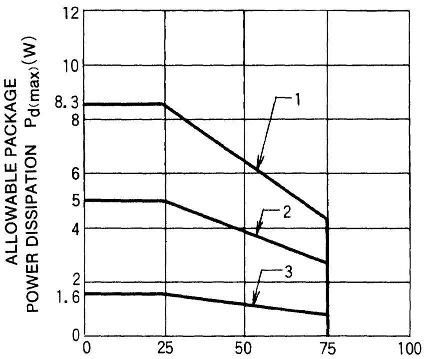
ELECTRICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Test conditions			Limits Min	Limits Typ	Limits Max	Unit
$I_{O(leak)}$	Output leakage current	V_{S1}=0V, S_{S2}=0V, V_{S3}=0V	V_O=0V, V_{CC}=V_S=20V				−100	μA
			V_O=14V, V_{CC}=V_S=14V				+100	
$V_{OH(1)}$	"H" output voltage (1)	V_{CC}=16V, $V_{IN(-)}$=0V, $V_{IN(+)}$=3V	V_{S1}=V_{S2}=0V, V_{S3}=3V	I_{OH}=−200mA	13			V
				I_{OH}=−500mA	12.8			
$V_{OH(2)}$	"H" output voltage (2)	V_{CC}=16V, $V_{IN(-)}$=0V, $V_{IN(+)}$=3V	V_{S1}=V_{S3}=0V, V_{S2}=3V	I_{OH}=−200mA	13			V
				I_{OH}=−500mA	12.8			
$V_{OL(1)}$	"L" output voltage (1)	V_{CC}=16V, $V_{IN(-)}$=0V, $V_{IN(+)}$=3V	V_{S1}=V_{S3}=0V, V_{S2}=3V	I_{OL}=200mA			1.1	V
				I_{OL}=500mA			1.2	
$V_{OL(2)}$	"L" output voltage (2)	V_{CC}=16V, $V_{IN(-)}$=0V, $V_{IN(+)}$=3V	V_{S1}=V_{S2}=0V, V_{S3}=3V	I_{OL}=200mA			1.1	V
				I_{OL}=500mA			1.2	
I_{IH}	"H" input current	V_{CC}=16V, V_{IS}=3V(S_1, S_2, S_3)					10	μA
I_{IL}	"L" input current	V_{CC}=16V, V_{IS}=0V(S_1, S_2, S_3)					−20	μA
I_{CC}	Supply current	V_{CC}=16V, V_{S1}=V_{S2}=V_{S3}=3V					30	mA
A	Op amp open-loop-gain				50			dB

BI-DIRECTIONAL MOTOR DRIVER WITH MOTOR SPEED CONTROL

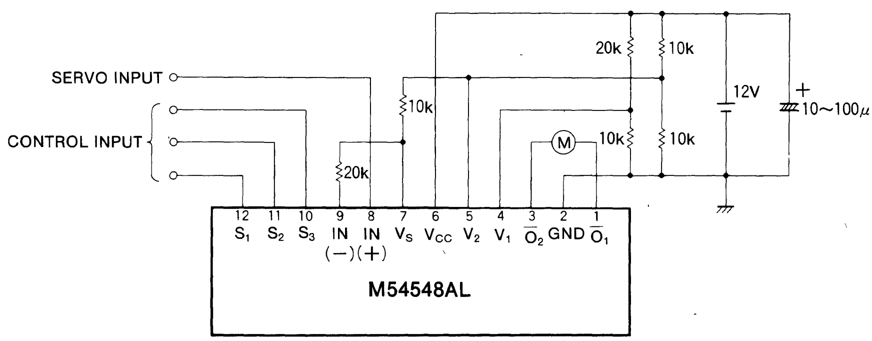
TYPICAL CHARACTERISTICS

ALLOWABLE AVERAGE POWER DISSIPATION



1) WITH HEAT SINK OF INFINITE SIZE
2) 25cm²×1.5mmt ALUMINUM HEAT SINK
3) FREE AIR

APPLICATION EXAMPLE



Unit : Ω

M54649L

DUAL BI-DIRECTIONAL MOTER DRIVER

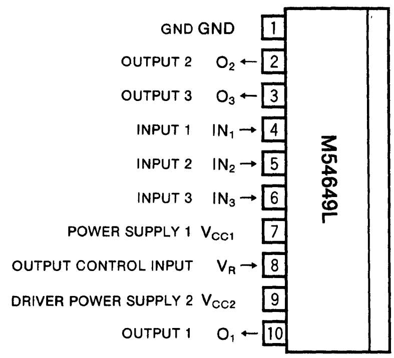
DESCRIPTION
The M54649L, BI-DIRECTIONAL MOTOR DRIVER, consists of a full bridge power designed for use in are two DC-motor control circuit. The internal operational amplifier is capable for controlling the voltage across the bridge outputs.

FEATURES
- Capable of driving two bi-directional motors
- "H" Output voltage control pin
- Internal thermal shutdown protector
- Large output sink current ($I_{O(max)}$=1.6A)
- Wide operating supply voltage (V_{CC}=4~18V)
- CMOS IC output for direct drive

APPLICATION
- Audio tape deck, radio cassette player
- VTR
- Home-use equipment

FUNCTION
The M54649L, full bridge motor driver, has the logic circuitry and the darlington power driver for bi-directional control of two DC motors operating at current up to 1.6A.
The input IN1, IN2 and IN3 are capable to control the bridge output polarity.

PIN CONFIGURATION (TOP VIEW)

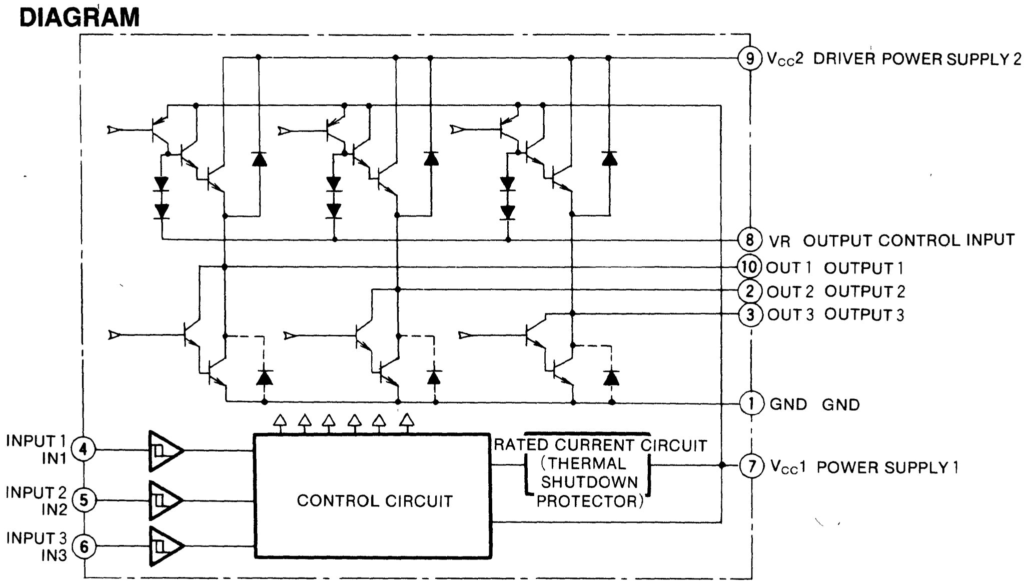


Outline 10P5

LOGIC TRUTH TABLE

Input			Output			Note
4 PIN (IN 1)	5 PIN (IN 2)	6 PIN (IN 3)	10 PIN (OUT 1)	2 PIN (OUT 2)	3 PIN (OUT 3)	
L	L	L H	L	L	L	Braking
H	L	L	H	L	OPEN	○
H	L	H	L	H	OPEN	○
L	H	L	H	OPEN	L	○
L	H	H	L	OPEN	H	○
H	H	L H	L	L	L	Braking

BLOCK DIAGRAM



MITSUBISHI ELECTRIC

ABSOLUTE MAXIMUM RATING (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
$V_{CC(1)}$	Supply voltage (1)		−0.5～+20.0	V
$V_{CC(2)}$	Supply voltage (2)		−0.5～+22.0	V
V_I	Input voltage		−0.5～+7.0	V
V_O	Output voltage		−2.0～V_{CC}+2.5	V
I_{OP}	Peak output current	top≧50ms, duty cycle 1/50	±1.60	A
I_O	Continuous output current	Note 1	±600	mA
P_d	Power dissipation	Time of power applicatton 10s or less	2.78	W
Topr	Operating ambient temperature		−20～+75	℃
Tstg	Storage temperature range		−55～+125	℃

RECOMMENDED OPERATING CONDITIONS (T_a=25℃, unless otherwise noted)

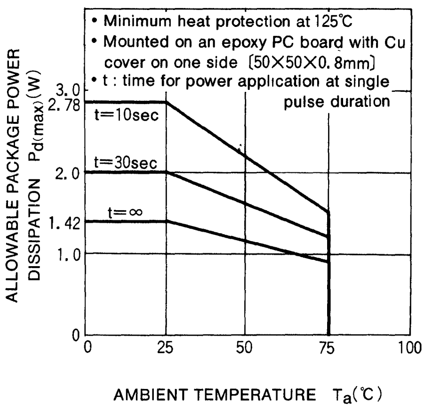
Symbol	Parameter	Conditions	Limits			Unit
			Min	Typ	Max	
$V_{CC(1)}$	Supply voltage (1)		4.0	12.0	18.0	V
$V_{CC(2)}$	Supply voltage (2)		0.0		22.0	V
I_O	Output current				±600	mA
V_{IH}	"H" input voltage		3.5		V_{CC}	V
V_{IL}	"L" input voltage		0.0		1.0	V
V_R	Control voltage		0.0		18.0	V
T_{ON}	Thermal shutdown temperature		125	150		℃
$\triangle T_{ON}$-OFF	Hysteresis temperature width			50		℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, unless oterwise noted)

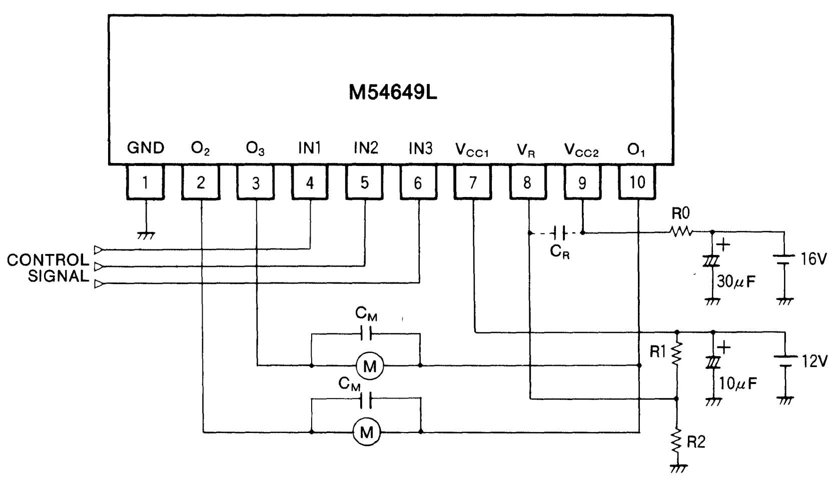
Simbol	Parameter	Test conditions		Limits			Unit
				Min	Typ	Max	
$I_{O(leak)}$	Output leakage current	Output open V_O=0 or 20V	$V_{CC1,2}$=20V			±100	μA
V_{OL}	"L" output saturation voltage	I_{OL}=500mA	$V_{CC1,2}$=12V			1.5	V
V_{OH}	"H" output saturation voltage	I_{OH}=−500mA	$V_{CC1,2}$=12V	10.0			V
$\triangle V_O$	"H" input current	I_O=±500mA V_R=6.0V	$V_{CC1,2}$=12V	−0.5		0.5	V
I_R	"L" input current	I_O±500mA V_R=6.0V	$V_{CC1,2}$=12V	0.2		1.5	mA
I_{CC1}	Supply current	$V_{IN1,2,3}$=1.0V I_O=0mA	$V_{CC1,2}$=12V		8.0	24.0	mA

TYPICAL CHARACTERISTICS

ALLOWABLE AVERAGE POWER DISSIPATION



APPLICATION EXAMPLE



CM : Noise absorbing capacitor when the motor is driven should be less than 0.1μF.

R_O : Current limiting resistor when output is shorted.

(R_1, R_2) : The "H" output voltage $V_{O(H)}$ is given in,

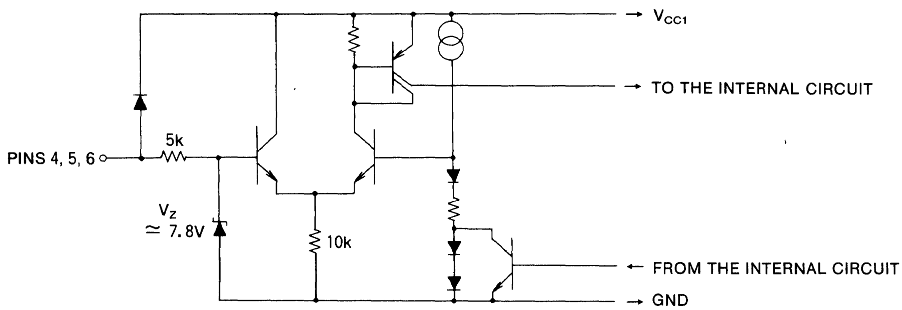
$$V_{O(H)} \fallingdotseq V_{CC1} \times \frac{R_2}{R_1+R_2}$$

If the resistance of the R_1 and R_2, the output current $V_{O(H)}$ is higher than the V_R (pin 8).

C_R : If separate power supply is used for the V_R (pin 8), the output may oscillate. In this case, a capacitor C_R (0.01μF) must be connected between the V_R (pin 8) and $V_{CC}2$ (pin 9).

PRECAUTIONS FOR USE

1. Input circuit schematic diagram

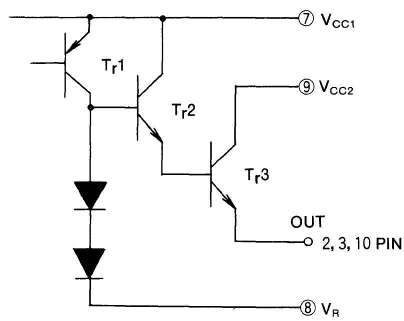


Apply 3.5V$-V_{CC}$ to the ON voltage (V_{IH}) and 0$-$1V to the OFF voltage (V_{IL}) of the input.
If the input voltage reaches approximately 7.8V or above, the impedance changes to approximately 5kΩ and, therefore the voltage should be kept below 7V.

2. Output voltage control method
The output cotrol circuit using the pin 8 is described on the right, and the voltage which is almost equal to the 8 pin voltage is output from the circuit. ("H" side)
If pin 8 is open, the maximum output voltage is available when $V_{CC2} > V_{CC1}$ and the voltage is given in,

$$V_O = V_{CC1} - V_{sat}(Tr1) - V_{BE}(Tr2) - V_{BE}(Tr3)$$

The output voltage can be controlled by varying the V_{CC1} in this condition.



3. Precaution for braking
Care must be taken to braking mode input because the motor may affect other motors at the moment when it is switched from driving condition to braking condition.

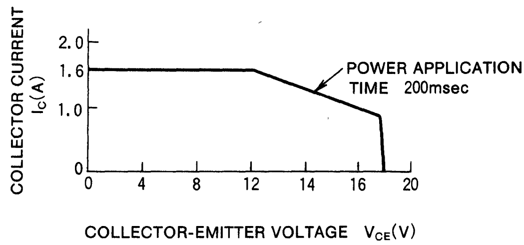
4. Allowable power dissapation
The allowable power dissipation of the IC (P_d), when $V_{CC2} > V_{CC1}$, is given by.

$$P_d = V_{CC1} \times I_{CC1} + I_O \{V_{CC2} - V_{OH} + V_{OL}\}$$

The equipment must be so designed as not exceed this limit.

5. Thermal shutdown
The internal thermal shutdown circuit is provided to protect the IC from overheating when excessive power is applied.
The protection circuit functions when the temperature of the IC reaches 150℃ (Min. 125℃), and all outputs are in the OPEN mode, and is canceled when the temperature is decreased to 100℃ (Max. 125℃).

6. Aso Characteristics



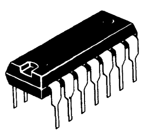
7. Others
Capacitors which are connected between power supply and GND should be placed as close to the IC as possible. Care should be taken as the capacitors may cause oscillation otherwise.

ANALOG SWITCHE

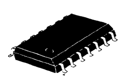
7

QUICK REFERENCE TABLE OF ANALOG SWITCHES

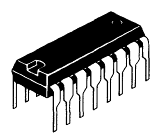
Structure	Type	No of switches: No of inputs	No of switches: No of circuits	Features	Maximum ratings: Supply voltage	Maximum ratings: Analog signal input voltage	Maximum ratings: Allowable power dissipation	Electrical characteristics (typ.): Crosstalk	Frequency bandwidth	Offset voltage	Distortion @1kHz	Output noise	Package Outline
CMOS	M4016BP	1	4	On resistance: 250Ω typ. (V_{DD}=15V)	20V	$V_{SS}-0.5V \sim V_{DD}+0.5V$	—	—	12MHz	—	0.3%	—	14-pin DIP
	M4051	8	1	On resistance: 50Ω typ. (V_{DD}=15V)	20V	$V_{EE}-0.5V \sim V_{DD}+0.5V$	—	—	25MHz	—	0.07%	—	16-pin DIP 16-pin FLAT
	M4052	4	2	On resistance: 50Ω typ. (V_{DD}=15V)	20V	$V_{EE}-0.5V \sim V_{DD}+0.5V$	—	—	25MHz	—	0.07%	—	16-pin DIP 16-pin FLAT
	M4053	2	3	On resistance: 50Ω typ. (V_{DD}=15V)	20V	$V_{EE}-0.5V \sim V_{DD}+0.5V$	—	—	25MHz	—	0.07%	—	16-pin DIP 16-pin FLAT
	M4066	1	4	On resistance: 50Ω typ. (V_{DD}=15V)	20V	$V_{SS}-0.5V \sim V_{DD}+0.5V$	—	—	25MHz	—	0.07%	—	14-pin DIP 14-pin FLAT
Bipolar	M51320P	2	3	3 circuits independent switching	14V	6V	1.25W	55dB at 5MHz	10MHz (Video switch)	100mV	0.02%	50μVrms (Audio switch)	16-pin DIP
	M51321P	3	3	3 circuits simultaneous switching	14V	6V	1.25W	55dB at 5MHz	10MHz (Video switch)	100mV	0.02%	50μVrms (Audio switch)	18-pin DIP
	M51326P	2	3	3 circuits independent switching	14V	6V	1.25W	55dB at 5MHz	10MHz (Video switch)	100mV	0.02%	50μVrms (Audio switch)	16-pin DIP
	M51327P	3	3	3 circuits simultaneous switching	14V	6V	1.25W	55dB at 5MHz	10MHz (Video switch)	100mV	0.02%	50μVrms (Audio switch)	18-pin DIP
	M51329P	3	3	Audio and visual independent switching	14V	6V	1.25W	55dB at 5MHz	10MHz (Video switch)	100mV	0.02%	50μVrms (Audio switch)	18-pin DIP
	M51330P	3	3	Audio and visual independent switching	14V	6V	1.25W	55dB at 5MHz	10MHz (Video switch)	100mV	0.02%	50μVrms (Audio switch)	18-pin DIP
	M51551	2	2	Low distortion: 0.006% Built-in channel indication LED driver	24V	—	620mW	52dB at 1kHz	100kHz	—	0.006%	5.5μVrms	14-pin DIP 14-pin FLAT



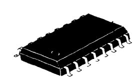
14-pin DIP



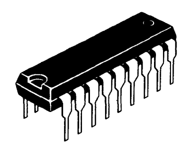
14-pin FLAT



16-pin DIP



16-pin FLAT



18-pin DIP

M4016BP

QUADRUPLE BILATERAL SWITCH

DESCRIPTION

The M4016BP is a semiconductor integrated circuit consisting of four independent bilateral analog switches.

FEATURES

- ON resistance: 250Ω typ. ($V_{DD}=15V$)
- High OFF resistance: $10^9Ω$ or greater (typ)
- Small differences in ON resistance between each switch in the package: 10Ω typ. ($V_{DD}=15V$)
- Wide operating voltage range: $V_{DD}=3\sim18V$
- Wide operating temperature range: $T_a=-40\sim+85$℃

APPLICATION

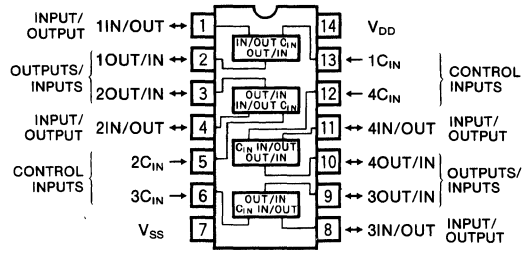
General purpose, for use in industrial and consumer digital equipment.

FUNCTIONAL DESCRIPTION

The control input (C_{IN}) can be used to change the input-to-output impedance (IN/OUT-OUT/IN) of the switches.
When (C_{IN}) is made high, the input-to-output switch impedance is low and wehn set to low, this impedance is high.

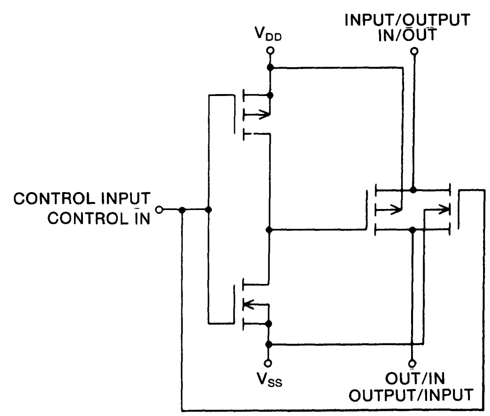
Input C_{IN}	Input/output and output/input resistance (V_{DD}=10V, 15V)
H	$2\sim20\times10^2Ω$
L	$>10^9Ω$ (typ)

PIN CONFIGURATION (TOP VIEW)

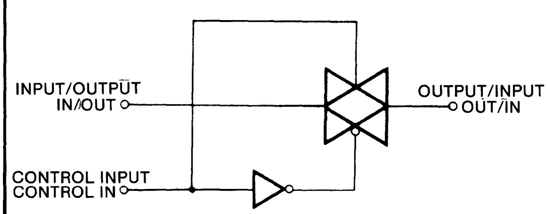


Outline 14P4

CIRCUIT SCHEMATIC (EACH SWITCH)



LOGIC DIAGRAM (EACH SWITCH)



ABSOLUTE MAXIMUM RATINGS ($T_a=-40\sim+85$℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{DD}	Supply voltage		$V_{SS}-0.5\sim V_{SS}+20$	V
V_I	Input voltage		$V_{SS}-0.5\sim V_{DD}+0.5$	V
I_I	Input current	Control inputs	±10	mA
I_O	Output current		±10	mA
Topr	Operating temperature range		−40∼+85	℃
Tstg	Storage temperature range		−65∼+150	℃

RECOMMENDED OPERATING CONDITIONS (T_a=−40~+85℃, V_{SS}=0V, unless otherwise noted)

Symbol	Parameter	Limits Min	Limits Typ	Limits Max	Unit
V_{DD}	Supply voltage	3		18	V
V_I	Input voltage	0		V_{DD}	V

ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

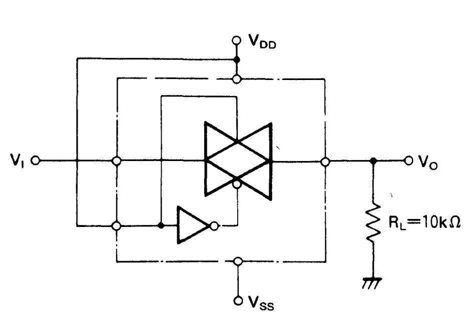
Symbol	Parameter	Test conditions	V_{SS}(V)	V_{DD}(V)	−40℃ Min	−40℃ Max	25℃ Min	25℃ Typ	25℃ Max	85℃ Min	85℃ Max	Unit
V_{IH}	"H" input voltage (C_{IN})	Input-to-output current=10μA	0	5	3.5		3.5			3.5		V
		Input-to-output current=10μA	0	10	7.0		7.0			7.0		V
		Input-to-output current=10μA	0	15	11.0		11.0			11.0		V
V_{IL}	"L" input current (C_{IN})	Input-to-output current=10μA	0	5		1.0			1.0		1.0	V
		Input-to-output current=10μA	0	10		1.0			1.0		1.0	V
		Input-to-output current=10μA	0	15		1.0			1.0		1.0	V
R_{ON}	ON resistance	V_I=5V	0	5				600				Ω
		V_I=2.5V	0	5				6000				
		V_I=0.25V	0	5				600				
		V_I=10V	0	10		600			700		900	
		V_I=5V	0	10		1300			1500		2000	
		V_I=0.25V	0	10		600			700		900	
		V_I=15V	0	15		430			500		650	
		V_I=7.5V	0	15		800			950		1200	
		V_I=0.25V	0	15		430			500		650	
		V_I=5V	−5	5		600			700		900	
		V_I=±0.25V	−5	5		1300			1500		2000	
		V_I=−5V	−5	5		600			700		900	
		V_I=7.5V	−7.5	7.5		430			500		650	
		V_I=±0.25V	−7.5	7.5		800			950		1200	
	Test circuit 1	V_I=−7.5V	−7.5	7.5		430			500		650	
ΔR_{ON}	ON resistance variations between switches of the same package		−5	5				15				Ω
			−7.5	7.5				10				
I_{OFF}	Input/output off-state leakage current	$V_{I/O}$=10V, $V_{O/I}$=0V	0	10					125			nA
		$V_{I/O}$=0V, $V_{O/I}$=10V	0	10					−125			
		$V_{I/O}$=18V, $V_{O/I}$=0V	0	18		250			250		1000	
		$V_{I/O}$=0V, $V_{O/I}$=18V	0	18		−250			−250		−1000	
I_{DD}	Quiescent supply current	$V_I(C_{IN})$=V_{DD}, V_{SS}	0	5		1			1		7.5	μA
			0	10		2			2		15	
			0	15		4			4		30	
I_{IH}	"H" input current (C_{IN})	V_I=18V	0	18		0.3			0.3		1.0	μA
I_{IL}	"L" input current (C_{IN})	V_{IL}=0V	0	18		−0.3			−0.3		−1.0	μA

SWITCHING CHARACTERISTICS (T_a=25℃)

Symbol	Parameter	Test conditions		V_{SS}(V)	V_{DD}(V)	Limits Min	Limits Typ	Limits Max	Unit
$f_{max(I/O)}$	Maximum transfer frequency	R_L=2kΩ	C_L=15pF Test circuit 2	−5	5		18		MHz
		R_L=10kΩ		−5	5		15		
		R_L=100kΩ		−5	5		12		
$f_{max(C_{IN})}$	Maximum control frequency	R_L=300Ω C_L=15pF	Test circuit 3	0	5		4		MHz
				0	10		10		
				0	15		12		
t_{PLH}	"L-H" and "H-L" output propagation time (IN/OUT-OUT/IN)	R_L=10kΩ C_L=50pF	Test circuit 4	0	5			100	ns
				0	10			40	
				0	15			30	
t_{PHL}				0	5			100	ns
				0	10			40	
				0	15			30	
t_{PLH}	"L-H" and "H-L" output propagation time (CONTROL IN-OUT/IN)	R_L=10kΩ C_L=50pF	Test circuit 5	0	5			140	ns
				0	10			60	
				0	15			50	
t_{PHL}				0	5			140	ns
				0	10			60	
				0	15			50	
—	Sine-wave distortion	R_L=10kΩ f_I=1kHz	Test circuit 2	−5	5		0.3		%
—	Feedthrough (switch off)	R_L=1kΩ	Test circuit 6	−5	5		600		kHz
—	Crosstalk (CONTROL IN-OUT/IN)	R_I=1kΩ R_L=10kΩ C_L=15pF	Test circuit 7	0	5		80		mV
				0	10		150		
				0	15		210		
C_I	Input capacitance	Control input					5		pF
		Switch input/output					4		

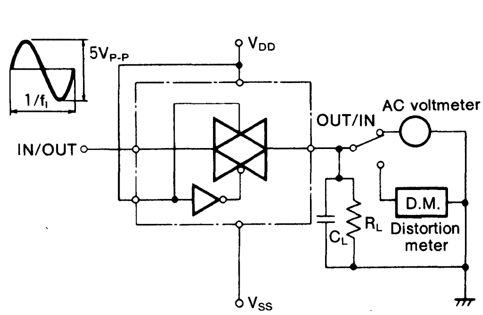
TEST CIRCUITS

1 ON resistance (R_{ON})



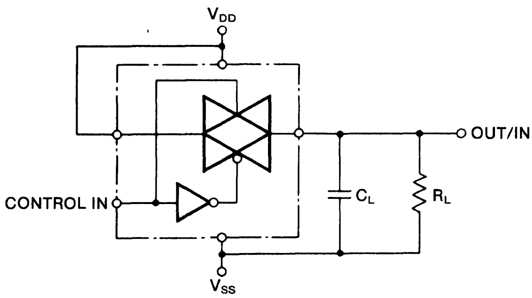
$$R_{ON}=10\times\frac{(V_I-V_O)}{V_O}\quad [k\Omega]$$

2 Maximum transfer frequency (fmax(I/O)) Sine-wave distortion

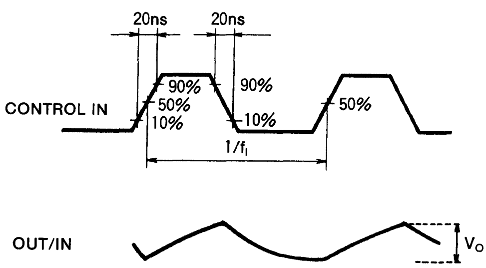


fmax (I/O) is taken as that frequency f_I at which, using a sine-wave input of 2.5V_{P-P}, 20 $\log_{10}(V_O/V_I)$=−3dB

3 Maximum control frequency (fmax(C_{IN}))

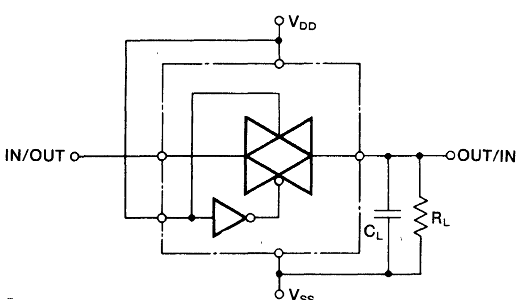


TIMING DIAGRAM

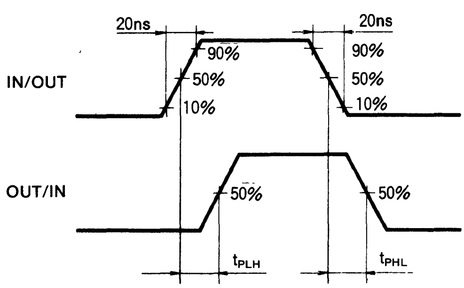


fmax(C_{IN}) is taken as that frequency f_I at which the output amplitude (V_O) is 1/2 that at 1 kHz.

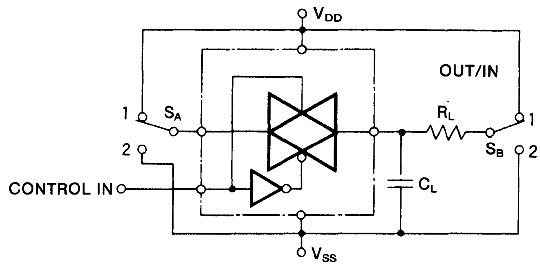
4 "L-H" and "H-L" output propagation time (IN/OUT-OUT/IN)



TIMING DIAGRAM



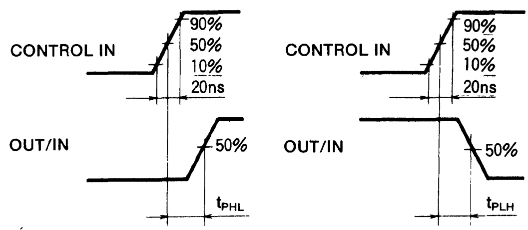
5 "L-H" and "H-L" output propagation time (CONTROL IN-OUT/IN)



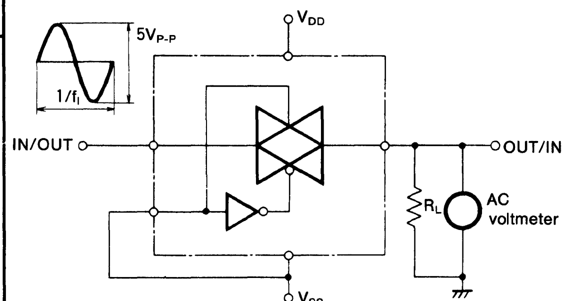
S_A=1, S_B=2

S_A=2, S_B=1

TIMING DIAGRAM

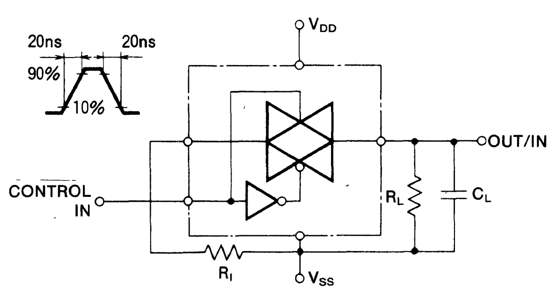


6 Feedthrough



The feedthrough is taken as that frequency f_I at which, using a sine-wave input of 2.5V_{P-P}, 20 $\log_{10}(V_O/V_I) = -50dB$.

7 Crosstalk



MITSUBISHI ELECTRIC

M4051BP
M4051BFP

8-CHANNEL ANALOG MULTIPLEXER/DEMULTIPLEXER

DESCRIPTION

The M4051BP is a semiconductor integrated circuit consisting of a multiplexer/demultiplexer which uses a 3-bit digital input to perform selection of eight analog switches.

FEATURES

- Low ON resistance: 50Ω typ. (V_{DD}=15V)
- High OFF resistance: 10^9Ω or greater (typ)
- Small differences iin ON resistance between each switch in the package: 10 Ω typ. (V_{DD} = 7.5V, V_{SS} = −7.5V)
- Linearized transfer characteristics: 0.07% distortion (typ)
- Signals with amplitude greater than the logic level amplitude of the control inputs may be switched.
- Provided with an inhibit input

APPLICATION

General purpose, for use in industrial and consumer digital eguipment.

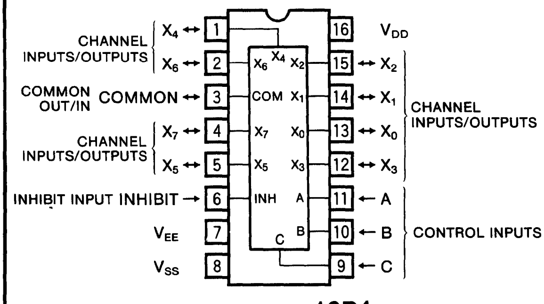
FUNCTIONAL DESCRIPTION

When a 3-bit binary input signal is applied to the control inputs (A, B, and C), the channel number corresponding to the binary value input (X_0 through X_7) is set at low impedance with respect to the (COMMON). All other channels remain at high impedance.

In this operation, if the (INHIBIT) input is held high, all channels (X_0 through X_7) will be put in the high-impedance state, regardless of the state of the other inputs.

It is possible to switch an analog signal of amplitude V_{DD}-V_{EE} if this is greater than the logic level span V_{DD}-V_{SS} for inputs (A, B, and C).

PIN CONFIGURATION (TOP VIEW)



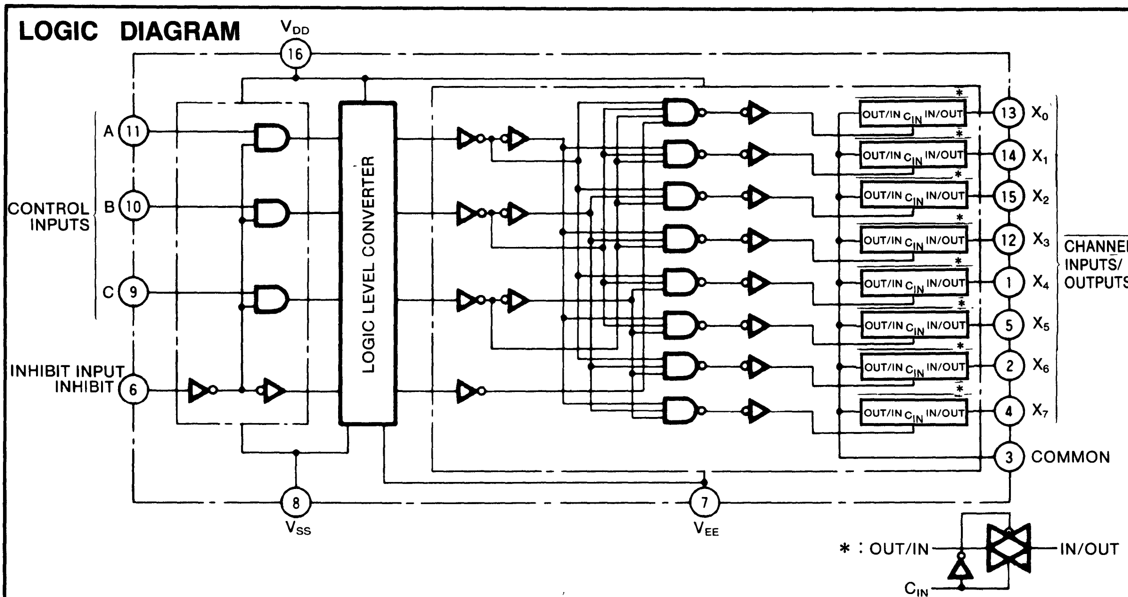
Outline 16P4
16P2N

FUNCTION TABLE (Note 1)

Inhibit input	Control inputs			Channel INPUT/OUTPUT to COMMON switch selection							
INHIBIT	C	B	A	X_0	X_1	X_2	X_3	X_4	X_5	X_6	X_7
L	L	L	L	ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF
L	L	L	H	OFF	ON	OFF	OFF	OFF	OFF	OFF	OFF
L	L	H	L	OFF	OFF	ON	OFF	OFF	OFF	OFF	OFF
L	L	H	H	OFF	OFF	OFF	ON	OFF	OFF	OFF	OFF
L	H	L	L	OFF	OFF	OFF	OFF	ON	OFF	OFF	OFF
L	H	L	H	OFF	OFF	OFF	OFF	OFF	ON	OFF	OFF
L	H	H	L	OFF	OFF	OFF	OFF	OFF	OFF	ON	OFF
L	H	H	H	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON
H	X	X	X	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF

Note 1 : X : Irrelevant
ON : Low impedance between X_n and COMMON (n=0~7)
OFF : High impedance between X_n and COMMON (n=0~7)

LOGIC DIAGRAM



8-CHANNEL ANALOG MULTIPLEXER/DEMULTIPLEXER

ABSOLUTE MAXIMUM RATINGS (T_a=−40~+85℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{DD}-V_{SS}	Supply voltage		−0.5~20	V
V_{DD}-V_{EE}			−0.5~20	V
V_I	Input voltage	Control and inhibit inputs	V_{SS}−0.5~V_{DD}+0.5	V
		Channel and common inputs	V_{EE}−0.5~V_{DD}+0.5	
V_{IO}	Input-to-output voltage		±0.5	V
I_I	Input current	Control and inhibit inputs	±10	mA
I_O	Output current	Switch-off	±10	mA
V_O	Output voltage	Channel and common outputs	V_{EE}−0.5~V_{DD}+0.5	V
Topr	Operating temperature range		−40~+85	℃
Tstg	Storage temperature range		−65~+150	℃

RECOMMENDED OPERATNG CONDITING CONDITIONS (T_a=−40~+85℃, unless otherwise noted)

Symbol	Parameter		Limits			Unit
			Min	Typ	Max	
V_{DD}-V_{SS}	Supply voltage		3		18	V
V_{DD}-V_{EE}			3		18	V
V_I	Input voltage	Control and inhibit inputs	V_{SS}		V_{DD}	V
		Channel and common inputs	V_{EE}		V_{DD}	
V_O	Output voltage		V_{EE}		V_{DD}	V

ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

Symbol	Parameter	Test conditions			Limits							Unit
					−40℃		25℃			85℃		
			V_{EE}(V)	V_{DD}(V)	Min	Max	Min	Typ	Max	Min	Max	
V_{IH}	"H" input voltage (A, B, C, INHIBIT)	Input-to-output current=10μA	0	5	3.5		3.5			3.5		V
			0	10	7.0		7.0			7.0		
			0	15	11.0		11.0			11.0		
V_{IL}	"L" input current (A, B, C, INHIBIT)	Input-to-output current=10μA	0	5		1.5			1.5		1.5	V
			0	10		3.0			3.0		3.0	
			0	15		4.0			4.0		4.0	
R_{ON}	ON resistance	V_I=5V	0	5		500			600		800	Ω
		V_I=2.5V	0	5		850			950		1300	
		V_I=0.25V	0	5		500			600		800	
		V_I=10V	0	10		210			250		300	
		V_I=5V	0	10		210			250		300	
		V_I=0.25V	0	10		210			250		300	
		V_I=15V	0	15		140			160		200	
		V_I=7.5V	0	15		140			160		200	
		V_I=0.25V	0	15		140			160		200	
		V_I=5V	−5	5		210			250		300	
		V_I=±0.25V	−5	5		210			250		300	
		V_I=−5V	−5	5		210			250		300	
		V_I=7.5V	−7.5	7.5		140			160		200	
		V_I=±0.25V	−7.5	7.5		140			160		200	
	Test circuit 1	V_I=−7.5V	−7.5	7.5		140			160		200	
ΔR_{ON}	ON resistance variations between switches of the same pckage		−2.5	2.5				30				Ω
			−5	5				15				
			−7.5	7.5				10				
I_{OFF}	Input-to-output off-state leakage current (X_0~X_7-COMMON)	$V_{I/O}$=10V, $V_{O/I}$=0V	0	10					125			nA
		$V_{I/O}$=0V, $V_{O/I}$=10V	0	10					−125			
		$V_{I/O}$=18V, $V_{O/I}$=0V	0	18		250			250		1000	
		$V_{I/O}$=0V, $V_{O/I}$=18V	0	18		−250			−250		−1000	
I_{DD}	Quiescent supply current	V_I=V_{DD}, V_{SS}	0	5		20			20		150	μA
			0	10		40			40		300	
			0	15		80			80		600	
I_{IH}	"H" input corrent (A~C, INH)	V_{IH}=18V	0	18		0.3			0.3		1.0	μA
I_{IL}	"L" input current (A~C, INH)	V_{IL}=0V	0	18		−0.3			−0.3		−1.0	μA

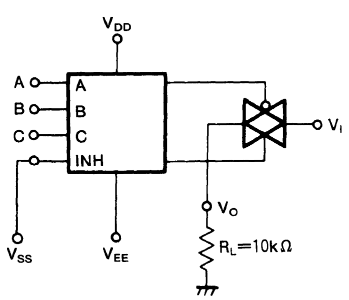
MITSUBISHI ELECTRIC

SWITCHING CHARACTERISTCS (T_a=25℃, V_{SS}=0V)

Symbol	Parameter	Tset conditions	V_{EE}(V)	V_{DD}(V)	Limits Min	Typ	Max	Unit
$f_{max(I/O)}$	Maximum transfer frequency	R_L=10kΩ, C_L=15pF Test circuit 2	−5	5		25		MHz
t_{PLH}	"L-H" and "H-L" output propagation time (A, B, C-X_0~X_7, COMMON)	R_L=10kΩ, C_L=50pF Test circuit 3	0	5			1000	ns
			0	10			500	
			0	15			400	
			−5	5			700	
			−7.5	7.5			500	
t_{PHL}			0	5			1000	ns
			0	10			500	
			0	15			400	
			−5	5			700	
			−7.5	7.5			500	
t_{PLH}	"L-H" and "H-L" output propation time (INHIBIT-X_0~X_7, COMMON)	R_L=10kΩ, C_L=50pF Tset circuit 4	0	5			1400	ns
			0	10			700	
			0	15			500	
			−5	5			900	
			−7.5	7.5			500	
t_{PHL}			0	5			1400	ns
			0	10			700	
			0	15			500	
			−5	5			900	
			−7.5	7.5			500	
t_{PLH}	"L-H" and "H-L" output propagation time (X_0~X_7/COMMON-COMMON/X_0~X_7)	R_L=10kΩ, C_L=50pF Test circuit 5	0	5			45	ns
			0	10			30	
			0	15			20	
t_{PHL}			0	5			45	ns
			0	10			30	
			0	15			20	
—	Sine-wave distortion	R_L=10kΩ, f_I=1kHz Test circuit 2	−5	5		0.1		%
—	Feedthroudh (switch off)	R_L=1kΩ Test circuit 6	−5	5		500		kHz
—	Crosstalk (A, B, C, INHIBIT-X_0~X_7, COMMON)	R_I=1kΩ, R_L=10kΩ, C_L=15pF Test circuit 7	0	5		200		mV
			0	10		300		
			0	15		400		
C_I	Input capacitance	Control and inhibit inputs					7.5	pF
		Channel and common inputs				10		

TEST CIRCUITS (V_{SS}=0V, capacitance C_L includes stray wirig capacitance and probe input capacitance)

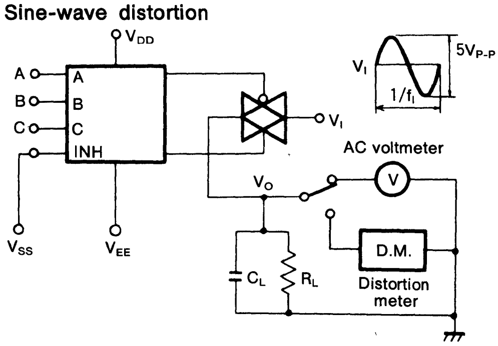
1 ON resistance (R_{ON})



$$R_{ON}=10\times\frac{(V_I-V_O)}{V_O}\ (k\Omega)$$

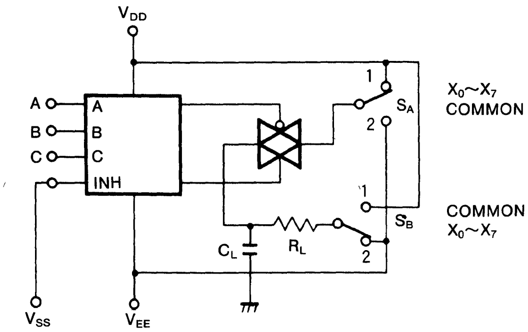
Refer to the function table for conditions of control inputs A, B, and C.

2 Maximum transfer frequency (fmax(I/O))
Sine-wave distortion

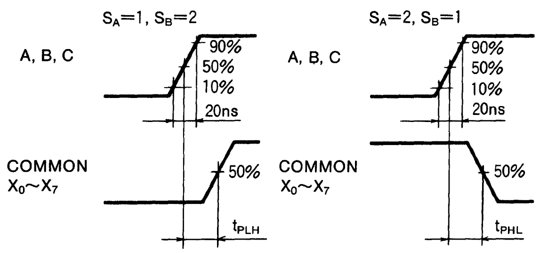


fmax (I/O) is taken as that frequency f_I at which, using a sine-wave input of 2 5V_{P-P}, 20 $\log_{10}(V_O/V_I)$=−3dB. Refer to the function table for conditions of control inputs A, B, and C.

3 "L-H" and "H-L" output propagation time
(A, B, C-X_0-X_7, COMMON)

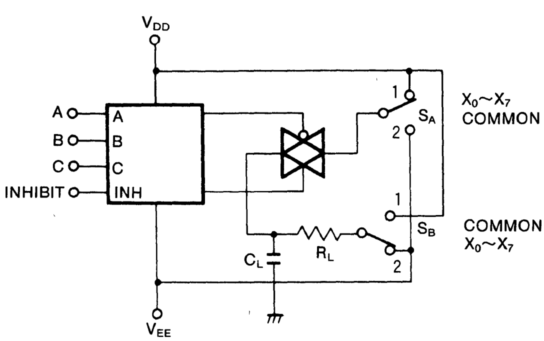


TIMNG DIAGRAM

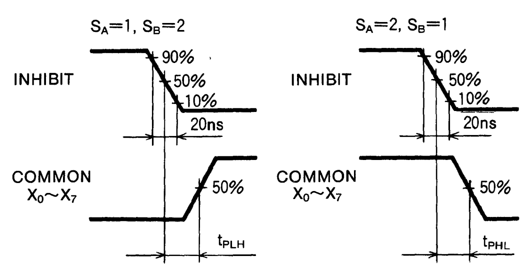


Refer to the function table for conditions of control inputs A, B, and C

4 "L-H" and "H-L" output propagation time
(INHIBIT-X_0-X_7, COMMON)

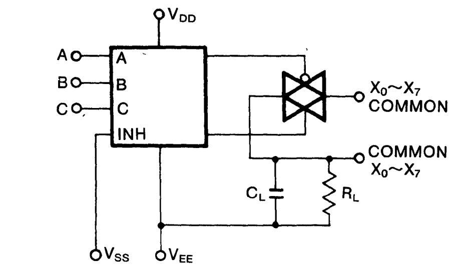


TIMNG DIAGRAM

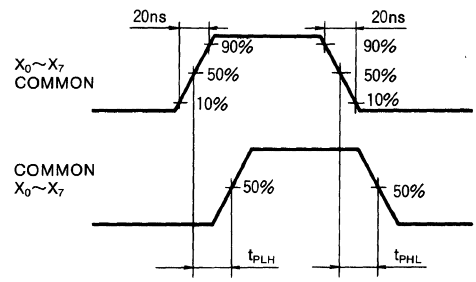


Refer to the function table for conditions of control inputs A, B, and C.

5 "L-H" and "H-L" output propagation time
(X_0-X_7/COMMON-COMMON/X_0-X_7)

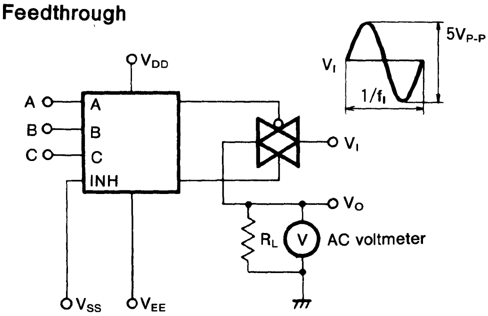


TIMNG DIAGRAM



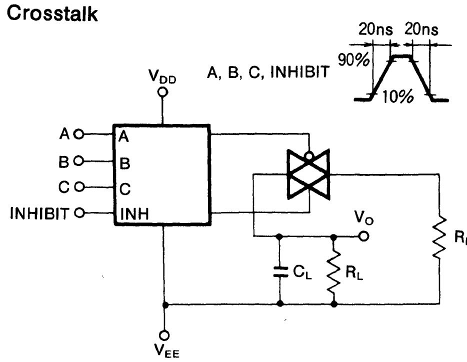
Refer to the function table for conditions of control inputs A, B, and C

6 Feedthrough



The feedthrough is taken as that freguency f_I at which, using a sine-wave input of $2.5V_{P-P}$, $20\log_{10}(V_O/V_I)=-50$dB. Refer to the function table for conditions of control inputs A, B, and C.

7 Crosstalk



Refer to the function table for conditions of control inputs A, B, and C.

M4052BP
M4052BFP

DUAL 4-CHANNEL ANALOG MULTIPLEXER/DEMULTIPLEXER

DESCRIPTION

The M4052BP is a semiconductor integrated circuit consisting of two multiplexer/demultiplexers which use 2-bit digital inputs to perform selection of four analog switches.

FEATURES

- Low ON resistance: 50Ω typ. (V_{DD}=15V)
- High OFF resistance: 10^9Ω or greater (typ)
- Small differences in ON resistance between each switch in the package: 10 Ω typ. (V_{DD}=7.5V, V_{SS}=−7.5V)
- Linearized transfer characteristics: 0.07% distortion (typ)
- Signals with amplitude greater than the logic level amplitude of the control inputs may be switched.
- Provided with an inhibit input

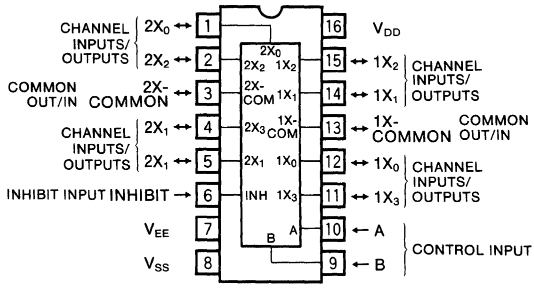
APPLICATION

General purpose, for use in industrial and consumer digital eguipment.

FUNCTIONAL DESCRIPTION

When a 2-bit binary input signal is applied to the control inputs (A and B), the channel number corresponding to the binary value input (X_0 through X_3) is set at low impedance with respect to the corresponding (X-COMMON). All other channels remain at high impedance.
In this operation, if the (INHIBIT) input is held high, all channels (X_0 through X_3) will be put in the high-impedance state, regardless of the state of the other inputs.
It is possible to switch an analog signal of amplitude V_{DD}-V_{EE} if this is greater than the logic level span V_{DD}-V_{SS} for inputs (A and B)

PIN COFIGRATION (TOP VIEW)



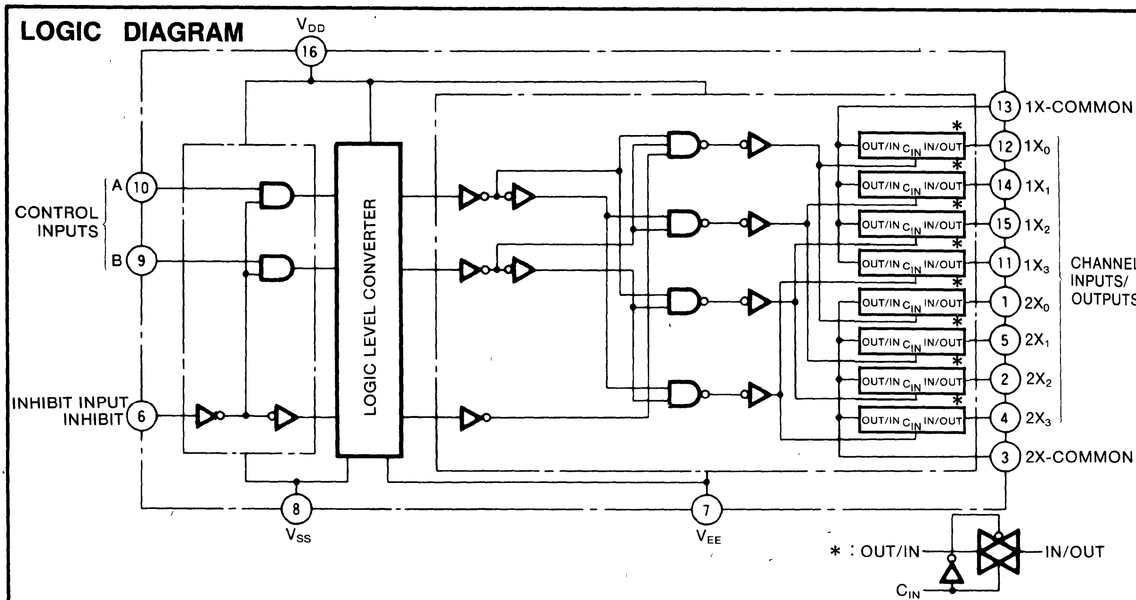
Outline 16P4
16P2N

FUNCTION TABLE (Note 1)

Inhibit input	Control inputs		Channel INPUT/OUTPUT to COMMON switch selection			
INHIBIT	B	A	X_0	X_1	X_2	X_3
L	L	L	ON	OFF	OFF	OFF
L	L	H	OFF	ON	OFF	OFF
L	H	L	OFF	OFF	ON	OFF
L	H	H	OFF	OFF	OFF	ON
H	X	X	OFF	OFF	OFF	OFF

Note 1 : X : Irrelevant
ON : Low impedance between X_n and X-COMMON (n=0~3)
OFF : High impedance between X_n and X-COMMON (n=0~3)

LOGIC DIAGRAM



ABSOLUTE MAXIMUM RATINGS (T_a=−40∼+85℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{DD}-V_{SS}	Supply voltage		−0.5∼20	V
V_{DD}-V_{EE}			−0.5∼20	V
V_I	Input voltage	Control and inhibit inputs	V_{SS}−0.5∼V_{DD}+0.5	V
		Channel and common inputs	V_{EE}−0.5∼V_{DD}+0.5	V
V_{IO}	Input-to-output voltage		±0.5	V
I_I	Input current	Control and inhibit inputs	±10	mA
I_O	Output current	Switch-off	±10	mA
V_O	Output voltage	Channel and common outputs	V_{EE}−0.5∼V_{DD}+0.5	V
Topr	Operating temperature range		−40∼+85	℃
Tstg	Storage temperature range		−65∼+150	℃

RECOMMENDED OPERATNG CONDITING CONDITIONS (T_a=−40∼+85℃, unless otherwise noted)

Symbol	Parameter		Limits			Unit
			Min	Typ	Max	
V_{DD}-V_{SS}	Supply voltage		3		18	V
V_{DD}-V_{EE}			3		18	V
V_I	Input voltage	Control and inhibit inputs	V_{SS}		V_{DD}	V
		Channel and common inputs	V_{EE}		V_{DD}	
V_O	Output voltage		V_{EE}		V_{DD}	V

ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

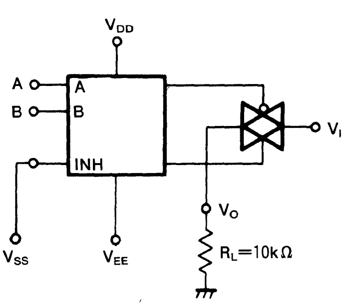
Symbol	Parameter	Test conditions			Limits							Unit
					−40℃		25℃			85℃		
			V_{EE}(V)	V_{DD}(V)	Min	Max	Min	Typ	Max	Min	Max	
V_{IH}	"H" input voltage (A, B, INHIBIT)	Input-to-output current=10μA	0	5	3.5		3.5			3.5		V
			0	10	7.0		7.0			7.0		
			0	15	11.0		11.0			11.0		
V_{IL}	"L" input current (A, B, INHIBIT)	Input-to-output current=10μA	0	5		1.5			1.5		1.5	V
			0	10		3.0			3.0		3.0	
			0	15		4.0			4.0		4.0	
R_{ON}	ON resistance	V_I=5V	0	5		500			600		800	Ω
		V_I=2.5V	0	5		850			950		1300	
		V_I=0.25V	0	5		500			600		800	
		V_I=10V	0	10		210			250		300	
		V_I=5V	0	10		210			250		300	
		V_I=0.25V	0	10		210			250		300	
		V_I=15V	0	15		140			160		200	
		V_I=7.5V	0	15		140			160		200	
		V_I=0.25V	0	15		140			160		200	
		V_I=5V	−5	5		210			250		300	
		V_I=±0.25V	−5	5		210			250		300	
		V_I=−5V	−5	5		210			250		300	
		V_I=7.5V	−7.5	7.5		140			160		200	
		V_I=±0.25V	−7.5	7.5		140			160		200	
	Test circuit 1	V_I=−7.5V	−7.5	7.5		140			160		200	
ΔR_{ON}	ON resistance variations between switches of the same pckage		−2.5	2.5				30				Ω
			−5	5				15				
			−7.5	7.5				10				
I_{OFF}	Input-to-output off-state leakage current (X_0∼X_3-X-COMMON)	$V_{I/O}$=10V, $V_{O/I}$=0V	0	10					125			nA
		$V_{I/O}$=0V, $V_{O/I}$=10V	0	10					−125			
		$V_{I/O}$=18V, $V_{O/I}$=0V	0	18		250			250		1000	
		$V_{I/O}$=0V, $V_{O/I}$=18V	0	18		−250			−250		−1000	
I_{DD}	Quiescent supply current	V_I=V_{DD}, V_{SS}	0	5		20			20		150	μA
			0	10		40			40		300	
			0	15		80			80		600	
I_{IH}	"H" input current (A, B, INH)	V_{IH}=18V	0	18		0.3			0.3		1.0	μA
I_{IL}	"L" input current (A, B, INH)	V_{IL}=0V	0	18		−0.3			−0.3		−1.0	μA

SWITCHING CHARACTERISTCS (T_a=25℃, V_{SS}=0V)

Symbol	Parameter	Tset conditions	V_{EE}(V)	V_{DD}(V)	Limits Min	Typ	Max	Unit
$f_{max(I/O)}$	Maximum transfer frequency	R_L=10kΩ, C_L=15pF Test circuit 2	−5	5		25		MHz
t_{PLH}	"L-H" and "H-L" output propagation time (A, B-X_0~X_3, X-COMMON)	R_L=10kΩ, C_L=50pF Test circuit 3	0	5			1000	ns
			0	10			500	
			0	15			400	
			−5	5			700	
			−7.5	7.5			500	
t_{PHL}			0	5			1000	ns
			0	10			500	
			0	15			400	
			−5	5			700	
			−7.5	7.5			500	
t_{PLH}	"L-H" and "H-L" output propation time (INHIBIT-X_0~X_3, X-COMMON)	R_L=10kΩ, C_L=50pF Tset circuit 4	0	5			1400	ns
			0	10			700	
			0	15			500	
			−5	5			900	
			−7.5	7.5			500	
t_{PHL}			0	5			1400	ns
			0	10			700	
			0	15			500	
			−5	5			900	
			−7.5	7.5			500	
t_{PLH}	"L-H" and "H-L" output propagation time (X_0~X_3/X-COMMON-X-COMMON/X_0~X_3)	R_L=10kΩ, C_L=50pF Test circuit 5	0	5			45	ns
			0	10			30	
			0	15			20	
t_{PHL}			0	5			45	ns
			0	10			30	
			0	15			20	
—	Sine-wave distortion	R_L=10kΩ, f_I=1kHz Test circuit 2	−5	5		0.1		%
—	Feedthroudh (switch off)	R_L=1kΩ Test circuit 6	−5	5		500		kHz
—	Crosstalk (A, B,INHIBIT-X_0~X_3, X-COMMON)	R_I=1kΩ, R_L=10kΩ, C_L=15pF Test circuit 7	0	5		200		mV
			0	10		300		
			0	15		400		
C_I	Input capacitance	Control and inhibit inputs					7.5	pF
		Channel and common inputs				10		

TEST CIRCUITS (V_{SS}=0V, capacitance C_L includes stray wirig capacitance and probe input capacitance)

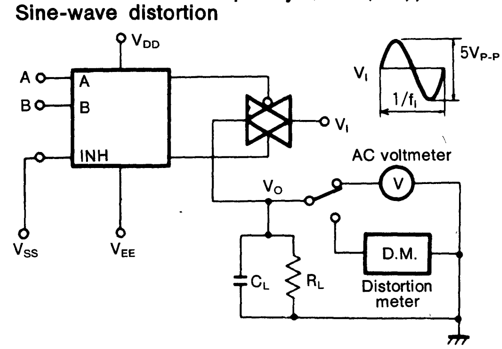
1 ON resistance (R_{ON})



$$R_{ON}=10\times\frac{(V_I-V_O)}{V_O}\,[k\Omega]$$

Refer to the function table for conditions of control inputs A and B

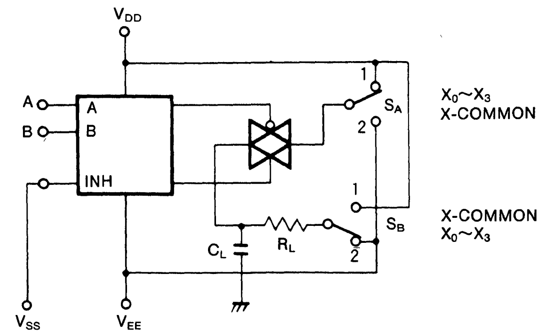
2 Maximum transfer frequency (fmax(I/O)) Sine-wave distortion



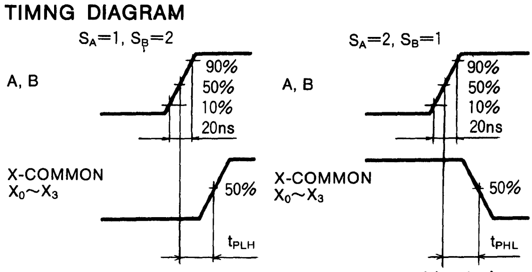
fmax (I/O) is taken as that frequency f_I at which, using a sine-wave input of 2.5V_{P-P}, 20 $\log_{10}(V_O/V_I)$=−3dB Refer to the function table for conditions of control inputs A and B.

DUAL 4-CHANNEL ANALOG MULTIPLEXER/DEMULTIPLEXER

3 "L-H" and "H-L" output propagation time
(A, B-X_0-X_7, COMMON)

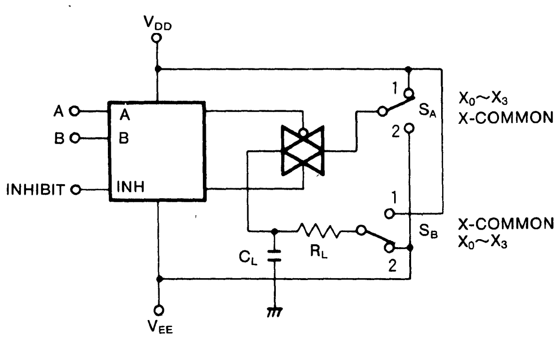


TIMNG DIAGRAM

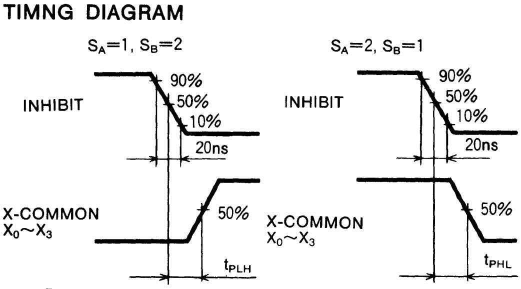


Refer to the function table for conditions of control inputs A and B.

4 "L-H" and "H-L" output propagation time
(INHIBIT-X_0-X_3, X-COMMON)

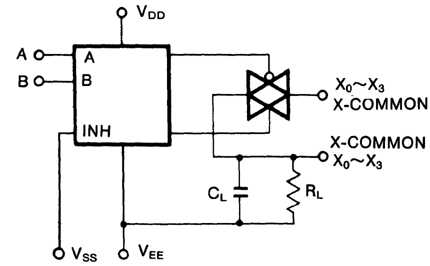


TIMNG DIAGRAM

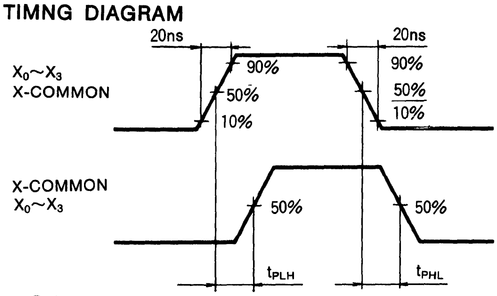


Refer to the function table for conditions of control inputs A and B

5 "L-H" and "H-L" output propagation time
(X_0-X_3/X-COMMON-X-COMMON/X_0-X_3)

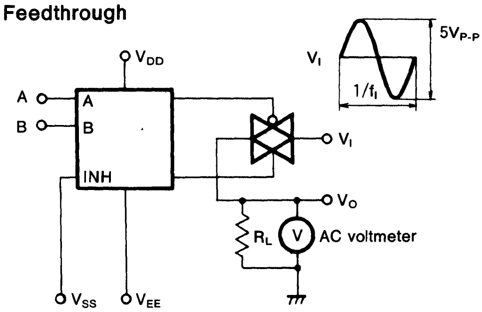


TIMNG DIAGRAM



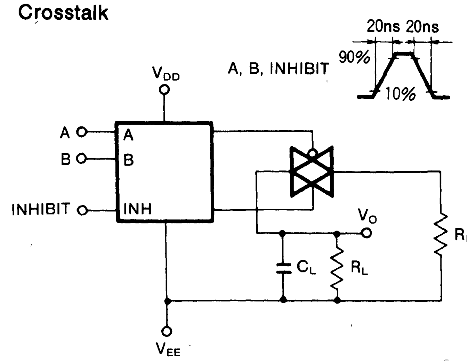
Refer to the function table for conditions of control inputs A and B.

6 Feedthrough



The feedthrough is taken as that frequency f_I at which, using a sine-wave input of $2.5V_{P\text{-}P}$, $20\log_{10}(V_O/V_I)=-50dB$. Refer to the function table for conditions of control inputs A and B.

7 Crosstalk



Refer to the function table for conditions of control inputs A and B

MITSUBISHI ELECTRIC

M4053BP
M4053BFP

TRIPLE 2-CHANNEL ANALOG MULTIPLEXER/DEMULTIPLEXER

DESCRIPTION
The M4053BP is a semiconductor integrated circuit consiting of three multiplexer/demultiplexers which use 1-bit digital inputs to perform selection of two analog switches.

FEATURES
- Low ON resistance: 50Ω typ. (V_{DD}=15V)
- High OFF resistance: 10^9Ω or greater (typ)
- Small differences in ON resistance between each switch in the package: 10 Ω typ. (V_{DD} = 7.5V, V_{SS} = −7.5V)
- Linearized transfer characteristics: 0.07% distortion (typ)
- Signals with amplitude greater than the logic level amplitude of the control inputs may be switched.
- Provided with an inhibit input

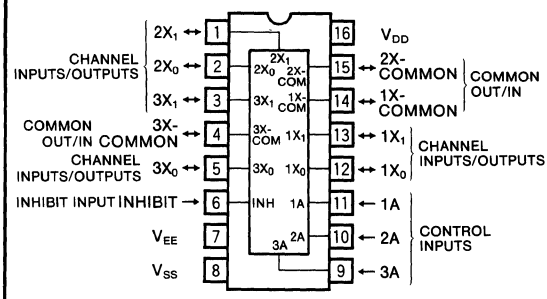
APPLICATION
Ceneral purpose, for use in industrial and consumer digital eguipment.

FUNCTIONAL DESCRIPTION
When a 1-bit binary input signal is applied to the control inputs (A), the channel numbers corresponding to the binary value input (X_0, X_1) are set to low impedance with respect to the corresponding (X-COMMON). All other channels reain at high impedance.

In this operation, if the (INHIBIT) input is held high, all channels (X_0, X_1) will be put in the high-impedance state, regardless of the state of the other inputs.

It is possible to switch an analog signal of amplitude V_{DD}-V_{EE} if this is greater than the logic level span V_{DD}-V_{SS} for inputs (A).

PIN COFIGRATION (TOP VIEW)



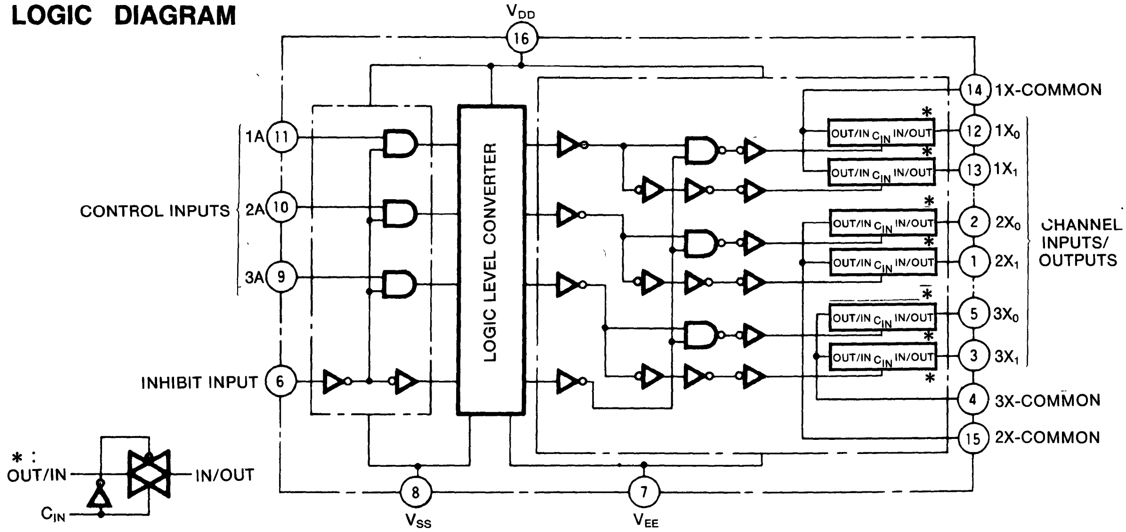
Outline 16P4
16P2N

FUNCTION TABLE (Note 1)

Inhibit input	Control inputs	Channel INPUT/OUTPUT to COMMON switch selection	
INHIBIT	A	X_0	X_1
L	L	ON	OFF
L	H	OFF	ON
H	X	FF	OFF

Note 1 : X : Irrelevant
ON : Low impedance between X_n and X-COMMON (n=0, 1)
OFF : High impedance between X_n and X-COMMON (n=0, 1)

LOGIC DIAGRAM



TRIPLE 2-CHANNEL ANALOG MULTIPLEXER/DEMULTIPLEXER

ABSOLUTE MAXIMUM RATINGS (T_a=−40~+85℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{DD}-V_{SS}	Supply voltage		−0.5~20	V
V_{DD}-V_{EE}			−0.5~20	V
V_I	Input voltage	Control and inhibit inputs	V_{SS}−0.5~V_{DD}+0.5	V
		Channel and common inputs	V_{EE}−0.5~V_{DD}+0.5	
V_{IO}	Input-to-output voltage		±0.5	V
I_I	Input current	Control and inhibit inputs	±10	mA
I_O	Output current	Switch-off	±10	mA
V_O	Output voltage	Channel and common outputs	V_{EE}−0.5~V_{DD}+0.5	V
Topr	Operating temperature range		−40~+85	℃
Tstg	Storage temperature range		−65~+150	℃

RECOMMENDED OPERATNG CONDITING CONDITIONS (T_a=−40~+85℃, unless otherwise noted)

Symbol	Parameter		Limits			Unit
			Min	Typ	Max	
V_{DD}-V_{SS}	Supply voltage		3		18	V
V_{DD}-V_{EE}			3		18	V
V_I	Input voltage	Control and inhibit inputs	V_{SS}		V_{DD}	V
		Channel and common inputs	V_{EE}		V_{DD}	
V_O	Output voltage		V_{EE}		V_{DD}	V

ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

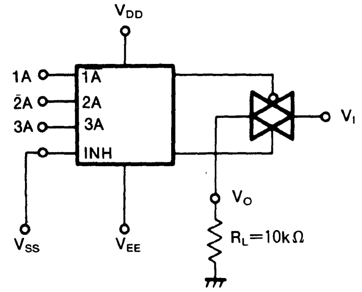
Symbol	Parameter	Test conditions			Limits							Unit
					−40℃		25℃			85℃		
			V_{EE}(V)	V_{DD}(V)	Min	Max	Min	Typ	Max	Min	Max	
V_{IH}	"H" input voltage (A, B, C, INHIBIT)	Input-to-output current=10μA	0	5	3.5		3.5			3.5		V
			0	10	7.0		7.0			7.0		
			0	15	11.0		11.0			11.0		
V_{IL}	"L" input current (A, B, C, INHIBIT)	Input-to-output current=10μA	0	5		1.5			1.5		1.5	V
			0	10		3.0			3.0		3.0	
			0	15		4.0			4.0		4.0	
R_{ON}	ON resistance	V_I=5V	0	5		500			600		800	Ω
		V_I=2.5V	0	5		850			950		1300	
		V_I=0.25V	0	5		500			600		800	
		V_I=10V	0	10		210			250		300	
		V_I=5V	0	10		210			250		300	
		V_I=0.25V	0	10		210			250		300	
		V_I=15V	0	15		140			160		200	
		V_I=7.5V	0	15		140			160		200	
		V_I=0.25V	0	15		140			160		200	
		V_I=5V	−5	5		210			250		300	
		V_I=±0.25V	−5	5		210			250		300	
		V_I=−5V	−5	5		210			250		300	
		V_I=7.5V	−7.5	7.5		140			160		200	
		V_I=±0.25V	−7.5	7.5		140			160		200	
	Test circuit 1	V_I=−7.5V	−7.5	7.5		140			160		200	
ΔR_{ON}	ON resistance variations between switches of the same pckage		−2.5	2.5				30				Ω
			−5	5				15				
			−7.5	7.5				10				
I_{OFF}	Input-to-output off-state leakage current (X_0~X_1-X-COMMON)	$V_{I/O}$=10V, $V_{O/I}$=0V	0	10					125			nA
		$V_{I/O}$=0V, $V_{O/I}$=10V	0	10					−125			
		$V_{I/O}$=18V, $V_{O/I}$=0V	0	18		250			250		1000	
		$V_{I/O}$=0V, $V_{O/I}$=18V	0	18		−250			−250		−1000	
I_{DD}	Quiescent supply current	V_I=V_{DD}, V_{SS}	0	5		20			20		150	μA
			0	10		40			40		300	
			0	15		80			80		600	
I_{IH}	"H" input corrent (A, INH)	V_{IH}=18V	0	18		0.3			0.3		1.0	μA
I_{IL}	"L" input current (A, INH)	V_{IL}=0V	0	18		−0.3			−0.3		−1.0	μA

SWITCHING CHARACTERISTCS (T_a=25℃, V_{SS}=0V)

Symbol	Parameter	Tset conditions			Limits			Unit
			V_{EE}(V)	V_{DD}(V)	Min	Typ	Max	
$f_{max(I/O)}$	Maximum transfer frequency	R_L=10kΩ C_L=15pF Test circuit 2	−5	5		25		MHz
t_{PLH}	"L-H" and "H-L" output propagation time (A-X_0, X_1, X-COMMON)	R_L=10kΩ C_L=50pF Test circuit 3	0	5			1000	ns
			0	10			500	
			0	15			400	
			−5	5			700	
			−7.5	7.5			500	
t_{PHL}			0	5			1000	ns
			0	10			500	
			0	15			400	
			−5	5			700	
			−7.5	7.5			500	
t_{PLH}	"L-H" and "H-L" output propation time (INHIBIT-X_0, X_1, X-COMMON)	R_L=10kΩ C_L=50pF Tset circuit 4	0	5			1400	ns
			0	10			700	
			0	15			500	
			−5	5			900	
			−7.5	7.5			500	
t_{PHL}			0	5			1400	ns
			0	10			700	
			0	15			500	
			−5	5			900	
			−7.5	7.5			500	
t_{PLH}	"L-H" and "H-L" output propagation time (X_0, X_1/X-COMMON-X-COMMON/X_0, X_1)	R_L=10kΩ C_L=50pF Test circuit 5	0	5			45	ns
			0	10			30	
			0	15			20	
t_{PHL}			0	5			45	ns
			0	10			30	
			0	15			20	
—	Sine-wave distortion	R_L=10kΩ f_I=1kHz Test circuit 2	−5	5		0.1		%
—	Feedthroudh (switch off)	R_L=1kΩ Test circuit 6	−5	5		500		kHz
—	Crosstalk (A, INHIBIT-X_0, X_1, X-COMMON)	R_I=1kΩ R_L=10kΩ C_L=15pF Test circuit 7	0	5		200		mV
			0	10		300		
			0	15		400		
C_I	Input capacitance	Control and inhibit inputs					7.5	pF
		Channel and common inputs				10		

TEST CIRCUITS (V_{SS}=0V, capacitance C_L includes stray wirig capacitance and probe input capacitance)

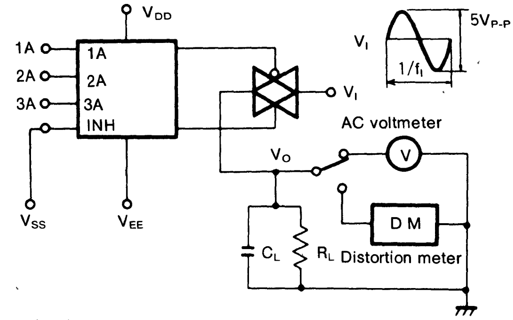
1 ON resistance (R_{ON})



$$R_{ON}=10\times\frac{(V_I-V_O)}{V_O}[k\Omega]$$

Refer to the function table for conditions of control input A.

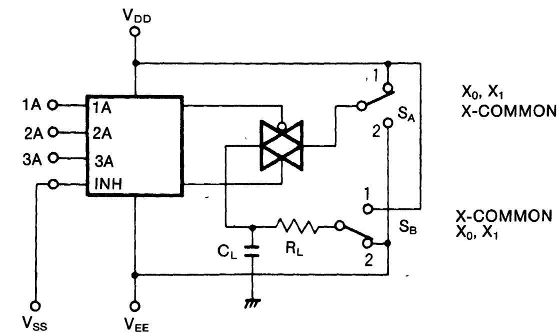
2 Maximum transfer frequency (fmax(I/O)) Sine-wave distortion



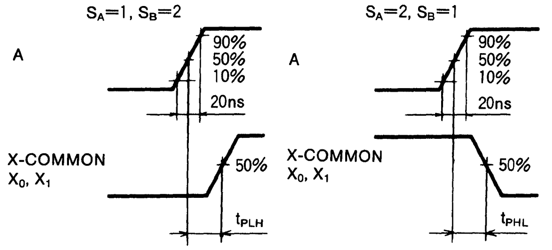
fmax (I/O) is taken as that frequency f_I at which, using a sine-wave input of 2 5V_{P-P}, 20 $\log_{10}(V_O/V_I)=-3$dB Refer to the function table for conditions of control input A

TRIPLE 2-CHANNEL ANALOG MULTIPLEXER/DEMULTIPLEXER

3 "L-H" and "H-L" output propagation time
(A-X_0, X_1, X-COMMON)

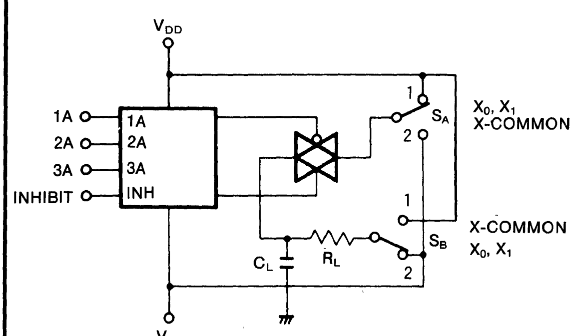


TIMNG DIAGRAM

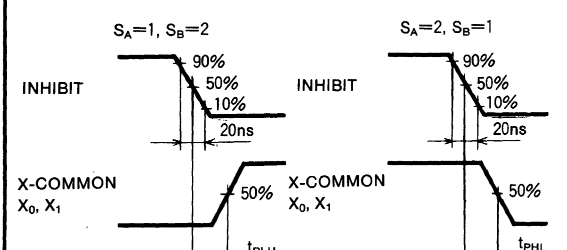


Refer to the function table for conditions of control input A.

4 "L-H" and "H-L" output propagation time
(INHIBIT-X_0, X_1, X-COMMON)

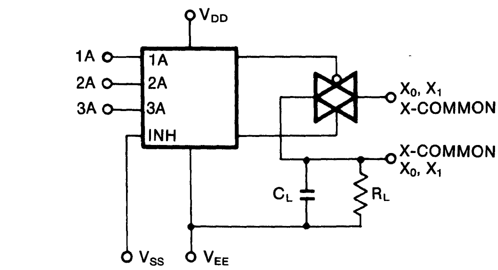


TIMNG DIAGRAM

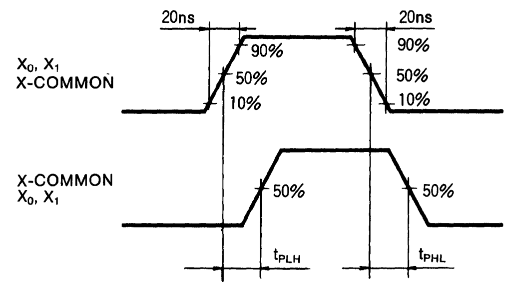


Refer to the function table for conditions of control input A.

5 "L-H" and "H-L" output propagation time
(X_0, X_1/X-COMMON-X-COMMON/X_0, X_1)

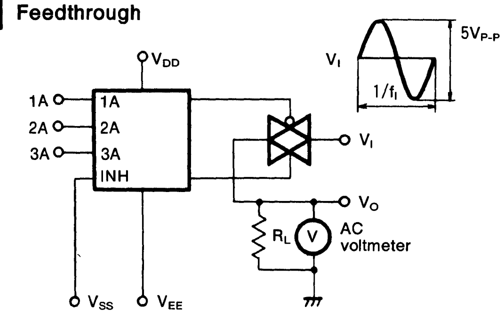


TIMNG DIAGRAM



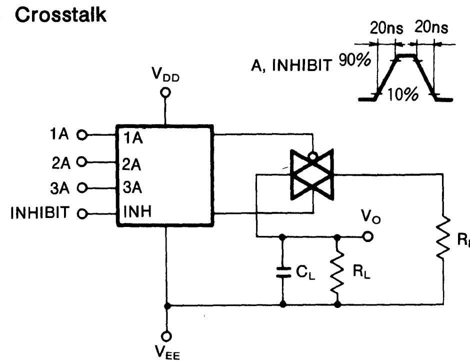
Refer to the function table for conditions of control input A.

6 Feedthrough



The feedthrough is taken as that frequency f_I at which, using a sine-wave input of 2.5V_{P-P}, 20 $\log_{10}(V_O/V_I)=-50$dB. Refer to the function table for conditions of control input A.

7 Crosstalk



Refer to the function table for conditions of control input A.

MITSUBISHI ELECTRIC

M4066BP
M4066BFP

QUADRUPLE BILATERAL SWITCH

DESCRIPTION

The M4066BP is a semiconductor integrated circuit consisting of four independent bilateral analog switches.

FEATURES

- Low ON resistance: 50Ω typ. (V_{DD}=15V)
- High OFF resistance: 10^9Ω or greater (typ)
- Small differences in ON resistance between each switch in the package: 10Ω typ. (V_{DD}=15V)
- Linearized transfer characteristics: 0.07% distortion (typ)
- Wide operating voltage range: V_{DD}=3~18V
- Wide operating temperature range: T_a=−40~+85℃

APPLICATION

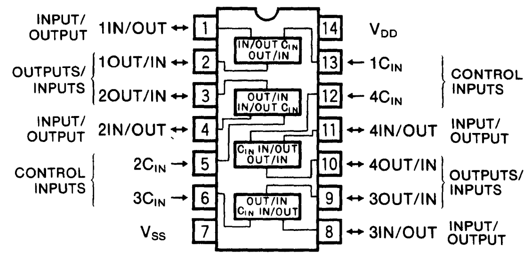
General purpose, for use in industrial and consumer digital equipment.

FUNCTIONAL DESCRIPTION

The control input (C_{IN}) can be used to change the input-to-output impedance (IN/OUT-OUT/IN) of the switches.
When (C_{IN}) is made high, the input-to-output switch impedance is low and when set to low, this impedance is high. While this device is compatible with the M4016BP, the lower ON resistance and better transfer characteristics allow a larger input voltage range.

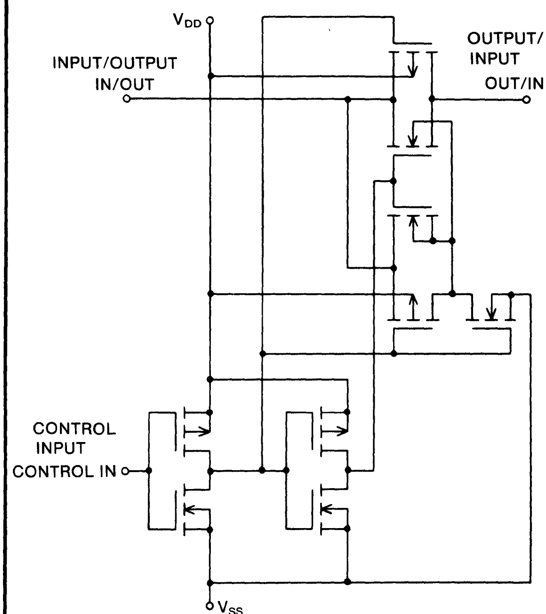
Input C_{IN}	Input/output and output/input resistance (V_{DD}=10V, 15V)
H	0.5~3X10^2Ω
L	>10^9Ω (typ)

PIN CONFIGURATION (TOP VIEW)

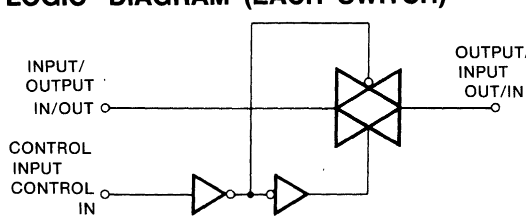


Outline 14P4
14P2N

CIRCUIT SCHEMATIC (EACH SWITCH)



LOGIC DIAGRAM (EACH SWITCH)



ABSOLUTE MAXIMUM RATINGS (T_a=−40~+85℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{DD}	Supply voltage		V_{SS}−0.5~V_{SS}+20	V
V_I	Input voltage		V_{SS}−0.5~V_{DD}+0.5	V
V_{IO}	Input-to-output voltage		±0.5	V
I_I	Input current	Control inputs	±10	mA
I_O	Output current	Switch-off	±10	mA
Topr	Operating temperature range		−40~+85	℃
Tstg	Storage temperature range		−65~+150	℃

RECOMMENDED OPERATING CONDITIONS (T_a=−40~+85℃, V_{SS}=0V, unless otherwise noted)

Symbol	Parameter	Limits			Unit
		Min	Typ	Max	
V_{DD}	Supply voltage	3		18	V
V_I	Input voltage	0		V_{DD}	V

ELECTRICAL CHARACTERISTICS

Symbol	Parameter	Test conditions			Limits							Unit
					−40℃		25℃			85℃		
			V_{SS}(V)	V_{DD}(V)	Min	Max	Min	Typ	Max	Min	Max	
V_{IH}	"H" input voltage (C_{IN})	Input-to-output current=10μA	0	5	3.5		3.5			3.5		V
			0	10	7.0		7.0			7.0		
			0	15	11.0		11.0			11.0		
V_{IL}	"L" input current (C_{IN})	Input-to-output current=10μA	0	5		1.5			1.5		1.5	V
			0	10		2.0			2.0		2.0	
			0	15		2.5			2.5		2.5	
R_{ON}	ON resistance	V_I=5V	0	5		500			600		800	Ω
		V_I=2.5V	0	5		850			950		1300	
		V_I=0.25V	0	5		500			600		800	
		V_I=10V	0	10		210			250		300	
		V_I=5V	0	10		210			250		300	
		V_I=0.25V	0	10		210			250		300	
		V_I=15V	0	15		140			160		200	
		V_I=7.5V	0	15		140			160		200	
		V_I=0.25V	0	15		140			160		200	
		V_I=5V	−5	5		210			250		300	
		V_I=±0.25V	−5	5		210			250		300	
		V_I=−5V	−5	5		210			250		300	
		V_I=7.5V	−7.5	7.5		140			160		200	
		V_I=±0.25V	−7.5	7.5		140			160		200	
	Test circuit 1	V_I=−7.5V	−7.5	7.5		140			160		200	
ΔR_{ON}	ON resistance variations between switches of the same package		−2.5	2.5				30				Ω
			−5	5				15				
			−7.5	7.5				10				
I_{OFF}	Input/output off-state leakage current	$V_{I/O}$=10V, $V_{O/I}$=0V	0	10					125			nA
		$V_{I/O}$=0V, $V_{O/I}$=10V	0	10					−125			
		$V_{I/O}$=18V, $V_{O/I}$=0V	0	18		250			250		1000	
		$V_{I/O}$=0V, $V_{O/I}$=18V	0	18		−250			−250		−1000	
I_{DD}	Quiescent supply current	$V_I(C_{IN})$=V_{DD}, V_{SS}	0	5		1			1		7.5	μA
			0	10		2			2		15	
			0	15		4			4		30	
I_{IH}	"H" input current (C_{IN})	V_I=18V	0	18		0.3			0.3		1.0	μA
I_{IL}	"L" input current (C_{IN})	V_{IL}=0V	0	18		−0.3			−0.3		−1.0	μA

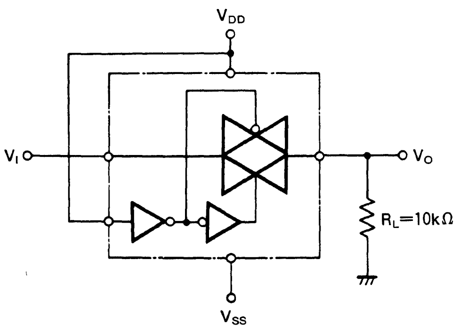
MITSUBISHI ELECTRIC

SWITCHING CHARACTERISTICS ($T_a=25°C$)

Symbol	Parameter	Test conditions	V_{SS}(V)	V_{DD}(V)	Limits Min	Limits Typ	Limits Max	Unit
fmax(I/O)	Maximum transfer frequency	$R_L=10k\Omega$ $C_L=15pF$ Test circuit 2	−5	5		25		MHz
fmax(C_{IN})	Maximum control frequency	$R_L=300\Omega$ $C_L=15pF$ Test circuit 3	0	5		6		MHz
			0	10		18		
			0	15		22		
t_{PLH}	"L-H" and "H-L" output propagation time (IN/OUT-OUT/IN)	$R_L=10k\Omega$ $C_L=50pF$ Test circuit 4	0	5			45	ns
			0	10			30	
			0	15			20	
t_{PHL}			0	5			45	ns
			0	10			30	
			0	15			20	
t_{PLH}	"L-H" and "H-L" output propagation time (CONTROL IN-OUT/IN)	$R_L=10k\Omega$ $C_L=50pF$ Test circuit 5	0	5			200	ns
			0	10			70	
			0	15			60	
t_{PHL}			0	5			200	ns
			0	10			70	
			0	15			60	
—	Sine-wave distortion	$R_L=10k\Omega$ $f_I=1kHz$ Test circuit 2	−5	5		0.07		%
—	Feedthrough (switch off)	$R_L=1k\Omega$ Test circuit 6	−5	5		500		kHz
—	Crosstalk (CONTROL IN-OUT/IN)	$R_I=1k\Omega$ $R_L=10k\Omega$ $C_L=15pF$ Test circuit 7	0	5		200		mV
			0	10		300		
			0	15		400		
C_I	Input capacitance	Control input					7.5	pF
		Switch input/output				10		

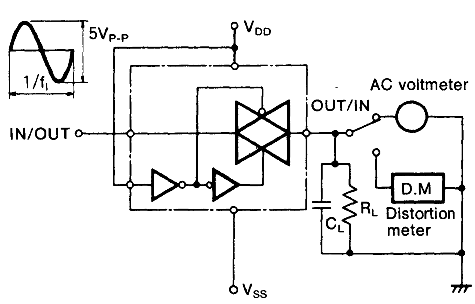
TEST CIRCUITS

1 ON resistance (R_{ON})



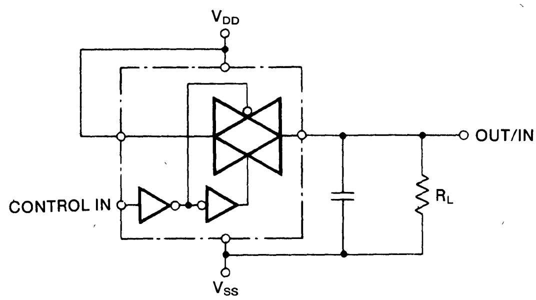
$$R_{ON}=10\times\frac{(V_I-V_O)}{V_O}\ [k\Omega]$$

2 Maximum transfer frequency (fmax(I/O))
Sine-wave distortion

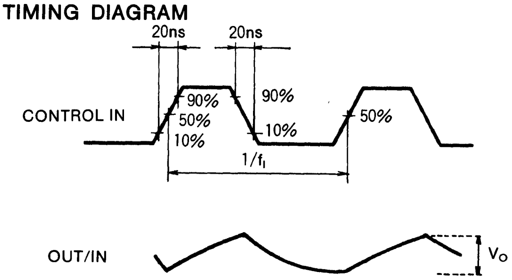


fmax (I/O) is taken as that frequency f_I at which, using a sine-wave input of 2.5V_{P-P}, 20 $\log_{10}(V_O/V_I)=-3dB$

3 Maximum control frequency (fmax(C_{IN}))



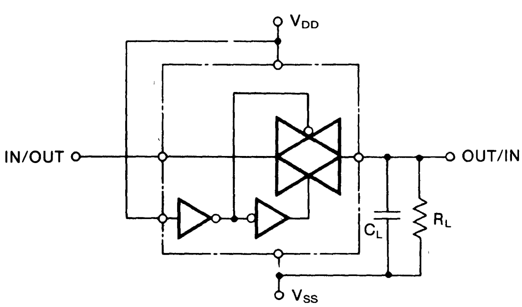
TIMING DIAGRAM



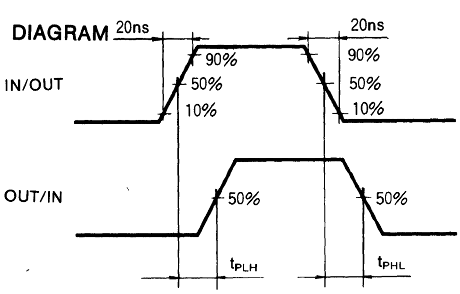
fmax(C_{IN}) is taken as that frequency f_I at which the output amplitude (V_O) is 1/2 that at 1kHz

4 "L-H" and "H-L" output propagation time

(IN/OUT-OUT/IN)

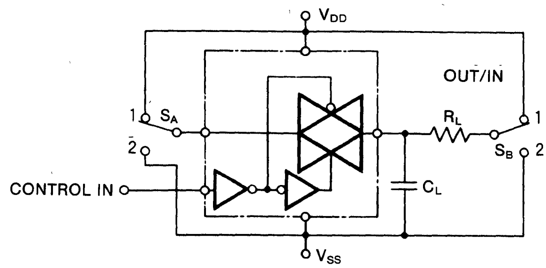


TIMING DIAGRAM



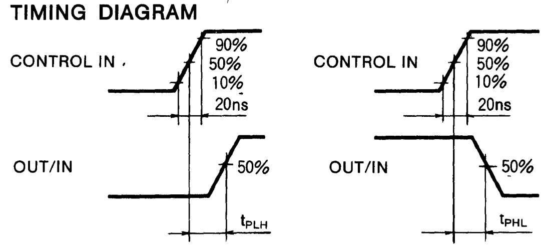
5 "L-H" and "H-L" output propagation time

(CONTROL IN-OUT/IN)

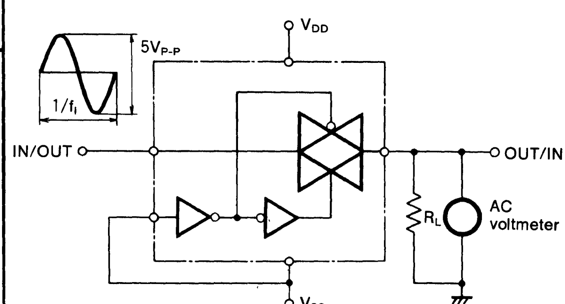


S_A=1, S_B=2 S_A=2, S_B=1

TIMING DIAGRAM

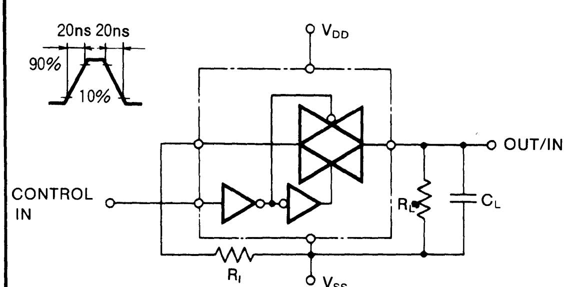


6 Feedthrough



The feedthrough is taken as that frequency f_I at which, using a sine-wave input of 2.5V_{P-P}, 20 $\log_{10}(V_O/V_I)$ = −50dB.

7 Crosstalk



M51320P

ANALOG SWITCH

DESCRIPTION

The M51320P is a semiconductor integrated circuit containing an analog switch designed for use in a video system. It contains two audio switches and one video switch. One of the audio switches has two inputs and the other, three. The video switch has two inputs. Each switch can be independently controlled. In addition, the video switch contains an amplifier with a gain of about 6.7dB.

FEATURES

- Video and stereo sound switches in one package
- Wide frequency range (video switch) ··········· DC~10MHz
- High separation (video)
  ································· Crosstalk 55dB(typ.) @5MHz

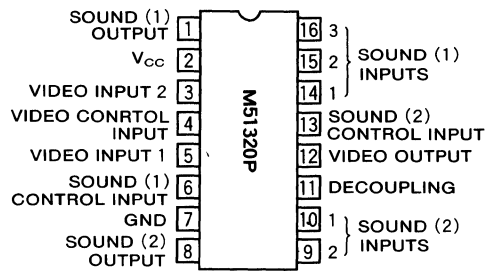
APPLICATION

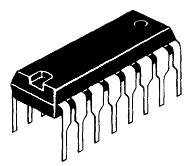
Video equipment.

RECOMMENDED OPERATING CONDITIONS

Supply voltage range ······································ 5~14V

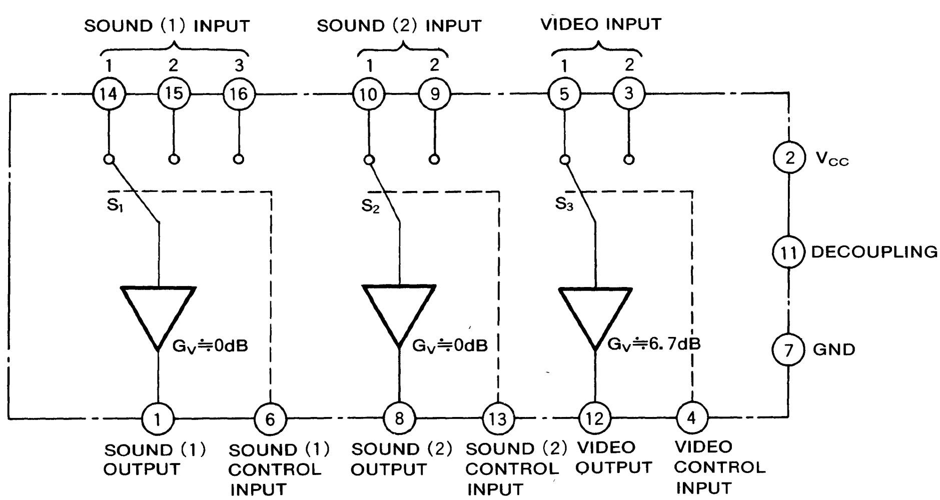
PIN CONFIGURATION (TOP VIEW)





16-pin molded plastic DIP

BLOCK DIAGRAM



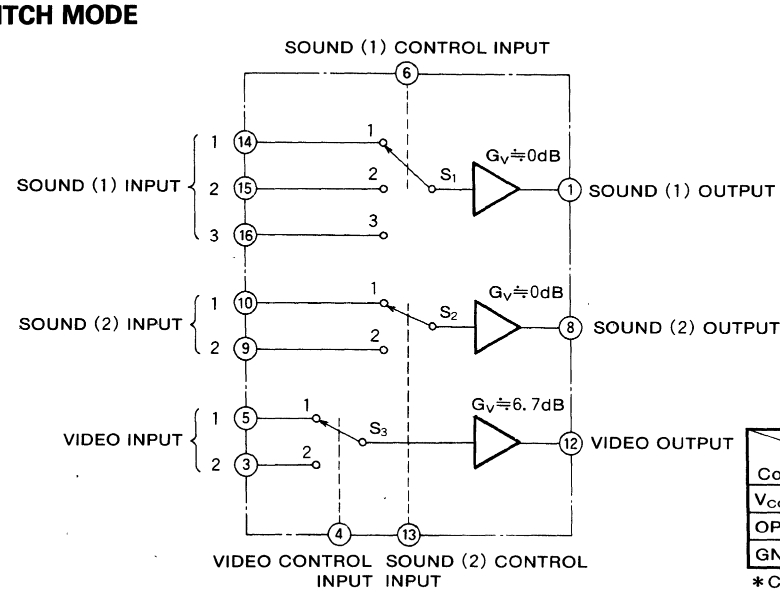
ABSOLUTE MAXIMUM RATINGS (T_a=25℃, V_{CC}=12V, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		14	V
V_{IS}	Input signal voltage	Sound	6	V
		Video	6	
V_{IC}	Input control voltage		V_{CC}	V
Pd	Power dissipation		1.25	W
K_θ	Thermal derating		12.5	mW/℃
T_{opr}	Operating temperature range		−20～+75	℃
T_{stg}	Storage temperature range		−40～+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=12V, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
I_{CC}	Circuit current			40	48	mA
$V_{I\,DC}$	Input bias voltage		3.8	4.2	4.6	V
$V_{O\,DC}$	Output bias voltage	Video	5.0	5.6	6.2	V
		Sound	3.0	3.6	4.2	
V_{OP}	Output DC offset voltage			15	100	mV
$V_{IC\,H}$	Control-pin threshold voltage	Sound (1) (Pin ⑥ 3-state input)	7.0	8.0	9.0	V
$V_{IC\,L}$		Sound (1) (Pin ⑥ 3-state input)	3.0	4.0	5.0	
V_{IC}		Sound (2) and video (Pins ④, ⑬)	1.7	2.1	2.5	
G_V	Voltage gain	Video, f=1MHz	5.7	6.7	7.7	dB
		Sound, f=1kHz	−0.5	−0.1		
THD	Total harmonic distortion	Sound, f=1kHz, V_O=1Vrms		0.02	0.2	%
V_N	Output noise voltage	Sound, R_g=600Ω, BW=15kHz		3	50	μVrms
		Video, R_g=75Ω, BW=10MHz		0.5	1.0	mVrms
CT	Crosstalk	Sound, f=1kHz	65	80		dB
		Video, f=5MHz	45	55		

SWITCH MODE



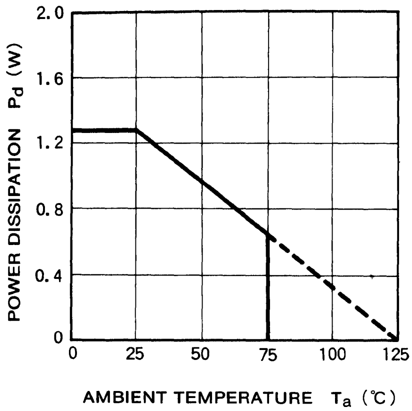
Control input \ Switch No.	S_1	S_2	S_3
V_{CC}	1	1	1
OPEN	2	*	*
GND	3	2	2

* Connect to V_{CC} or GND

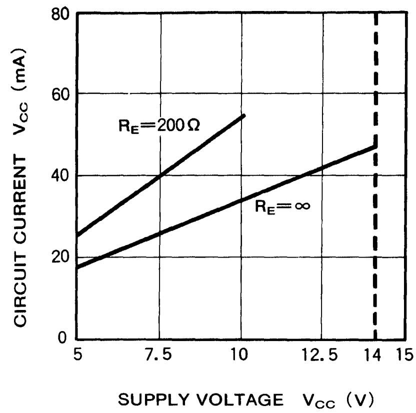
MITSUBISHI ELECTRIC

TYPICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

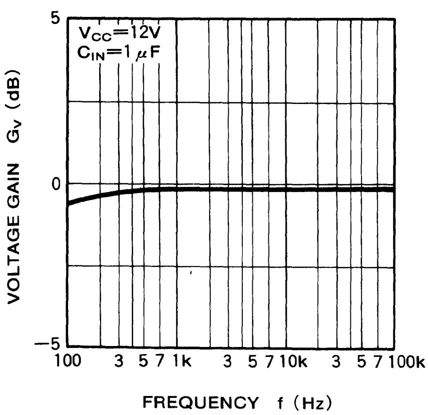
THERMAL DERATING (MAXIMUM RATING)



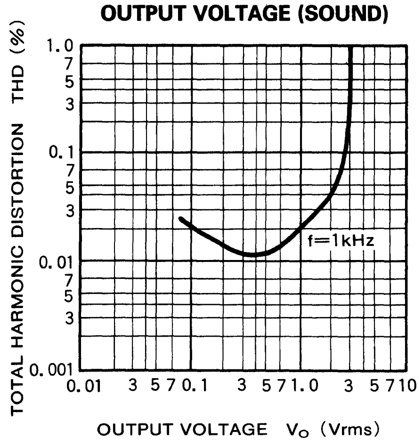
CIRCUIT CURRENT VS. SUPPLY VOLTAGE



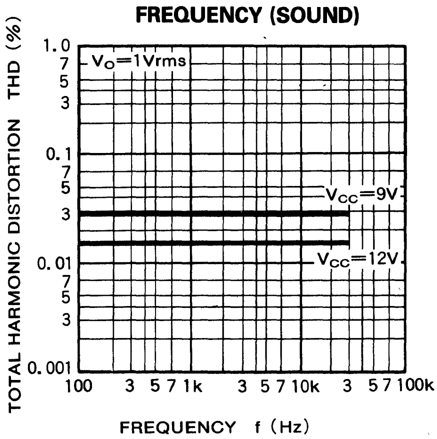
VOLTAGE GAIN VS. FREQUENCY (SOUND)



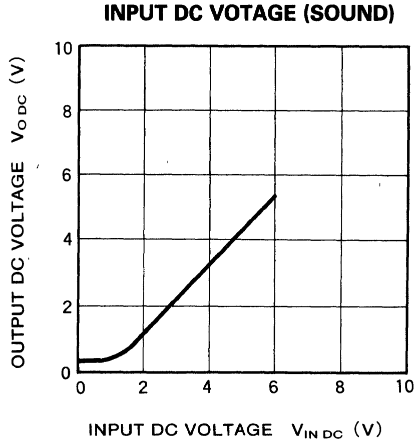
TOTAL HARMONIC DISTORTION VS. OUTPUT VOLTAGE (SOUND)



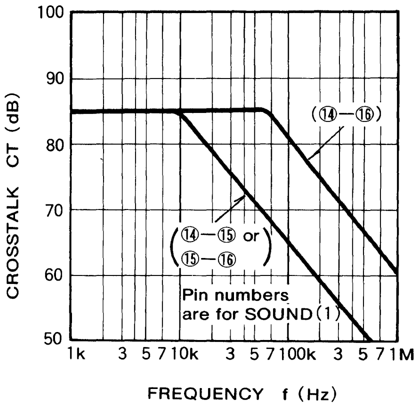
TOTAL HARMONIC DISTORTION VS. FREQUENCY (SOUND)



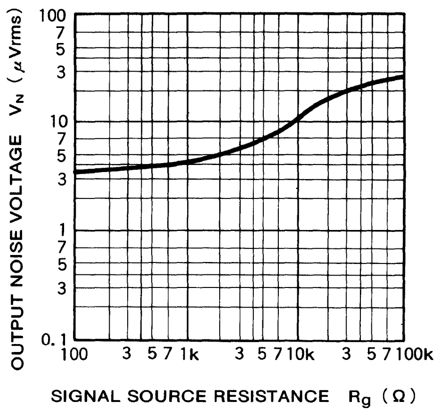
OUTPUT DC VOLTAGE VS. INPUT DC VOTAGE (SOUND)



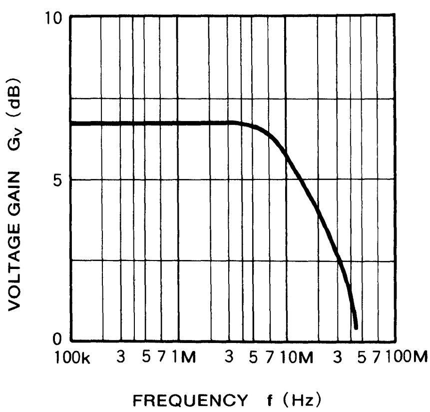
CROSSTALK VS. FREQUENCY (SOUND)



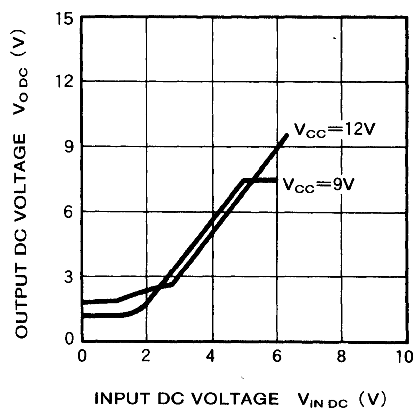
OUTPUT NOISE VOLTAGE VS. SIGNAL SOURCE RESISTANCE (SOUND)



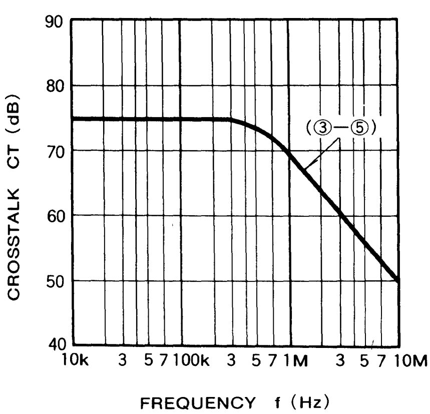
VOLTAGE GAIN VS. FREQUENCY (VIDEO)



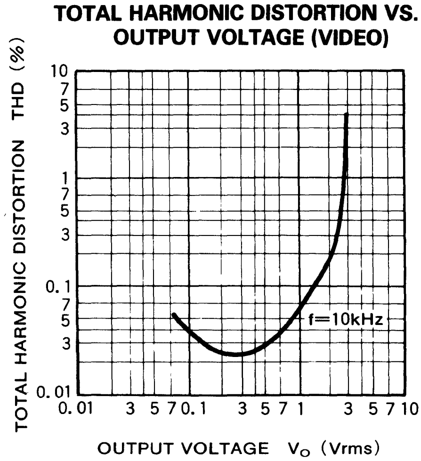
OUTPUT DC VOLTAGE VS. INPUT DC VOLTAGE (VIDEO)



CROSSTALK VS. FREQUENCY (VIDEO)

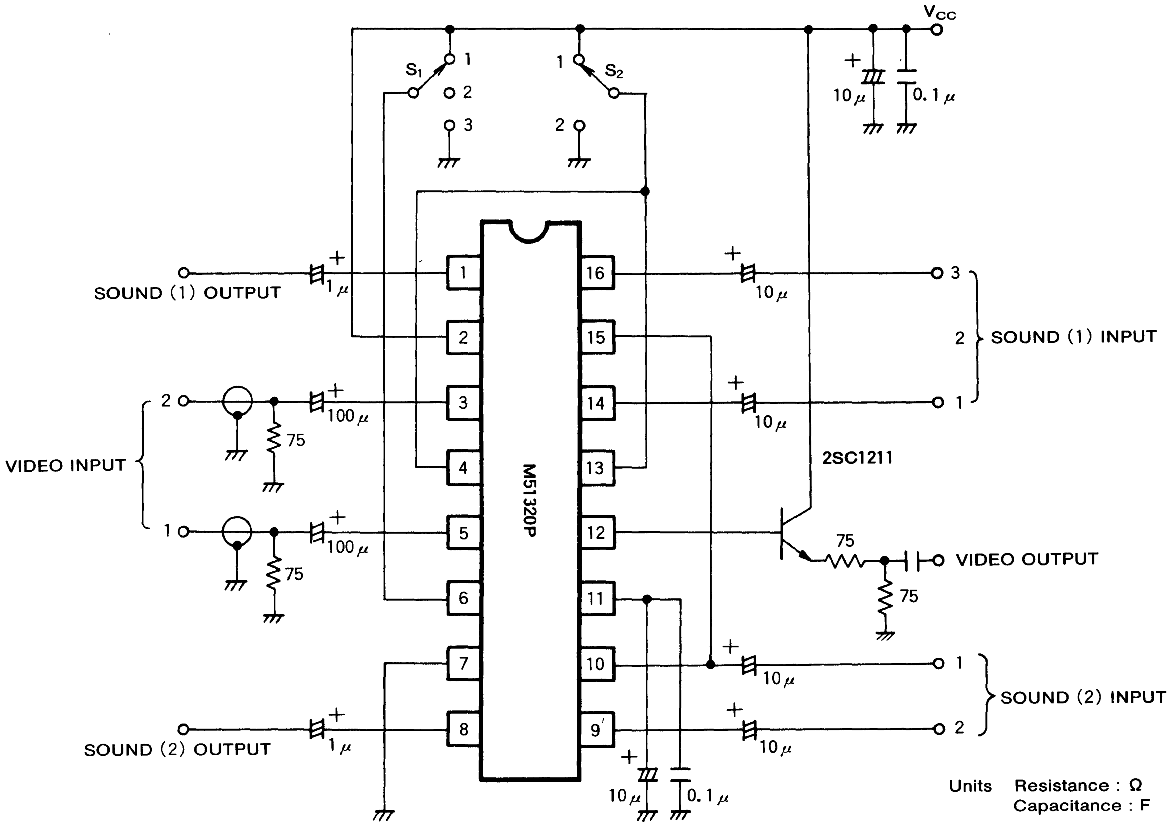


TOTAL HARMONIC DISTORTION VS. OUTPUT VOLTAGE (VIDEO)



MITSUBISHI ELECTRIC

APPLICATION EXAMPLE

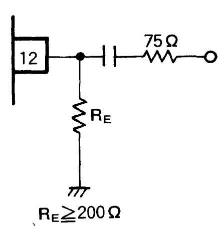


PRECAUTIONS FOR USE

When the video output is sent through a 75Ω output and the supply voltage of 12V is used, and external transistor buffer such as the one shown in the above diagram should be connected to maintain a balance with the power dissipation of the package.

Should 9V be the sole supply voltage, a direct drive arrangement can be used as in the diagram at right by connecting resistor R_E between the output pin and ground.

Since an emitter-follower output is used in the video and sound outputs, when the external wiring is long or a capacitive load is connected, a resistor with a value of several tens of ohms should be connected at a position near the output pin.



M51321P

ANALOG SWITCH

DESCRIPTION

The M51321P is a semiconductor integrated circuit containing an analog switch designed for use in a video system. It contains two audio switches and one video switch. Each switch has three inputs and can be undependently controlled. In addition, the video switch contains an amplifier with a gain of about 6.7dB.

FEATURES

- Video and stereo sound switches in one package
- Wide frequency range (video switch) ·········· DC~10MHz
- High separation (video)··· Crosstalk 55dB(typ.) (@5MHz)

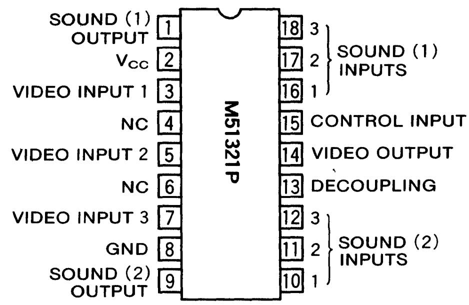
APPLICATION

Video equipment.

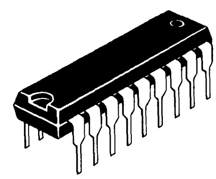
RECOMMENDED OPERATING CONDITIONS

Supply voltage range ····································· 5~14V

PIN CONFIGURATION (TOP VIEW)

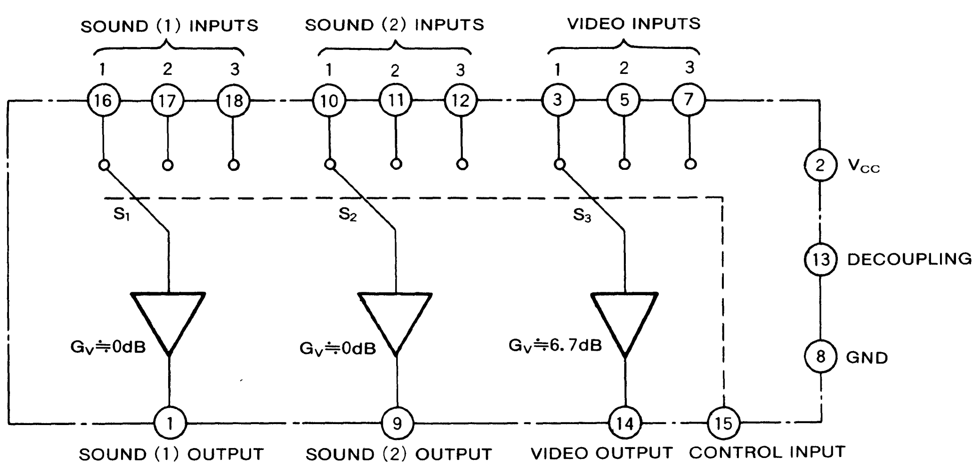


NC : NO CONNECTION



18-pin molded plastic DIP

BLOCK DIAGRAM



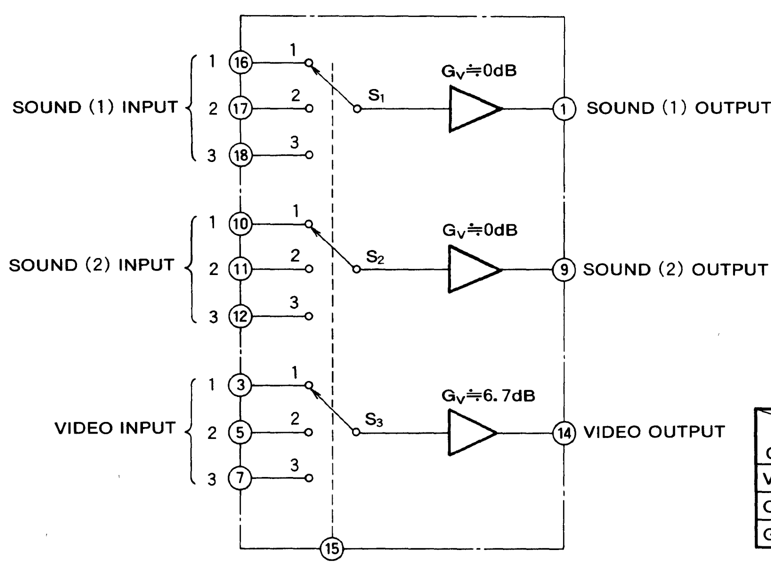
ABSOLUTE MAXIMUM RATINGS (T_a=25℃, V_{CC}=12V, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		14	V
V_{IS}	Input signal voltage	Sound	6	V
		Video	6	
V_{IC}	Input control voltage		V_{CC}	V
Pd	Power dissipation		1.25	W
K_θ	Thermal derating		12.5	mW/℃
T_{opr}	Operating temperature range		−20～+75	℃
T_{stg}	Storage temperature range		−40～+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=12V, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
I_{CC}	Circuit current			39	48	mA
$V_{I\,DC}$	Input bias voltage		3.8	4.2	4.6	V
$V_{O\,DC}$	Output bias voltage	Video	5.0	5.6	6.2	V
		Sound	3.0	3.6	4.2	
V_{OP}	Output DC offset voltage			15	100	mV
$V_{IC\,H}$	Control-pin threshold voltage		7.0	8.0	9.0	V
$V_{IC\,L}$			3.0	4.0	5.0	V
G_V	Voltage gain	Video, f=1MHz	5.7	6.7	7.7	dB
		Sound, f=1kHz	−0.5	−0.1		
THD	Total harmonic distortion	Sound, f=1kHz, V_O=1Vrms		0.02	0.2	%
V_N	Output noise voltage	Sound, R_g=600Ω, BW=15kHz		3	50	μVrms
		Video, R_g=75Ω, BW=10MHz		0.5	1.0	mVrms
CT	Crosstalk	Sound, f=1kHz	65	80		dB
		Video, f=5MHz	45	55		

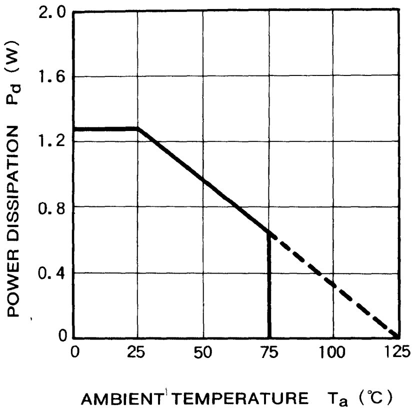
SWITCH MODE



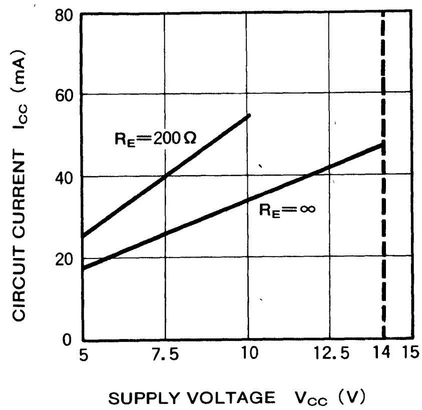
Control input \ Switch No.	S_1	S_2	S_3
V_{CC}	1	1	1
OPEN	2	2	2
GND	3	3	3

TYPICAL CHARACTERISTICS (T_a=25°C, unless otherwise noted)

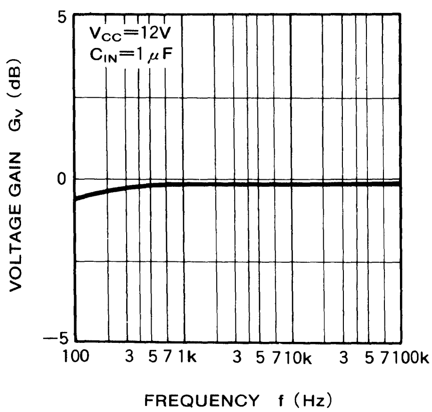
THERMAL DERATING (MAXIMUM RATING)



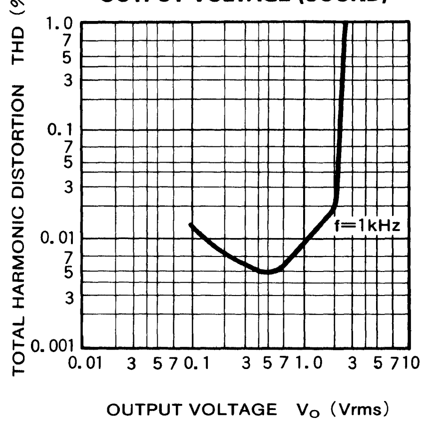
CIRCUIT CURRENT VS. SUPPLY VOLTAGE



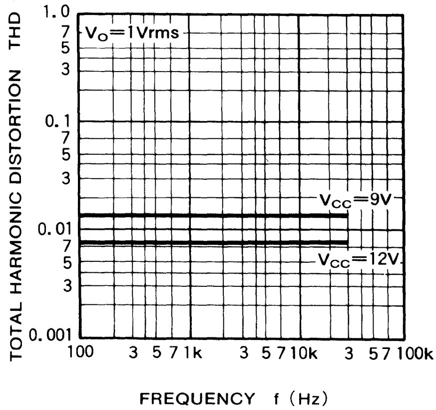
VOLTAGE GAIN VS. FREQUENCY (SOUND)



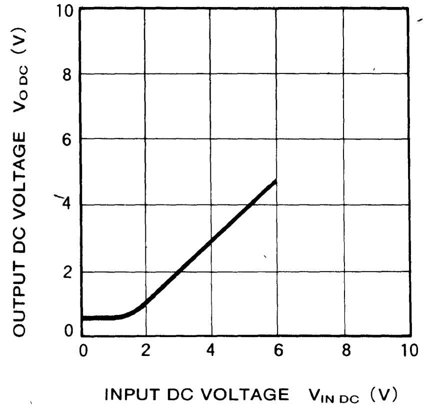
TOTAL HARMONIC DISTORTION VS. OUTPUT VOLTAGE (SOUND)



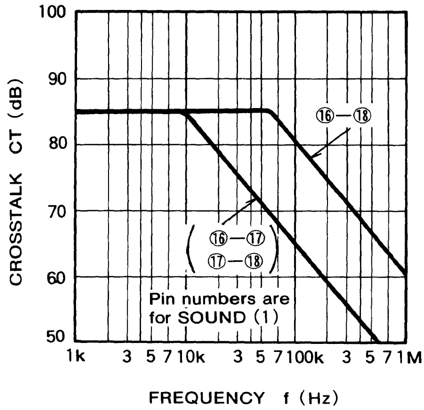
TOTAL HARMONIC DISTORTION VS. FREQUENCY (SOUND)



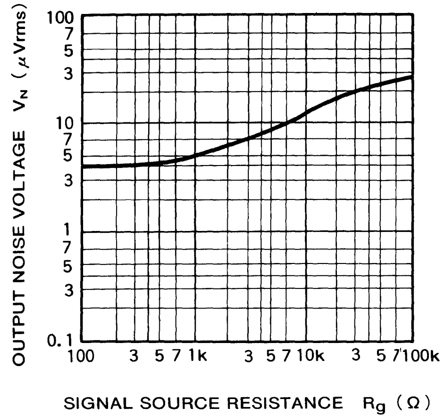
OUTPUT DC VOLTAGE VS. INPUT DC VOLTAGE (SOUND)



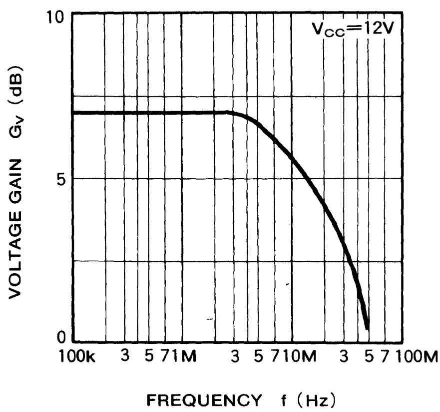
CROSSTALK VS. FREQUENCY (SOUND)



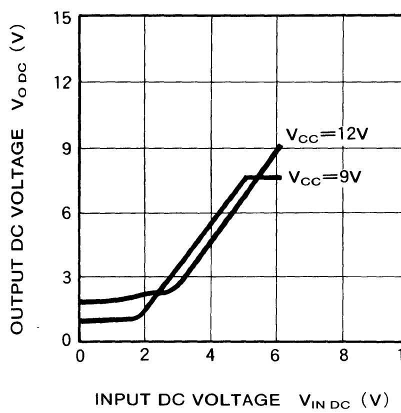
OUTPUT NOISE VOLTAGE VS. SIGNAL SOURCE RESISTANCE (SOUND)



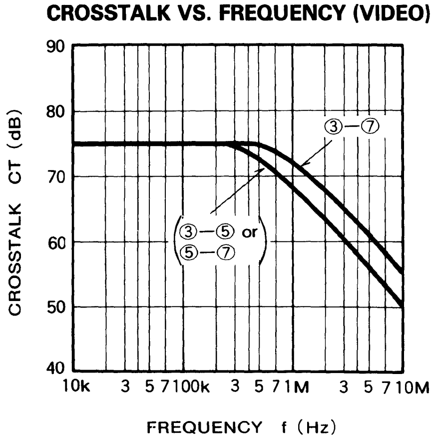
VOLTAGE GAIN VS. FREQUENCY (VIDEO)



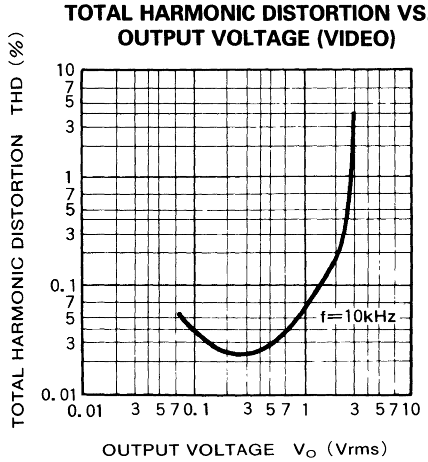
OUTPUT DC VOLTAGE VS. INPUT DC VOLTAGE (VIDEO)



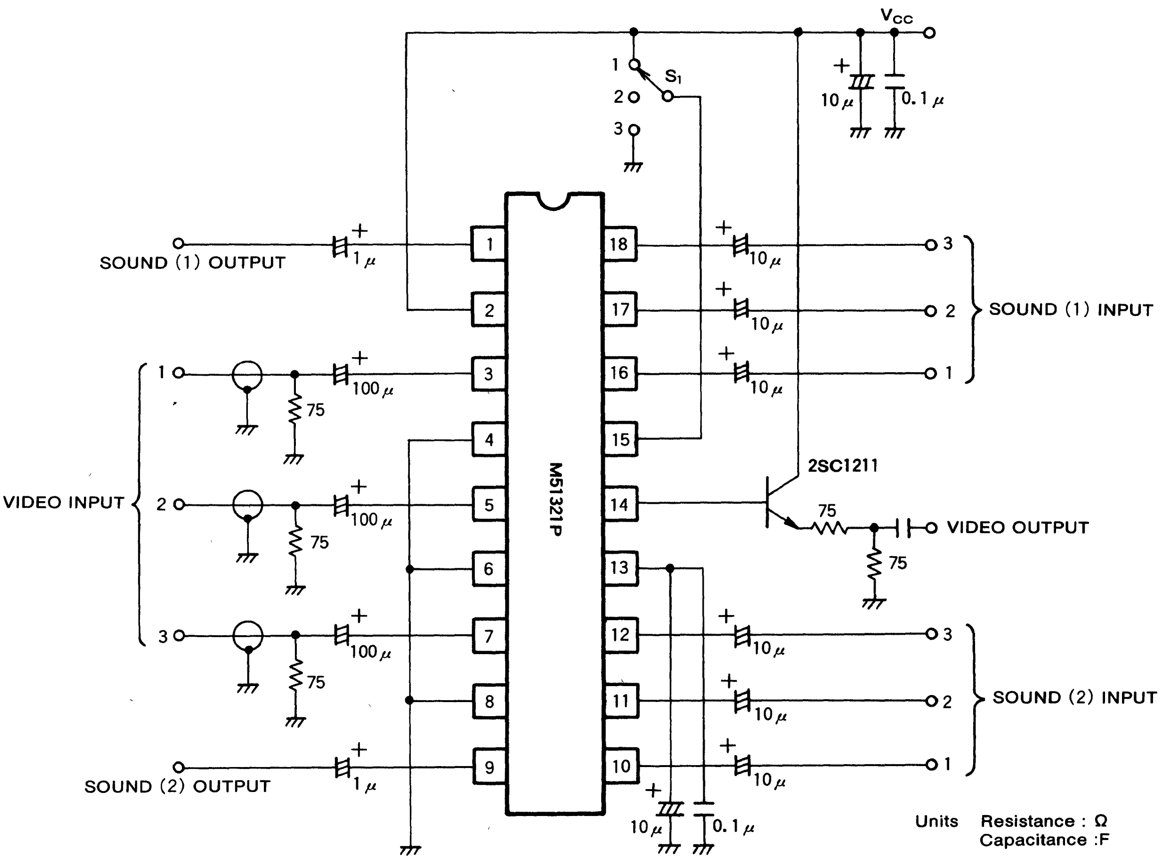
CROSSTALK VS. FREQUENCY (VIDEO)



TOTAL HARMONIC DISTORTION VS. OUTPUT VOLTAGE (VIDEO)



APPLICATION EXAMPLE

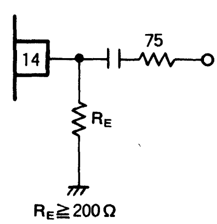


PRECAUTIONS FOR USE

When the video output is sent throuth a 75Ω output and the supply voltage of 12V is used, and external transistor buffer such as the one shown in the above diagram should be connected to maintain a balance with the power dissipation of the package.

Should 9V be the sole supply voltage, a direct drive arrangement can be used as in the diagram at right by connecting resistor R_E between the output pin and ground.

Since an emitter-follower output is used in the video and sound outputs, when the external wiring is long or a capacitive load is connected, a resistor with a value of several tens of ohms should be connected at a position near the output pin.



M51326P

ANALOG SWITCH

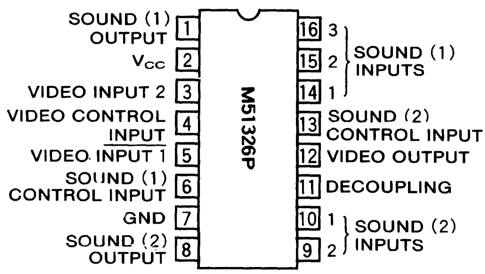
DESCRIPTION
The M51326P is a semiconductor integrated circuit containing an analog switch designed for use in a video system. It contains two audio switches and one video switch. One of the audio switches has two inputs and the other, three. The video switch has two inputs. Each switch can be independently controlled.

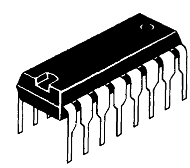
FEATURES
- Video and stereo sound switches in one package
- Wide frequency range (video switch) ··········· DC~10MHz
- High separation (video) ·································· Crosstalk 55dB(typ.) @5MHz

APPLICATION
Video equipment.

RECOMMENDED OPERATING CONDITIONS
Supply voltage range ······································ 5~14V

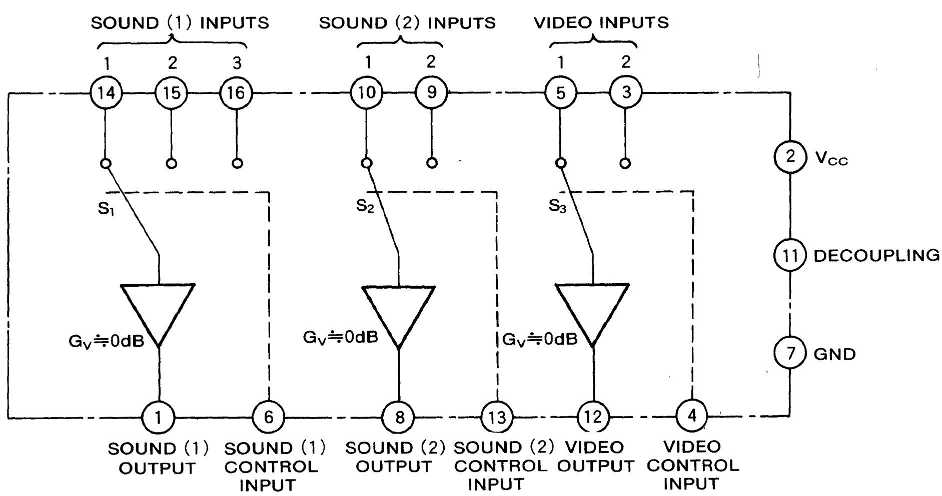
PIN CONFIGURATION (TOP VIEW)





16-pin molded plastic DIP

BLOCK DIAGRAM



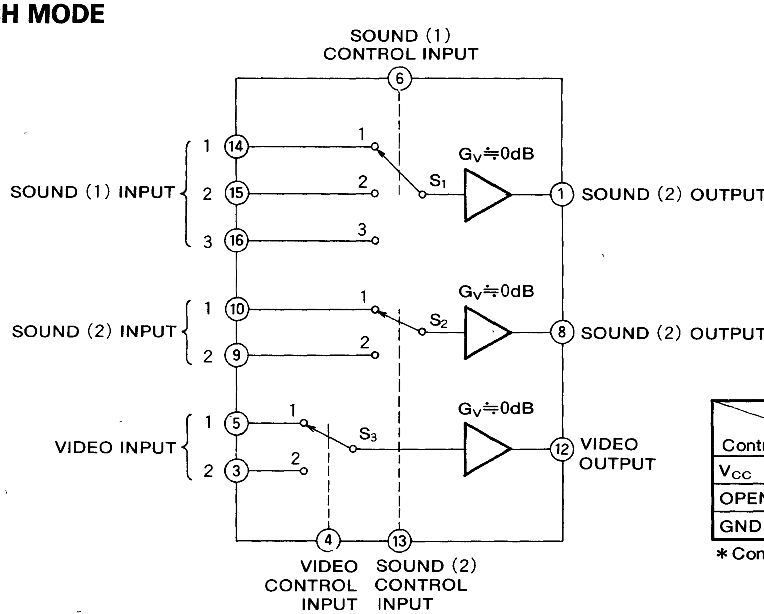
ABSOLUTE MAXIMUM RATINGS (T_a=25℃, V_{CC}=12V, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		14	V
V_{IS}	Input signal voltage		6	V
V_{IC}	Input control voltage		V_{CC}	V
Pd	Power dissipation		1.25	W
$K\theta$	Thermal derating		12.5	mW/℃
T_{opr}	Operating temperature range		−20～+75	℃
T_{stg}	Storage temperature range		−40～+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=12V, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
I_{CC}	Circuit current			28	36	mA
$V_{I\ DC}$	Input bias voltage		3.8	4.2	4.6	V
$V_{O\ DC}$	Output bias voltage		3.0	3.6	4.2	V
V_{OP}	Output DC offset voltage			15	100	mV
$V_{IC\ H}$	Control-pin threshold voltage	Sound (1) (pin ⑥ 3-state input)	7.0	8.0	9.0	V
$V_{IC\ L}$		Sound (1) (pin ⑥ 3-state input)	3.0	4.0	5.0	V
V_{IC}		Sound (2) and video (pins ④, ⑬)	1.7	2.1	2.5	V
G_V	Voltage gain	f=1kHz	−0.5	−0.1		dB
THD	Total harmonic distortion	Sound, f=1kHz, V_O=1Vrms		0.02	0.2	%
V_N	Output noise voltage	Sound, R_g=600Ω, BW=15kHz		3	50	μVrms
		Video, R_g=75Ω, BW=10MHz		0.5	1.0	mVrms
CT	Crosstalk	Sound, f=1kHz	65	80		dB
		Video, f=5MHz	45	55		

SWITCH MODE

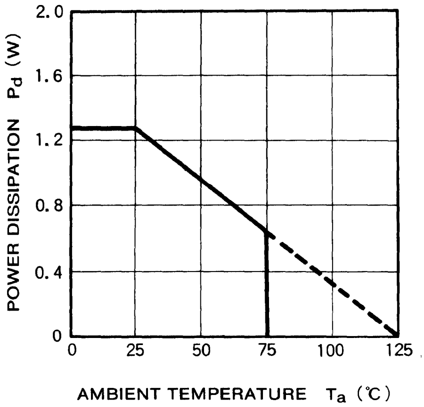


Control input \ Switch No.	S_1	S_2	S_3
V_{CC}	1	1	1
OPEN	2	*	*
GND	3	2	2

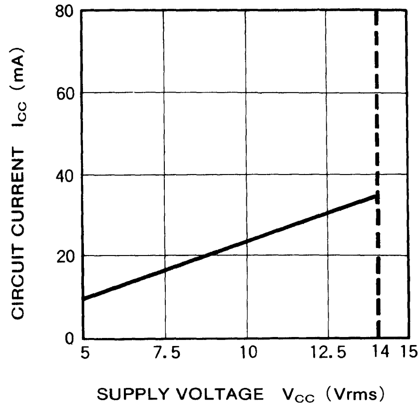
* Connect to V_{CC} or GND

TYPICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

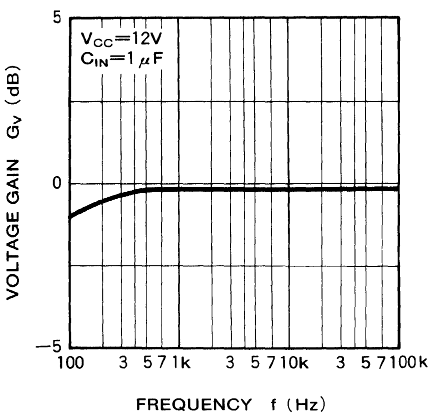
THERMAL DERATING (MAXIMUM RATING)



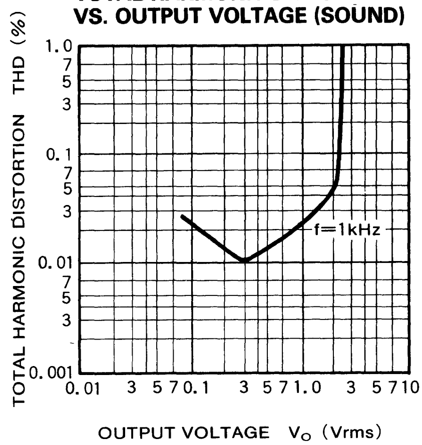
CIRCUIT CURRENT VS. SUPPLY VOLTAGE



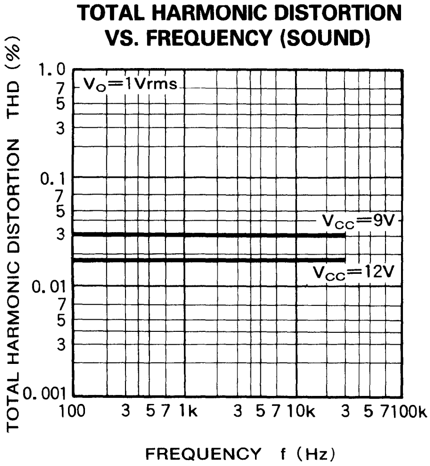
VOLTAGE GAIN VS. FREQUENCY (SOUND)



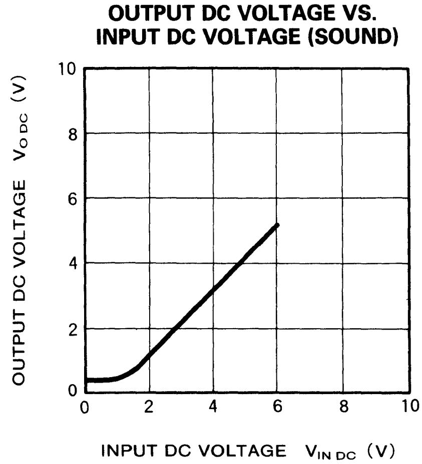
TOTAL HARMONIC DISTORTION VS. OUTPUT VOLTAGE (SOUND)



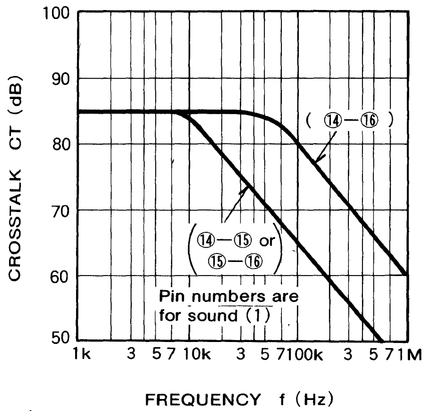
TOTAL HARMONIC DISTORTION VS. FREQUENCY (SOUND)



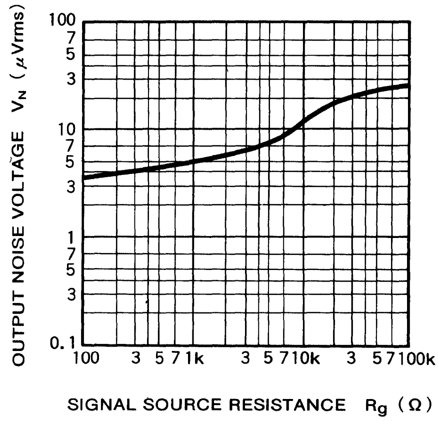
OUTPUT DC VOLTAGE VS. INPUT DC VOLTAGE (SOUND)



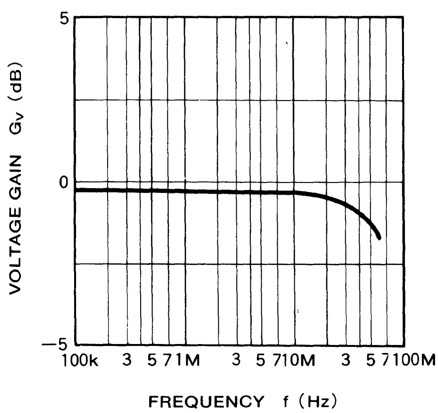
CROSSTALK VS. FREQUENCY (SOUND)



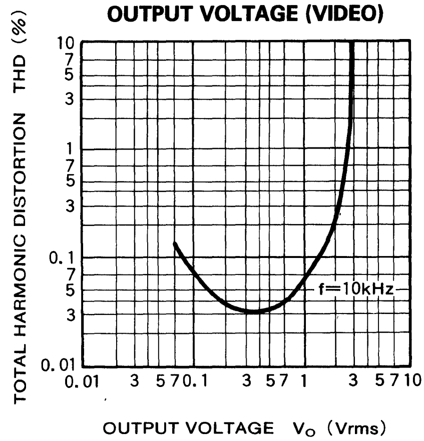
OUTPUT NOISE VOLTAGE VS SIGNAL SOURCE RESISTANCE (SOUND)



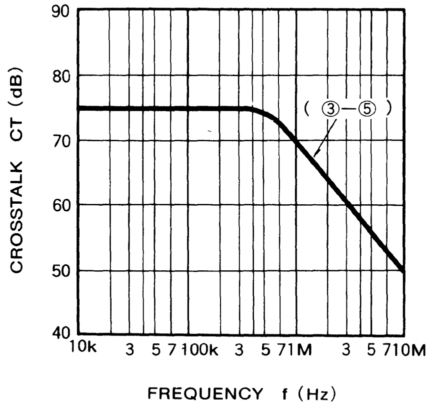
VOLTAGE GAIN VS. FREQUENCY (VIDEO)



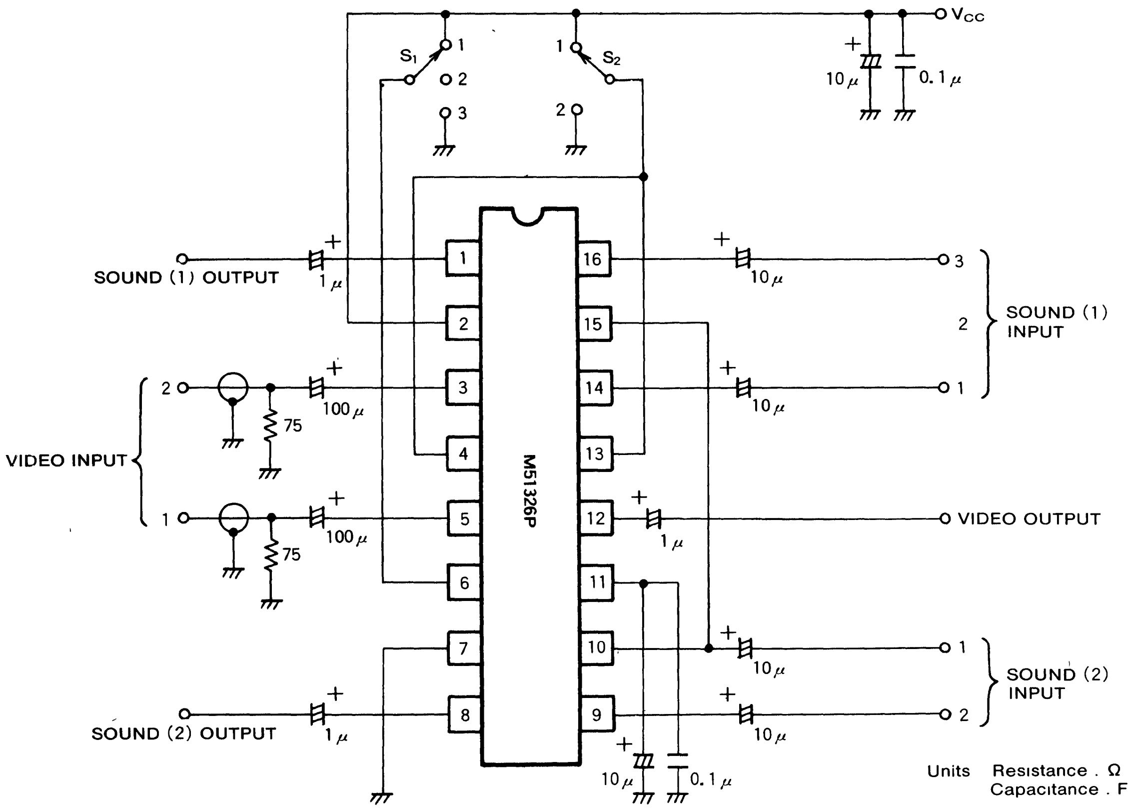
TOTAL HARMONIC DISTORTION VS. OUTPUT VOLTAGE (VIDEO)



CROSSTALK VS. FREQUENCY (VIDEO)



APPLICATION EXAMPLE



PRECAUTIONS FOR USE

Since an emitter-follower output is used in the video and sound outputs, when the external wiring is long or a capacitive load is connected, a resistor with a value of several tens of ohms should be connected at a position near the output pin.

M51327P

DESCRIPTION

The M51327P is a semiconductor integrated circuit containing an analog switch designed for use in a video system. It contains two audio switches and one video switch. Each switch has three inputs and can be independently controlled.

FEATURES

- Video and stereo sound switches in one package
- Wide frequency range (video switch) ·········· DC~10MHz
- High separation (video) ······ Crosstalk 55dB(typ.) @5MHz

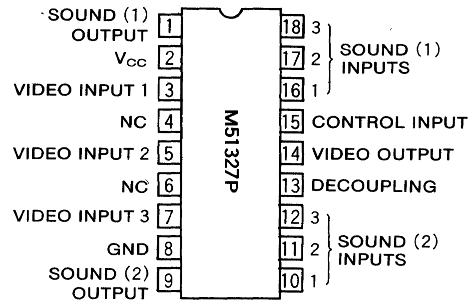
APPLICATION

Video equipment.

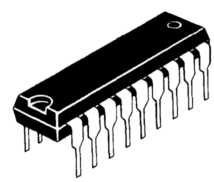
RECOMMENDED OPERATING CONDITIONS

Supply voltage range ······································ 5~14V

PIN CONFIGURATION (TOP VIEW)

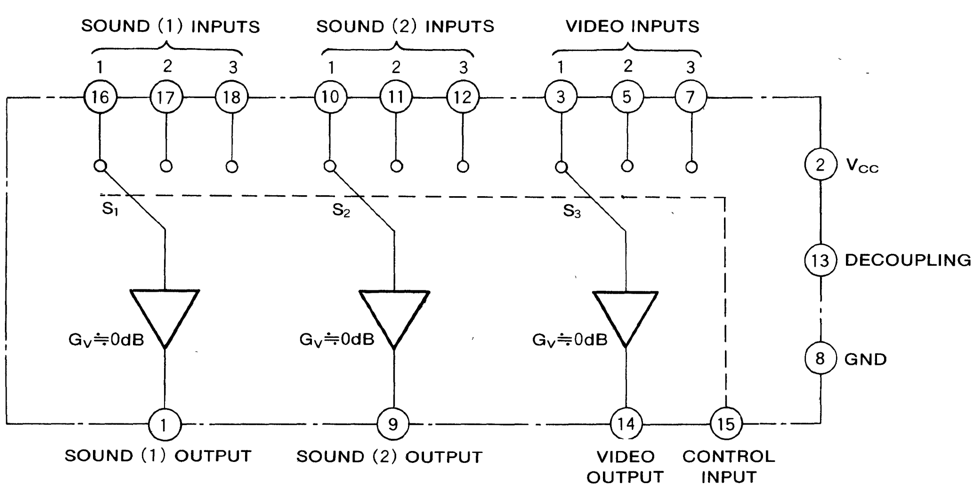


NC NO CONNECTION



18-pin molded plastic DIP

BLOCK DIAGRAM



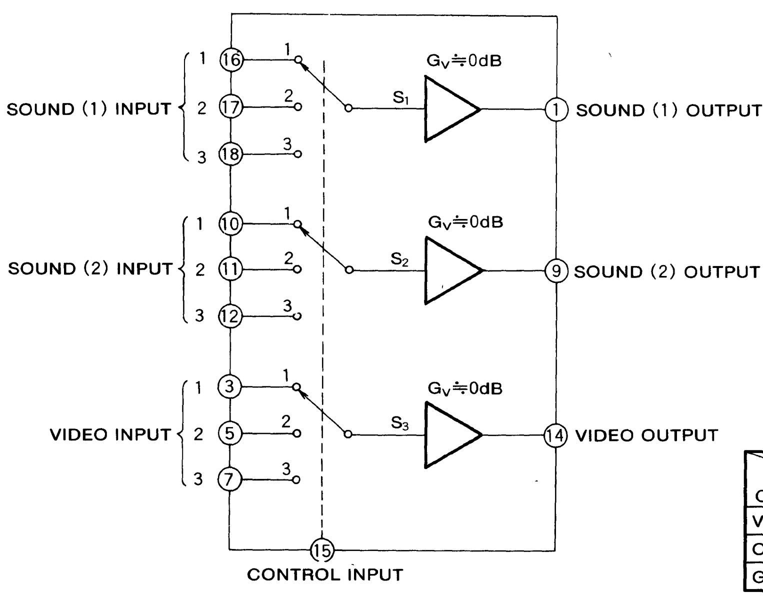
ABSOLUTE MAXIMUM RATINGS (T_a=25℃, V_{CC}=12V, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		14	V
V_{IS}	Input signal voltage		6	V
V_{IC}	Input control voltage		V_{CC}	V
Pd	Power dissipation		1.25	W
$K\theta$	Thermal derating		12.5	mW/℃
T_{opr}	Operating temperature range		−20～+75	℃
T_{stg}	Storage temperature range		−40～+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=12V, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
I_{CC}	Circuit current			28	36	mA
$V_{I\ DC}$	Input bias voltage		3.8	4.2	4.6	V
$V_{O\ DC}$	Output bias voltage		3.0	3.6	4.2	V
V_{OP}	Output DC offset voltage			15	100	mV
$V_{IC\ H}$	Control-pin threshold voltage		7.0	8.0	9.0	V
$V_{IC\ L}$			3.0	4.0	5.0	V
G_V	Voltage gain	Sound, f=1kHz	−0.5	−0.1		dB
THD	Total harmonic distortion	Sound, f=1kHz, V_O=1Vrms		0.02	0.2	%
V_N	Output noise voltage	Sound, R_g=600Ω, BW=15kHz		3	50	μVrms
		Video, R_g=75Ω, BW=10MHz		0.5	1.0	mVrms
CT	Crosstalk	Sound, f=1kHz	65	80		dB
		Video, f=5MHz	45	55		

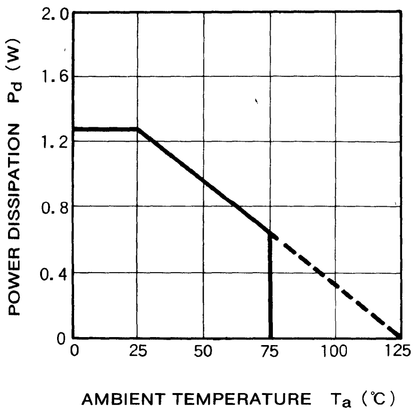
SWITCH MODE



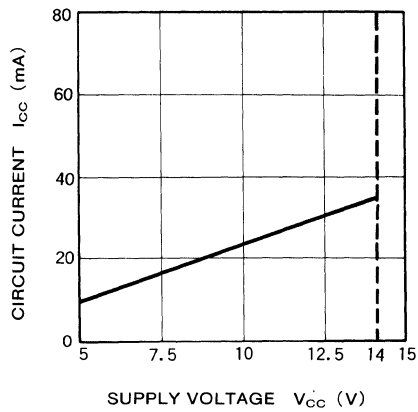
Control input \ Switch No.	S1	S2	S3
V_{CC}	1	1	1
OPEN	2	2	2
GND	3	3	3

TYPICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

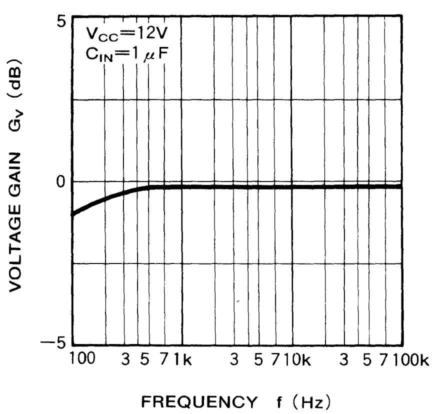
THERMAL DERATING (MAXIMUM RATING)



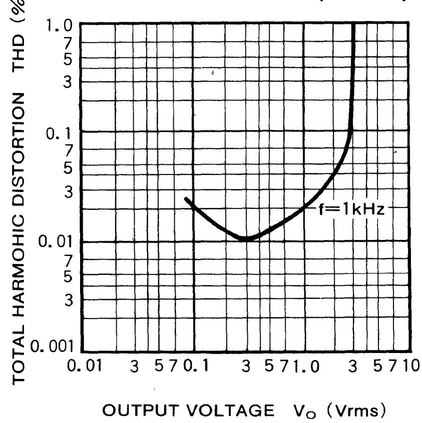
CIRCUIT CURRENT VS. SUPPLY VOLTAGE



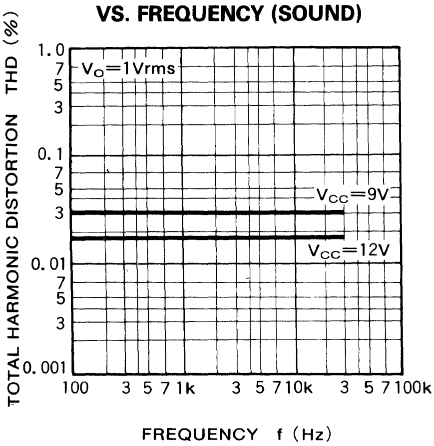
VOLTAGE GAIN VS. FREQUENCY (SOUND)



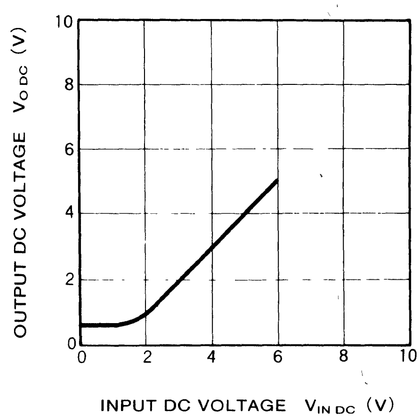
TOTAL HARMONIC DISTORTION VS. OUTPUT VOLTAGE (SOUND)



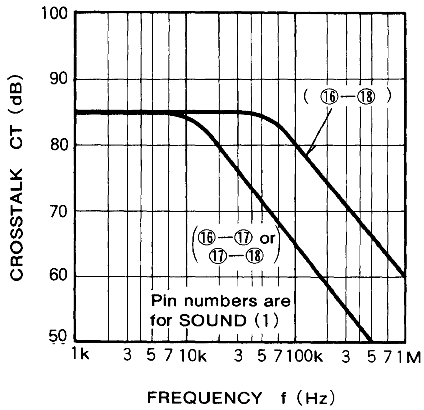
TOTAL HARMONIC DISTORTION VS. FREQUENCY (SOUND)



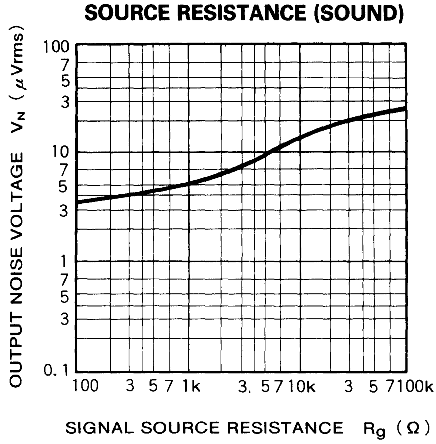
OUTPUT DC VOLTAGE VS. INPUT DC VOLTAGE (SOUND)



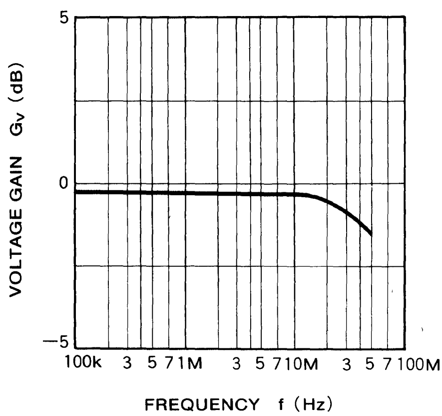
CROSSTALK VS. FREQUENCY (SOUND)



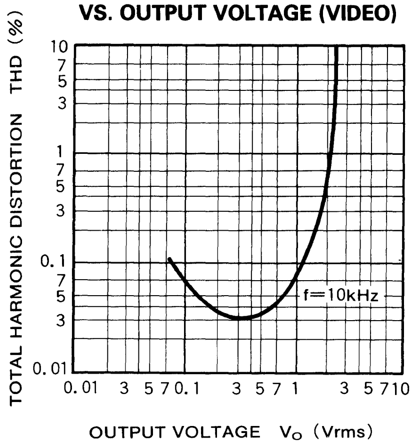
OUTPUT NOISE VOLTAGE VS. SIGNAL SOURCE RESISTANCE (SOUND)



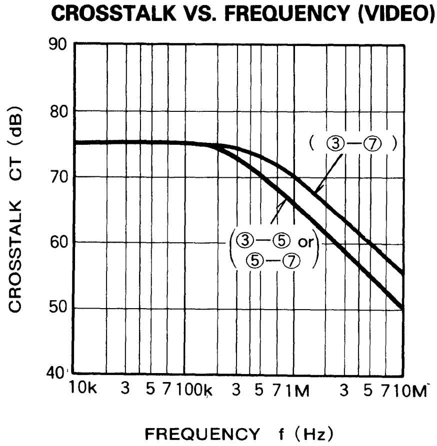
VOLTAGE GAIN VS. FREQUENCY (VIDEO)



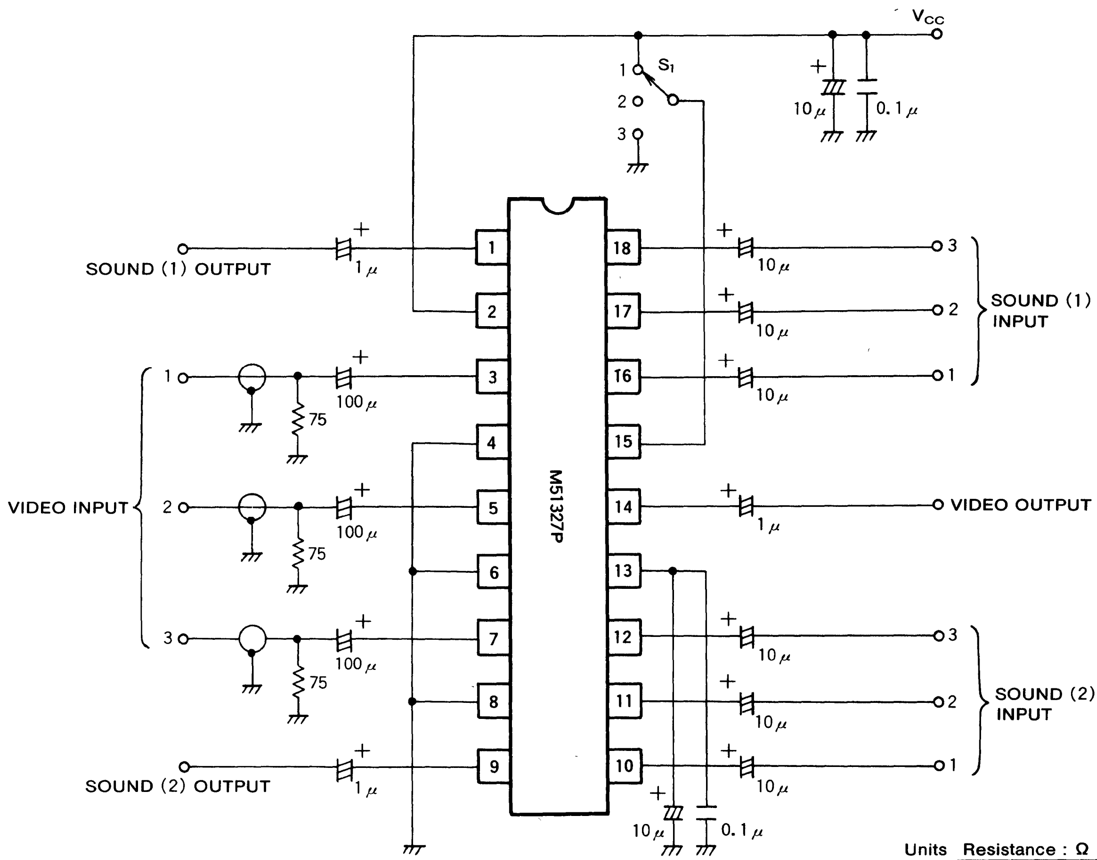
TOTAL HARMONIC DISTORTION VS. OUTPUT VOLTAGE (VIDEO)



CROSSTALK VS. FREQUENCY (VIDEO)



APPLICATION EXAMPLE



Units Resistance : Ω
Capacitance : F

PRECAUTIONS FOR USE

Since an emitter-follower output is used in the video and sound outputs, when the external wiring is long or a capacitive load is connected, a resistor with a value of several tens of ohms should be connected at a position near the output pin.

MITSUBISHI
ELECTRIC

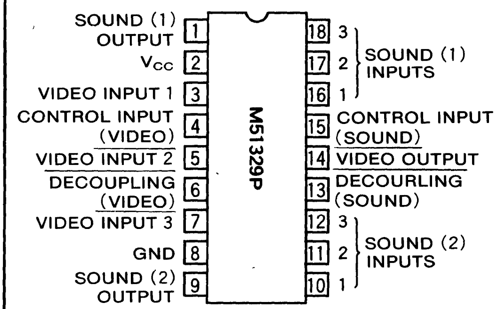
DESCRIPTION
The M51329P is a semiconductor integrated circuit containing an analog switch designed for use in a video system. It contains two audio switches and one video switch. Each switch has three inputs and can be independently controlled in each of the audio and the video sections. In addition, the video switch contains an amplifier with a gain of about 6.7dB.

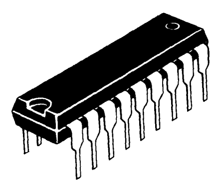
FEATURES
- Video and stereo sound switches in one package
- Wide frequency range (video switch) ·········· DC~10MHz
- High separation (video) ································ Crosstalk 55dB(typ.) @5MHz

APPLICATION
Video equipment.

RECOMMENDED OPERATING CONDITIONS
Supply voltage range ···································· 5~14V

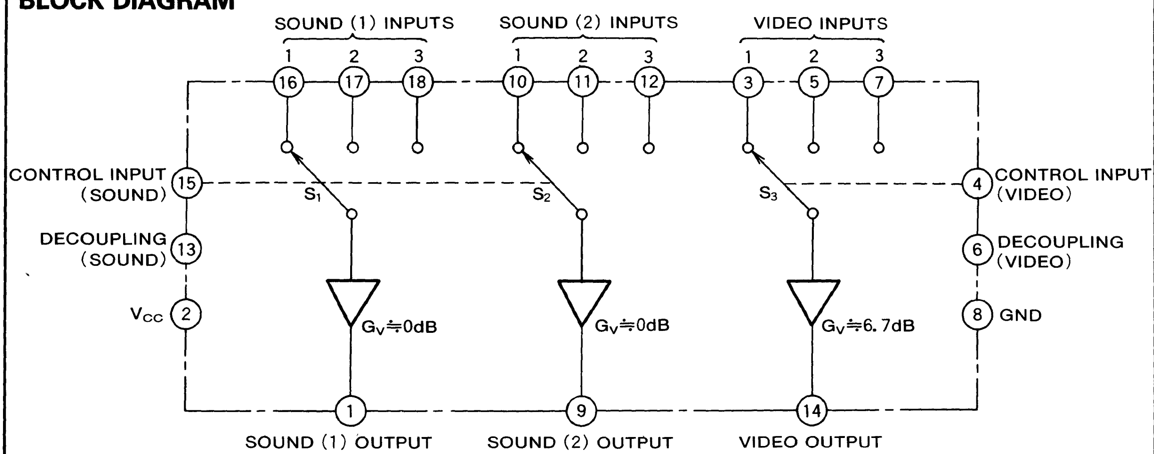
PIN CONFIGURATION (TOP VIEW)





18-pin molded plastic DIP

BLOCK DIAGRAM



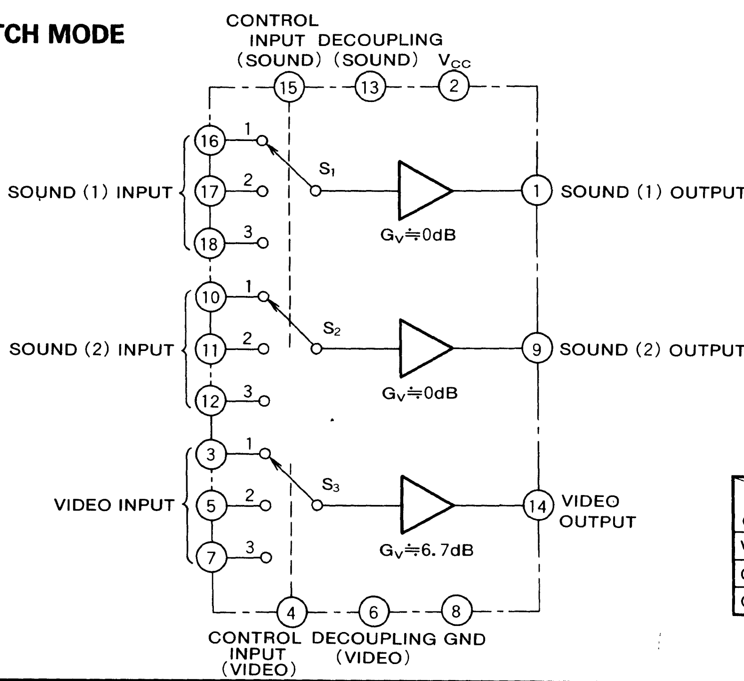
ABSOLUTE MAXIMUM RATINGS (T_a=25℃, V_{CC}=12V, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		14	V
V_{IS}	Input signal voltage	Sound	6	V
		Video	6	
V_{IC}	Input control voltage		V_{CC}	V
Pd	Power dissipation		1.25	W
K_θ	Thermal derating		12.5	mW/℃
T_{opr}	Operating temperature range		−20～+75	℃
T_{stg}	Storage temperature range		−40～+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=12V, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
I_{CC}	Circuit current			44	56	mA
$V_{I\ DC}$	Input bias voltage		3.8	4.2	4.6	V
$V_{O\ DC}$	Output bias voltage	Video	5.0	5.6	6.2	V
		Sound	3.0	3.6	4.2	
V_{OP}	Output DC offset voltage			15	100	mV
$V_{IC\ H}$	Control-pin threshold voltage		7.0	8.0	9.0	V
$V_{IC\ L}$			3.0	4.0	5.0	V
G_V	Voltage gain	Video, f=1MHz	5.7	6.7	7.7	dB
		Sound, f=1kHz	−0.5	−0.1		
R_I	Input resistance	Sound, f=1kHz		22		kΩ
		Video, f=5MHz		11		
C_I	Input capacitance	Video, f=5MHz		4		pF
THD	Total harmonic distortion	Sound, f=1kHz, V_O=1Vrms		0.02	0.2	%
V_N	Output noise voltage	Video, R_g=75Ω, BW=10MHz		0.5	1.0	mVrms
		Sound, R_g=600Ω, BW=15kHz		3	50	μVrms
CT	Crosstalk	Sound, f=1kHz	65	80		dB
		Video, f=5MHz	45	55		

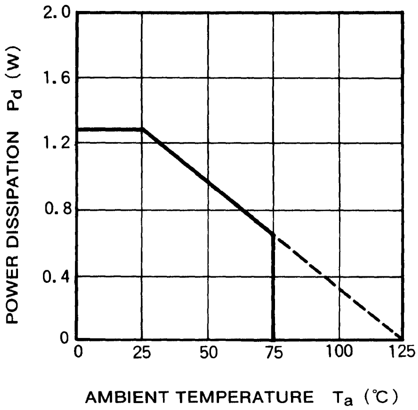
SWITCH MODE



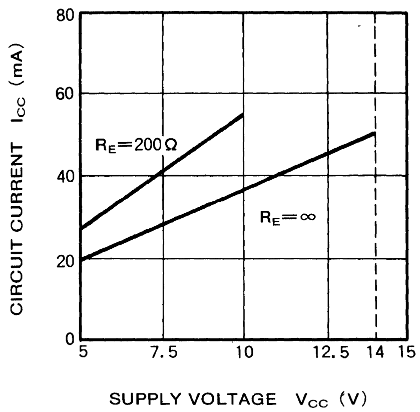
Control input \ Switch No.	Sound S_1	Sound S_2	Video S_3
V_{CC}	1		1
OPEN	2		2
GND	3		3

TYPICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

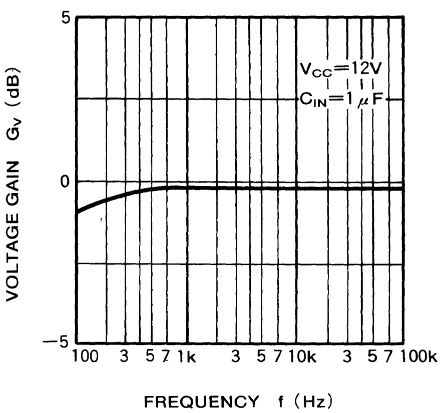
THERMAL DERATING (MAXIMUM RATING)



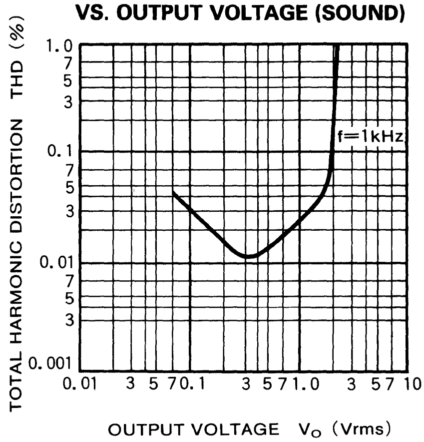
CIRCUIT CURRENT VS. SUPPLY VOLTAGE



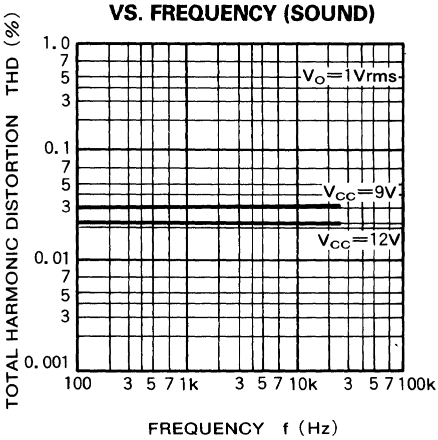
VOLTAGE GAIN VS. FREQUENCY (SOUND)



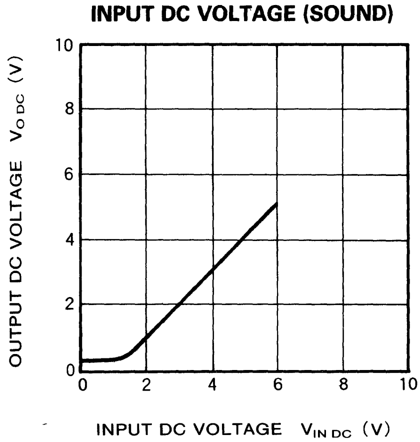
TOTAL HARMONIC DISTORTION VS. OUTPUT VOLTAGE (SOUND)

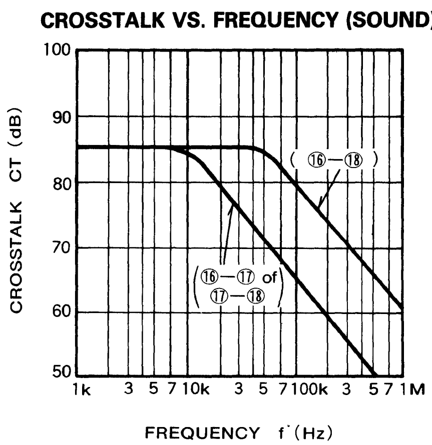


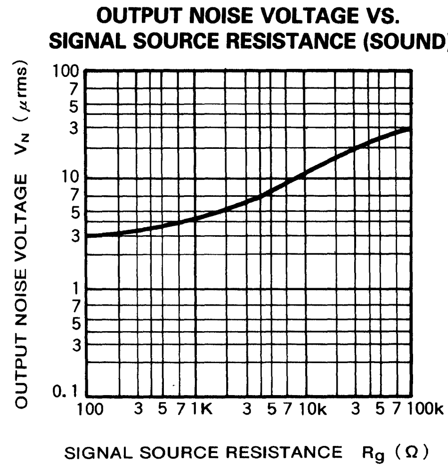
TOTAL HARMONIC DISTORTION VS. FREQUENCY (SOUND)

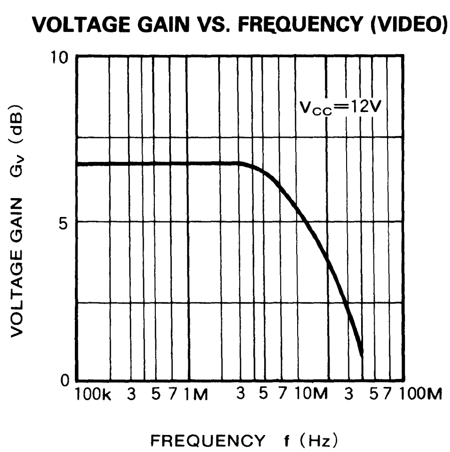


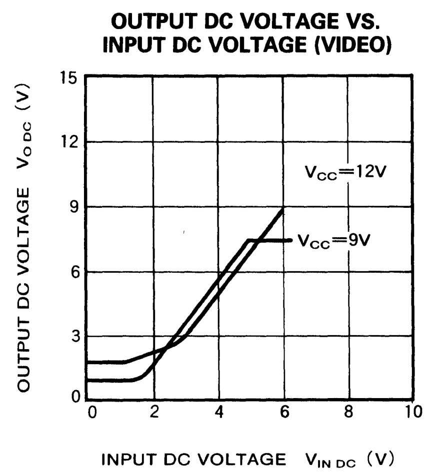
OUTPUT DC VOLTAGE VS. INPUT DC VOLTAGE (SOUND)

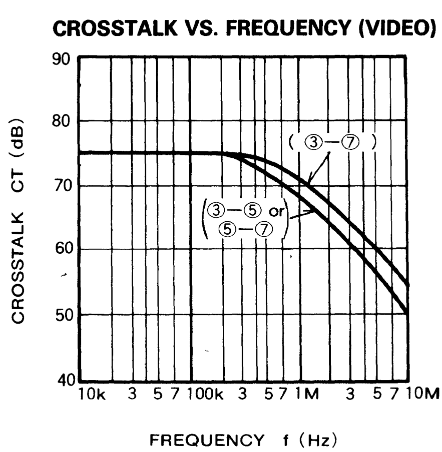


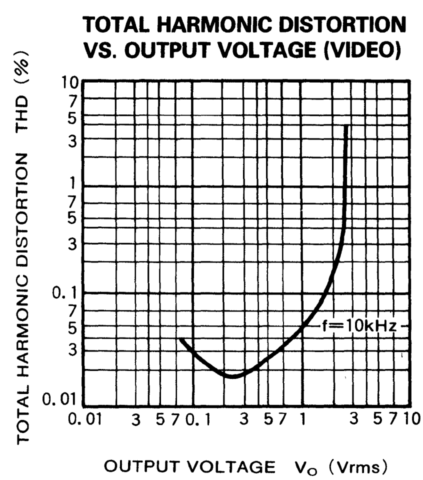

CROSSTALK VS. FREQUENCY (SOUND)
100
90
80
70
60
50
CROSSTALK CT (dB)
(⑯—⑱)
(⑯—⑰ of ⑰—⑱)
1k 3 5 7 10k 3 5 7 100k 3 5 7 1M
FREQUENCY f (Hz)


OUTPUT NOISE VOLTAGE VS. SIGNAL SOURCE RESISTANCE (SOUND)
OUTPUT NOISE VOLTAGE VN (μrms)
100 7 5 3 10 7 5 3 1 7 5 3 0.1
100 3 5 7 1K 3 5 7 10k 3 5 7 100k
SIGNAL SOURCE RESISTANCE Rg (Ω)

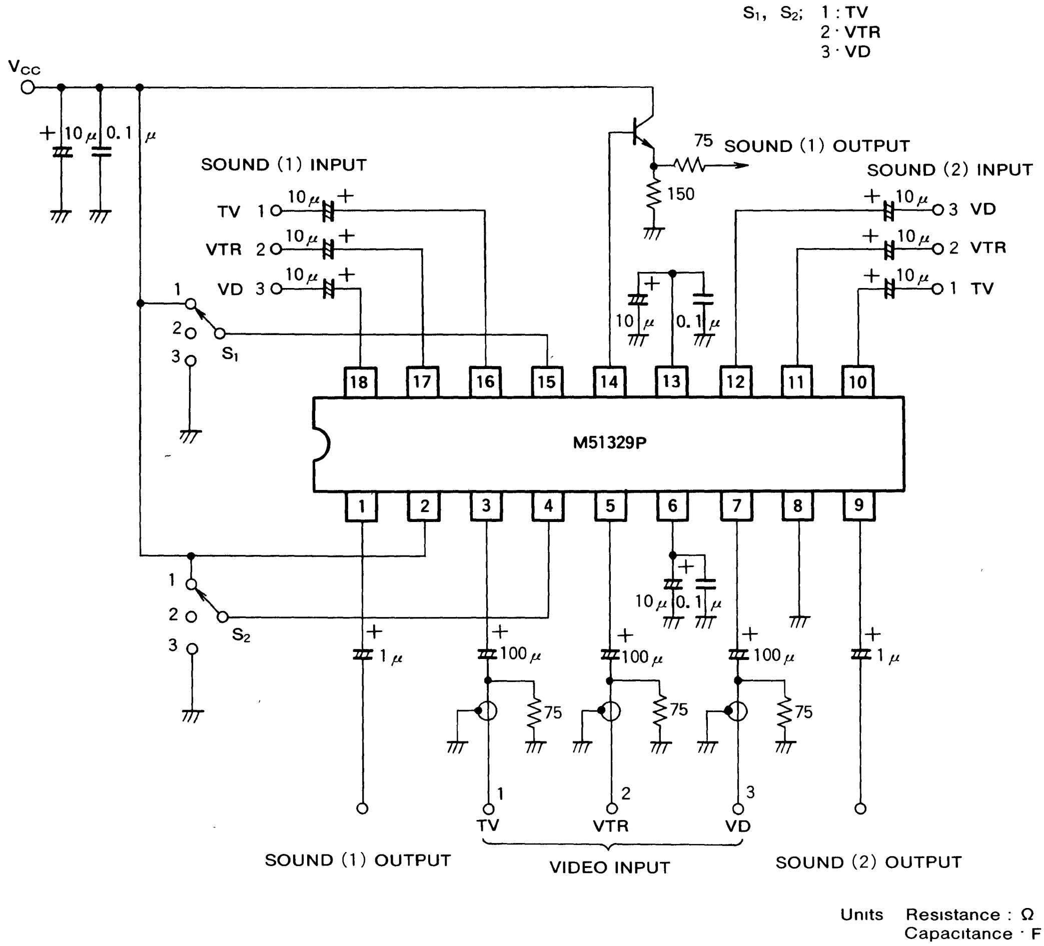

VOLTAGE GAIN VS. FREQUENCY (VIDEO)
VOLTAGE GAIN GV (dB)
10
5
0
VCC=12V
100k 3 5 7 1M 3 5 7 10M 3 5 7 100M
FREQUENCY f (Hz)


OUTPUT DC VOLTAGE VS. INPUT DC VOLTAGE (VIDEO)
OUTPUT DC VOLTAGE VO DC (V)
15
12
9
6
3
0
VCC=12V
VCC=9V
0 2 4 6 8 10
INPUT DC VOLTAGE VIN DC (V)


CROSSTALK VS. FREQUENCY (VIDEO)
CROSSTALK CT (dB)
90
80
70
60
50
40
(③—⑦)
(③—⑤ or ⑤—⑦)
10k 3 5 7 100k 3 5 7 1M 3 5 7 10M
FREQUENCY f (Hz)


TOTAL HARMONIC DISTORTION VS. OUTPUT VOLTAGE (VIDEO)
TOTAL HARMONIC DISTORTION THD (%)
10 7 5 3 1 7 5 3 0.1 7 5 3 0.01
f=10kHz
0.01 3 5 7 0.1 3 5 7 1 3 5 7 10
OUTPUT VOLTAGE VO (Vrms)

APPLICATION EXAMPLE



PRECAUTIONS FOR USE

Since an emitter-follower output is used in the video and sound outputs, when the external wiring is long or a capacitive load is connected, a resistor with a value of several tens of ohms should be connected at a position near the output pin.

M51330P

ANALOG SWITCH

DESCRIPTION

The M51330P is a semiconductor integrated circuit containing an analog switch designed for use in a video system. It contains two audio switches and one video switch. Each switch has three inputs and can be independently controlled in each of the audio and the video sections.

FEATURES

- Video and stereo sound switches in one package
- Wide frequency range (video switch) ··········· DC~10MHz
- High separation (video) ································· Crosstalk 55dB(typ.) @5MHz

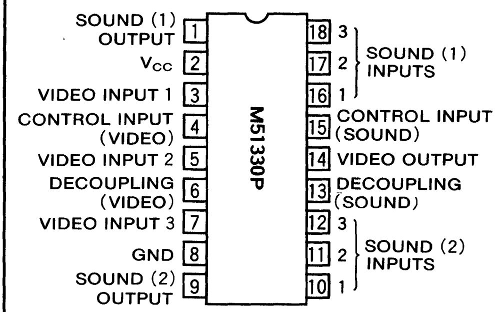
APPLICATION

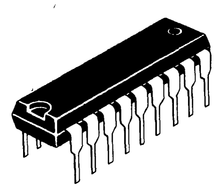
Video equipment.

RECOMMENDED OPERATING CONDITIONS

Supply voltage range ······································· 5~14V

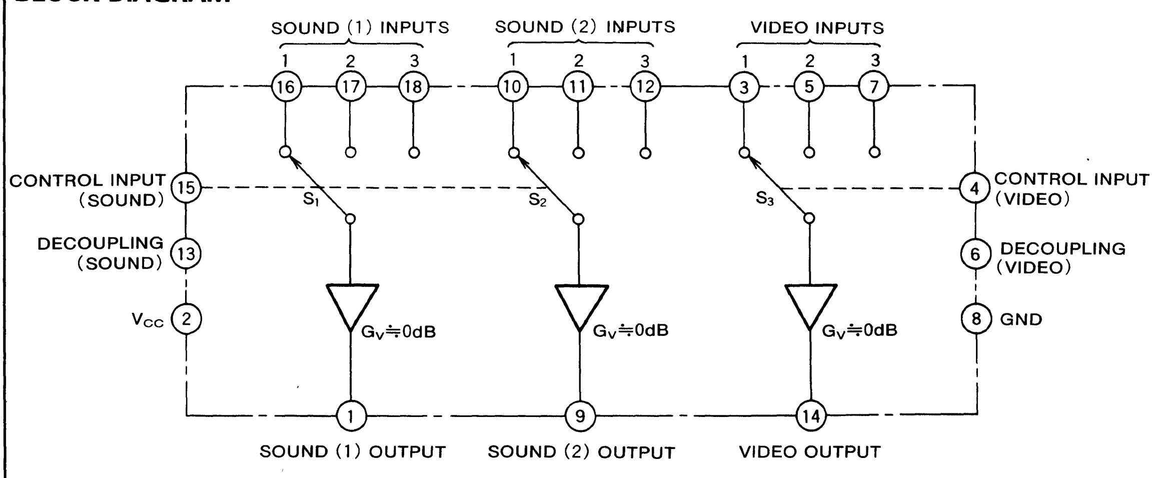
PIN CONFIGURATION (TOP VIEW)





18-pin molded plastic DIP

BLOCK DIAGRAM



MITSUBISHI ELECTRIC

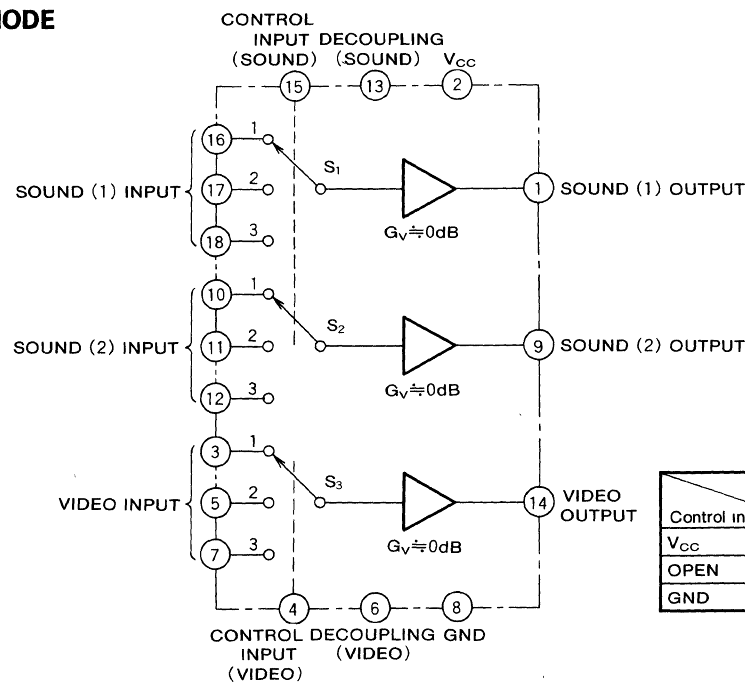
ABSOLUTE MAXIMUM RATINGS (T_a=25℃, V_{CC}=12V, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		14	V
V_{IS}	Input signal voltage	Sound	6	V
		Video	6	
V_{IC}	Input control voltage		V_{CC}	V
Pd	Power dissipation		1.25	W
K_θ	Thermal derating		12.5	mW/℃
T_{opr}	Operating temperature range		−20～+75	℃
T_{stg}	Storage temperature range		−40～+125	℃

ELECTRICAL CHALACTERISTICS (T_a=25℃, V_{CC}=12V, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
I_{CC}	Circuit current			36	48	mA
$V_{I\ DC}$	Input bias voltage		3.8	4.2	4.6	V
$V_{O\ DC}$	Output bias voltage		3.0	3.6	4.2	V
V_{OP}	Output DC offset voltage			15	100	mV
$V_{IC\ H}$	Control-pin threshold voltage		7.0	8.0	9.0	V
$V_{IC\ L}$			3.0	4.0	5.0	V
G_V	Voltage gain	Video, f=1MHz	−0.5	−0.1		dB
		Sound, f=1kHz	−0.5	−0.1		
R_I	Input resistance	Sound, f=1kHz		22		kΩ
		Video, f=5MHz		11		
C_I	Input capacitance	Video, f=5MHz		4		pF
THD	Total harmonic distortion	Sound, f=1kHz, V_O=1Vrms		0.02	0.2	%
V_N	Output noise voltage	Video, R_g=75Ω, BW=10MHz		0.5	1.0	mVrms
		Sound, R_g=600Ω, BW=15kHz		3	50	μVrms
CT	Crosstalk	Sound, f=1kHz	65	80		dB
		Video, f=5MHz	45	55		

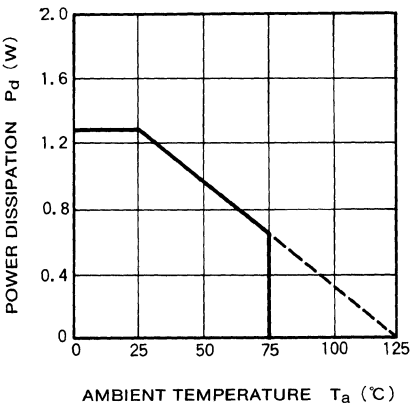
SWITCH MODE



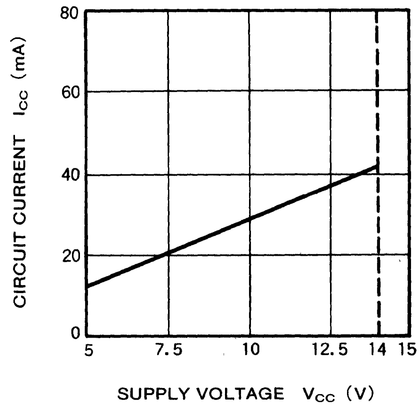
Control input \ Switch No.	Sound		Video
	S_1	S_2	S_3
V_{CC}	1		1
OPEN	2		2
GND	3		3

TYPICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

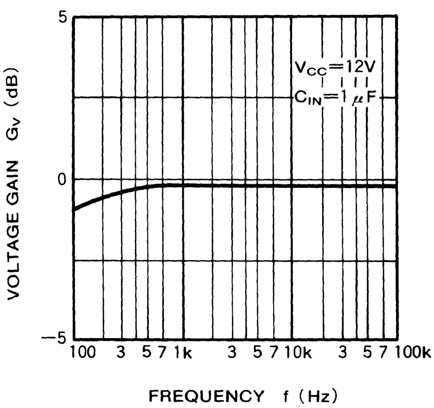
THERMAL DERATING (MAXIMUM RATING)



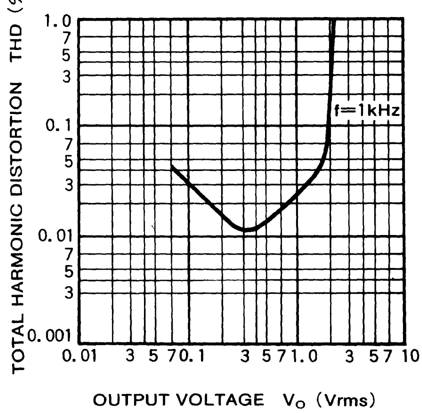
CIRCUIT CURRENT VS. SUPPLY VOLTAGE



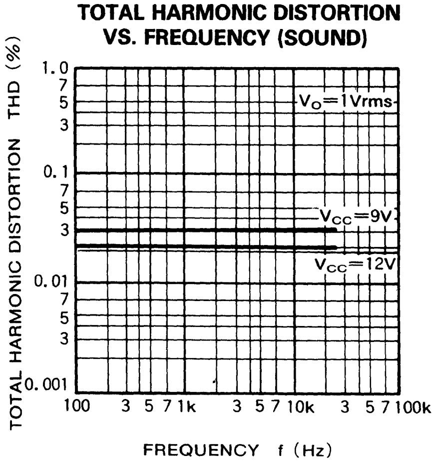
VOLTAGE GAIN VS. FREQUENCY (SOUND)



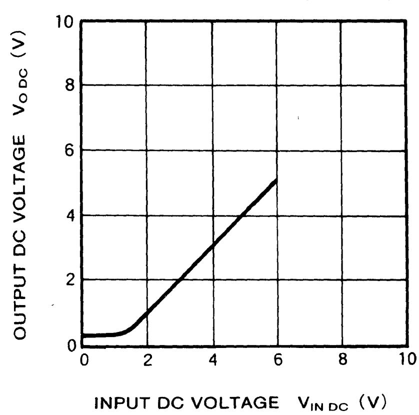
TOTAL HARMONIC DISTORTION VS. OUTPUT VOLTAGE (SOUND)



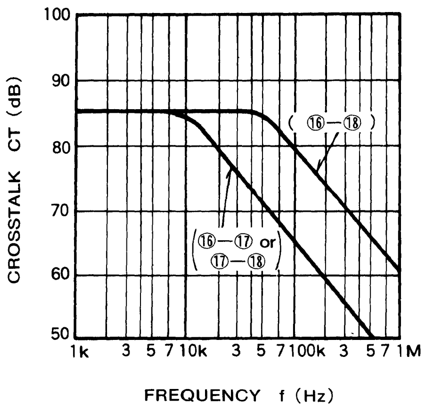
TOTAL HARMONIC DISTORTION VS. FREQUENCY (SOUND)



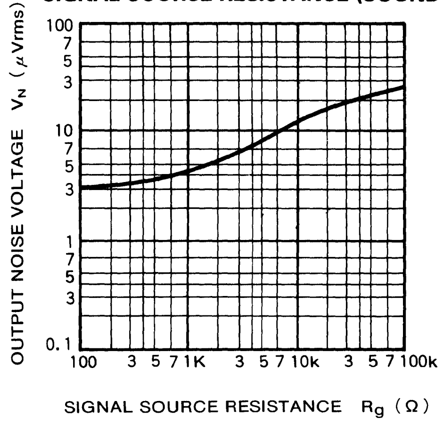
OUTPUT DC VOLTAGE VS. INPUT DC VOLTAGE (SOUND)



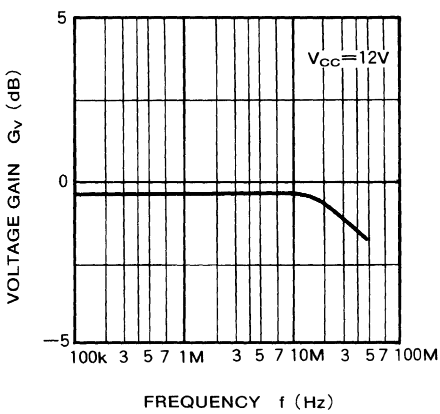
CROSSTALK VS. FREQUENCY (SOUND)



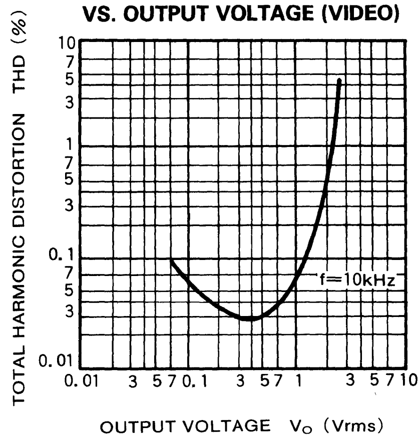
OUTPUT NOISE VOLTAGE VS. SIGNAL SOURCE RESISTANCE (SOUND)



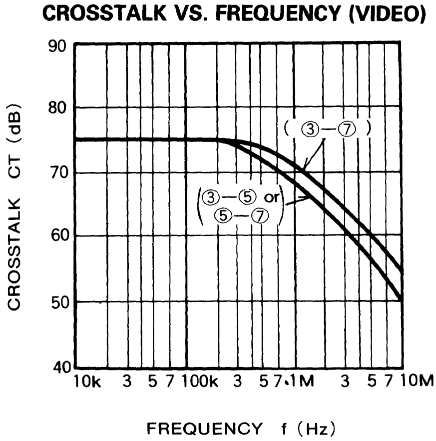
VOLTAGE GAIN VS. FREQUENCY (VIDEO)



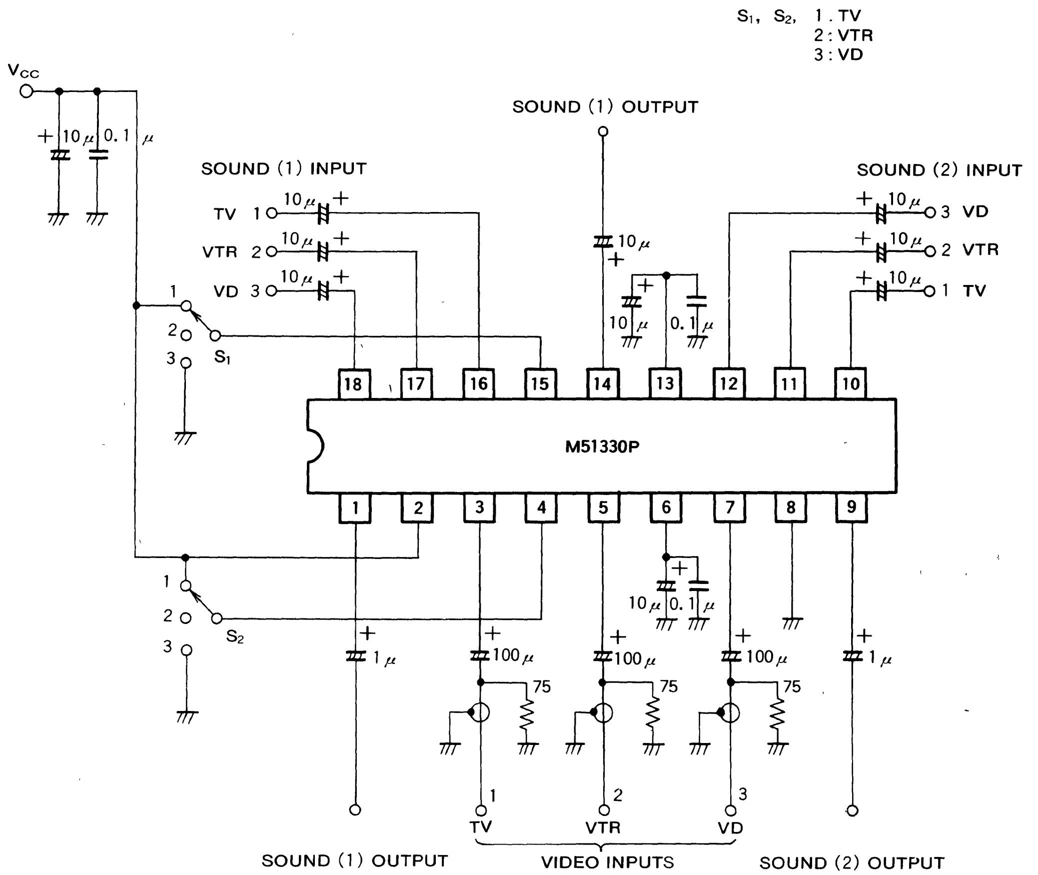
TOTAL HARMONIC DISTORTION VS. OUTPUT VOLTAGE (VIDEO)



CROSSTALK VS. FREQUENCY (VIDEO)



APPLICATION EXAMPLE



Units Resistance : Ω
Capacitance : F

PRECAUTIONS FOR USE

Since an emitter-follower output is used in the video and sound outputs, when the external wiring is long or a capacitive load is connected, a resistor with a value of several tens of ohms should be connected at a position near the output pin.

M51551P,FP

ANALOG SWITCH

DESCRIPTION

The M51551P,FP is a semiconductor integrated circuit containing two electronic switches, each with two inputs and a single output.

Channel input is simultaneously selectable for supply DC voltage to the control pin. The device also contains an output circuit designed for use in driving an LED or other indicator to display which channel is operating.

M51551FP is housed in a 14-pin plastic flat package, while the housing for M51551P is housed in a 14-pin molded plastic dual in-line (DIL) package.

FEATURES

- Dual channel 2-input 1-output analogue signal switch.
- Mode switched for supply DC voltage.
- Built-in output circuit for use in driving a mode indicator.
- Bipolar construction assures low distortion ······································ 0.006% (typ)(Vi=1.0Vrms)
- Operation possible with either dual or single polarity power supplies. (Control pin operates by switching between GND and supply.)

APPLICATION

Audio selector, stereo radio cassette tape recorders, car-stereos.

RECOMMENDED OPERATING CONDITIONS

Dual polarity power supplies :

Supply voltage range······························±6~±10V

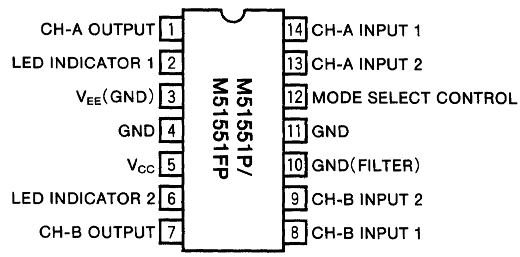
Rated supply voltage··±8V

Single polarity power supplies :

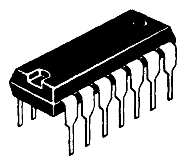
Supply voltage range····································6~20V

Rated supply voltage·· 15V

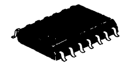
PIN CONFIGURATION (TOP VIEW)



ITEMS IN PARENTHESES APLICABLE TO SINGLE POLARITY POWER SUPPLY.

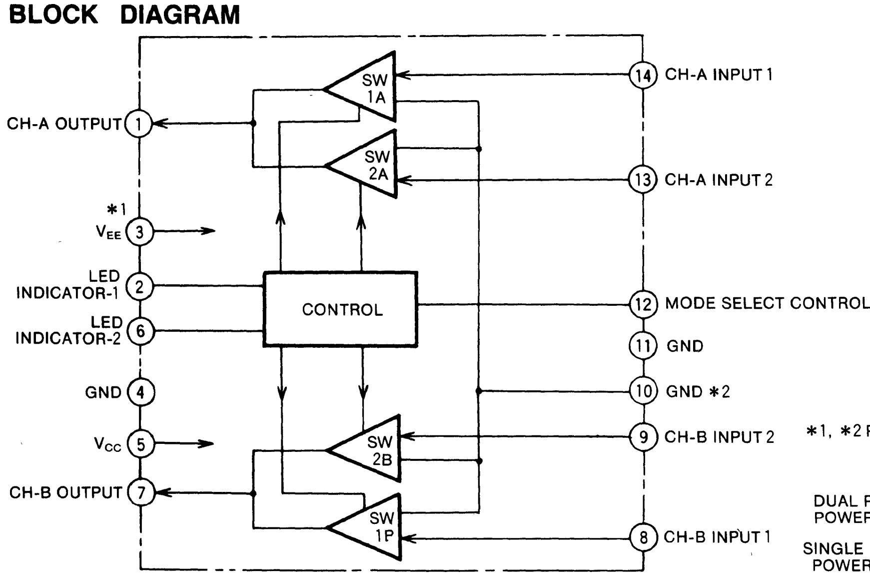


14-pin molded plastic DIP



14-pin molded plastic FLAT

BLOCK DIAGRAM



*1, *2 PIN DESCRIPTION

	PIN 3	PIN 10
DUAL POLARITY POWER SUPPLY	V_{EE}	GND
SINGLE POLARITY POWER SUPPLY	GND	FILTER

MITSUBISHI ELECTRIC

ANALOG SWITCH

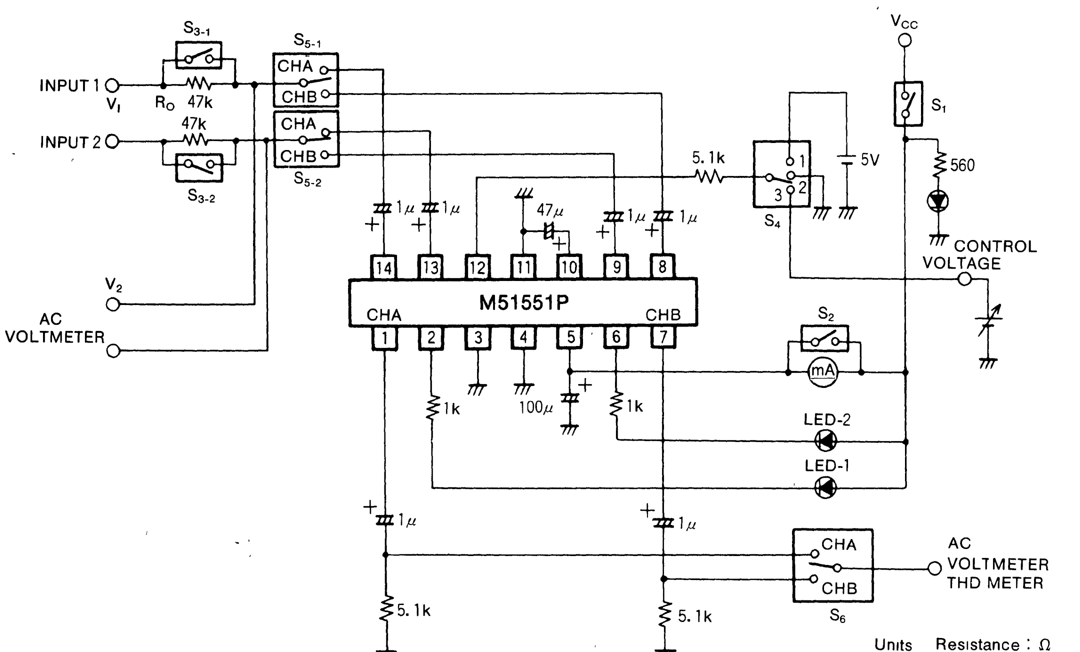
ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage	Quiescent, between pins 5 and 3.	24	V
I_{CC}	Circuit current	Except pins 2 and 6	30	mA
$I_{CC②,⑥}$	LED drive current	Pin 2, Pin 6	40	mA
P_d	Power dissipation		620	mW
K_θ	Thermal derating	T_a≧25℃	6.2	mW/℃
Topr	Operating temperature		−20～+75	℃
Tstg	Storage temperature		−40～+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=15V, V_i=1.5Vrms, f=1kHz, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
I_{CC}	Circuit current	Except pins 2 and 6		12	16	mA
V_{CNTL1}	Select control voltage 1	Control voltage when input 1 is selected	2.0			V
V_{CNTL-2}	Select control voltage 2	Control voltage when input 2 is selected.			0.7	V
R_i	Input resistance	V_i=1.5Vrms, f=1kHz, R_O=47kΩ	30	47		kΩ
G_V	Voltage gain	V_i=1.5Vrms, f=1kHz	−1	0	1	dB
$V_{O(max)}$	Maximum output voltage	The output voltage at THD=1%	4.0	4.5		Vrms
THD	Total harmonic distortion	V_O=1.0Vrms		0.006	0.017	%
N_O	Output noise level	BPF(20Hz～20kHz), connect pin 1 to GND		5.5	10	μVrms
C.T.	Crosstalk	The ratio of signal leakage between input 1 and input 2, f=1kHz	52	58		dB
C.L.	Channel leakage	The ratio of signal leakage between CH-A and CH-B, f=1kHz	77	83		dB
C.B.	Channel balance	Output level ratio between CH-A and CH-B	−0.5	0	0.5	dB

TEST CIRCUIT (Using single polarity power supply)



Units Resistance : Ω
Capacitance : F

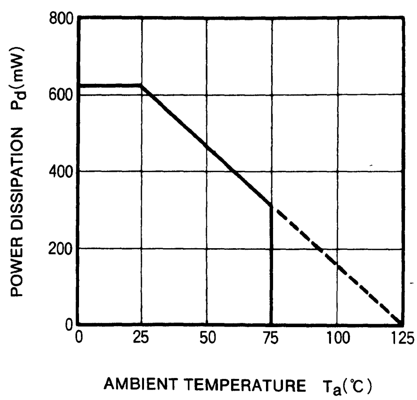
Note : When a dual polarity power supply is used, pin 3 is the V_{EE} pin (Ground pin 3 for signal polarity supply)

TEST METHODS

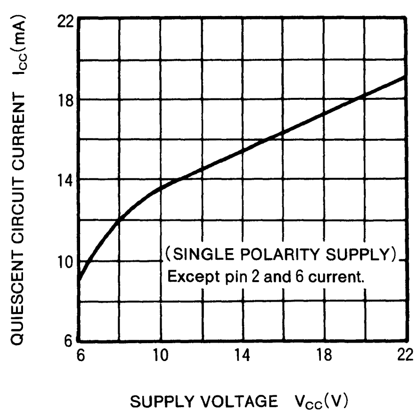
Symbol	Switch conditions							Test method
	S_1	S_2	S_3	S_4	S_{5-1}	S_{5-2}	S_6	
I_{CC}	ON	OFF	ON	1/2				Read ammeter with V_{CC}=15V.
V_{CNTL1}	ON	ON	ON	3				Measure the voltage applied to pin 12 at the point the signal applied to input 1 appears at output.
V_{CNTL2}	ON	ON	ON	3				Measure the voltage applied to pin 12 at the point the signal applied to input 2 appears at output.
R_i	ON	ON	OFF	1/2	CHA / CHB	CHA / CHB		$R_i=\frac{V_2 \times R_0}{V_1-V_2}$ At V_i=1.5Vrms, R_0=47kΩ measure V_2 relative to input 1 and input 2.
G_V	ON	ON	ON	1/2	CHA / CHB	CHA / CHB	CHA / CHB	$G_V=20\log\frac{V_O}{V_1}$(dB) V_1=1.5Vrms, V_O=voltage output
$V_{O(max)}$	ON	ON	ON	1/2	CHA / CHB	CHA / CHB	CHA / CHB	Measure output voltage for THD=1% at output.
THD	ON	ON	ON	1/2	CHA / CHB	CHA / CHB	CHA / CHB	Measure output distortion for V_2=1.0Vrms
N_O	ON	ON	ON	1/2			CHA / CHB	Input terminal AC ground, BPF 20Hz~20kHz
C.T.	ON	ON	ON	1⇄2	CHA / CHB		CHA / CHB	$C.T.=20\log\left(\frac{V_O(S_4\to1)}{V_O(S_4\to2)}\right)$ (dB)
C.L.	ON	ON	ON	1	CHA	CHA	CHA ⇅ CHB	$C.L.=20\log\left(\frac{V_O(CHA)}{V_O(CHB)}\right)$ (dB)
C.B.	ON	ON	ON	1	CHA / CHB	CHA / CHB	CHA / CHB	$C.B.=20\log\left(\frac{V_O(CHA)}{V_O(CHB)}\right)$ (dB)

TYPICAL CHARACTERISTICS (T_a=25℃, V_{CC}=15V, unless otherwise noted)

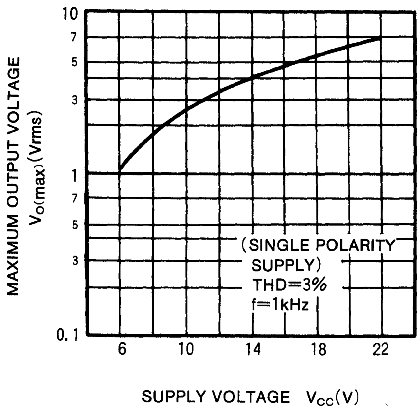
THERMAL DERATING (MAXIMUM RATING)



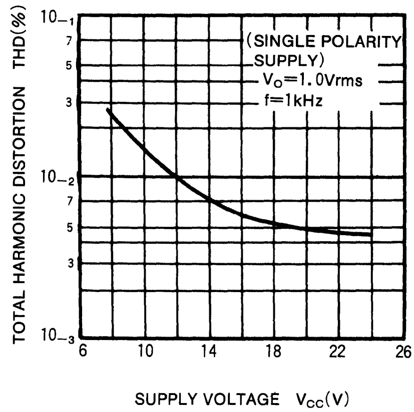
QUIESCENT CIRCUIT CURRENT VS SUPPLY VOLTAGE



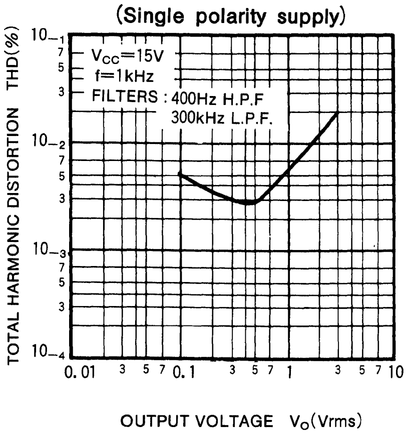
MAXIMUM OUTPUT VOLTAGE VS SUPPLY VOLTAGE



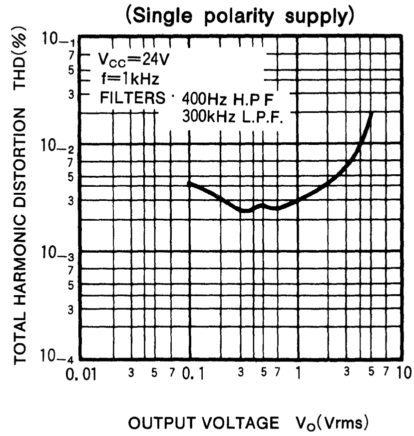
TOTAL HARMONIC DISTORTION VS SUPPLY VOLTAGE



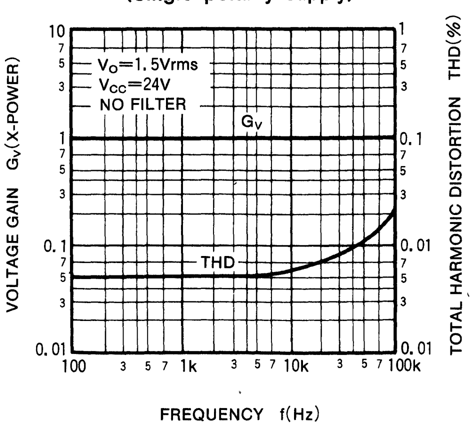
TOTAL HARMONIC DISTORTION VS OUTPUT VOLTAGE (V_{CC}=15V) (Single polarity supply)



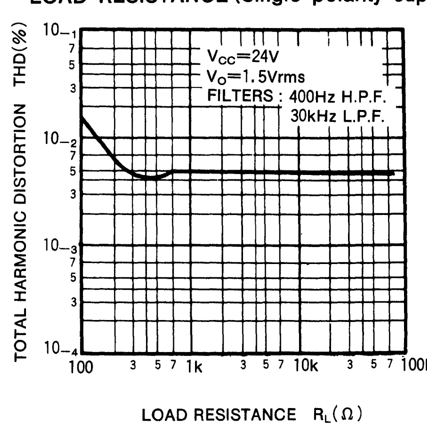
TOTAL HARMONIC DISTORTION VS OUTPUT VOLTAGE (V_{CC}=24V) (Single polarity supply)



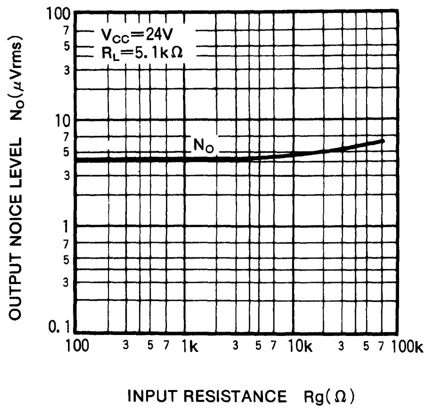
FREQUENCY RESPONSE (Single polarity supply)



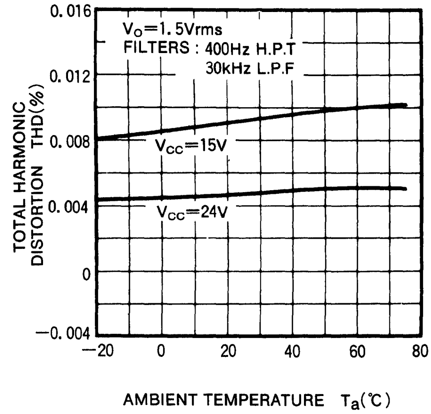
TOTAL HARMONIC DISTORTION VS LOAD RESISTANCE (Single polarity supply)



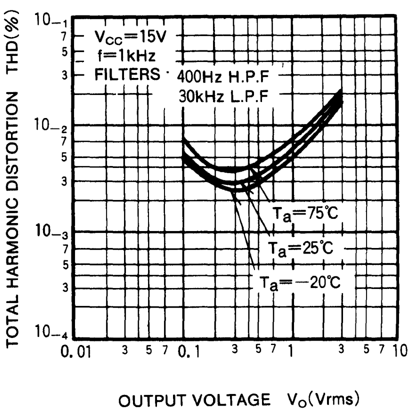
OUTPUT NOISE LEVEL VS INPUT RESISTANCE (Single polarity supply)



TOTAL HARMONIC DISTORTION VS AMBIENT TEMPERATURE (Single polarity supply)

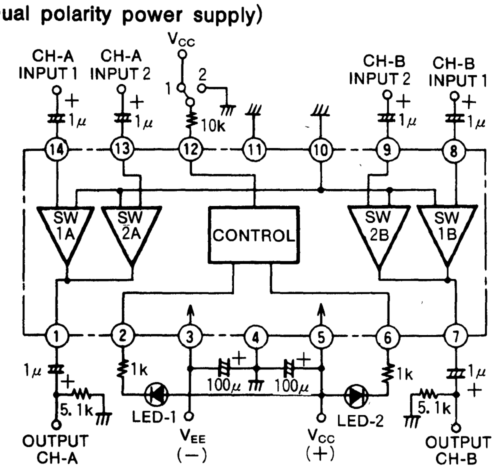


TEMPERATURE CHARACTERISTICS (Single polarity supply)



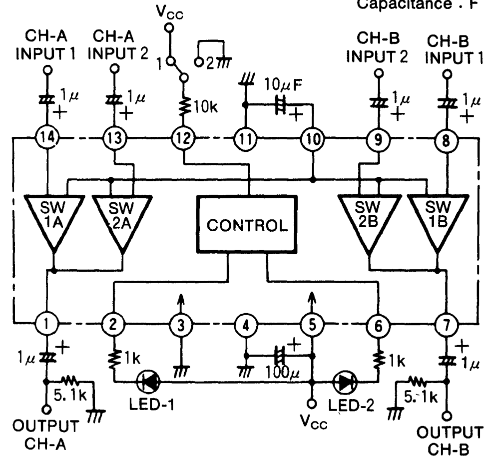
APPLICATION EXAMPLES

(Dual polarity power supply)



(Single polarity power supply)

Unit Resistance : Ω
Capacitance : F

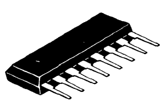


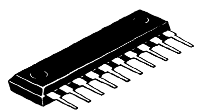
LEVEL INDICATOR

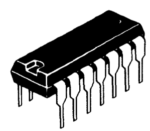
8

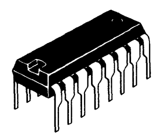
QUICK REFERENCE TABLE OF LEVEL INDICATOR

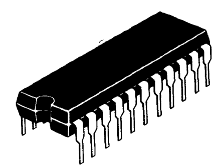
Type No.	Function						Features	Maximum ratings			Package outline
	Max No of LEDs driven	Display format	Display threshold	Output format	Ref voltage	Detection amplifier		Supply voltage (V)	Load current	Allowable power consumption (mW)	
M51901P	12	Dot display, 1 or 2 LEDs	Linear	Open collector	Externally set 5.0～7.5V	—	● 23 operation modes ● Blanking mode included	10.2～16.5	30mAmax	650	16-pin DIP
M51903L	5	Bar display, linear LEDs	Linear	Open collector	Internal 1.25V	—	● Wide supply voltage range ● Brightness of uppermost LED varies linearly with the input voltage	4～18	15mAmax	450	8-pin SIP
M51910P	9	Dot display, only 1 LEDs	Linear	Open collector	Externally set 0～3.5V	—	● Built-in timer ● 2 LED-drive modes, so 2 inputs can be displayed	8～18	20mAmax	1400	22-pin DIP
M51906P	6	Bar display	Acoustic threshold (dB)	Open collector	Internal 1.25V	Internal (gain set externally)	● Wide supply voltage range ● Detection amp built-in Cut-off frequency········500kHz typ Offset voltage·· ···············2mV typ	4～15	30mAmax	1500	14-pin DIP
M51907P	8	Bar display	Acoustic threshold (dB)	Constant current cascade connection	Internal 1.25V (Ref voltage terminal included)	Internal (gain set externally)	● Wide supply voltage range ● Output cascade connection reduces power consumption by half ● Detection amp built-in ● Abundant applications circuits	4～15	25mAmax	1600	16-pin DIP
M51909P	8	Bar display	Linear	Constant current cascade connection	Internal 1.25V (Ref voltage terminal included)	Internal (gain set externally)		4～15	25mAmax	1600	
M51911L	6	Bar display	Acoustic threshold (dB)	Constant current cascade connection	Internal 1.25V	Internal (gain 17dB)	● Wide supply voltage range ● Few external attachments required ● Output cascade connection reduces power consumption by half ● Detection amp built-in	4～15	13mAtyp internally decided	1100	10-pin SIP
M51912L	6	Bar display	Linear	Constant current cascade connection	Internal 1.25V	Internal (gain 17dB)		4～15	13mAtyp internally decided	1100	


8-pin SIP


10-pin SIP


14-pin DIP


16-pin DIP


22-pin DIP

M51901P

12-POINT/23-MODE LED DRIVER

DESCRIPTION

The M51901P is a semiconductor integrated circuit consisting of a driver circuit capable of driving 12 LEDs in 23 modes.

When a DC voltage is applied to the input pin the LED driving outputs are activated either 1 or 2 at a time to provide 23 LED drive modes in accordance with the applied voltage level. In addition, a blanking function is available when the reference voltage is made a low level.

The M51901P consists of 12 differential amplifiers and the associated ladder circuit as well as a blanking circuit.

FEATURES

- 12 LEDs may be driven in accordance with the level of a DC voltage applied to the input, using a built-in A-D conversion capability.
- 23 operating modes are provided
- Built-in blanking function
- The reference voltage level may be freely selected

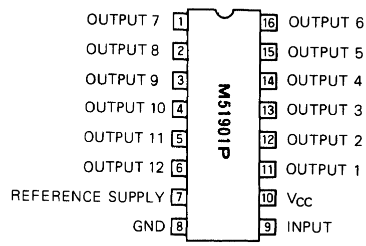
APPLICATION

23-mode drivers for 12 LEDs, simplified A-D converters

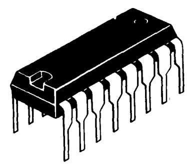
RECOMMENDED OPERATING CONDITIONS

Supply voltage range .... 10.2~16.5V
Rated supply voltage 13.2V
Reference voltage range .... 5.0~7.5V
Input voltage range .... 0~9.2V

PIN CONFIGURATION (TOP VIEW)

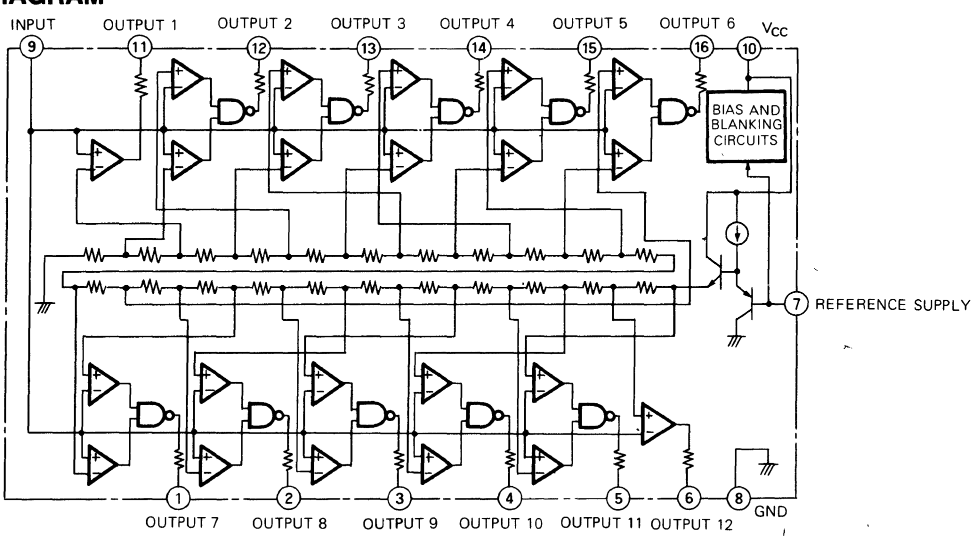


Outline 16P4



16-pin molded plastic DIP

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

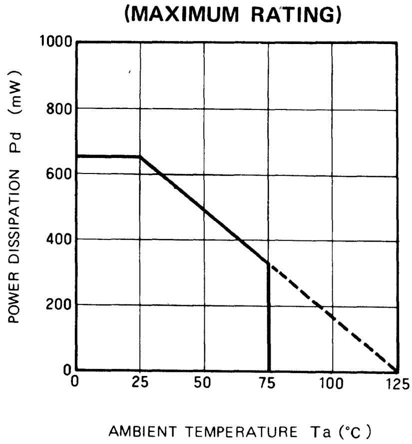
Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		18	V
I_O	Output current		30	mA
Pd	Power dissipation		650	mW
K_θ	Derating	Ta≧25°C	6.5	mW/°C
Topg	Operating temperature		−20～+75	°C
Tstg	Storage temperature		−40～+125	°C

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=±13.2V, V_{REF}=7.20V, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
I_{CC}	Circuit current	V_{IN}=0V, outputs open		2	5	mA
I_I	Input current	V_{IN}=9.2V			100	μA
V_O	Output voltage (pins ①～⑫)	R_L=620 Ω	4.2	5.5	6.8	V
V_{BL}	Blanking voltage	V_{IN}=9.2V, I_O=100μA			0.8	V
$I_⑦$	Pin ⑦ output current	V_{IN}=0V			15	μA
$V_②$	Output 2 on-state central input voltage	I_O≧1mA		1.99		V
$V_③$	Output 3 on-state central input voltage	I_O≧1mA		2.51		V
$V_④$	Output 4 on-state central input voltage	I_O≧1mA		3.03		V
$V_⑤$	Output 5 on-state central input voltage	I_O≧1mA		3.55		V
$V_⑥$	Output 6 on-state central input voltage	I_O≧1mA		4.07		V
$V_⑦$	Output 7 on-state central input voltage	I_O≧1mA		4.59		V
$V_⑧$	Output 8 on-state central input voltage	I_O≧1mA		5.11		V
$V_⑨$	Output 9 on-state central input voltage	I_O≧1mA		5.63		V
$V_⑩$	Output 10 on-state central input voltage	I_O≧1mA		6.15		V
$V_⑪$	Output 11 on-state central input voltage	I_O≧1mA		6.67		V

TYPICAL CHARACTERISTICS (Ta =25°C , unless otherwise noted)

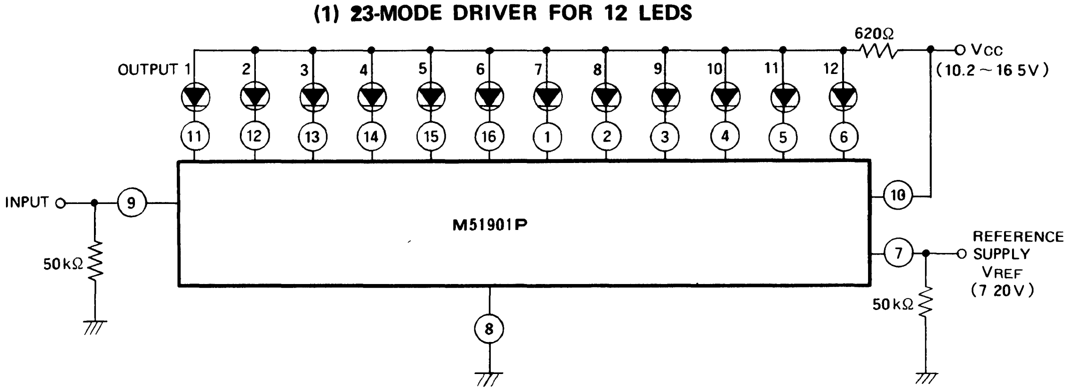
THERMAL DERATING
(MAXIMUM RATING)



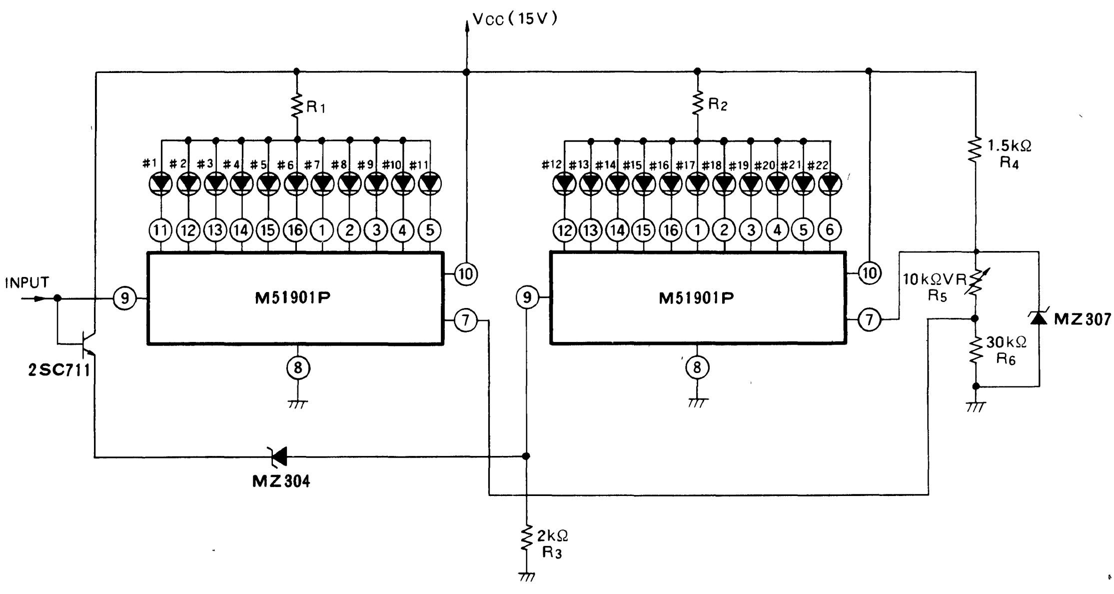
MITSUBISHI ELECTRIC

APPLICATION EXAMPLES

(1) 23-MODE DRIVER FOR 12 LEDS



(2) 22-LED DRIVER (USING CASCADE CONNECTION)



Note R_5 is chosen such that the lower drive level limit for LED #12 is just 0.24V higher than higher drive level limit for LED #10

M51903L

LED LINEAR LEVEL INDICATOR

DESCRIPTION

The M51903L is a semiconductor integrated circuit consisting of a circuit designed for use in level meters. It is capable of driving 5 LEDs to create a bar-type display. In accordance with the input level, the uppermost LED brightness varies to form a linear indicator, making this device ideal for use in signal meters and VU meters. A low-voltage reference power supply is built in, so that the only external components required are 'LEDs, resistors and capacitors.

FEATURES

- Bar-type display of input level using 5 LEDs
- The uppermost LED brightness varies linearly with respect to the input level resulting in a high-resolution display with no radiation.
- By changing the external resistance values, the LED brightness can be adjusted ·················· I_O=15mA(max.)
- Operates over a wide range of supply voltages ·· V_{CC}=4~18V
- Built-in reference supply
- High input impedance ·················· I_{IN}=100nA (typ.)

APPLICATION

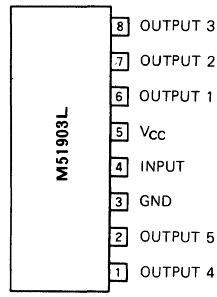
Signal meters, VU meters, tuning meters, and other general display applications

RECOMMENDED OPERATING CONDITIONS

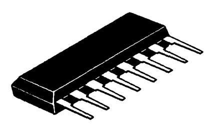
Supply voltage range ···································· 4~18V

Rated supply voltage ·· 10V

PIN CONFIGURATION (TOP VIEW)

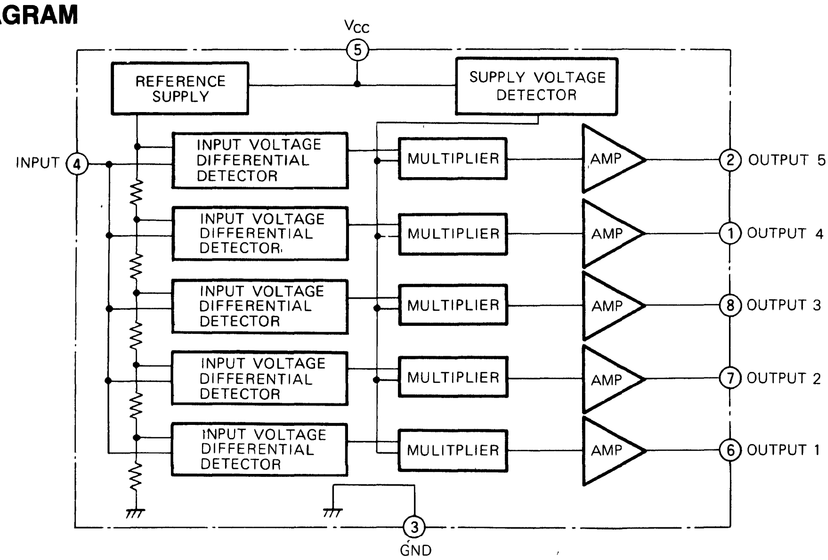


Outline 8P5



8-pin molded plastic SIP

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		18	V
V_{IN}	Input voltage		6	V
BV_O	Output breakdown voltage		18	V
I_O	Output current		15 (per pin)	mA
P_{dF}	Power dissipation	With the M51903L soldered to a printed circuit board (copper-clad area 4 5 x 5 5cm, thickness 35μ, board thickness 2 0mm)	550	mW
$K_{\theta F}$	Derating	$T_a \geqq 25℃$	5.5	mW/℃
T_{opg}	Operating temperature		−20～+75	℃
T_{stg}	Storage temperature		−40～+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=±10V, unless otherwise noted)

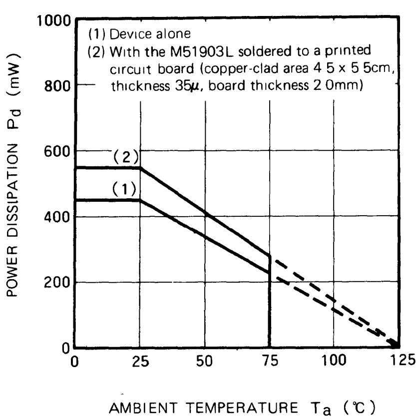
Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage range		4	10	18	V
V_{INF}	Fullscale input voltage			1320		mV
V_{step}	Step voltage			210		mV
I_{IN}	Input current	V_{IN}=0V (Note 1)		0.1	1.0	μA
I_{CC}	Circuit current	V_{IN}=0V		5	8	mA
$V_{IT⑥}$	Output 1 LED drive voltage	R_L=1.5kΩ, I_L=100μA, Using red GaAlAs LEDs	170	230	300	mV
$V_{IT⑦}$	Output 2 LED drive voltage		380	450	530	mV
$V_{IT⑧}$	Output 3 LED drive voltage		580	660	730	mV
$V_{IT①}$	Output 4 LED drive voltage		780	860	940	mV
$V_{IT②}$	Output 5 LED drive voltage		980	1070	1180	mV

Note 1 Current flowing from pin ④ is taken as positive current

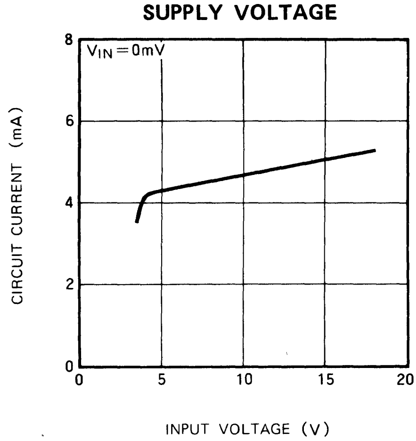
TYPICAL CHARACTERISTICS (T_a=25℃, V_{CC}=10V unless otherwise noted)

(For the following typical characteristics, R_L in the application example (1) is 1 5kΩ and red GaAlAs LEDs are used for measurements)

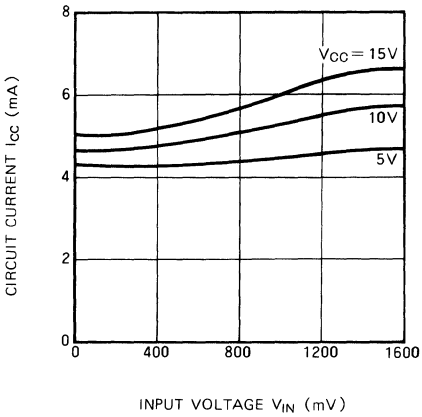
THERMAL DERATING (MAXIMUM RATING)



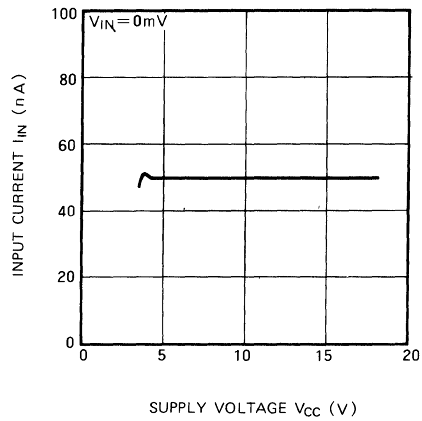
CIRCUIT CURRENT VS SUPPLY VOLTAGE



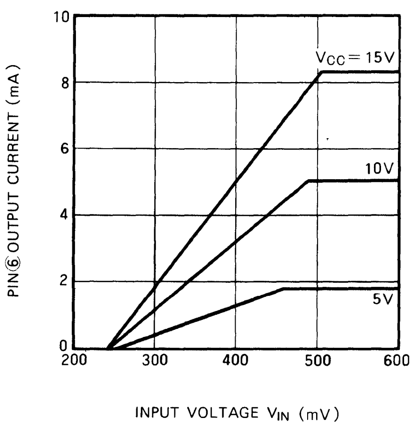
CIRCUIT CURRENT VS INPUT VOLTAGE



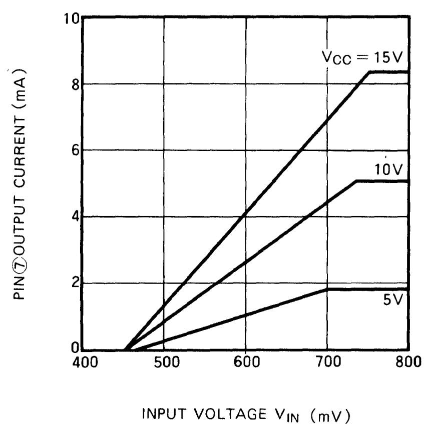
INPUT CURRENT VS SUPPLY VOLTAGE



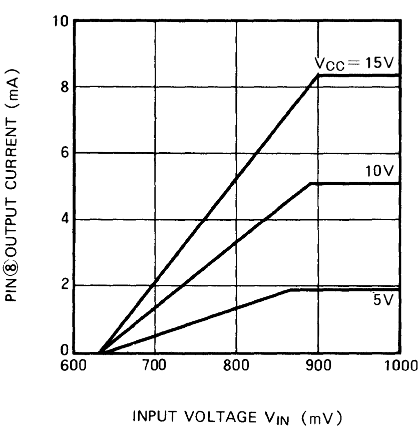
PIN⑥OUTPUT CURRENT VS INPUT VOLTAGE



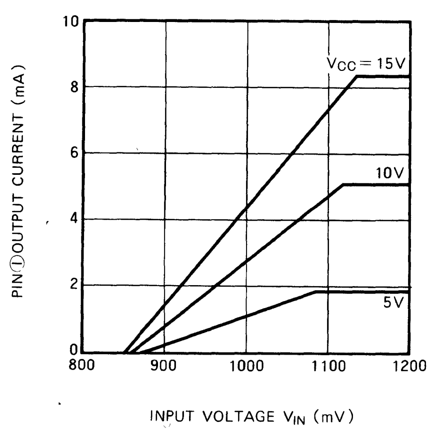
PIN⑦OUTPUT CURRENT VS INPUT VOLTAGE



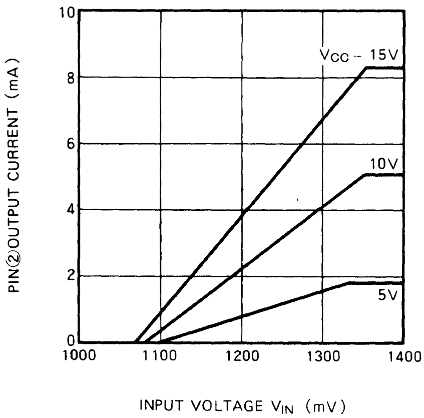
PIN⑧OUTPUT CURRENT VS INPUT VOLTAGE



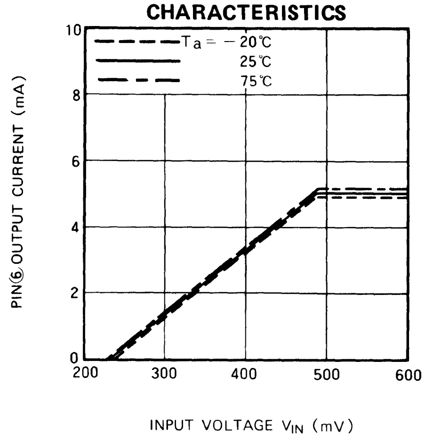
PIN①OUTPUT CURRENT VS INPUT VOLTAGE



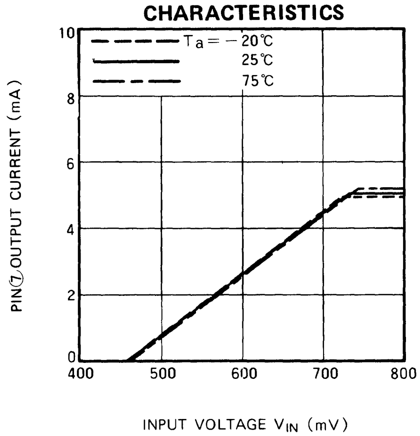
PIN ② OUTPUT CURRENT VS INPUT VOLTAGE



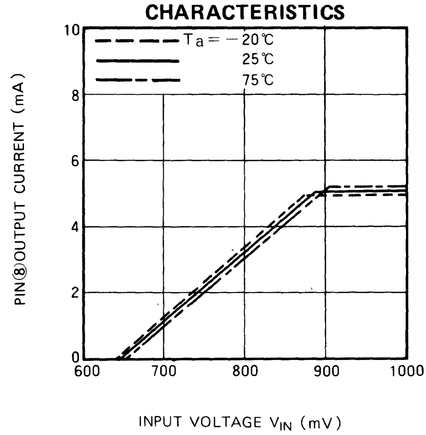
PIN ⑥ OUTPUT CURRENT VS INPUT VOLTAGE TEMPERATURE CHARACTERISTICS



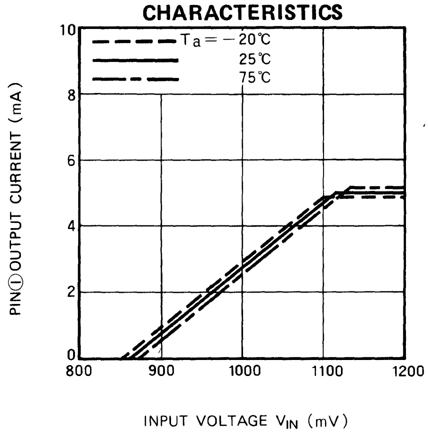
PIN ⑦ OUTPUT CURRENT VS INPUT VOLTAGE TEMPERATURE CHARACTERISTICS



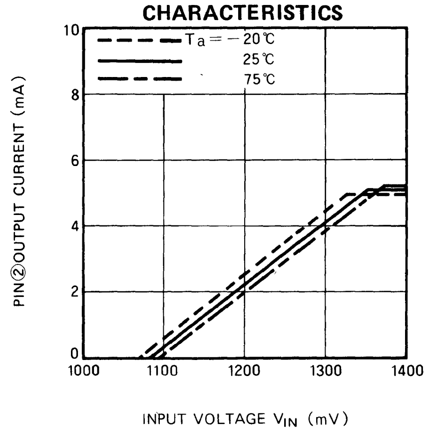
PIN ⑧ OUTPUT CURRENT VS INPUT VOLTAGE TEMPERATURE CHARACTERISTICS



PIN ① OUTPUT CURRENT VS INPUT VOLTAGE TEMPERATURE CHARACTERISTICS

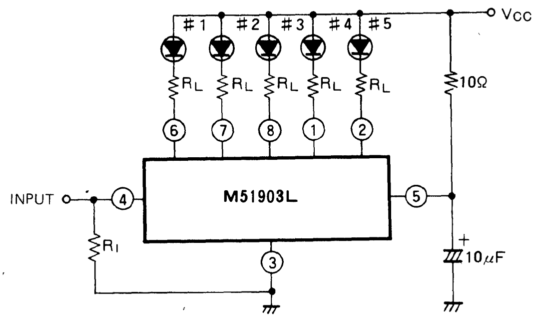


PIN ② OUTPUT CURRENT VS INPUT VOLTAGE TEMPERATURE CHARACTERISTICS



APPLICATION EXAMPLES

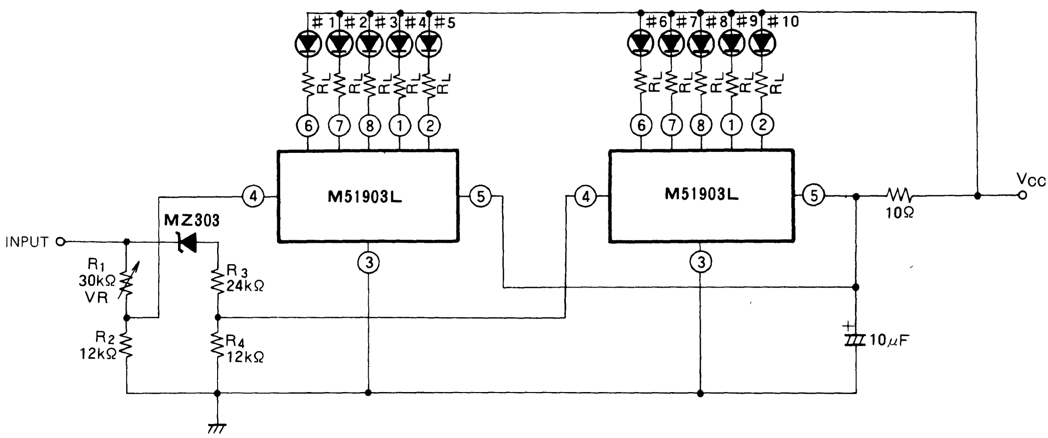
(1) M51903L used alone



Note 1 The value of R_L is chosen to suit the LED devices to be used The maximum LED current ≒ (V_{CC}-LED forward voltage drop−1 0)/R_L ≦ 15mA

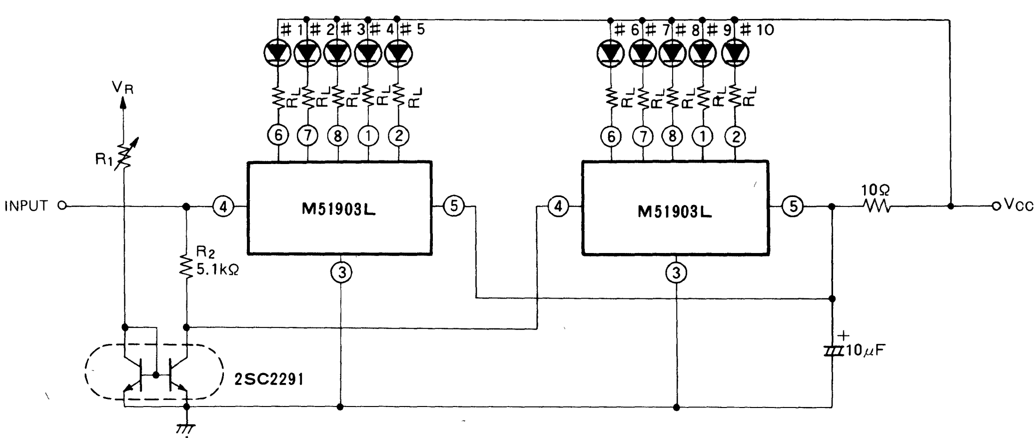
(2) M51903L used in cascade connection

(i) Circuit for a maximum input voltage of 7V



Note 1 Resistance R_1 is selected so that the turn-on voltage for LED #6 is approximately 630mV higher than that of LED # 5

(3) Circuit for a maximum input voltage of 2.3V



Note 1 Resistance R_1 selected so that the turn-on voltage for LED #6 is approximately 210mV higher than that of LED #5

M51910P

8-POINT/2-INPUT LED DRIVER

DESCRIPTION

The M51910P is an IC capable of driving a LED input level display according to the LED display mode. It can also be used as a comparator because it can issue a control signal after comparing input values. The M51910P has a built-in timer for control use.

There are two input pins for the display. One input is for the continuous display mode, and the other is for the on-off display mode, so that two inputs can be displayed on the same LED.

FEATURES

- Drives two display modes, displaying two inputs
- Reference voltage can be freely selected ········· 0.5~3.5V
- Built-in regulated power supply ········· V_S=4.8V, I_{Omax}=10mA
- Built-in timer ········· setting range is 5min.

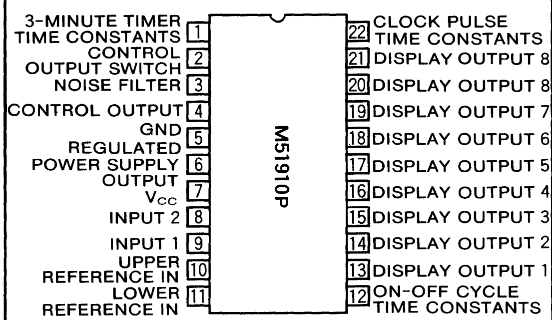
APPLICATION

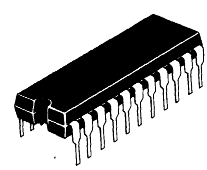
Control equipment level indicator, thermometer for temperature adjustment devices.

RECOMMENDED OPERATING CONDITIONS

Supply voltage range ········· 8~18V
Rated supply voltage ········· 12V

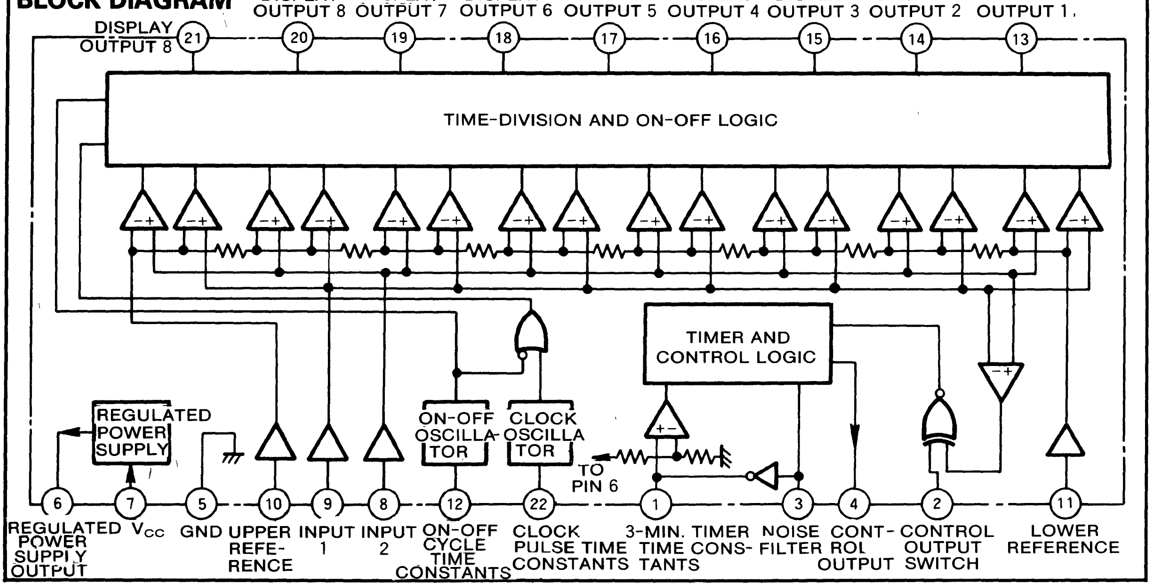
PIN CONFIGURATION (TOP VIEW)





22-pin molded plastic DIP

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		18	V
I_{odis}	Display output current		*30	mA
BV_{odis}	Display output dielectric strength		18	V
$I_{④}$	Pin ④ input current		50	mA
$BV_{④}$	Pin ④ dielectric strength		30	V
$I_{⑥}$	Pin ⑥ output current		−10	mA
P_d	Power dissipation		1400	mW
$K\theta$	Thermal derating		1.4	mW/℃
T_{opr}	Operating temperature		−20～+75	℃
T_{stg}	Storage temperature		−40～+125	℃

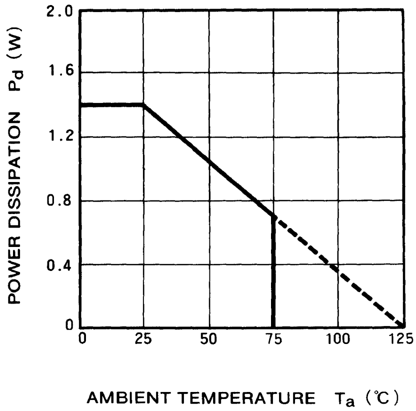
* The peak current may be as high as 40mA when the clock frequency is over 30Hz.

ELECTRICAL CHALACTERISTICS (T_a=25℃, V_{CC}=12V, unless otherwise noted)

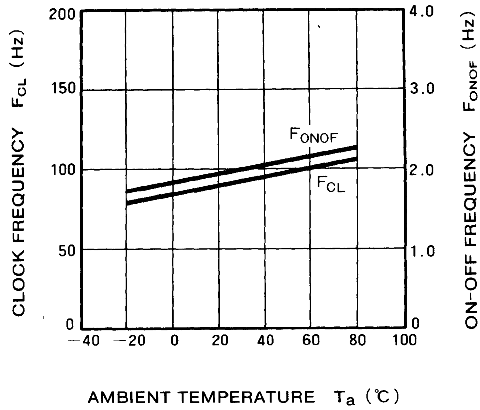
Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
I_{CC}	Circuir current	Pin ⑦ input current		10	20	mA
V_S	Regulated power voltage	Pin ⑥ voltage	4.0	4.8	5.4	V
$I_{⑧in}$	Pin ⑧ output current			1.7	10	μA
$I_{⑨in}$	Pin ⑧ output current			1.7	10	μA
$I_{⑩in}$	Pin ⑩ output current			1.7	10	μA
$I_{⑪in}$	Pin ⑪ output current			2.7	15	μA
$V_{⑧on2}$	Pin ⑧ threshold voltage output 2	$V_{⑪}$=2.2V $V_{⑩}$=2.8V Pin ⑧ voltage increases from low level and all outpus go ON.	2.180	2.22	2.250	V
$V_{⑧on3}$	Pin ⑧ threshold voltage output 3		2.265	2.30	2.335	V
$V_{⑧on4}$	Pin ⑧ threshold voltage output 4		2.345	2.38	2.415	V
$V_{⑧on5}$	Pin ⑧ threshold voltage output 5		2.425	2.46	2.495	V
$V_{⑧on6}$	Pin ⑧ threshold voltage output 6		2.505	2.54	2.575	V
$V_{⑧on7}$	Pin ⑧ threshold voltage output 7		2.585	2.62	2.655	V
$V_{⑧on8}$	Pin ⑧ threshold voltage output 8		2.670	2.70	2.740	V
$V_{⑧on9}$	Pin ⑧ threshold voltage output 9		2.750	2.79	2.820	V
$V_{⑨on2}$	Pin ⑨ threshold voltage output 2	$V_{⑪}$=2.2V $V_{⑩}$=2.8V Pin ⑨ voltage increases from low level and all outputs go ON	2.180	2.22	2.250	V
$V_{⑨on3}$	Pin ⑨ threshold voltage output 3		2.265	2.38	2.335	V
$V_{⑨on4}$	Pin ⑨ threshold voltage output 4		2.345	2.38	2.415	V
$V_{⑨on5}$	Pin ⑨ threshold voltage output 5		2.425	2.46	2.495	V
$V_{⑨on6}$	Pin ⑨ threshold voltage output 6		2.505	2.54	2.575	V
$V_{⑨on7}$	Pin ⑨ threshold voltage output 7		2.585	2.62	2.655	V
$V_{⑨on8}$	Pin ⑨ threshold voltage output 8		2.670	2.70	2.740	V
$V_{⑨on9}$	Pin ⑨ threshold voltage output 9		2.750	2.79	2.820	V
$V_{⑧TH}$ $V_{⑨TH}$	Pin ⑧ display output hysterisis Pin ⑨ display output hysterisis	Difference between input levels when output is ON and OFF	3	5	7	mV
$\Delta V_{⑧}$ $\Delta V_{⑨}$	Pin ⑧ output i to i+1 step voltage Pin ⑨ output i to i+1 step voltage	Difference between input levels when neighboring outputs are ON	70	82	95	mV
$\Delta V_{⑧⑨}$	Threshold voltage difference for same output between pin ⑧ and pin ⑨		−12	0	12	mV
F_{CL}	Oscillator frequency	1/2 pin ㉒ oscillator frequency		90		Hz
F_{ONOF}	On-off oscillator frequency	1/2 pin ⑫ oscillator frequency	2		Hz	
V_{CTH}	Error detector threshold voltage	V ⑧=2,500V and V ⑨ changes	2.490	2.505	2.520	V
Δ_{CT}	Error detector hysterisis	Pin ④ inversion voltage and hysterisis	5	15	25	mV
T	Timer operating time	1.5MΩ resistance attached to pin ① 100ΩF capacity connected to pin ①		200		sec

TYPICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

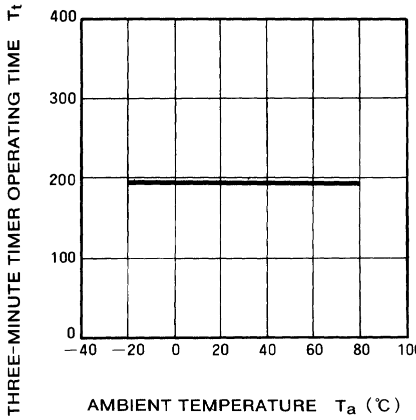
THERMAL DERATING (MAXIMUM RATING)



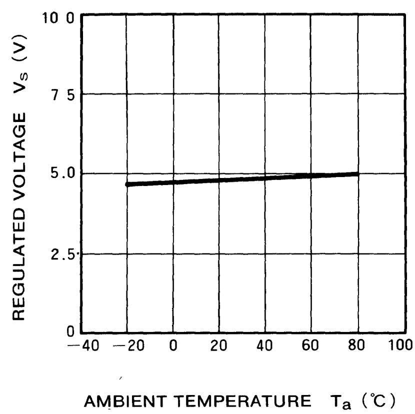
ON-OFF, CLOCK FREQUENCIES VS. AMBIENT TEMPERATURE



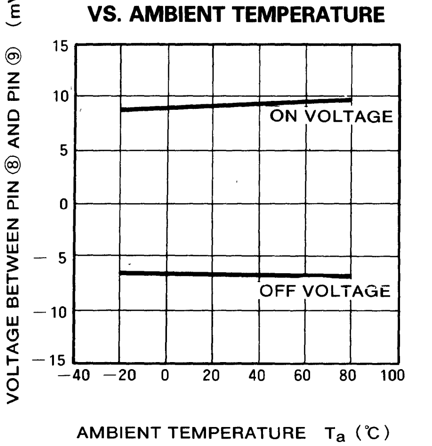
THREE-MINUTE TIMER OPERATING TIME VS. AMBIENT TEMPERATURE



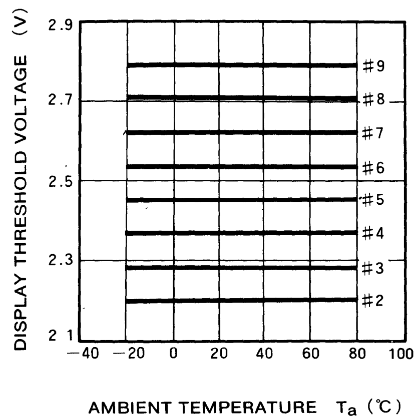
REGULATED VOLTAGE VS. AMBIENT TEMPERATURE



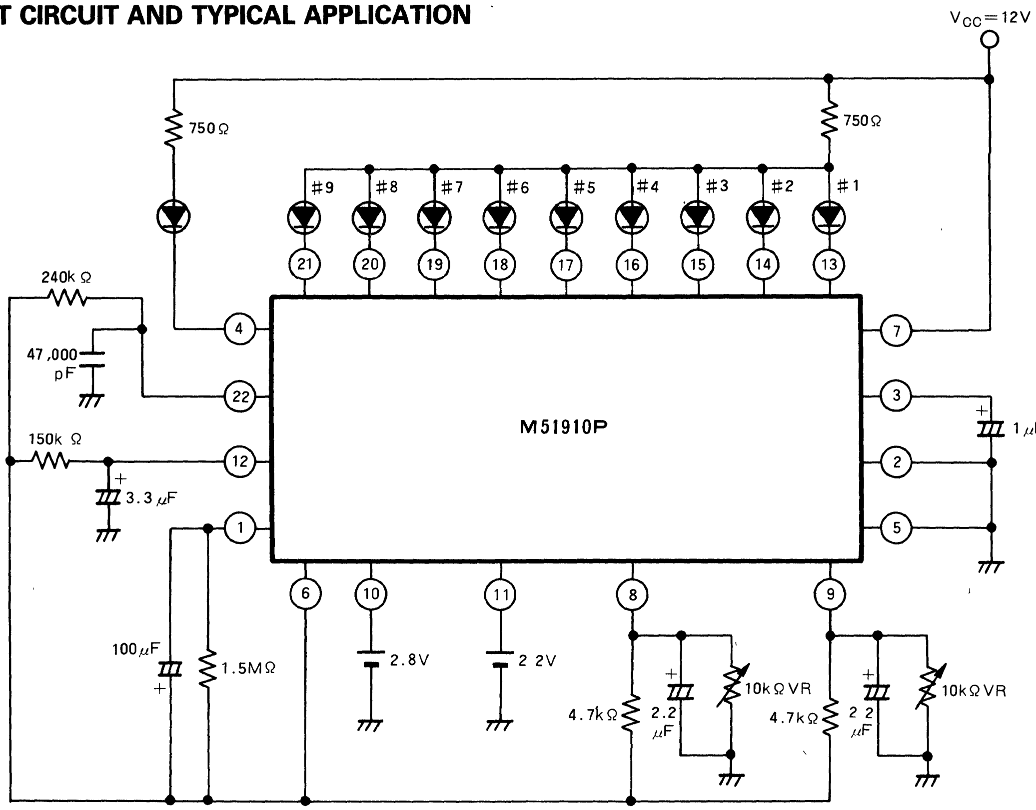
ERROR AMPLIFIER ON-OFF VOLTAGE VS. AMBIENT TEMPERATURE



DISPLAY THRESHOLD VOLTAGE VS. AMBIENT TEMPERATURE



TEST CIRCUIT AND TYPICAL APPLICATION



M51906P

6-STEP BAR TYPE LED LEVEL INDICATOR

DESCRIPTION

The M51906P is a semiconductor integrated circuit designed for LED level meters. It functions as a bar-type display for inputs of up to 6 LEDs. With its built-in advanced half-wave rectification operational amplifier, it accepts direct input of either AC or DC signals.

A logarithmic scale of 3, 0, −3, −7, −12, and −18dB display levels is provided, making the M51906P ideal for VU meters applications.

FEATURES

- Advanced half-wave rectification OP amp built in
  - Cut-off frequency .... 500kHz(typ.)
  - Offset voltage .... 2mV(typ.)
- High output drive current .... 30mA(max)
- Wide supply voltage range .... 4V~15V
- Small circuit current when in no-signal condition .... 0.9mA(typ.)
- Open-collector-type output, so power dissipation is low and low-voltage operation is possible
- Input amp gain is varied by external resistance
- Shifting the LED turn-on voltage is easy with the reference voltage setting pin

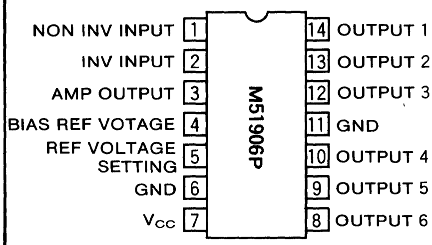
APPLICATION

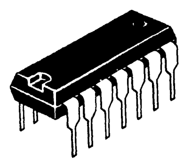
Signal meters, VU meters, and tuning meters.

RECOMMENDED OPERATING CONDITIONS

Supply voltage range .... 4~15V
Rated power supply .... 9V±10%

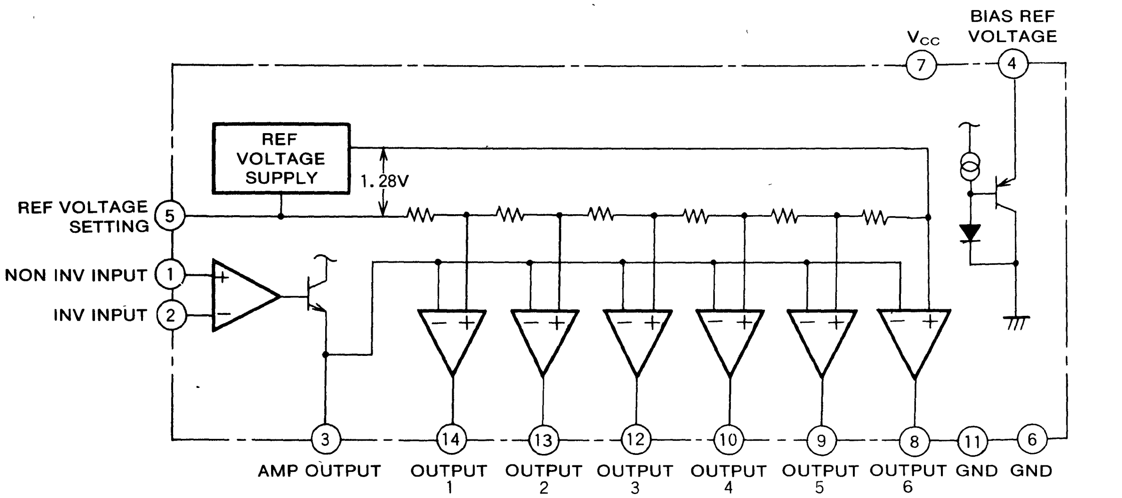
PIN CONFIGURATION (TOP VIEW)





14-pin molded plastic DIP

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

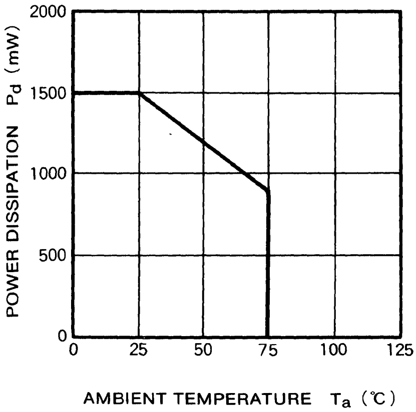
Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		16	V
BV_O	Output voltage		16	V
I_O	Output current		30	mA
V_{IN}	Input voltage	Input terminal to GND	$-3 \sim V_{CC}-0.8$	V
$\lvert V_{①}-V_{②} \rvert$	Input differential voltage	Pin ① to pin ②	5	V
$V_{⑤}$	Pin ⑤ voltage	Pin ⑤ to GND	4	V
$I_{④}$	Pin ④ input current		1.5	mA
$I_{③}$	Pin ③ output current		−1	mA
P_d	Power dissipation		1500	mW
K_θ	Thermal derating	$T_a \geqq 25$℃	12	mW/℃
T_{opr}	Operating temperature		−20～+75	℃
T_{stg}	Storage temperature		−40～+125	℃
$V_{③}$	Pin ③ voltage	Pin ③ to GND	6	V

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=9V, unless otherwise noted)

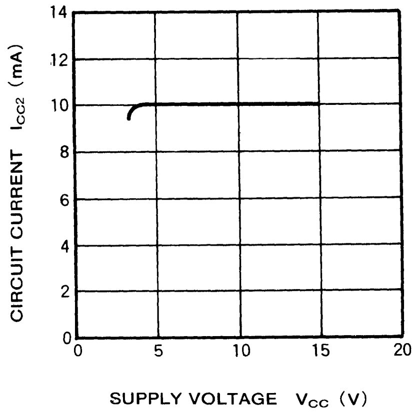
Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage		4.0		15.0	V
I_{CC1}	Circuit current	$V_{①}-V_{⑤}$=0V(when all LEDs are off)		0.9	2	mA
I_{CC2}	Circuit current	$V_{①}-V_{⑤}$=2V(when all LEDs are on)		10	20	mA
V_{IO}	Input amp offset	Input voltage $V_{①}$=2V		2	10	mV
I_{IB}	Input amp bias current	Input voltage $V_{①}$=2V		50	250	nA
V_{ref}	Reference voltage	Pin ④ voltage	1.15	1.35	1.55	V
$I_{⑤}$	Pin ⑤ output current	$V_{⑤}$=0V	−600	−400	−260	μA
V_{SAT}	Output saturation voltage	I_{sink}=30mA		0.3	1	V
V_{th1}	Output 1 threshold voltage	Amp gain=1 Pin ⑤ voltage is taken as reference	91	114	144	mV
			−20	−18	−16	dB
V_{th2}	Output 2 threshold voltage		181	228	287	mV
			−14	−12	−10	dB
V_{th3}	Output 3 threshold voltage		341	405	481	mV
			−8.5	−7	−5.5	dB
V_{th4}	Output 4 threshold voltage		572	641	720	mV
			−4	−3	−2	dB
V_{th5}	Output 5 threshold voltage		807	906	1017	mV
			−1	0	+1	dB
V_{th6}	Output 6 threshold voltage		1141	1280	1436	mV
			+2	+3	+4	dB
I_{OL}	Output leak current	$V_{OUT}=V_{CC}$			1	μA

TYPICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

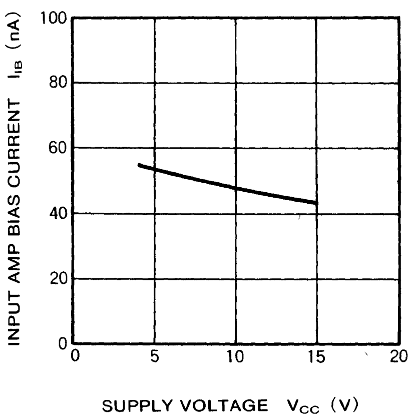
THERMAL DERATING (MAXIMUM RATING)



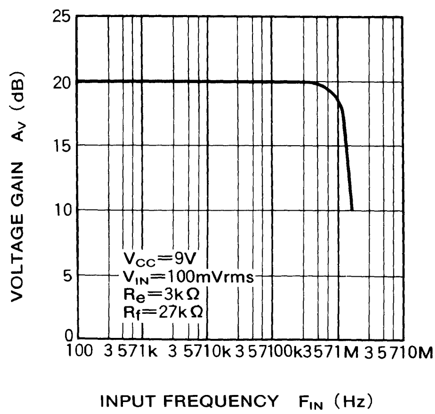
CIRCUIT CURRENT VS. SUPPLY VOLTAGE



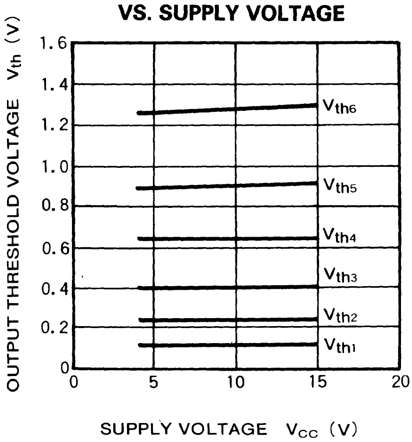
INPUT AMP BIAS CURRENT VS. SUPPLY VOLTAGE



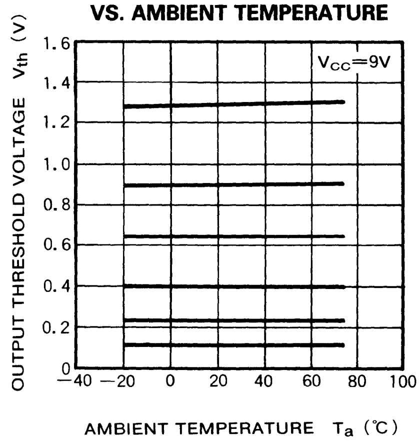
VOLTAGE GAIN VS. INPUT FREQUENCY



OUTPUT THRESHOLD VOLTAGE VS. SUPPLY VOLTAGE

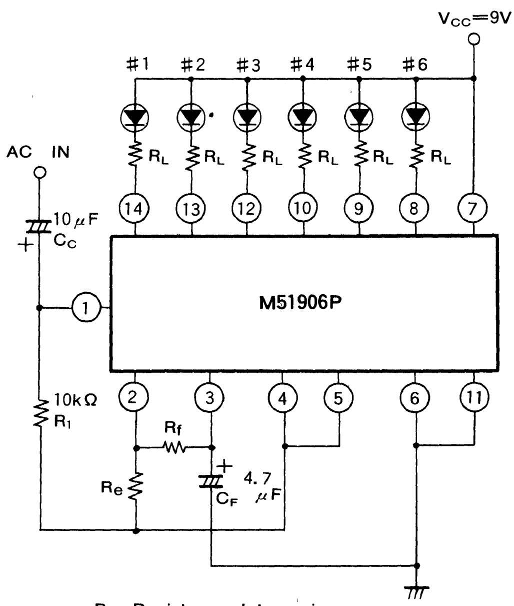


OUTPUT THRESHOLD VOLTAGE VS. AMBIENT TEMPERATURE



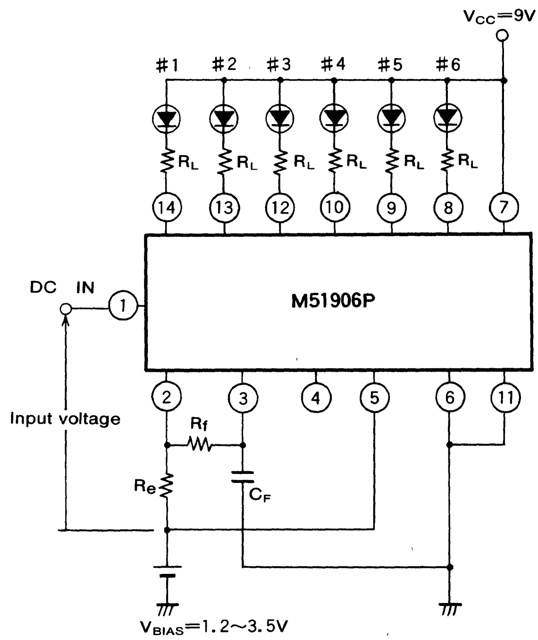
APPLICATION EXAMPLES

(1)AC INPUT



R_L Resistance determining LED current (470Ω typ)

(2) DC INPUT



OPERATION

The AC signal applied through the coupling capacitor C_C is rectified and amplified mainly at reference Pin ④, and then output at Pin ③. The voltage at Pin ③ is compared with the reference voltage at Pin ⑤ (internal reference voltage 1.28V divided on a logarithmic scale), and the LED is driven according to the comparator output.

Note 1. Amp gain

$$\frac{R_e+R_f}{R_e} \quad (R_e+R_f \sim 30k\Omega)$$

The peak value is output at Pin ③, so a DC voltage of approximately 1.4 times the rms value is output.

Note 2. Select the value of C_F according to the recovery time.

Recovery time: $C_F \times (R_e+R_f)$

Attack time: $C_F \times 430\Omega$

Note 3. LED current

$$\frac{V_{CC}-V_{FLED}-V_{SAT}}{R_L}$$

V_{FLED}: LED forward voltage drop

V_{SAT}: IC output saturation voltage

Note 4. Pin ④ voltage is approximately 1.35V at normal temperature (25℃), the temperature coefficient is −4mV/℃.

Note 5. If less then 6 LEDs are used, leave the unused output terminals open.

Note 6. When using DC input, leave Pin ④ open and connect the external reference voltage of 1.2~3.5V to Pin ⑤

CAUTION

1. If the power supply connection positive and negative terminals are reversed, the M51906P will lose a lot of current and this can cause serious damage to the device.
2. The output is an open collector, so load resistances must be connected in series with the LEDs.

M51907P

8-STEP BAR TYPE LED LEVEL INDICATOR

DESCRIPTION

The M51907P is a semiconductor integrated circuit designed for LED level meters. It drives a bar-type input-level display for up to 8 LEDs. With its built-in advanced half-wave rectification operational amplifier, the M51907P accepts direct input of either AC or DC signals.

A logarithmic scale of 5, 2, 0, −2, −5, −8, −13, and −18dB display levels is provided, making the M51907P ideal for signal meter applications.

FEATURES

- Advanced half-wave rectification OP amp built in
  - Cut-off frequency .... 200kHz(typ.)
  - Offset voltage .... 2mV(typ.)
- Output current can be adjusted with a single resistor .... 2~25mA
- Wide supply voltage range .... 4~15V
- LEDs are grouped in two's by cascade connection, so when all LEDs are driven in parallel, the current required is reduced by half
- Parallel shifting of the LED turn-on voltage is easy with the lower ref in pin
- Advanced half-wave OP amp gain is varied by external resistance
- Reference voltage terminal for full-scale coordination, making it easy to use the M51907P and the companion M51909P in cascade connection to drive more than 8 LEDs.

APPLICATION

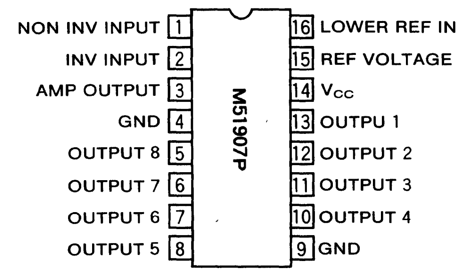
Signal meters, VU meters, and tuning meters.

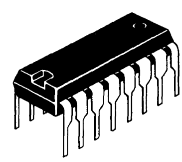
RECOMMENDED OPERATING CONDITIONS

Supply voltage range .... 4~15V

Rated power supply .... 9V±10%

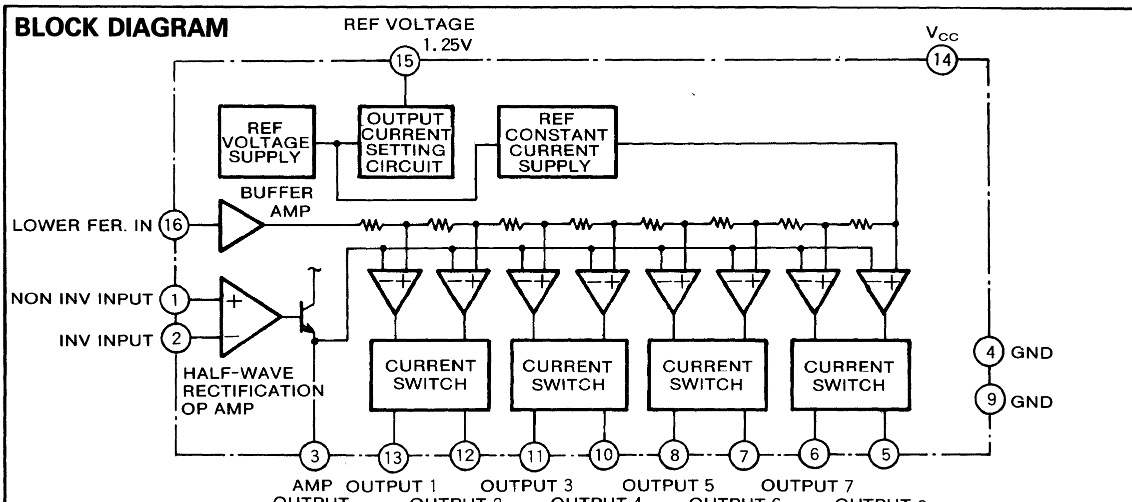
PIN CONFIGURATION (TOP VIEW)





16-pin molded plastic DIP

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

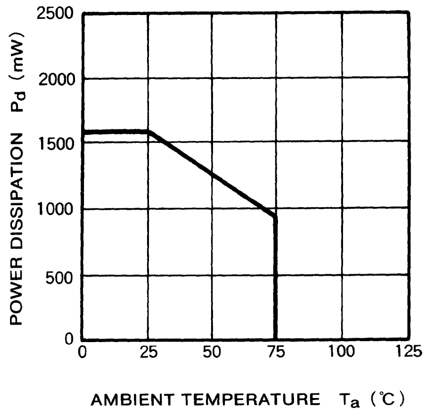
Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		16	V
BV_O	Output voltage		16	V
I_O	Output current		25	mA
V_{IN}	Input voltage	Input pin to GND	−3∼V_{CC}	V
$\|V_{①}-V_{②}\|$	Input differential voltage	Pin ① to pin ②	5	V
$V_{⑯}$	Pin ⑯ voltage	Pin ⑯ to GND	V_{CC}	V
$I_{⑮}$	Pin ⑮ input current		500	μA
$I_{③}$	Pin ③ output current	Static value	−1	mA
P_d	Power dissipation		1600	mW
K_{θ}	Thermal derating	T_a≧25℃	12.8	mW/℃
T_{opr}	Operating temperature		−20∼+75	℃
T_{stg}	Storage temperature		−40∼+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=9V, unless otherwise noted) R_{ad}: Pin ⑮ adjustable resistor

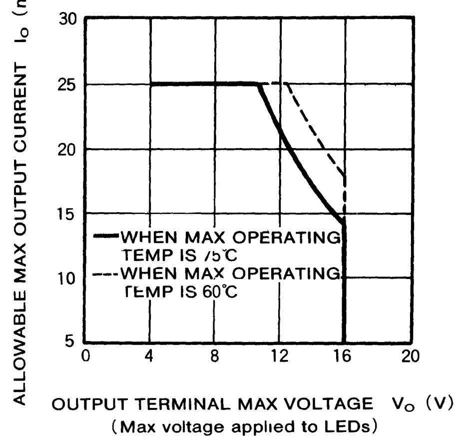
Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage		4.0		15.0	V
I_{CC1}	Circuit current	$V_{①}$=0V(when all LEDs are off) R_{ad}=2.8kΩ		5.0	8.0	mA
I_{CC2}	Circuit current	$V_{①}$=2V(when all LEDs are on) R_{ad}=2.8kΩ		7.0	11.2	mA
V_{IO}	Input offset voltage	Input voltage $V_{①}$=1V		2	10	mV
I_{IB}	Input bias current	Input voltage $V_{①}$=0V	−300	−50		nA
V_{IN}	Input voltage range		0		V_{CC}−2	V
V_{ref}	Reference voltage	R_{ad}=6.4kΩ	1.125	1.250	1.375	V
$V_{⑯}$	Pin ⑯ set voltage range		−0.2		V_{CC}−3.5	V
$I_{⑯}$	Pin ⑯ output current		−2000	−50		nA
V_{th1}	Output 1 threshold voltage	Amp gain=1 Pin ⑯ voltage is taken as reference	70	89	111	mV_{DC}
			−20	−18	−16	dB
V_{th2}	Output 2 threshold voltage		125	157	198	mV_{DC}
			−15	−13	−11	dB
V_{th3}	Output 3 threshold voltage		235	280	333	mV_{DC}
			−9.5	−8	−6.5	dB
V_{th4}	Output 4 threshold voltage		352	395	443	mV_{DC}
			−6	−5	−4	dB
V_{th5}	Output 5 threshold voltage		498	558	627	mV_{DC}
			−3	−2	−1	dB
V_{th6}	Output 6 threshold voltage		627	703	789	mV_{DC}
			−1	0	+1	dB
V_{th7}	Output 7 threshold voltage		789	885	993	mV_{DC}
			+1	+2	+3	dB
V_{th8}	Output 8 threshold voltage		1114	1250	1403	mV_{DC}
			+4	+5	+6	dB
I_{OL}	Output leak current				1	μA
I_O	Output current	R_{ad}=6.4kΩ	9.6	12	14.4	mA
I_O'	Output current	R_{ad}=2.8kΩ	20	25	30	mA
V_{SAT}	Output saturation voltage	R_{ad}=2.8kΩ I_O=12.5mA			500	mV

TYPICAL CHARACTERISTICS (Ta=25℃, unless otherwise noted)

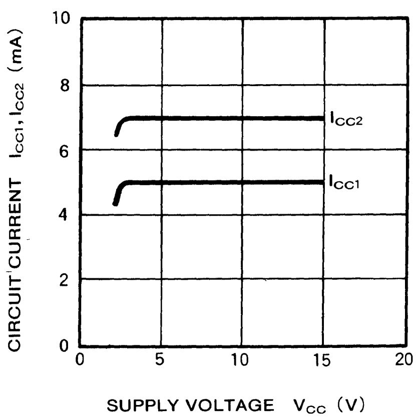
THERMAL DERATING (MAXIMUM RATING)



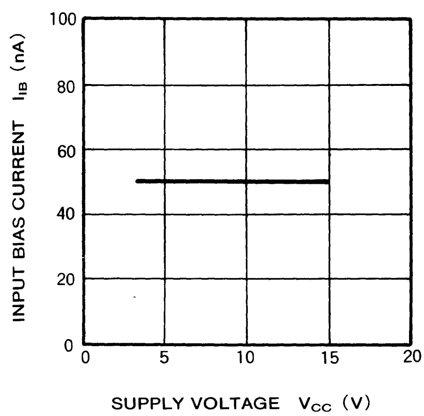
ALLOWABLE MAX OUTPUT CURRENT VS. OUTPUT TERMINAL MAX VOLTAGE



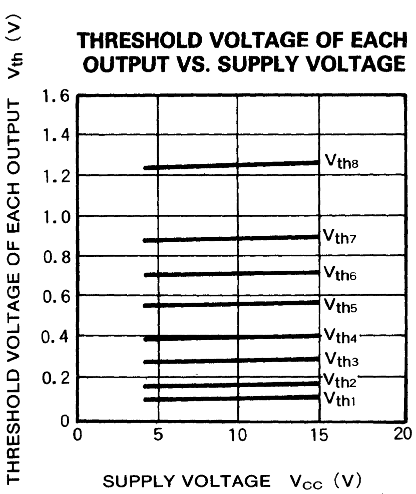
CIRCUIT CURRENT VS. SUPPLY VOLTAGE



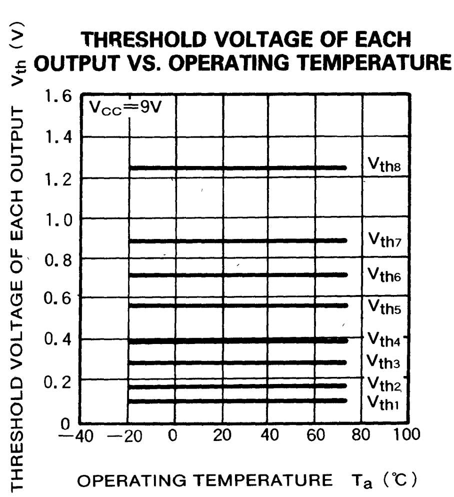
INPUT BIAS CURRENT VS. SUPPLY VOLTAGE



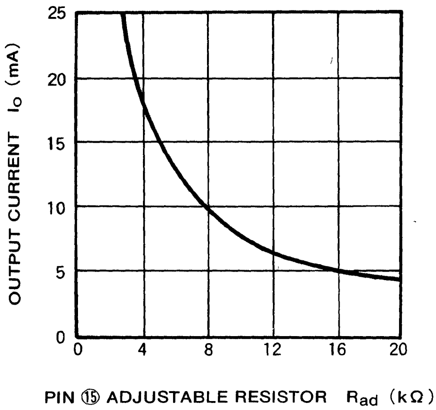
THRESHOLD VOLTAGE OF EACH OUTPUT VS. SUPPLY VOLTAGE



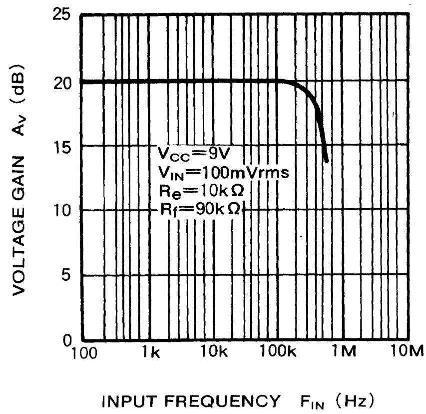
THRESHOLD VOLTAGE OF EACH OUTPUT VS. OPERATING TEMPERATURE



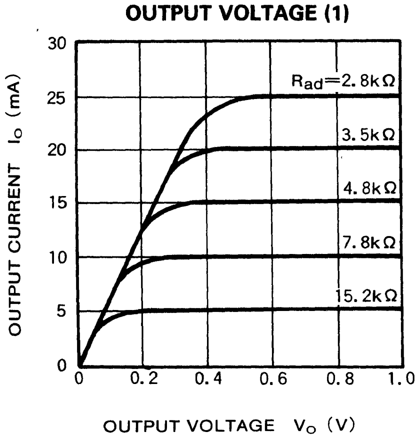
OUTPUT CURRENT VS. PIN ⑮ ADJUSTABLE RESISTOR



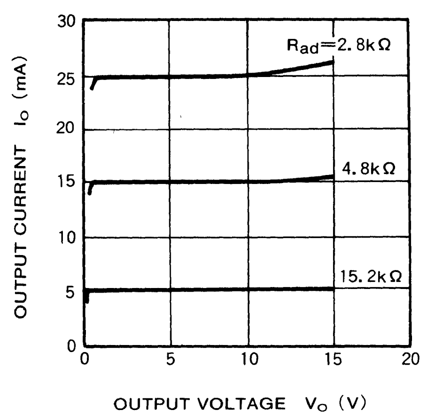
HALF-WAVE RECTIFIER OP AMP VOLTAGE GAIN VS. INPUT FREQUENCY



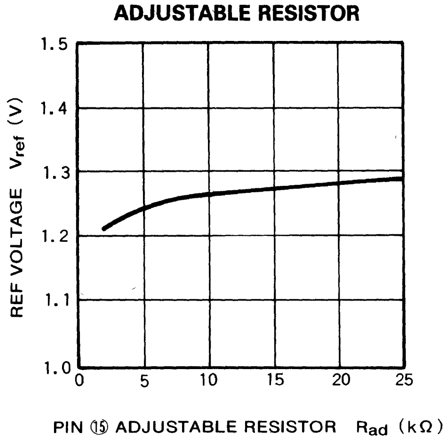
OUTPUT CURRENT VS. OUTPUT VOLTAGE (1)



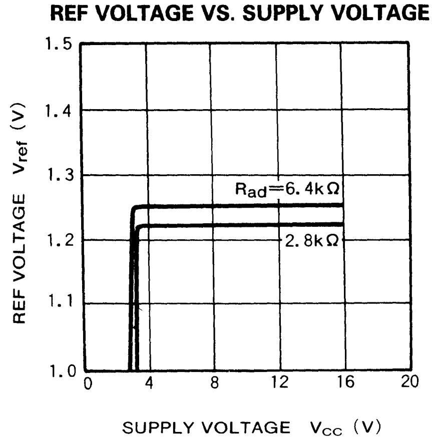
OUTPUT CURRENT VS. OUTPUT VOLTAGE (2)



REF VOLTAGE VS. PIN ⑮ ADJUSTABLE RESISTOR



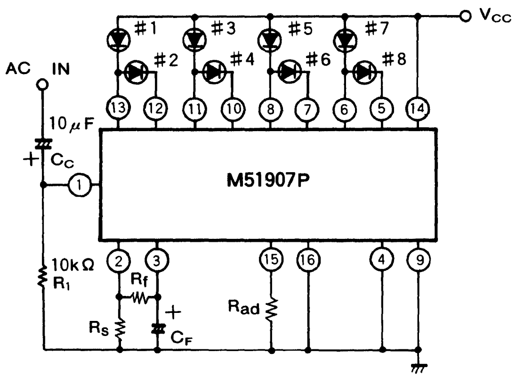
REF VOLTAGE VS. SUPPLY VOLTAGE



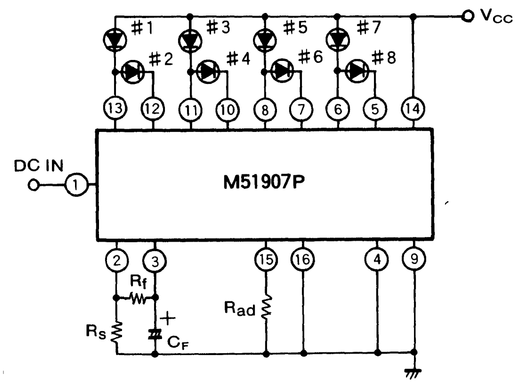
MITSUBISHI ELECTRIC

APPLICATION EXAMPLES

(1) AC INPUT



(2) DC INPUT



R_{ad}: Resistance determining LED current
(See OUTPUT CURRENT VS. PIN ⑮ ADJUSTABLE RESISTANCE graph)

OPERATION

The AC signal applied through the coupling capacitor C_C is rectified and amplified mainly by the GND voltage and output at Pin ③. The voltage at Pin ③ is compared with the reference voltage at Pin ⑯ (internal reference voltage 1.25V divided on a logarithmic scale), and the resultant comparator output drives the LEDs.

Note 1. Amp gain

$$\frac{R_S+R_f}{R_S}$$

The peak value is output at Pin ③, so when this is a sine wave, a DC voltage of approximately 1.4 times the rms value is output.

Note 2. Select the value of C_F according to the recovery time.

Recovery time: $C_F \times (R_S+R_f)$

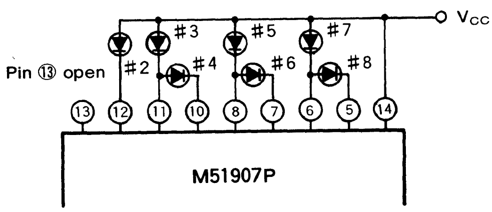
Attack time: $C_F \times 460\Omega$

Note 3. LED current

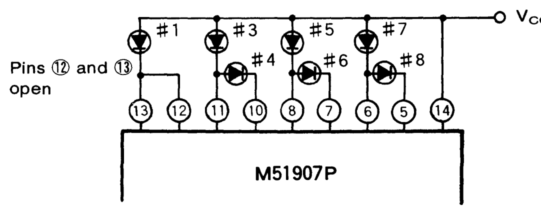
Pin ⑮ adjustable resistor determines the LED current. (See the OUTPUT CURRENT VS. PIN ⑮ ADJUSTABLE RESISTOR graph)

Note 4. When less than 8 LEDs are used, proceed as follows.

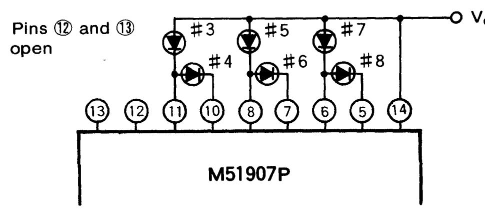
1. When #1 LED is not used:



2. When #2 LED is not used:

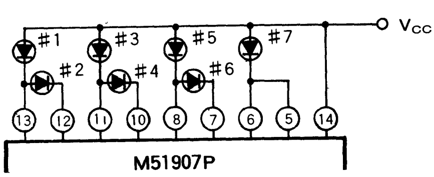


3. When #1 and #2 LEDs are not used:



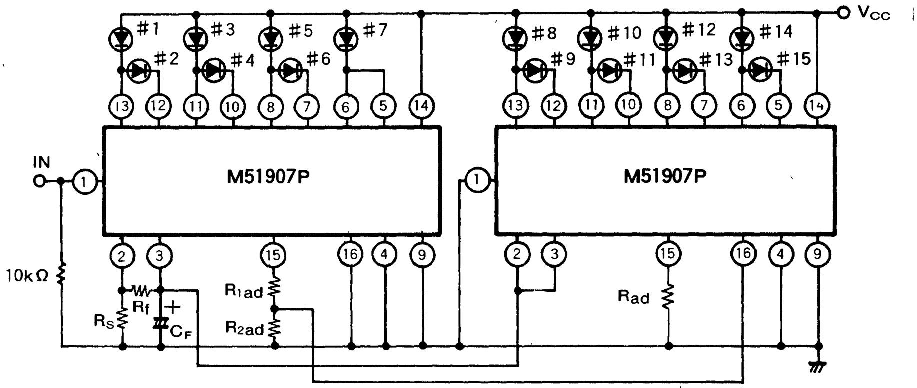
4. When any of LEDs #3 to #8 are not used:

When an even-numbered LED is not used, follow the procedure given for LED # 2, and when an odd-numbered LED is not used, follow that for LED #3.



(3) Cascade connection

It is easy to create a 16-step indicator by using two M51907Ps, but the drive threshold value (dB) is irregular, so there is a tendency to unnatural deviation is the drive threshold value at the connection. The following example illustrates how this problem is avoided. Fifteen LEDs can be driven using this configuration with the M51907P and the M51909P.

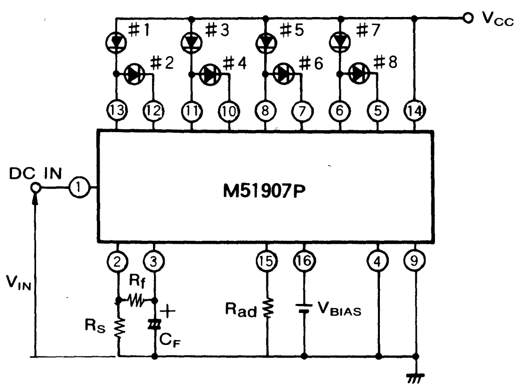


Note 1. To equalize the brightness levels of the M51907P and the M51909P, select R_{1ad} and R_{2ad} so that $R_{ad}=R_{1ad}+R_{2ad}$.

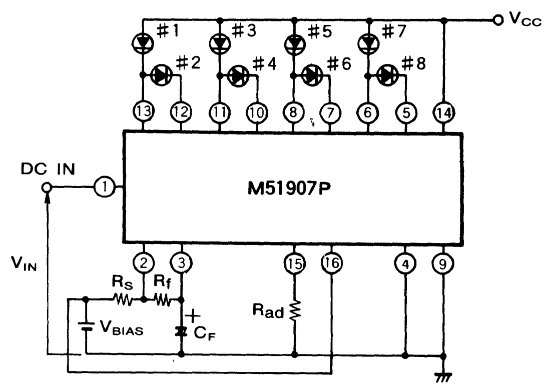
Note 2. When values for R_{1ad} and R_{2ad} are selected so that $R_{1ad}:R_{2ad}=1:2.53$, the threshold values are as follows.

#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12	#13	#14	#15
−24.6dB	−19.7dB	−14.7dB	−11.7dB	−8.7dB	−6.7dB	−4.7dB	−3.2dB	−2.0dB	−0.9dB	0dB	0.86dB	1.63dB	2.34dB	3dB

(4) Fixed reference bias DC input



Display is given by the formula $V_{IN}\times\frac{R_S+R_f}{R_S}-V_{BIAS}$

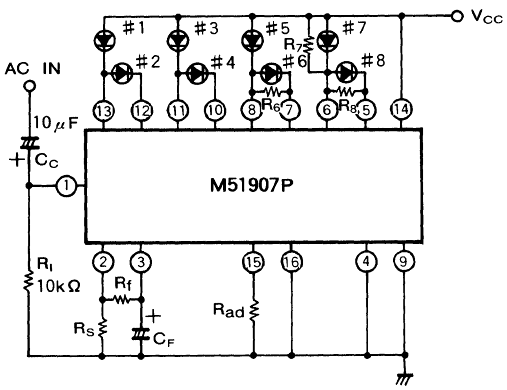


Display is given by the formula $(V_{IN}-V_{BIAS})\times\frac{R_S+R_f}{R_S}$

(5) Different color LEDs (when different drive currents are desired for the LEDs)

Select Pin ⑮ adjustable resistor for connection to the LED that requires the maximum drive current. Then connect resistors in parallel to the remaining LEDs with reduced current.

For example, to reduce the current for LEDs #6, #7, and #8, use the following arrangement.



The currents flowing through each of the LEDs in the above circuit configuration are given by the following formulas.

For LEDs #1～#5

$$I_{LEDA} \sim 60 \times \frac{V_{⑮}}{R_{ad}}$$

For LED #6

$$I_{LEDB} \sim 60 \times \frac{V_{⑮}}{R_{ad}} - \frac{V_{F6}}{R_6} = I_{LEDA} - \frac{V_{F6}}{R_6}$$

For LED #7

$$I_{LEDC} \sim 60 \times \frac{V_{⑮}}{R_{ad}} - \frac{V_{F7}}{R_7} = I_{LEDA} - \frac{V_{F7}}{R_7}$$

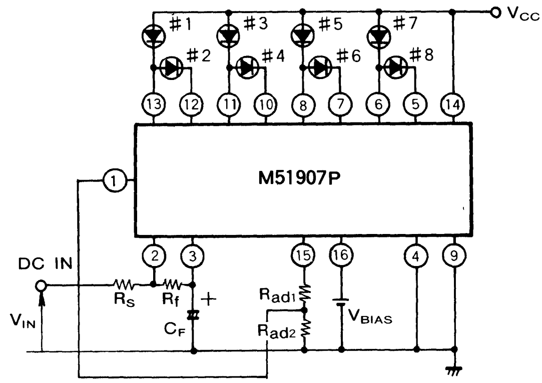
For LED #8

$$I_{LEDD} \sim 60 \times \frac{V_{⑮}}{R_{ad}} - \frac{V_{F8}}{R_8} = I_{LEDA} - \frac{V_{F8}}{R_8}$$

$V_{⑮}$, Pin ⑮ voltage, is 1.25V and V_{F6}, V_{F7}, and V_{F8} are the forward voltage drops for LEDs #6, #7, and #8 respectively.

The M51907P is designed so that the temperature-dependency of the voltage at Pin ⑮ is very low. The LED forward voltage drop, only −2 to −2.5mV/℃, also has a relatively low temperature dependence. These design features make it possible to accurately set the current flowing through each LED.

(6) All LEDs light at minimum-voltage input signal, and the LEDs are extinguished as the input voltage increases



Display follows the formula:

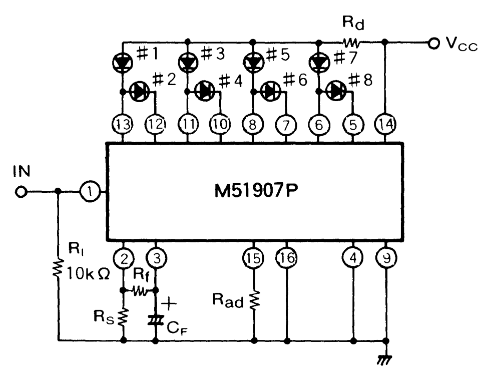
$$\frac{1.25(V) \times R_{ad2}}{R_{ad1} + R_{ad2}} \times \left(1 + \frac{R_f}{R_S}\right) - V_{IN} \times \frac{R_f}{R_S} - V_{BIAS}$$

Note LED drive voltage is determined by $R_{ad1} + R_{ad2}$

(7) High supply voltage produces high output currents

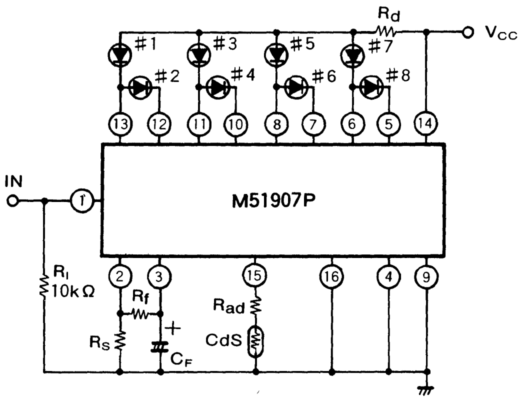
The relation between the allowable output current and the maximum voltage at the output terminal is determined by the thermal derating curve. (See the ALLOWABLE OUTPUT CURRENT VS. OUTPUT TERMINAL MAXIMUM VOLTAGE graph)

Therefore, if the user wants a high supply voltage to produce high output currents, the following circuit configuration can be used, but the output terminal voltage must be low



A realistic design involves taking the required output current (LED current· I_{LED}) as the allowable maximum output current, and then determining the corresponding output terminal maximum voltage $V_{O\,max}$ from the ALLOWABLE OUTPUT CURRENT VS. OUTPUT TERMINAL MAX VOLTAGE graph. Then if the maximum value for the supply voltage is $V_{CC\,max}$, the value of R_d has to be determined to satisfy the relation $4 \cdot I_{LED} \cdot R_d > V_{CC\,max} - V_{O\,max}$.

(8) Adjusting LED brightness with respect to the surrounding light



The LED current is determined by $R_{ad}+R_{cds}$.

M51909P

8-STEP BAR TYPE LED LEVEL INDICATOR

DESCRIPTION

The M51909P is a semiconductor integrated circuit designed for LED level meters. It drives a bar-type input-level display for up to 8 LEDs. With its built-in advanced half-wave rectification operational amplifier, the M51909P accepts direct input of either AC or DC signals.

A linear scale of display levels is provided, making the M51909P especially suitable for signal meter applications.

FEATURES

- Advanced half-wave rectification OP amp built in
  Cut-off frequency ································ 200kHz(typ.)
  Offset voltage ··2mV(typ.)
- Output current can be adjusted with a single resistor
  ·· 2~25mA
- Wide supply voltage range ································4~15V
- LEDs are grouped in two's by cascade connection, so when all LEDs are driven in parallel, the current required is reduced by half
- Parallel shifting of the LED turn-on voltage is easy with the lower ref in pin
- Advanced half-wave OP amp gain is varied by external resistance
- Reference voltage terminal for full-scale coordination, making it easy to use the M51907P and the M51909P in cascade connection to drive more than 8 LEDs

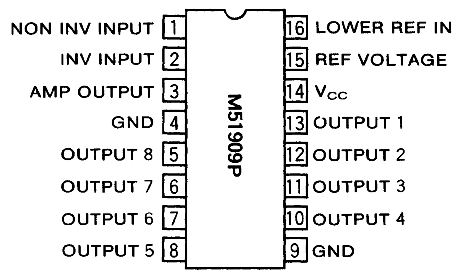
APPLICATION

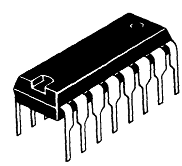
Signal meters, VU meters, and tuning meters.

RECOMMENDED OPERATING CONDITIONS

Supply voltage range ·································· 4~15V
Rated power supply ································ 9V±10%

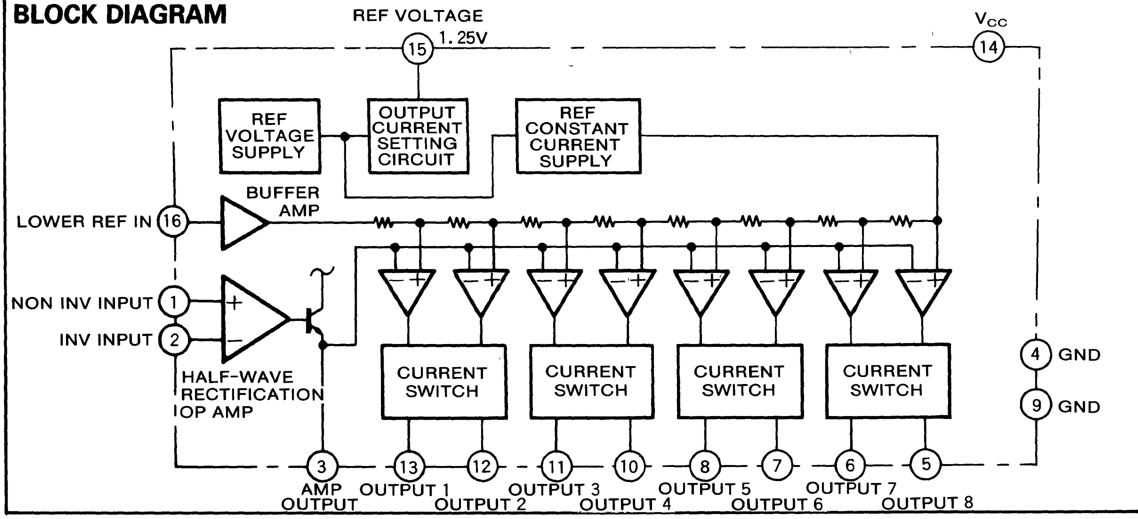
PIN CONFIGURATION (TOP VIEW)





16-pin molded plastic DIP

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

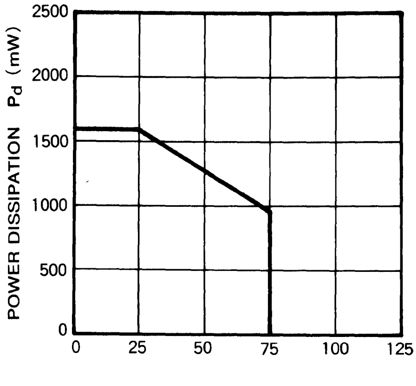
Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		16	V
BV_O	Output voltage		16	V
I_O	Output current		25	mA
V_{IN}	Input voltage	Input pin to GND	−3～V_{CC}	V
$\|V_{①}-V_{②}\|$	Input differential voltage	Pin ① to pin ②	5	V
$V_{⑯}$	Pin ⑯ voltage	Pin ⑯ to GND	V_{CC}	V
$I_{⑮}$	Pin ⑮ input current		−500	μA
$I_{③}$	Pin ③ output current	Static value	−1	mA
P_d	Power dissipation		1600	mW
K_θ	Thermal derating	T_a≧25℃	12.8	mW/℃
T_{opr}	Operating temperature		−20～+75	℃
T_{stg}	Storage temperature		−40～+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=9V, unless otherwise noted) R_{ad} Pin ⑮ adjustable resistor

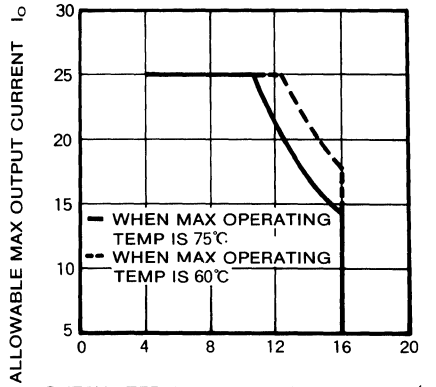
Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage		4.0		15.0	V
I_{CC1}	Circuit current	$V_{①}$=0V(when all LEDs are off) R_{ad}=2.8kΩ		5.0	8.0	mA
I_{CC2}	Circuit current	$V_{①}$=2V(when all LEDs are on) R_{ad}=2.8kΩ		7.0	11.2	mA
V_{IO}	Input offset voltage	Input voltage $V_{①}$=1V		2	10	mV
I_{IB}	Input bias current	Input voltage $V_{①}$=0V	−300	−50		nA
V_{IN}	Input voltage range		0		V_{CC}−2	V
V_{ref}	Reference voltage	R_{ad}=6.4kΩ	1.125	1.250	1.375	V
$V_{⑯}$	Pin ⑯ set voltage		−0.2		V_{CC}−3.5	V
$I_{⑯}$	Pin ⑯ output current		−2000	−50		nA
V_{th1}	Output 1 threshold voltage	Amp gain=1 Pin ⑯ voltage is taken	136	156	177	mV
V_{th2}	Output 2 threshold voltage		276	313	349	mV
V_{th3}	Output 3 threshold voltage		417	469	521	mV
V_{th4}	Output 4 threshold voltage		558	625	693	mV
V_{th5}	Output 5 threshold voltage		698	781	864	mV
V_{th6}	Output 6 threshold voltage		839	938	1036	mV
V_{th7}	Output 7 threshold voltage		979	1094	1208	mV
V_{th8}	Output 8 threshold voltage		1120	1250	1380	mV
I_{OL}	Output leak current				1	μA
I_O	Output current	R_{ad}=6.4kΩ	9.6	12	14.4	mA
I_O'	Output current	R_{ad}=2.8kΩ	20	25	30	mA
V_{SAT}	Output saturation voltage	R_{ad}=2.8kΩ I_O=12.5mA			500	mV

TYPICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

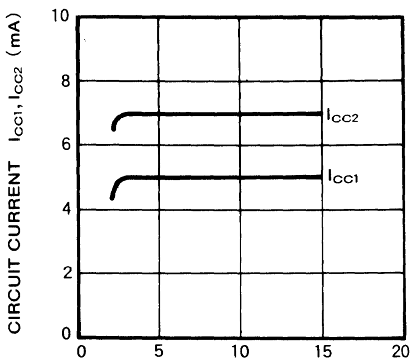
THERMAL DERATING (MAXIMUM RATING)



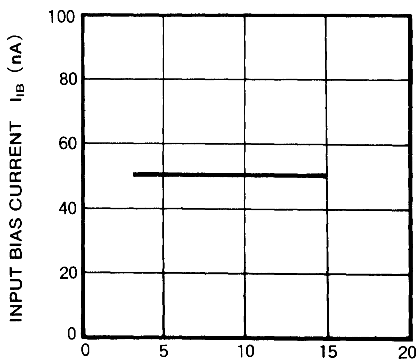
ALLOWABLE MAX OUTPUT CURRENT VS. OUTPUT TERMINAL MAX VOLTAGE



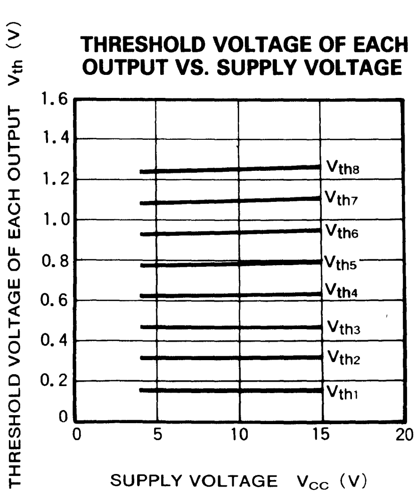
CIRCUIT CURRENT VS. SUPPLY VOLTAGE



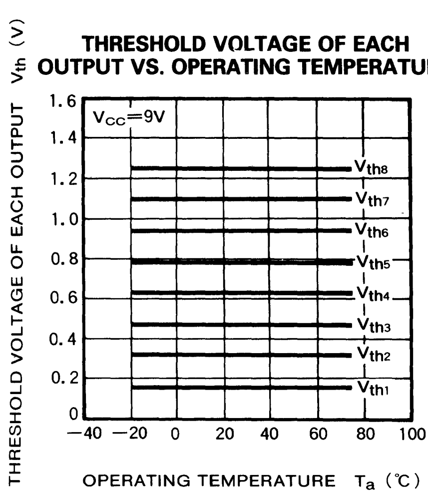
INPUT BIAS CURRENT VS. SUPPLY VOLTAGE



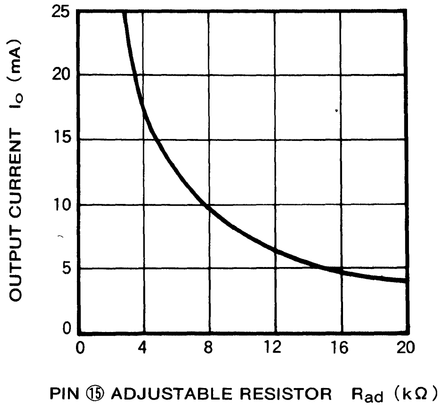
THRESHOLD VOLTAGE OF EACH OUTPUT VS. SUPPLY VOLTAGE



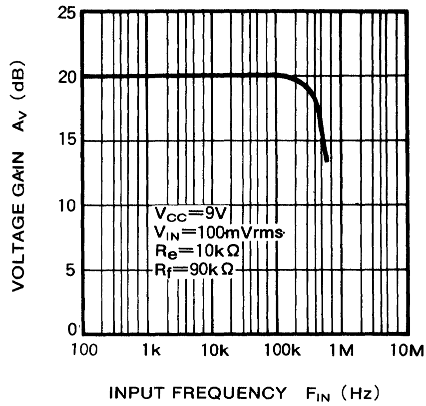
THRESHOLD VOLTAGE OF EACH OUTPUT VS. OPERATING TEMPERATURE



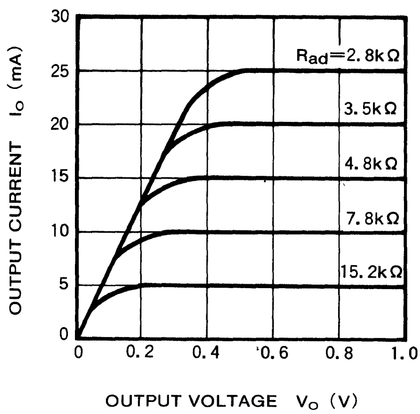
OUTPUT CURRENT VS. PIN ⑮ ADJUSTABLE RESISTOR



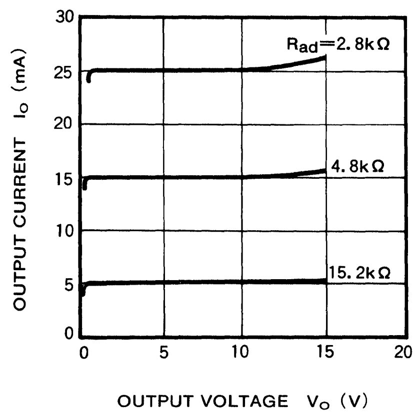
HALF-WAVE RECTIFIER OF AMP VOLTAGE GAIN VS. INPUT FREQUENCY



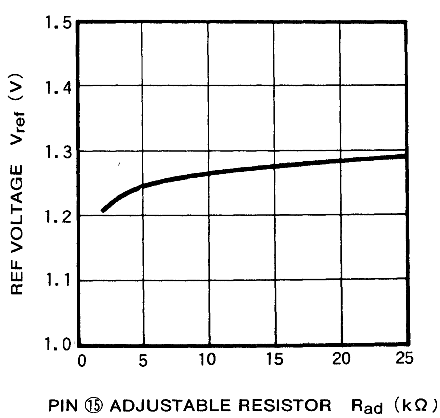
OUTPUT CURRENT VS. OUTPUT VOLTAGE (1)



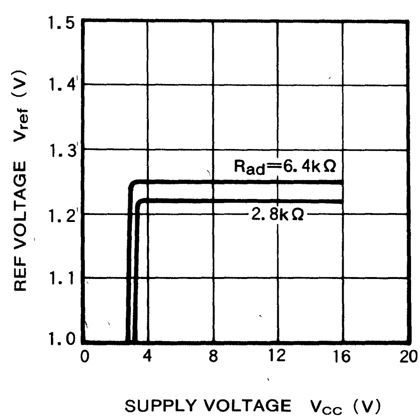
OUTPUT CURRENT VS. OUTPUT VOLTAGE (2)



REF VOLTAGE VS. PIN ⑮ ADJUSTABLE RESISTOR

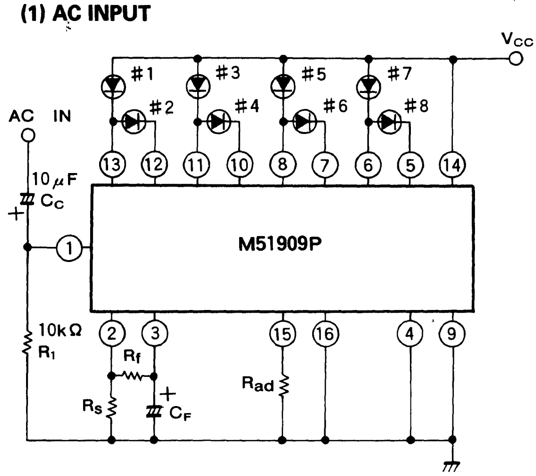


REF VOLTAGE VS. SUPPLY VOLTAGE

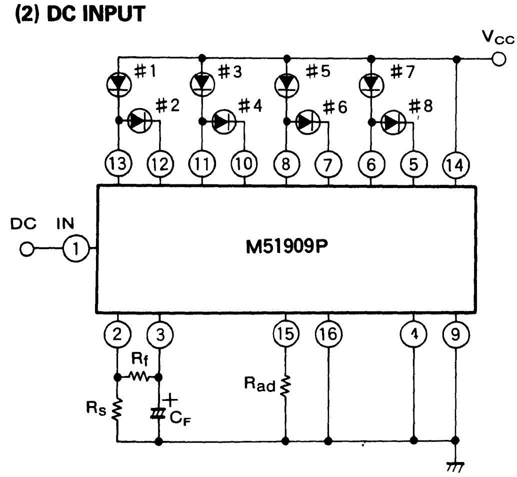


APPLICATION EXAMPLES

(1) AC INPUT



(2) DC INPUT



R_{ad}: Resistance determining LED current
(See OUTPUT CURRENT VS. PIN ⑮ ADJUSTABLE RESISTOR graph)

OPERATION

The AC signal applied through the coupling capacitor C_C is rectified and amplified mainly with the GND voltage and output at Pin ③. The voltage at Pin ③ compared with the reference voltage at Pin ⑯ (internal reference voltage 1.25V divided on a logarithmic scale), and the resultant comparator output drives the LEDs.

Note 1. Amp gain

$$\frac{R_S+R_f}{R_S}$$

The peak value is output at Pin ③, so when this is a sine wave, a DC voltage of approximately 1.4 times the rms value is output.

Note 2. Select the value of C_F according to the recovery time.

Recovery time: $C_F \times (R_S+R_f)$

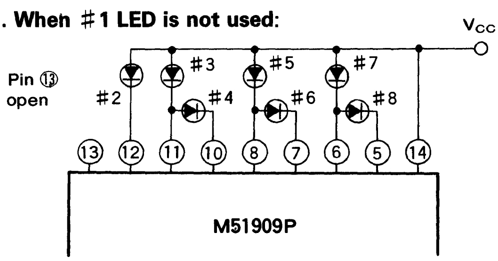
Attack time: $C_F \times 460\Omega$

Note 3. LED current

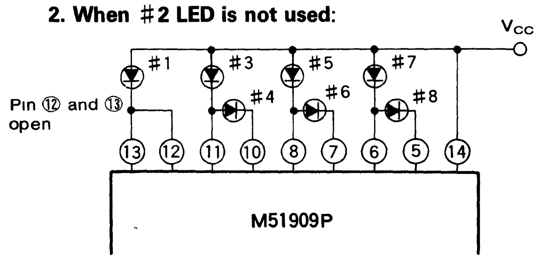
Pin ⑮ adjustable resistor determines the LED current. (See the OUTPUT CURRENT VS. PIN ⑮ ADJUSTABLE RESISTOR graph)

Note 4. When less than 8 LEDs are used, proceed as follows.

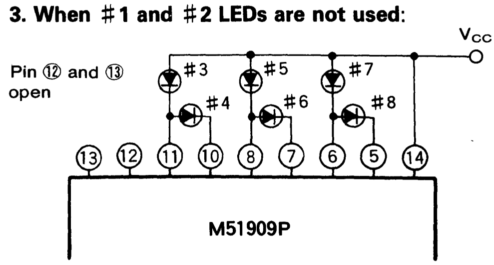
1. When #1 LED is not used:



2. When #2 LED is not used:

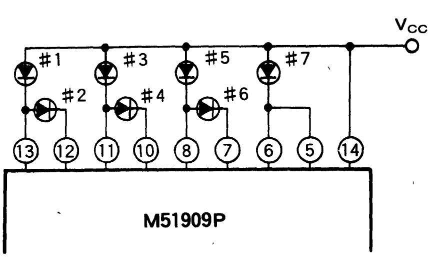


3. When #1 and #2 LEDs are not used:

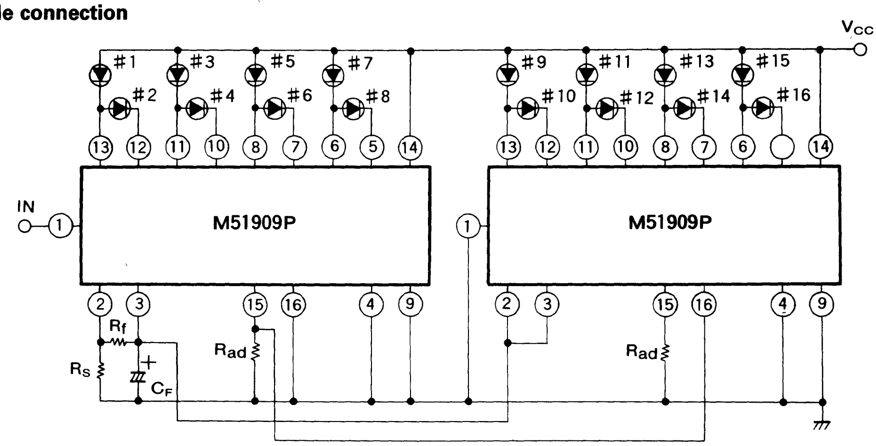


4. When any of LEDs #3 to #8 are not used:

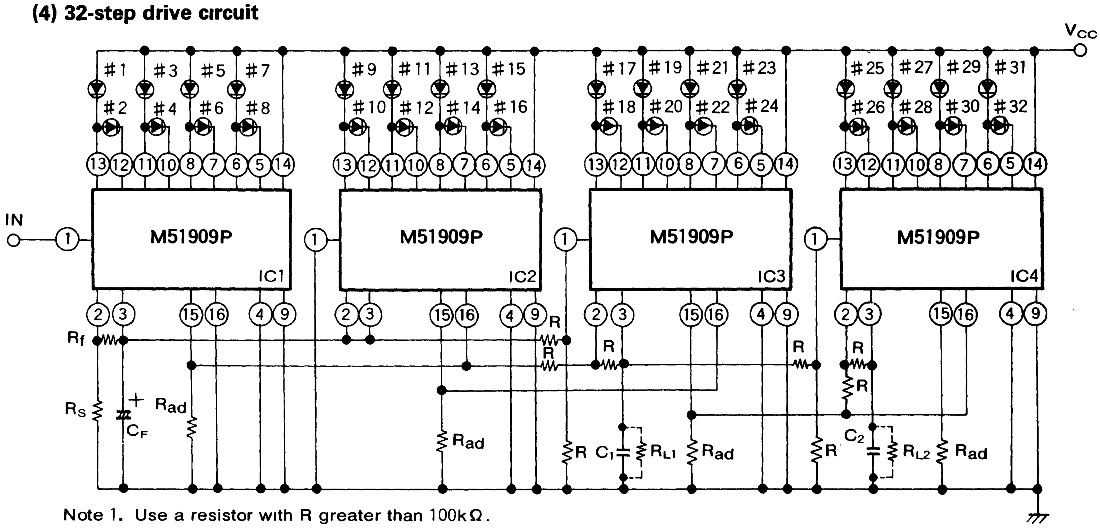
When an even-numbered LED is not used, follow the procedure given for LED #2, and when an odd-numbered LED is not used, follow that for LED #3.



(3) Cascade connection



(4) 32-step drive circuit



Note 1. Use a resistor with R greater than 100kΩ.

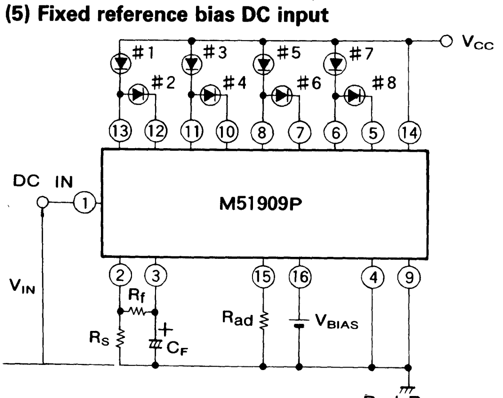
Note 2. The circuit above works best when V_{CC} is greater than 6V.

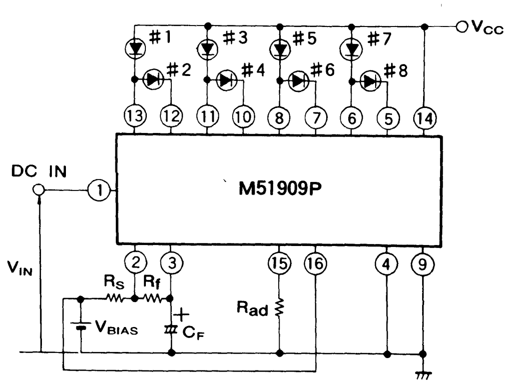
Note 3. Adjust the LED drive current by adjusting R_{ad}

Note 4. Select C_F for the desired recovery time.
Time constants $\sim C_F(R_f+10k)$

Note 5. C_1 and C_2 stop oscillation.
The recovery time must be extended so that the following relation holds between charge resistors R_{L1} and R_{L2} for C_1 and C_2.

(5) Fixed reference bias DC input

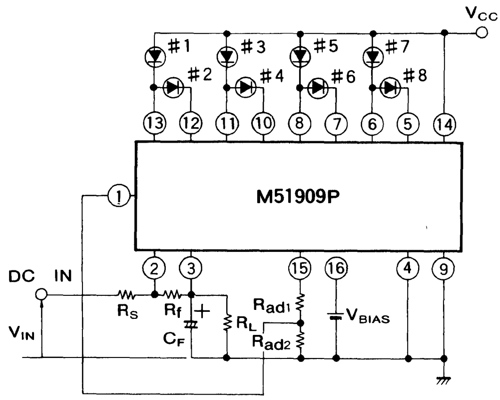




Display is given by the formula $V_{IN} \times \frac{R_S+R_f}{R_S} - V_{BIAS}$

Display is given by the formula $(V_{IN}-V_{BIAS}) \times \frac{R_S+R_f}{R_S}$

(6) All LEDs light at minimum-voltage input signal, and the LEDs are extinguished as the input voltage increases



Display follows the formula:

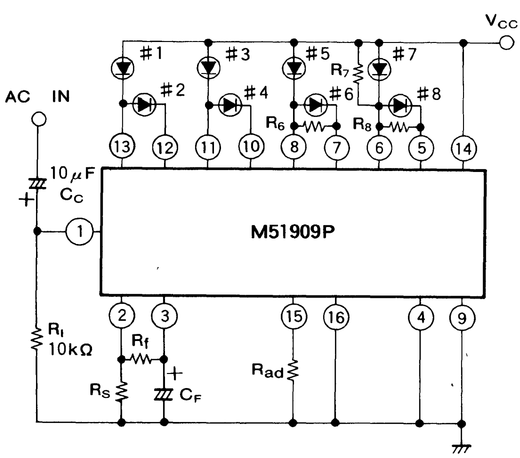
$$\frac{1.25(V)\times R_{ad2}}{R_{ad1}+R_{ad2}}\times\left(1+\frac{R_f}{R_S}\right)-V_{IN}\times\frac{R_f}{R_S}-V_{BIAS}$$

Note LED drive voltage is determined by $R_{ad1}+R_{ad2}$

(7) Different color LEDs (when different drive currents are desired for the LEDs)

Select Pin ⑮ adjustable resistor for connection to the LED that requires the maximum drive current. Then connect resistors in parallel to the remaining LEDs using reduced current.

For example, to reduce the current for LEDs #6, #7, and #8, use the following arrangement.



The currents flowing through each of the LEDs in the above circuit configuration are given by the following formulas.

For LEDs #1~#5

$$I_{LEDA}\sim 60\times\frac{V_{⑮}}{R_{ad}}$$

For LED #6

$$I_{LEDB}\sim 60\times\frac{V_{⑮}}{R_{ad}}-\frac{V_{F6}}{R_6}=I_{LEDA}-\frac{V_{F6}}{R_6}$$

For LED #7

$$I_{LEDC}\sim 60\times\frac{V_{⑮}}{R_{ad}}-\frac{V_{F7}}{R_7}=I_{LEDA}-\frac{V_{F7}}{R_7}$$

For LED #8

$$I_{LEDC}\sim 60\times\frac{V_{⑮}}{R_{ad}}-\frac{V_{F8}}{R_8}=I_{LEDA}-\frac{V_{F8}}{R_8}$$

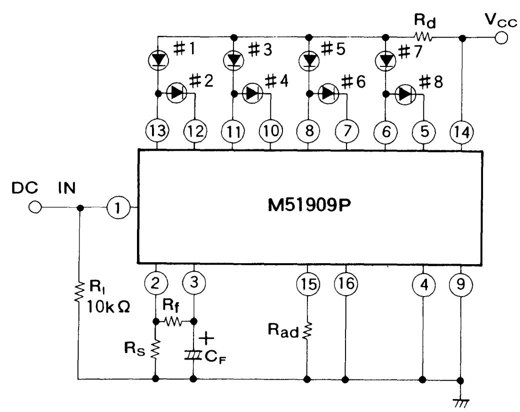
$V_{⑮}$, Pin ⑮ voltage, is 1.25V and V_{F6}, V_{F7}, and V_{F8} are the forward voltage drips for LEDs #6, #7, and #8 respectively.

The M51907P is designed so that the temperature-dependency of the voltage at Pin ⑮ is very low. The LED forward voltage drop, only −2 to −2.5mV/℃, also has a relatively low temperature dependence. These design features make it possible to accurately set the current flowing through each LED.

(8) High supply voltage produces high output currents

The relation between the allowable output current and the maximum voltage at the output terminal is determined by the thermal derating curve. (See the ALLOWABLE OUTPUT CURRENT VS. OUTPUT TERMINAL MAXIMUM VOLTAGE graph)

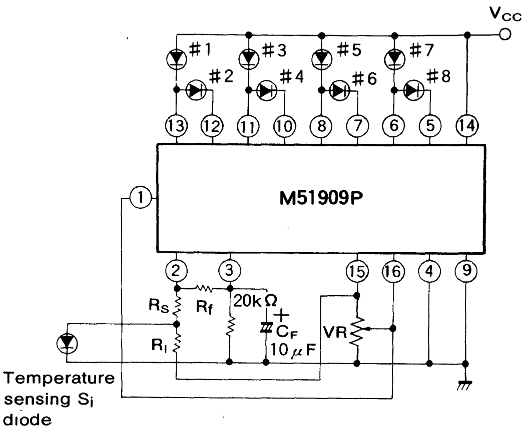
Therefore, if the user wants a high supply voltage to produce high output currents, the following circuit configuration can be used, but the output terminal voltage must be low.



A realistic design involves taking the required output current (LED current: I_{LED}) as the allowable maximum output current, and then determining the corresponding output terminal maximum voltage $V_{O\,max}$ from the ALLOWABLE OUTPUT CURRENT VS. OUTPUT TERMINAL MAX VOLTAGE graph. Then if the maximum value for the supply voltage is $V_{CC\,max}$, the value of R_d has to be determined to satisfy the relation $4\cdot I_{LED}\cdot R_d > V_{CC\,max}-V_{O\,max}$.

(9) Thermometer

This application example makes use of the S_i diode's temperature sensing characteristics. A thermistor can be used in exactly the same way. Also, a CdS can be used to create a lux meter.



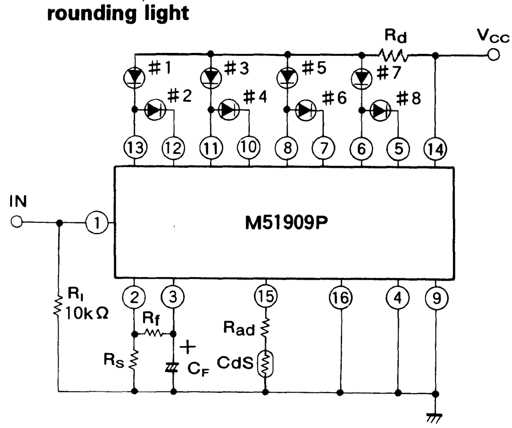
Note 1. The values of VR and R_l connected to Pin ⑮ determine the LED brightness
If V_f is the temperature sensing diode forward voltage drop then the following relation holds

$$I_{LED} \sim 60 \times \left(\frac{V_{⑮}}{R_{VR}} + \frac{V_{⑮} - V_f}{R_l}\right)$$

Note 2. The VR setting determines the range of temperature desired on the display.

Note 3. The values of R_S and R_f determine how many degrees rise in temperature constitutes one display step The diode has a temperature coefficient of approximately $-2mV/℃$ To advance display one step in one direction requires around 156mV For example, if one step is to be set at 1℃, then $R_f/R_S \fallingdotseq 78$.

(10) Adjusting LED brightness with respect to the surrounding light



The LED current is determined by $R_{ad} + R_{cds}$.

6-STEP BAR TYPE LED LEVEL INDICATOR

DESCRIPTION

The M51911L is a semiconductor integrated circuit designed for LED level meters. It drives a bar-type input-level display for up to 6 LEDs. With its built-in advanced half-wave rectification operational amplifier, the M51911L accepts direct input of either AC or DC signals. Output is provided for the LEDs grouped in two's by cascade connection, drastically reducting power consumption.

The logarithmic scale of 3, 0 −3, −7, −12, and −18dB display levels makes this device ideal for VU meter applications.

FEATURES

- Advanced half-wave rectification OP amp built in
  - Cut-off frequency ·································· 200kHz(typ.)
  - Offset voltage ···2mV(typ.)
- Output current is determined by internal circuits, reducing the number of attachments ························· 13mA(typ.)
- The internal reference voltage threshold value for the supply voltage is only slightly affected by temperature ·· 1.25V(typ.)
- Wide supply voltage range ································4~15V
- Advanced half-wave OP amp gain is set internally ···17dB(typ.)

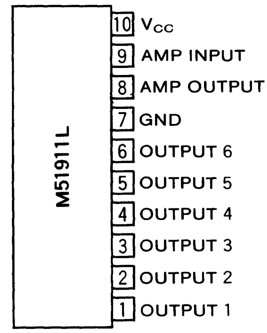
APPLICATION

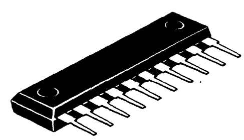
Signal meters, VU meters, and tuning meters, and other general display applications.

REMONNECDED OPERATING CONDITIONS

Supply voltage range ·····································4~15V
Rated power supply ···································9V±10%

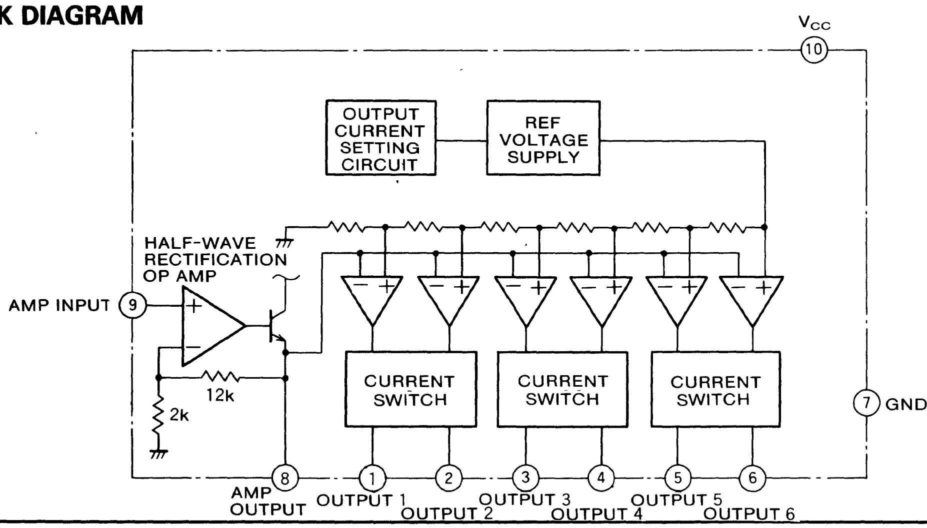
PIN CONFIGURATION (TOP VIEW)





10-pin molded plastic SIP

BLOCK DIAGRAM



6-STEP BAR TYPE LED LEVEL INDICATOR

ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

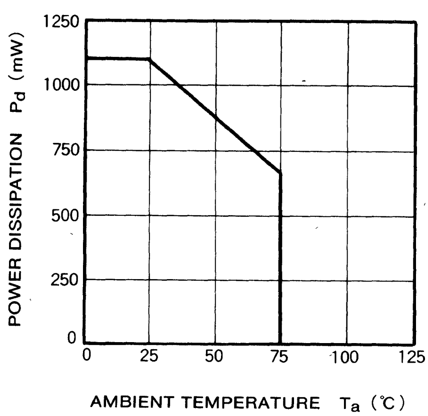
Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		16	V
BV_O	Output voltage		16	V
V_{IN}	Input voltage	Pin ⑨−GND	−2~V_{CC}	V
$I_{⑧}$	Pin ⑧ output current		−1	mA
$V_{⑧}$	Pin ⑧ output voltage	Pin ⑧−GND	6	V
P_d	Power dissipation		1100	mW
K_θ	Thermal derating	T_a≧25℃	8.8	mW/℃
T_{opr}	Operating temperature		−20~+75	℃
T_{stg}	Storage temperature		−40~+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=9V, unless otherwise noted)

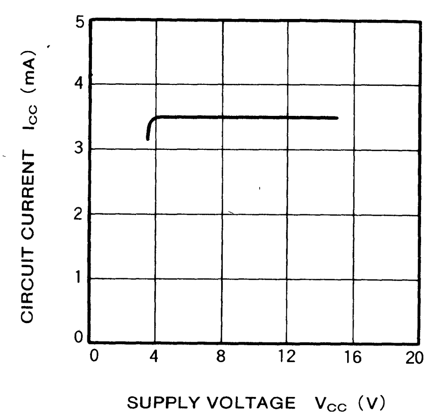
Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage		4.0		15.0	V
I_{CC1}	Circuit current	$V_{⑨}$=0V (when all LEDs are off)		3.5	5.6	mA
I_{CC2}	Circuit current	$V_{⑨}$=200mV (when all LEDs are on)		4.0	6.4	mA
I_{IB}	Input bias current	$V_{⑨}$=0V	−500	−150		nA
A_V	Input amp gain			17		dB
V_{th1}	Output 1 threshold voltage	Amp gain=17dB Pin ⑨−GND	6.3	11.2	16.8	mVrms
			−23	−18	−14.5	dB
V_{th2}	Output 2 threshold voltage		16.8	22.5	28.3	mVrms
			−14.5	−12	−10	dB
V_{th3}	Output 3 threshold voltage		33.7	40	47.6	mVrms
			−8.5	−7	−5.5	dB
V_{th4}	Output 4 threshold voltage		56.6	63.5	71.3	mVrms
			−4	−3	−2	dB
V_{th5}	Output 5 threshold voltage		79.9	89.7	100.6	mVrms
			−1	0	+1	dB
V_{th6}	Output 6 threshold voltage		112.9	126.6	142.2	mVrms
			+2	+3	+4	dB
I_O	Output current		8	13	20	mA
I_{OL}	Output leak current	Output voltage=V_{CC}			1	μA
$R_{⑧}$	Pin ⑧ adjustable resistor	$V_{⑧}$=0.3V	9	14	19	kΩ

TYPICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

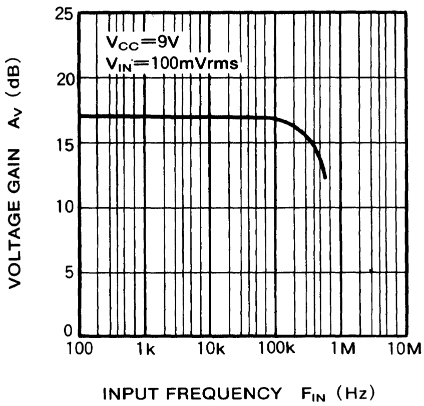
THERMAL DERATING (MAXIMUM RATING)



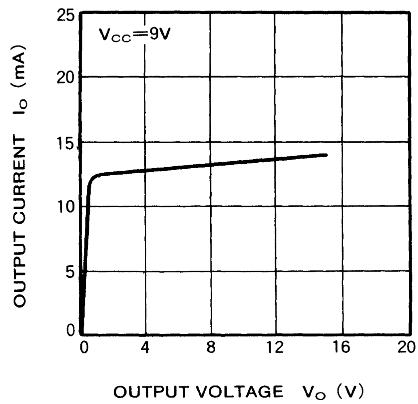
CIRCUIT CURRENT VS. SUPPLY VOLTAGE



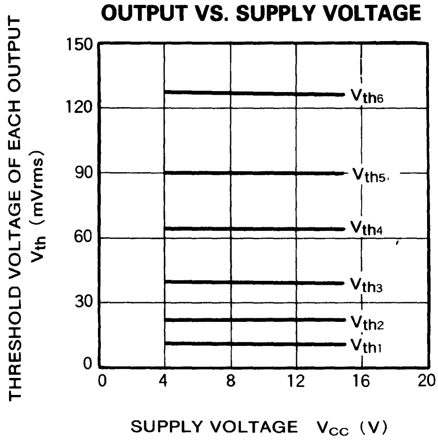
HALF-WAVE RECTIFIER OP AMP VOLTAGE GAIN VS. INPUT FREQUENCY



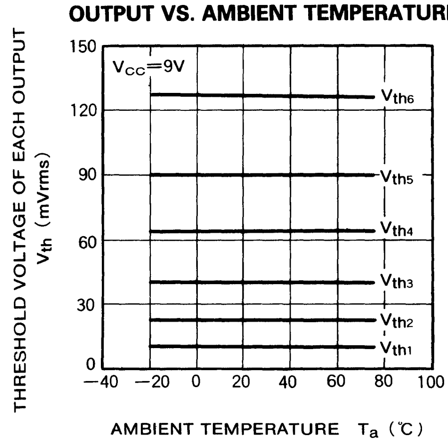
OUTPUT CURRENT VS. OUTPUT VOLTAGE



THRESHOLD VOLTAGE OF EACH OUTPUT VS. SUPPLY VOLTAGE

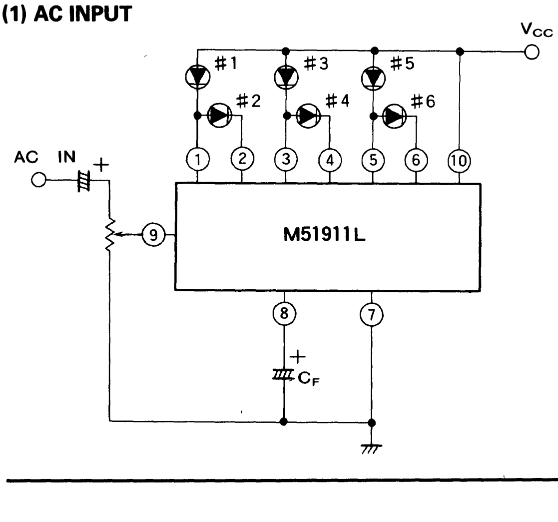


THRESHOLD VOLTAGE OF EACH OUTPUT VS. AMBIENT TEMPERATURE

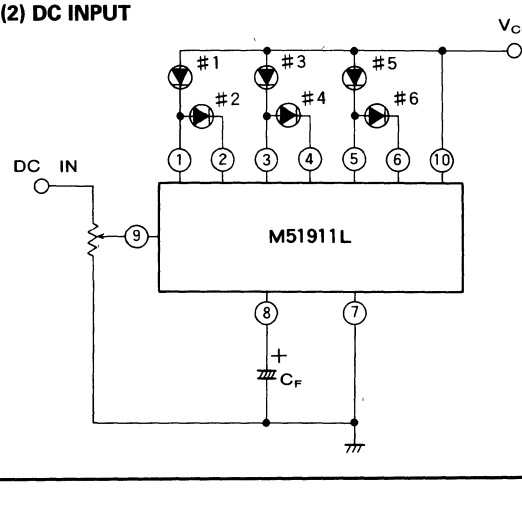


APPLICATION EXAMPLES

(1) AC INPUT

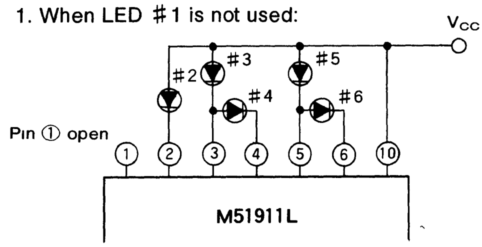


(2) DC INPUT

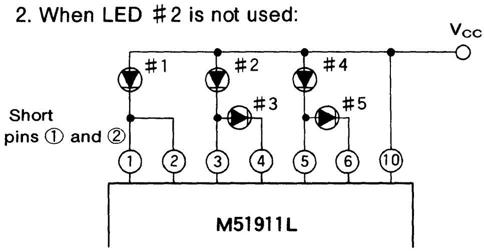


(3) Less than six LEDs are required

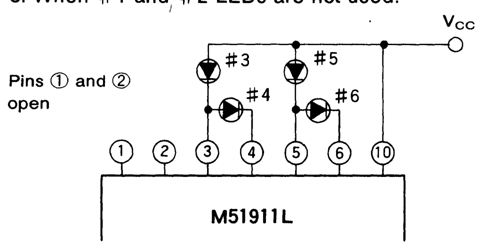
1. When LED #1 is not used:



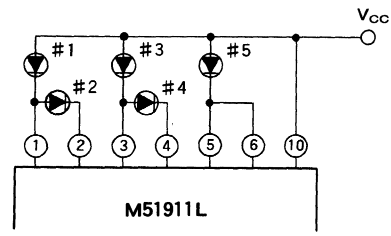
2. When LED #2 is not used:



3. When #1 and #2 LEDs are not used:



4. When any of LEDs #3 to #6 are not used:
When an even-numbered LED is not used, follow the procedure given for LED #2, and when an odd-numbered LED is not used, follow that for LED #3.



PRECAUTIONS

1. Output current determined by internal circuit ···· 13mA
2. Amp gain is set by internal resistor ·················· 17dB
3. Recovery time: $C_F \times 14k\Omega$
4. Attack time: $C_F \times 430\Omega$

M51912L

6-STEP BAR TYPE LED LEVEL INDICATOR

DESCRIPTION

The M51912L is a semiconductor integrated circuit designed for LED level meters. It drives a bar-type input-level display for up to 6 LEDs. With its built-in advanced half-wave rectification operational amplifier, the M51912L accepts direct input of either AC or DC signals. Output is provided for the LEDs grouped in two's by cascade connection, drastically reducing power consumption.

The M51912L provides linear-scale display levels, just right for signal meter applications.

FEATURES

- Advanced half-wave rectification OP amp built in
  - Cut-off frequency ······························ 200kHz(typ.)
  - Offset voltage ·· 2mV(typ.)
- Output current is set internally, reducing the number of attachments ··· 13mA(typ.)
- The internal reference voltage threshold value for the supply voltage is only slightly affected by temperature ·· 1.25V(typ.)
- Wide supply voltage range ······························ 4~15V
- Advanced half-wave OP amp gain is set by internal resistor ··· 17dB(typ.)

APPLICATION

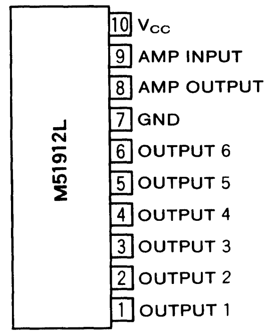
Signal meters, VU meters, and tuning meters, and other general display applications.

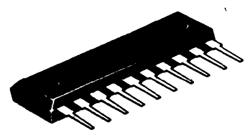
RECOMMENDED OPERATING CONDITIONS

Supply voltage range ···································· 4~15V

Rated power supply ································· 9V±10%

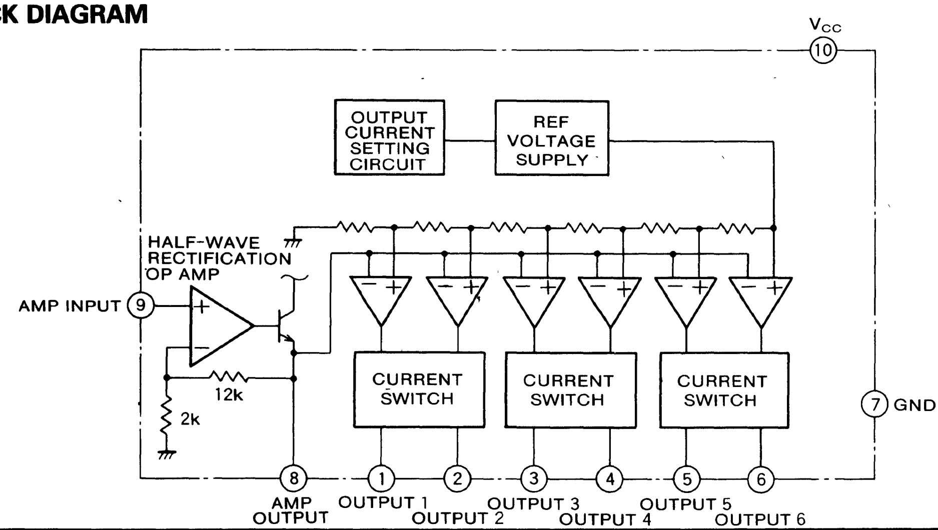
PIN CONFIGURATION (TOP VIEW)





10-pin molded plastic SIP

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		16	V
BV_O	Output voltage		16	V
V_{IN}	Input voltage	Pin ⑨—GND	$-2\sim V_{CC}$	V
$I_{⑧}$	Pin ⑧ output current		−1	mA
$V_{⑧}$	Pin ⑧ output voltage	Pin ⑧—GND	6	V
P_d	Power dissipation		1100	mW
K_θ	Thermal derating	$T_a \geqq 25$℃	8.8	mW/℃
T_{opr}	Operating temperature		−20～+75	℃
T_{stg}	Storage temperature		−40～+125	℃

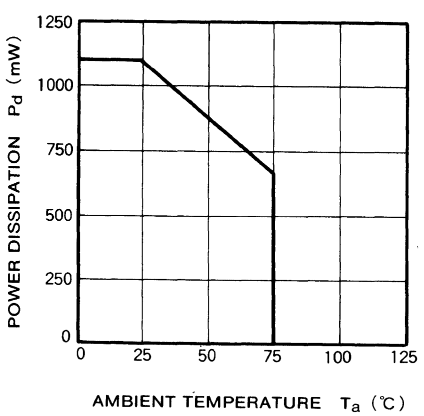
ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=9V, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage		4.0		15.0	V
I_{CC1}	Circuit current	$V_{⑨}$=0V (when all LEDs are off)		3.5	5.6	mA
I_{CC2}	Circuit current	$V_{⑨}$=200mV (when all LEDs are on)		4.0	6.4	mA
I_{IB}	Input bias current	$V_{⑨}$=0V	−500	−150		nA
A_V	Input amp gain			17		dB
V_{th1}	Output 1 threshold voltage	Amp gain=17dB Pin ⑨—GND	22	29	36	mV
V_{th2}	Output 2 threshold voltage		49	59	69	mV
V_{th3}	Output 3 threshold voltage		75	89	*103	mV
V_{th4}	Output 4 threshold voltage		*102	119	*136	mV
V_{th5}	Output 5 threshold voltage		*128	149	*170	mV
V_{th6}	Output 6 threshold voltage		*153	179	205	mV
I_O	Output current		8	13	20	mA
I_{OL}	Output leak current	Output voltage=V_{CC}			1	μA
$R_{⑧}$	Pin ⑧ adjustable resistor		9	14	19	kΩ

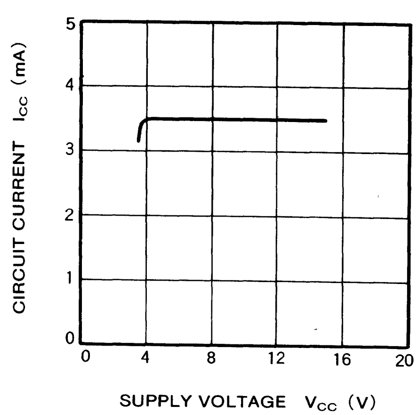
*: Over-wrap for the IC package is not provided.

TYPICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

THERMAL DERATING (MAXIMUM RATING)

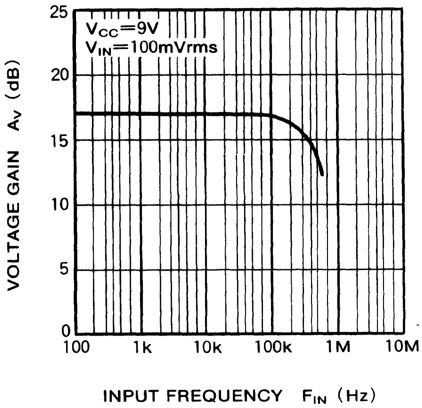


CIRCUIT CURRENT VS. SUPPLY VOLTAGE

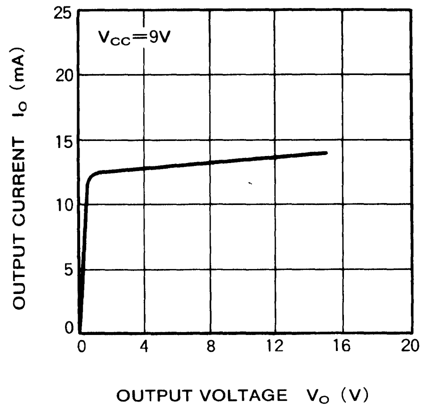


6-STEP BAR TYPE LED LEVEL INDICATOR

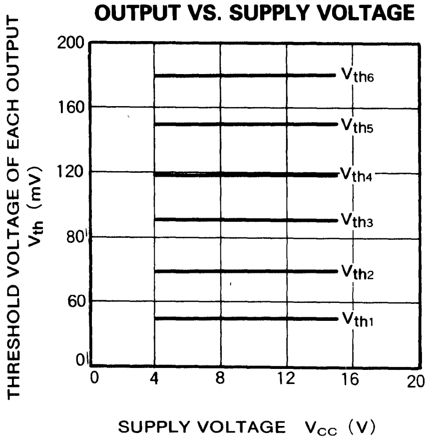
HALF-WAVE RECTIFIER OP AMP VOLTAGE GAIN VS. INPUT FREQUENCY



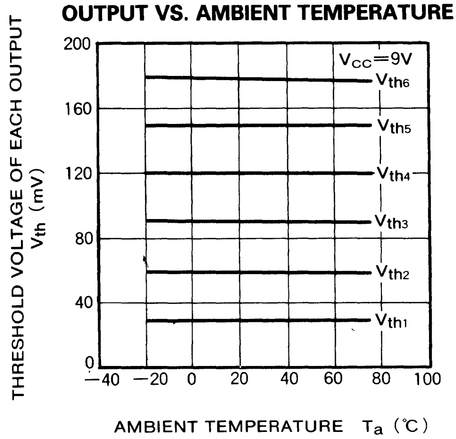
OUTPUT CURRENT VS. OUTPUT VOLTAGE



THRESHOLD VOLTAGE OF EACH OUTPUT VS. SUPPLY VOLTAGE

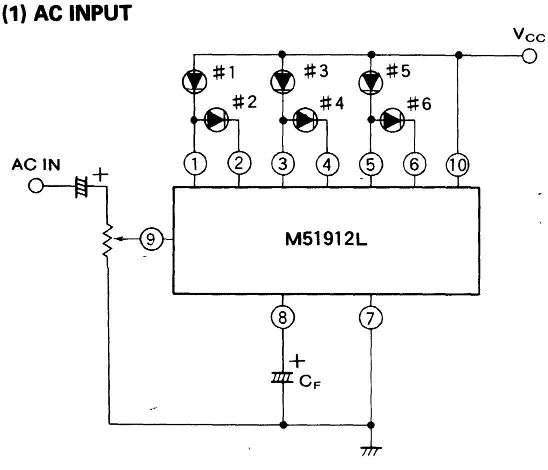


THRESHOLD VOLTAGE OF EACH OUTPUT VS. AMBIENT TEMPERATURE

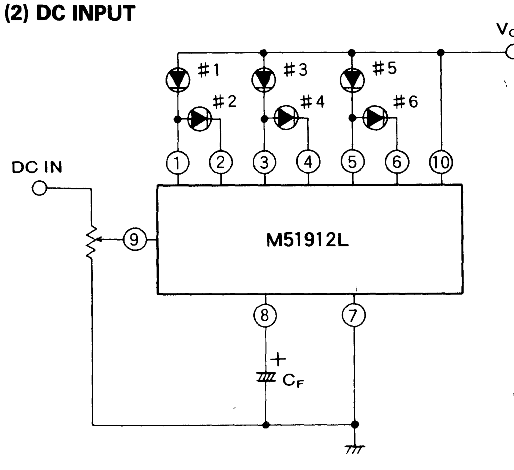


APPLICATION EXAMPLES

(1) AC INPUT

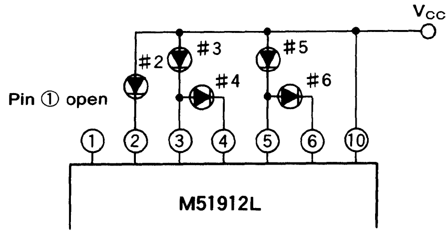


(2) DC INPUT

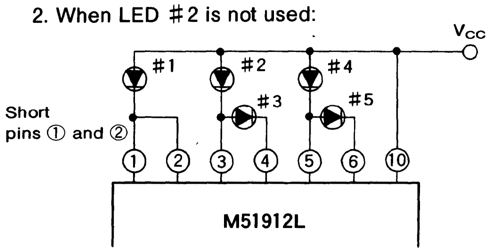


(3) Less than six LEDs are required

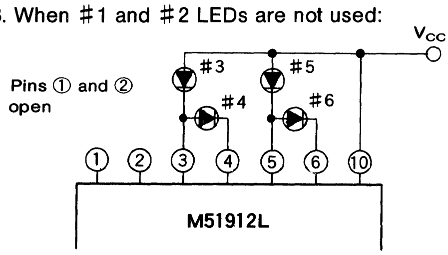
1. When LED #1 is not used:



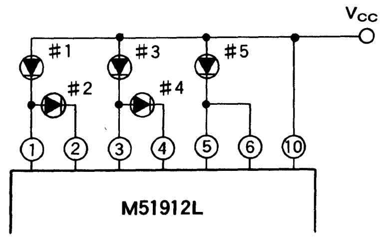
2. When LED #2 is not used:



3. When #1 and #2 LEDs are not used:



4. When any of LEDs #3 to #6 are not used:
When an even-numbered LED is not used, follow the procedure given for LED #2, and when an odd-numbered LED is not used, follow that for LED #3.



PRECAUTIONS

1. Output current is determined by internal circuit ············ 13mA
2. Amp gain is set by internal resistor ············ 17dB
3. Recovery time: $C_F \times 14k\Omega$
4. Attack time: $C_F \times 430\Omega$

MITSUBISHI ELECTRIC

TRANSISTOR ARRAY

INDEX BY FUNCTION OF TRANSISTOR ARRAYS

QUICK REFERENCE TABLE OF TRANSISTOR ARRAY SERIES

No.	Input/output type		No. of circuits	Type No.	Output current(mA)			Withstand voltage(V)				Output type		CD	Remarks
	Input	Output			1.5A	500 ~300	Less than 150	80	50	40	20	Darl-ington	Low saturation		
1	"H" active	Current sink	4	M54512L			○				○		○		
				M54532L	○				○			○		○	
				M54594P★	○			■				■		■	Sprague ULN2065B
				M54595P★	○			■				■		■	Sprague ULN2067B
			5	M54516P, 521P		○					○	○			
				M54529AP, 529P		○					○		○		
			6	M54533P, 534P, 539P, 578P		○					○		○	○	
				M54527P			○			○		○		○	
				M54571P		○				○			○	○	
			7	M54514AP, 515P, 577P, 577FP			50				○		○		Output withstand voltage
				M54537P, 535P, 536P		○					○				Up to V_{CC} for the
				M54517P, 519P		○				○	○				535P, 536P
				M54528P			○			○					
				M54523P, 524P, 525P, 526P,		○			○			○		○	Sprague ULN2000A series
				M54530P, 531P		○				○		○		○	
			8	M54513P			○			○			○		
				M54538P		○					○		○		
				M54522P		○				○		○		○	
				M54585P*		■			■			■		■	Sprague ULN2803A
				M54584P*		■					■				8-unit version of the 537P
				M54590P, 591P, 592P, 593P★★		■		■				■		■	Sprague ULN2823A, 2821A ULN2822A, 2824A
2	"H"	Source	8	M54562P, 563P		○			○			○		○	Sprague ULN2981A, 2982A
				M54564P		○			○			○			Changed from DC to R of the 562P
				M54597P, 598P★		■		■				■		■	Sprague ULN2983A, 2984A
3	"L"	Sink	4	M54567P	○				○			○		○	Toshiba TD62308AP
				M54596P★	■			■				■		■	Toshiba TD62308BP
				M54661P	■			■				■		■	Tokyo Sanyo LB1205
			7	M54576P, 576FP			50				○		○		
				M54566P		○			○			○			Toshiba TD62305AP
			8	M54565P			○				○		○		
				M54583P★		○			○			○			8-unit version of the 566P
4	"L"	Source	4	M54568L			30				○		○		
			7	M54560P, 561P			○			○		○		○	
				M54580P			○		○			○			
			8	M54581P		○			○			○		○	Sprague UDN2580A
				M54586P★		■			■			■			Changed from CD to R of the 581P
				M54660P★		■		■				■		■	Sprague UDN2580A-1

★: New products, ★★: Under development, ○: Current product, ■: New and under-development product

M54512L

4-UNIT 50mA TRANSISTOR ARRAY

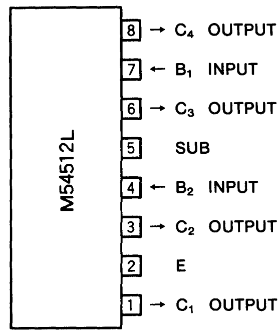
DESCRIPTION
The M54512L, 4-channel sink driver, consists of four NPN transistors, and designed for use in medium-current switching applications.

FEATURES
- Output breakdown voltage to 20V
- 50mA output sink current capability
- Wide operating temperature range (T_a =−20~+75℃)

APPLICATION
LED or incandescent display driver

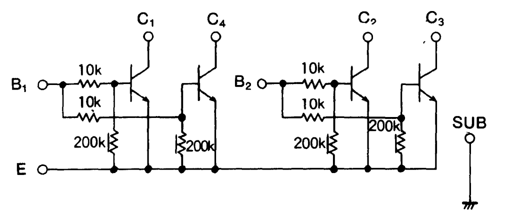
FUNCTION
The M54512L is comprised of four NPN transistors with a 10kΩ series input resistor, connected to form dual 2-parallel output drivers. All emitters of transistors are connected together to pin 2. The substrate is connected to pin 5 and pin 5 must be tied to the most negative point in the external circuit. The drivers are capable of sinking 50mA and will withstand 20V in the OFF state.

PIN CONFIGURATION (TOP VIEW)

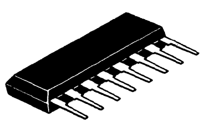


Outline 8P5

CIRCUIT SCHEMATIC



Unit : Ω



8-pin molded plastic SIP

ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CEO}	Output sustaining voltage	Transistor OFF	−0.5~+20	V
V_{EBO}	Emitter-base sustaining voltage		4	V
I_C	Collector current	Transistor ON	50	mA
V_I	Input voltage		20	V
P_d	Power dissipation	T_a =75℃	500	mW
T_{opr}	Operating ambient temperature range		−10~+75	℃
T_{stg}	Storage temperature range		−55~+125	℃

RECOMMENDED OPERATING CONDITIONS (T_a=25℃, unless otherwise noted)

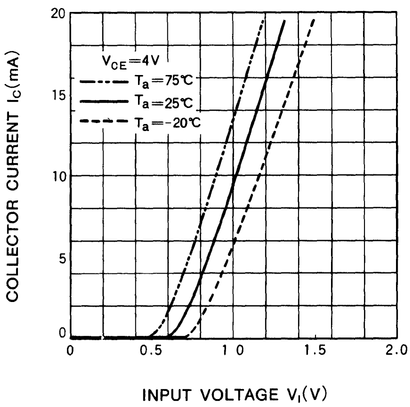
Symbol	Parameter		Limits			Unit
			Min	Typ	Max	
V_C	Output voltage		0		18	V
I_C	Collector current per channel		0		20	mA
V_{IH}	"H" Input voltage	I_C =30mA	11		18	V
V_{IL}	"L" Input voltage		0		0.2	V

ELECTRICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

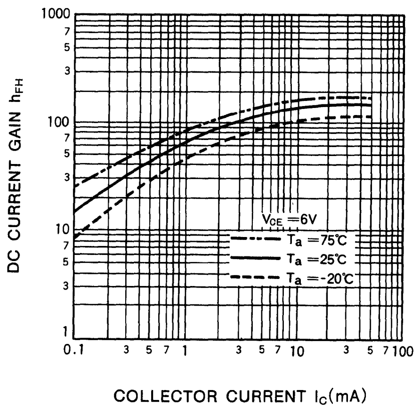
Symbol	Parameter	Test conditions		Limits Min	Limits Typ	Limits Max	Unit
$I_{O(leak)}$	Output leakage current	V_{CE} =20V				20	μA
$V_{CE(sat)}$	Output saturation voltage	I_B = 2 mA	I_C =10mA		0.02	0.1	V
			I_C =20mA		0.04	0.2	V
BV_{EBO}	Emitter-base sustaining voltage	I_{EBO} =150 μA		4			V
V_I	Input voltage	I_B = 2 mA		4	11	18	V
h_{FE}	DC forward current gain	V_{CE} = 6 V, I_C =20mA, T_a=25℃		60	150		—

TYPICAL CHARACTERISTICS

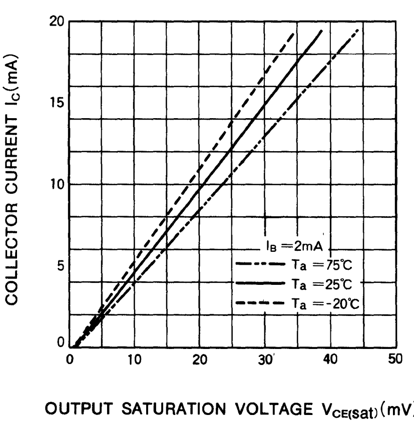
OUTPUT CURRENT CHARACTERISTICS



DC CURRENT GAIN CHARACTERISTICS



OUTPUT CHARACTERISTICS



M54532P

4-UNIT 1.5A DARLINGTON TRANSISTOR ARRAY WITH CLAMP DIODE

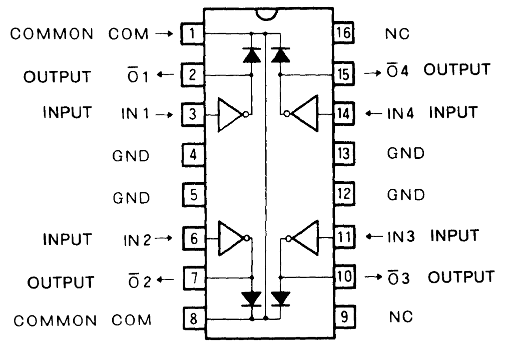
DESCRIPTION
The M54532P, 4-channel sink driver, consists of 8 NPN transistors connected to form high current gain driver pairs.

FEATURES
- High output sustaining voltage to 50V
- High output sink current to 1.5A
- Integral diodes for transient suppression
- Wide operating temperature range (T_a = −20～+75℃)

APPLICATION
Relay and printer driver, Display driver

FUNCTION
The M54532P is comprised of eight NPN darlington driver pairs with 340Ω series input resistors. Each output has a diode for inductive load transient suppression and the cathodes of the diodes are connected to pin 8. The outputs are capable of sinking 1.5A and will withstand 50V in the OFF state.

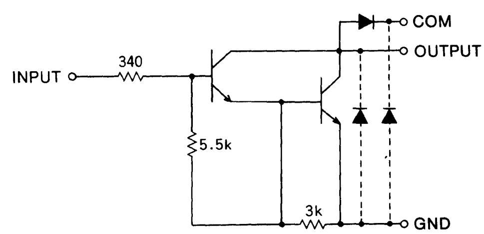
PIN CONFIGURATION (TOP VIEW)



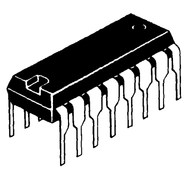
Outline 16P4

NC : NO CONNECTION

CIRCUIT SCHEMATIC



Unit : Ω



16-pin molded plastic DIP

ABSOLUTE MAXIMUM RATINGS (T_a=−20～+75℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CEO}	Output sustaining voltage	Transistor OFF	−0.5～+50	V
I_C	Collector current	Transistor ON	1.5	A
V_I	Input voltage		10	V
$I_{F(D)}$	Clamp diode forward current		1.5	A
			1.25	A
$V_{R(D)}$	Clamp diode reverse voltage		50	V
P_d	Power dissipation	T_a=25℃	1.92	W
T_{opr}	Operating ambient temperature range		−20～+75	℃
T_{stg}	Storage temperature range		−55～+125	℃

4-UNIT 1.5A DARLINGTON TRANSISTOR ARRAY WITH CLAMP DIODE

RECOMMENDED OPERATIONAL CONDITIONS ($T_a=-20\sim+75$℃, unless otherwise noted)

Symbol	Parameter		Limits			Unit
			Min	Typ	Max	
V_O	Output voltage		0		50	V
I_C	Collector current per channel	Percent duty cycle less than 4%	0		1.25	A
		Percent duty cycle less than 18%	0		700	mA
V_{IH}	"H" Input voltage	$I_C=1.25A$	3		6	V
V_{IL}	"L" Input voltage	$I_{O(leak)}=50\mu A$	0		0.4	V

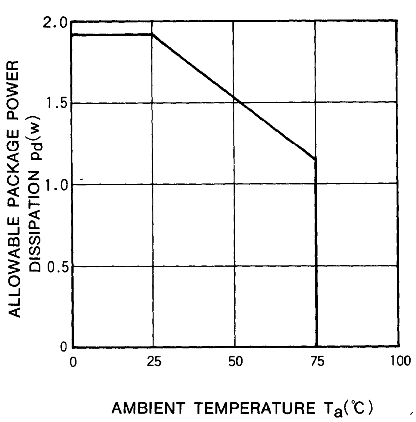
ELECTRICAL CHARACTERISTICS ($T_a=-20\sim+75$℃, unless otherwise noted)

Symbol	Parameter	Test conditions		Limits			Unit
				Min	Typ*	Max	
$V_{(BR)CEO}$	Output sustaining voltage	$I_{CEO}=100\mu A$		50			V
$V_{CE(sat)}$	Output saturation voltage	$I_I=2mA$	$I_C=1.25A$		1.3	2.2	V
			$I_C=700mA$		1.1	1.7	
I_I	Input current	$V_I=3V$			5	8.5	mA
V_F	Clamp diode forward voltage	$I_F=1.25A$			1.6	2.3	V
V_R	Clamp diode reverse voltage	$I_R=100\mu A$		50			V
h_{FE}	DC forward current gain	$V_{CE}=4V$, $I_C=1A$, $T_a=25$℃		800	7000		—

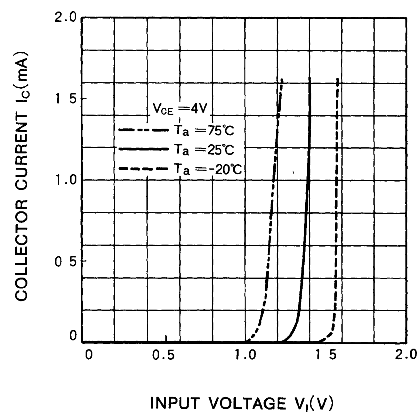
* : A typical value is at $T_a=25$℃

TYPICAL CHARACTERISTICS

ALLOWABLE AVERAGE POWER DISSIPATION



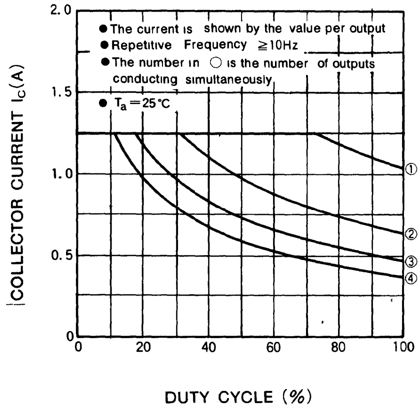
OUTPUT CURRENT CHARACTERISTICS



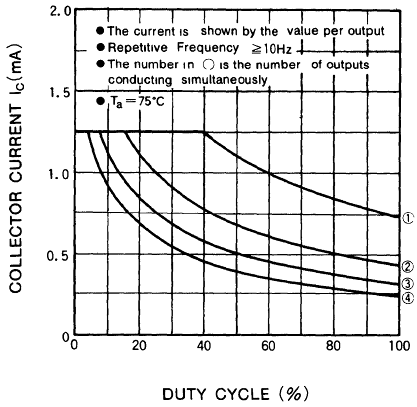
MITSUBISHI ELECTRIC

4-UNIT 1.5A DARLINGTON TRANSISTOR ARRAY WITH CLAMP DIODE

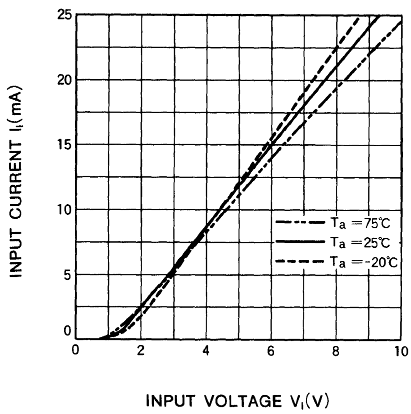
ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



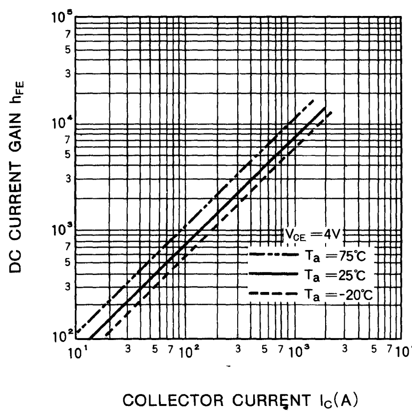
ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



INPUT CHARACTERISTICS



DC CURRENT GAIN CHARACTERISTICS



M54516P

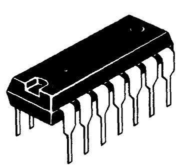
5-UNIT 500mA DARLINGTON TRANSISTOR ARRAY

DESCRIPTION
The M54516P, 5-channel sink driver, consists of 10 NPN transistors connected to form five high current gain driver pairs.

FEATURES
- Output sustaining voltage to 25 V
- High output sink current to 500mA
- PMOS Compatible input
- Wide operating temperature range ($Ta = -20 \sim +75$℃)

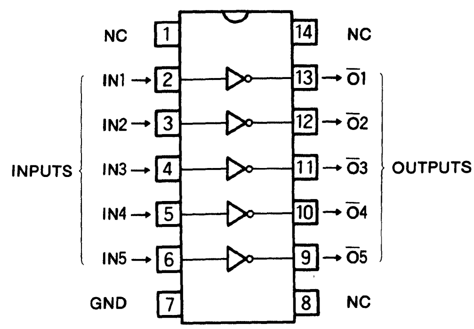
APPLICATION
Relay and printer driver, LED or incandescent display digit driver, Interfacing for standard MOS/BIPOLAR logics.

FUNCTION
The M54516P is comprised of five NPN darlington driver pairs with 20kΩ series input resistors. All emitter and the substrate are connected together to pin 7. The output are capable of sinking 500mA and will withstand 25V in the OFF state.



14-pin molded plastic DIP

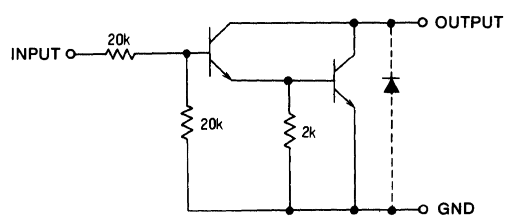
PIN CONFIGURATION (TOP VIEW)



Outline 14P4

NC : NO CONNECTION

CIRCUIT SCHEMATIC



Unit : Ω

ABSOLUTE MAXIMUM RATINGS ($T_a = -20 \sim +75$℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CEO}	Output sustaining voltage	Transistor OFF	−0.5～+25	V
I_C	Collector current	Transistor ON	500	mA
V_I	Input voltage		25	V
P_d	Power dissipation	T_a=25℃	1.47	W
T_{opr}	Operating ambient temperature range		−20～+75	℃
T_{stg}	Storage temperature range		−55～+125	℃

RECOMMENDED OPERATIONAL CONDITIONS (T_a=−20~+75℃, unless otherwise noted)

Symbol	Parameter		Limits Min	Limits Typ	Limits Max	Unit
V_O	Output voltage		0		25	V
I_C	Collector current per channel	Percent duty cycle less than 10%	0		400	mA
		Percent duty cycle less than 55%	0		200	
V_{IH}	"H" Input voltage	I_C=400mA	8		20	V
		I_C=200mA	5		20	
V_{IL}	"L" Input voltage	$I_{O(leak)}$=50μA	0		0.5	V

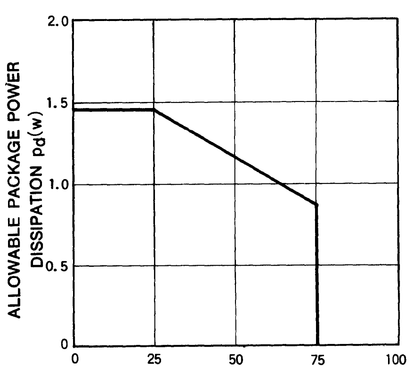
ELECTRICAL CHARACTERISTICS (T_a=−20~+75℃, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits Min	Limits Typ	Limits Max	Unit
$V_{(BR)CEO}$	Output sustaining voltage	I_{CEO}=100μA	25			V
$V_{CE(sat)}$	Output saturation voltage	V_I=8V, I_C=400mA		1.15	2.2	V
		V_I=5V, I_C=200mA		0.95	1.4	
I_I	Input current	V_I=17V		0.8	1.8	mA
h_{FE}	DC forward current gain	V_{CE}=4V, I_C=400mA, T_a=25℃	1000	4000		—

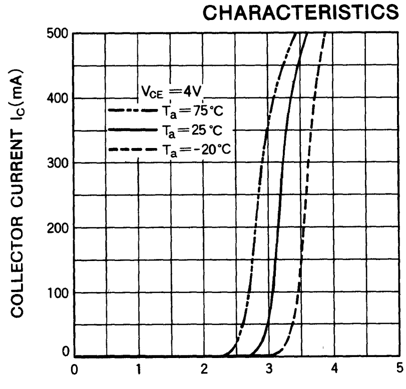
* : A typical value is at T_a=25℃.

TYPICAL CHARACTERISTICS

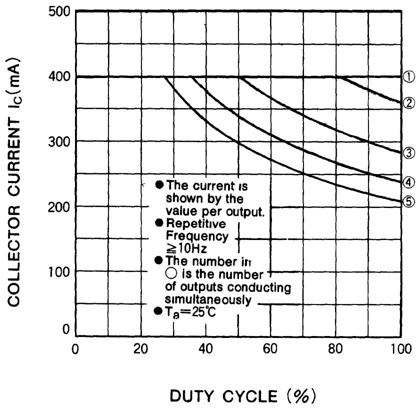
ALLOWABLE AVERAGE POWER DISSIPATION



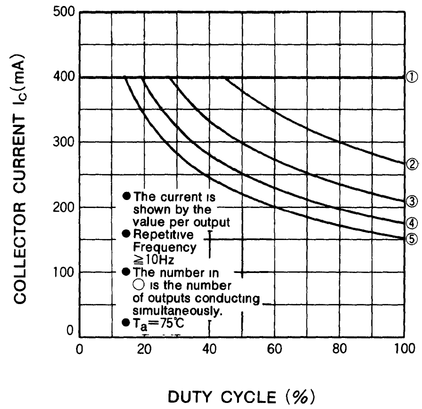
OUTPUT CURRENT CHARACTERISTICS



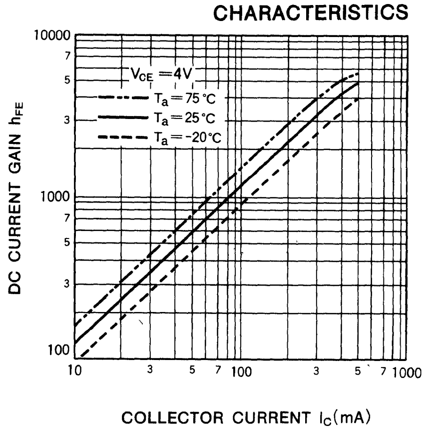
ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



DC CURRENT GAIN CHARACTERISTICS



M54521P

5-UNIT 500mA DARLINGTON TRANSISTOR ARRAY

DESCRIPTION

The M54521P, 5-channel sink driver, consists of 10 NPN transistors connected to form high current gain driver pairs.

FEATURES

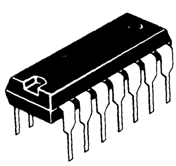
- Output sustaining voltage to 30V
- High output sink current to 500mA
- Wide operating temperature range (Ta = −20∼+75℃)

APPLICATION

Relay and printer drivers, LED or incandescent display digit driver, Interfacing for standard MOS/BIPOLAR logics

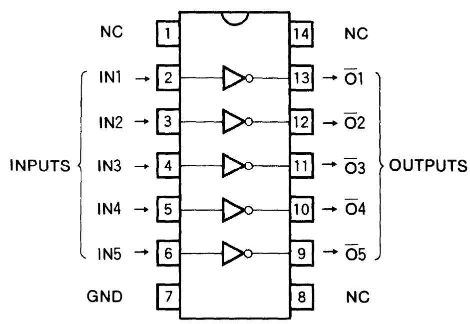
FUNCTION

The M54521P is comprised of five NPN darlington driver pairs. All emitters and the substrate are connected together to pin 7. The output are capable of sinking 500mA and will withstand 30V in the OFF state.



14-pin molded plastic DIP

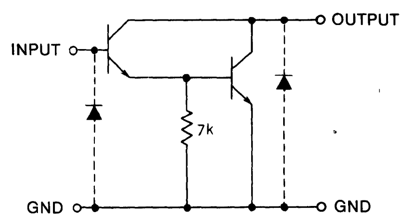
PIN CONFIGURATION (TOP VIEW)



Outline 14P4

NC : NO CONNECTION

CIRCUIT SCHEMATIC



Unit : Ω

ABSOLUTE MAXIMUM RATINGS (T_a=−20∼+75℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CEO}	Output sustaining voltage	Transistor OFF	−0.5∼+30	V
I_C	Collector current	Transistor ON	500	mA
P_d	Power dissipation	T_a=25℃	1.47	W
T_{opr}	Operating ambient temperature range		−20∼+75	℃
T_{stg}	Storage temperature range		−55∼+125	℃

MITSUBISHI ELECTRIC

5-UNIT 500mA DARLINGTON TRANSISTOR ARRAY

RECOMMENDED OPERATIONAL CONDITIONS (T_a=−20~+75℃, unless otherwise noted)

Symbol	Parameter		Limits Min	Limits Typ	Limits Max	Unit
V_O	Output voltage		0		30	V
I_C	Collector current per channel	Percent duty cycle less than 10%	0		400	mA
		Percent duty cycle less than 55%	0		200	
I_{IH}	"H" Input current	I_C=200mA	1		5	mA
		I_C=400mA	2		5	
I_{IL}	"L" Input current			0		μA

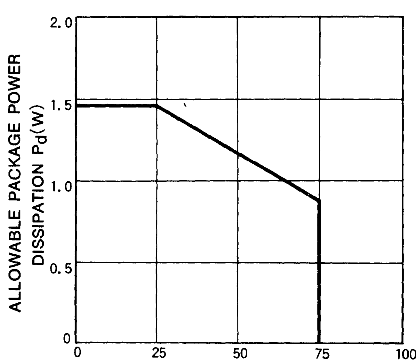
ELECTRICAL CHARACTERISTICS (T_a=−20~+75℃, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits Min	Limits Typ*	Limits Max	Unit
$V_{(BR)CEO}$	Output sustaining voltage	I_{CEO}=100μA	30			V
$V_{CE(sat)}$	Output saturation voltage	V_I=2mA, I_C=400mA		1.0	2.4	V
		V_I=1mA, I_C=200mA		0.8	1.6	
V_I	Input voltage	I_I=1mA	0.6	1.35	1.7	V

* : A typical value is at T_a=25℃.

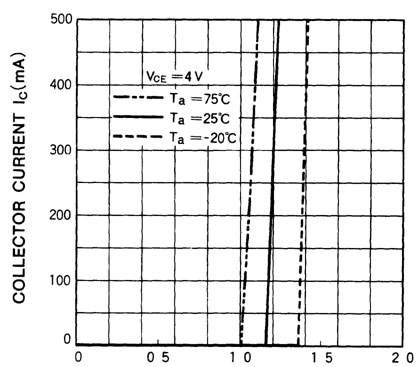
TYPICAL CHARACTERISTICS

ALLOWABLE AVERAGE POWER DISSIPATION



AMBIENT TEMPERATURE T_a(℃)

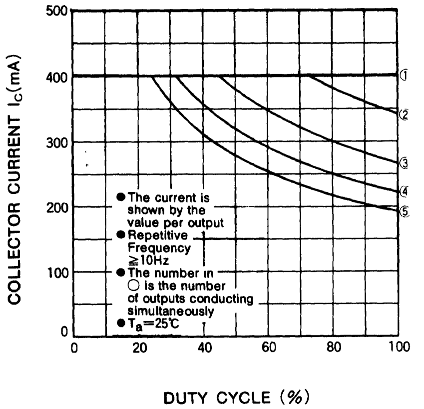
OUTPUT CURRENT CHARACTERISTICS



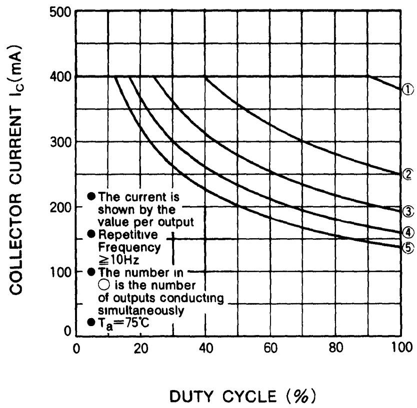
INPUT VOLTAGE V_I(V)

MITSUBISHI ELECTRIC

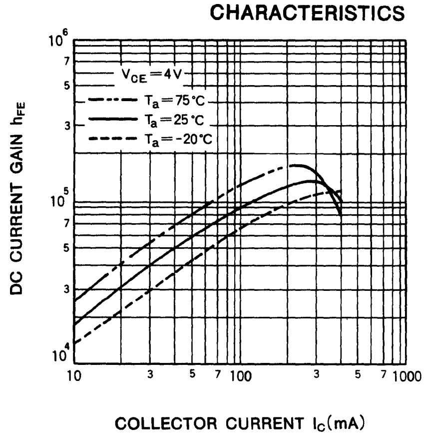
ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



DC CURRENT GAIN CHARACTERISTICS



M54529AP

5-UNIT 320mA TRANSISTOR ARRAY WITH STROBE

DESCRIPTION

The M54529AP, 5-channel sink driver, consists of 10 NPN transistors connected to form high current gain driver pairs.

FEATURES

- Output sustaining voltage to 20V
- High output sink current to 320mA
- CMOS compatible input with strobe control
- Wide operating temperature range (T_a = −20∼+75℃)

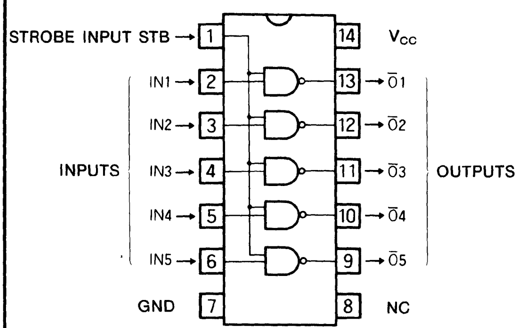
APPLICATION

Relay and printer driver, LED or incandescent display digit driver, Interfacing for standard MOS/BIPOLAR logics

FUNCTION

The M54529AP uses a predriver stage. Each input has a diode and 30kΩ resistor in series to have a wide input voltage range from −25V to +20V. All input can be controlled simultaneously by a strobe input at pin 1. The power supply of the predrivers is connected to pin 14. All emitters and the substrate are connected together to pin 7 . The outputs are capable of sinking 320mA and will withstand 20V in the OFF state.

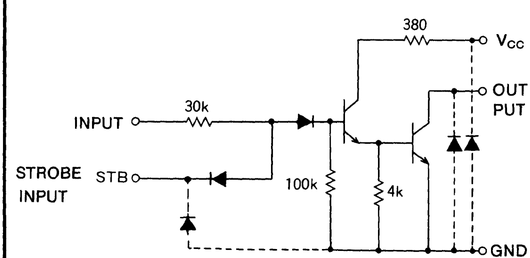
PIN CONFIGURATION (TOP VIEW)



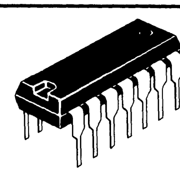
Outline 14P4

NC : NO CONNECTION

CIRCUIT SCHEMATIC



Unit : Ω



14-pin molded plastic DIP

FUNCTIONAL TABLE

IN	STB	OUT
L	L	H
H	L	H
L	H	H
H	H	L

ABSOLUTE MAXIMUM RATINGS (T_a=−20∼+75℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		10	V
V_{CEO}	Output sustaining voltage	Transistor OFF	−0.5∼+20	V
I_C	Collector current	Transistor ON	320	mA
V_I	Input voltage		−20∼+20	V
$V_{I(STB)}$	Strobe input voltage		20	V
P_d	Power dissipation	T_a=25℃	1.47	W
T_{opr}	Operating ambient temperature range		−20∼+75	℃
T_{stg}	Storage temperature range		−55∼+125	℃

5-UNIT 320mA TRANSISTOR ARRAY WITH STROBE

RECOMMENDED OPERATIONAL CONDITIONS (T_a=−20~+75℃, unless otherwise noted)

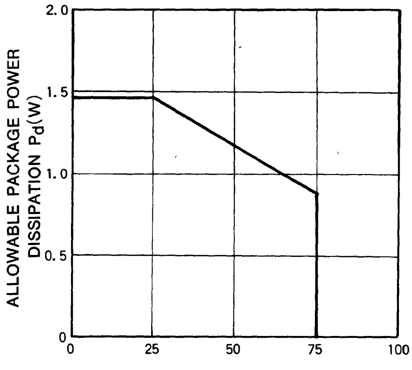
Symbol	Parameter		Limits Min	Typ	Max	Unit
V_{CC}	Supply voltage		3	5	8	V
V_O	Output voltage		0		20	V
I_C	Collector current per channel	Percent duty cycle less than 33%, V_{CC}=6.5V	0		300	mA
		Percent duty cycle less than 80%, V_{CC}=6.5V	0		150	mA
V_{IH}	"H" Input voltage	I_C=150mA	3.5		15	V
		I_C=300mA	5		15	
V_{IL}	"L" Input voltage	$I_{O(leak)}$=50μA	0		1	V
$V_{IH(STB)}$	"H" Input voltage (strobe input)		2.4		15	V
$V_{IL(STB)}$	"L" Input voltage (strobe input)		0		0.2	V

ELECTRICAL CHARACTERISTICS (T_a=−20~+75℃, unless otherwise noted)

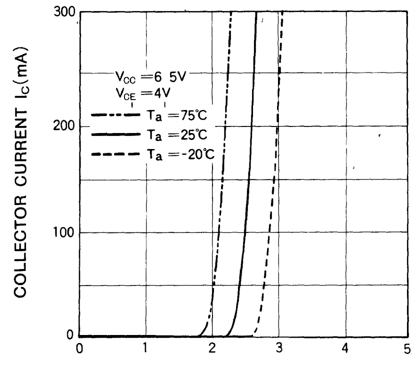
Symbol	Parameter	Test conditions		Limits Min	Typ	Max	Unit
$V_{(BR)CEO}$	Output sustaining voltage	V_{CC}=8V, V_I=8V, $V_{I(STB)}$=0.2V I_{CEO}=100μA		20			V
$V_{CE(sat)}$	Output saturation voltage	$V_{I(STB)}$=2.4V	V_{CC}=6.5V, V_I=5V, I_C=250mA		0.35	0.85	V
			V_{CC}=3V, V_I=3.5V, I_C=150mA		0.2	0.6	
I_I	Input current	V_{CC}=5V, V_I=3.5V, $V_{I(STB)}$=2.4V			20	120	μA
I_R	Input leakage current	V_{CC}=8V, V_I=−20V				−20	μA
$I_{I(STB)}$	Strobe input current	V_{CC}=5V, V_I=5V all input $V_{I(STB)}$=0.2V			−0.8	−1.5	mA
$I_{R(STB)}$	Strobe input leakage current	V_{CC}=8V, V_I=0V, $V_{I(STB)}$=20V				10	μA
I_{CC}	Supply current	V_{CC}=8V, V_I=5V all input $V_{I(STB)}$=2.4V			95	170	mA
h_{FE}	DC forward current gain	V_{CE}=4V, V_{CC}=6.5V, I_C=300mA, T_a=25℃		1000	18000		—

TYPICAL CHARACTERISTICS

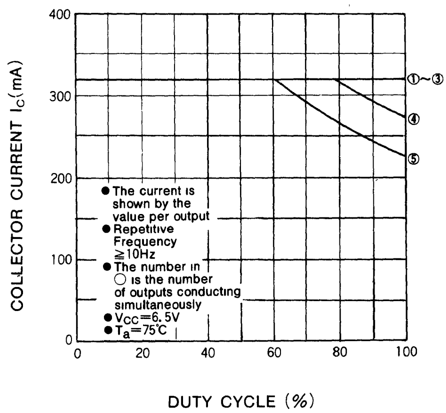
ALLOWABLE AVERAGE POWER DISSIPATION



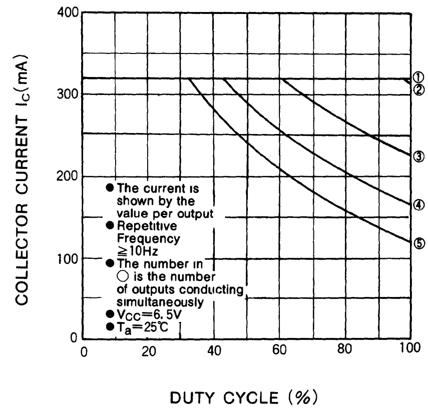
OUTPUT CURRENT CHARACTERISTICS



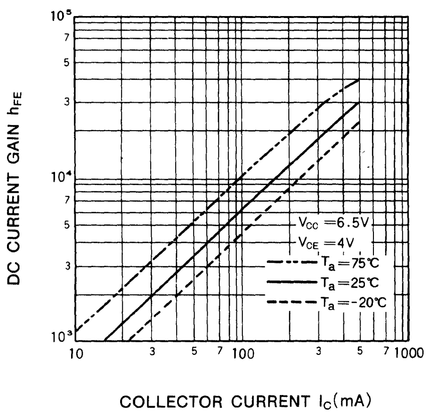
ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



DC CURRENT GAIN CHARACTERISTICS



M54529P

5-UNIT 320mA TRANSISTOR ARRAY WITH STROBE

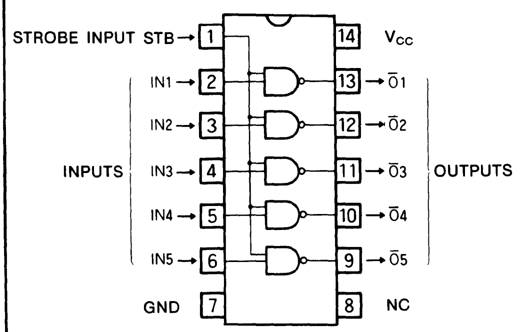
DESCRIPTION
The M54529P, 5-channel sink driver, consists of 10 NPN transistors connected to form high current gain driver pairs.

FEATURES
- Output sustaining voltage to 20V
- High output sink current to 320mA
- PMOS Compatible input with strobe control
- Wide operating temperature range (T_a=−20∼+75℃)

APPLICATION
Relay and printer driver, LED and incandescent display digit driver, Interfacing for standard MOS/BIPOLAR logics

FUNCTION
The M54529P uses a predriver stage. Each input has a diode and 20kΩ resistor in series to have a wide input voltage range from −25V to +20V. All input can be controlled simultaneously by a strobe input at pin 1. The power supply of the predrivers is connected to pin 14. All emitters and the substrate are connected together to pin 7. The outputs are capable of sinking 320mA and will withstand 20V in the OFF state.

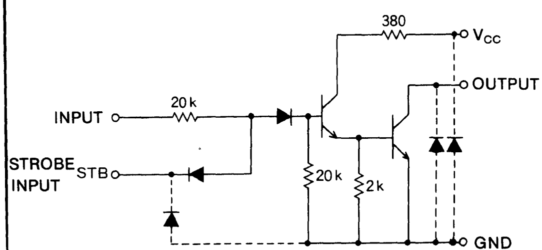
PIN CONFIGURATION (TOP VIEW)



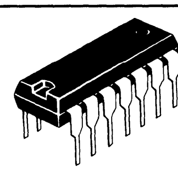
Outline 14P4

NC : NO CONNECTION

CIRCUIT SCHEMATIC



Unit : Ω



14-pin molded plastic DIP

FUNCTIONAL TABLE

IN	STB	OUT
L	L	H
H	L	H
L	H	H
H	H	L

ABSOLUTE MAXIMUM RATINGS (T_a=−20∼+75℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		10	V
V_{CEO}	Output sustaining voltage	Transistor OFF	−0.5∼+20	V
I_C	Collector current	Transistor ON	320	mA
V_I	Input voltage		−25∼+20	V
$V_{I(STB)}$	Strobe input voltage		20	V
P_d	Power dissipation	T_a=25℃	1.47	W
T_{opr}	Operating ambient temperature range		−20∼+75	℃
T_{stg}	Storage temperature range		−55∼+125	℃

RECOMMENDED OPERATIONAL CONDITIONS (T_a=−20~+75℃, unless otherwise noted)

Symbol	Parameter		Limits Min	Limits Typ	Limits Max	Unit
V_{CC}	Supply voltage		3		8	V
V_O	Output voltage		0		20	V
I_C	Collector current per channel	Percent duty cycle less than 33%, V_{CC}=6.5V	0		300	mA
		Percent duty cycle less than 80%, V_{CC}=6.5V	0		150	mA
V_{IH}	"H" Input voltage	I_C=300mA	7		15	V
		I_C=150mA	6		15	V
V_{IL}	"L" Input voltage	$I_{O(leak)}$=50μA	0		1	V
$V_{IH(STB)}$	"H" Input voltage (strobe input)		2.4		15	V
$V_{IL(STB)}$	"L" Input voltage (strobe input)		0		0.2	V

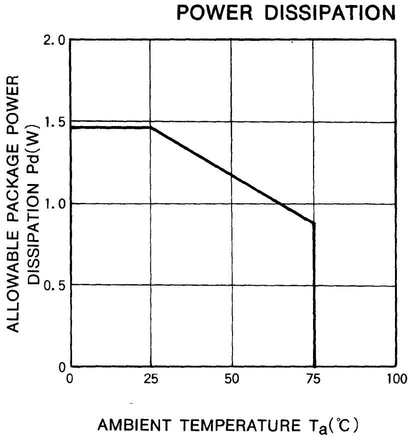
ELECTRICAL CHARACTERISTICS (T_a=−20~+75℃, unless otherwise noted)

Symbol	Parameter	Test conditions		Limits Min	Limits Typ*	Limits Max	Unit
$V_{(BR)CEO}$	Output sustaining voltage	V_{CC}=8V, V_I=7V, $V_{I(STB)}$=0.2V I_{CEO}=100μA		20			V
$V_{CE(sat)}$	Output saturation voltage	V_I=7V	V_{CC}=6.5V, I_C=250mA		0.5	0.85	V
		$V_{I(STB)}$=2.4V	V_{CC}=3V, I_C=120mA		0.3	0.5	V
I_I	Input current	V_{CC}=8V, V_I=18V, $V_{I(STB)}$=2.4V			0.9	1.8	mA
I_R	Input leakage current	V_{CC}=8V, V_I=−25V			0	−20	μA
$I_{I(STB)}$	Strobe input current	V_{CC}=8V, V_I=7V all input $V_{I(STB)}$=0.2V			−4		mA
$I_{R(STB)}$	Strobe input leakage current	V_{CC}=8V, V_I=0V, $V_{I(STB)}$=20V			0	10	μA
I_{CC}	Supply current	V_{CC}=8V, V_I=7V all input $V_{I(STB)}$=2.4V			95	170	mA
h_{FE}	DC forward current gain	V_{CE}=4V, V_{CC}=6.5V, I_C=300mA, T_a=25℃		1000	3000		—

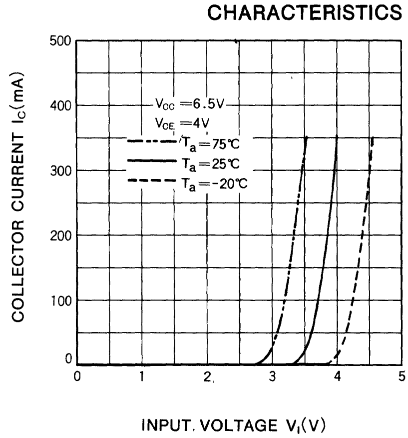
* : All typical values are at T_a=25℃.

TYPICAL CHARACTERISTICS

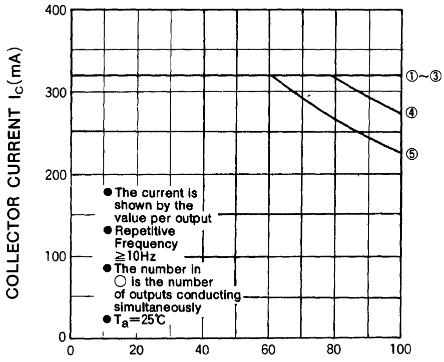
ALLOWABLE AVERAGE POWER DISSIPATION



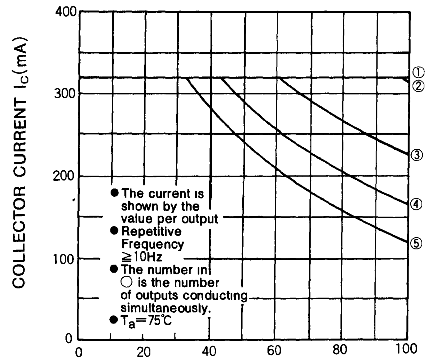
OUTPUT CURRENT CHARACTERISTICS



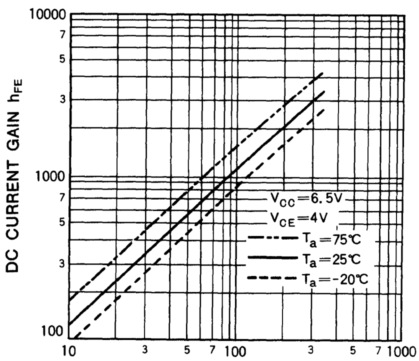
ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



DC CURRENT GAIN CHARACTERISTICS



M54533P

6-UNIT 320mA TRANSISTOR ARRAY WITH CLAMP DIODE AND STROBE

DESCRIPTION
The M54533P, 6-channel sink driver, consists of 12 NPN transistors to form high current gain driver pairs.

FEATURES
- Output breakdown voltage to 20V
- High output sink current to 320mA
- Integral diode for transient suppression
- Strobe control input
- Wide input voltage range from −25V to +20V
- Wide operating temperature range (T_a = −20~+75℃)

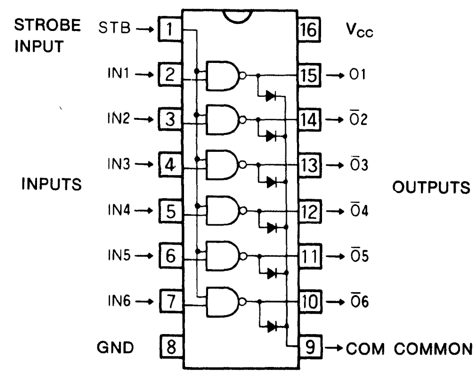
APPLICATION
Relay and printer driver, LED or incandescent display digit driver

FUNCTION
The M54533P uses a predriver stage. Each input has a diode and 20kΩ resistor in series to allow a negative voltage input. All input can be controlled simultaneously by a strobe input at pin 1.

The power supply of the predrivers is connected to pin 16. All emitters and the substrate are connected together to pin 8. Each output has an integral diode for inductive load transient suppression and the cathodes of the diodes are connected to pin 9.

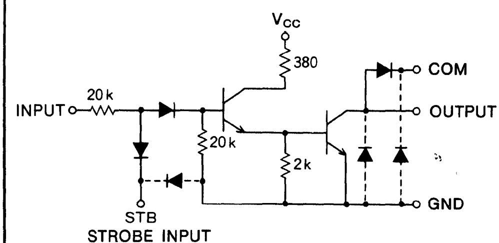
The outputs are capable of sinking 320mA and will withstand 20V in the OFF state.

PIN CONFIGURATION (TOP VIEW)



Outline 16P4

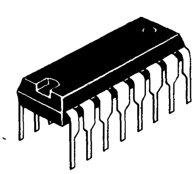
CIRCUIT SCHEMATIC



Unit : Ω

FUNCTIONAL TABLE

IN	STB	OUT
L	L	H
H	L	H
L	H	H
H	H	L



16-pin molded plastic DIP

ABSOLUTE MAXIMUM RATINGS (T_a=−20~+75℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		10	V
V_{CEO}	Output sustaining voltage	Transistor OFF	−0.5~+20	V
I_C	Collector current	Transistor ON	320	mA
V_I	Input voltage		−25~+20	V
$V_{I(STB)}$	Strobe input voltage		20	V
$V_{R(D)}$	Clamp diode reverse voltage		20	V
$I_{F(D)}$	Clamp diode forward current		320	mA
P_d	Power dissipation	T_a=25℃	1.47	W
T_{opr}	Operating ambient temperature range		−20~+75	℃
T_{stg}	Storage temperature range		−55~+125	℃

RECOMMENDED OPERATIONAL CONDITIONS (T_a=−20∼+75℃, unless otherwise noted)

Symbol	Parameter		Limits Min	Limits Typ	Limits Max	Unit
V_{CC}	Supply voltage		3		8	V
V_O	Output voltage		0		20	V
I_C	Collector current per channel	Percent duty cycle less than 25%, V_{CC}=6.5V	0		300	mA
		Percent duty cycle less than 65%, V_{CC}=6.5V	0		150	
V_{IH}	"H" input voltage	I_C=300mA	7		18	V
		I_C=150mA	5		18	
V_{IL}	"L" input voltage	$I_{O(leak)}$=50μA	0		1	V
$V_{IH(STB)}$	"H" input voltage (strobe input)		2.4		18	V
$V_{IL(STB)}$	"L" input voltage (strobe input)		0		0.2	V

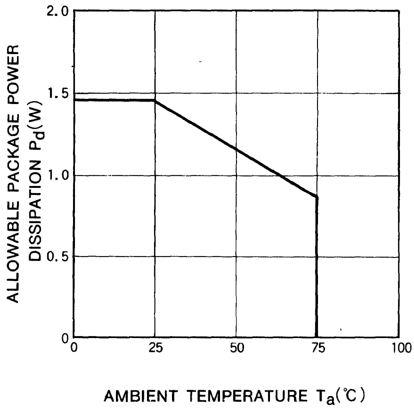
ELECTRICAL CHARACTERISTICS (T_a=−20∼+75℃, unless otherwise noted)

Symbol	Parameter	Test conditions		Limits Min	Limits Typ	Limits Max	Unit
$V_{(BR)CEO}$	Output sustaining voltage	V_{CC}=8V, V_I=18V, $V_{I(STB)}$=0.2V I_{CEO}=100μA		20			V
$V_{CE(sat)}$	Output saturation voltage	V_I=7V $V_{I(STB)}$=2.4V	V_{CC}=6.5V, I_C=250mA		0.5	0.85	V
			V_{CC}=3V, I_C=120mA		0.3	0.5	
I_I	Input current	V_{CC}=8V, V_I=18V, $V_{I(STB)}$=2.4V			0.8	1.8	mA
I_R	Input leakage current	V_{CC}=8V, V_I=−25V				−20	μA
$I_{I(STB)}$	Strobe input current	V_{CC}=8V, V_I=18V (all input), $V_{I(STB)}$=0.2V			−4		mA
$I_{R(STB)}$	Strobe input leakage current	V_{CC}=8V, V_I=0V, $V_{I(STB)}$=20V				20	μA
$V_{F(D)}$	Clamp diode forward voltage	$I_{F(D)}$=320mA			1.4	2.4	V
$V_{R(D)}$	Clamp diode reverse voltage	$I_{R(D)}$=100μA		20	40		V
I_{CC}	Supply current	V_{CC}=8V, V_I=7V (all input) $V_{I(STB)}$=2.4V			120	200	mA
h_{FE}	DC forward current gain	V_{CE}=4V, V_{CC}=6.5V, I_C=300mA, T_a=25℃		1000	3000		—

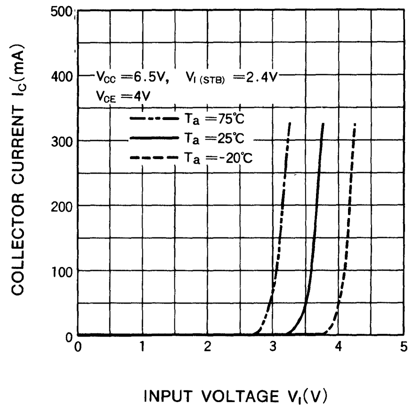
6-UNIT 320mA TRANSISTOR ARRAY WITH CLAMP DIODE AND STROBE

TYPICAL CHARACTERISTICS

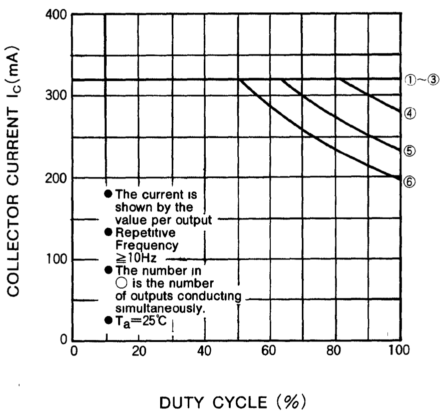
ALLOWABLE AVERAGE POWER DISSIPATION



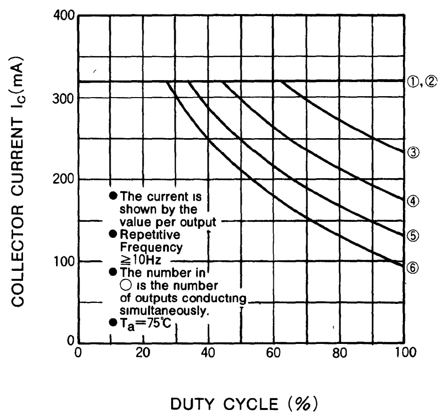
OUTPUT CURRENT CHARACTERISTICS



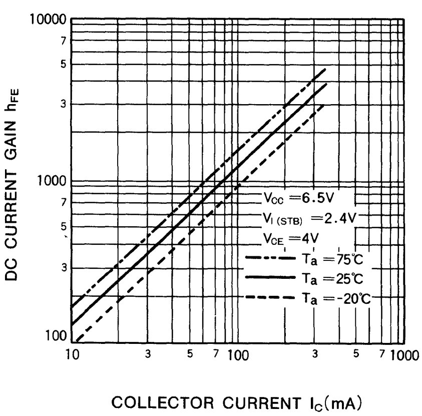
ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



DC CURRENT GAIN CHARACTERISTICS



M54534P

6-UNIT 320mA TRANSISTOR ARRAY WITH CLAMP DIODE AND STROBE

DESCRIPTION

The M54534P, 6-channel sink driver, consists of 12 NPN transistors connected to form high current gain driver pairs.

FEATURES

- Output breakdown voltage to 20V
- High output sink current to 320mA
- Integral diodes for transient suppression
- Strobe control input
- Wide input voltage range from −25V to +20V
- Wide operating temperature range (T_a = −20∼+75℃)

APPLICATIONS

Relay and printer driver, LED or incandescent display digit driver

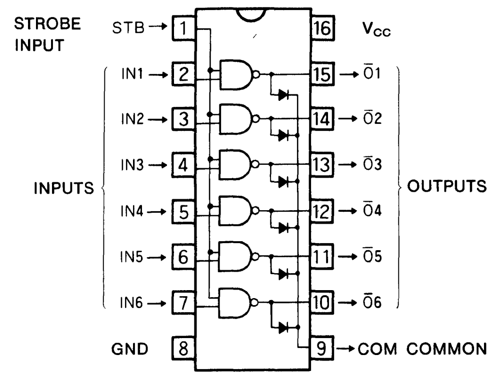
FUNCTION

The M54534P uses a predriver stage. Each input has a diode and 1.6kΩ resistor in series to allow a negative voltage input. All input can be controlled simultaneously by a strobe input at pin 1.

The power supply of the predrivers is connected to pin 16. Each output has an integral diode for inductive load transient suppression and the cathodes of the diodes are connected to pin 9. All emitters and the substrate are connected together to pin 8.

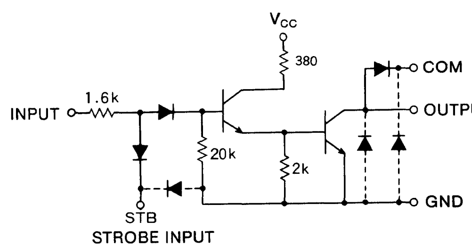
The outputs are capable of sinking 320mA and will withstand 20V in the OFF state.

PIN CONFIGURATION (TOP VIEW)



Outline 16P4

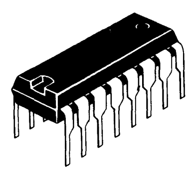
CIRCUIT SCHEMATIC



Unit : Ω

FUNCTIONAL TABLE

IN	STB	OUT
L	L	H
H	L	H
L	H	H
H	H	L



16-pin molded plastic DIP

ABSOLUTE MAXIMUM RATINGS (T_a=−20∼+75℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		10	V
V_{CEO}	Output sustaining voltage	Transistor OFF	−0.5∼+20	V
I_C	Collector current	Transistor ON	320	mA
V_I	Input voltage		−25∼+20	V
$V_{I(STB)}$	Strobe input voltage		20	V
$V_{R(D)}$	Clamp diode reverse voltage		20	V
$I_{F(D)}$	Clamp diode forward current		320	mA
P_d	Power dissipation	T_a=25℃	1.47	W
T_{opr}	Operating ambient temperature range		−20∼+75	℃
T_{stg}	Storage temperature range		−55∼+125	℃

6-UNIT 320mA TRANSISTOR ARRAY WITH CLAMP DIODE AND STROBE

RECOMMENDED OPERATIONAL CONDITIONS (T_a=−20~+75℃, unless otherwise noted)

Symbol	Parameter		Limits Min	Typ	Max	Unit
V_{CC}	Supply voltage		3		8	V
V_O	Output voltage		0		20	V
I_C	Collector current per channel	Percent duty cycle less than 25%, V_{CC}=6.5V	0		300	mA
		Percent duty cycle less than 65%, V_{CC}=6.5V	0		150	
V_{IH}	"H" Input voltage	I_C=300mA	3.2		18	V
V_{IL}	"L" Input voltage	$I_{O(leak)}$=50μA	0		0.7	V
$V_{IH(STB)}$	"H" Input voltage (strobe input)		2.4		18	V
$V_{IL(STB)}$	"L" Input voltage (strobe input)		0		0.2	V

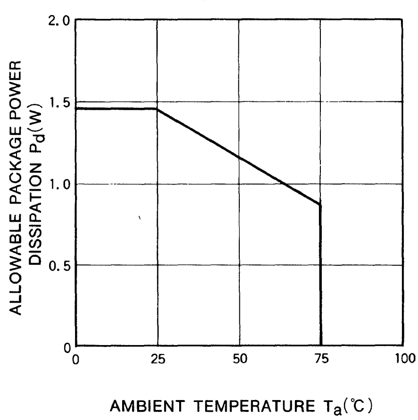
ELECTRICAL CHARACTERISTICS (T_a=−20~+75℃, unless otherwise noted)

Symbol	Parameter	Test conditions		Limits Min	Typ*	Max	Unit
$V_{(BR)CEO}$	Output sustaining voltage	V_{CC}=8V, V_I=3.2V, $V_{I(STB)}$=0.2V, I_{CEO}=100μA		20			V
$V_{CE(sat)}$	Output saturation voltage	V_I=3V, $V_{I(STB)}$=2.4V	V_{CC}=6.5V, I_C=250mA		0.5	0.85	V
			V_{CC}=3V, I_C=120mA		0.3	0.5	
I_I	Input current	V_{CC}=8V, V_I=3.2V, $V_{I(STB)}$=2.4V				1.4	mA
I_R	Input leakage current	V_{CC}=8V, V_I=−25V				−20	μA
$I_{I(STB)}$	Strobe input current	V_{CC}=8V, V_I=3.2V (all input), $V_{I(STB)}$=0.2V			−7.9		mA
$I_{R(STB)}$	Strobe input leakage current	V_{CC}=8V, V_I=0V, $V_{I(STB)}$=20V				20	μA
$V_{F(D)}$	Clamp diode forward voltage	$I_{F(D)}$=320mA			1.4	2.4	V
$V_{R(D)}$	Clamp diode reverse voltage	$I_{R(D)}$=100μA		20	40		V
I_{CC}	Supply current	V_{CC}=8V, V_I=3.2V (all input), $V_{I(STB)}$=2.4V			120	200	mA
h_{FE}	DC forward current gain	V_{CE}=4V, V_{CC}=6.5V, I_C=300mA, T_a=25℃		1000	3000		—

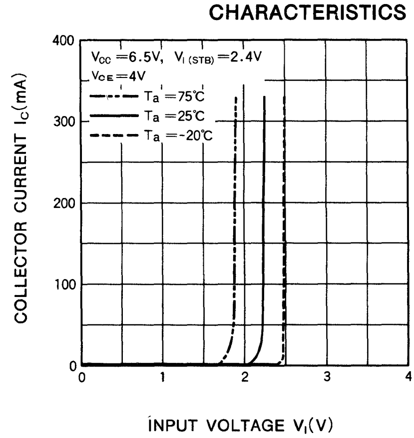
* : All typical values are at T_a=25℃.

TYPICAL CHARACTERISTICS

ALLOWABLE AVERAGE POWER DISSIPATION



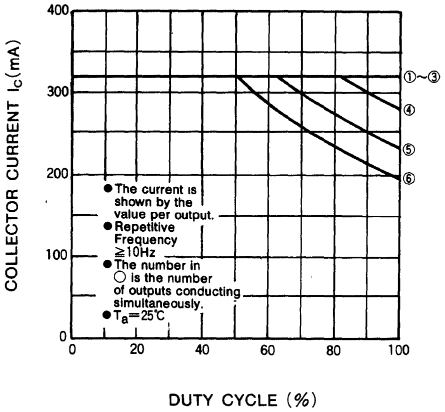
OUTPUT CURRENT CHARACTERISTICS



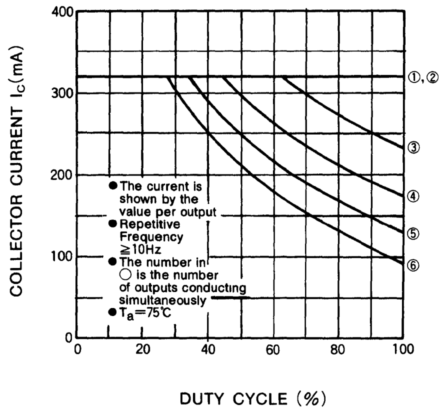
MITSUBISHI ELECTRIC

6-UNIT 320mA TRANSISTOR ARRAY WITH CLAMP DIODE AND STROBE

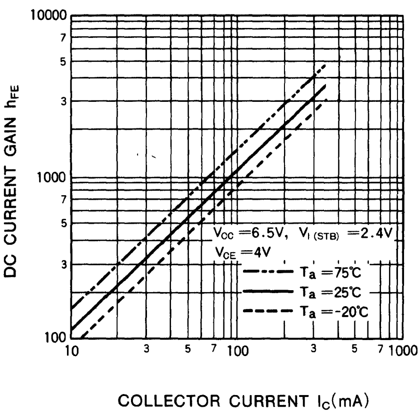
ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



DC CURRENT GAIN CHARACTERISTICS



M54539P

6-UNIT 700mA TRANSISTOR ARRAY WITH CLAMP DIODE

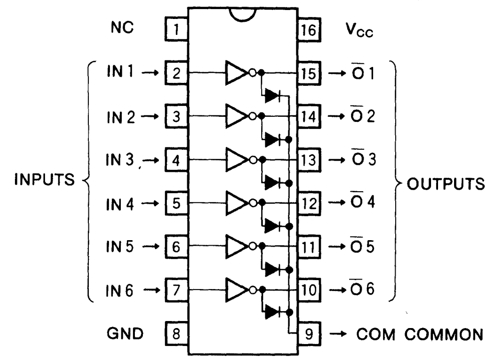
DESCRIPTION
The M54539P, 6-channel sink driver, consists of 12 NPN transistors connected to form high current gain driver pairs.

FEATURES
- Output breakdown voltage to 20V
- High output sink current to 700mA
- Integral diodes for transient suppression
- Wide operating temperature range (T_a=−20～+75℃)

APPLICATIONS
Relay and solenoid driver, LED or incandescent display driver, Thermal head driver

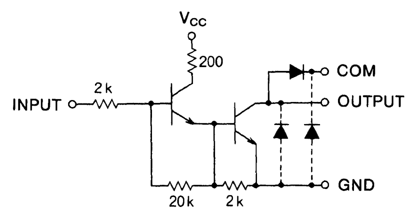
FUNCTION
The M54539P uses a predriver stage with 2kΩ series input resistor. The power supply of the predrivers is connected to pin 16. Each output has an integral diode for inductive load transient suppression and the cathodes of the diodes are connected to pin 9 . All emitters and the substrate are connected together to pin 8 . The outputs are capable of sinking 700mA and will withstand 20V in the OFF state.

PIN CONFIGURATION (TOP VIEW)



Outline 16P4 NC : NO CONNECTION

CIRCUIT SCHEMATIC



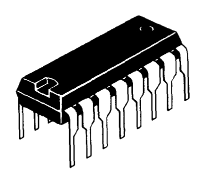
Unit : Ω

ABSOLUTE MAXIMUM RATINGS (T_a=−20～+75℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		10	V
V_{CEO}	Output sustaining voltage	Transistor OFF	−0.5～+20	V
I_C	Collector current	Transistor ON	700	mA
V_I	Input voltage		10	V
V_R	Clamp diode reverse voltage		20	V
I_F	Clamp diode forward current	Pulse width≦35ms, Percent duty cycle≦5%	700	mA
			350	mA
P_d	Power dissipation	T_a=25℃	1.47	W
T_{opr}	Operating ambient temperature range		−20～+75	℃
T_{stg}	Storage temperature range		−55～+125	℃

RECOMMENDED OPERATIONAL CONDITIONS (T_a=−20～+75℃, unless otherwise noted)

Symbol	Parameter		Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage		3	5	7	V
V_O	Output voltage		0		20	V
I_C	Collector current per channel	The three outputs conducting simultaneously Percent duty cycle less than 20%	0		700	mA
		The three outputs conducting simultaneously Percent duty cycle less than 90%	0		200	mA
V_{IH}	"H" Input voltage	I_C=450mA	3		6	V
V_{IL}	"L" Input voltage	$I_{O(leak)}$=50μA	0		0.3	V



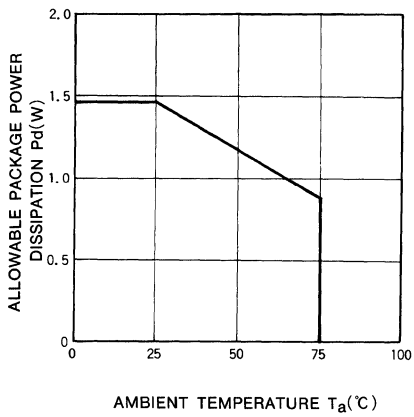
16-pin molded plastic DIP

ELECTRICAL CHARACTERISTICS (T_a=−20~+75℃, unless otherwise noted)

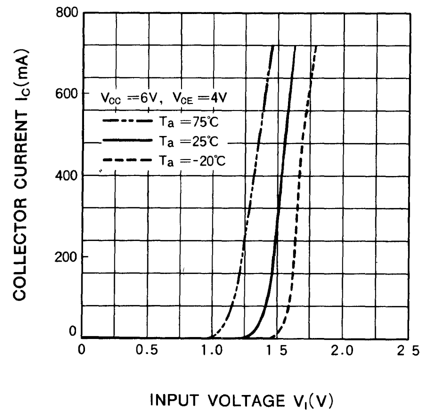
Symbol	Parameter	Test conditions		Limits			Unit
				Min	Typ	Max	
$V_{(BR)CEO}$	Output sustaining voltage	V_{CC}=7V, I_{CEO}=100μA		20			V
$V_{CE(sat)}$	Output saturation voltage	V_{CC}=5V	I_C=450mA		0.46	0.8	V
		V_I=3V	I_C=200mA		0.2	0.45	
I_I	Input current	V_{CC}=7V, V_I=3.2V			0.75	1.4	mA
V_R	Clamp diode reverse voltage	I_R=100μA		20			V
V_F	Clamp diode forward voltage	I_F=350mA			1.5	2.7	V
I_{CC}	Supply current	V_{CC}=7V, V_I=3.2V (all input)			190	300	mA
h_{FE}	DC forward current gain	V_{CE}=4V, V_{CC}=6V, I_C=300mA, T_a=25℃		3000	8000		—

TYPICAL CHARACTERISTICS

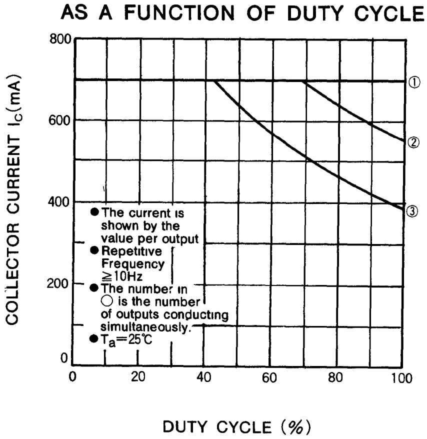
ALLOWABLE AVERAGE POWER DISSIPATION



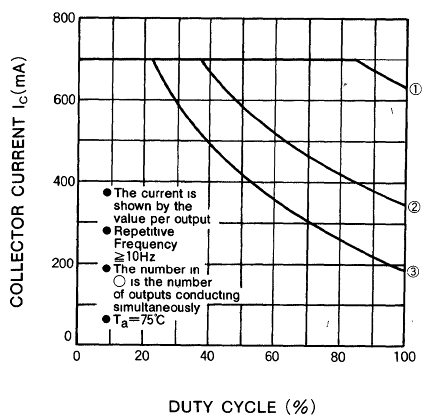
OUTPUT CURRENT CHARACTERISTICS



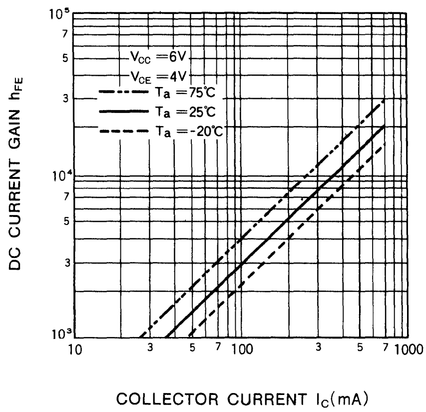
ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



DC CURRENT GAIN CHARACTERISTICS



M54578P

6-UNIT 700mA TRANSISTOR ARRAY WITH CLAMP DIODE AND STROBE

DESCRIPTION

The M54578P, 6-channel sink driver, consists of 12 NPN transistors connected to form high current gain driver pairs.

FEATURES

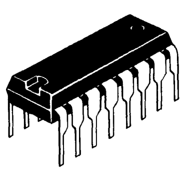
- 20V breakdown
- High output sink current to 700mA
- PMOS Compatible
- Wide operating temperature range (T_a =−20∼+75℃)

APPLICATIONS

Relay and printer driver, LED or incandescent display digit driver, Interfacing for standard MOS/BIPOLAR logics

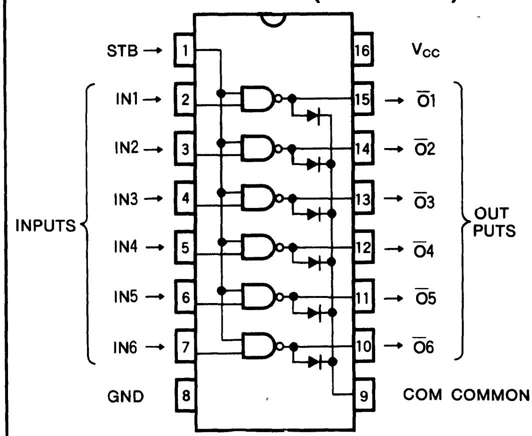
FUNCTION

The M54578P uses a predriver stage. Each input has a diode and 2 kΩ resistor in series to allow a negative voltage input. All input can be controlled simultaneously by a strobe input at pin 1. The power supply of the predrivers is connected to pin 16. Each output has an integral diode for inductive load transient suppression and the cathodes of the diodes are connected to pin 9. All emitters and the substrate are connected together to pin 8. The outputs are capable of sinking 700mA and will withstand 20V in the OFF state.



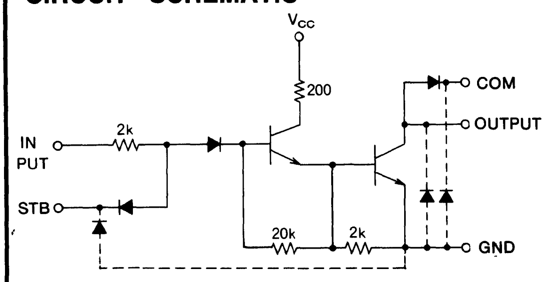
16-pin molded plastic DIP

PIN CONFIGURATION (TOP VIEW)



Outline 16P4

CIRCUIT SCHEMATIC



Unit : Ω

ABSOLUTE MAXIMUM RATINGS (T_a=−20∼+75℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		10	V
V_{CEO}	Output sustaining voltage	Transistor OFF	−0.5∼+20	V
I_C	Collector current	Transistor ON	700	mA
V_I	Input voltage		−25∼+20	V
$V_{I(STB)}$	Strobo input voltage		20	V
$V_{R(D)}$	Clamp diode reverse voltage		20	V
$I_{F(D)}$	Clamp diode forward current	Pulse width≦35ms, Duty cycle≦5%	700	mA
			350	
P_d	Power dissipation	T_a=25℃	1.47	W
T_{opr}	Operating ambient temperature range		−20∼+75	℃
T_{stg}	Storage temperature range		−55∼+125	℃

RECOMMENDED OPERATIONAL CONDITIONS (T_a=−20∼+75℃, unless otherwise noted)

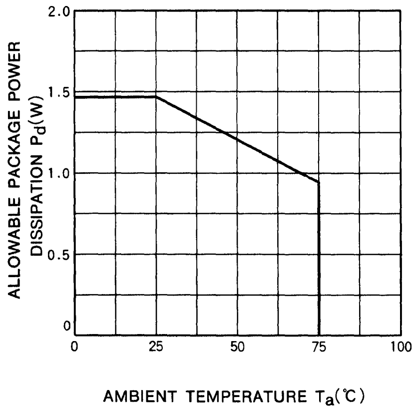
Symbol	Parameter		Limits Min	Limits Typ	Limits Max	Unit
V_{CC}	Supply voltage		3	5	8	V
V_O	Output voltage		0		20	V
I_C	Collector current per channel	The three outputs conducting simultaneously Percent duty cycle less than 20%	0		700	mA
		The three outputs conducting simultaneously Percent duty cycle less than 90%	0		200	
$V_{IH(STB)}$	"H" Input voltage (strobe input)		2.4		V_{CC}	V
$V_{IL(STB)}$	"L" Input voltage (strobe input)		0		0.2	V
V_{IH}	"H" Input voltage	I_C=450mA, V_{CC}=5V	3.5		V_{CC}	V
		I_C=700mA, V_{CC}=6V	5		V_{CC}	
V_{IL}	"L" Input voltage	$I_{O(leak)}$=50μA	0		0.8	V

ELECTRICAL CHARACTERISTICS (T_a=−20∼+75℃, unless otherwise noted)

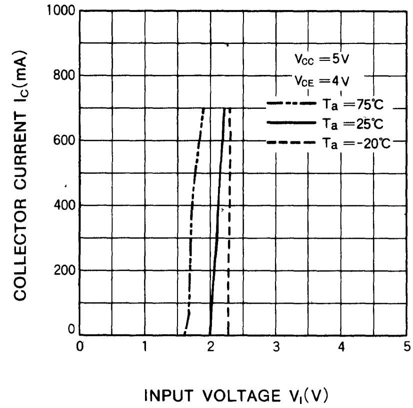
Symbol	Parameter	Test conditions		Limits Min	Limits Typ	Limits Max	Unit
$V_{(BR)CEO}$	Output sustaining voltage	V_{CC}=7V, $V_{I(STB)}$=0.4V V_I=3.5V, I_{CEO}=100μA		20			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	V_{CC}=5V	I_C=450mA		0.5	0.8	V
		V_I=3.5V	I_C=200mA		0.23	0.45	
I_I	Input current	V_{CC}=7V, V_I=3.5V $V_{I(STB)}$=2.4V			0.6	1.4	mA
I_R	Input leakage current	V_{CC}=7V, V_R=−25V				−20	μA
$I_{I(STB)}$	Strobe input current	V_{CC}=7V, $V_{I(STB)}$=0.4V V_I=3.5V (all input)			−7.2	−10.7	mA
$I_{R(STB)}$	Strobe input leakage current	V_{CC}=7V, V_I=0V, $V_{I(STB)}$=20V				20	μA
$V_{F(D)}$	Clamp diode forward current	$I_{F(D)}$=600mA			1.6	5	V
$V_{R(D)}$	Clamp diode reverse voltage	$I_{R(D)}$=100μA		20			V
I_{CC}	Supply current	V_{CC}=8V, $V_{I(STB)}$=2.4V V_I=3.5V (all input)			220	320	mA
h_{FE}	DC forward current gain	V_{CC}=5V V_{CE}=4V, I_C=450mA, T_a=25℃		2000	10000		—

TYPICAL CHARACTERISTICS

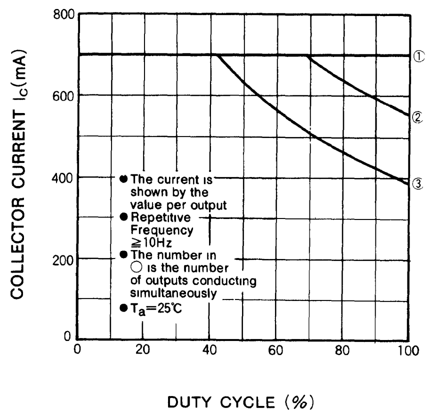
ALLOWABLE AVERAGE POWER DISSIPATION



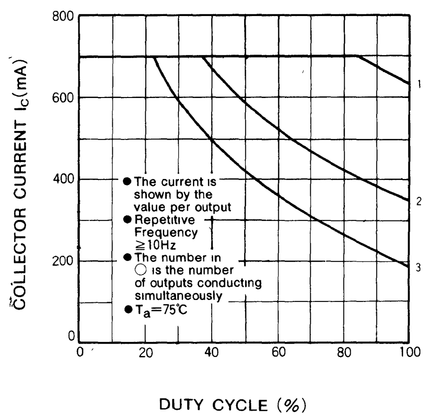
OUTPUT CURRENT CHARACTERISTICS



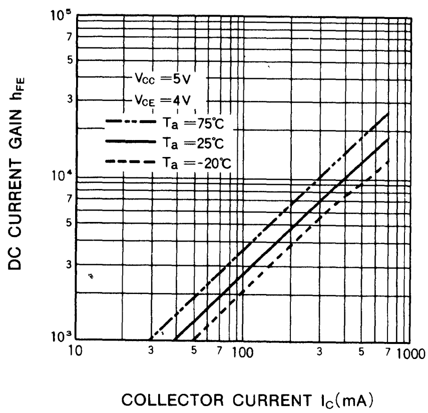
ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



DC CURRENT GAIN CHARACTERISTICS



M54527P

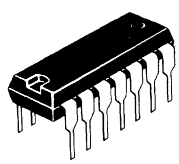
6-UNIT 150mA DARLINGTON TRANSISTOR ARRAY WITH CLAMP DIODE

DESCRIPTION
The M54527P, 6-channel sink driver, consists of 12 NPN transistors connected to form high current gain driver pairs.

FEATURES
- High output sustaining voltage to 40V
- Output sink current to 150mA
- PMOS compatible input
- Integral diode for transient suppression
- Wide input voltage range from −40V to +40V
- Wide operating temperature range (T_a = −20∼+75℃)

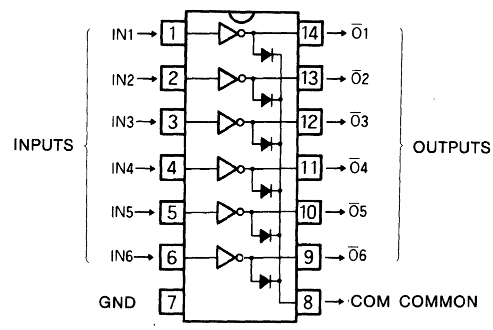
APPLICATIONS
Relay and printer driver, LED or incandescent display digit driver, Interfacing for standard MOS/BIPOLAR logics

FUNCTION
The M54527P is comprised of six darlington driver pairs. Each input has a diode and 20kΩ resistor in series to allow a negative voltage input. Between pin 8 and each output, there are integral diodes for inductive load transient suppression. All emitters and the substrate are connected together to pin 7. The outputs are capable of sinking 150mA and will withstand 40V in the OFF state.



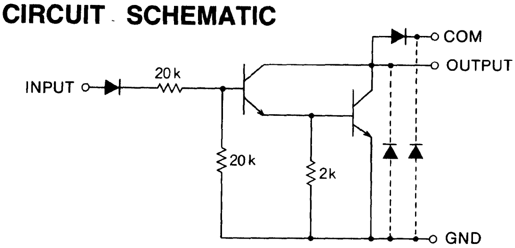
14-pin molded plastic DIP

PIN CONFIGURATION (TOP VIEW)



Outline 14P4

CIRCUIT SCHEMATIC



Unit : Ω

ABSOLUTE MAXIMUM RATINGS (T_a=−20∼+75℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CEO}	Output sustaining voltage	Transistor OFF	−0.5∼+40	V
I_C	Collector current	Transistor ON	150	mA
V_I	Input voltage		−40∼+40	V
$I_{F(D)}$	Clamp diode forward current		150	mA
$V_{R(D)}$	Clamp diode reverse voltage		40	V
P_d	Power dissipation	T_a=25℃	1.47	W
T_{opr}	Operating ambient temperature range		−20∼+75	℃
T_{stg}	Storage temperature range		−55∼+125	℃

RECOMMENDED OPERATIONAL CONDITIONS (T_a=−20∼+75℃, unless otherwise noted)

Symbol	Parameter		Limits			Unit
			Min	Typ	Max	
V_O	Output voltage		0		40	V
I_C	Collector current per channel	Percent duty cycle less than 50%	0		150	mA
V_{IH}	"H" Input voltage	I_C=150mA	7		35	V
V_{IL}	"L" Input voltage	$I_{O(leak)}$=50μA	0		1	V

6-UNIT 150mA DARLINGTON TRANSISTOR ARRAY WITH CLAMP DIODE

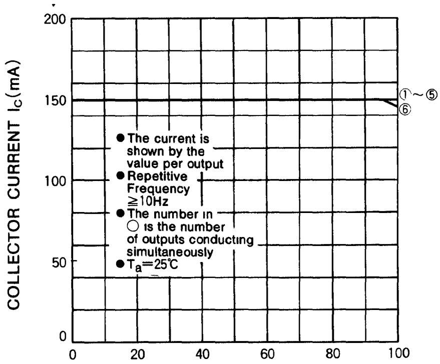
ELECTRICAL CHARACTERISTICS (T_a=−20~+75℃, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ*	Max	
$V_{(BR)CEO}$	Output sustaining voltage	I_{CEO}=100μA	40			V
$V_{CE(sat)}$	Output saturation voltage	V_I=7V, I_C=150mA		1.4	1.7	V
		V_I=7V, I_C=100mA		1.2	1.4	
I_I	Input current	V_I=18V		0.9	1.8	mA
		V_I=35V		1.9	5	
I_R	Input leakage current	V_I=−35V			−20	μA
$V_{F(D)}$	Clamp diode forward voltage	$I_{F(D)}$=150mA		1.15	1.6	V
$I_{R(D)}$	Clamp diode leakage current	$V_{R(D)}$=40V			100	μA
h_{FE}	DC forward current gain	V_{CE}=4V, I_C=150mA, T_a=25℃	800	2500		—

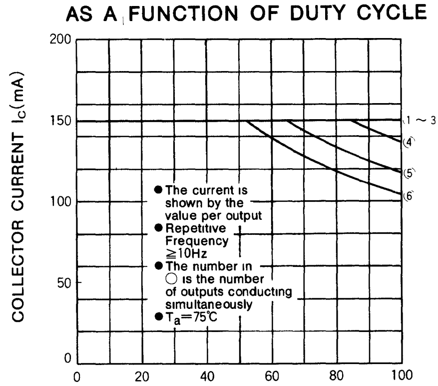
* : All typical values are at T_a=25℃.

TYPICAL CHARACTERISTICS

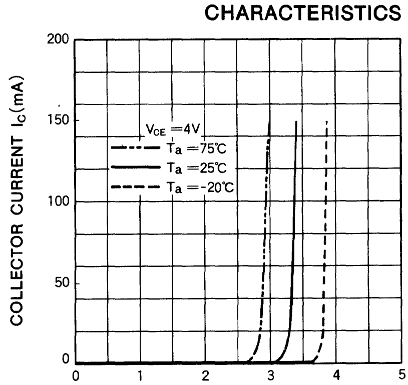
ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



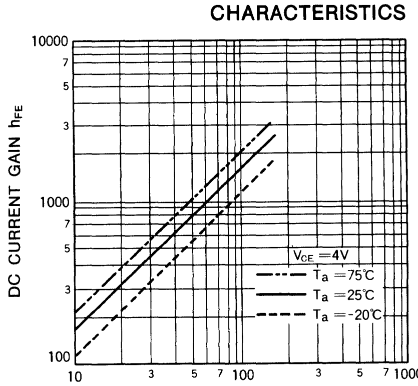
ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



OUTPUT CURRENT CHARACTERISTICS



DC CURRENT GAIN CHARACTERISTICS



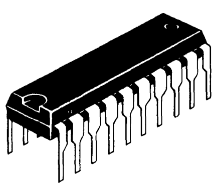
6-UNIT 350mA TRANSISTOR ARRAY AND MOTOR DRIVER

DESCRIPTION
The M54571P, 6-channel sink driver and voltage regulator, is designed for use with a small printer.

FEATURES
- High output sustaining voltage to 40V
- High output sink current to 350mA
- Voltage regulator with a control circuit
- Wide operating temperature range ($T_a=-20\sim+75$℃)

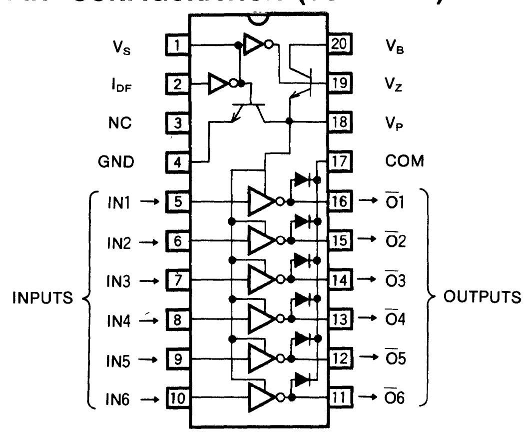
APPLICATION
Small calculator printer driver

FUNCTION
The M54571P is designed for driving a small serial printer made by CITIZEN and EPSON, and consists of 6 relay drivers and 1.2A motor driver. Each driver has 4.3kΩ series input resistor and output transient suppression diode. The driver outputs are capable of sinking 350mA and will withstand 43V in the OFF state. The output of the motor driver at pin 18 can drive 1.2A.



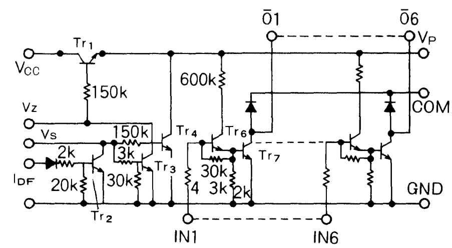
20-pin molded plastic DIP

PIN CONFIGURATION (TOP VIEW)



Outline 20P4 NC : NO CONNECTION

CIRCUIT SCHEMATIC



Unit : Ω

ABSOLUTE MAXIMUM RATINGS ($T_a=-20\sim+75$℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		40	V
V_{CEO}	Output sustaining voltage		−0.5～+40	V
I_{C1}	Collector current	T_{r1}	100	nA
I_{C2}		T_{r2}	100	mA
I_{C3}		T_{r3}	100	mA
I_{C4}		T_{r4} Spike current 2A max Pulse width≦ 5 ms, Duty cycle≦ 5 %	1200	mA
I_{C7}		T_{r7} (Per channel)	350	nA
V_I	Input voltage	IN1～IN6	40	V
$V_{I(IDF)}$			40	V
$V_{R(IDF)}$	Input reverse voltage		−45	V
$V_{R(D)}$	Clamp diode reverse voltage		40	V
$I_{F(D)}$	Clamp diode forward current		350	mA
Pd	Power dissipation	T_a =25℃	1.79	W
T_{opr}	Operating ambient temperature range		−20～+75	℃
T_{stg}	Storage temperature range		−55～+125	℃

RECOMMENDED OPERATIONAL CONDITIONS (T_a=−20∼+75℃, unless otherwise noted)

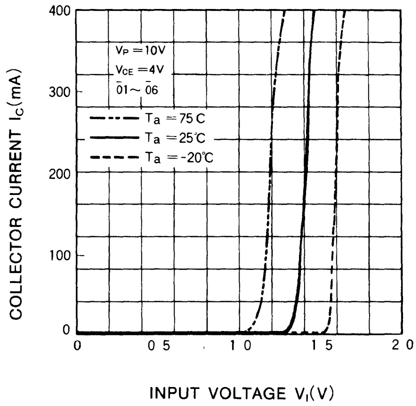
Symbol	Parameter		Limits Min	Limits Typ	Limits Max	Unit
V_{CC}	Supply voltage		8		40	V
V_P	Supply voltage		4		18	V
V_S	Reference voltage			10		V
I_C	Collector current	Ō1∼Ō6	5		250	mA
		Ō1∼Ō6	0		100	
$V_{I(IDF)}$	Input voltage				−35	V
			9		17	
V_I		IN1∼IN6	9		17	V
V_O	Output voltage	Ō1∼Ō6	0		40	V

ELECTRICAL CHARACTERISTICS (T_a=−20∼+75℃, unless otherwise noted)

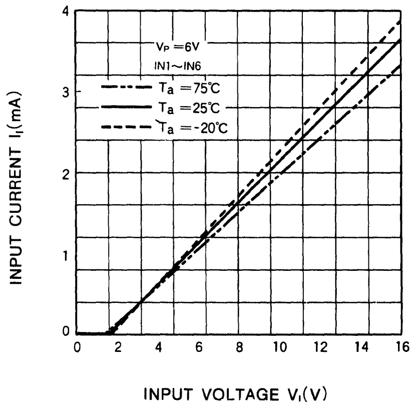
Symbol	Parameter		Test conditions	Limits Min	Limits Typ	Limits Max	Unit
$V_{BR(CEO)}$	Output sustaining voltage		I_{CEO}=100μA, V_P=5V, (Ō1∼Ō7)	40			V
$V_{CE(sat)}$	Collector emitter saturation voltage	Ō1∼Ō7	V_P=6.5V, V_I=3V, I_C=250mA			0.8	V
			V_P=3V, V_I=2.4V, I_C=120mA			0.5	
		T_{r1}	I_B=1mA, I_C=10mA, V_P=0V			0.5	
		T_{r2}	$V_{I(IDF)}$=10V, I_{VS}=100mA			0.5	
		T_{r3}	$V_{I(Vs)}$=3V, I_{VZ}=30mA, $V_{I(IDF)}$=0V			0.4	
		T_{r4}	I_{VS}=50mA, I_{VP}=0.3V, $V_{I(IDF)}$=0V			0.45	
			I_{VS}=80mA, I_{VP}=1A, $V_{I(IDF)}$=0V			1.2	
I_I	Input current		V_P=6V, V_I=10V, (IN1∼IN6)			3.5	mA
$I_{I(IDF)}$			$V_{I(IDF)}$=10V			6.5	mA
$I_{I(Vs)}$			$V_{I(Vs)}$=3V, $V_{I(IDF)}$=0V			26	mA
$I_{R(IDF)}$	Input leakage current		$V_{R(IDF)}$=−35V			−20	μA
$V_{F(D)}$	Clamp diode forward voltage		$I_{F(D)}$=250mA			2.4	V
I_{VP}	Supply current		V_P=17V, V_I=10V (all input)			240	mA
			V_P=5V, V_I=10V (all input)			60	
h_{FE} 1	DC forward current gain	T_{r4}	I_C=50mA, V_{CE}=4V, T_a=25℃	100			—
h_{FE} 2	DC forward current gain	T_{r4}	I_C=1A, V_{CE}=4V, T_a=25℃	80			—
h_{FE} 3	DC forward current gain	Ō1∼Ō7	V_P=6.5V, I_C=350mA, V_{CE}=4V, T_a=25℃	1000			—

TYPICAL CHARACTERISTICS

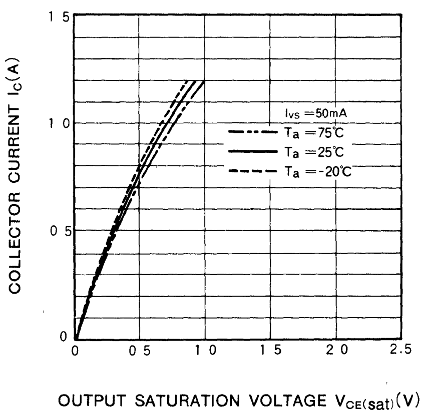
OUTPUT CURRENT CHARACTERISTICS



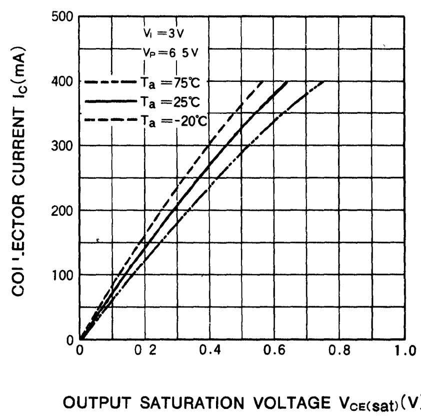
INPUT CHARACTERISTICS



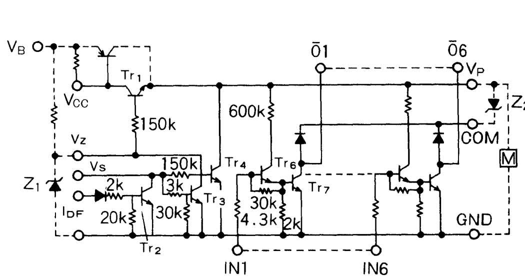
MOTOR DRIVER OUTPUT SATURATION CHARACTERISTICS



MAGNET RELAY DRIVER OUTPUT SATURATION CHARACTERISTICS



TYPICAL APPLICATION



NOTE

	V_B	V_{Z1}	Z_2	Magnet Relay Drive Current
EPSON Printer	15~40V	18V	—	90mA
CITIZEN Printer	3 ~ 9 V	6 V	connect between the V_P and the COM	250mA

M54514AP

7-UNIT 50mA TRANSISTOR ARRAY

DESCRIPTION

The M54514AP, 7-channel sink drivers, consists of 7 NPN transistors with 2.8kΩ series input resistors.

FEATURES

- Output breakdown voltage to 20V
- 50mA output sink current capability
- Low output saturation voltage
- Wide operating temperature range (T_a = −20∼+75℃)

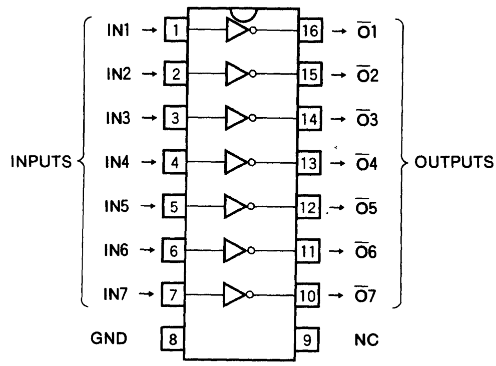
APPLICATION

LED or incandescent display digit driver

FUNCTION

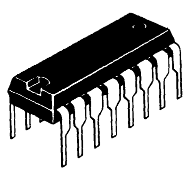
The M54514AP is comprised of seven NPN drivers. Each input has a voltage divider by 2.8kΩ and 10kΩ resistors. All emitters and the substrate are connected together to pin 8. The open collector outputs are capable of sinking 50mA and will withstand 20V in the OFF state.

PIN CONFIGURATION (TOP VIEW)



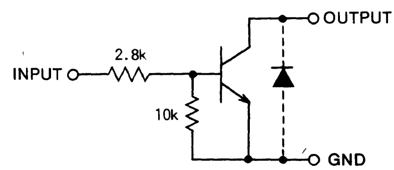
Outline 16P4

NC : NO CONNECTION



16-pin molded plastic DIP

CIRCUIT SCHEMATIC



Unit : Ω

ABSOLUTE MAXIMUM RATINGS (T_a = −20∼+75℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CEO}	Output sustaining voltage	Transistor OFF	−0.5∼+20	V
I_C	Collector current	Transistor ON	50	mA
V_I	Input voltage		10	V
P_d	Power dissipation	T_a=25℃	1.47	W
T_{opr}	Operating ambient temperature range		−20∼+75	℃
T_{stg}	Storage temperature range		−55∼+125	℃

RECOMMENDED OPERATIONAL CONDITIONS (T_a = −20∼+75℃, unless otherwise noted)

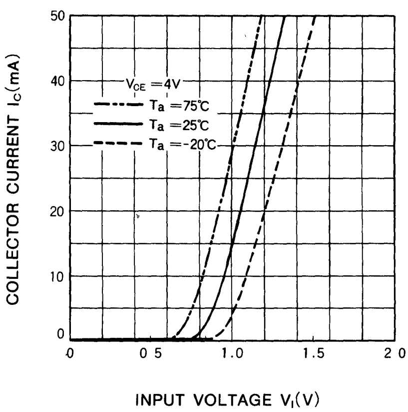
Symbol	Parameter		Limits			Unit
			Min	Typ	Max	
V_O	Output voltage		0		20	V
I_C	Collector current		0		20	mA
V_{IH}	"H" input voltage	I_C=50mA	2.4		8	V
V_{IL}	"L" input voltage		0		0.2	V

ELECTRICAL CHARACTERISTICS (T_a=−20~+75℃, unless otherwise noted)

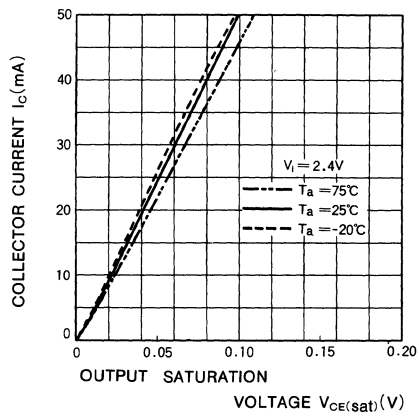
Symbol	Parameter	Test conditions		Limits			Unit
				Min	Typ	Max	
$I_{O(leak)}$	Output leakage current	V_O=20V				20	μA
$V_{CE(sat)}$	Output saturation voltage	V_I=2.4V	I_C=20mA		0.04	0.17	V
			I_C=40mA		0.08	0.23	
I_I	Input current	V_I=2.4V			0.7	1.1	mA
h_{FE}	DC forward current gain	V_{CE}=4V, I_C=40mA, T_a=25℃		80	200		—

TYPICAL CHARACTERISTICS

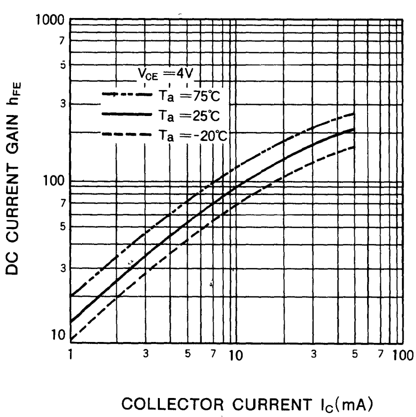
OUTPUT CURRENT CHARACTERISTICS



OUTPUT CHARACTERISTICS



DC CURRENT GAIN CHARACTERISTICS



MITSUBISHI ELECTRIC

M54515P

7-UNIT 16mA TRANSISTOR ARRAY

DESCRIPTION

The M54515P, transistor array, consists of seven NPN transistors and is connected in a common-emitter configuration.

FEATURES

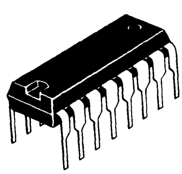
- Output breakdown voltage to 17V
- 16mA output sink current capability
- Wide operating temperature range (T_a = −20∼+75℃)

APPLICATION

LED or incandescent display driver

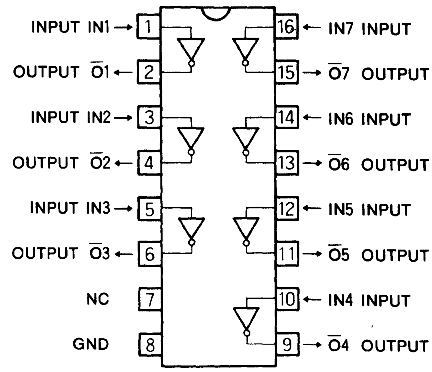
FUNCTION

The M54515P is comprised of seven NPN transistors. All emitters and the substrate are connected together to pin 8. The outputs are capable of sinking 16mA and will withstand 17V in the OFF state.



16-pin molded plastic DIP

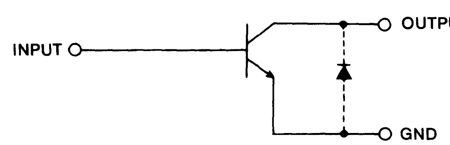
PIN CONFIGURATION (TOP VIEW)



Outline 16P4

NC : NO CONNECTION

CIRCUIT SCHEMATIC



Unit : Ω

ABSOLUTE MAXIMUM RATINGS (T_a = −20∼+75℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CEO}	Output sustaining voltage	Transistor OFF	−0.5∼+17	V
V_I	Input voltage		1.2	V
I_C	Collector current	Transistor ON	16	mA
T_{opr}	Operating ambient temperature range		−20∼+75	℃
T_{stg}	Storage temperature range		−55∼+125	℃

RECOMMENDED OPERATIONAL CONDITIONS (T_a = −20∼+75℃, unless otherwise noted)

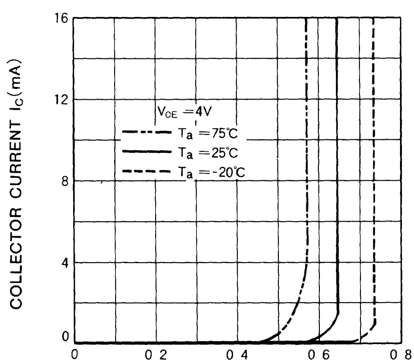
Symbol	Parameter	Limits			Unit
		Min	Typ	Max	
V_O	Output voltage	0		17	V
I_C	Collector current per channel	0		16	mA

ELECTRICAL CHARACTERISTICS ($T_a = -20 \sim +75$℃, unless otherwise noted)

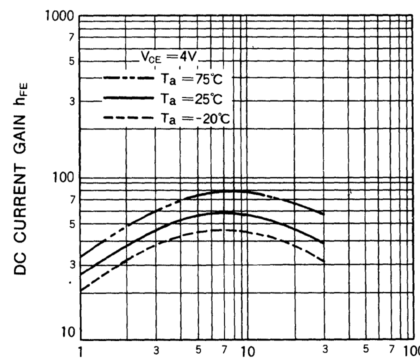
Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
$V_{(BR)CEO}$	Output sustaining voltage	$I_{OH}=100\mu A$	17			V
$V_{CE(sat)}$	Output saturation voltage	$I_{OL}=16mA$, $I_B=0.5mA$		0.14	0.5	V
$V_{BE(sat)}$	Base-emitter saturation voltage	$I_{OL}=16mA$, $I_B=0.5mA$		0.64	1.2	V
h_{FE}	DC forward current gain	$V_{CE}=5V$, $I_C=16mA$, $T_a=25$℃	32	50		—
$I_{O(leak)}$	Output leakage current	$V_O=17V$, $V_I=0.2V$			700	μA

TYPICAL CHARACTERISTICS

OUTPUT CURRENT CHARACTERISTICS



DC CURRENT GAIN CHARACTERISTICS



MITSUBISHI ELECTRIC

M54577P,FP

7-UNIT 30mA TRANSISTOR ARRAY

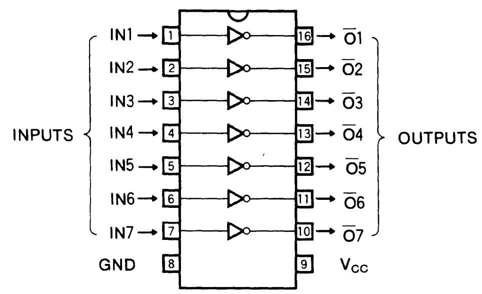
DESCRIPTION
The M54577P, FP, 7-channel sink driver, consists of 14 NPN transistors connected to form high current gain driver pairs.

FEATURES
- Output breakdown voltage to 30V
- Output sink current to 30mA
- PMOS, CMOS Compatible input
- Low output saturation voltage
- Wide operating temperature range (T_a = −20∼+75℃)

APPLICATION
LED or incandescent display digit driver

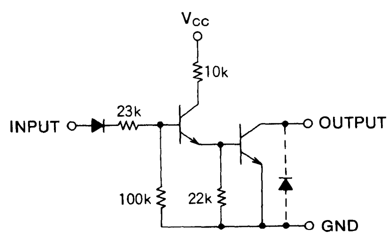
FUNCTION
The M54577P, FP uses a predriver stage with a diode and 23kΩ resistor in series to the input. The power supply of the predrivers is connected to pin 9. The outputs are capable of sinking 30mA and will withstand 30V in the OFF state. The M54577FP features a small flat mold package.

PIN CONFIGURATION (TOP VIEW)

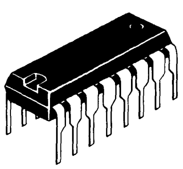


Outline 16P2 (M54577FP)
Outline 16P4 (M54577P)

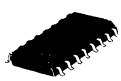
CIRCUIT SCHEMATIC



Unit : Ω



16-pin molded plastic DIP



16-pin molded plastic FLAT

ABSOLUTE MAXIMUM RATINGS (T_a=−20∼+75℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		13	V
V_{CEO}	Output sustaining voltage	Transistor OFF	−0.5∼+30	V
I_C	Collector current	Transistor ON	30	mA
V_I	Input voltage		−20∼+30	V
T_{opr}	Operating ambient temperature range		−20∼+75	℃
T_{stg}	Storage temperature range		−55∼+125	℃

RECOMMENDED OPERATIONAL CONDITIONS (T_a=−20∼+75℃, unless otherwise noted)

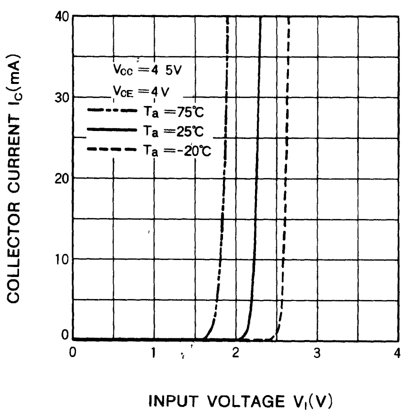
Symbol	Parameter		Limits Min	Typ	Max	Unit
V_{CC}	Supply voltage		4.5	5	13	V
I_C	Collector current per channel		0	10	20	mA
V_{IH}	"H" Input voltage	I_C=20mA	3		V_{CC}	V
V_{IL}	"L" Input voltage		0		1	V

ELECTRICAL CHARACTERISTICS (T_a=−20∼+75℃, unless otherwise noted)

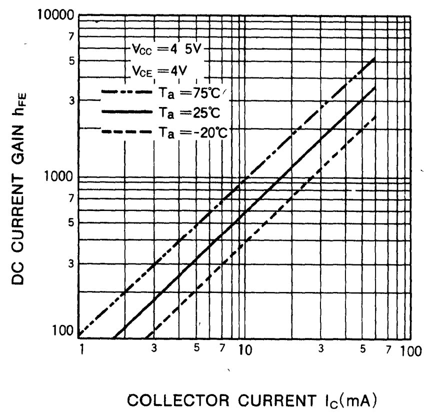
Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
$I_{O(leak)}$	Output leak current	V_{CE}=30 V			100	μA
$V_{CE(sat)}$	Output saturation voltage	V_{CC}=4.5 V, V_I=3 V, I_C=10 mA			0.25	V
		V_{CC}=6 V, V_I=3 V, I_C=20 mA			0.35	
I_I	Input current	V_{CC}=4.5 V, V_I=3 V	30		90	μA
I_{CC}	Supply current per channel (an only output conducting)	V_{CC}=4.5 V, V_I=3 V		0.4	0.9	mA
		V_{CC}=13 V, V_I=3 V		1.3	2.3	
h_{FE}	DC forward current gain	V_{CE}=4 V, V_{CC}=4.5 V, I_C=20 mA, T_a=25℃	500	1200		—

TYPICAL CHARACTERISTICS

OUTPUT CURRENT CHARACTERISTICS



DC CURRENT GAIN CHARACTERISTICS



MITSUBISHI ELECTRIC

M54537P

7-UNIT 350mA TRANSISTOR ARRAY

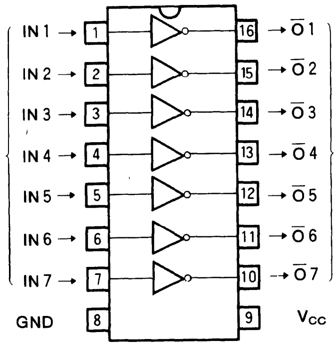
DESCRIPTION
The M54537P, 7-channel sink driver, consists of 14 NPN transistors connected to form high current gain driver pairs.

FEATURES
- Output breakdown voltage to 20V
- High output sink current to 250mA
- PMOS Compatible input
- Low output saturation voltage
- Wide operating temperature range (T_a =−20∼+75℃)

APPLICATION
Relay and printer driver, LED or incandescent display digit driver, Interfacing for standard MOS/BIPOLAR logics

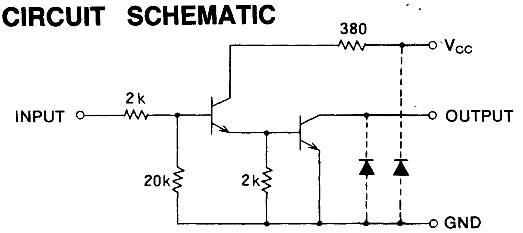
FUNCTION
The M54537P uses a predriver stage with 2kΩ series input resistor. The power supply of the predrivers is connected to pin 9. All emitters and the substrate are connected together to pin 8. The outputs are capable of sinking 250mA and will withstand 20V in the OFF state.

PIN CONFIGURATION (TOP VIEW)



Outline 16P4

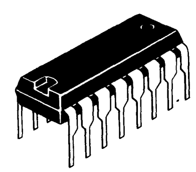
CIRCUIT SCHEMATIC



Unit : Ω

RECOMMENDED OPERATIONAL CONDITIONS (T_a=−25∼+75℃, unless otherwise noted)

Symbol	Parameter		Limits Min	Limits Typ	Limits Max	Unit
V_{CC}	Supply voltage		3		8	V
V_O	Output voltage		0		20	V
I_C	Collector current per channel	V_{CC}=6.5V Percent duty cycle less than 40%	0		250	mA
		V_{CC}=6.5V Percent duty cycle less than 65%	0		150	
V_{IH}	"H" Input voltage	I_C=250mA	3		6	V
V_{IL}	"L" Input voltage	$I_{O(leak)}$=50μA	0		0.3	V



16-pin molded plastic DIP

ABSOLUTE MAXIMUM RATINGS (T_a=−25∼+75℃, unless otherwise noted)

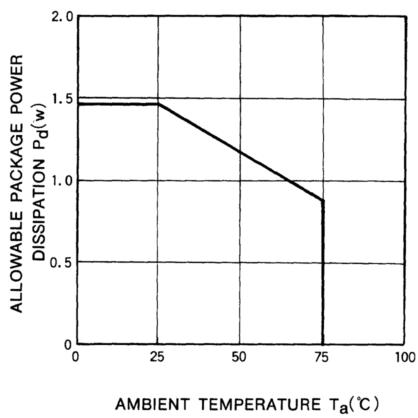
Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		10	V
V_{CEO}	Output sustaining voltage	Transistor OFF	−0.5∼+20	V
I_C	Collector current	Transistor ON	350	mA
V_I	Input voltage		10	V
P_d	Power dissipation	T_a=25℃	1.47	W
T_{opr}	Operating ambient temperature range		−20∼+75	℃
T_{stg}	Storage temperature range		−55∼+125	℃

ELECTRICAL CHARACTERISTICS (T_a=−25~+75℃, unless otherwise noted)

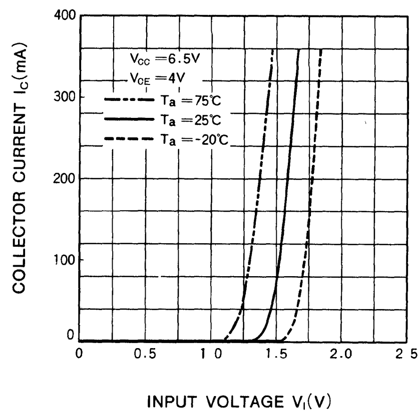
Symbol	Parameter	Test conditions		Limits Min	Limits Typ	Limits Max	Unit
$V_{(BR)CEO}$	Output sustaining voltage	V_{CC}=8V, I_{CEO}=100μA		20			V
$V_{CE(sat)}$	Output saturation voltage	V_I=3V	V_{CC}=6.5V, I_C=250mA		0.28	0.5	V
			V_{CC}=3V, I_C=150mA		0.17	0.35	
I_I	Input current	V_{CC}=8V, V_I=3.2V			0.7	1.5	mA
		V_{CC}=8V, V_I=10V			3.8	7.3	
I_{CC}	Supply current	V_{CC}=8V, V_I=3.2V			130	190	mA
h_{FE}	DC forward current gain	V_{CE}=4V, V_{CC}=6.5V, I_C=250mA, T_a=25℃		1000	7000		

TYPICAL CHARACTERISTICS

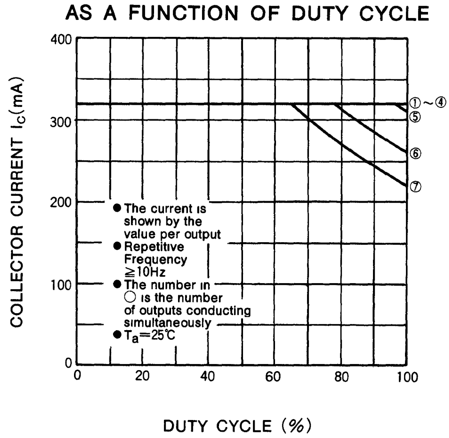
ALLOWABLE AVERAGE



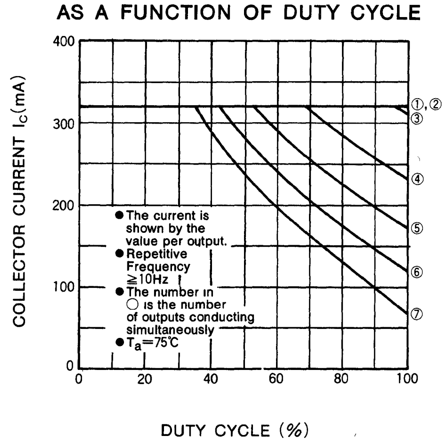
OUTPUT CURRENT CHARACTERISTICS

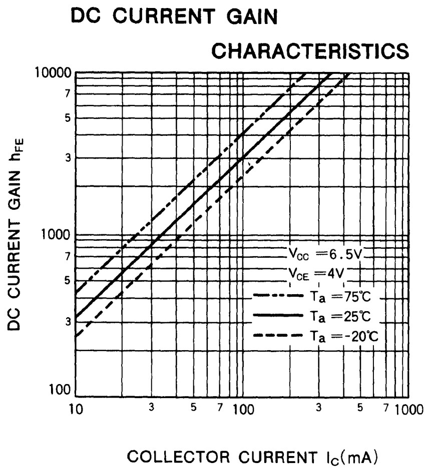


ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE




DC CURRENT GAIN
CHARACTERISTICS
10000
7
5
3
1000
7
5
3
100
10
3
5
7
100
3
5
7
1000
DC CURRENT GAIN h_{FE}
COLLECTOR CURRENT I_C(mA)
V_{CC} =6.5V
V_{CE} =4V
T_a =75℃
T_a =25℃
T_a =-20℃

M54535P

7-UNIT 150mA TRANSISTOR ARRAY WITH CLAMP DIODE AND STROBE

DESCRIPTION

The M54535P, 7-channel sink driver, consists of 14 NPN transistors connected to form high current gain driver pairs.

FEATURES

- Output sink current to 150mA
- Strobe input control
- PMOS Compatible input
- Wide operating temperature range (T_a = −20∼+75℃)

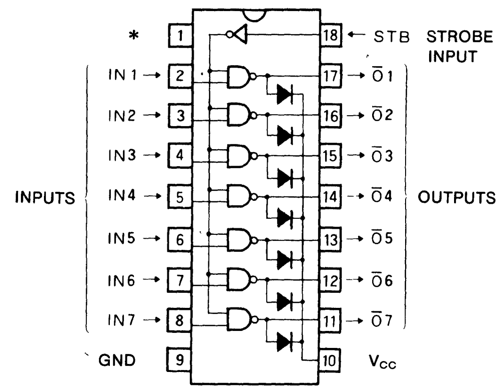
APPLICATION

Relay and printer driver, LED or incandescent display digit driver, Interfacing for standard MOS/BIPOLAR logics

FUNCTION

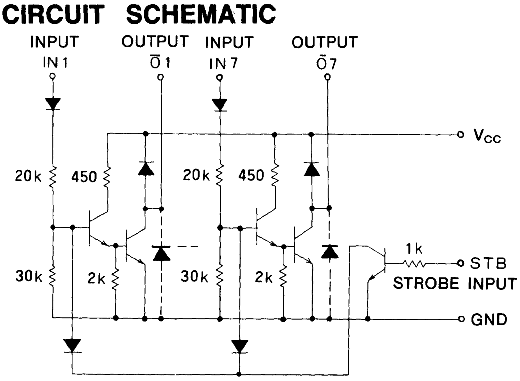
The M54535P uses a predriver stage. Each input has a diode and 20kΩ resistor in series to allow a negative voltage input. All inputs can be controlled simultaneously by a strobe input at pin 18. Each output has an integral diode for inductive load transient suppression.
The cathodes of the diodes and the power supply of the predrivers are connected to pin 10. All emitters and the substrate are connected together to pin 9 .
The outputs are capable of sinking 150mA and will withstand 10V in the OFF state.

PIN CONFIGURATION (TOP VIEW)



Outline 18P4

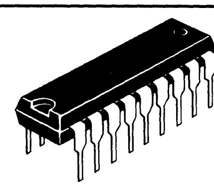
CIRCUIT SCHEMATIC



Unit : Ω

FUNCTIONAL TABLE

IN	STB	OUT
L	L	H
H	L	L
L	H	H
H	H	H



18-pin molded plastic DIP

ABSOLUTE MAXIMUM RATINGS (T_a=−20∼+75℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		10	V
V_O	Output voltage	Transistor OFF	−0.5∼V_{CC}	V
I_C	Collector current	Transistor ON	150	mA
V_I	Input voltage		−25∼+20	V
$V_{I(STB)}$	Strobe input voltage		20	V
$V_{R(D)}$	Clamp diode reverse voltage		10	V
$I_{F(D)}$	Clamp diode forward current		150	mA
P_d	Power dissipation	T_a=25℃	1.47	W
T_{opr}	Operating ambient temperature range		−20∼+75	℃
T_{stg}	Storage temperature range		−55∼+125	℃

7-UNIT 150mA TRANSISTOR ARRAY WITH CLAMP DIODE AND STROBE

RECOMMENDED OPERATIONAL CONDITIONS (T_a=−20~+75℃, unless otherwise noted)

Symbol	Parameter		Limits Min	Limits Typ	Limits Max	Unit
V_{CC}	Supply voltage		3		8	V
V_O	Output voltage	V_{CC}=10V	0		10	V
I_C	Collector current per channel	Percent duty cycle less than 65%	0		150	mA
V_{IH}	"H" Input voltage	I_C=100mA	7		18	V
V_{IL}	"L" Input voltage		0		0.8	V
$V_{IH(STB)}$	"H" Input voltage (strobe input)	V_I=12V	1.3		6	V
		V_I=20V	2.4		6	
$V_{IL(STB)}$	"L" Input voltage (strobe input)		0		0.2	V

ELECTRICAL CHARACTERISTICS (T_a=−20~+75℃, unless otherwise noted)

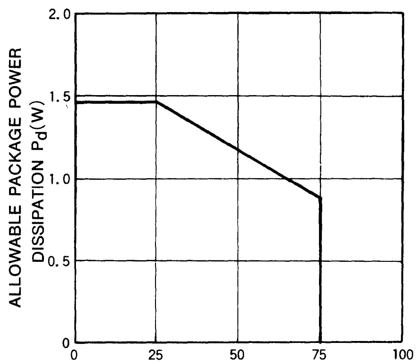
Symbol	Parameter	Test conditions		Limits Min	Limits Typ*	Limits Max	Unit
$V_{CE(sat)}$	Output saturation voltage	$V_{I(STB)}$=0.2V, V_{CC}=6V, I_I=300μA, I_C=100mA			0.1	0.3	V
		V_I=7V, $V_{I(STB)}$=0.2V	V_{CC}=3V, I_C=100mA		0.1	0.3	
			V_{CC}=8V, I_C=150mA		0.16	0.5	
$I_{O(leak)}$	Output leak current	V_{CC}=8V, V_I=0.8V, V_O=8V, $V_{I(STB)}$=0.2V				50	μA
I_I	Input current	V_{CC}=8V, V_I=12V, $V_{I(STB)}$=0.2V			0.5	1	mA
I_R	Input leakage current	V_{CC}=8V, V_I=−25V				−20	μA
$I_{I(STB)}$	Strobe input current	V_I=12V, $V_{I(STB)}$=2.4V			0.6	3	mA
$V_{F(D)}$	Clamp diode forward voltage	$I_{F(D)}$=150mA			1.1	2.1	V
$V_{R(D)}$	Clamp diode reverse voltage	$I_{R(D)}$=100μA		10			V
I_{CC}	Supply current	V_{CC}=8V, V_I=12V all input, $V_{I(STB)}$=0.2V			120	200	mA
h_{FE}	DC forward current gain	V_{CE}=4V, V_{CC}=6V, I_C=150mA, T_a=25℃		700	2500		—

* : The typical value is at T_a=25℃

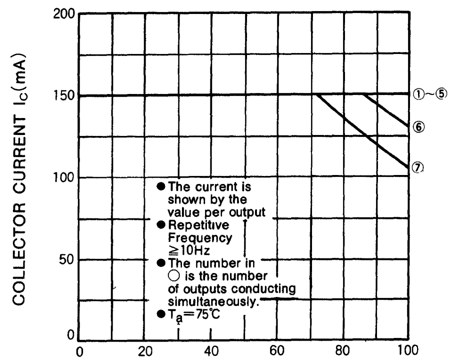
7-UNIT 150mA TRANSISTOR ARRAY WITH CLAMP DIODE AND STROBE

TYPICAL CHARACTERISTICS

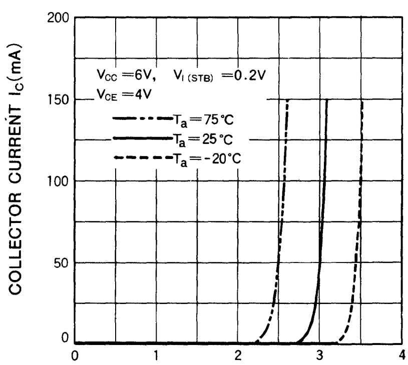
ALLOWABLE AVERAGE POWER DISSIPATION



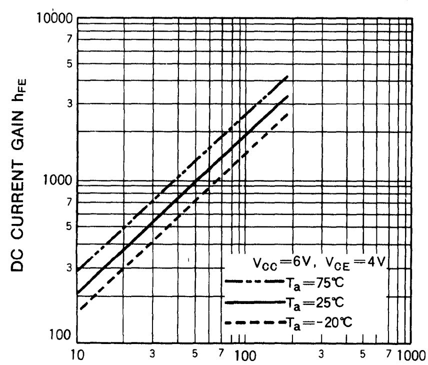
ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



OUTPUT CURRENT CHARACTERISTICS



DC CURRENT GAIN CHARACTERISTICS



M54536P

7-UNIT 150mA TRANSISTOR ARRAY WITH CLAMP DIODE AND STROBE

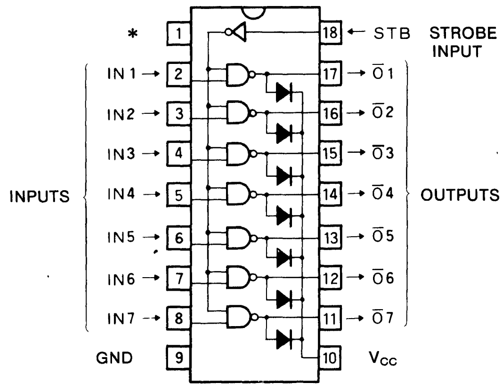
DESCRIPTION
The M54536P, 7-channel sink driver, consists of 14 NPN transistors connected to form high current gain driver pairs.

FEATURES
- Output sink current to 150mA
- Strobe input control
- TTL Compatible input
- Wide operating temperature range (T_a=−20~+75°C)

APPLICATION
Relay and printer driver, LED or incandescent display digit driver, Interfacing for standard MOS/BIPOLAR logics

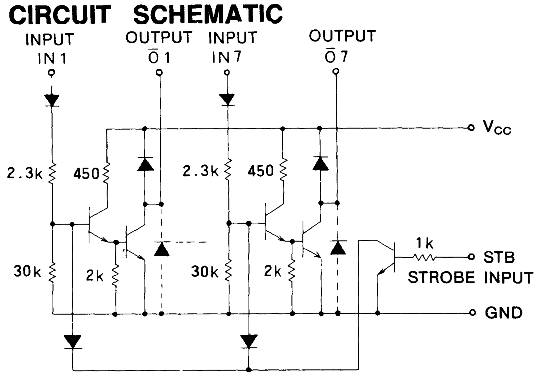
FUNCTION
The M54536P uses a predriver stage. Each input has a diode and 20kΩ resistor in series to allow a negative voltage input. All inputs can be controlled simultaneously by a strobe input at pin 18. Each output has an integral diode for inductive load transient suppression.
The cathodes of the diodes and the power supply of the predrivers are connected to pin 10. All emitters and the substrate are connected together to pin 9.
The outputs are capable of sinking 150mA and will withstand 10V in the OFF state.

PIN CONFIGURATION (TOP VIEW)



Outline 18P4

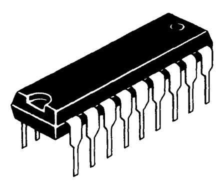
CIRCUIT SCHEMATIC



Unit : Ω

FUNCTION TABLE

IN	STB	OUT
L	L	H
H	L	L
L	H	H
H	H	H



18-pin molded plastic DIP

ABSOLUTE MAXIMUM RATINGS (T_a=−25~+75°C, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		10	V
V_O	Output voltage	Transistor OFF	−0.5~V_{CC}	V
I_C	Collector current	Transistor ON	150	mA
V_I	Input voltage		−25~+10	V
$V_{I(STB)}$	Strobe input voltage		20	V
$V_{R(D)}$	Clamp diode reverse voltage		10	V
$I_{F(D)}$	Clamp diode forward current		150	mA
P_d	Power dissipation	T_a=25°C	1.47	W
T_{opr}	Operating ambient temperature range		−20~+75	°C
T_{stg}	Storage temperature range		−55~+125	°C

RECOMMENDED OPERATIONAL CONDITIONS (T_a=−25~+75℃, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits Min	Limits Typ	Limits Max	Unit
V_{CC}	Supply voltage		3		8	V
V_O	Output voltage	V_{CC}=10V	0		10	V
I_C	Collector current per channel	Percent duty cycle less than 65%	0		150	mA
V_{IH}	"H" Input voltage	I_C=100mA	3.2		6	V
V_{IL}	"L" Input voltage		0		0.8	V
$V_{IH(STB)}$	"H" Input voltage (strobe input)	V_I=3.5V	1.3		6	V
		V_I=10V	2.4		6	
$V_{IL(STB)}$	"L" Input voltage (strobe input)		0		0.2	V

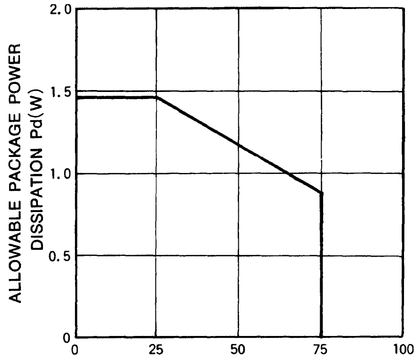
ELECTRICAL CHARACTERISTICS (T_a=−25~+75℃, unless otherwise noted)

Symbol	Parameter	Test conditions		Limits Min	Limits Typ*	Limits Max	Unit
$V_{CE(sat)}$	Output saturation voltage	$V_{I(STB)}$=0.2V, V_{CC}=6V, I_I=300μA, I_C=100mA			0.1	0.3	V
		V_I=3.2V, $V_{I(STB)}$=0.2V	V_{CC}=3V, I_C=100mA		0.1	0.3	
			V_{CC}=8V, I_C=150mA		0.16	0.5	
$I_{O(leak)}$	Output leak current	V_{CC}=8V, V_I=0.8V, V_O=8V, $V_{I(STB)}$=0.2V				50	μA
I_I	Input current	V_{CC}=8V, V_I=3.5V, $V_{I(STB)}$=0.2V			0.6	1.2	mA
I_R	Input leakage current	V_{CC}=8V, V_I=−25V				−20	μA
$I_{I(STB)}$	Strobe input current	V_I=3.5V, $V_{I(STB)}$=2.4V			0.9	3	mA
$V_{F(D)}$	Clamp diode forward voltage	$I_{F(D)}$=150mA			1.1	2.1	V
$V_{R(D)}$	Clamp diode reverse voltage	$I_{R(D)}$=100μA		10			V
I_{CC}	Supply current	V_{CC}=8V, V_I=3.5V (all input), $V_{I(STB)}$=0.2V			120	200	mA
h_{FE}	DC forward current gain	V_{CE}=4V, V_{CC}=6V, I_C=150mA, T_a=25℃		700	3000		—

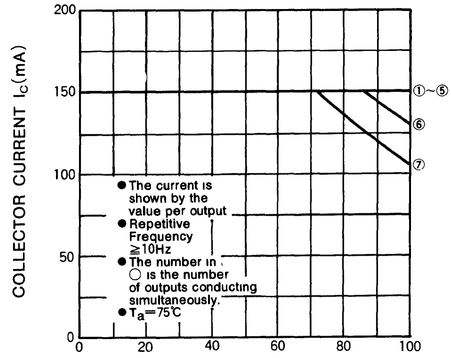
* : A typical value is at T_a=25℃.

TYPICAL CHARACTERISTICS

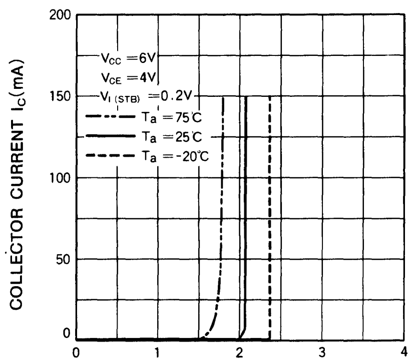
ALLOWABLE AVERAGE POWER DISSIPATION



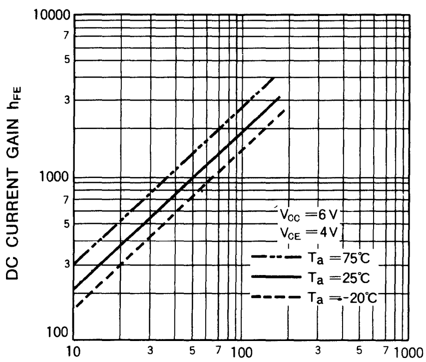
ALLOWABLE COLLECT CURRENT AS A FUNCTION OF DUTY CYCLE



OUTPUT CURRENT CHARACTERISTICS



DC CURRENT GAIN CHARACTERISTICS



M54517P

7-UNIT 400mA DARLINGTON TRANSISTOR ARRAY

DESCRIPTION

The M54517P, 7-channel sink driver, consists of 14 NPN transistors connected to form seven high current gain driver pairs.

FEATURES

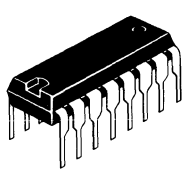
- Output sustaining voltage to 25V
- High output sink current to 400mA
- PMOS Compatible input
- Wide operating temperature range (T_a = −20～+75℃)

APPLICATION

Relay and printer driver, LED or incandescent display digit driver, Interfacing for standard MOS/BIPOLAR logics

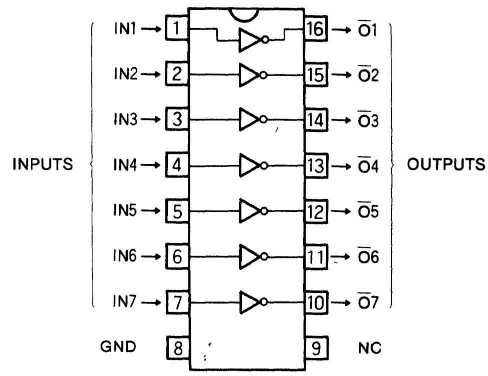
FUNCTION

The M54517P is comprised of seven NPN darlington driver pairs with 20kΩ series input resistors. All emitters and the substrate are connected to pin 8. The output are capable of sinking 400mA and will withstand 25V in the OFF state.



16-pin molded plastic DIP

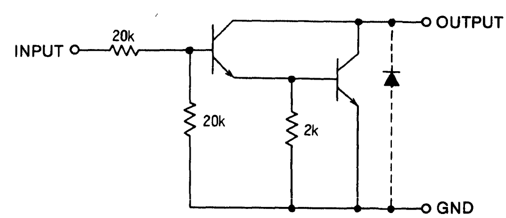
PIN CONFIGURATION (TOP VIEW)



Outline 16P4

NC : NO CONNECTION

CIRCUIT SCHEMATIC



Unit : Ω

ABSOLUTE MAXIMUM RATINGS (T_a=−20～+75℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CEO}	Output sustaining voltage	Transistor OFF	−0.5～+25	V
I_C	Collector current	Transistor ON	400	mA
V_I	Input voltage		25	V
P_d	Power dissipation	T_a=25℃	1.47	W
T_{opr}	Operating ambient temperature range		−20～+75	℃
T_{stg}	Storage temperature range		−55～+125	℃

RECOMMENDED OPERATIONAL CONDITIONS (T_a=−20∼+75℃, unless otherwise noted)

Symbol	Parameter		Limits Min	Typ	Max	Unit
V_O	Output voltage		0		25	V
I_C	Collector current per channel	Percent duty cycle less than 8 %	0		400	mA
		Percent duty cycle less than 40%	0		200	
V_{IH}	"H" input voltage	I_C=400mA	8		20	V
		I_C=100mA	5		20	
V_{IL}	"L" input voltage	$I_{O(leak)}$=50μA	0		0.5	V

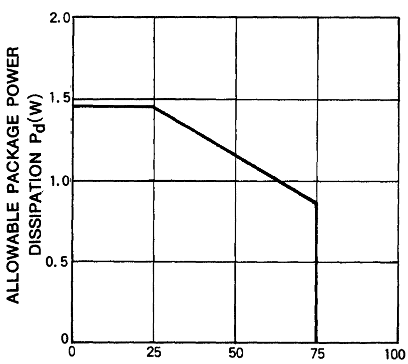
ELECTRICAL CHARACTERISTICS (T_a=−20∼+75℃, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits Min	Typ*	Max	Unit
$V_{(BR)CEO}$	Output sustaining voltage	I_{CEO}=100μA	25			V
$V_{CE(sat)}$	Output saturation voltage	V_I=8V, I_C=400mA		1.15	2.2	V
		V_I=5V, I_C=200mA		0.95	1.4	
I_I	Input current	V_I=17V		0.8	1.8	mA
h_{FE}	DC forward current gain	V_{CE}=4V, I_C=400mA, T_a=25℃	1000	4500		—

* : A typical value is at T_a=25℃.

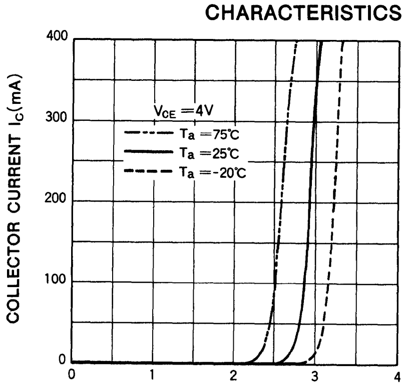
TYPICAL CHARACTERISTICS

ALLOWABLE AVERAGE POWER DISSIPATION



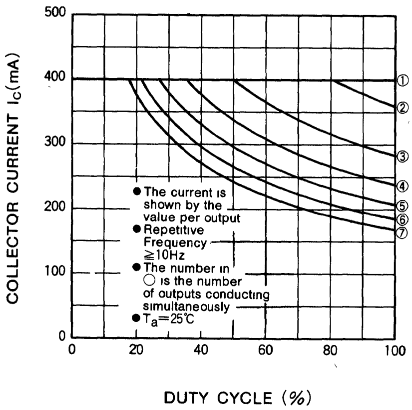
AMBIENT TEMPERATURE T_a(℃)

OUTPUT CURRENT CHARACTERISTICS

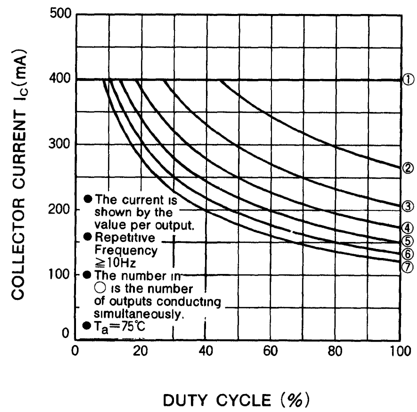


INPUT VOLTAGE V_I(V)

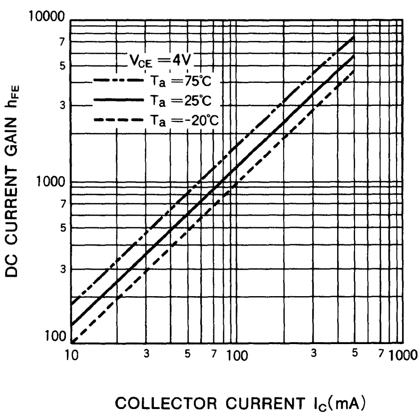
ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



DC CURRENT GAIN CHARACTERISTICS



M54519P

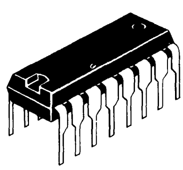
7-UNIT 400mA DARLINGTON TRANSISTOR ARRAY

DESCRIPTION
The M54519P, 7-channel sink driver, consists of 14 NPN transistors connected to form seven high current gain driver pairs.

FEATURES
- High output sustaining voltage to 40V
- High output sink current to 400mA
- PMOS Compatible input
- Wide operating temperature range (T_a=−20∼+75℃)

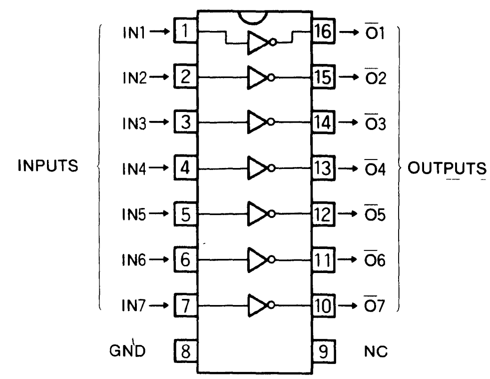
APPLICATION
Relay and printer driver, LED or incandescent display digit driver, Interfacing for standard MOS/BIPOLAR logics

FUNCTION
The M54519P is comprised of seven NPN darlington driver pairs with 20kΩ series input resistors.
All emitters and the substrate are connected together to pin 8. The output are capable of sinking 400mA and will withstand 40V in the OFF state.



16-pin molded plastic DIP

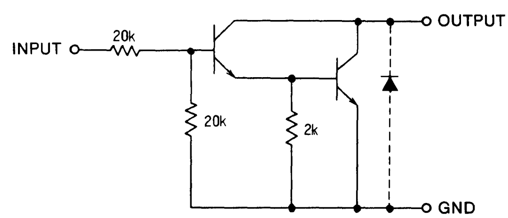
PIN CONFIGURATION (TOP VIEW)



Outline 16P4

NC : NO CONNECTION

CIRCUIT SCHEMATIC



Unit : Ω

ABSOLUTE MAXIMUM RATINGS (T_a=−20∼+75℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CEO}	Output sustaining voltage	Transistor OFF	−0.5∼+40	V
I_C	Collector current	Transistor ON	400	mA
V_I	Input voltage		40	V
P_d	Power dissipation	T_a=25℃	1.47	W
T_{opr}	Operating ambient temperature range		−20∼+75	℃
T_{stg}	Storage temperature range		−55∼+125	℃

RECOMMENDED OPERATIONAL CONDITIONS (T_a= -20~+75℃, unless otherwise noted)

Symbol	Parameter		Limits Min	Limits Typ	Limits Max	Unit
V_O	Output voltage		0		40	V
I_C	Collector current per channel	Percent duty cycle less than 8%	0		400	mA
		Percent duty cycle less than 30%	0		200	
V_{IH}	"H" Input voltage	I_C=400mA	8		30	V
		I_C=100mA	5		30	
V_{IL}	"L" Input voltage	$I_{O(leak)}$=50μA	0		0.5	V

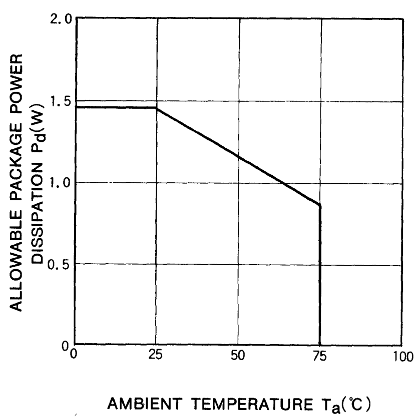
ELECTRICAL CHARACTERISTICS (T_a=−20~+75℃, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits Min	Limits Typ*	Limits Max	Unit
$V_{(BR)CEO}$	Output sustaining voltage	I_{CEO}=100μA	40			V
$V_{CE(sat)}$	Output saturation voltage	V_I=8V, I_C=400mA		1.2	2.4	V
		V_I=5V, I_C=200mA		0.9	1.6	
I_I	Input current	V_I=17V	0.3	0.8	1.8	mA
h_{FE}	DC forward current gain	V_{CE}=4V, I_C=400mA, T_a=25℃	1000	6000		—

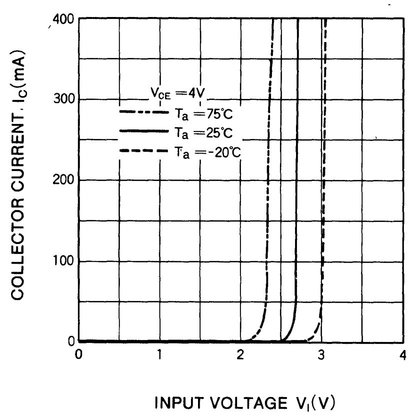
* : A typical value is at T_a=25℃.

TYPICAL CHARACTERISTICS

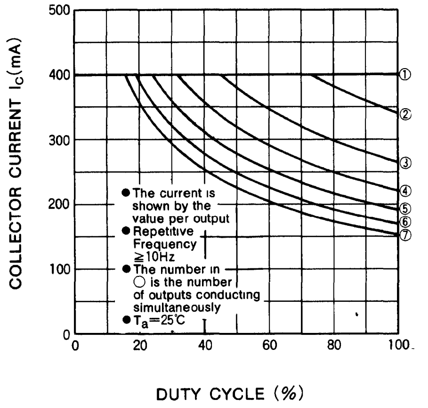
ALLOWABLE AVERAGE POWER DISSIL



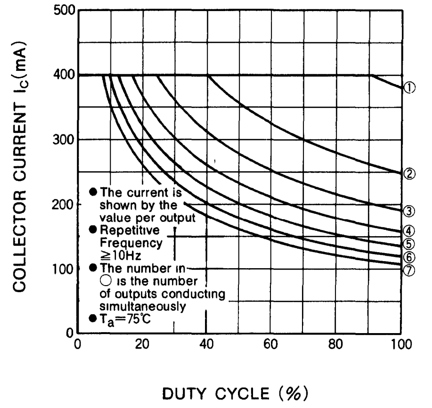
OUTPUT CURRENT CHARACTERISTICS



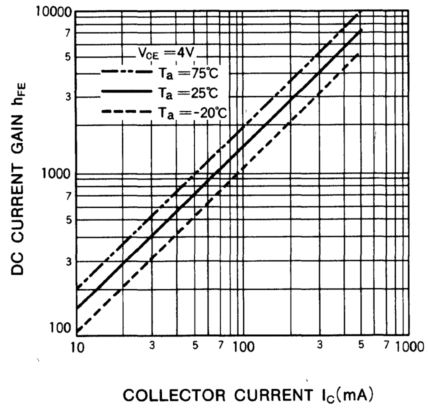
ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



DC CURRENT GAIN CHARACTERISTICS



M54528P

7-UNIT 150mA DARLINGTON TRANSISTOR ARRAY WITH CLAMP DIODE

DESCRIPTION

The M54528P, 7-channel sink driver, consists of 14 NPN transistors connected to form high current gain driver pairs.

FEATURES

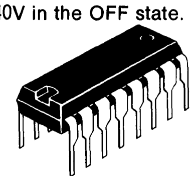
- High output sustaining voltage to 40V
- Output sink current to 150mA
- Efficient I/O pin layout
- PMOS compatible input
- Integral diodes for transient suppression
- Wide input voltage range from −40V to +40V
- Wide operating temperature range (T_a = −20∼+75℃)

APPLICATION

Relay and printer driver, LED or incandescent display digit driver, Interfacing for standard MOS/BIPOLAR logics

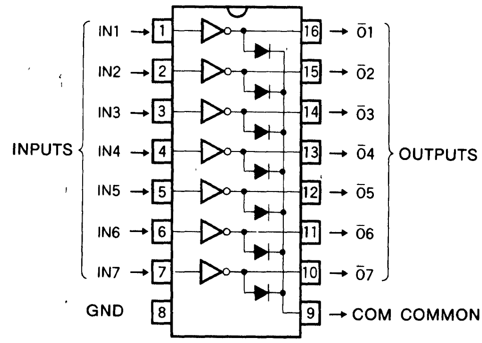
FUNCTION

The M54528P is comprised of seven darlington driver pairs. Each input has a diode and 20kΩ resistor in series to allow a negative voltage input. Between pin 9 and each output, there are integral diodes for inductive load transient suppression. All emitters and the substrate are connected together to pin 8 . The outputs are capable of sinking 150mA and will withstand 40V in the OFF state.



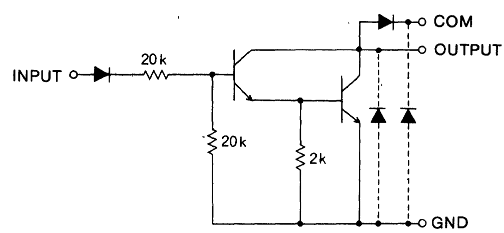
16-pin molded plastic DIP

PIN CONFIGURATION (TOP VIEW)



Outline 16P4

CIRCUIT SCHEMATIC



Unit : Ω

ABSOLUTE MAXIMUM RATINGS (T_a=−20∼+75℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CEO}	Output sustaining voltage	Transistor OFF	−0.5∼+40	V
I_C	Collector current	Transistor ON	150	mA
V_I	Input voltage		−40	V
			40	V
I_F	Clamp diode forward current		150	mA
V_R	Clamp diode reverse voltage		40	V
P_d	Power dissipation	T_a=25℃	1.47	W
T_{opr}	Operating ambient temperature range		−20∼+75	℃
T_{stg}	Storage temperature range		−55∼+125	℃

RECOMMENDED OPERATIONAL CONDITIONS (T_a=−20∼+75℃, unless otherwise noted)

Symbol	Parameter		Limits			Unit
			Min	Typ	Max	
V_O	Output voltage		0		40	V
I_C	Collector current per channel	Percent duty cycle less than 40%	0		150	mA
V_{IH}	"H" Input voltage	I_C=150mA	7		35	V
V_{IL}	"L" Input voltage	$I_{O(leak)}$=50μA	0		1	V

7-UNIT 150mA DARLINGTON TRANSISTOR ARRAY WITH CLAMP DIODE

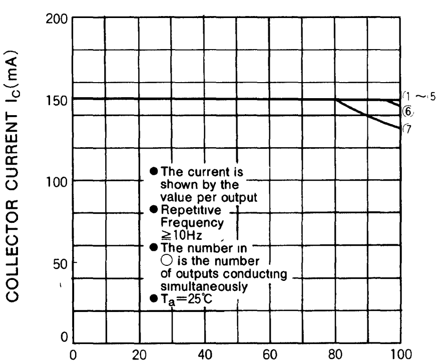
ELECTRICAL CHARACTERISTICS ($T_a=-20\sim+75$℃, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ*	Max	
$V_{(BR)CEO}$	Output sustaining voltage	$I_{CEO}=100\mu A$	40			V
$V_{CE(sat)}$	Output saturation voltage	$V_I=7V$, $I_C=150mA$		1.4	1.7	V
		$V_I=7V$, $I_C=100mA$		1.2	1.4	
I_I	Input current	$V_I=18V$		0.9	1.8	mA
		$V_I=35V$		1.9	5	
I_R	Input leakage current	$V_I=-35V$			−20	μA
$V_{F(D)}$	Clamp diode forward voltage	$I_{F(D)}=150mA$		1.15	1.6	V
$I_{R(D)}$	Clamp diode leakage current	$V_{R(D)}=40V$			100	μA
h_{FE}	DC forward current gain	$V_{CE}=4V$, $I_C=150mA$, $T_a=25$℃	800	2500		—

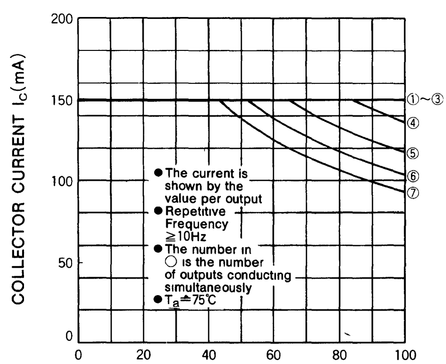
* : All typical values are at $T_a=25$℃

TYPICAL CHARACTERISTICS

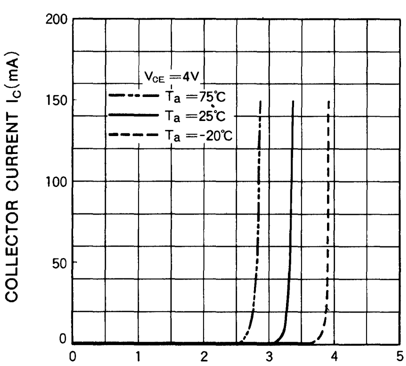
ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



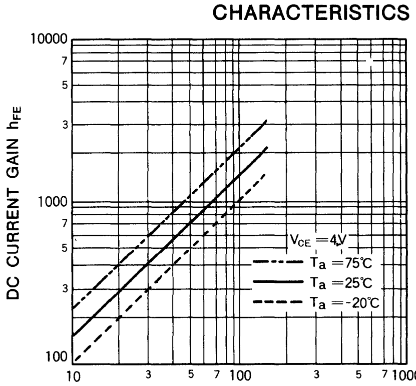
ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



OUTPUT CURRENT CHARACTERISTICS



DC CURRENT GAIN CHARACTERISTICS



M54523P

7-UNIT 500mA DARLINGTON TRANSISTOR ARRAY WITH CLAMP DIODE

DESCRIPTION

The M54523P, 7-channel sink driver, consists of 14 NPN transistors connected to form seven high current gain driver pairs.

FEATURES

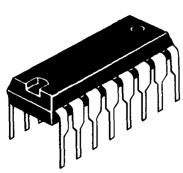
- High output sustaining voltage to 50V
- High output sink current to 500mA
- Integral diodes for transient suppression
- PMOS Compatible input
- Wide operating temperature range (T_a = −20∼+75℃)

APPLICATION

Relay and printer driver, LED or incandescent display digit driver, Interfacing for standard MOS/BIPOLAR logics.

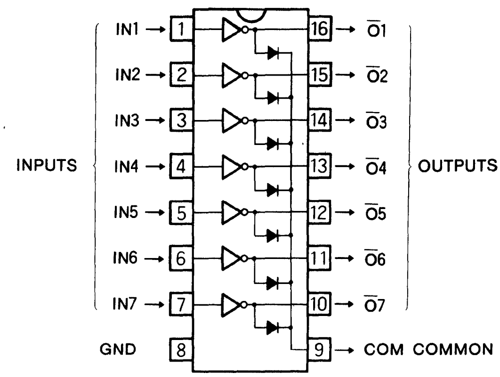
FUNCTION

The M54523P is comprised of seven NPN darlington driver pairs with 2.7kΩ series input resistors. Between pin 9 and each output, there are integral diodes for inductive load transient suppression. All emitters and the substrate are connected together to pin 8. The outputs are capable of sinking 500mA and will withstand 50V in the OFF state.



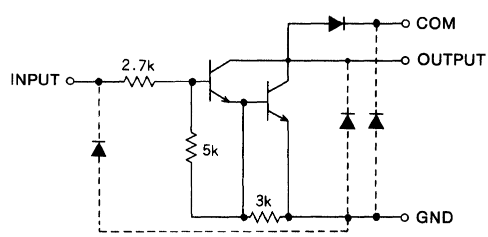
16-pin molded plastic DIP

PIN CONFIGURATION (TOP VIEW)



Outline 16P4

CIRCUIT SCHEMATIC



Unit : Ω

ABSOLUTE MAXIMUM RATINGS (T_a=−20∼+75℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CEO}	Output sustaining voltage	Transistor OFF	−0.5∼+50	V
I_C	Collector current	Transistor ON	500	mA
V_I	Input voltage		30	V
I_F	Clamp diode forward current		500	mA
V_R	Clamp diode reverse voltage		50	V
P_d	Power dissipation	T_a=25℃	1.47	W
T_{opr}	Operating ambient temperature range		−20∼+75	℃
T_{stg}	Storage temperature range		−55∼+125	℃

7-UNIT 500mA DARLINGTON TRANSISTOR ARRAY WITH CLAMP DIODE

RECOMMENDED OPERATIONAL CONDITIONS (T_a=−20∼+75℃, unless otherwise noted)

Symbol	Parameter		Limits Min	Limits Typ	Limits Max	Unit
V_O	Output voltage		0		50	V
I_C	Collector current per channel	Percent duty cycle less than 8%	0		400	mA
		Percent duty cycle less than 30%	0		200	
V_{IH}	"H" Input voltage	I_C=400mA	3.85		25	V
		I_C=100mA	3.4		25	V
V_{IL}	"L" Input voltage		0		0.5	V

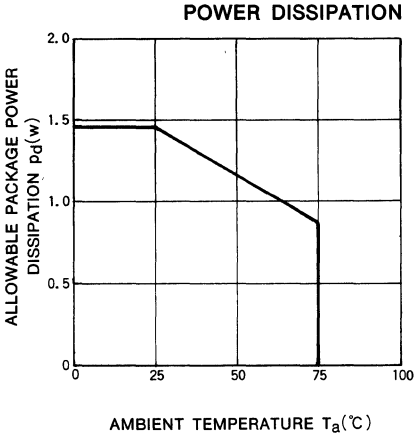
ELECTRICAL CHARACTERISTICS (T_a=−20∼+75℃, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits Min	Limits Typ*	Limits Max	Unit
$I_{O(leak)}$	Output leakage current	V_{CE}=50V			100	μA
$V_{CE(sat)}$	Output saturation voltage	V_I=3.85V, I_C=400mA		1.3	2.4	V
		V_I=3.85V, I_C=200mA		0.95	1.6	
I_I	Input current	V_I=3.85V		0.95	1.8	mA
		V_I=25V		9	18	
V_F	Clamp diode forward voltage	I_F=400mA		1.5	2.4	V
I_R	Clamp diode leakage voltage	V_R=50V			100	μA
h_{FE}	DC forward current gain	V_{CE}=4V, I_C=350mA, T_a=25℃	1000	2500		—

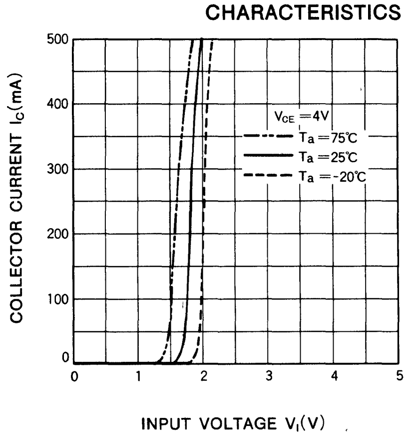
* : All typical values are at T_a=25℃

TYPICAL CHARACTERISTICS

ALLOWABLE AVERAGE POWER DISSIPATION

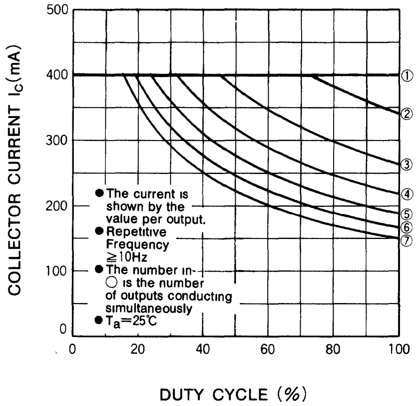


OUTPUT CURRENT CHARACTERISTICS

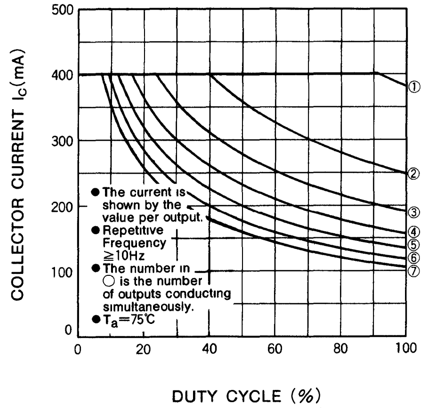


7-UNIT 500mA DARLINGTON TRANSISTOR ARRAY WITH CLAMP DIODE

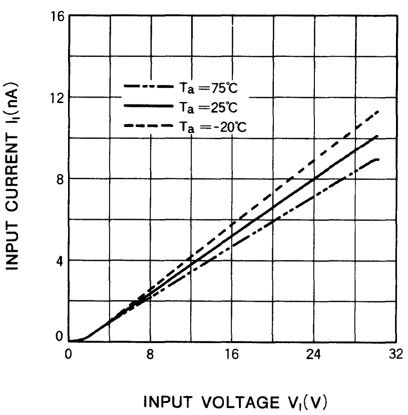
ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



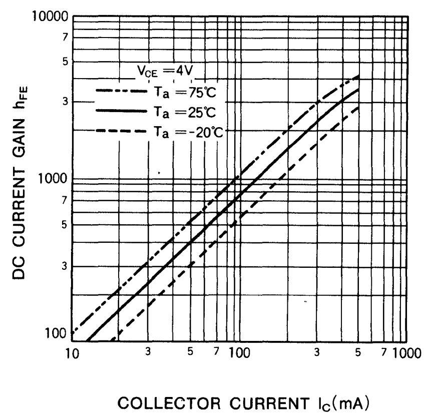
ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



INPUT CHARACTERISTICS



DC CURRENT GAIN CHARACTERISTICS



MITSUBISHI ELECTRIC

M54524P

7-UNIT 500mA DARLINGTON TRANSISTOR ARRAY WITH CLAMP DIODE

DESCRIPTION

The M54524P, 7-channel sink driver, consists of 14 NPN transistors connected to form high current gain driver pairs.

FEATURES

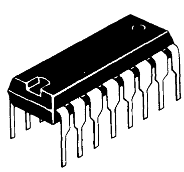
- High output sustaining voltage to 50V
- High output sink current to 500mA
- Integral diodes for transient suppression
- Wide operating temperature range ($T_a = -20 \sim +75$℃)

APPLICATION

Relay and printer drivers, LED or incandescent display digit driver, Interfacing for standard MOS/BIPOLAR logics

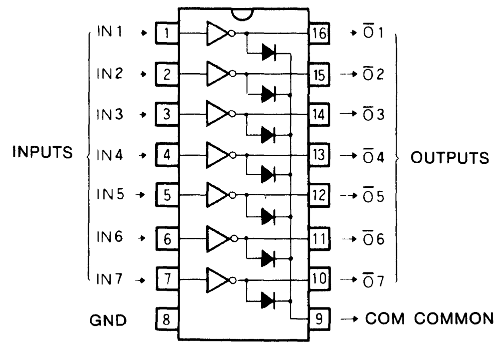
FUNCTION

The M54524P is comprised of seven NPN darlington driver pairs. Between pin 9 and each output, there are integral diodes for inductive load transient suppression. All emitters and the substrate are connected together to pin 8. The outputs are capable of sinking 500mA and will withstand 50V in the OFF state.



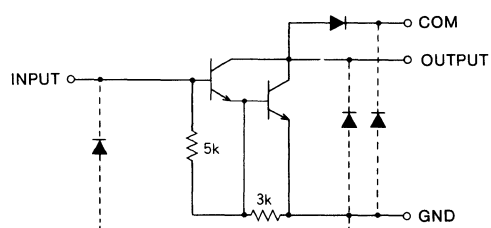
16-pin molded plastic DIP

PIN CONFIGURATION (TOP VIEW)



Outline 16P4

CIRCUIT SCHEMATIC



Unit : Ω

ABSOLUTE MAXIMUM RATINGS ($T_a = -20 \sim +75$℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CEO}	Output sustaining voltage	Transistor OFF	−0.5∼+50	V
I_C	Collector current	Transistor ON	500	mA
I_F	Clamp diode forward current		500	mA
V_R	Clamp diode reverse voltage		50	V
P_d	Power dissipation	T_a=25℃	1.47	W
T_{opr}	Operating ambient temperature range		−20∼+75	℃
T_{stg}	Storage temperature range		−55∼+125	℃

RECOMMENDED OPERATIONAL CONDITIONS (T_a=−20~+75℃, unless otherwise noted)

Symbol	Parameter		Limits			Unit
			Min	Typ	Max	
V_O	Output voltage		0		50	V
I_C	Collector current per channel	Percent duty cycle less than 8%	0		400	mA
		Percent duty cycle less than 30%	0		200	
I_{IH}	"H" Input current	I_C=400mA	1		20	mA
I_{IL}	"L" Input current		0		20	μA

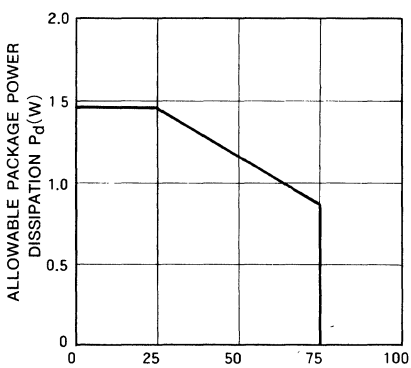
ELECTRICAL CHARACTERISTICS (T_a=−20~+75℃, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ*	Max	
$I_{O(leak)}$	Output leakage current	V_{CE}=50V			100	μA
$V_{CE(sat)}$	Output saturation voltage	I_I=1mA, I_C=400mA		1.3	2.4	V
		I_I=1mA, I_C=200mA		0.95	1.6	
V_I	Input voltage	I_I=1mA		1.35	1.7	V
V_F	Clamp diode forward voltage	I_F=400mA		1.5	2.4	V
I_R	Clamp diode leakage current	V_R=50V			100	μA
h_{FE}	DC forward current gain	V_{CE}=4V, I_C=350mA, T_a=25℃	1000	2500		—

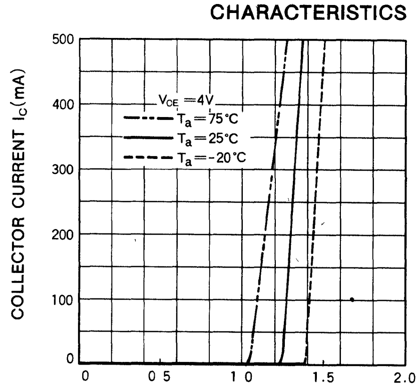
* : All typical values are at T_a=25℃

TYPICAL CHARACTERISTICS

ALLOWABLE AVERAGE POWER DISSIPATION



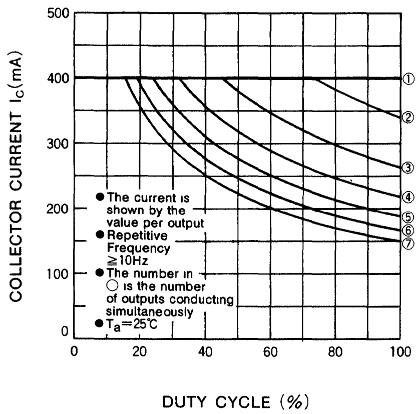
OUTPUT CURRENT CHARACTERISTICS



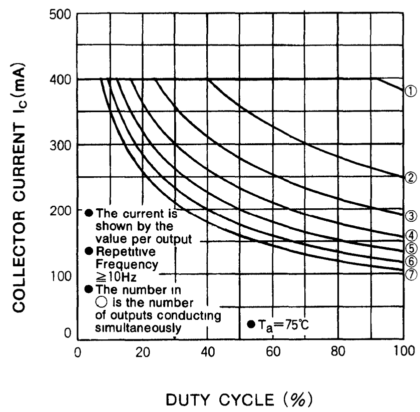
MITSUBISHI ELECTRIC

7-UNIT 500mA DARLINGTON TRANSISTOR ARRAY WITH CLAMP DIODE

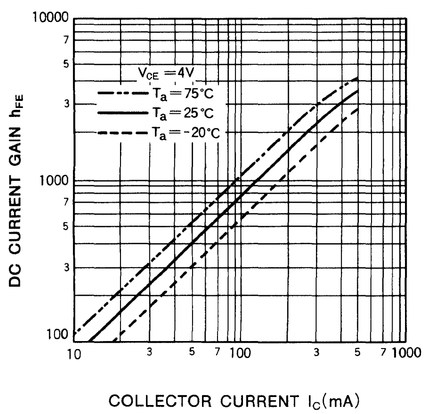
ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



DC CURRENT GAIN CHARACTERISTICS



M54525P

7-UNIT 500mA DARLINGTON TRANSISTOR ARRAY WITH CLAMP DIODE

DESCRIPTION

The M54525P, 7-channel sink driver, consists of 14 NPN transistors connected to form high current gain driver pairs.

FEATURES

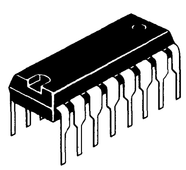
- High output sustaining voltage to 50V
- High output sink current to 500mA
- Integral diodes for transient suppression
- 24V PMOS compatible input
- Wide operating temperature range ($T_a = -20 \sim +75$℃)

APPLICATION

Relay and printer driver, LED or incandescent display digit driver, Interfacing for standard MOS/BIPOLAR logics

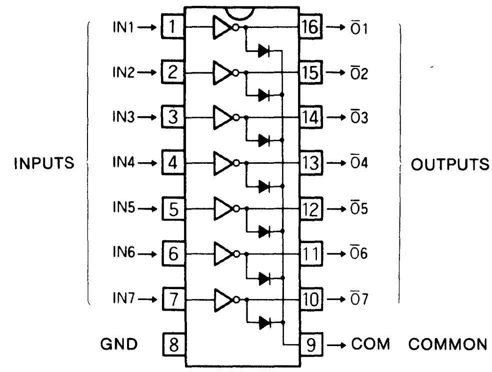
FUNCTION

The M54525P is comprised of seven NPN darlington driver pairs. Each input has a Zener diode and 10.5kΩ resistor in series to limit the input current. Between pin 9 and each output, there are integral diodes for inductive load transient suppression. All emitters and the substrate are connected together to pin 8 . The outputs are capable of sinking 500mA and will withstand 50V in the OFF state.



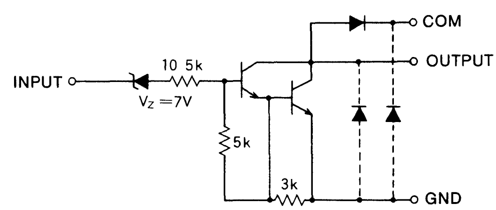
16-pin molded plastic DIP

PIN CONFIGURATION (TOP VIEW)



Outline 16P4

CIRCUIT SCHEMATIC



Unit : Ω

ABSOLUTE MAXIMUM RATINGS ($T_a = -20 \sim +75$℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CEO}	Output sustaining voltage	Transistor OFF	−0.5∼+50	V
I_C	Collector current	Transistor ON	500	mA
V_I	Input voltage		30	V
I_F	Clamp diode forward current		500	mA
V_R	Clamp diode reverse voltage		50	V
P_d	Power dissipation	T_a=25℃	1.47	W
T_{opr}	Operating ambient temperature range		−20∼+75	℃
T_{stg}	Storage temperature range		−55∼+125	℃

MITSUBISHI ELECTRIC

7-UNIT 500mA DARLINGTON TRANSISTOR ARRAY WITH CLAMP DIODE

RECOMMENDED OPERATIONAL CONDITIONS (T_a=−20∼+75℃, unless otherwise noted)

Symbol	Parameter		Limits Min	Limits Typ	Limits Max	Unit
V_O	Output voltage		0		50	V
I_C	Collector current per channel	Percent duty cycle less than 8%	0		400	mA
		Percent duty cycle less than 30%	0		200	
V_{IH}	"H" Input voltage	I_C=400mA	17		25	V
V_{IL}	"L" Input voltage		0		6	V

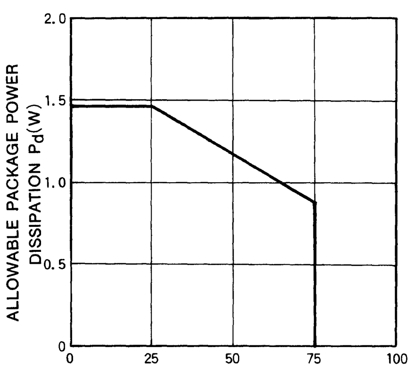
ELECTRICAL CHARACTERISTICS (T_a=−20∼+75℃, unless otherwise noted)

Symbol	Parameter	Test conditions		Limits Min	Limits Typ*	Limits Max	Unit
$I_{O(leak)}$	Input leakage current	V_{CE}=50V	I_I=0mA			100	μA
			V_I=6V			500	
$V_{CE(sat)}$	Output saturation voltage	V_I=17V, I_C=400mA			1.3	2.4	V
		V_I=17V, I_C=200mA			0.95	1.6	
I_I	Input current	V_I=17V			0.85	1.8	mA
		V_I=25V			1.6	3.2	
V_F	Clamp diode forward voltage	I_F=400mA			1.5	2.4	V
I_R	Clamp diode leakage current	V_R=50V				100	μA
h_{FE}	DC forward current gain	V_{CE}=4V, I_C=350mA, T_a=25℃		1000	2500		—

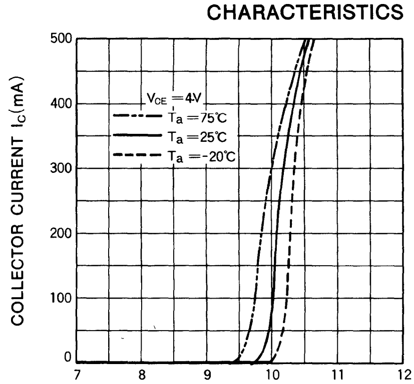
* : All typical values are at T_a=25℃.

TYPICAL CHARACTERISTICS

ALLOWABLE AVERAGE POWER DISSIPATION

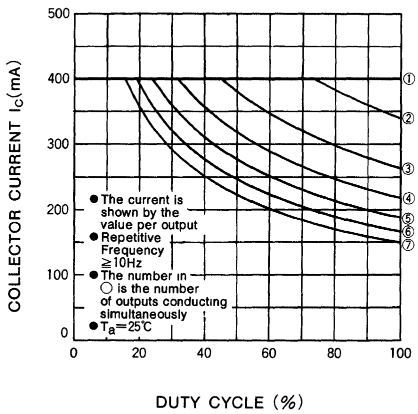


OUTPUT CURRENT CHARACTERISTICS

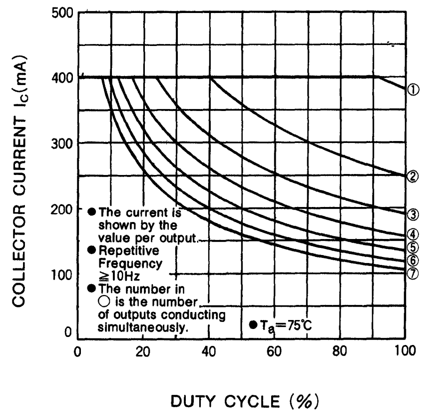


7-UNIT 500mA DARLINGTON TRANSISTOR ARRAY WITH CLAMP DIODE

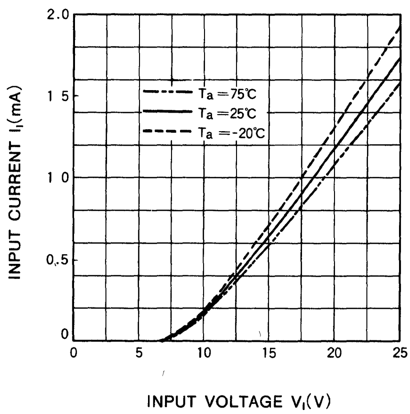
ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



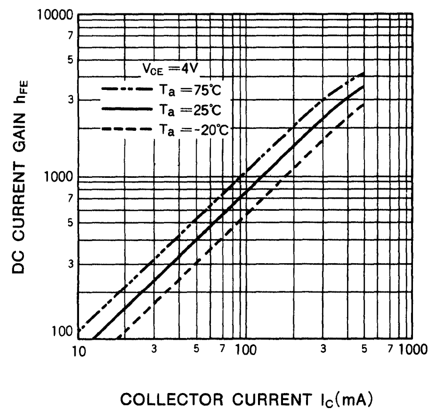
ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



INPUT CHARACTERISTICS



DC CURRENT GAIN CHARACTERISTICS



M54526P

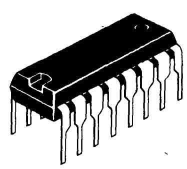
7-UNIT 500mA DARLINGTON TRANSISTOR ARRAY WITH CLAMP DIODE

DESCRIPTION
The M54526P, 7-channel sink driver, consists of 14 NPN transistors connected to form high current gain driver pairs.

FEATURES
- High output sustaining voltage to 50V
- High output sink current to 500mA
- Integral diodes for transient suppression
- PMOS compatible input
- Wide operating temperature range (T_a =−20～+75℃)

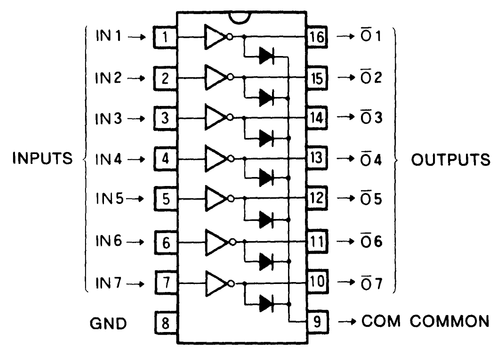
APPLICATION
Relay and printer driver, LED or incandescent display digit driver, Interfacing for standard MOS/BIPOLAR logics

FUNCTION
The M54526P is comprised of seven darlington driver pairs with 10.5kΩ series input resistors. Between pin 9 and each output, there are integral diodes for inductive load transient suppression. All emitters and the substrate are connected together to pin 8 . The outputs are capable of sinking 500mA and will withstand 50V in the OFF state.



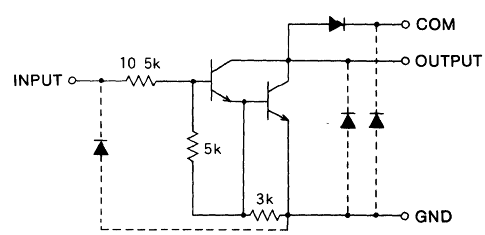
16-pin molded plastic DIP

PIN CONFIGURATION (TOP VIEW)



Outline 16P4

CIRCUIT SCHEMATIC



Unit : Ω

ABSOLUTE MAXIMUM RATINGS (T_a=−20～+75℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CEO}	Output sustaining voltage	Transistor OFF	−0.5～+50	V
I_C	Collector current	Transistor ON	500	mA
V_I	Input voltage		30	V
I_F	Clamp diode forward current		500	mA
V_R	Clamp diode reverse voltage		50	V
P_d	Power dissipation	T_a=25℃	1.47	W
T_{opr}	Operating ambient temperature range		−20～+75	℃
T_{stg}	Storage temperature range		−55～+125	℃

RECOMMENDED OPERATIONAL CONDITIONS (T_a=−20~+75℃, unless otherwise noted)

Symbol	Parameter		Limits Min	Typ	Max	Unit
V_O	Output voltage		0		50	V
I_C	Collector current per channel	Percent duty cycle less than 8%	0		400	mA
		Percent duty cycle less than 30%	0		200	
V_{IH}	"H" input voltage	I_C=400mA	8	10	25	V
V_{IL}	"L" input voltage		0		0.5	V

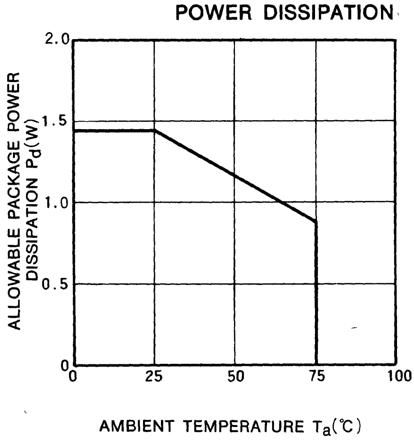
ELECTRICAL CHARACTERISTICS (T_a=−20~+75℃, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits Min	Typ*	Max	Unit
$I_{O(leak)}$	Output leakage current	V_{CE}=50V			100	μA
$V_{CE(sat)}$	Output saturation voltage	V_I=8V, I_C=400mA		1.3	2.4	V
		V_I=8V, I_C=200mA		0.95	1.6	
I_I	Input current	V_I=10V		0.9	1.5	mA
		V_I=25V		2.8	4.1	
V_F	Clamp diode forward voltage	I_F=400mA		1.5	2.4	V
I_R	Clamp diode leakage current	V_R=50V			100	μA
h_{FE}	DC forward current gain	V_{CE}=4V, I_C=350mA, T_a=25℃	1000	2500		—

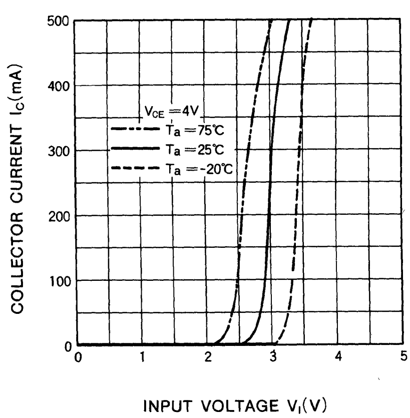
* : All typical values are at T_a=25℃.

TYPICAL CHARACTERISTICS

ALLOWABLE AVERAGE POWER DISSIPATION



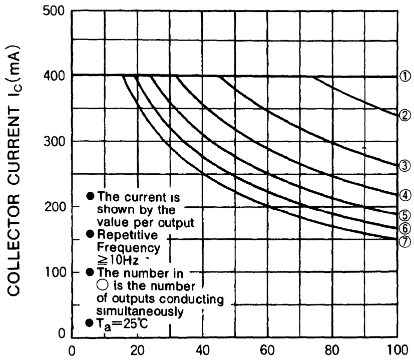
OUTPUT CURRENT CHARACTERISTICS



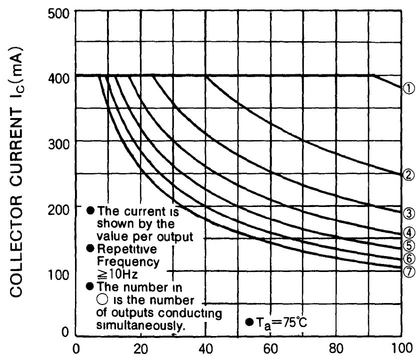
MITSUBISHI ELECTRIC

7-UNIT 500mA DARLINGTON TRANSISTOR ARRAY WITH CLAMP DIODE

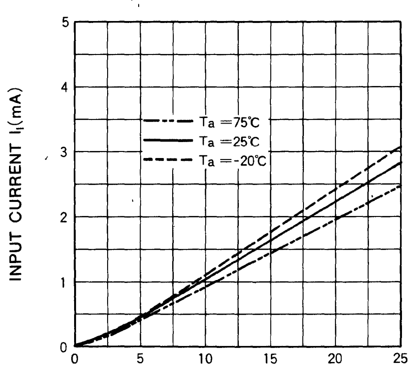
ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



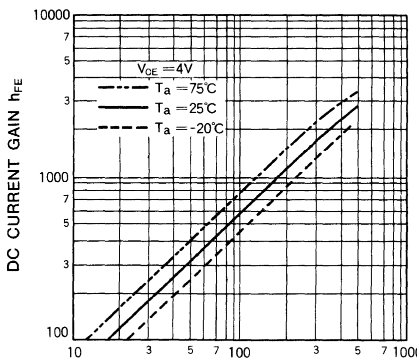
ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



INPUT CHARACTERISTICS



DC CURRENT GAIN CHARACTERISTICS



M54530P

7-UNIT 400mA DARLINGTON TRANSISTOR ARRAY WITH CLAMP DIODE

DESCRIPTION

The M54530P, 7-channel sink driver, consists of 14 NPN transistors connected to form seven high current gain driver pairs.

FEATURES

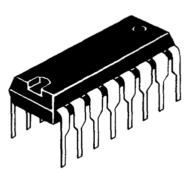
- High output sustaining voltage to 40V
- High output sink current to 400mA
- Integral diodes for transient suppression
- PMOS compatible input
- Wide operating temperature range (T_a =−20∼+75℃)

APPLICATION

Relay and printer driver, LED or incandescent display digit driver, Interfacing for standard MOS/BIPOLAR logics

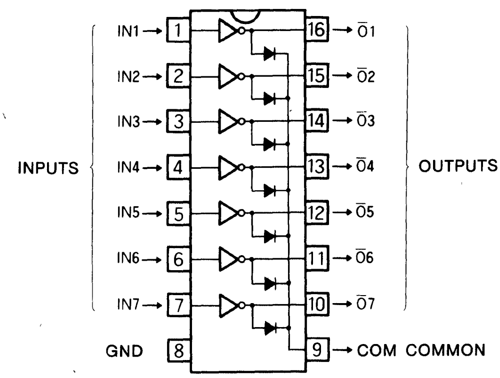
FUNCTION

The M54530P is comprised of seven NPN darlington driver pairs with 20kΩ series input resistors. Between pin 9 and each output, there are integral diodes for inductive load transient suppression. All emitters and the substrate are connected together to pin 8 . The outputs are capable of sinking 400mA and will withstand 40V in the OFF state.



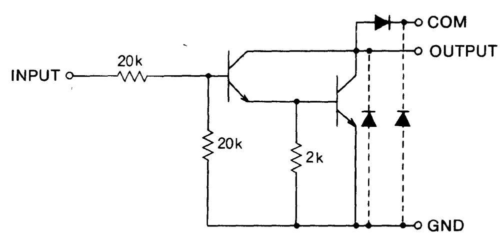
16-pin molded plastic DIP

PIN CONFIGURATION (TOP VIEW)



Outline 16P4

CIRCUIT SCHEMATIC



Unit : Ω

ABSOLUTE MAXIMUM RATINGS (T_a=−20∼+75℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CEO}	Output sustaining voltage	Transistor OFF	−50∼+40	V
I_C	Collector current	Transistor ON	400	mA
V_I	Input voltage		40	V
I_F	Clamp diode forward current		400	mA
V_R	Clamp diode reverse voltage		40	V
P_d	Power dissipation	T_a=25℃	1.47	W
T_{opr}	Operating ambient temperature range		−20∼+75	℃
T_{stg}	Storage temperature range		−55∼+125	℃

7-UNIT 400mA DARLINGTON TRANSISTOR ARRAY WITH CLAMP DIODE

RECOMMENDED OPERATIONAL CONDITIONS (T_a=−20~+75℃, unless otherwise noted)

Symbol	Parameter		Limits Min	Limits Typ	Limits Max	Unit
V_O	Output voltage		0		40	V
I_C	Collector current per channel	Percent duty cycle less than 8%	0		400	mA
		Percent duty cycle less than 30%	0		200	mA
V_{IH}	"H" Input voltage	I_C=400mA	8		35	V
		I_C=200mA	5		35	V
V_{IL}	"L" Input voltage	$I_{O(leak)}$=50μA	0		0.5	V

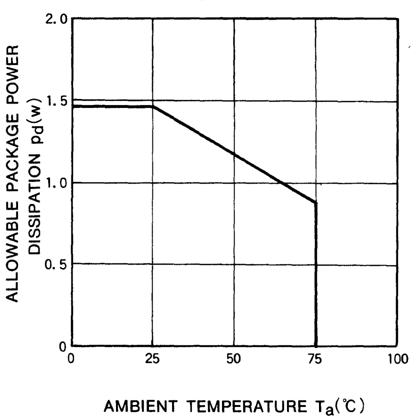
ELECTRICAL CHARACTERISTICS (T_a=−20~+75℃, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits Min	Limits Typ*	Limits Max	Unit
$V_{(BR)CEO}$	Output sustaining voltage	I_{CER}=100μA	40			V
$V_{CE(sat)}$	Output saturation voltage	V_I=8V, I_C=400mA		1.3	2.4	V
		V_I=5V, I_C=200mA		1	1.6	V
I_I	Input current	V_I=17V		0.85	1.8	mA
		V_I=35V		2.0	3.8	mA
V_F	Clamp diode forward voltage	$I_{F(D)}$=400mA		1.5	2.4	V
V_R	Clamp diode reverse voltage	$V_{R(D)}$=100μA	40			V
h_{FE}	DC forward current gain	V_{CE}=4V, I_C=300mA, T_a=25℃	1000	3500		—

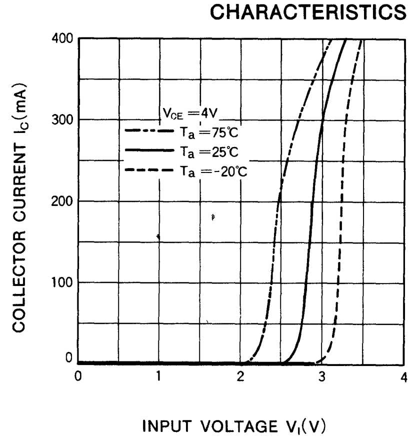
* : All typical values are at T_a=25℃.

TYPICAL CHARACTERISTICS

ALLOWABLE AVERAGE POWER DISSIPATION

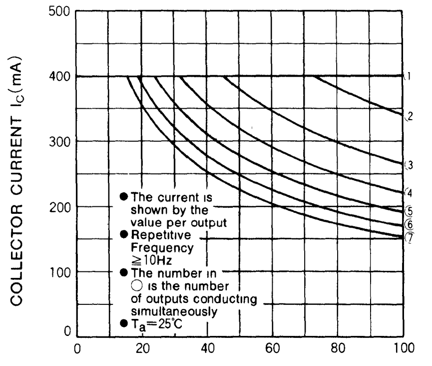


OUTPUT CURRENT CHARACTERISTICS

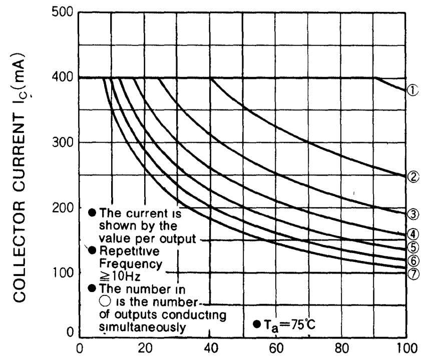


7-UNIT 400mA DARLINGTON TRANSISTOR ARRAY WITH CLAMP DIODE

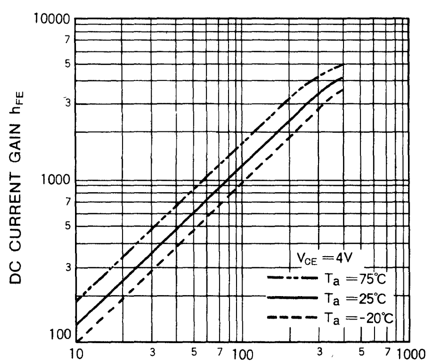
ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



DC CURRENT GAIN CHARACTERISTICS



M54531P

7-UNIT 400mA DARLINGTON TRANSISTOR ARRAY WITH CLAMP DIODE

DESCRIPTION

The M54531P, 7-channel sink driver, consists of 14 NPN transistors connected to form high current gain driver pairs.

FEATURES

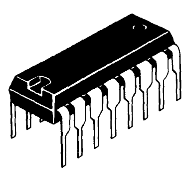
- High output sustaining voltage to 40V
- High output sink current to 400mA
- Integral diodes for transient suppression
- PMOS compatible input
- Wide input voltage range from −40V to +40V
- Wide operating temperature range (T_a = −20∼+75℃)

APPLICATION

Relay and printer driver, LED and incandescent display digit driver, Interfacing for standard MOS/BIPOLAR logics

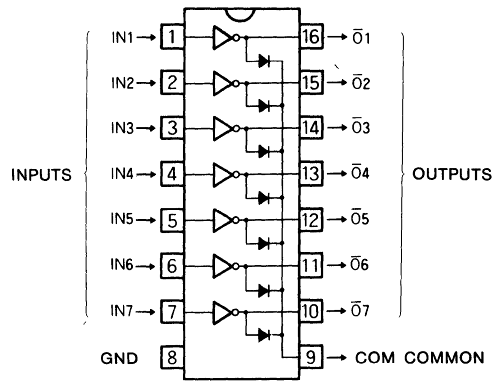
FUNCTION

The M54531P is comprised of seven NPN darlington driver pairs. Each input has a diode and 20kΩ resistor in series to allow a negative voltage input. Between pin 9 and each out, there are integral diodes for inductive load transient suppression. All emitters and the substrate are connected together to pin 8. The outputs are capable of sinking 400mA and will withstand 40V in the OFF state.



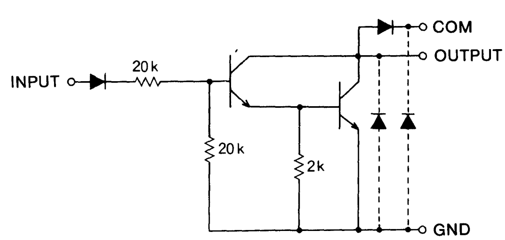
16-pin molded plastic DIP

PIN CONFIGURATION (TOP VIEW)



Outline 16P4

CIRCUIT SCHEMATIC



Unit : Ω

ABSOLUTE MAXIMUM RATINGS (T_a=−20∼+75℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CEO}	Output sustaining voltage	Transistor OFF	−0.5∼+40	V
I_C	Collector current	Transistor ON	400	mA
V_I	Input voltage		−40∼+40	V
$I_{F(D)}$	Clamp diode forward current		400	mA
$V_{R(D)}$	Clamp diode reverse voltage		40	V
P_d	Power dissipation	T_a=25℃	1.47	W
T_{opr}	Operating ambient temperature range		−20∼+75	℃
T_{stg}	Storage temperature range		−55∼+125	℃

7-UNIT 400mA DARLINGTON TRANSISTOR ARRAY WITH CLAMP DIODE

RECOMMENDED OPERATIONAL CONDITIONS (T_a=−20~+75℃, unless otherwise noted)

Symbol	Parameter		Limits Min	Limits Typ	Limits Max	Unit
V_O	Output voltage		0		40	V
I_C	Collector current per channel	Percent duty cycle less than 8%	0		400	mA
		Percent duty cycle less than 30%	0		200	
V_{IH}	"H" Input voltage	I_C=400mA	9		35	V
		I_C=200mA	6		35	
V_{IL}	"L" Input voltage	$I_{O(leak)}$=50μA	0		1	V

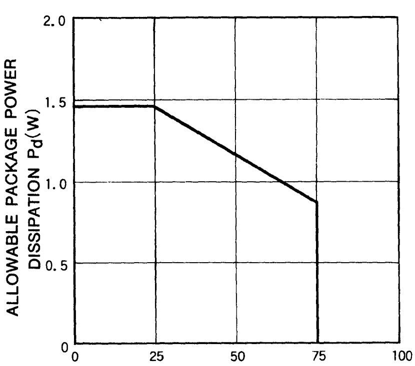
ELECTRICAL CHARACTERISTICS (T_a=−20~+75℃, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits Min	Limits Typ*	Limits Max	Unit
$V_{(BR)CEO}$	Output sustaining voltage	I_{CEO}=100μA	40			V
$V_{CE(sat)}$	Output saturation voltage	V_I=9V, I_C=400mA		1.3	2.4	V
		V_I=6V, I_C=200mA		1	1.6	
I_I	Input current	V_I=18V		0.85	1.8	mA
		V_I=35V		2.0	3.8	
I_R	Input leakage current	V_I=−35V			−20	μA
$V_{F(D)}$	Clamp diode forward voltage	$I_{F(D)}$=400mA		1.5	2.4	V
$V_{R(D)}$	Clamp diode reverse voltage	$I_{R(D)}$=100μA	40			V
h_{FE}	DC forward current gain	V_{CE}=4V, I_C=300mA, T_a=25℃	1000	3500		—

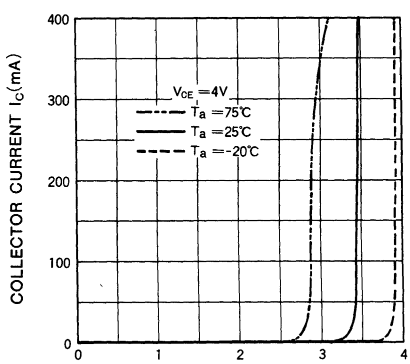
* : All typical values are at T_a=25℃.

TYPICAL CHARACTERISTICS

ALLOWABLE AVERAGE POWER DISSIPATION



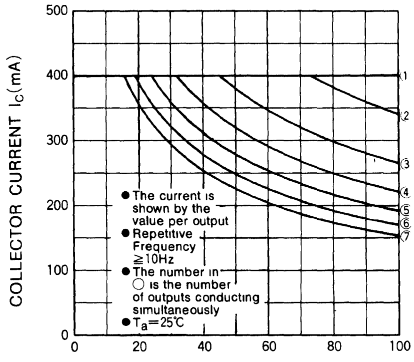
OUTPUT CURRENT CHARACTERISTICS



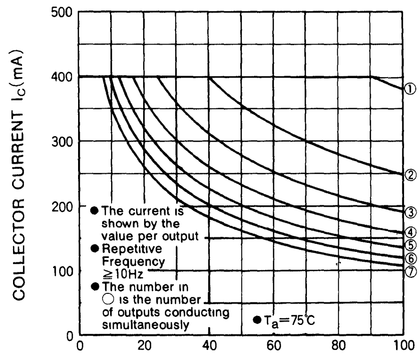
MITSUBISHI ELECTRIC

7-UNIT 400mA DARLINGTON TRANSISTOR ARRAY WITH CLAMP DIODE

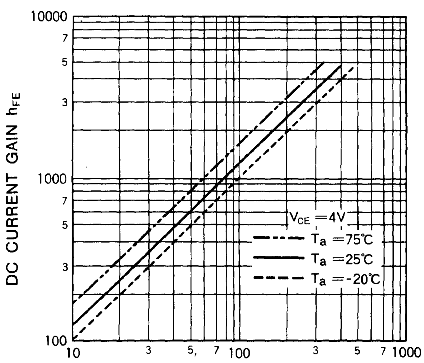
ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



DC CURRENT GAIN CHARACTERISTICS



M54513P

8-UNIT 50mA TRANSISTOR ARRAY

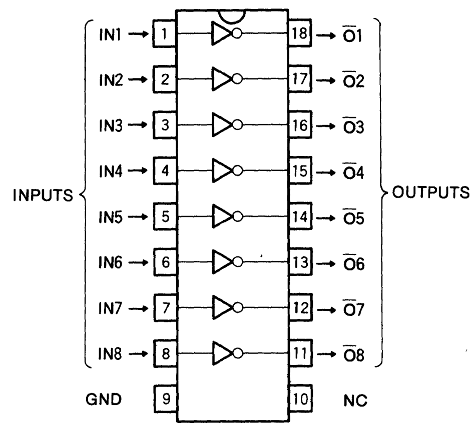
DESCRIPTION
The M54513P, 8-channel sink drivers, consists of 8 NPN transistors with 2 kΩ series input resistors.

FEATURES
- High output sustaining voltage of 40V
- 50mA output sink current capability
- Wide operating temperature range (T_a = −20∼+75℃)

APPLICATION
LED or incandescent display digit driver

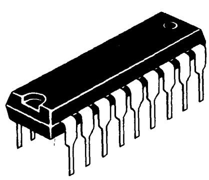
FUNCTION
The M54513P is comprised of eight NPN drivers. Each input has a voltage divider by 2kΩ and 13.6kΩ resistors. All emitters and the substrate are connected together to pin 9. The open collector outputs are capable of sinking 50mA and will withstand 40V in the OFF state.

PIN CONFIGURATION (TOP VIEW)



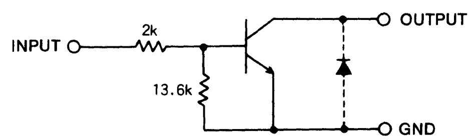
Outline 18P4

NC : NO CONNECTION



18-pin molded plastic DIP

CIRCUIT SCHEMATIC



Unit : Ω

ABSOLUTE MAXIMUM RATINGS (T_a = −20∼+75℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CEO}	Output sustaining voltage	Transistor OFF	−0.5∼+40	V
I_C	Collector current	Transistor ON	50	mA
V_I	Input voltage		10	V
T_{opr}	Operating ambient temperature range		−20∼+75	℃
T_{stg}	Storage temperature range		−55∼+125	℃

RECOMMENDED OPERATIONAL CONDITIONS (T_a = −20∼+75℃, unless otherwise noted)

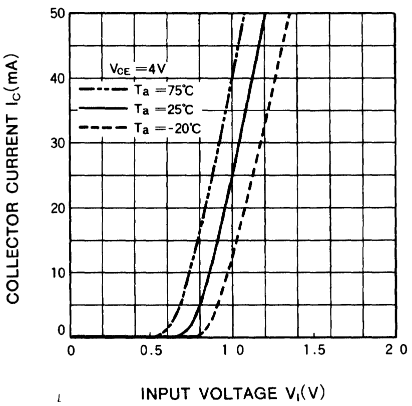
Symbol	Parameter		Limits Min	Limits Typ	Limits Max	Unit
V_O	Output voltage		0		40	V
I_C	Collector current per channel		0		20	mA
V_{IH}	"H" Input voltage	I_C = 20 mA	2		8	V
V_{IL}	"L" Input voltage		0		0.2	V

ELECTRICAL CHARACTERISTICS (T_a = −20∼+75℃, unless otherwise noted)

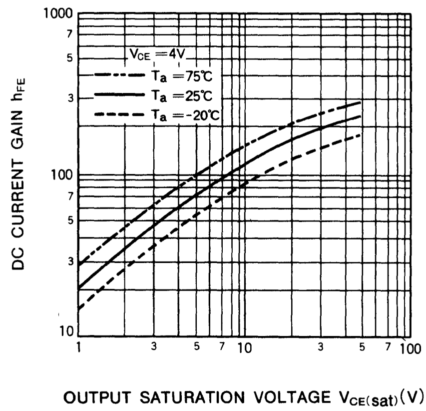
Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
$I_{O(leak)}$	Output leakage current	V_O = 40V			50	μA
$V_{CE(sat)}$	Output saturation voltage	V_I = 2V, I_C = 12mA		30	100	mV
		V_I = 2.5V, I_C = 30mA		70	170	
I_I	Input current	V_I = 2.5V		0.85	1.7	mA
h_{FE}	DC forward current gain	V_{CE} = 4 V, I_C = 30mA, T_a = 25℃	80	200		—

TYPICAL CHARACTERISTICS

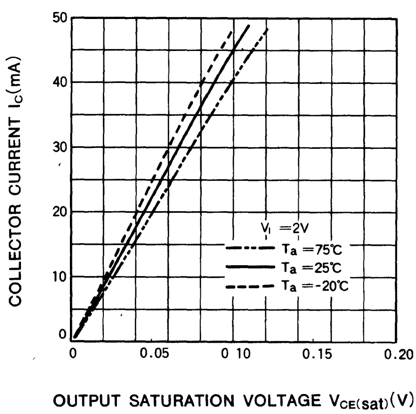
OUTPUT CURRENT CHARACTERISTICS



DC CURRENT GAIN CHARACTERISTICS



OUTPUT CHARACTERISTICS



M54538P

7-UNIT 350mA TRANSISTOR ARRAY AND MOTOR DRIVER

DESCRIPTION

The M54538P, 7-channel sink driver and a motor driver, is designed for use in a thermal printer.

FEATURES

- Output breakdown voltage to 20V
- High output sink current to 350mA
- Wide operating temperature range ($T_a = -20 \sim +75°C$)

APPLICATION

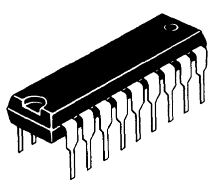
Thermal printer driver, LED or incandescent display driver, Interfacing for standard MOS/BIPOLAR logic

FUNCTION

The M54538P is designed for use in a thermal printer, consisting 7-channel thermal head driver and a D-C or stepper motor driver.

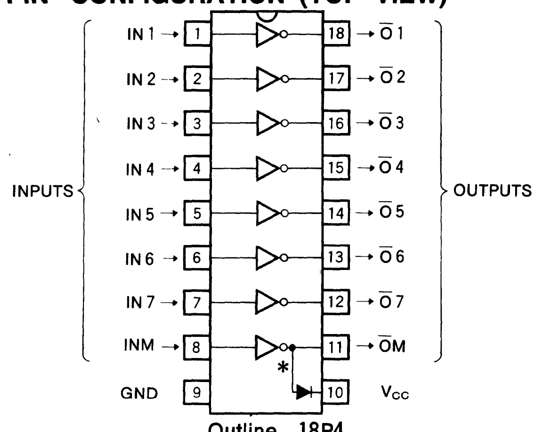
The output of the motor driver has a diode for inductive load transient suppression.

The outputs of the sink drivers are capaple of sinking 350mA and will withstand 20V in the OFF state.



18-pin molded plastic DIP

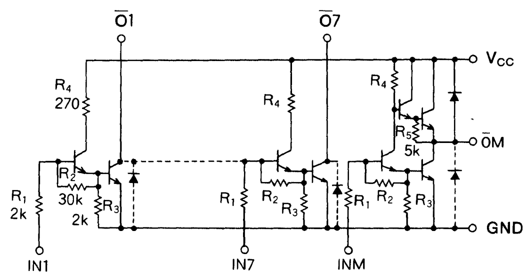
PIN CONFIGURATION (TOP VIEW)



Outline 18P4

* : MOTOR DRIVER

CIRCUIT SCHEMATIC



Unit : Ω

ABSOLUTE MAXIMUM RATINGS ($T_a = -20 \sim +75°C$, unless otherwise noted)

Symbol	Parameter	Conditions		Ratings	Unit
V_{CC}	Supply voltage			10	V
V_{CEO}	Output sustaining voltage	Transistor OFF	Ō1 to Ō7 Outputs	−0.5∼+20	V
			ŌM Output	$-0.5 \sim V_{CC}$	
I_C	Collector current	Transistor ON		350	mA
V_I	Input voltage			10	V
I_F	Clamp diode forward current	Pulse width≦35ms, Percent duty cycle≦5%		700	mA
				350	
P_d	Power dissipation	T_a=25°C		1.47	W
T_{opr}	Operating ambient temperature range			−20∼+75	°C
T_{stg}	Storage temperature range			−55∼+125	°C

RECOMMENDED OPERATIONAL CONDITIONS (T_a=−20~+75℃, unless otherwise noted)

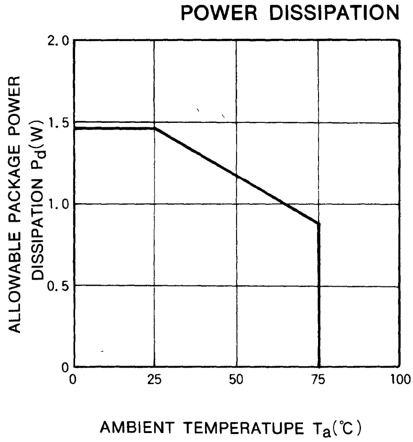
Symbol	Parameter		Limits Min	Typ	Max	Unit
V_{CC}	Supply voltage		3		6	V
V_O	Output voltage		0		20	V
I_C	Collector current per channel	Percent duty cycle less than 30%, V_{CC}=6V	0		250	mA
		Percent duty cycle less than 35%, V_{CC}=6V	0		170	
V_{IH}	"H" Input voltage	I_C=250mA	3.2		6	V
		I_C=150mA	2.4		6	
V_{IL}	"L" Input voltage		0		0.3	V

ELECTRICAL CHARACTERISTICS (T_a=−20~+75℃, unless otherwise noted)

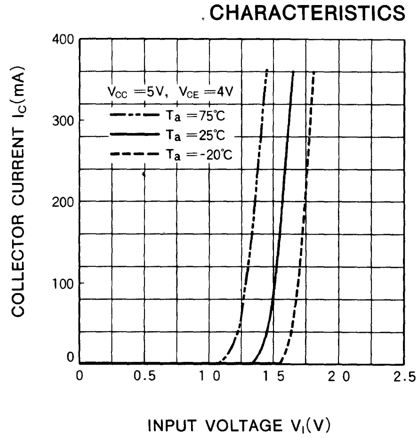
Symbol	Parameter	Test conditions	Limits Min	Typ	Max	Unit
$I_{O(leak)}$	Input leakage current	V_{CC}=6V, V_I=0.4V, V_{CE}=20V			50	μA
$V_{CE(sat)}$	Output saturation voltage	V_{CC}=3.5V, V_I=3V, I_C=250mA		0.23	0.6	V
		V_{CC}=3V, V_I=2.4V, I_C=150mA		0.14	0.4	
$V_{OH(M)}$	"H" Output voltage (motor driver)	V_{CC}=6V, $I_{OH(M)}$=−250mA	2.4			V
I_I	Input current	V_{CC}=6V, V_I=3.2V		0.8	1.5	mA
		V_{CC}=6V, V_I=10V		4.6	7.3	
$V_{F(M)}$	Clamp diode forward voltage	$I_{F(M)}$=350mA		1.6	3	V
I_{CC}	Supply current	V_{CC}=6V, V_I=3.2V (all input)			235	mA
h_{FE}	DC forward current gain	V_{CC}=5V, V_{CE}=4V, I_C=250mA, T_a=25℃	1000	6000		—

TYPICAL CHARACTERISTICS

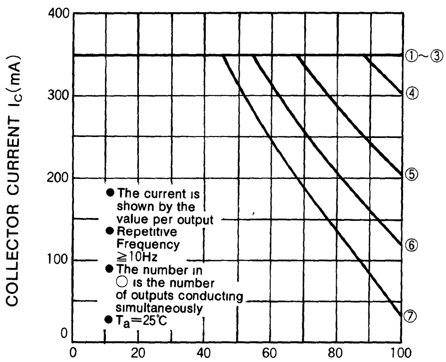
ALLOWABLE AVERAGE POWER DISSIPATION



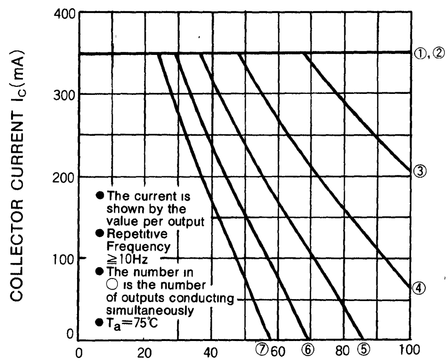
OUTPUT CURRENT CHARACTERISTICS



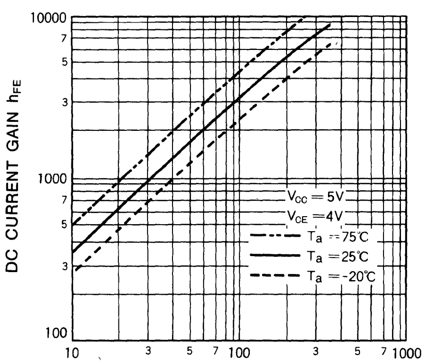
ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



DC CURRENT GAIN CHARACTERISTICS



M54522P

8-UNIT 400mA DARLINGTON TRANSISTOR ARRAY

DESCRIPTION

The M54522P, 8-channel sink driver, consists of 16 NPN transistors connected to form eight high current gain driver pairs.

FEATURES

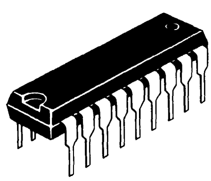
- High output sustaining voltage to 40V
- High output sink current to 400mA
- Integral diodes for transient suppression
- PMOS Compatible input
- Wide operating temperature range (T_a = −20∼+75℃)

APPLICATION

Relay and printer driver, LED or incandescent display digit driver, Interfacing between MOS/BIPOLAR logics and high power loads

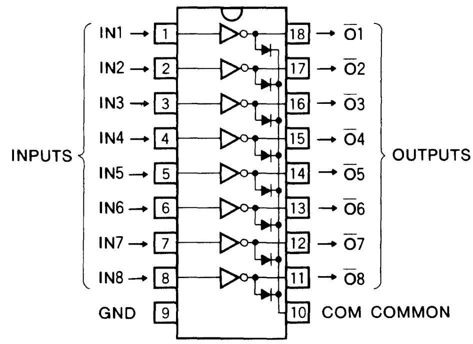
FUNCTION

The M54522P is comprised of eight NPN darlington driver pairs with 20kΩ series input resistors. Each output has an integral diode for inductive load transient suppression. The cathodes of the diodes are connected together to pin 10. All emitters and the substrate are connected to pin 9 . The output are capable of sinking 400mA and will withstand 40V in the OFF state.



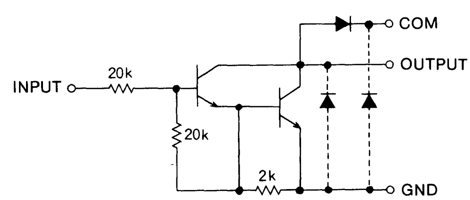
18-pin molded plastic DIP

PIN CONFIGURATION (TOP VIEW)



Outline 18P4

CIRCUIT SCHEMATIC



Unit : Ω

ABSOLUTE MAXIMUM RATINGS (T_a=−20∼+75℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CEO}	Output sustaining voltage	Transistor OFF	−0.5∼+40	V
I_C	Collector current	Transistor ON	400	mA
V_I	Input voltage		40	V
I_F	Clamp diode forward current		400	mA
V_R	Clamp diode reverse voltage		40	V
P_d	Power dissipation	T_a=25℃	1.79	W
T_{opr}	Operating ambient temperature range		−20∼+75	℃
T_{stg}	Storage temperature range		−55∼+125	℃

RECOMMENDED OPERATIONAL CONDITIONS (T_a=−20~+75℃, unless otherwise noted)

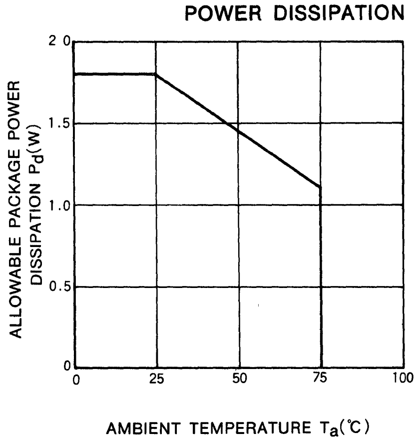
Symbol	Parameter		Limits Min	Limits Typ	Limits Max	Unit
V_O	Output voltage		0		40	V
I_C	Collector current per channel	Percent duty cycle less than 7%	0		400	mA
		Percent duty cycle less than 30%	0		200	
V_{IH}	"H" Input voltage	I_C=400mA	8		30	V
		I_C=200mA	4		30	
V_{IL}	"L" Input voltage	$I_{O(leak)}$=50μA	0		0.5	V

ELECTRICAL CHARACTERISTICS (T_a=−20~+75℃, unless otherwise noted)

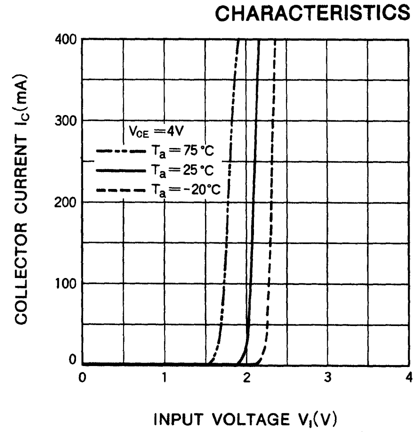
Symbol	Parameter	Test conditions	Limits Min	Limits Typ	Limits Max	Unit
$V_{(BR)CEO}$	Output sustaining voltage	I_{CEO}=100μA	40			V
$V_{CE(sat)}$	Output saturation voltage	V_I=8V, I_C=400mA		1.15	2.4	V
		V_I=4V, I_C=200mA		0.95	1.6	
I_I	Input current	V_I=17V	0.3	0.9	1.8	mA
V_F	Clamp diode forward voltage	I_F=400mA		1.5	2.4	V
V_R	Clamp diode reverse voltage	I_R=100μA	40			V
h_{FE}	DC forward current gain	V_{CE}=4V, I_C=300mA, T_a=25℃	1000	8000		—

TYPICAL CHARACTERISTICS

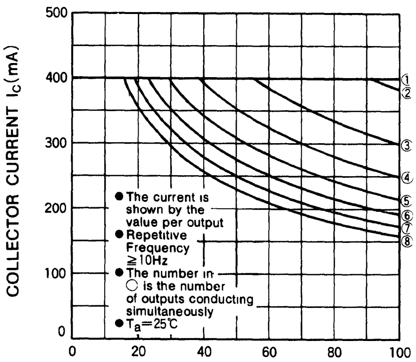
ALLOWABLE AVERAGE POWER DISSIPATION



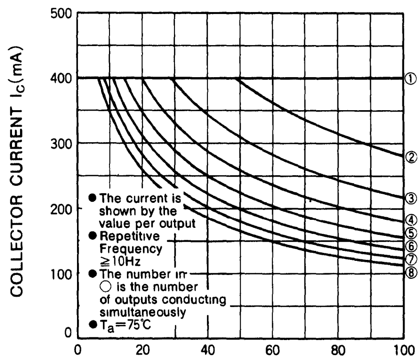
OUTPUT CURRENT CHARACTERISTICS



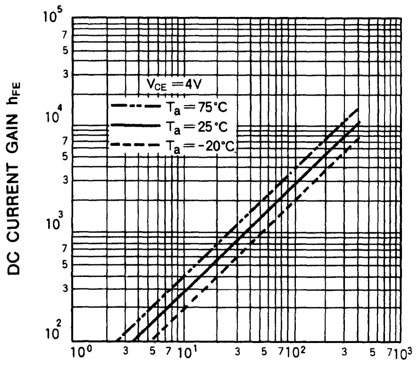
ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



DC CURRENT GAIN CHARACTERISTICS



M54585P

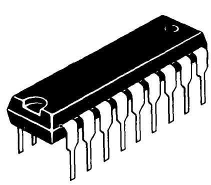
8-UNIT 500mA TRANSISTOR ARRAY WITH CLAMP DIODE

DESCRIPTION
The M54585P, 8-channel sink driver, consists of 16 NPN darlington transistors with internal clamp diodes connected to form high current gain driver pairs with low input current.

FEATURES
- High output sustaining voltage to 50V
- High output sink current to 500mA
- Built-in clamp diode
- TTL, PMOS IC output for drive
- Wide operating temperature range (T_a=−20∼+75℃)

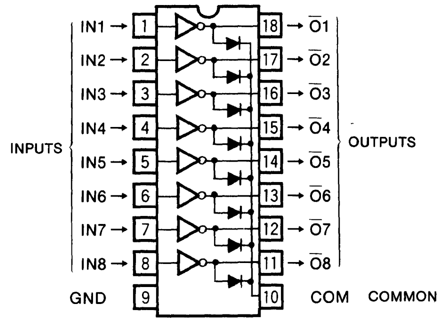
APPLICATION
Relay and small printer driver, LED or incandescent display digit driver, Output for microcomputer and interface with high voltage system

FUNCTION
The M54585P is composed of eight NPN darlington transistor pairs. A resistor of 2.7kΩ is connected between the base of input transistor and the input pin.
A clamp diode for inductive load transient suppression is connected for the output pin (collector) and COM pin (pin 10). All emitters of the output transistors are connected to GND (pin 9).
The outputs are capable of sinking 500mA and will withstand 40V between collector and emitter.



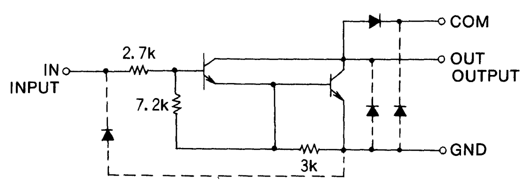
18-pin molded plastic DIP

PIN CONFIGURATION (TOP VIEW)



Outline 18P4

CIRCUIT SCHEMATIC (EACH CIRCUIT)



COM and GND are all common to 8 circuits.
The diodes shown by broken line are parasite diodes and must not be used.

Unit : Ω

ABSOLUTE MAXIMUM RATINGS (T_a=−20+75℃, unless otherwise noted)

Symbol	Parameteter	Conditions	Ratings	Unit
V_{CEO}	Output sustaining voltage	When the output is "H"	−0.5∼+50	V
I_C	Collector current	Per channel current, when the output is "L"	500	mA
V_I	Input voltage		−0.5∼+30	V
I_F	Clamp diode forward voltage		500	mA
V_R	Clamp diode reverse current		−0.5∼+50	V
P	Power dissipation	T_a=25℃	1.79	W
Topr	Operating ambient temperature range		−20∼+75	℃
Tstg	Storage temperature range		−55∼+125	℃

8-UNIT 500mA DARLINGTON TRANSISTOR ARRAY WITH CLAMP DIODE

RECOMMENDED OPERATIONAL CONDITIONS (T_a=−20~+75℃, unless otherwise noted)

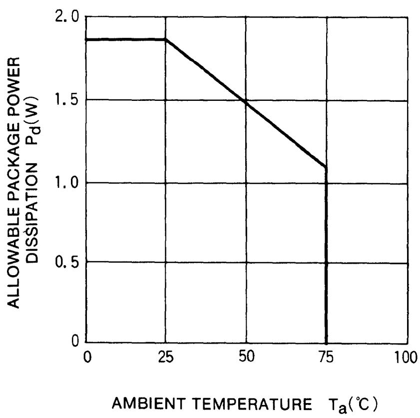
Symbol	Parameter		Limits Min	Typ	Max	Unit
V_O	Output voltage		0		50	V
I_I	Collector current per channel	Percent duty cycle less than 6%	0		400	mA
		Percent duty cycle less than 34%	0		200	
V_{IH}	"H" Input voltage	I_C=400mA	3.85		30	V
		I_C=200mA	3.4		30	
V_{IL}	"L" Input voltage	$I_{O(leak)}$=50μA	0		0.6	V

ELECTRICAL CHARACTERISTICS (T_a=−20~+75℃, unless otterwise noted)

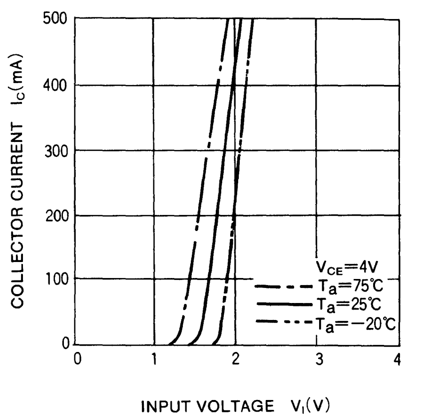
Symbol	Parameter	Test condittons	Limits Min	Typ	Max	Unit
$I_{O(leak)}$	Output leakage current	V_{CE}=50V			100	μA
$V_{CE(sat)}$	Output saturation voltage	V_I=3.85V, I_C=400mA		1.3	2.4	V
		V_I=3.85V, I_C=200mA		1.0	1.6	
I_I	Input current	V_I=3.85V		0.95	1.8	mA
		V_I=25V		11	18	
V_F	Clamp diode forward voltage	I_F=400mA		1.5	2.4	V
I_R	Clamp diode reverse voltage	V_R=50V			100	μA
h_{FE}	DC forward current transter ratio	V_{CC}=4V, I_C=350mA, T_a=25℃	1000	2500		—

TYPICAL CHARACTERISTICS

ALLOWABLE AVERAGE POWER DISSIPATION

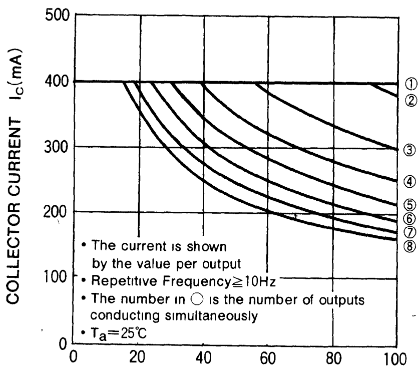


OUTPUT CURRENT CHARACTERISTICS

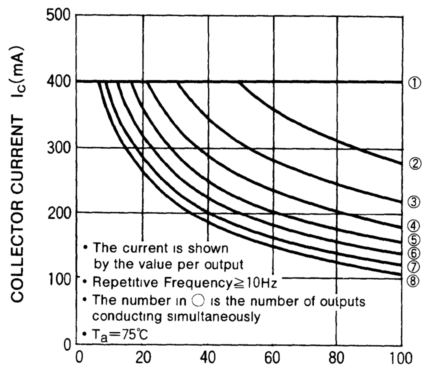


8-UNIT 500mA DARLINGTON TRANSISTOR ARRAY WITH CLAMP DIODE

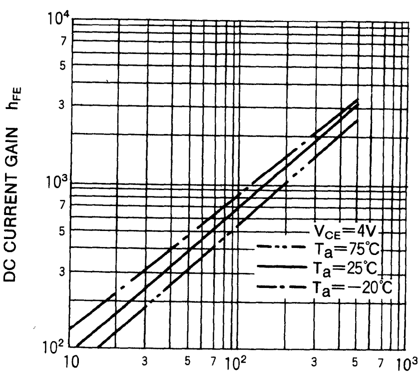
ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



CURRENT GAIN CHARACTERISTICS



M54584P

8-UNIT 350mA TRANSISTOR ARRAY

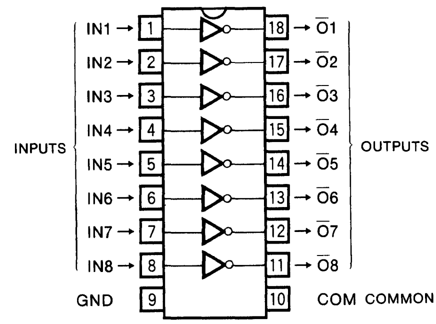
DESCRIPTION
The M54584P, 8-channel sink driver, consists of 16 NPN transistors connected to form high current gain driver pairs with low input current.

FEATURES
- High output sustaining voltage to 20V
- High output sink current to 350mA
- PMOS IC output for drive
- Low output saturation voltage ($V_{CE(sat)}$=0.5V at I_C=250mA)
- Wide operating temperature range (T_a=−20~+75℃)

APPLICATION
Relay and thermal printer dot driver, LED or incandescent display digit driver, Interface for MOS-bipolar logic IC_S

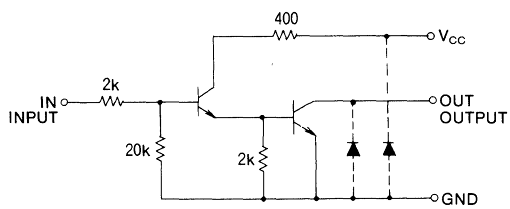
FUNCTION
The M54584P is composed of eight NPN transistors with the emitters of output transistors connected to GND pin (pin 9). The collectors of NPN predriver transistors are connected to the V_{CC} (pin 10) via a resistor of 400Ω. The outputs are capable of sinking 350mA and will withstand 20V between collector and emitter.

PIN CONFIGURATION (TOP VIEW)



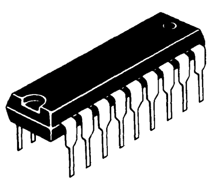
Outline 18P4

CIRCUIT SCHEMATIC (EACH CIRCUIT)



V_{CC} and GND are all common to 8 circuits
The diodes shown by broken line are parasite diodes and must not be used

Unit : Ω



18-pin molded plastic DIP

ABSOLUTE MAXIMUM RATINGS (T_a=−20~+75℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		−0.5~10	V
V_{CEO}	Output sustaining voltage	When the output is "H"	−0.5~+20	V
I_C	Collector current	Per channel current, when the output is "L"	350	mA
V_I	Input voltage		−0.5~+10	V
P_d	Power dissipation	T_a=25℃	1.79	W
Topr	Operating ambient temperature range		−20~+75	℃
Tsqg	Storage temperature range		−55~+125	℃

RECOMMENDED OPERATIONAL CONDITIONS (T_a=−20~+75℃, unless otherwise noted)

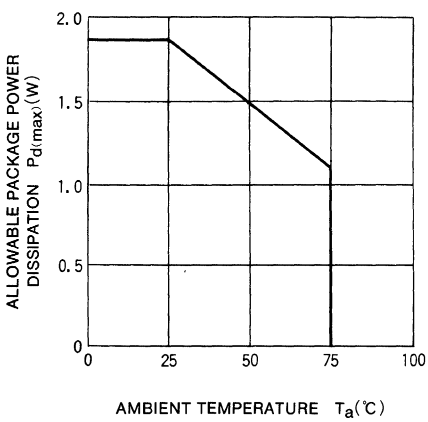
Symbol	Parameter		Limits Min	Typ	Max	Unit
V_{CC}	Supply voltage		3	5	8	V
V_O	Output voltage		0		20	V
I_C	Collector current per channel	Percent duty cycle less than 45%, V_{CC}=6.5V			250	mA
		Percent duty cycle less than 70%, V_{CC}=6.5V			150	
V_{IH}	"H" Input voltage	I_C≧250mA	3		V_{CC}	V
V_{IL}	"L" Input voltage	$I_{O(leak)}$≧50μA	0		0.4	V

ELECTRICAL CHARACTERISTICS (T_a=−20~+75℃, unless otherwise noted)

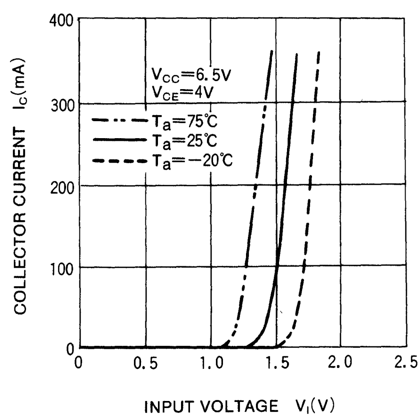
Symbol	Parameter	Test conditions	Limits Min	Typ	Max	Unit
$I_{O(leak)}$	Output leakage voltage	V_{CC}=8V, V_{CE}=20V			100	μA
$V_{CE(sat)}$	Output saturawlon voltage	V_{CC}=6.5V, V_I=3V, I_C=250mA		0.3	0.5	V
		V_{CC}=3V, V_I=3V, I_C=150mA		0.7	0.35	
I_I	Input current	V_{CC}=8V, V_I=3V		0.7	1.5	mA
		V_{CC}=8V, V_I=10V		4.3	7.3	
I_{CC}	Supply current (all output ON)	V_{CC}=8V, V_I=3V			220	mA
h_{FE}	DC forward current transter ratio	V_{CC}=6.5V, V_{CE}=4V, I_C=250mA, T_a=25℃	1000	7000		—

TYPICAL CHARACTERISTICS

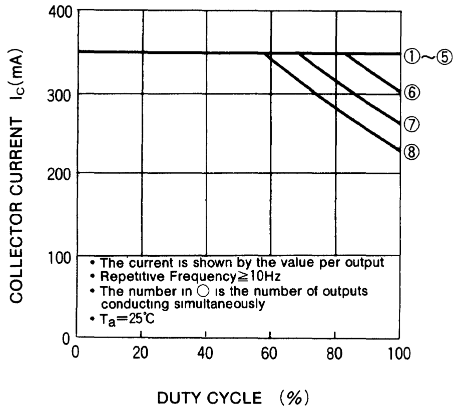
ALLOWABLE AVERAGE POWER DISSIPATION



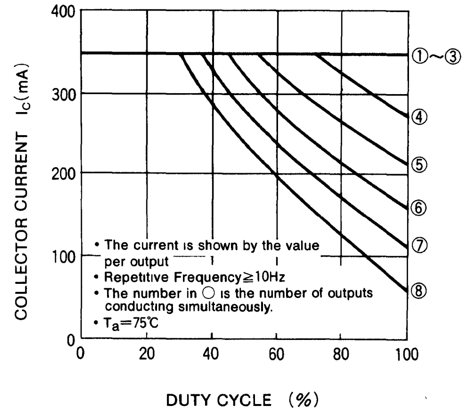
OUTPUT CURRENT CHARACTERISTICS



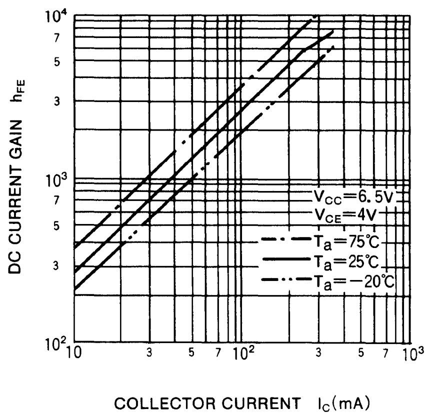
ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



CURRENT GAIN CHARACTERISTICS



M54562P

8-UNIT 500mA SOURCE TYPE DARLINGTON TRANSISTOR ARRAY

DESCRIPTION

The M54562P, 8-channel source driver, is designed for use with +6 to +16V MOS logic systems.

FEATURES

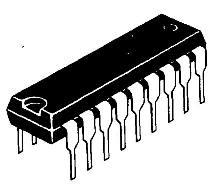
- High output sustaining voltage to 50V
- High output source current to 500mA
- Integral diode for transient suppression
- 6~16V CMOS compatible input
- Wide operating temperature range (T_a = −20~+75℃)

APPLICATION

Relay and printer driver, LED, incandescent or fluorescent display driver, Interfacing for standard MOS/BIPOLAR logics

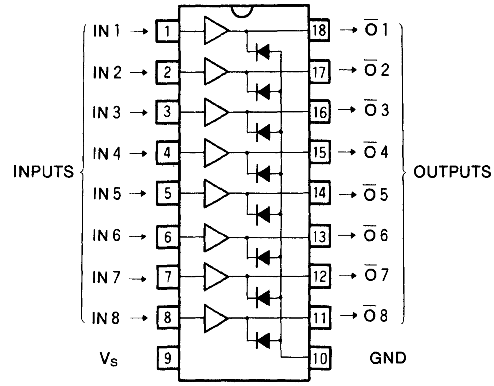
FUNCTION

The driver of the M54562P is comprised of a NPN invertor and compound PNP/NPN/NPN output source driver, and the output is turned ON by an active high input level. Each output has an integral diode for inductive load transient suppression. The outputs are capable of driving 500mA and are rated for operation with output voltage up to 50V.



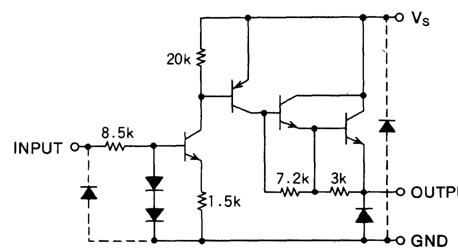
18-pin molded plastic DIP

PIN CONFIGURATION (TOP VIEW)



Outline 18P4

CIRCUIT SCHEMATIC



Unit : Ω

ABSOLUTE MAXIMUM RATINGS (T_a = −20~+75℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CEO}	Output sustaining voltage	Output is in "L"	−0.5~+50	V
V_S	Supply voltage		50	V
V_I	Input voltage		0~+30	V
I_O	Output current	Per channel current at "H" output	−500	mA
I_F	Clamp diode forward current		−500	mA
V_R	Clamp diode reverse voltage		50	V
P_d	Power dissipation	T_a=25℃	1.79	W
T_{opr}	Operating ambient temperature range		−20~+75	℃
T_{stg}	Storage temperature range		−55~+125	℃

8-UNIT 500mA SOURCE TYPE DARLINGTON TRANSISTOR ARRAY

RECOMMENDED OPERATIONAL CONDITIONS (T_a=−20∼+75℃, unless otherwise noted)

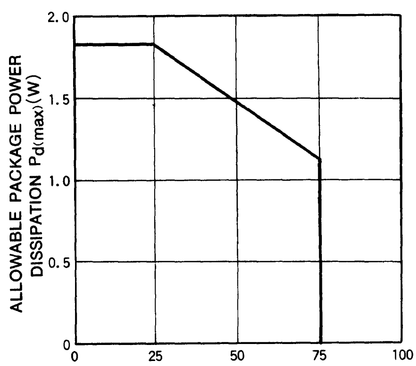
Symbol	Parameter		Limits Min	Limits Typ	Limits Max	Unit
V_S	Supply voltage		0		50	V
I_O	Output current per channel	Percent duty cycle less than 8%	0		−350	mA
		Percent duty cycle less than 55%	0		−100	
V_{IH}	"H" Input voltage	I_O=−350mA	2.4	5	30	V
V_{IL}	"L" Input voltage		0		0.2	V

ELECTRICAL CHARACTERISTICS (T_a=−20∼+75℃, unless otherwise noted)

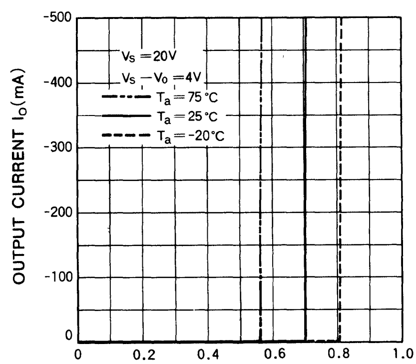
Symbol	Parameter	Test conditions	Limits Min	Limits Typ	Limits Max	Unit
$I_{S(leak)}$	Supply leak current	V_S=50V, V_I=0.2V			100	μA
$V_{CE(sat)}$	Output saturation voltage	V_S=10V, V_I=4V, I_O=−350mA		1.6	2.4	V
		V_S=10V, V_I=4V, I_O=−100mA		1.45	2.0	
I_I	Input current	V_I=5V		0.48	0.75	mA
		V_I=25V		2.8	4.7	
I_S	Supply current	V_S=50V, V_I=5V		5.6	6.5	mA
V_F	Clamp diode forward voltage	I_F=−350mA		−1.2	−2.4	V
V_R	Clamp diode reverse voltage	I_R=100μA	50			V

TYPICAL CHARACTERISTICS

ALLOWABLE AVERAGE POWER DISSIPATION

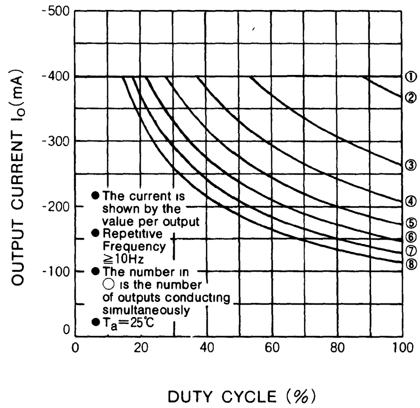


OUTPUT CURRENT CHARACTERISTICS

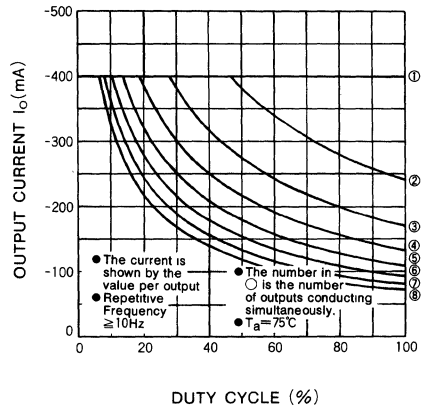


8-UNIT 500mA SOURCE TYPE DARLINGTON TRANSISTOR ARRAY

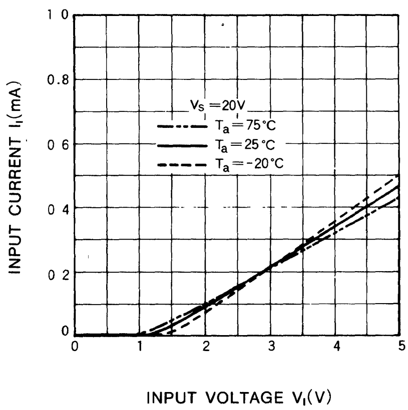
ALLOWABLE OUTPUT CURRENT AS A FUNCTION OF DUTY CYCLE



ALLOWABLE OUTPUT CURRENT AS A FUNCTION OF DUTY CYCLE



INPUT CHARACTERISTICS



MITSUBISHI ELECTRIC

M54563P

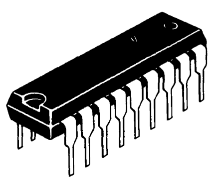
8-UNIT 500mA SOURCE TYPE DARLINGTON TRANSISTOR ARRAY

DESCRIPTION
The M54563P, 8-channel source driver, is designed for use with +6 to +16V MOS logic systems.

FEATURES
- High output sustaining voltage to 50V
- High output source current to 500mA
- Integral diode for transient suppression
- Wide operating temperature range (T_a=−20∼+75℃)

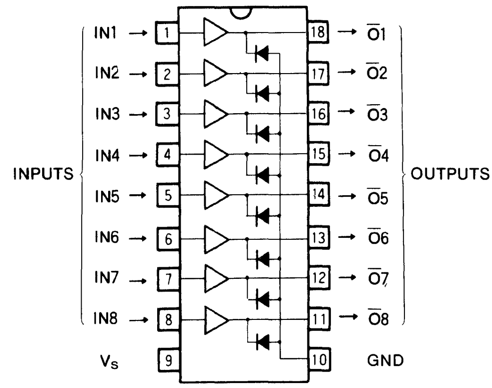
APPLICATION
Relay and printer driver, LED, incandescent or fluorescent display driver, Interfacing for standard MOS/BIPOLAR logics

FUNCTION
The driver of the M54563P is comprised of a NPN invertor and compound PNP/NPN/NPN output source driver and the output is turned ON by an active high input level. Each output has an integral diode for inductive load transient suppression. The outputs are capable of driving 500mA and are rated for operating with output voltage up to 50V.



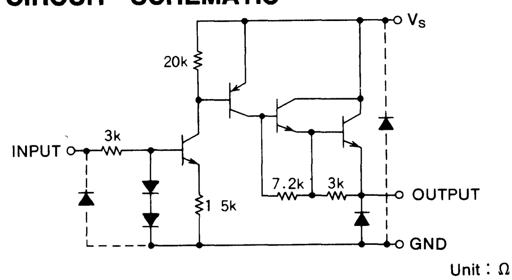
18-pin molded plastic DIP

PIN CONFIGURATION (TOP VIEW)



Outline 18P4

CIRCUIT SCHEMATIC



ABSOLUTE MAXIMUM RATINGS (T_a=−20∼+75℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CEO}	Output sustaining voltage	Transistor OFF	−0.5∼+50	V
V_S	Supply voltage		50	V
V_I	Input voltage		0∼+10	V
I_O	Output current	Transistor OFF	−500	mA
I_F	Clamp diode forward current		−500	mA
V_R	Clamp diode reverse voltage		50	V
P_d	Power dissipation	T_a=25℃	1.79	W
T_{opr}	Operating ambient temperature range		−20∼+75	℃
T_{stg}	Storage temperature range		−55∼+125	℃

RECOMMENDED OPERATIONAL CONDITIONS (T_a=−20~+75℃, unless otherwise noted)

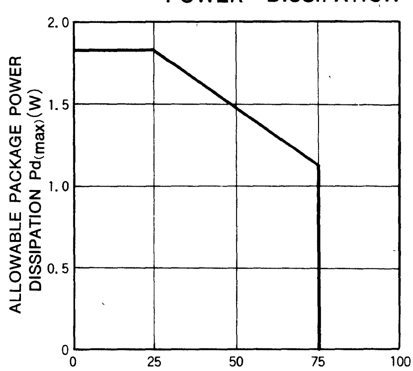
Symbol	Parameter		Limits Min	Limits Typ	Limits Max	Unit
V_S	Supply voltage		0		50	V
I_O	Output current per channel	Percent duty cycle less than 8%	0		−350	mA
		Percent duty cycle less than 55%	0		−100	mA
V_{IH}	"H" Input voltage	I_O=−350mA	2.4		6	V
V_{IL}	"L" Input voltage		0		0.2	V

ELECTRICAL CHARACTERISTICS (T_a=−20~+75℃, unless otherwise noted)

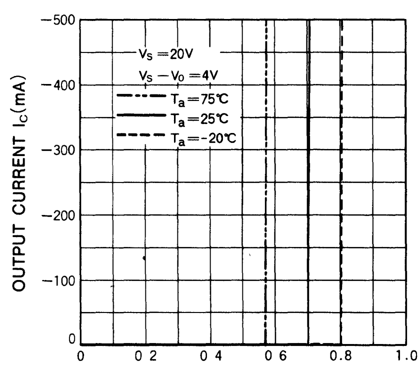
Symbol	Parameter	Test conditions	Limits Min	Limits Typ	Limits Max	Unit
$I_{S\,(leak)}$	Supply leakage current	V_S = 50 V, V_I = 0.2 V			100	μA
$V_{CE\,(sat)}$	Output saturation voltage	V_S = 10 V, V_I = 2.4 V, I_O = −350 mA		1.6	2.4	V
		V_S = 10 V, V_I = 2.4 V, I_O = −100 mA		1.45	2	V
I_I	Input current	V_I = 3 V		0.6	1	mA
		V_I = 10 V		2.9	5	mA
I_S	Supply current	V_S = 50 V, V_I = 3 V		5.6	6.5	mA
V_F	Clamp diode forward voltage	I_F = −350 mA		−1.2	−2.4	V
V_R	Clamp diode reverse voltage	I_R = 100 μA	50			V

TYPICAL CHARACTERISTICS

ALLOWABLE AVERAGE POWER DISSIPATION

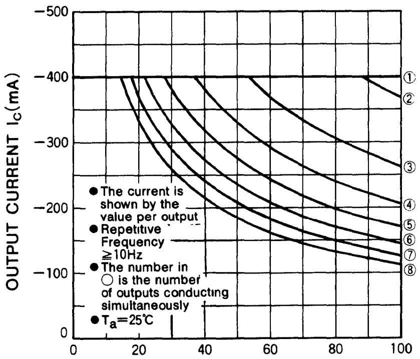


OUTPUT CURRENT CHARACTERISTICS

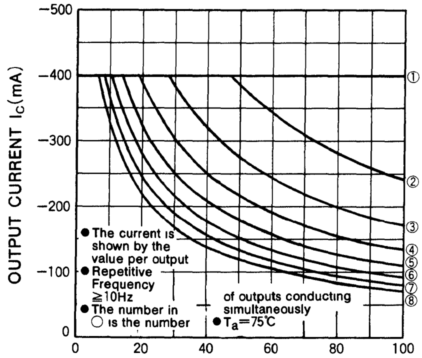


8-UNIT 500mA SOURCE TYPE DARLINGTON TRANSISTOR ARRAY

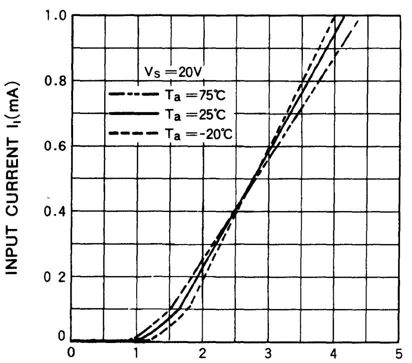
ALLOWABLE OUTPUT CURRENT AS A FUNCTION OF DUTY CYCLE



ALLOWABLE OUTPUT CURRENT AS A FUNCTION OF DUTY CYCLE



INPUT CHARACTERISTICS



M54564P

8-UNIT 500mA SOURCE TYPE DARLINGTON TRANSISTOR ARRAY

DESCRIPTION

The M54564P, 8-channel source driver, is designed for interfacing between low power digital logic and a fluorescent display.

FEATURES

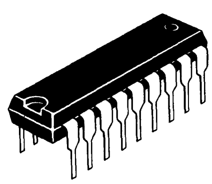
- High output sustaining voltage to 50V
- High output source current to 500mA
- CMOS, TTL Compatible input
- Internal pull-down resistors
- Wide operating temperature range (T_a = −20∼+75℃)

APPLICATION

Relay and printer driver, LED, incandescent or fluorescent display driver, Interfacing for standard MOS/BIPOLAR logic

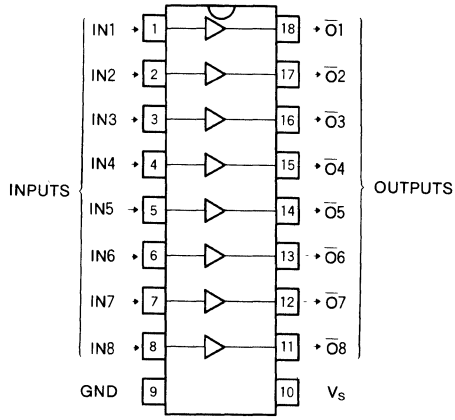
FUNCTION

The driver of the M54564P is comprised of a NPN invertor and compound PNP/NPN/NPN output source driver and the output is turned ON by an active high input level. Each output has 50kΩ pull-down resistor suitable for driving fluorescent displays. The outputs are capable of driving 500mA and are rated for operation with output voltage up to 50V.



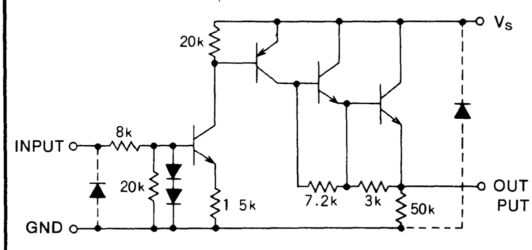
18-pin molded plastic DIP

PIN CONFIGURATION (TOP VIEW)



Outline 18P4

CIRCUIT SCHEMATIC



Unit : Ω

ABSOLUTE MAXIMUM RATINGS (T_a = −20∼+75℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CEO}	Output sustaining voltage		−0.5∼+50	V
V_S	Supply voltage		50	V
V_I	Input voltage		0∼+30	V
I_O	Output current		−500	mA
P_d	Power dissipation	T_a=25℃	1.79	W
T_{opr}	Operating ambient temperature range		−20∼+75	℃
T_{stg}	Storage temperature range		−55∼+125	℃

RECOMMENDED OPERATIONAL CONDITIONS (T_a=−20∼+75℃, unless otherwise noted)

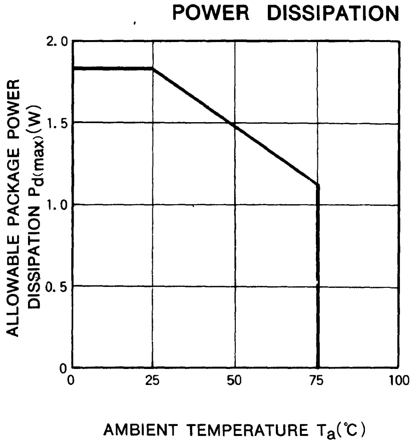
Symbol	Parameter		Limits			Unit
			Min	Typ	Max	
V_S	Supply voltage		0		50	V
I_O	Output current per channel	Percent duty cycle less than 8%	0		−350	mA
		Percent duty cycle less than 60%	0		−100	
V_{IH}	"H" Input voltage	I_O=−350mA	4		25	V
V_{IL}	"L" Input voltage		0		0.2	V

ELECTRICAL CHARACTERISTICS (T_a=−20∼+75℃, unless otherwise noted)

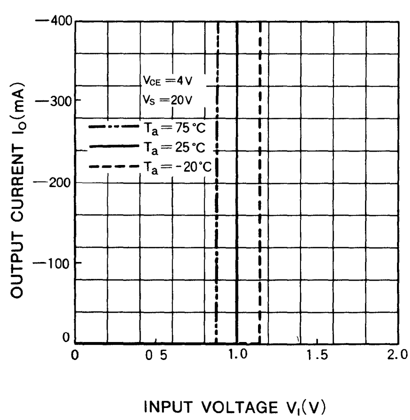
Symbol	Parameter	Test conditions		Limits			Unit
				Min	Typ	Max	
$I_{S(leak)}$	Supply leak current	V_S=50V, V_I=0.2V				100	μA
$V_{CE(sat)}$	Output saturation voltage	V_S=10V	I_O=−350mA		1.6	2.4	V
		V_I=4V	I_O=−100mA		1.45	2	
I_I	Input current	V_I=4V			0.4	0.7	mA
		V_I=25V			2.9	4.7	
I_S	Supply current	V_S=50V, V_I=4V			5.6	6.5	mA

TYPICAL CHARACTERISTICS

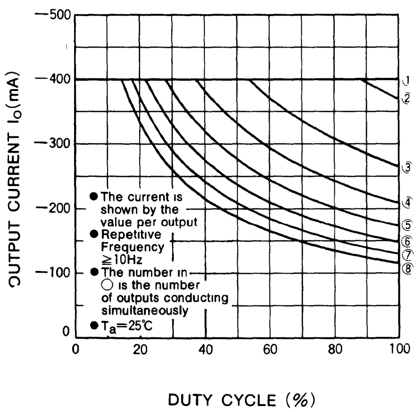
ALLOWABLE AVERAGE POWER DISSIPATION



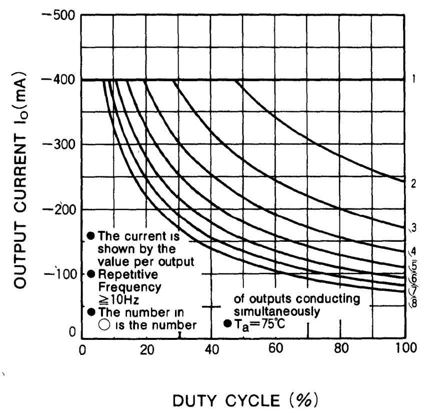
OUTPUT CURRENT CHARACTERISTICS



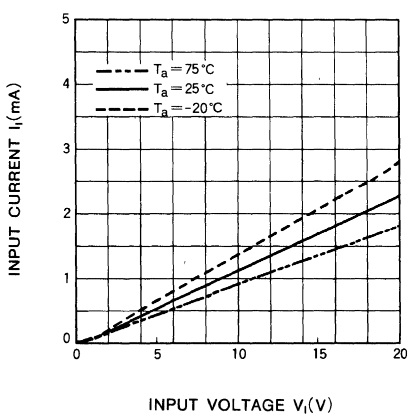
ALLOWABLE OUTPUT CURRENT AS A FUNCTION OF DUTY CYCLE



ALLOWABLE OUTPUT CURRENT AS A FUNCTION OF DUTY CYCLE



INPUT CHARACTERISTICS



M54567P

4-UNIT 1.5A DARLINGTON TRANSISTOR ARRAY WITH CLAMP DIODE

DESCRIPTION

The M54567P, 4-channel sink driver, consists of 4 PNP and 14 NPN transistors to form high current gain driver pairs.

FEATURES

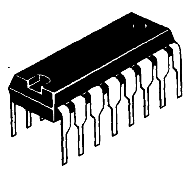
- High output sustaining voltage to 50V
- High output current to 1.5A
- Integral diodes for transient suppression
- NMOS Compatible input
- Wide operating temperature range (T_a = −20∼+75℃)

APPLICATION

Relay and printer driver, LED or incandescent display digit driver

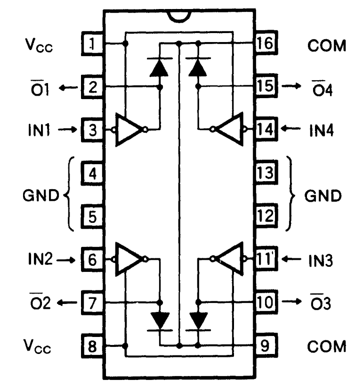
FUNCTION

The M54567P is comprised of four PNP invertors with 8kΩ series input resistors and NPN darlington sink drivers. Each output has an integral diode for inductive load transient suppression and the anodes of the diode connected to pins 9 and 16. The outputs are capable of sinking 1.5A and will withstand 50V in the OFF state.



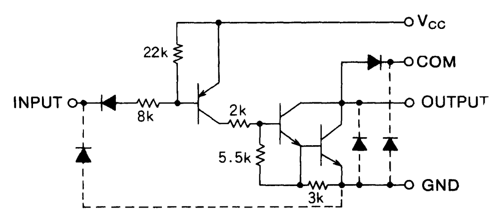
16-pin molded plastic DIP

PIN CONFIGURATION (TOP VIEW)



Outline 16P4

CIRCUIT SCHEMATIC



Unit : Ω

ABSOLUTE MAXIMUM RATINGS (T_a=−20∼+75℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		10	V
V_{CEO}	Output sustaining voltage	Transistor OFF	−0.5∼+50	V
V_I	Input voltage		30	V
I_C	Collector current	Transistor ON	1.5	A
V_R	Clamp diode reverse voltage		50	V
I_F	Clamp diode forward current	Pulse width≦10ms, Repetitive cycle≦10Hz	1.5	A
			1	A
P_d	Power dissipation	T_a =25℃	1.92	W
T_{opr}	Operating ambient temperature range		−20∼+75	℃
T_{stg}	Storage temperature range		−55∼+125	℃

4-UNIT 1.5A DARLINGTON TRANSISTOR ARRAY WITH CLAMP DIODE

RECOMMENDED OPERATIONAL CONDITIONS (T_a=−20～+75℃, unless otherwise noted)

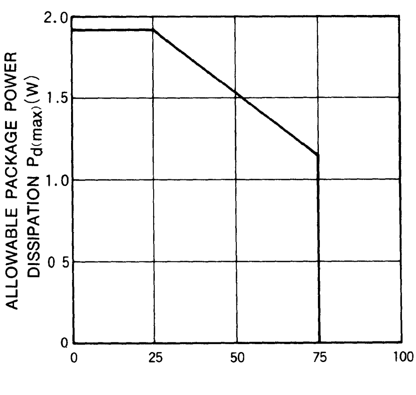
Symbol	Parameter		Limits Min	Limits Typ	Limits Max	Unit
V_{CC}	Supply voltage		4	5	6	V
V_O	Output voltage		0		40	V
I_C	Collector current per channel	All units ON Percent duty cycle≦ 4 %	0		1.25	A
		All units ON Percent duty cycle≦18%	0		0.7	
V_{IH}	"H" Input voltage	$I_{O(leak)}$=50μA	V_{CC}−0.5		V_{CC}	V
V_{IL}	"L" Input voltage	I_C=1.25A	0		V_{CC}−3.5	V

ELECTRICAL CHARACTERISTICS (T_a=−20～+75℃, unless otherwise noted)

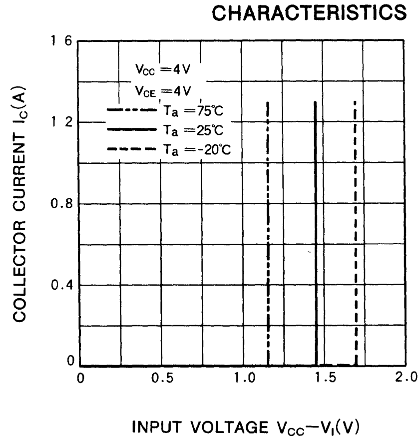
Symbol	Parameter	Test conditions		Limits Min	Limits Typ	Limits Max	Unit
$V_{(BR)CEO}$	Output sustaining voltage	I_{CEO}=100μA		50			V
I_{CC}	Supply current	V_{CC} = 6 V, V_I =0.5V			3.0	4.5	mA
$V_{CE(sat)}$	Output saturation voltage	V_{CC} = 4 V	I_C =1.25A		1.6	2.2	V
		V_I =0.5V	I_C =0.7A		1.1	1.7	
I_I	Input current	V_I =V_{CC} −3.5V			−0.3	−0.6	mA
		V_I =V_{CC}− 6 V			−0.58	−0.95	
V_R	Clamp diode reverse voltage	I_R=100μA		50			V
V_F	Clamp diode forward voltage	I_F=1.25A			1.6	2.3	V
h_{FE}	DC forward current gain	V_{CC} =4V, V_{CE} =4V, I_C =1A, T_a =25℃		4000	30000		—

TYPICAL CHARACTERISTICS

ALLOWABLE AVERAGE POWER DISSIPATION



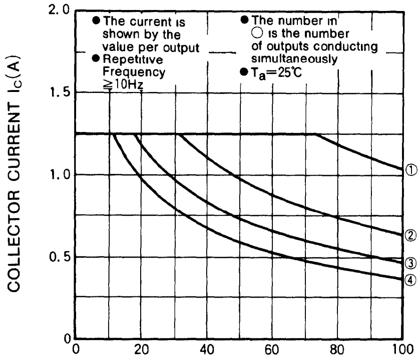
OUTPUT CURRENT CHARACTERISTICS



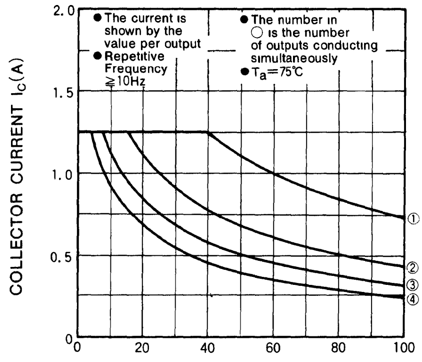
MITSUBISHI ELECTRIC

4-UNIT 1.5A DARLINGTON TRANSISTOR ARRAY WITH CLAMP DIODE

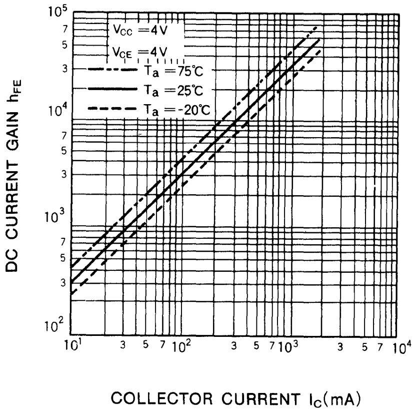
ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



DC CURRENT GAIN CHARACTERISTICS



M54576P,FP

7-UNIT 30mA TRANSISTOR ARRAY (INPUT "L" ACTIVE)

DESCRIPTION

The M54576P, FP, 7-channel sink driver, consists of 28 NPN transistors connected to form high current gain driver pairs.

FEATURES

- 30V output breakdown
- 30mA output sink current capability
- CMOS compatible input
- Low output saturation voltage
- Wide operating temperature range (T_a =−20∼+75℃)

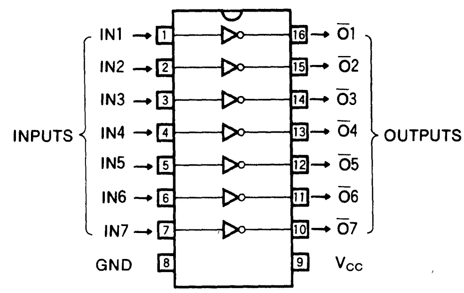
APPLICATION

LED or incandescent display digit driver

FUNCTION

The M54576P, FP is comprised of seven NPN invertors with diodes and 23kΩ resistors in series to the input and non darlington NPN sink drivers. The output is turned ON by switching the input low. The outputs are capable of sinking 30mA and will withstand 30V in the OFF state. The M54576FP features a small flat mold package.

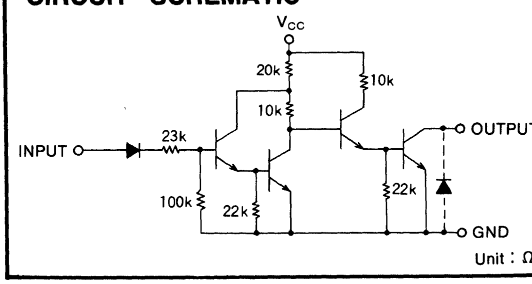
PIN CONFIGURATION (TOP VIEW)

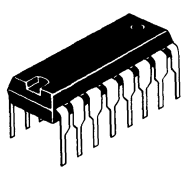


Outline 16P2 (M54576FP)

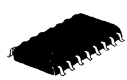
Outline 16P4 (M54576P)

CIRCUIT SCHEMATIC





16-pin molded plastic DIP



16-pin molded plastic FLAT

ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		13	V
V_{CEO}	Output sustaining voltage	Transistor OFF	−0.5∼+30	V
I_C	Collector current	Transistor ON	30	mA
V_I	Input voltage		−20, 13	V
P_d	Power dissipation	T_a=25℃	1.47/0.56	W
T_{opr}	Operating ambient temperature range		−20∼+75	℃
T_{stg}	Storage temperature range		−55∼+125	℃

RECOMMENDED OPERATIONAL CONDITIONS (T_a=−20∼+75℃, unless otherwise noted)

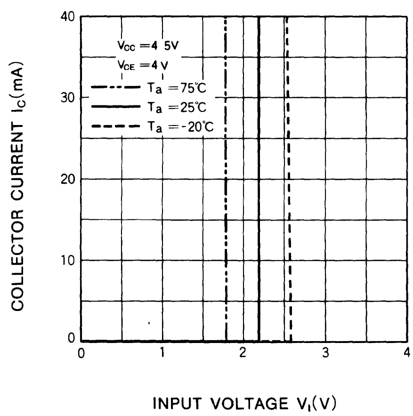
Symbol	Parameter		Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage		4	5	13	V
I_C	Collector current per channel		0	10	20	mA
V_{IH}	"H" Input voltage		3		V_{CC}	V
V_{IL}	"L" Input voltage	I_C=20mA	0		1	V

ELECTRICAL CHARACTERISTICS (T_a=−20~+75℃, unless otherwise noted)

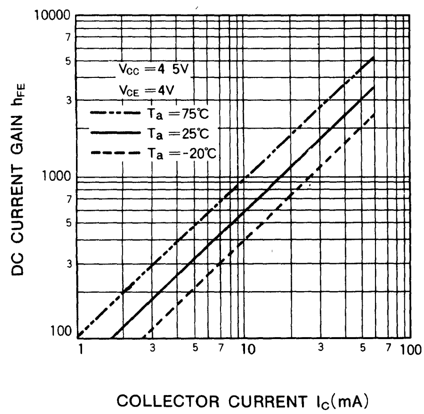
Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
$I_{O(leak)}$	Output leakage current	V_{CE}=30V, V_I=3V, V_{CC}=6V			100	μA
$V_{CE(sat)}$	Output saturation voltage	V_{CC}=4.5V, V_I=1V, I_C=10mA		0.02	0.25	V
		V_{CC}=6V, V_I=1V, I_C=20mA		0.04	0.35	
I_I	Input current	V_{CC}=4.5V, V_I=3V	30	60	90	μA
I_{CC}	Supply current	V_{CC}=4.5V, V_I=1V			6.3	mA
		V_{CC}=13V, V_I=1V			18	
h_{FE}	DC forward current gain	V_{CE}=4V, V_{CC}=4.5V, I_C=20mA, T_a=25℃	500	1200		—

TYPICAL CHARACTERISTICS

OUTPUT CURRENT CHARACTERISTICS



DC CURRENT GAIN CHARACTERISTICS



M54566P

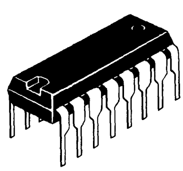
7-UNIT 400mA DARLINGTON TRANSISTOR ARRAY (INPUT "L" ACTIVE)

DESCRIPTION
The M54566P, 7-channel sink driver, consists of 7 PNP and 14 NPN transistors connected to form high current gain driver pairs.

FEATURES
- High output sustaining voltage to 50V
- High output sink current to 400mA
- "L" Active input
- Wide operating temperature range (T_a =−20∼+75℃)

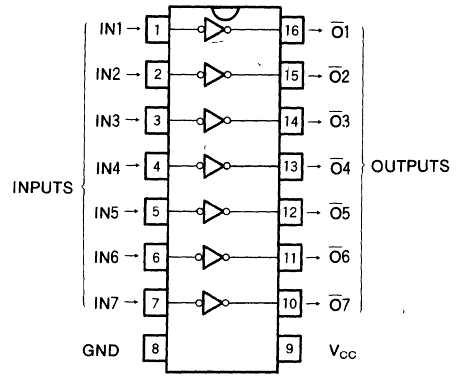
APPLICATION
Relay and printer driver, Interfacing between standard MOS/BIPOLAR logics

FUNCTION
The M54566P is comprised of seven PNP invertors with 8 kΩ series input resistors and NPN darlington sink drivers. The output is turned ON by switching the input low. The outputs are capable of sinking 400mA and will withstand 50V in the OFF state.



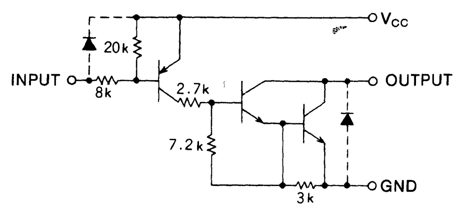
16-pin molded plastic DIP

PIN CONFIGURATION (TOP VIEW)



Outline 16P4

CIRCUIT SCHEMATIC



Unit : Ω

ABSOLUTE MAXIMUM RATINGS (T_a=−20∼+75℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		10	V
V_{CEO}	Output sustaining voltage	Transistor OFF	−0.5∼+50	V
V_I	Input voltage		0∼V_{CC}	V
I_C	Collector current	Transistor ON	400	mA
P_d	Power dissipation	T_a =25℃	1.47	W
T_{opr}	Operating ambient temperature range		−20∼+75	℃
T_{stg}	Storage temperature range		−55∼+125	℃

RECOMMENDED OPERATIONAL CONDITIONS (T_a=−20~+75℃, unless otherwise noted)

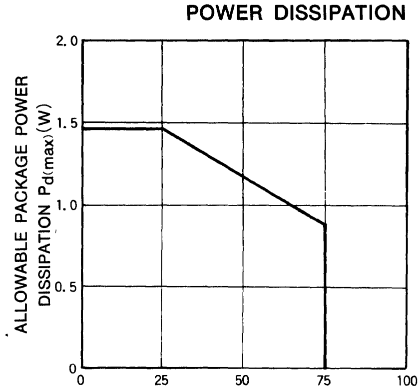
Symbol	Parameter		Limits Min	Typ	Max	Unit
V_{CC}	Supply voltage		4	5	8	V
I_C	Collector current per channel	Percent duty cycle less than 10%	0		350	mA
		Percent duty cycle less than 30%	0		200	
V_{IH}	"H" Input voltage	$I_{O(leak)}$=50μA	V_{CC}−0.2		V_{CC}	V
V_{IL}	"L" Input voltage	I_C=350mA	0		V_{CC}−3	V

ELECTRICAL CHARACTERISTICS (T_a=−20~+75℃, unless otherwise noted)

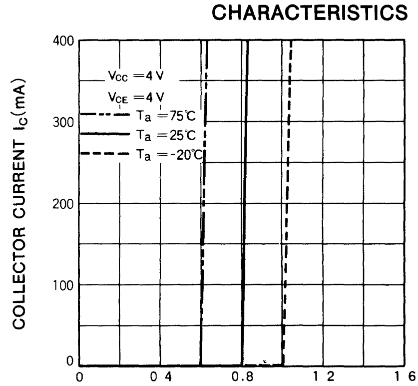
Symbol	Parameter	Test conditions		Limits Min	Typ	Max	Unit
$V_{(BR)CEO}$	Output sustaining voltage	I_{CEO} =100 μA		50			V
$V_{CE(sat)}$	Output saturation voltage	$V_I = V_{CC}$ −3V	I_C =350 mA		1.1	2.2	V
			I_C =200 mA		0.9	1.6	
I_I	Input current	$V_I = V_{CC}$ −3.5 V			−0.38	−0.58	mA
I_{CC}	Supply current	V_{CC} =5 V, $V_I = V_{CC}$ −3.5 V			1.4	3	mA
h_{FE}	DC forward current gain	V_{CE} =4 V, V_{CC} =5 V, I_C =350 mA, T_a =25℃		2000	10000		—

TYPICAL CHARACTERISTICS

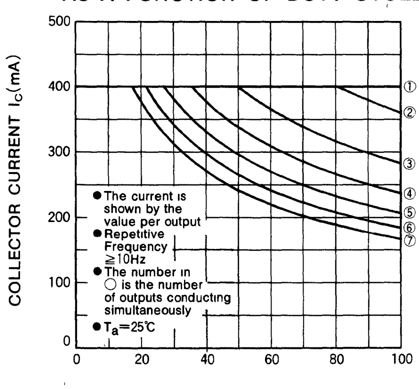
ALLOWABLE AVERAGE POWER DISSIPATION



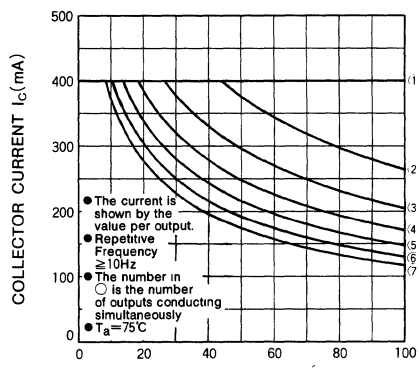
OUTPUT CURRENT CHARACTERISTICS



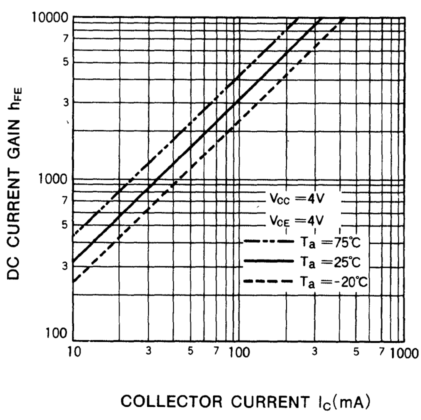
ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE



DC CURRENT GAIN CHARACTERISTICS



M54565P

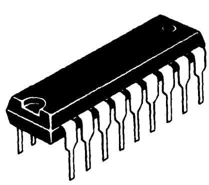
8-UNIT 50mA TRANSISTOR ARRAY (INPUT "L" ACTIVE)

DESCRIPTION
The M54565P, 8-channel sink driver, consists of 7 PNP and 7 NPN transistors connected to form high current gain driver pairs.

FEATURES
- Output breakdown voltage to 20V
- Output sink current to 50mA
- Wide operating temperature range ($T_a = -20 \sim +75$℃)
- "L" Active Input

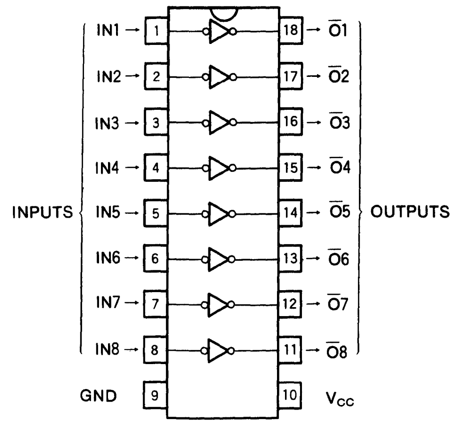
APPLICATION
LED or incandescent display driver, Interfacing for standard MOS/BIPOLAR logics

FUNCTION
The M54565P is comprised of eight PNP-NPN non darlington sink drivers. It functions from 2 V of supply voltage and features low output saturation voltage. The output is turned ON by switching the input low.



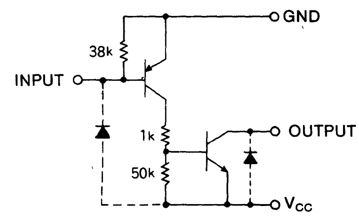
18-pin molded plastic DIP

PIN CONFIGURATION (TOP VIEW)



Outline 18P4

CIRCUIT SCHEMATIC



Unit : Ω

ABSOLUTE MAXIMUM RATINGS ($T_a = -20 \sim +75$℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		10	V
V_{CEO}	Output sustaining voltage	Transistor OFF	$-0.5 \sim +20$	V
I_C	Collector current	Transistor ON	50	mA
V_I	Input voltage		$0 \sim V_{CC}$	V
T_{opr}	Operating ambient temperature range		$-20 \sim +75$	℃
T_{stg}	Storage temperature range		$-55 \sim +125$	℃

RECOMMENDED OPERATIONAL CONDITIONS (Ta=−20~+75℃, unless otherwise noted)

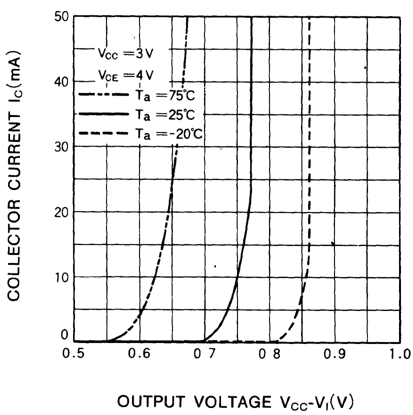
Symbol	Parameter		Limits Min	Typ	Max	Unit
V_{CC}	Supply voltage		2		6	V
V_O	Output voltage		0		20	V
I_C	Collector current		0		20	mA
I_{IH}	"H" Input current		−8		8	μA
I_{IL}	"L" Input current	I_O=40mA	−200		−5000	μA

ELECTRICAL CHARACTERISTICS (Ta=−20~+75℃, unless otherwise noted)

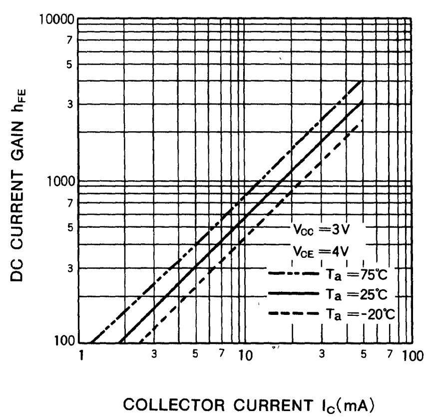
Symbol	Parameter	Test conditions		Limits Min	Typ	Max	Unit
$I_{O(leak)}$	Output leakage current	V_{CC} =6V, V_O =20V				50	μA
$V_{CE(sat)}$	Output saturation voltage	V_{CC} = 3 V	I_C =20mA		0.03	0.17	V
		I_I = −200μA	I_C =40mA		0.05	0.23	
V_I	Input voltage	V_{CC} = 2 V, I_I = −200μA		1	1.25		V
I_{CC}	Supply current	V_{CC}= 3 V, I_I = −200μA			2.3	4	mA
h_{FE}	DC forward current gain	V_{CE} =4V, V_{CC} =3V, I_C =40mA, T_a =25℃		800	2500		—

TYPICAL CHARACTERISTICS

OUTPUT CURRENT CHARACTERISTICS



DC CURRENT GAIN CHARACTERISTICS



MITSUBISHI ELECTRIC

M54583P

8-UNIT 400mA DARLINGTON TRANSISTOR ARRAY

DESCRIPTION

The M54583P, 8-channel source driver, is composed of 16 NPN and PNP current sink darlington transistors which form high current gain driver pairs at low input current.

FEATURES

- High output sustaining voltage to 50V
- High output source current to 400mA
- "L" active level input
- Internal input diodes
- Wide operating temperature range (T_a=−20～+75℃)

APPLICATION

Interfacing for microcomputer and high voltage and high current driver system, Interfacing for standard MOS/ BIPOLAR logics, Relay

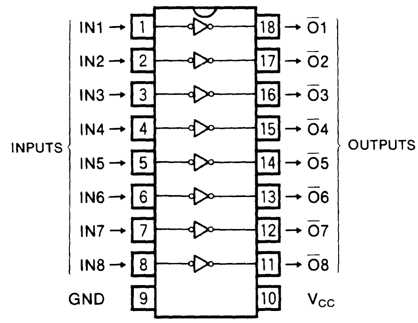
FUNCTION

The driver of the M54583P is composed of an input circuit of the M54523P with additional PNP transistors and "L" active input. A resistor of 7kΩ is connected between the input and the base of PNP transistors. The input diode is intended to prevent the flow of current from the input to the V_{CC}. Without this diode, the current flows from "H" input to the V_{CC} and the "L" input circuit is activated, in such a case where one of the inputs of the 8 circuits is "H" and the others are "L" to save power consumption. The diode is inserted to prevent such misoperation.

The outputs are capable of driving 400mA and are rated for operation with output voltage up to 50V.

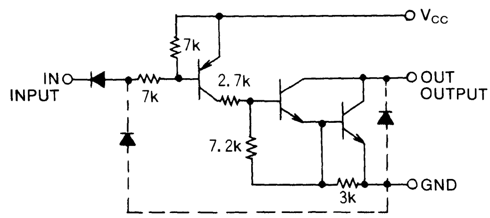
This device is most suitable for a driver using NMOS IC output, especially for the driver of current sink.

PIN CONFIGURATION (TOP VIEW)



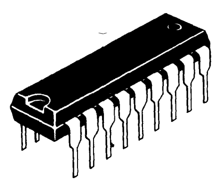
Outline 18P4

CIRCUIT SCHEMATIC (EACH CIRCUIT)



V_{CC} and GND are common to the 8 pairs
The diodes shown by broken line are parasite diodes and must not be used

Unit : Ω



18-pin molded plastic DIP

ABSOLUTE MAXIMUM RATINGS (T_a=−20～+75℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		−0.5～+10	V
V_{CEO}	Ounput sustaining voltage	Output is in "H"	−0.5～+50	V
V_I	Input voltage		−0.5～V_{CC}	V
I_C	Collector current	Per channel current at "L" output	400	mA
P_d	Power dissipation	T_a=25℃	1.79	W
Topr	Operating ambient temperature range		−20～+75	℃
Tstg	Storage temperature range		−55～+125	℃

RECOMMENDED OPERATING CONDITONS (T_a=−20~+75℃, unless otherwise noted)

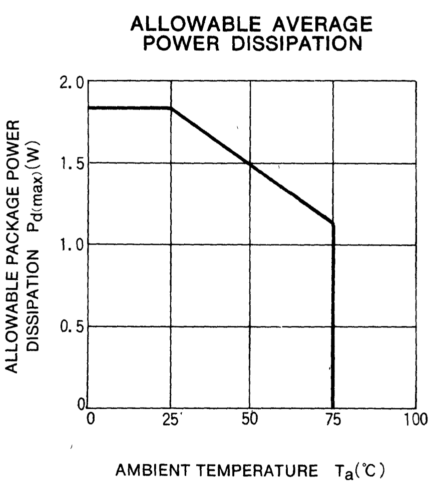
Symbol	Parameter		Limits Min	Typ	Max	Unit
V_{CC}	Supply voltage		4	5	8	V
I_C	Collector current per channel	Percent duty cycle less than 10%, V_{CC}=5V	0		350	mA
		Percent duty cycle less than 34%, V_{CC}=5V	0		200	
V_{IH}	"H" Input voltage	$I_{O(leak)} \leqq 50\mu A$	$V_{CC}-0.7$		V_{CC}	V
V_{IL}	"L" Input voltage	$I_C \leqq 350mA$	0		$V_{CC}-3.6$	V

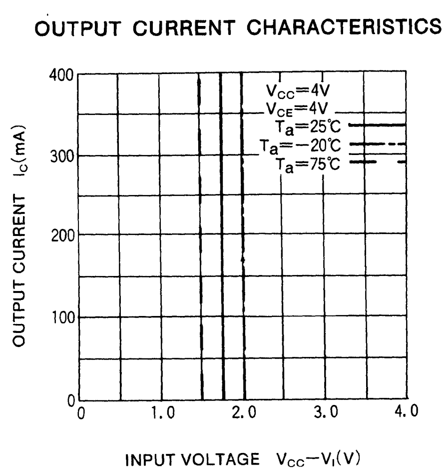
ELECTRICAL CHARACTERISTICS (T_a=−20~+75℃, unless otherwise noted)

Symbol	Parameter	Test conditions		Limits Min	Typ*	Max	Unit
$I_{O(leak)}$	Output leakage current	V_{CEO}=50V				100	μA
$V_{CE(sat)}$	Output saturation voltage	$V_I=V_{CC}-3.6V$	I_C=350mA		1.1	2.2	V
			I_C=200mA		0.98	1.6	
I_I	Input current	$V_I=V_{CC}-3.6V$			−320	−600	μA
I_{CC}	Supply current (an only input)	V_{CC}=5V, $V_I=V_{CC}-3.6V$				3	mA
h_{FE}	DC forward current gain	V_{CE}=4V, V_{CC}=5V, I_C=350mA, T_a=25℃		2000			—

* : A typical value is at T_a=25℃.

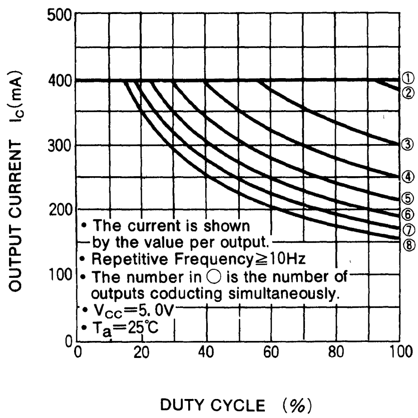
TYPICAL CHARACTERISTICS



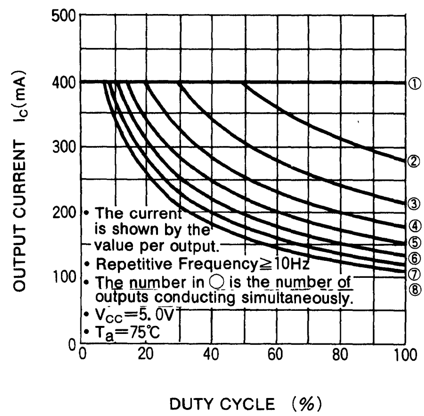


MITSUBISHI ELECTRIC

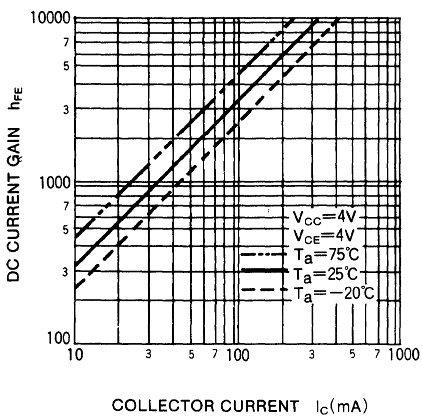
ALLOWABLE OUTPUT CURRENT AS A FUNCTION OF DUTY CYCLE



ALLOWABLE OUTPUT CURRENT AS A FUNCTION OF DUTY CYCLE



DC CURRENT GAIN CHARACTERISTICS



M54568L

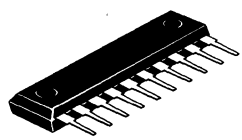
4-UNIT 30mA PNP TRANSISTOR ARRAY

DESCRIPTION
The M54568L, general purpose transistor array, consists of 4 PNP transistors connected in a commom-emitter configuration.

FEATURES
- 20V breakdown
- 30mA output source current capability
- Wide operating temperature range (T_a=−20∼+75℃)

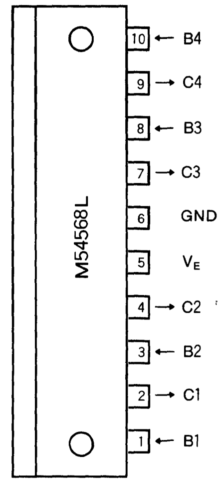
APPLICATION
LED or incandescent display driver

FUNCTION
The M54568L is comprised of 4 PNP transistors. ALL emitters are connected to pin 5 . Each transistor is capable of switching 30mA and will withstand 20V in the OFF state.



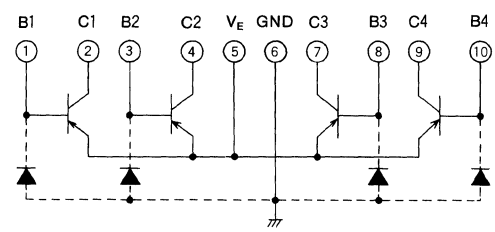
10-pin molded plastic SIP

PIN CONFIGURATION (TOP VIEW)



Outline 10P5

CIRCUIT SCHEMATIC



ABSOLUTE MAXIMUM RATINGS (T_a=−20∼+75℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CBO}	Collector-base sustaining voltage	Base voltage : 0V	−40	V
V_{EBO}	Emitter-base sustaining voltage	Base voltage : 0V	−40	V
V_{CEO}	Collector-emitter sustaining voltage	Emitter voltage : 0V	−20	V
I_C	Collector current per transistor		−30	mA
I_B	Base current per transistor		−20	mA
P_d	Power dissipation	T_a =25℃	1000	mW
T_{opr}	Operating ambient temperature range		−20∼+75	℃
T_{stg}	Storage temperature range		−55∼+125	℃

RECOMMENDED OPERATIONAL CONDITIONS (T_a=−20～+75℃, unless otherwise noted)

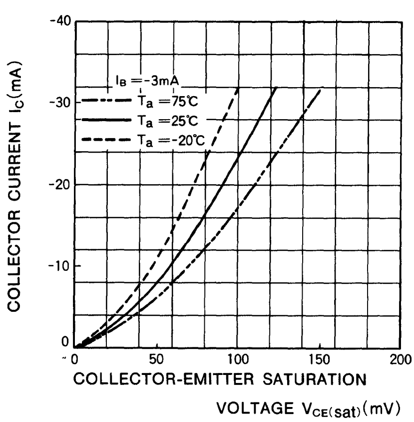
Symbol	Parameter		Limits			Unit
			Min	Typ	Max	
I_C	Collector current	I_B=−3mA	0		−20	mA
I_B	Base current		0		−10	mA
V_E	Emitter current		−0.3		20	V
V_B	Base voltage		−0.3		V_E	V

ELECTRICAL CHARACTERISTICS (T_a=−20～+75℃, unless otherwise noted)

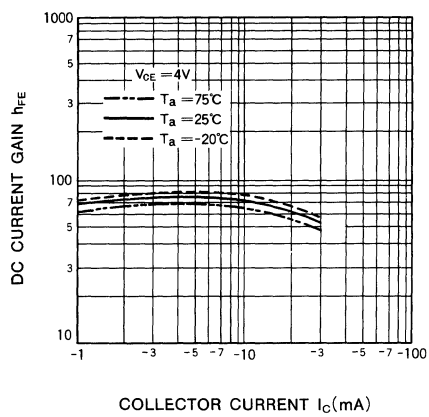
Symbol	Parameter	Test conditions		Limits			Unit
				Min	Typ	Max	
$V_{(BR)CBO}$	Collector-emitter sustaining voltage	I_C =−10μA, V_B =0 V, V_E : OPEN		−40			V
$V_{(BR)EBO}$	Emitter-base sustaining voltage	I_E =−10μA, V_B =0 V, V_C : OPEN		−40			V
$V_{(BR)CEO}$	Collector-emitter sustaining voltage	I_C =−100μA, V_E =0 V, V_B : OPEN		−20			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_C =−20 mA, I_B =−3 mA, V_E =5 V			−0.09	−0.3	V
		I_C =−2 mA, I_B =−0.2 mA, V_E =5 V			−0.02	−0.28	
h_{FE}	DC forward current gain	V_{CE} =−4 V	I_C =−2 mA	20	80		—
		T_a =25℃	I_C =−20 mA	15	60		

TYPICAL CHARACTERISTICS

OUTPUT CHARACTERISTICS



DC CURRENT GAIN CHARACTERISTICS



M54560P

7-UNIT 150mA SOURCE TYPE DARLINGTON TRANSISTOR ARRAY

DESCRIPTION

The M54560P, 7-channel source driver, consists of 7 PNP and 7 NPN transistors, connected to form high current gain driver with PNP action.

FEATURES

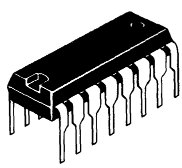
- High output sustaining voltage to 40V
- Output source current to 150mA
- Integral diode for transient suppression
- Active "L" input
- Wide operating temperature range (T_a = −20∼+75℃)

APPLICATION

Relay and printer driver, LED, incandescent or fluorescent display driver, Interfacing for standard MOS/BIPOLAR logics

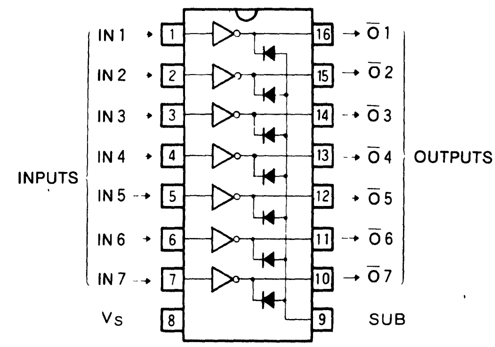
FUNCTION

The M54560P is comprised of seven PNP-NPN darlington source driver pairs with 20kΩ series input resistors. Each output has an integral diode for inductive load transient suppression. The anodes of the diodes and the substrate connected together to pin 9. The outputs are capable of driving 150mA and are rated for operation with output voltages of up to 40V. The output is turned ON by switching the input low.



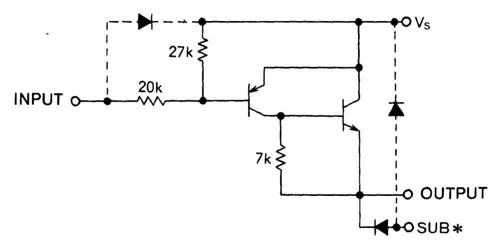
16-pin molded plastic DIP

PIN CONFIGURATION (TOP VIEW)



Outline 16P4

CIRCUIT SCHEMATIC



Unit : Ω

ABSOLUTE MAXIMUM RATINGS (T_a=−20∼+75℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CEO}	Output sustaining voltage	Output is in "L"	−0.5∼+40	V
V_S	Supply voltage		40	V
V_I	Input voltage		0∼+40	V
I_O	Output current	Per channel current at "H" output	−150	mA
I_F	Clamp diode forward current		−150	mA
V_R	Clamp diode reverse voltage		40	V
P_d	Power dissipation	T_a=25℃	1.47	W
T_{opr}	Operating ambient temperature range		−20∼+75	℃
T_{stg}	Storage temperature range		−55∼+125	℃

7-UNIT 150mA SOURCE TYPE DARLINGTON TRANSISTOR ARRAY

RECOMMENDED OPERATIONAL CONDITIONS (T_a=−20∼+75℃, unless otherwise noted)

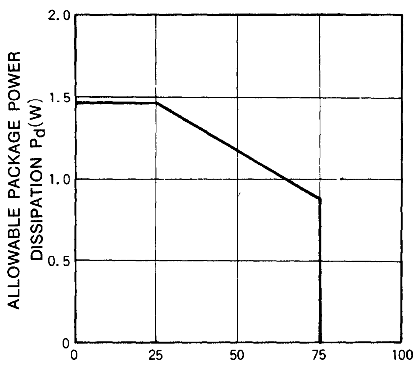
Symbol	Parameter		Limits Min	Limits Typ	Limits Max	Unit
V_S	Supply voltage		0		40	V
I_O	Output current per channel	Percent duty cycle less than 90%	0		−100	mA
		Percent duty cycle less than 100%	0		−50	
V_{IH}	"H" input voltage		V_S−0.2		V_S+0.3	V
V_{IL}	"L" input voltage	I_O=−100mA	0		V_S−5	V
		I_O=−50mA	0		V_S−3.5	

ELECTRICAL CHARACTERISTICS (T_a=−20∼+75℃, unless otherwise noted)

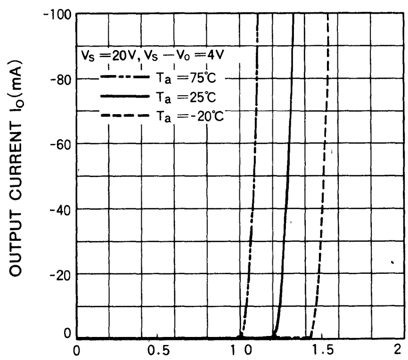
Symbol	Parameter	Test conditions	Limits Min	Limits Typ	Limits Max	Unit
$I_{S(leak)}$	Supply leakage current	V_S=40V			100	μA
$V_{CE(sat)}$	Output saturation voltage	V_I=V_S−5V, I_O=−100mA		0.82	1.5	V
		V_I=V_S−3.5V, I_O=−50mA		0.75	1.2	
I_I	Input voltage	V_I=V_S−8.5V		−380	−670	μA
V_F	Clamp diode forward voltage	I_F=−100mA		−1.1	−2.4	V
V_R	Clamp diode reverse voltage	I_R=100μA	40			V
h_{FE}	DC forward current gain	V_S−V_O=4V, I_O=−100mA, T_a=25℃	500	2800		—

TYPICAL CHARACTERISTICS

ALLOWABLE AVERAGE POWER DISSIPATION

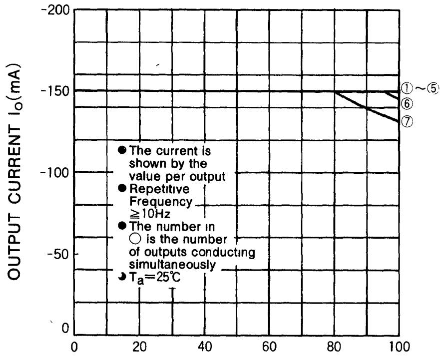


OUTPUT CURRENT CHARACTERISTICS

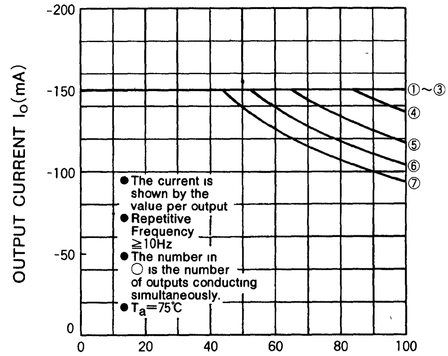


7-UNIT 150mA SOURCE TYPE DARLINGTON TRANSISTOR ARRAY

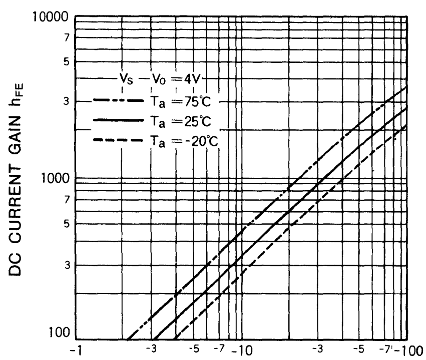
ALLOWABLE OUTPUT CURRENT AS A FUNCTION OF DUTY CYCLE



ALLOWABLE OUTPUT CURRENT AS A FUNCTION OF DUTY CYCLE



DC CURRENT GAIN CHARACTERISTICS



M54561P

7-UNIT 300mA SOURCE TYPE DARLINGTON TRANSISTOR ARRAY

DESCRIPTION

The M54561P, 7-channel source driver, consists of 7 PNP and 14 NPN transistors connected to form high current gain driver with PNP action.

FEATURES

- High output sustaining voltage to 40V
- High output source current to 300mA
- Integral diode for transient suppression
- Active "L" input
- Wide operating temperature range (T_a = −20∼+75℃)

APPLICATION

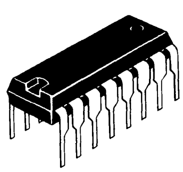
Relay and printer driver, LED, incandescent or fluorescent display driver, Active "L" input, Interfacing for standard MOS/BIPOLAR logics

FUNCTION

The M54561P functions like a PNP transistor and the compound PNP/NPN/NPN output provides high current gain. Each output has an integral diode for inductive load transient suppression and the anodes of the diodes and the substrate are connected together to pin 9.

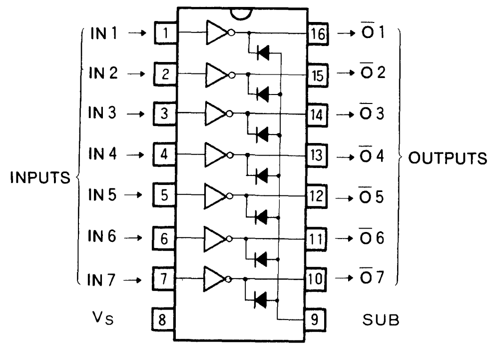
The output are capable of driving 300mA and are rated for operation with output voltage up to 40V.

The output is turned ON by switching the input low.



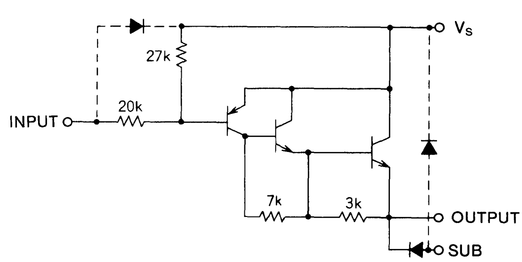
16-pin molded plastic DIP

PIN CONFIGURATION (TOP VIEW)



Outline 16P4

CIRCUIT SCHEMATIC



Unit : Ω

ABSOLUTE MAXIMUM RATINGS (T_a=−20∼+75℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CEO}	Output sustaining voltage	Output is in "L"	−0.5∼+40	V
V_S	Supply voltage		40	V
V_I	Input voltage		0∼+40	V
I_O	Output current	Per channel current at "H" output	−300	mA
I_F	Clamp diode forward current		−300	mA
V_R	Clamp diode reverse voltage		40	V
P_d	Power dissipation	T_a =25℃	1.47	W
T_{opr}	Operating ambient temperature range		−20∼+75	℃
T_{stg}	Storage temperature range		−55∼+125	℃

RECOMMENDED OPERATIONAL CONDITIONS (T_a=−20∼+75℃, unless otherwise noted)

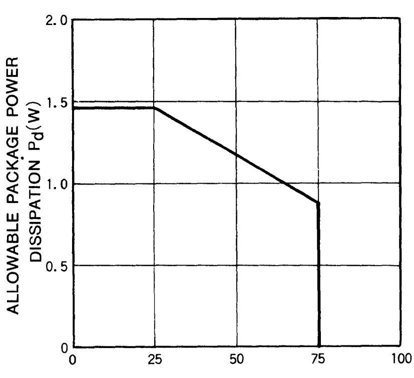
Symbol	Parameter		Limits Min	Limits Typ	Limits Max	Unit
V_S	Supply voltage		0		40	V
I_O	Output current per channel	Percent duty cycle less than 15%	0		−250	mA
		Percent duty cycle less than 50%	0		−100	mA
V_{IH}	"H" Input voltage		V_S−0.2		V_S+0.3	V
V_{IL}	"L" Input voltage	I_O=−250mA	0		V_S−3	V

ELECTRICAL CHARACTERISTICS (T_a=−20∼+75℃, unless otherwise noted)

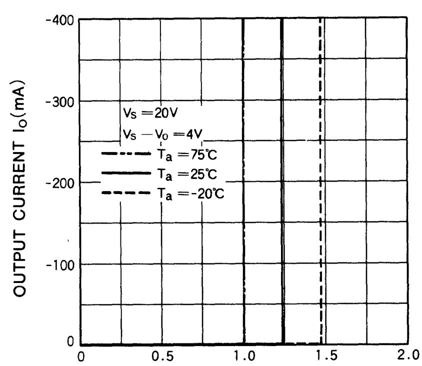
Symbol	Parameter	Test conditions	Limits Min	Limits Typ	Limits Max	Unit
$I_{S(leak)}$	Supply leakage current	V_S=40V			100	μA
$V_{CE(sat)}$	Output saturation voltage	V_I=V_S−3V, I_O=−250mA		1.6	2.3	V
		V_I=V_S−3V, I_O=−100mA		1.45	2.0	V
I_I	Input current	V_I=V_S−3.5V		−150	−250	μA
V_F	Clamp diode forward voltage	I_F=−300mA		−1.6	−2.4	V
V_R	Clamp diode reverse voltage	I_R=100μA	40			V
h_{FE}	DC forward current gain	V_S−V_O=4V, I_O=−300mA, T_a=25℃	1000	8000		—

TYPICAL CHARACTERISTICS

ALLOWABLE AVERAGE POWER DISSIPATION

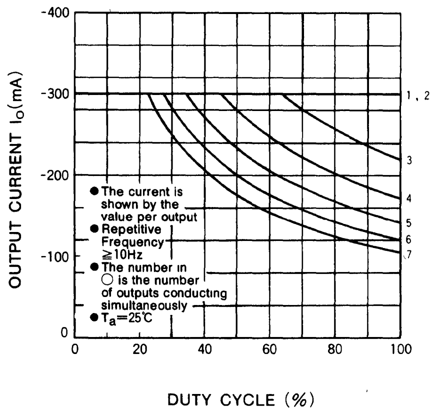


OUTPUT CURRENT CHARACTERISTICS

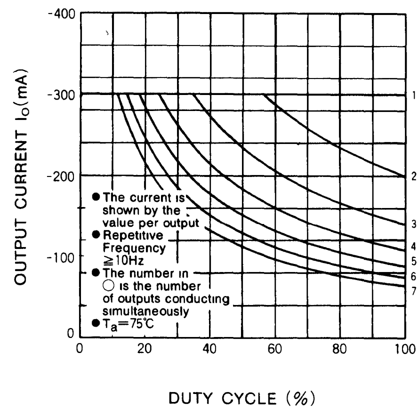


7-UNIT 300mA SOURCE TYPE DARLINGTON TRANSISTOR ARRAY

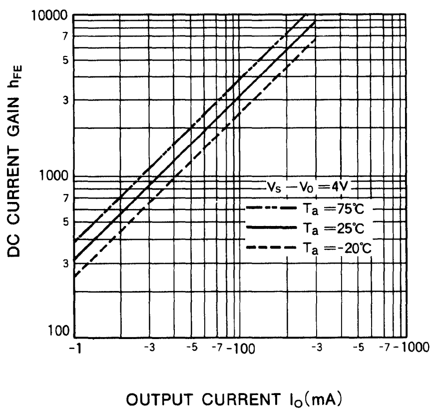
ALLOWABLE OUTPUT CURRENT AS A FUNCTIONAL OF DUTY CYCLE



ALLOWABLE OUTPUT CURRENT AS A FUNCTIONAL OF DUTY CYCLE



DC CURRENT GAIN CHARACTERISTICS



M54580P

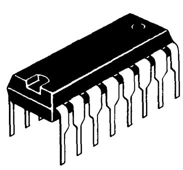
7-UNIT 150mA SOURCE TYPE DARLINGTON TRANSISTOR ARRAY

DESCRIPTION
The M54580P, 7-channel source driver, consists of 7 PNP and 7 NPN transistors connected to form high current gain driver with PNP action.

FEATURES
- High output sustaining voltage to 50V
- High output source current to 150mA
- Wide operating temperature range (T_a =−20∼+75℃)

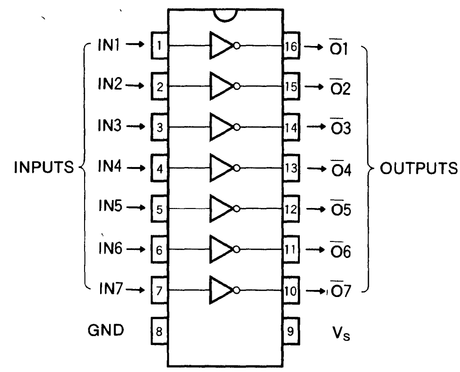
APPLICATION
Relay and printer driver, LED, incandescent or fluorescent display driver, Interfacing for standard MOS/BIPOLAR logics

FUNCTION
The M54580P is comprised of seven PNP-NPN darlington source driver pairs with a diode and 7 kΩ resistor in series to the input. The output is turned ON by switching the input low. Each output has 50kΩ pull-down resistor suitable for driving fluorescent displays. The outputs are capable of driving 100mA and are rated for operation with output voltage up to 50V.



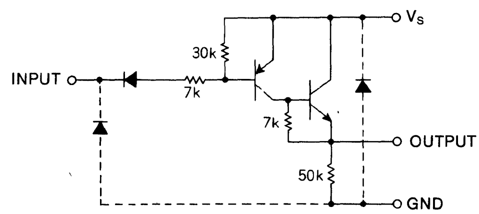
16-pin molded plastic DIP

PIN CONFIGURATION (TOP VIEW)



Outline 16P4

CIRCUIT SCHEMATIC



Unit : Ω

ABSOLUTE MAXIMUM RATINGS (T_a=−20∼+75℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_S	Supply voltage		50	V
V_{CEO}	Output sustaining voltage	Transistor OFF	−0.5∼+50	V
V_I	Input voltage		0∼V_S	V
I_O	Output current	Transistor OFF	−150	mA
P_d	Power dissipation	T_a =25℃	1.47	W
T_{opr}	Operating ambient temperature range		−20∼+75	℃
T_{stg}	Storage temperature range		−55∼+125	℃

7-UNIT 150mA SOURCE TYPE DARLINGTON TRANSISTOR ARRAY

RECOMMENDED OPERATIONAL CONDITIONS (T_a=−20∼+75℃, unless otherwise noted)

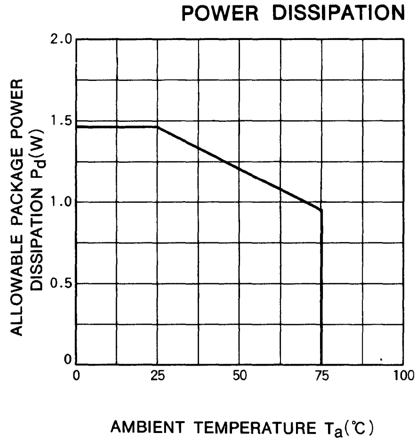
Symbol	Parameter		Limits			Unit
			Min	Typ	Max	
V_S	Supply voltage		4		50	V
I_O	Output current per channel	All outputs conducting simultaneously Percent duty cycle less than 85%	0		−100	mA
		All outputs conducting simultaneously Percent duty cycle less than 100%	0		−50	
V_{IH}	"H" Input voltage	$I_{O(leak)}$=50μA	V_S−0.4		V_S	V
V_{IL}	"L" Input voltage	I_O =−100mA	0		V_S−3.2	V

ELECTRICAL CHARACTERISTICS (T_a=−20∼+75℃, unless otherwise noted)

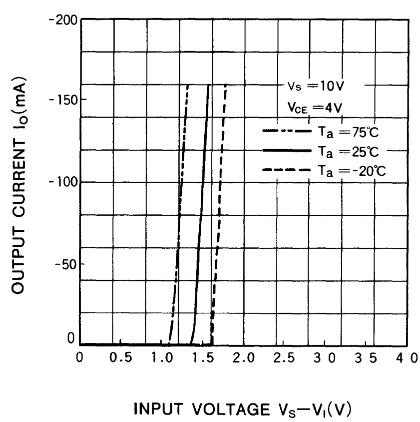
Symbol	Parameter	Test conditions		Limits			Unit
				Min	Typ	Max	
$V_{(BR)CEO}$	Output sustaining voltage	I_{CEO} = 100μA		50			V
$V_{CE(sat)}$	Output saturation voltage	V_I = V_S−3.2V	I_O =−100mA		0.9	1.5	V
			I_O =−50mA		0.8	1.2	
I_I	Input current	V_I = V_S−3.5V			−0.3	−0.6	mA
		V_I = V_S−6V			−0.65	−0.95	
I_R	Input leakage current	V_I =40V				100	μA
h_{FE}	DC forward current gain	V_{CE} =4V, V_S =10V, I_C =−100mA, T_a=25℃		800	3000		—

TYPICAL CHARACTERISTICS

ALLOWABLE AVERAGE POWER DISSIPATION

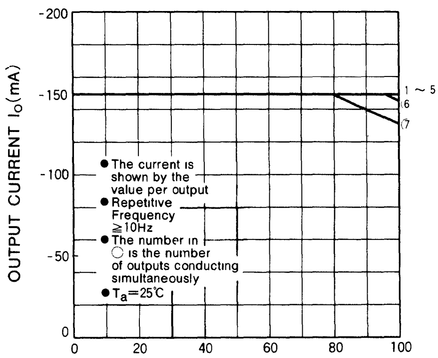


OUTPUT CURRENT CHARACTERISTICS

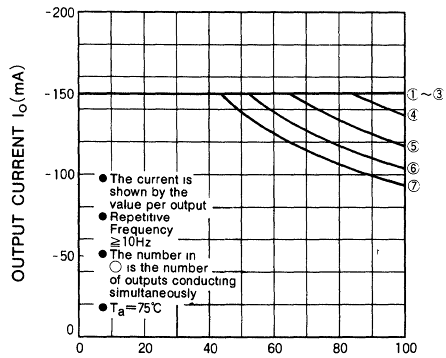


7-UNIT 150mA SOURCE TYPE DARLINGTON TRANSISTOR ARRAY

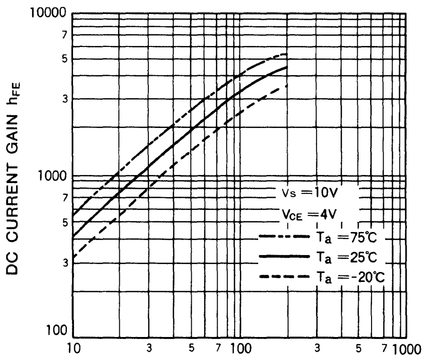
ALLOWABLE OUTPUT CURRENT AS A FUNCTION OF DUTY CYCLE



ALLOWABLE OUTPUT CURRENT AS A FUNCTION OF DUTY CYCLE



DC CURRENT GAIN CHARACTERISTICS



M54581P

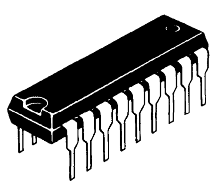
8-UNIT 500mA SOURCE TYPE DARLINGTON TRANSISTOR ARRAY WITH CLAMP DIODE

DESCRIPTION
The M54581P, 8-channel source driver, consists of 8 NPN and 8 PNP source type darlington transistors connected to form high current gain driver.

FEATURES
- High output sustaining voltage to 50V ($BV_{CEO}>50V$)
- High output source current to 500mA ($I_{O(max)}=-500mA$)
- "L" active input level
- Internal input diode
- Integral clamp diode for transient suppression
- Wide operating temperature range ($T_a=-20-+75$℃)

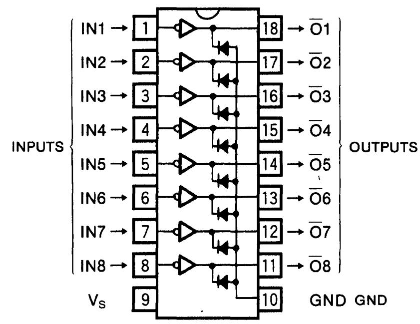
APPLICATION
Relay and printer driver, LED or incandescent or fluorescent display driver, Interfacing for standard MOS/BIPOLAR logics and interfacing for relay, solenoid or small printer

FUNCTION
The M54581P is composed of 8 PNP and 8 NPN source type darlington transistors. A diode and a resistor of 7kΩ is connected between the input pin and the base of PNP transistor. The emitter and the collector of NPN transistor are connected to V_S (pin 9), and the output NPN transistors are in darlington configuration. An integral clamp diode is inserted between each output and GND, and V_S (pin 9) and GND (pin 10) are common to the 8 circuits.
The outputs are capable of driving 500mA and are rated for operation with output voltage up to 50V.
The device is activated with "L" level input.



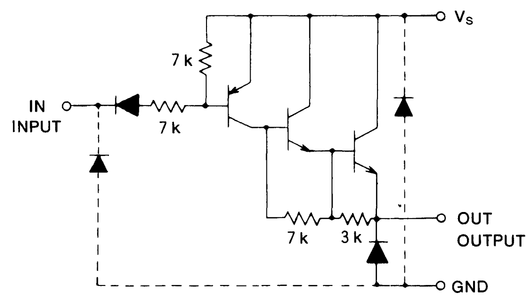
18-pin molded plastic DIP

PIN CONFIGURATION (TOP VIEW)



Outline 18P4

CIRCUIT SCHEMATIC (EACH CIRCUIT)



V_S and GND are common to the 8 circuits

The diodes shown by broken line are parasite diodes and must not be used

Unit : Ω

ABSOLUTE MAXIMUM RATINGS ($T_a=-20\sim+75$℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CEO}	Output sustaining voltage	Output is in "L"	−0.5～+50	V
V_S	Supply voltage		−0.5～+50	V
V_I	Input voltage		O, V_S−30	V
I_O	Output current	Per channel current at "H" output	−500	mA
I_F	Clamp diode forward current	Per channel current	−500	mA
V_R	Clamp diode reverse voltage		−0.5～+50	V
Pd	Power dissipation	T_a=25℃	1.79	W
Topr	Operating ambient temperature range		−20～+75	℃
Tstg	Storage temperature range		−55～+125	℃

8-UNIT 500mA SOURCE TYPE DARLINGTON TRANSISTOR ARRAY WITH CLAMP DIODE

RECOMMENDED OPERATIONAL CONDITIONS (T_a=−20+75℃, unless otherwise noted)

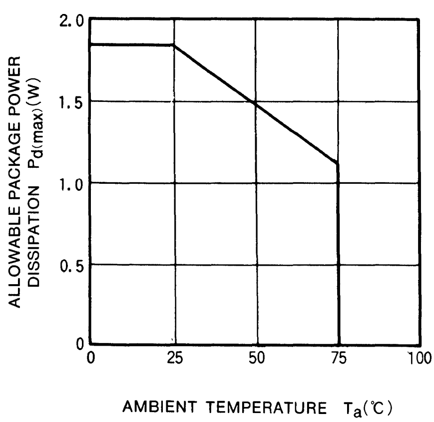
Symbol	Parameter	Conditions	Limits Min	Limits Typ	Limits Max	Unit
V_S	Supply voltage		0		50	V
I_O	Output current per channel	Percent duty cycle less than 8%	0		−350	mA
		Percent duty cycle less than 55%	0		−100	
V_{IH}	"H" input voltage	$I_{O(leak)}$=−50μA	V_S−0.7		V_S	V
V_{IL}	"L" input voltage	I_C=−350mA	0		V_S−3.6	V

ELECTRICAL CHARACTERISTICS (T_a=−20+75℃, unless otherwise noted)

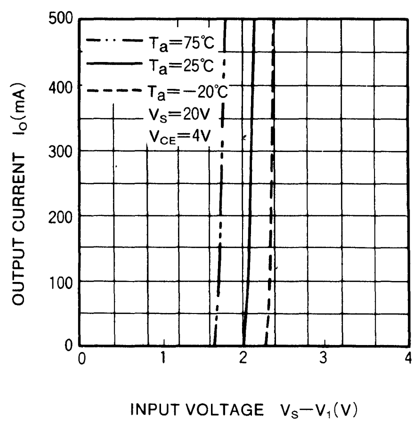
Symbol	Parameter	Test conditions	Limits Min	Limits Typ	Limits Max	Unit
I_{CEO}	Output leakage current	V_{CEO}=50V			−100	μA
$V_{CE(sat)}$	Output saturation voltage	V_I=V_S−3.2V, I_O=−100mA			2.0	V
		V_I=V_S−3.6V, I_O=−350mA			2.4	
I_I	Input current	V_I=V_S−3.6V			−600	μA
		V_I=V_S−15V			−3.2	mA
V_R	Clamp diode reverse voltage	I_R=100μA			50	V
V_F	Clamp diode forward voltage	I_F=−350mA			−2.4	V

TYPICAL CHARACTERISTICS

ALLOWABLE AVERAGE POWER DISSIPATION

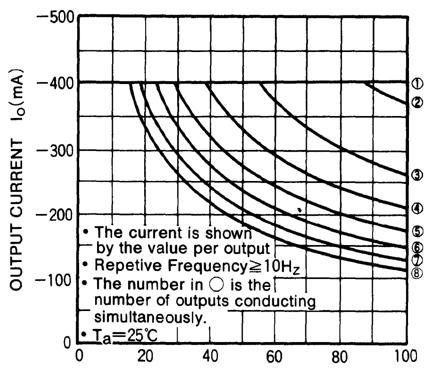


OUTPUT CURRENT CHARACTERISTICS

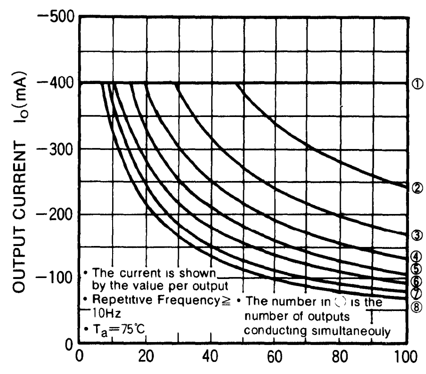


MITSUBISHI ELECTRIC

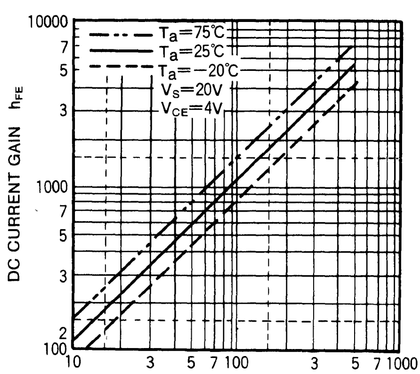
ALLOWABLE OUTPUT CURRENT AS A FUNCTION OF DUTY CYCLE



ALLOWABLE OUTPUT CURRENT AS A FUNCTION OF DUTY CYCLE



CURRENT GAIN VS OUTPUT CURRENT



M54586P

8-UNIT 500mA SOURCE TYPE DARLINGTON TRANSISTOR ARRAY

DESCRIPTION

The 54586P, 8-channel source driver, consists of 8 NPN and 8 PNP source type darlington transistors connected to form high current gain driver.

FEATURES

- High output sustaining voltage to 50V (BV_{CEO}>550V)
- High output source current to 500mA ($I_{O(max)}$=−500mA)
- "L" active input level
- Internal input diode
- Wide operating temperature range (T_a=−20~+75℃)

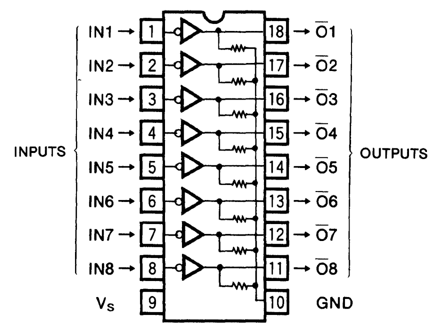
APPLICATION

Relay and printer driver, LED or incandescent or fluorescent display driver, Interfacing for standard MOS/BIPOLAR logics and interfacing for relay, solenoid or small printer

FUNCTION

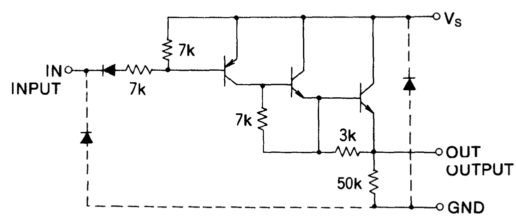
The M54586P is composed of 8 PNP and 8 NPN source type darlington transistors. A diode and a resistor of 7kΩ is connected between the input pin and the base of PNP transistors. The emitter of the transistor and the collector of NPN transistor are connected to V_S (pin 9), and a resistor of 50kΩ is connected between each output pin and GND pin (pin 10).
The outputs are capable of driving 500mA and are rated for operation with ortput voltage up to 50V.
The device is activated with "L" level input.

PIN CONFIGURATION (TOP VIEW)



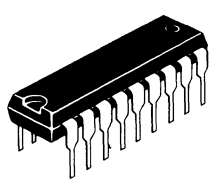
Outline 18P4

CIRCUIT SCHEMATIC (EACH CIRCUIT)



V_S and GND are common to the 8 circuits.
The diodes shown by broken line are parasite diodes and must not be used.

Unit : Ω



18-pin molded plastic DIP

18-pin molded plastic DIP

ABSOLUTE MAXIMUM RATINGS (T_a=−20~+75℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_S	Supply voltage		−0.5~+50	V
V_{CEO}	Output sustaining voltage	Output is in "L"	−0.5~+50	V
V_I	Input voltage		−0.5~+V_S	V
I_O	Output current		−500	mA
P_d	Power dissipation	T_a=25℃	1.79	W
Topr	Operating ambient temperature range		−20~+75	℃
Tstg	Storage temperature range		−55~+125	℃

MITSUBISHI ELECTRIC

RECOMMENDED OPERATIONAL CONDITIONS (T_a=−20~+75℃, unless otherwise noted)

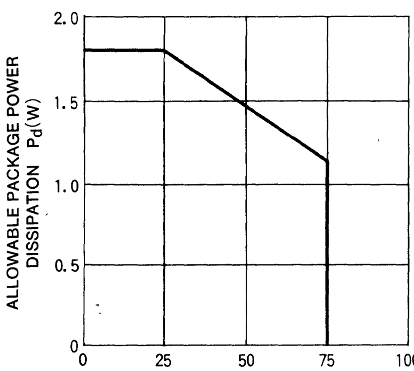
Symbol	Parameter		Limits			Unit
			Min	Typ	Max	
V_S	Supply voltage		4		50	V
I_O	Output current per channel when 8 outputs are conducting simultaneously	Percent duty cycle less than 8%	0		−350	mA
		Percent duty cycle less than 60%	0		−100	
V_{IH}	"H" Input voltage	$I_{O(leak)} \geq 50\mu A$	$V_S-0.7$		V_S	V
V_{IL}	"L" Input voltage	$I_O \geq -350mA$	0		$V_S-3.6$	V

ELECTRICAL CHARACTERISTICS (T_a=−20~+75℃, unless otherwise notted)

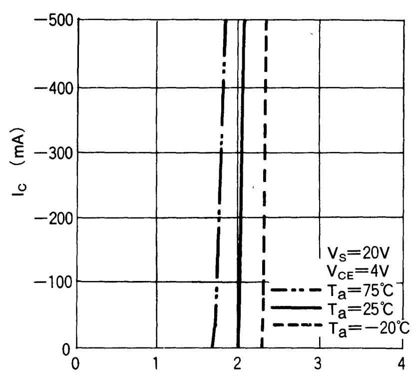
Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
$I_{O(leak)}$	Output leakage voltage	$V_{CEO}=50V$			−100	μA
$V_{CE(sat)}$	Output saturation voltage	$V_I=V_S-3.2V$, $I_O=-100mA$		1.6	2.0	V
		$V_I=V_S-3.6V$, $I_O=-350mA$		1.8	2.4	
I_I	Input current	$V_I=V_S-3.6V$		−320	−600	μA
		$V_I=V_S-15V$		−1.6	−3.2	mA
h_{FE}	Collector-emitter saturation voltage	$V_{CE}=4V$, $V_S=20V$, $I_O=-350mA$, $T_a=25℃$	800	3500		—

TYPICAL CHARACTERISTICS

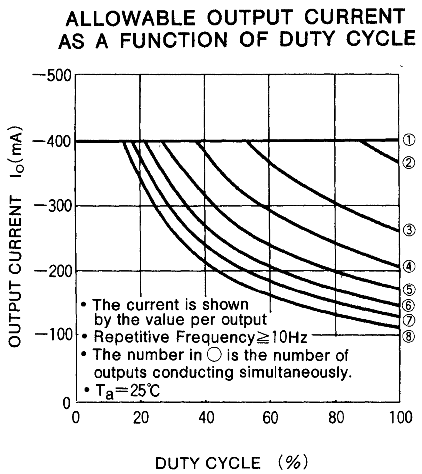
ALLOWABLE AVERAGE POWER DISSIPATION

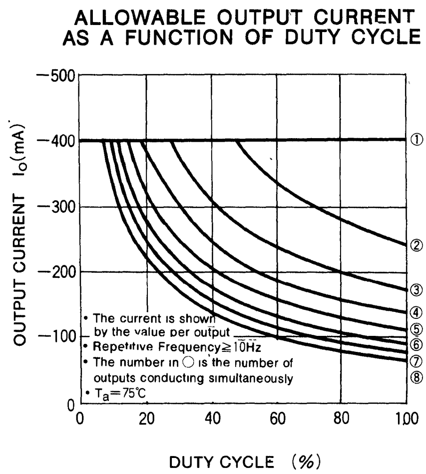


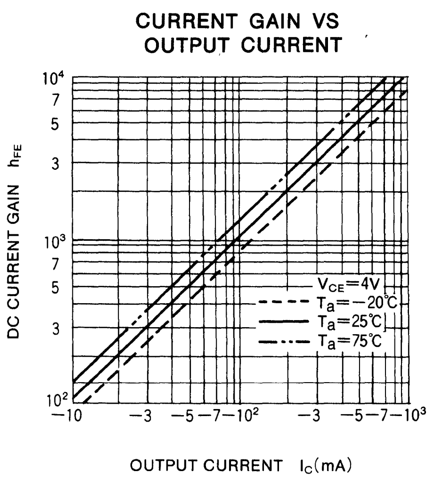
OUTPUT CURRENT CHARACTERISTICS



8-UNIT 500mA SOURCE TYPE DARLINGTON TRANSISTOR ARRAY







M54569P

8-UNIT 30mA PNP TRANSISTOR ARRAY

DESCRIPTION

The M54569P, general purpose transistor array, consists of 8 PNP transistors connected in a common-emitter configuration.

FEATURES

- 20V breakdown
- 30mA output source current capability
- Wide operating temperature range (T_a = −20∼+75℃)

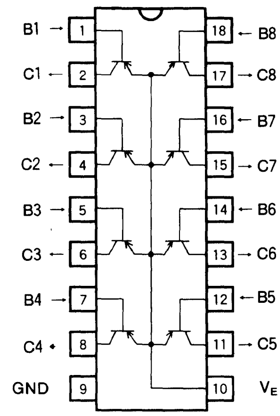
APPLICATION

LED or incandescent display driver

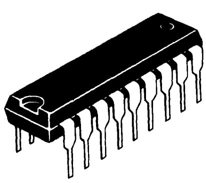
FUNCTION

The M54569P is comprised of 8 PNP transistors. All emitters are connected to pin 10. Each transistor is capable of switching 30mA and will withstand 20V in the OFF state.

PIN CONFIGURATION (TOP VIEW)

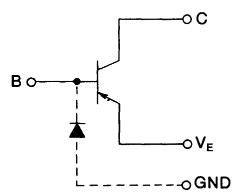


Outline 18P4



18-pin molded plastic DIP

CIRCUIT SCHEMATIC



ABSOLUTE MAXIMUM RATINGS (T_a=−20∼+75℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CBO}	Collector-base sustaining voltage	Base voltage . 0V	−40	V
V_{EBO}	Emitter-base sustaining voltage	Base voltage . 0V	−40	V
V_{CEO}	Collector-emitter sustaining voltage	Emitter voltage : 0V	−20	V
I_C	Collector current per transistor		−30	mA
I_B	Base current per transistor		−20	mA
P_d	Power dissipation	T_a=25℃	1.47	W
T_{opr}	Operating ambient temperature range		−20∼+75	℃
T_{stg}	Storage temperature range		−55∼+125	℃

RECOMMENDED OPERATIONAL CONDITIONS (T_a=−20～+75℃, unless otherwise noted)

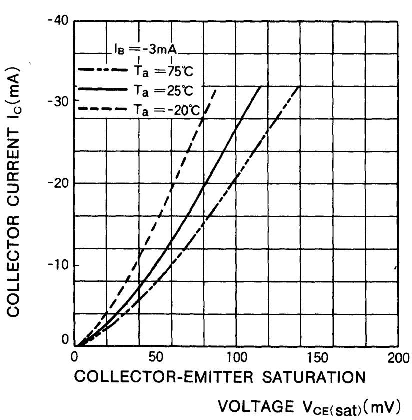
Symbol	Parameter		Limits			Unit
			Min	Typ	Max	
I_C	Collector current	I_B=−3mA	0		−20	mA
I_B	Base current		0		−10	mA
V_E	Emitter voltage		−0.3		20	V
V_B	Base voltage		−0.3		V_E	V

ELECTRICAL CHARACTERISTICS (T_a=−20～+75℃, unless otherwise noted)

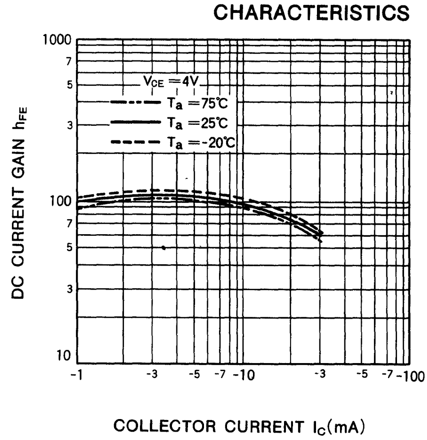
Symbol	Parameter	Test conditions		Limits			Unit
				Min	Typ	Max	
$V_{(BR)CBO}$	Collector-emitter sustaining voltage	I_C=−10μA, V_B=0V V_E : OPEN		−40			V
$V_{(BR)EBO}$	Emitter-base sustaining voltage	I_E=−10μA, V_B=0V V_C : OPEN		−40			V
$V_{(BR)CEO}$	Collector-emitter sustaining voltage	I_C=−100μA, V_E=0V V_B : OPEN		−20			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_C=−20mA I_B=−3mA, V_E=5V			−0.09	−0.3	V
		I_C=−2mA I_B=−0.2mA, V_E=5V			−0.02	−0.28	
h_{FE}	DC forward current gain	V_{CE}=−4V	I_C=−2mA	20	100		—
		T_a=25℃	I_C=−20mA	15	70		

TYPICAL CHARACTERISTICS

OUTPUT CHARACTERISTICS



DC CURRENT GAIN CHARACTERISTICS



MITSUBISHI ELECTRIC

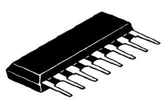
MISCELLANEOU

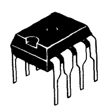
10

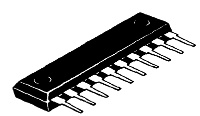
QUICK REFERENCE TABLE OF ELECTRONIC VOLUME CONTROL, BATTERY CHECKER

Classification	Type	Function	Features	Maximum ratings: Supply voltage range V_{CC} (V)	Maximum ratings: Power dissipation P_d (mW)	Electrical characteristics: Circuit current I_{CC} (mA)	Electrical characteristics: Remarks	Package outlines	Interchange-able products
Electronic volume	M5222	Two-channel voltage controlled amplifier (VCA) for use in a low-voltage electronic volume control	● A-curve characteristics (logarithmic response) ● Low-voltage operation ● Large attenuation. ATT=90dB	1.8～20	800/625/440	3.6		L: 8-pin SIP P: 8-pin DIP	—
	★ M5241L	Two-channel VCA with a high withstand voltage for use in a hi-fi electronic volume control	● Wide supply voltage range ● Low distortion: THD=0.02% ● Large attenuation. ATT=90dB ● Independent control capability for R and L channels	±3～±18	800	9.0		10-pin SIP	—
Battery checker	M5232L	Voltage detector/on-off alarm circuit	● Built-in comparator, oscillator circuit, reference voltage generator and voltage regulating circuits ● Variable LED flash rate	5～20	800	2.0	V_{ref}=1.31V f=1.8Hz	8-pin SIP	—

★. New product


8-pin SIP


8-pin DIP


10-pin SIP

M5222L, P, FP

VOLTAGE CONTROLLED AMPLIFIER(VCA)FOR USE IN A LOW-VOLTAGE ELECTRONIC VOLUME CONTROL

DESCRIPTION

The M5222 is a semiconductor integrated cirucit consisting of a dual voltage controlled amplifier (VCA) designed for use in an electronic volume control. Operable over a wide supply voltage range from 1.8V to 20V, the M5222 is available in a compact 8-pin SIP, DIP or FP. The two built-in channels and especially the attenuation characteristics that change logarithmically with respect to the external DC control voltage (a response equivalent to the A-curve volume) permit the M5222 to be applied widely in portable stereo radio/cassette recorders, car stereo system, and electronic musical instruments.

FEATURES

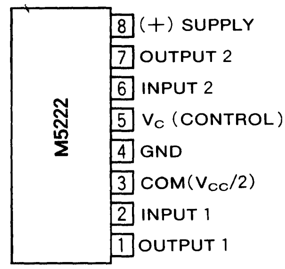
- Operable at low voltages ························ V_{CC}=1.8~20V
- Two built-in channels
  ·········Simultaneous control of both channels is possible with V_C (control) at Pin ⑤
- Logarithmic response VCA
  ·········Logarithmic response equivalent to A-curve volume
- Wide attenuation range
  ··············· 0dB(V_C≒0)~−90dB(V_C≒−270mV)(typ.)
- High maximum input voltage
  ································ V_i=1.0Vrms(typ.)(@V_{CC}=3V)
- Low distortion ··THD=0.05%
- Similar characteristics between the two channels

APPLICATION

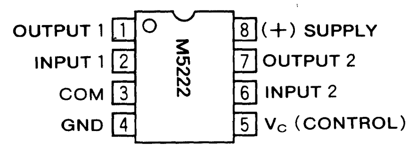
As an electronic volume control in portable stereo radio/cassette recorders, car stereos, electronic musical instruments, VCAs.

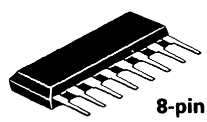
PIN CONFIGURATION (TOP VIEW)

SIP

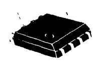


DIP, MINIFLAT

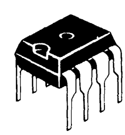




8-pin molded plastic SIP

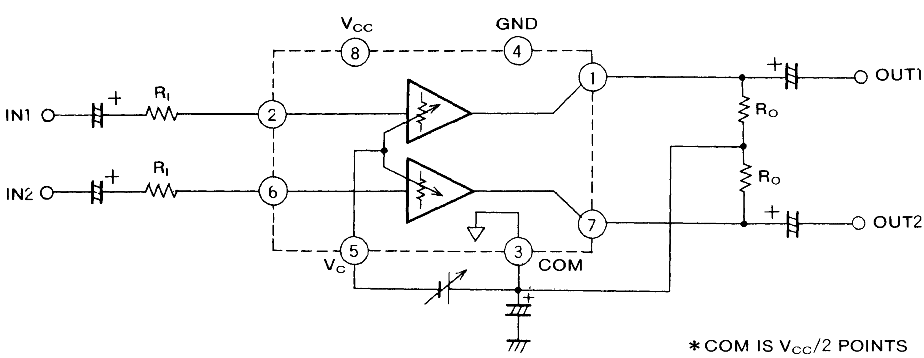


8-pin molded plastic FP (MINI FLAT)



8-pin molded plastic DIP

BLOCK DIAGRAM



Note: 1. R_I is used to convert input voltage to current.
2. R_O is an output resistor used to convert the currentoutput signal to voltage Connect this output with COM pin ③ to fix the DC output potential
3. The COM pin is used for making a 1/2pint supply voltage within the IC. It is used in connecting R_O and in V_C control

VOLTAGE CONTROLLED AMPLIFIER(VCA)FOR USE IN A LOW-VOLTAGE ELECTRONIC VOLUME CONTROL

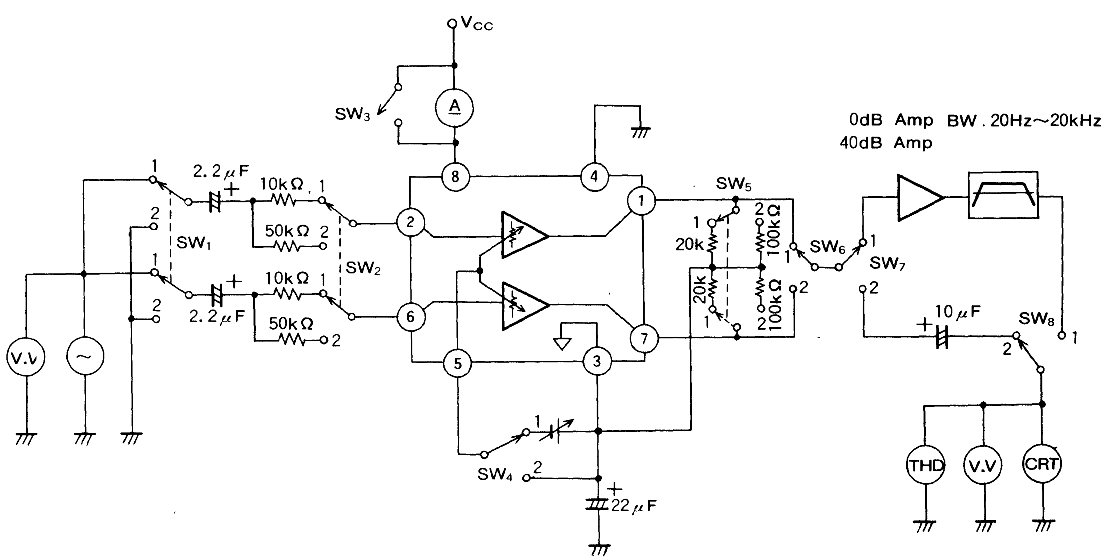
ABSOLUTE MAXIMUM RATINGS (Ta=25℃ unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		20	V
P_d	Power dissipation		800(SIP)/625(DIP)/440(FP)	mW
$K\theta$	Thermal derating	Ta≧25℃	8(SIP)/6.25(DIP)/4.4(FP)	mW/℃
T_{opr}	Operating temperature range		−20～+75	℃
T_{stg}	Storage temperature range		−55～+125	℃

ELECTRICAL CHARACTERISTICS (Ta=25℃, unless otherwise noted)

Symbol	Patameter	Test conditions		Vcc	Limits Min	Typ	Max	Unit
I_{CC}	Circuit current	V_i=0, V_C=0		3V	2.5	3.6	5.5	mA
V_iM1	Maximum input voltage	f=1kHz, V_C=0, THD=1%	R_i=10kΩ, R_O=20kΩ	3V	0.7	1.0		Vrms
V_iM2	Maximum input voltage		R_i=50kΩ, R_O=100kΩ	9V	2.3	3.4		Vrms
ATT_M	Maximum attenuation	R_i=10kΩ, R_O=20kΩ, V_C=−270mV		3V	80	90		dB
ATT_{01}	Attenuation error	f=1kHz, V_C=0, V_i=0dBm	R_i=10kΩ, R_O=20kΩ	3V	−4.4	−1.4	+1.6	dB
ATT_{02}	Attenuation error		R_i=50kΩ, R_O=100kΩ	9V	−5.0	−2.0	+1.0	dB
ΔATT	Attenuation deviation between chan-nels	f=1kHz, V_C=0, V_i=0dBm, R_i=10kΩ, R_O=20kΩ		3V		0.1	3.0	dB
V_{NO1}	Noise output voltage	V_C=0(ATT=−1.4dB), R_i=10kΩ, R_O=20kΩ, BW=20Hz～20kHz		3V		30	60	μVrms
V_{NO2}	Noise output voltage	ATT=−40dB, R_i=10kΩ, R_O=20kΩ, BW=20Hz～20kHz		3V		5		μVrms

TEST CIRCUIT



MITSUBISHI ELECTRIC

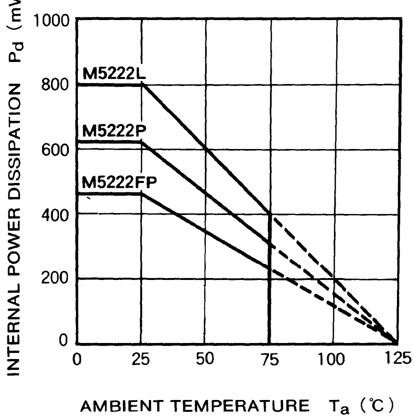
SWITCH MATRIX

Parameter		SW_1	SW_2	SW_3	SW_4	SW_5	SW_6	SW_7	SW_8
I_{CC}		2	1	OFF	2	1	1/2	2	2
V_{IM}	1	1	1	ON	2	1	1/2	1	1
	2	1	2	ON	2	2	1/2	1	1
ATTM		1	1	ON	1	1	1/2	2	2
ATT	01	1	1	ON	2	1	1/2	2	2
	02	1	2	ON	2	2	1/2	2	2
V_{NO}	1	2	1	ON	2	1	1/2	1	1
	2	2	1	ON	1	1	1/2	1	1

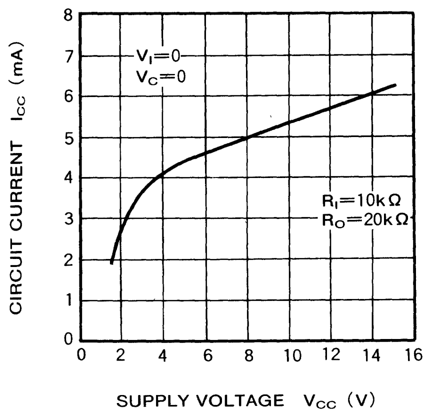
(Note)1. Use 0dB amplification when measuring V_{IM}
2. Use 40dB amplification when measuring V_{NO}
3. V_{NO}=measurement value/100(40dB) 〔μVrms〕

TYPICAL CHARACTERISTICS

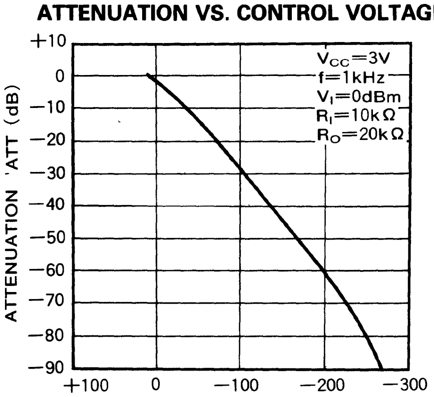
POWER DISSIPATION VS. AMBIENT TEMPERATURE (MAXIMUM RATINGS)



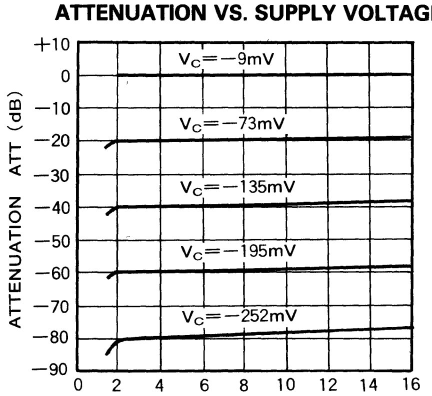
CIRCUIT CURRENT VS. SUPPLY VOLTAGE



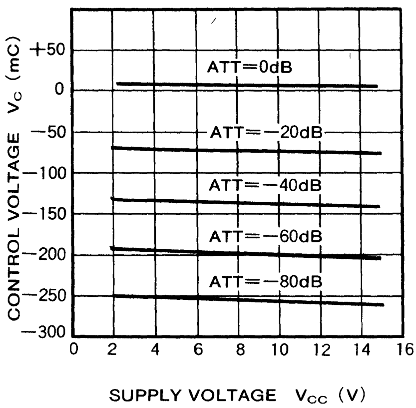
ATTENUATION VS. CONTROL VOLTAGE



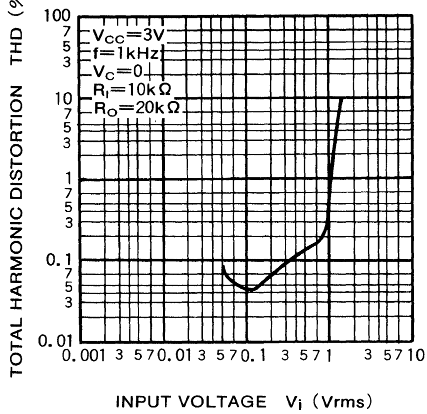
ATTENUATION VS. SUPPLY VOLTAGE



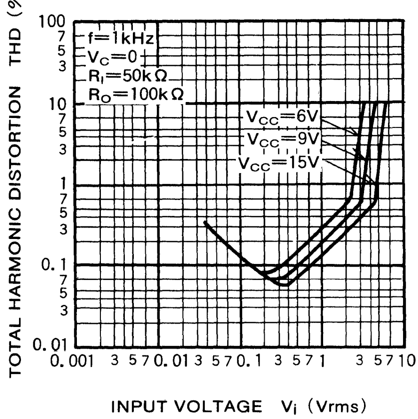
CONTROL VOLTAGE VS. SUPPLY VOLTAGE



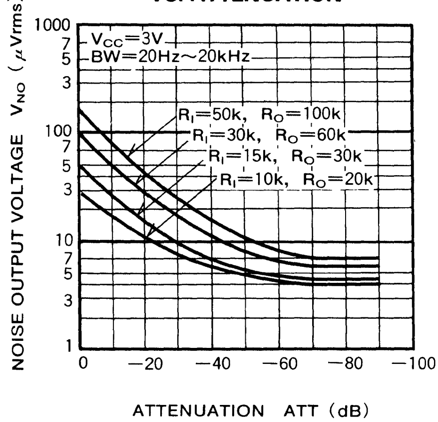
TOTAL HARMONIC DISTORTION VS. INPUT VOLTAGE



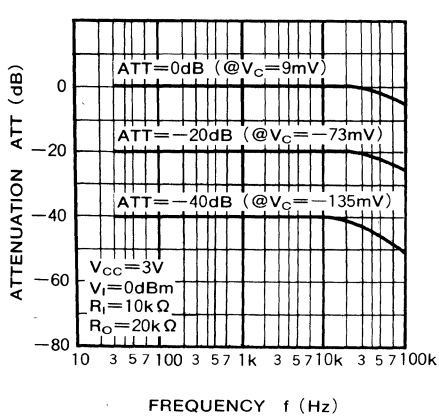
TOTAL HARMONIC DISTORTION VS. INPUT VOLTAGE



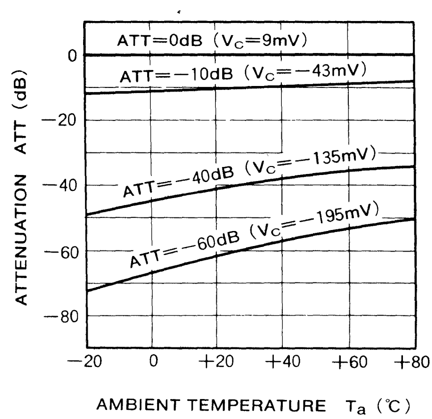
NOISE OUTPUT VOLTAGE VS. ATTENUATION



ATTENUATION VS. FREQUENCY

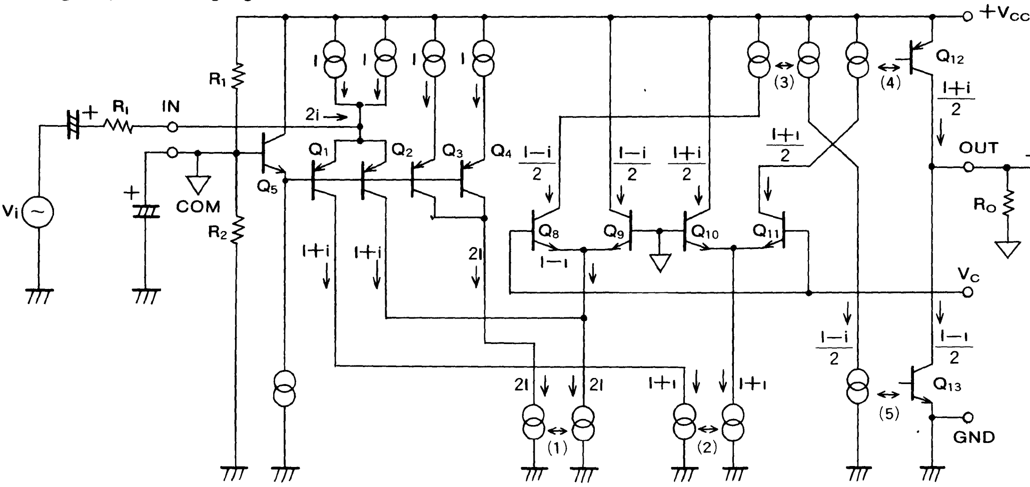


ATTENUATION VS. AMBIENT TEMPERATURE



BASIC PRINCIPLE OF OPERATION

The M5222 is a current input, current output type of VCA IC. This amplifier uses the principle by which changing the balance of the differential circuit with external control voltage V_C will change gm. The circuit is also called a variable transconductance (variable gm) OP amp. The basic principle of operation will be simply explained below.



※(⏚) is the $V_{CC}/2$ pin (COM pin) derived by voltage division by B_1, B_2 and so on. ALL coupling is internal.

Fig. 1 M5222 EQUIVALENT CIRCUIT

Basic voltage-current conversion mechanism for input and output

Applying the input signal V_I which flows through external input resistor R_I results in a change to a current signal at input terminal IN. The V_{BE} level shift of R_1, R_2, Q_5, Q_1, and Q_2 will cause input pin IN to become ground level by means of $V_{CC}/2$ in terms of direct current and to become ground level by means of the externally-connected capacitor in terms of alternating current. The signal input in this way will be sent to the output pin as a current signal by the current mirror and differential circuit. By taking this current signal through the externlaly-connected output resistor (load resistor), the signal can go through a current-to-voltage conversion and be obtained as output signal V_O.

The output transistors combine the currents by means of the joined PNP and NPN collector circuits. Basically, the DC potential floats and is not determined in this joining of currents. This is why one end of externally-connected resistor R_O is connected to the $V_{CC}/2$ pin and the DC level ($V_{CC}/2$) at the time of no signal is set.

Basic mechanism of attenuation

The output is controlled by means of changing the control voltage applied to the V_C pin with respect to the COM pin ($V_{CC}/2$ pin). By applying voltage from the COM pin to the base of one side of a differential circuit and applying voltage from the V_C pin to the other base, the current distribution of the differential circuit is changed and the gain of this circuit is changed.

Let us first consider when V_C equals zero (V_C—COM is shorted). Input signal V_i is converted to current by input resistor R_I and the i currents ($2i = V_i/R_I$) flow through the collectors of Q_1 and Q_2. When the current flowing in Q_i becomes i+i, the overall emitter current of the differential circuit consisting of Q_{10} and Q_{11} will also be determined as I+i by means of current mirror (2). Since the base potential of Q_{10} and Q_{11} is the same, the curret will be divided equally and current (I+i)/2 will flow in each of Q_{10} and Q_{11}. The current of current mirror (4) will also be determined as (I+i)/2 because of this.

Since the current of current mirror (1) is determined as 2I by the current flowing in Q_3 and Q_4, the total of the current flowing in Q_2 and the current flowing in differential circuit Q_8, Q_9 will also be 2I. The current from Q_2 which will become I+i flows here and as a result, the overall emitter current of the differential circuit will be 2I −(I+i)=I−i. This current is devided the same way as in the differential circuit consisting of Q_{10} and Q_{11} with current (I−i)/2 flowing in each of Q_8 and Q_9. From this, the current of current mirror (3) is determined as (I−i) /2 and the current of current mirror (5) becomes (I+i) /2.

Now, current (I−i)/2 from current mirror (4) flows in transistor Q_{12} of the output stage. Since the current flowing in transistor Q_{13} from current mirror (5) is held at (I −i)/2, connecting output resistor R_O between the output pin and the COM pin will result in current i flowing through R_O and providing a voltage signal $V_O = i \cdot R_O$.

Here, by selecting $R_O = 2R_I$, $V_O = i \cdot R_O = 2i \cdot R_I = V_i$ and the amplifier will have a gain of 1.

Next, we will consider case of when control voltage V_C is applied with regard to the selection of this resistance.

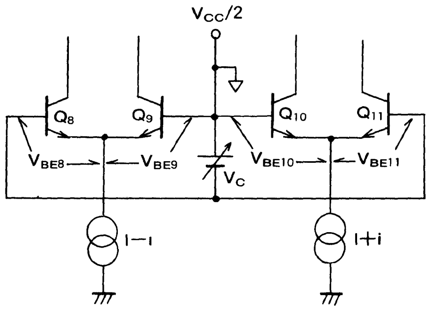


Fig. 2 DIFFERENTIAL CIRCUIT

The values of V_{BE} of the differential stage will be as follows:

$$V_{BE8} \fallingdotseq \frac{kT}{q} \ln\left(\frac{I_{C8}}{I_S}\right)$$

$$V_{BE9} \fallingdotseq \frac{kT}{q} \ln\left(\frac{I_{C9}}{I_S}\right)$$

$$V_{BE10} \fallingdotseq \frac{kT}{q} \ln\left(\frac{I_{C10}}{I_S}\right)$$

$$V_{BE11} \fallingdotseq \frac{kT}{q} \ln\left(\frac{I_{C11}}{I_S}\right)$$

where, I_S: the saturation current
k: the Boltzmann constant
q: the amount of electric charge on the electrons
T: the absolute temperature

From this,

$$-V_C = V_{BE8} - V_{BE9} = \frac{kT}{q} \ln \frac{I_{C8}}{I_{C9}}$$

$$-V_C = V_{BE11} - V_{BE10} = \frac{kT}{q} \ln \frac{I_{C11}}{I_{C10}}$$

Here,

$$I_{C8} + I_{C9} \fallingdotseq I - i$$

$$I_{C10} + I_{C11} \fallingdotseq I - i$$

$$-V_C = \frac{kT}{q} \ln \frac{I_{C8}}{I - i - I_{C8}}$$

$$-V_C = \frac{kT}{q} \ln \frac{I_{C11}}{I - i - I_{C11}}$$

The current flowing through Q_8 and Q_{11} will be

$$I_{C8} = \frac{(I-i)\exp(-\frac{q}{kT}V_C)}{1+\exp(-\frac{q}{kT}V_C)} = \frac{I-i}{1+\exp(-\frac{q}{kT}V_C)}$$

$$I_{C11} = \frac{(I+i)\exp(-\frac{q}{kT}V_C)}{1+\exp(-\frac{q}{kT}V_C)} = \frac{I-i}{1+\exp(-\frac{q}{kT}V_C)}$$

Current I_{C11} is the current of current mirror (4), and I_{C8} will be the same as the current of current mirror (5).

At this time, the current that will flow through the output pin will be the same as that in the explanation when V_C was equal to zero, and is expressed as

$$i_O = \frac{2i}{1+\exp(\frac{q}{kT} \cdot V_C)}$$

The gain will be

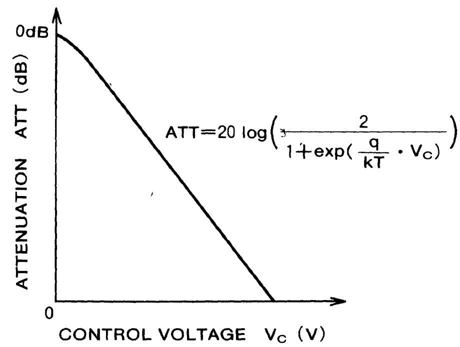
$$\frac{V_O}{V_i} = \frac{i_O \cdot R_O}{2i \cdot R_I} = \frac{2}{1+\exp(\frac{q}{kT} \cdot V_C)}$$

and when calculated in dB,

$$ATT = 20 \log\left(\frac{2}{1+\exp(\frac{q}{kT} \cdot V_C)}\right)$$

As in the graph below, the attenuation will change logarithmically with respect to the change of V_C.

ATTENUATION VS. CONTROL VOLTAGE



Setting and connection of input/output resistance

As explained above, the input signal is converted to current, but since the transistor of the input stage is biased at a fixed current of $I = 76\mu A$, the maximum value of the input current is determined at the least upper bound of I (FIG.3). Accordingly, when a large signal is input it is necessary to select a large input/output resistance and decrease the input current. Note that increasing the resistance will also increase the noise distortion factor, so the value of the setting should be made to suit the particular application.

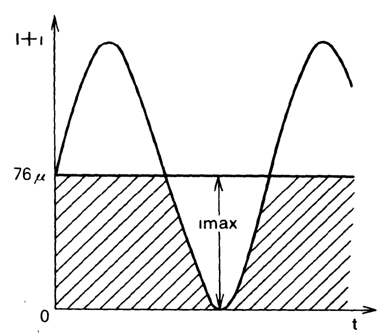


Fig. 3 MAXIMUM CURRENT SIGNAL

The M5222 has a floating-type output stage with the collectors of Q_{12} and Q_{13} joined as shown in FIG. 4. Here, the difference of the combined currents will become the output current that will flow through the load. Note that it is necessary to set the DC potential of this output pin by externally-connected resistor R_O and that it is generally DC-connected to the $V_{CC}/2$ pin (or to pin (3)).

In terms of AC, it is necessary to set the output pin to ground level so that capacitor C is required. Since the voltage gain (amount of attenuation) is determined by R_O, the value of the input impedance connected to the next stage is sometimes affected. (Placing Z_I in parallel with R_O will lower the impedance.) Generally, a buffer amplifier composed of a transistor or OP amp connected.

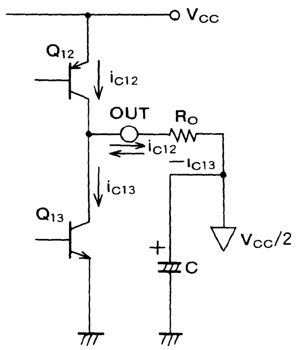


Fig. 4 EQUIVALENT CIRCUIT OF OUTPUT STAGE

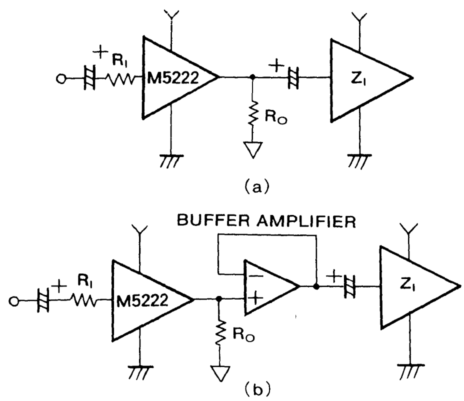
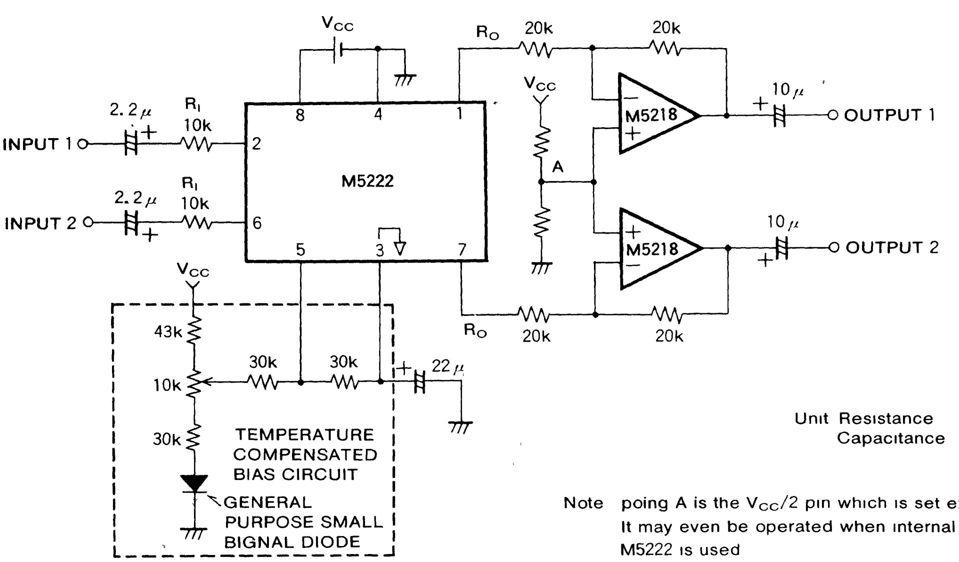


Fig. 5

APPLICATION EXAMPLES

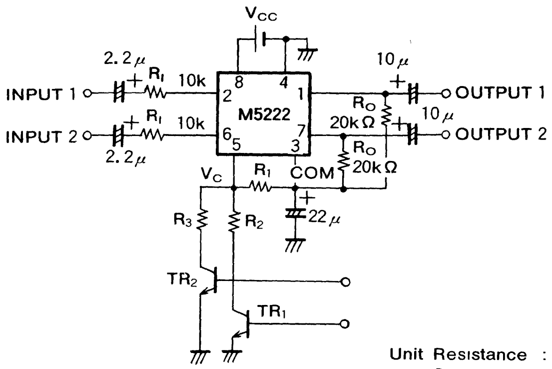
(1) TEMPERATURE COMPENSATED BIAS AND OUTPUT BUFFER CIRCUITS



Unit Resistance Ω
Capacitance F

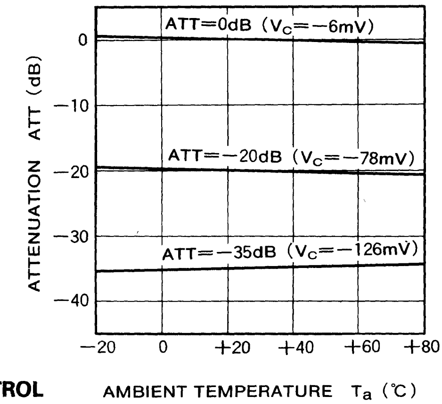
Note poing A is the $V_{CC}/2$ pin which is set externally It may even be operated when internal pin (3) of M5222 is used

(2) PROGRAMMABLE ATTENUATION CIRCUIT

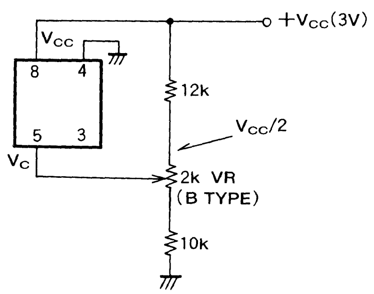


Unit Resistance : Ω
Capacitance : F

ATTENUATION VS. AMBIENT TEMPERATURE (TEMPERATURE COMPENSATION)



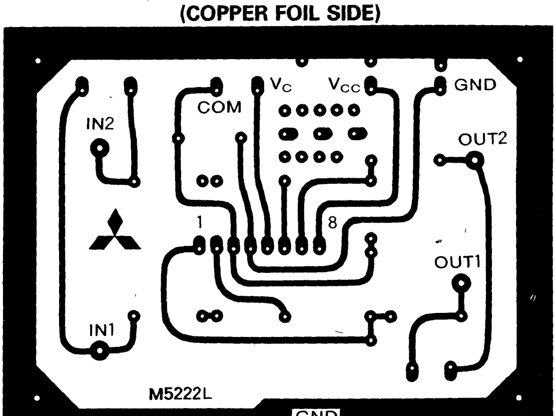
(3) CONTROL APPLICATION WITH EXISTING VOLTAGE CONTROL



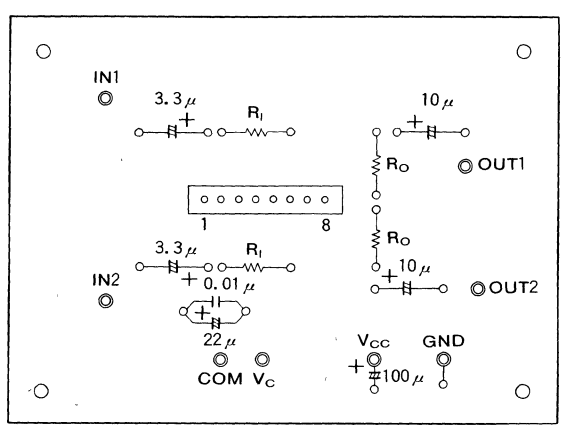
Unit Resistance Ω
Capacitance F

PRINTED CIRCUIT BOARD FOR CIRCUIT TESTING

PRINTED CIRCUIT BOARD WIRING DIAGRAM (COPPER FOIL SIDE)



(PARTS SIDE)



M5241L

VOLTAGE CONTROLLED AMPLIFIER(VCA)FOR USE IN AN ELECTRONIC VOLUME CONTROL

DESCRIPTION

The M5241L is a semiconductor integrated circuit consisting of a dual voltage controlled amplifier (VCA) with a 2-power supply system designed for use in an electronic volume control for analog signals. Housed in a 10-pin SIP, the M5241L as two built-in channels and is designed to hi-fi specifications with a high dynamic range, low distortion factor, and high signal-to-noise ratio. There are control pins for each channel permitting independent control of each channel with an external DC control voltage. The attenuation characteristics change logarithmically with respect to the external DC control voltage (a response equivalent to the A-curve volume) and make the M5241L and ideal electronic volume control for use in stereos, radio/cassette recorders, car audio systems, hi-fi VTRs, and electronic musical instruments.

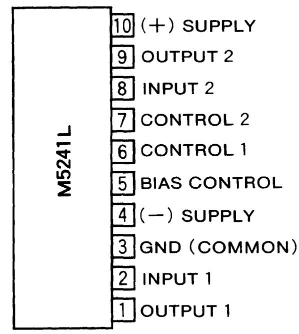
FEATURES

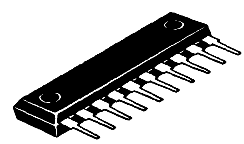
- Two built-in channels with independent control pins ·········Independent control of each channel is possible with V_C (control) at pins ⑥ and ⑦ for channels 1 and 2, respectively.
- High maximum input voltage ································ V_i=3Vrms(when THD=0.5%)
- Low distortion ···············THD=0.02%(when V_O=1Vrms)
- Wide attenuation range ······························ 0~−100dB
- High signal-to-noise ratio (dynamic range)·············94dB (when ATT=0dB, R_i=15kΩ, R_O=30kΩ, and R_C=1.8kΩ)
- Logarithmic response VCA ··· Logarithmic response equivalent to A-curve volume
- Bias boltage can be adjusted with external resistor
- Can be operated with a single power supply ························· Built-in COM Pin ③ V_{CC}/2 bias pin

APPLICATION

As an electronic volume control in stereo equipment, radio/cassette recorders, car audio systems, hi-fi VTRs, and as a program attenuator in electronic musical instruments.

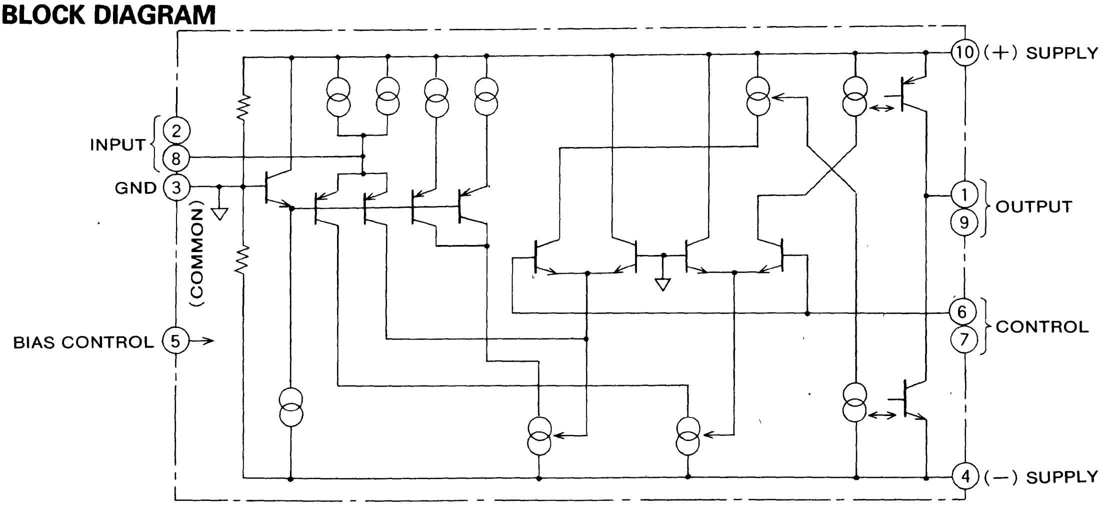
PIN CONFIGURATION (TOP VIEW)





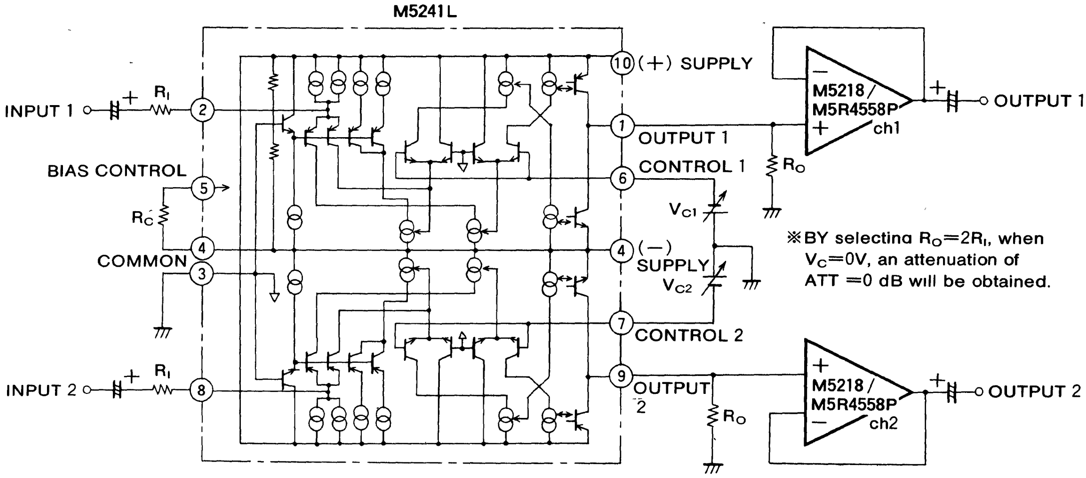
10-pin moded plastic SIP

BLOCK DIAGRAM



VOLTAGE CONTROLLED AMPLIFIER(VCA)FOR USE IN AN ELECTRONIC VOLUME CONTROL

APPLICATION EXAMPLE



ABSOLUTE MAXIMUM RATINGS ($T_a=25°C$, unless otherwise noted)

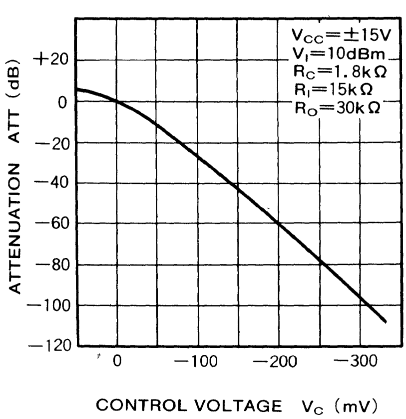
Symbol	Parameter	Ratings	Unit
V_{CC}	Supply voltage	±18(36)	V
P_d	Power dissipation	800	mW

ELECTRICAL CHARACTERISTICS ($T_a=25°C$, $V_{CC}=±15V$, $R_I=15kΩ$, $R_O=30kΩ$, $V_C=0V$, $V_I=10dBm$, f=1kHz, unless otherwise noted)

Symbol	Parameter	Conditions	Typ	Unit
I_{CC}	Circuit current	$V_I=0V$	3.8	mA
V_{IMI}	Maximum input voltage	THD=0.5%	3.0	Vrms
ATT_M	Maximum attenuation	$V_C=-300mV$	100	dB
ATT	Attenuation error		−0.5	dB
THD	Total harmonic distortion	$V_O=1Vrms$	0.02	%
V_{NO}	Noise output voltage	$V_I=0$ input shorted	57	μVrms

TYPICAL CHARACTERISTICS

ATTENUATION VS. CONTROL VOTAGE



MITSUBISHI ELECTRIC

M5232L

VOLTAGE DETECTOR/ON-OFF ALARM CIRCUIT

DESCRIPTION

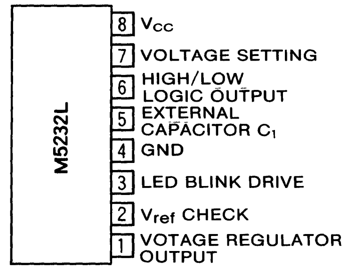
The M5232L is a unique semiconductor integrated circuit designed for use as a voltage detector/on-off alarm circuit.

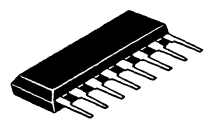
Housed in a compact 8-pin SIP, the M5232L contains a comparator, reference voltage source, a vibrator circuit for turning the LED on and off, and a voltage regulation circuit. When the input voltage of the comparator at Pin ⑦ is higher than the internal reference voltage, the LED lights up, and when it is lower, the LED turns on and off. Also provided is an output pin (Pin ⑥) which does not operate intermittentlyk but permits a relay or micro buzzer to be driven while the LED is being turned on and off by Pin ③. Signals from a low voltage checker for batteries, or from optical or thermal sensors are detected at the input pin of the comparator (Pin ⑦) allowing the M5232L to be applied widely in the alarm and protection circuits of electronic equipment.

FEATURES

- Starting supply voltage at which the LED will blink can be set optionally by using external resistors R_1 and R_2 (in the case of a low voltage checker for batteries)
- LED on/off frequency can be set optionally with external capacitor C_1
- Buily-in logic output pin (Pin ⑥) causes a high-to-low level transition as soon as the blinking begins
- Hysteresis operation is possible at the blink starting voltage using Pin ⑥
- LED lights when the input voltage of the comparator at Pin ⑦ is higher than the internal reference voltage, permitting the M5232L to be used as a pilot lamp for power ON indication

PIN CONFIGURATION (TOP VIEW)





8-pin molded plastic SIP

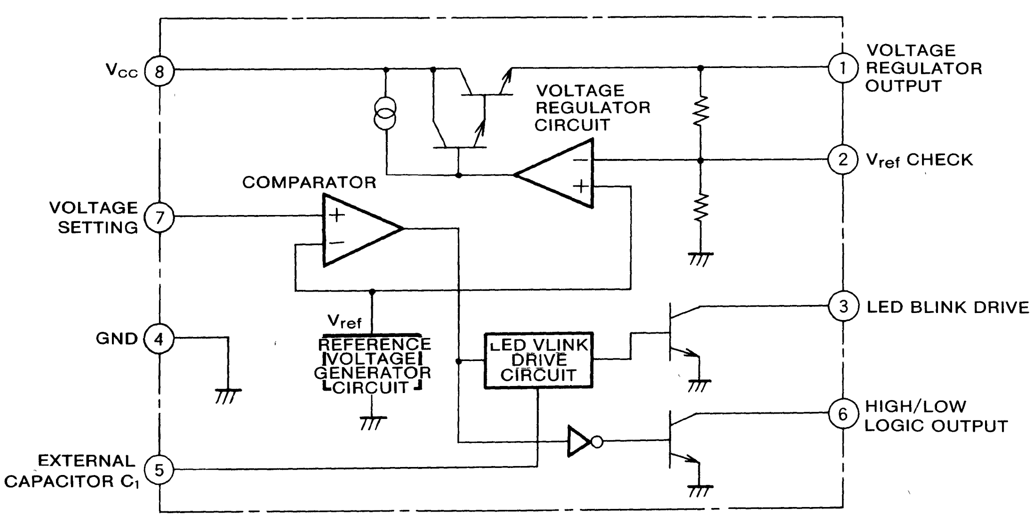
APPLICATION

Low voltage checker for batteries in equipment such as radio/cassette recorders, portable VTRs, cameras. Alarm and protection circuits of electronic equipment.

RECOMMENDED OPERATING CONDITIONS

Supply voltage range ················· $V_{CC}=5\sim18V$

BLOCK DIAGRAM



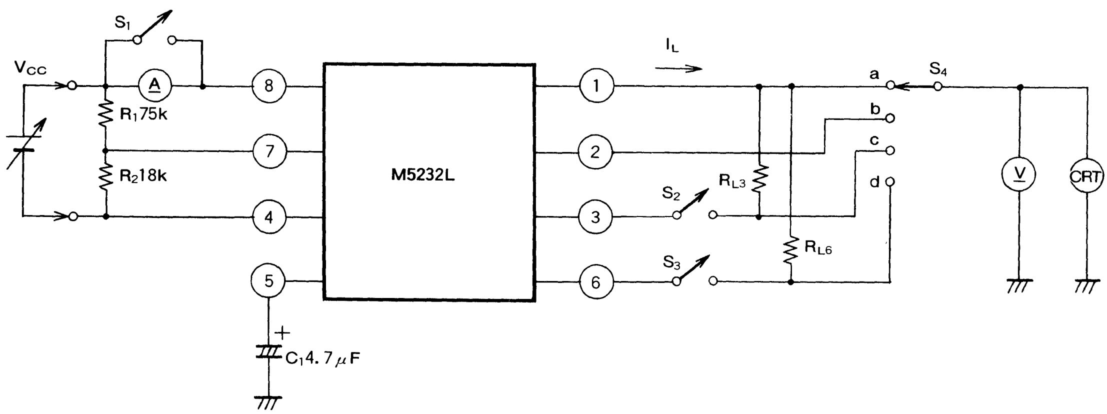
ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		20	V
P_d	Power dissipation		800	mW
I_{LP}	Load current		50	mA
$K\theta$	Thermal derating	$T_a \geqq 25$℃	8	mW/℃
T_{opr}	Operating temperature range		−20～+75	℃
T_{stg}	Storage temperature range		−55～+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃)

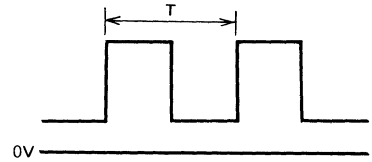
Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
I_{CC}	Circuit current	V_{CC}=9V, I_L=0		2.0	3.0	mA
V_2	Reference voltage	V_{CC}=9V, R_{L3}=400Ω	1.22	1.31	1.40	V
V_1	Output voltage	V_{CC}=9V, R_{L3}=400Ω	3.6	4.0	4.4	V
V_3	Saturation voltage	V_{CC}=9V, R_{L3}=400Ω		0.2	0.5	V
V_6	Saturation voltage	V_{CC}=6V, R_{L6}=400Ω		0.2	0.5	V
f	Oscillation frequency	V_{CC}=6V, C_1=4.7μF, R_{L3}=400Ω		1.8		Hz

TEST CIRCUIT



Parameter	V_{CC}	S_1	S_2	S_3	S_4
I_{CC}	9V	OFF	OFF	OFF	—
V_2	9V	ON	ON	OFF	b
V_1	9V	ON	ON	OFF	a
V_3	9V	ON	ON	OFF	c
V_6	6V	ON	OFF	ON	d
f	6V	ON	ON	OFF	c

☆ MEASUREMENT OF f ON CRT
PIN ③ WAVEFORM f=1/T (Hz)



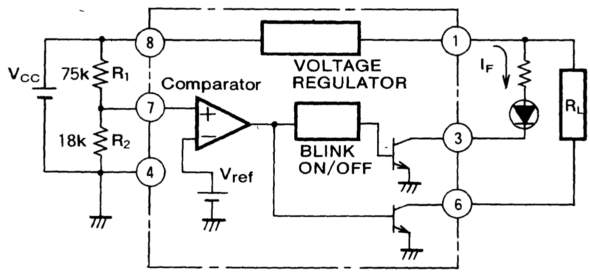
(Duty cycle is approx 50%)

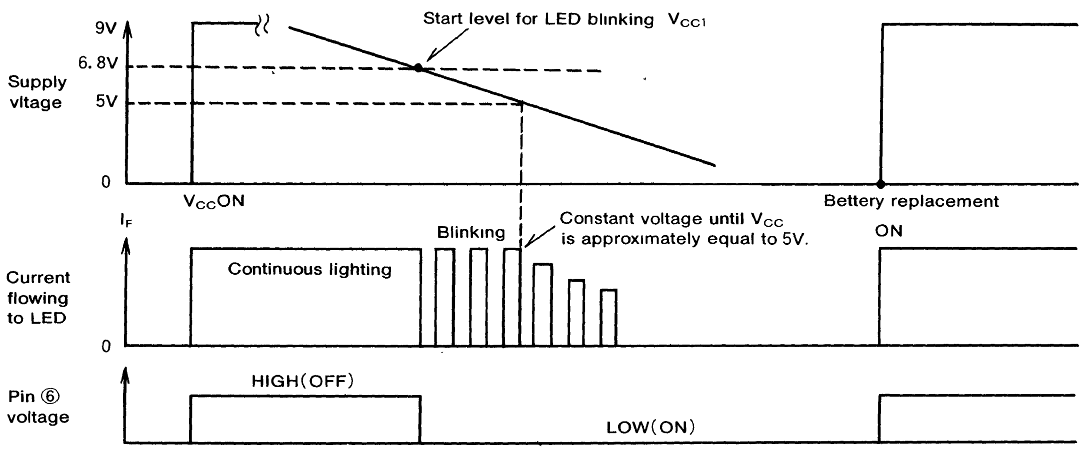
MITSUBISHI ELECTRIC

1. Basic principle of M5232L operation

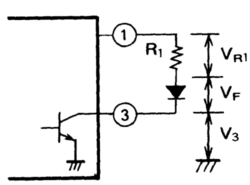
- When supply voltage V_{CC} is normal, the LED lights and functions as a pilot lamp. In this case, Pin ③ drives the LED with open-collector output.
- V_{CC} drops, becoming V_{CC1} and when the Pin ⑦ potential becomes
  $$V_7=\frac{R}{R_1+R_2}\cdot V_{CC1}<V_{ref}$$
  the comparator inverts, the blink curcuit is switched on, and the LED blinks on and off. (V_{ref}, produced by the internal reference voltage source, is 1.31V typ.)
- The on/off alarm circuit shown on the right will activate when the voltage is 6.8V, which is 25% less than V_{CC}=9V (six 1.5V cells).
- Pin ⑥ is an open-collector output that causes a high-to-low level transition simulataneously with the Pin ③ on/off operation. A micro buzzer, relay or other load can be connected across this pin and Pin ① of V_{CC} (Pin ⑧) for a wide range of applications.

LOW VOLTAGE CHECKER FOR BATTERIES (SIMPLIFIED DIAGRAM)





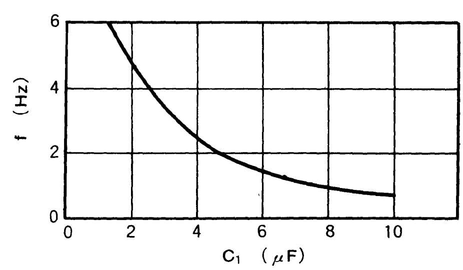
2. LED Drive current I_F



- Assuming that Pin ① output voltage is 4V, LED forward voltage is V_F, and V_3 is 0.2V, then
  $$I_F=\frac{4V-0.2V-V_F}{R_1}$$
  I_F is approximately equal to 4.6mA with V_F= 2V, and R_1=390Ω (in a typical application circuit).

3. On/off oscillation frequency

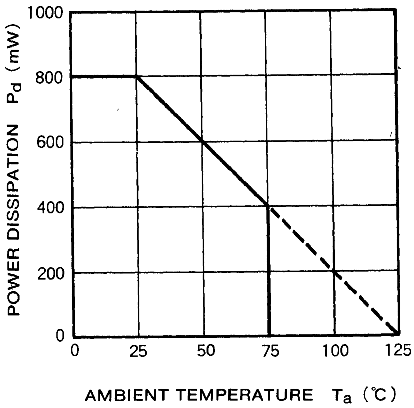
The on/off oscillation frequency can be varied by changing the value of external capacitor C_1.



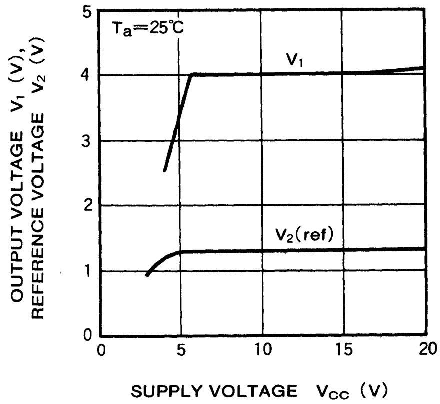
* If capacitance C_1 is even further reduced. oscillation will be possible up to a frequency of about 10 kHz

TYPICAL CHARACTERISTICS

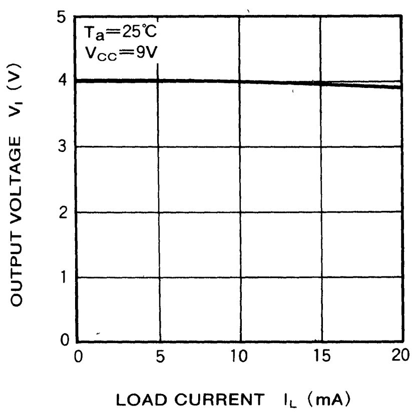
POWER DISSIPATION VS. AMBIENT TEMPERATURE



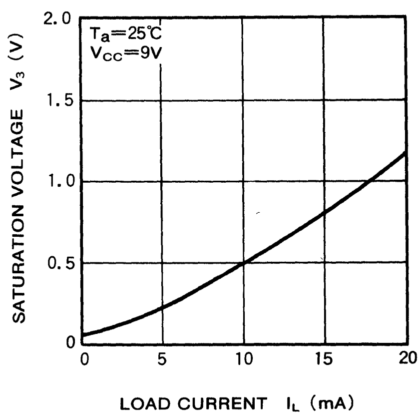
OUTPUT VOLTAGE. REFERENCE VOLTAGE VS. SUPPLY VOLTAGE



OUTPUT VOLTAGE VS. LOAD CURRENT

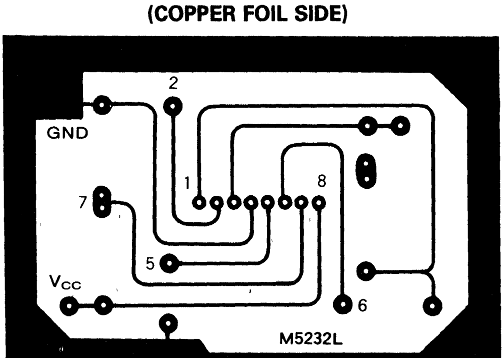


SATURATION VOLTAGE VS. LOAD CURRENT

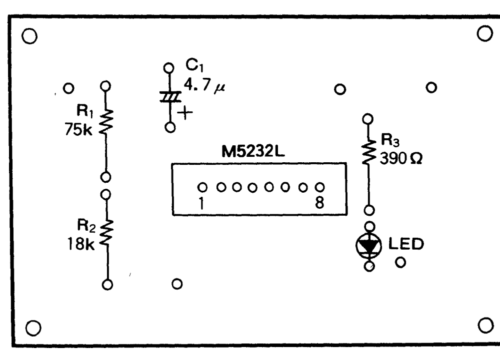


PRINTED CIRCUIT BOARD FOR CIRCUIT TESTING (TYPICAL APPLICATION EXAMPLE)

PRINTED CIRCUIT BOARD WIRING DIAGRAM (COPPER FOIL SIDE)

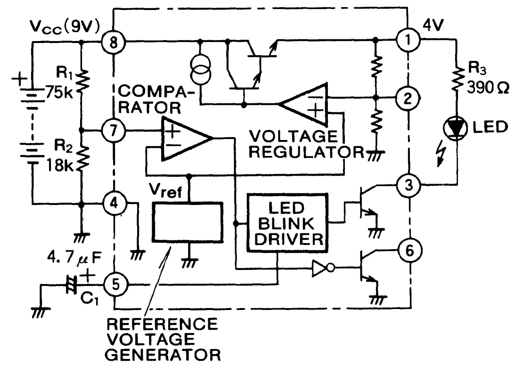


(PARTS SIDE)



APPLICATION EXAMPLES

1. Low voltage checker for batteries

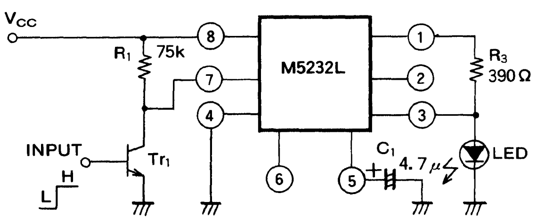


This low voltage checker for batteries is set to start the LED blinking when supply voltage $V_{CC} = 9V$ (six 1.5V cells) is reduced by 25% (to 6.8V).

$C_1 = 4.7\mu F \rightarrow f \fallingdotseq 1.8Hz$

C_2, which has a value of 100pF, prevents oscillation. It should be inserted when the input/output leads are long or when parasitic oscillation is generated by the load.

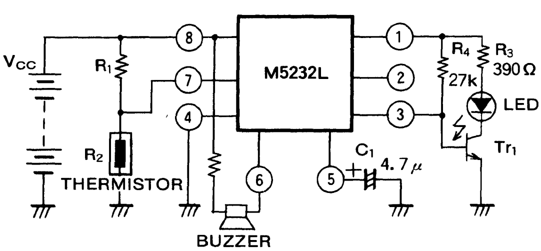
2. Trouble indicator



When the base of transistor T_{r1} is set low (the normal condition), Pin ⑦ comparator voltage is set high, Pin ③ is set low, and the LED is switched off.

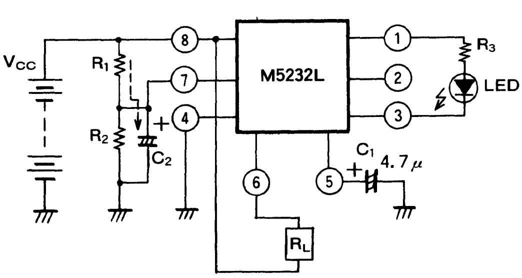
When the base of transistor T_{r1} is set high (signifying trouble), Pin ⑦ comparator input voltage is set low, the internal vibrator circuit is switched on, Pin ③ is repeatedly set high and low, and the LED blinks on and off. At the same time, an electronic buzzer can be sounded using Pin ⑥ or a relay can be driven. (An ordinary switch may be used in place of transistor T_{r1}.)

3. Abnormal temperature indicator



In normal circumstances, the LED is off and power dissipation is kept low. In abnormal circumstances, the LED blinks on and off. It is also possible to sound a buzzer or drive a relay using Pin ⑥.

4. Timer and muting indicator

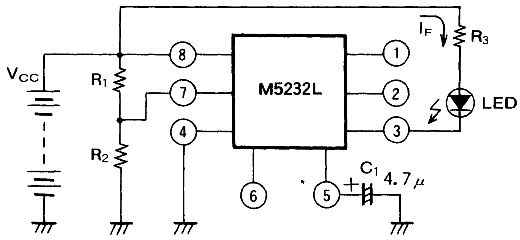


By connecting C_2 in parallel with R_2, V_{CC} is switched on, the charging current indicated by the dotted line in the figure flows, and the LED blinks on and off until the Pin ⑦ voltage reaches:

$$V_{CC} \cdot \frac{R_2}{R_1+R_2}$$

When C_2 is charged up, the LED will light. These operations can be applied to timer and muting circuits.

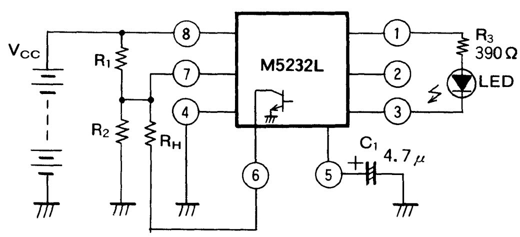
5. Low voltage checker for batteries (of 5V or less)



Since output Pin ① of the M5232L is regulated at 4V, the output is not stabilized at V_{CC} less than 5V.

When an LED is connected directly from V_{CC} as shown in the figure at left, it is possible to construct a battery checker for batteries of less than V_{CC} 5V, (for instance, $V_{CC}=3\sim5V$). Note that in this case, the I_F of the LED will fluctuate in accordance with the changes in V_{CC}.

6. Hysteresis operation of the on/off starting voltage



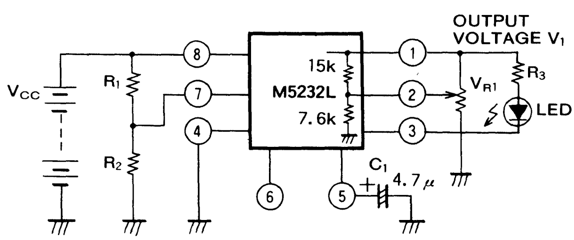
By connecting R_H across pins ⑥ and ⑦, as shown in the figure on the left, the on/off starting voltage is set at:

$$V_{2(ref)} \cdot \frac{R_1+R_2}{R_2}$$

After the start of the on/off blinking, Pin ⑥ (the open collector) goes on, and so it is possible to apply hysteresis and the voltage expressed below:

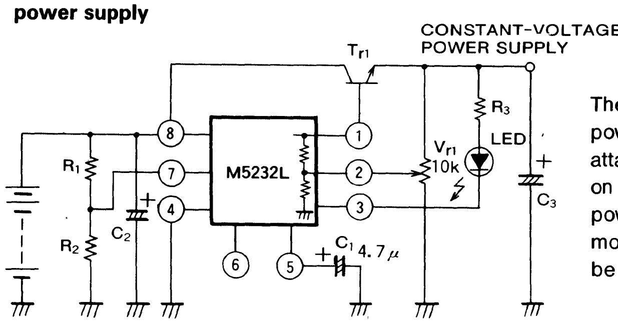
$$V_{2(ref)} \cdot \frac{R_1+R_2/\!/R_H}{R_2/\!/R_H}$$

7. Modification of output voltage V



The output voltage V_1 of the M5232L is set by the internal resistor as shown in the figure at left, but this can be changed by connecting a semi-fized resistor across GND and pins ① and ②.

8. Increased current capacity of constant-voltage power supply



The current capacity of the built-in constant-voltage power supply is approximately 20mA. However, by attaching external transistor T_{r1} as shown in the figure on the left, it is possible to obtain a constant-voltage power supply with a large current capacity of 1A or more. The output voltage of the power supply can also be varied with variable resistor V_{r1}.

Note : Oscillation may be generated when the input or output leads are long In cases like this, input and output capacitors C_1 and C_2 (1~ 10uF) should be inserted near the IC

ELECTRONIC VOLUME CONTROL CMOS D-A CONVERTER

DESCRIPTION

The M50601P is a semiconductor integrated circuit designed to digitally control the control voltage of an electronic volume control. Fabricated using aluminum gate CMOS technology, this device contains a PWM-type 6-bit D-A converter that functions to control the amplitude of the analog signal by dividing it into 64 steps.

FEATURES

- Low power dissipation
- Built-in ceramic oscillator for high frequency stability
- Analog signal amplitude may be controlled over 64 steps
- Includes a memory function
- Includes a preset function

APPLICATION

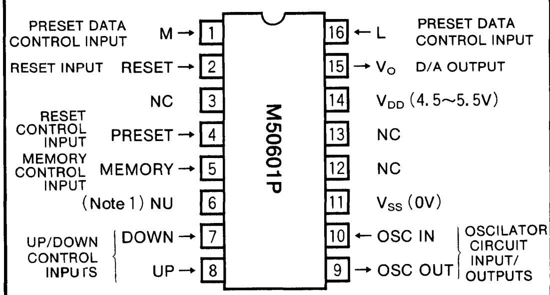
All types of electronic volume cotrols.

FUNCTIONAL DESCRIPTION

The M50601P is a CMOS integrated circuit containing a 6-bit up/down counter, oscillator circuit, dvider circuit, D-A converter, and the other circuits required to digitally process the control voltage of an electronic volume control.

The major functions include both manual and automatic operation of the 6-bit up/down counter, and a memory function designed to hold the contents of the up/down counter. It also has a preset function that allows the contents of the memory, or "0" or "32" to be set into the up/down counter.

PIN CONFIGURATION (TOP VIEW)

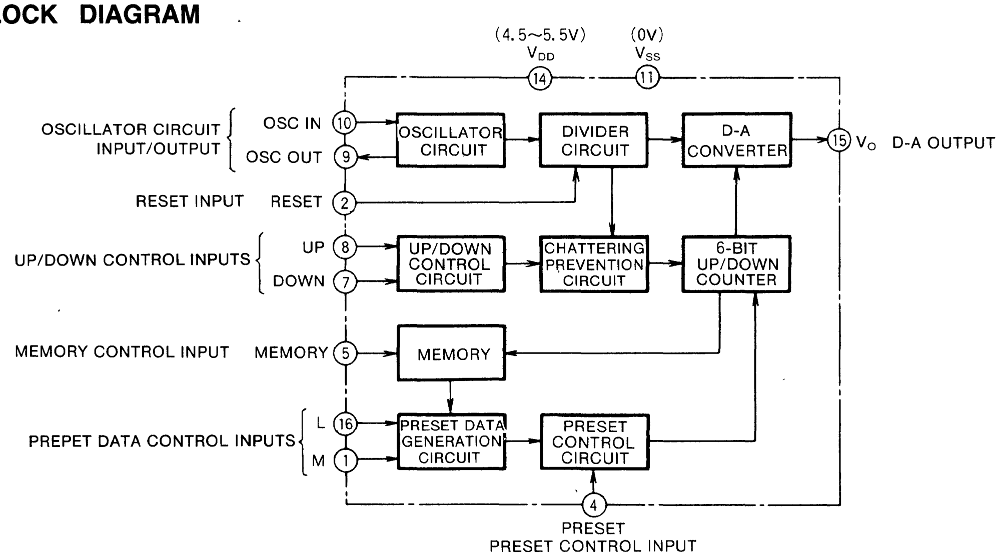


Outline 16P4

NC : NO CONNECTION

NOTE 1 : LEAVE PIN (6) OPEN , DO NOT USE

BLOCK DIAGRAM



FUNCTIONAL DESCRIPTION

Oscillator Circuit

The internal oscillator circuit generates a reference signal by connecting one ceramic resonator and two capacitors to the OSC IN and OSC OUT terminals. An example circuit is shown in Fig. 1.

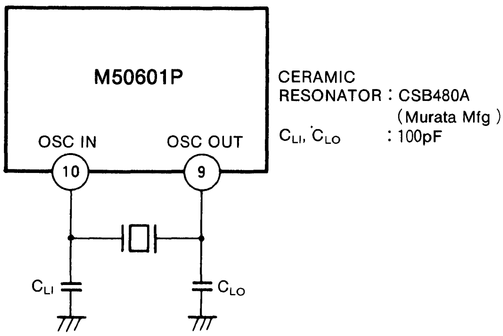


Fig. 1 . Example Oscillator Circuit (using a ceramic resonator)

Up/Down Counter Function

Each time the UP pin receives a high-level input, the contents of the 6-bit up/down counter are incremented by one step. The count will continue to "63", after which it will not increase.

If the high level is held at the UP pin for 0.41 to 0.52 seconds, the contents of the up/down counter will be incremented at a rate of approximately 9.77 steps/sec. The counter will stop when it reaches "63".

Each time the DOWN pin receives a high-level input, the contents of the 6-bit up/down counter are decremented by one step. The count will continue to "0", after which it will not decrease.

If the high level is held at the DOWN pin for 0.41 to 0.52 seconds, the contents of the up/down counter will be decremented at a rate of approximately 9.77 steps/sec. The counter will stop when it reaches "0".

When both the UP and DOWN pins receive a simultaneous high-level input, the contents of the up/down counter will not change.

The chattering prevention circuit also prevents data from being entered into the counter (for both of the UP and DOWN pins) if the duration of the high-level signal is less than 25 to 50ms.

Memory Function

When a pulse similar to the one shown in Fig. 2 is applied to the MEMORY pin, the contents of the 6-bit up/down counter are stored in memory.

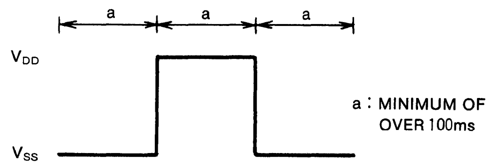


Fig. 2 . Input Signal Waveform at the MEMORY Terminal

Preset Function

When the PRESET pin and the the M pin are at low level and a pulse similar to the one shown in Fig. 3 is applied to the L preset to "0".

When the PRESET pin and the L pin are at low level and a pulse signal similar to the one shown in Fig. 3 is applied to the M pin, the contents of the 6-bit up/down counter are preset to "32".

When the L pin and the M pin are at low level and a pulse similar to the one shown in Fig. 3 is applied to the PRESET pin, the contents of the 6-bit up/down counter will not be preset.

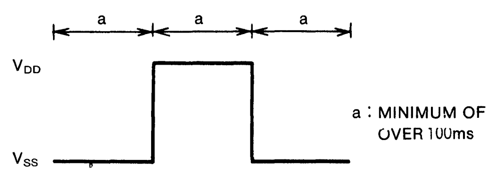


Fig. 3 . Input Signal Waveform for the L, M, and PRESET Terminals

Reset Function

Reset is a test function. When a high-level signal is applied to the RESET pin, the divider (480 kHz-4.88Hz) is reset.

D-A Output

The internal 6-bit D/A converter functions to control the analog signal amplitude in 64 steps.

Output is repetitious at a frequency of 1.25 kHz ; it is a pulse-width modulated output with a minimum pulse width of 12.5us.

Operation of the UP or DOWN terminal, if set in the automatic mode, will increment or decrement the analog signal amplitude at a rate of approximately 9.77 steps/sec. Consequently, the time required to cover the full range from minimum to maximum analog value, or vice versa is approximately 6.45 seconds.

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Conditions	Ratings	Unit
V_{DD}	Supply voltage	With respect to V_{SS} pin	−0.3~7	V
V_I	Input voltage		$V_{SS} \leqq V_I \leqq V_{DD}$	—
V_O	Output voltage		$V_{SS} \leqq V_O \leqq V_{DD}$	—
P_d	Maximum power dissipation	T_a=25℃	300	mW
Topr	Operating temperature range		−30~70	℃
Tstg	Storage temperature range		−40~125	℃

RECOMMENDED OPERATING CONDITIONS

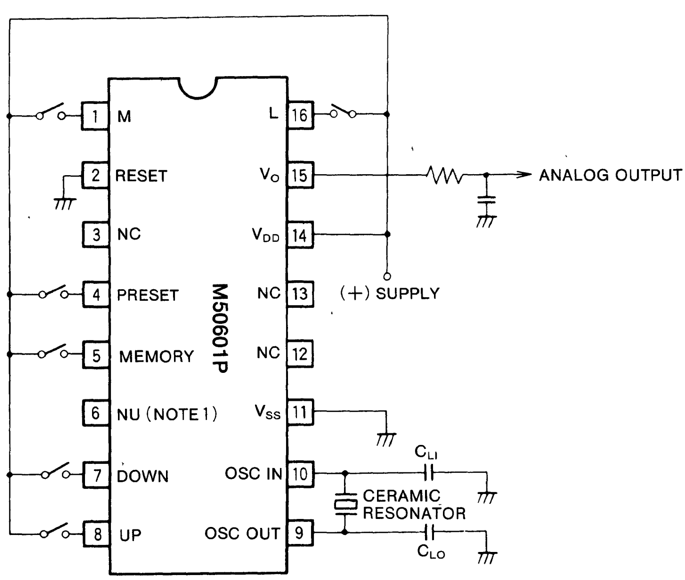
Symbol	Parameter	Limits			Unit
		Min	Typ	Max	
V_{DD}	Supply voltage	4.5	5	5.5	V
f_{OSC}	Oscillation frequency	480		kHz	
V_{IH}	"H" input voltage (Note 2)	$0.7 \times V_{DD}$	V_{DD}	V_{DD}	—
V_{IL}	"L" input voltage (Note 2)	0	0	$0.3 \times V_{DD}$	—

Note 2 : Applicable to the seven terminals, M, PRESET, RESET, MEMORY, DOWN, UP, and L.

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{DD}=5V, V_{SS}=0V, C_{LI}=C_{LO}=100pF, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
V_{DD}	Operating supply voltage	T_a=−30~70℃, f_{OSC}=480kHz	4.5	5	5.5	V
V_{DD}	Supply current	f_{OSC}=480kHz		0.3	2	mA
R_I	Pull-down resistor (Note 2)	V_I=5V		100		kΩ
I_{OH}	"H" output current	V_O=0V	2			mA
I_{OL}	"L" output current	V_O=5V	2			mA

APPLICATION EXAMPLE



M51017AP

FLEXIBLE DISK DRIVE (FDD) READ/WRITE AND LOGIC IC

DESCRIPTION

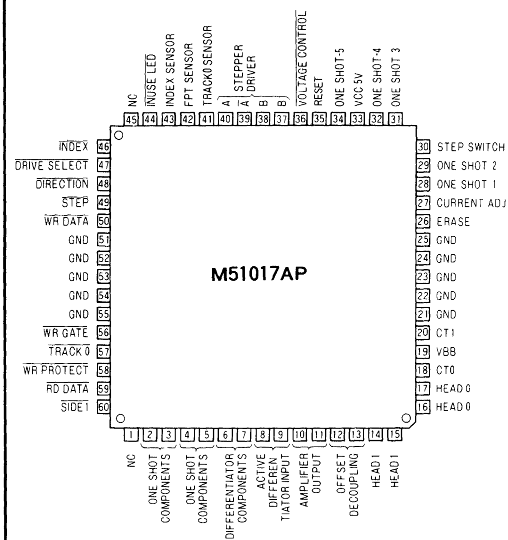
The M51017AP is a semiconductor integrated circuit designed for use in flexible disk drives. It consists of read, write, and stepping motor drive pulse generator circuit sections, as well as a wide variety of control logic circuits.

The M51017AP can be used for double-sided recording. The magnetic head is selected by side select signal.

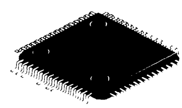
FEATURES

- Read circuit section
  Amplifies the signals from the magnetic head and outputs the required read data.
- Write circuit section
  Drives the write switching circuit according to the write data and the recording current is made to flow in the magnetic head. The recording current is set externally. Also drives the erasing circuit (tunnel erase system) according to the on/off switching of the write gate. The erase timing can be set by an external constant.
- Stepping motor drive pulse generator section
  Generates a drive pulse corresponding to the two-phase excitation system according to the step input signal.
  A switching terminal for selecting one step/one pulse or one step/two pulses has been provided. The output is TTL level.
- Control logic circuit sections
  (functions of each section are described later)
  The input circuit section provides hysteresis operation and LSTTL level, while the output circuit section has open collector output.
- Housed in a 60-pin molded plastic quad flat package (with a lead pitch of 0.8mm)

PIN CONFIGURATION (TOP VIEW)

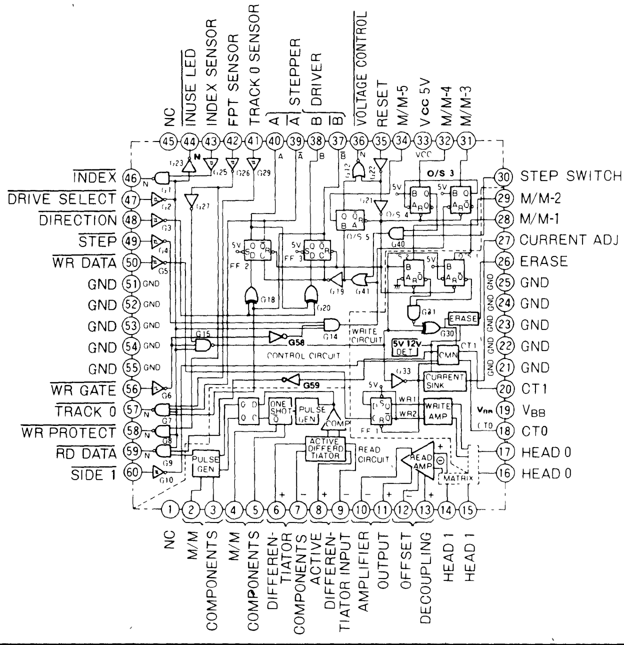


NC NO CONNECTION



60-pin molded plastic flat quad package

BLOCK DIAGRAM



MITSUBISHI ELECTRIC

FLEXIBLE DISK DRIVE (FDD) READ/WRITE AND LOGIC IC

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		7.0	V
V_{BB}	Supply voltage		15.0	V
Topr	Operating temperature range		0~+60	℃
Tstg	Storage temperature range		−40~+125	℃
Vhd	Voltage applied to head input pins (pins ⑭, ⑮, ⑯, ⑰)	Pulse applied for 2μs	25	V
V㉖	Voltage applied to erase-current pin (pin ㉖)	Pulse applied for 2μs	20	V
I㉖	Erase-current pin output current (pin ㉖)	Erase mode	100	mA
I⑱ I⑳	Center-tap pin output current (pin ⑱, ⑳)	Write/erase mode	110	mA

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=5V, V_{BB}=12V, unless otherwise noted)

Symbol		Parameter	Test conditions	Limits Min	Limits Typ	Limits Max	Unit
G_V	Read amplifier	Voltage gain	f=125kHz	47	49	51	dB
B_W	Read amplifier	Preamplifier high range gain attenuation	f=5MHz		−3		dB
V_O	Read amplifier	Differential output voltage width	Pins ⑩—⑪		6		V_{P-P}
I_{OS}	Read amplifier	Differential output current width	Pins ⑩—⑪		8		mA_{P-P}
r_I	Read amplifier	Differential input resistance	Pins ⑭—⑮/⑯—⑰	20	25		kΩ
r_O	Read amplifier	Differential output resistance	Pins ⑩—⑪		30		Ω
N_I	Read amplifier	Input conversion noise voltage	B_W=10kHz~1MHz		8		μVrms
V_{OFF}	Read amplifier	Output offset voltage	Pins ⑩—⑪	−0.6		+0.6	V
CMRR	Read amplifier	In-phase signal suppression ratio	V_I=5mVrms, f=10kHz		50		dB
SVRR	Read amplifier	Supply fluctuation suppression ratio	ΔV_{BB}=100mVrms, f=10kHz		60		dB
r_{id}	Differ-entiator	Differential input resistance	Pins ⑧—⑨	22	30		kΩ
I_{OS}	Differ-entiator	Output sink current	Pins ⑥, ⑦		1.5		mA
P_S	Differ-entiator	Peak shift		−2		+2	%
—	Waveform restoration circuit	Monostable one-pulse width setting range		500	2000	2400	ns
—	Waveform restoration circuit	Monostable two-pulse width setting range		150	1000	1200	ns
—	Waveform restoration circuit	Monostable one-pulse width precision	R_1=5.6kΩ, C_1=560pF, t_W=2000ns	−15		+15	%
—	Waveform restoration circuit	Monostable two-pulse width precision	R_2=5.6kΩ, C_2=300pF, t_W=1200ns	−20		+20	%
I_{WR}	Write circuit	Write current	R_{IWR}=5.6kΩ		6		mA
—	Write circuit	Write current precision		−10		+10	%
—	Write circuit	Write current supply dependency	V_{CC}=5V, V_{BB}=10.8~13.2V		±0.1		%/V
—	Write circuit	Write current temperature dependency	T_a=0~60℃		±0.05		%/℃
ΔI_{WR}	Write circuit	Write current pair quality	$I_{WR1}-I_{WR2}$	−1		+1	%
—	Write circuit	Write current setting range				10	mA
V_{sat}	Write circuit	Output saturation voltage	I_{OL}=7.5mA			4	V
I_{OH1}	Write circuit	Off-state leakage current	Head on non-selected side			250	μA
I_{OH2}	Write circuit	Off-state leakage current	Head on selected side			100	μA
V_{OL}	Erase circuit	Output saturation voltage	I_{OL}=70mA			0.6	V
I_{OH}	Erase circuit	Output leakage current	V_{OH}=20V			250	μA
I_{er}	Erase circuit	Erase current range				100	mA
V_{OH}	Common driver	Output voltage at time of write selection		10.2	11.3		V
V_{OL}	Common driver	Output voltage at time of read selection			2		V
—	Common driver	Output current range				110	mA
t_{W1}	Monostable multivibrator	M/M—1 output pulse width	R_1=100kΩ, C_1=0.01μF, k≒0.28		285		μs
t_{W2}	Monostable multivibrator	M/M—2 output pulse width	R_2=82kΩ, C_2=0.033μF, k≒0.27		730		μs
t_{W3}	Monostable multivibrator	M/M—3 output pulse width	R_3=100kΩ, C_3=0.12μF, k≒0.29		3.7		ms
t_{W5}	Monostable multivibrator	M/M—5 output pulse width	R_5=100kΩ, C_5=2.2μF, k≒0.31		68		ms

ELECTRICAL CHARACTERISTICS (CONTINUED) (T_a=25℃, V_{CC}=5V, V_{BB}=12V, unless otherwise noted)

Symbol	Parameter		Test conditions	Limits			Unit
				Min	Typ	Max	
V_{OL}	Open-collector output	"L" output voltage	I_{OL}=48mA			0.4	V
I_{OH}		"H" output current	V_{OH}=12V			250	μA
—		Applicable pins: ㊹, ㊻, ㊼, ㊽, ㊾					
V_{OL}		"L" output voltage	I_{OL}=12mA			0.4	V
I_{OH}		"H" output current	V_{OH}=12V			250	μA
—		Applicable pins: ㊱					
V_{OH}	Output circuit	"H" output voltage	I_{OH}=1mA	2.7	3.4		V
V_{OL}		"L" output voltage	I_{OL}=0.1mA			0.4	V
—		Applicable pins: ㊲, ㊳, ㊴, ㊵ Totem-pole output					
V_{th+}	Schmitt trigger input	Positive-going threshold voltage		1.2	1.6	1.9	V
V_{th-}		Negative-going threshold voltage		0.5	0.8	1.1	V
H_{ys}		Hysteresis		0.4	0.8		V
I_{IH}		"H" input current	V_I=2.7V			40	μA
I_{IL}		"L" input current	V_I=0.4V			−0.4	mA
—		Applicable pins ㊶, ㊷, ㊸, ㊼, ㊽, ㊾, ㊿, 56, 60					
V_{IH}	Input	"H" input voltage		2.0			V
V_{IL}		"L" input voltage				0.8	V
I_{IH}		"H" input current	V_I=2.4V			40	μA
I_{IL}		"L" input current	V_I=0.4V			−0.4	mA
—		Applicable pins: ㉚, ㉟					
V_{th5}	Supply detection	5V-system detection voltage		3.4	3.9	4.4	V
V_{th12}		12V-system detection voltage		7.6	8.6	9.6	V
I_{CC}	Circuit current	5V-system circuit current	Read mode		68		mA
I_{BB}		12V-system circuit current	Read mode		18		mA

M51660L

SERVO MOTOR CONTROL FOR RADIO CONTROL

DESCRIPTION

The M51660L is a semiconductor integrated circuit for use in servo motor conrol in radio control applications.

Housed in a 14-pin molded plastic zig-zag inline package (ZIP), the M51660L contributes to the miniaturization of the set.

The built-in voltage regulating circuit, and the differential comparator used in the comparator circuit provide the M51660L with extremely stable power supply voltage fluctuation characteristics and temperature change characteristics.

FEATURES

- Small circuit current ······3.5mA typ. (When output is off)
- Excellent power supply and temperature stability
- Simple setting of dead band
- Includes protection circuit for continuous "H" level input

APPLICATION

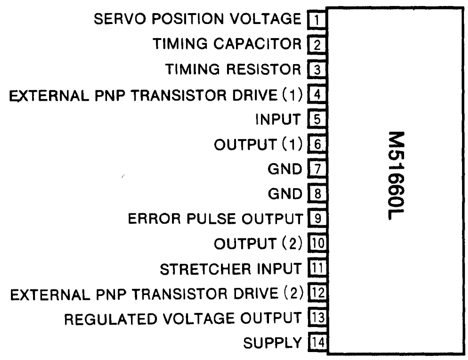
Digital proprtional systems for radio control, servo motor control circuits.

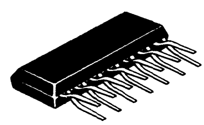
RECOMMENDED OPERATING CONDITIONS

Supply voltage range ······································ 3.5~7V

Rated supply voltage ·· 4.8V

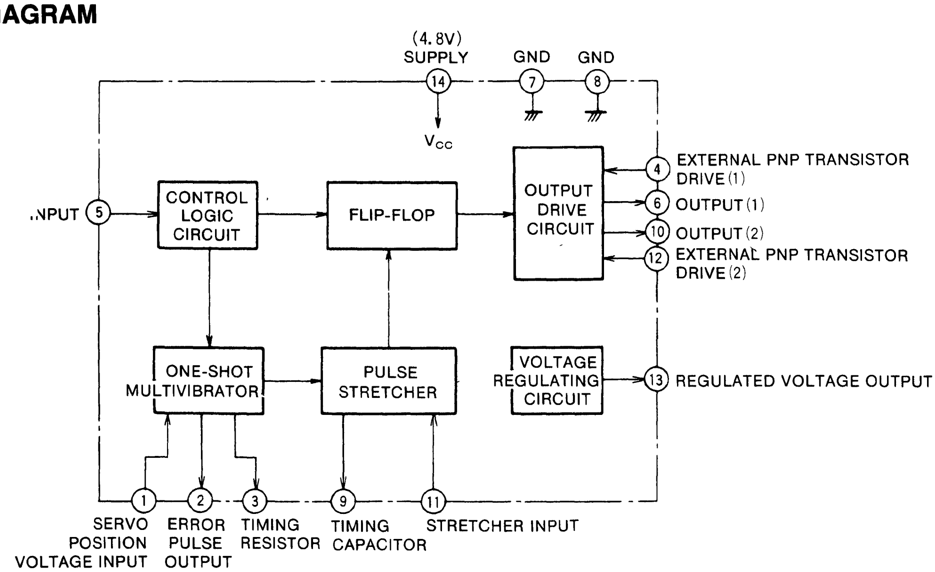
PIN CONFIGURATION (TOP VIEW)





14-pin molded plastic ZIP

BLOCK DIAGRAM



SERVO MOTOR CONTROL FOR RADIO CONTROL

ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

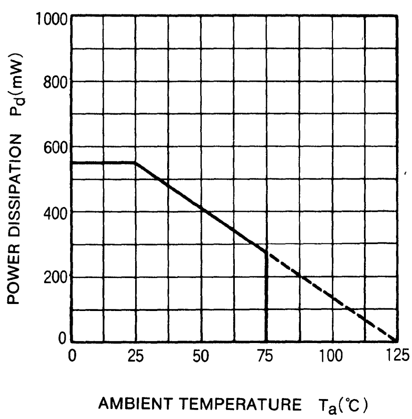
Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		7.5	V
$I_{O\ SINK}$	Output sink current		500	mA
$I_{O\ SOURSE}$	Output source current		200	mA
P_d	Power dissipation		550	mW
K_θ	Thermal derating range	$T_a \geqq 25$℃	5.5	mW/℃
Topr	Operating temperature		−20～+75	℃
Tstg	Storage temperature range		−40～−+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=4.8V unless otherwise noted)

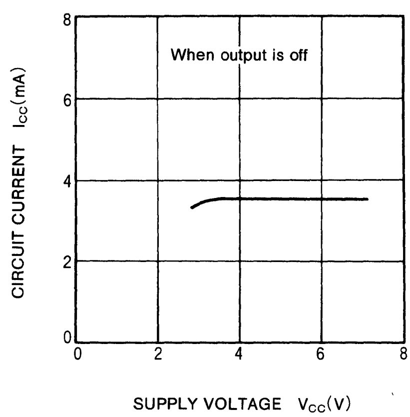
Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
I_{CC}	Circuit current	When output is off		3.5	5	mA
		When output is on		20		
V_{OL}	Output voltage "L"	$I_{O\ SINK}$=100mA		0.1	0.2	V
		$I_{O\ SINK}$=400mA		0.4	0.7	
V_{OH}	Output voltage "H"	$I_{O\ SOURCE}$=100mA	3.4	3.8		V
I_{PNP}	External PNP transistor drive current		30			mA
V_{Reg}	Internal regulated supply voltage		2.3	2.45	2.6	V
I_{Reg}	Internal regulated supply output current				3.0	mA
T_{DB}	Minimum dead band width	R_{DB}=510Ω, C_S=0.1μF			1.5	μs

TYPICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

THERMAL DERATING (MAXIMUMRATING)

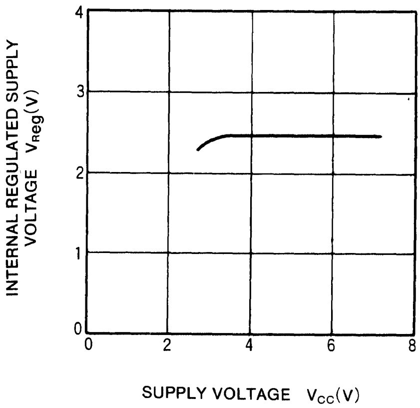


CIRCUIT CURRENT VS SUPPLY VOLTAGE

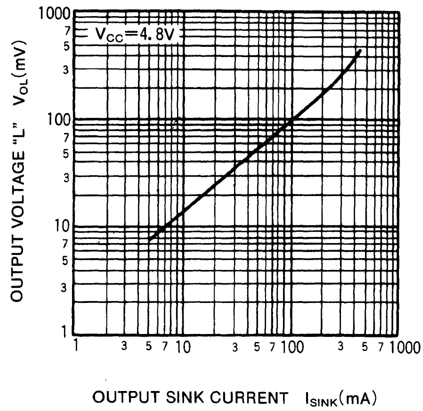


MITSUBISHI ELECTRIC

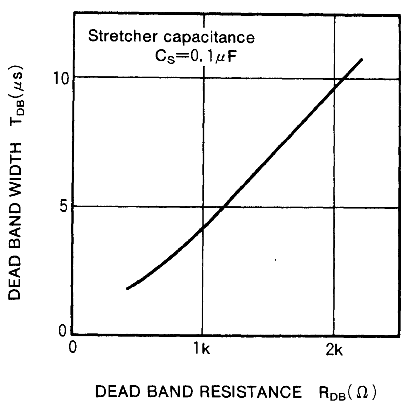
INTERNAL REGULATED SUPPLY VOLTAGE VS SUPPLY VOLTAGE



OUTPUT VOLTAGE "L" VS OUTPUT SINK CURRENT

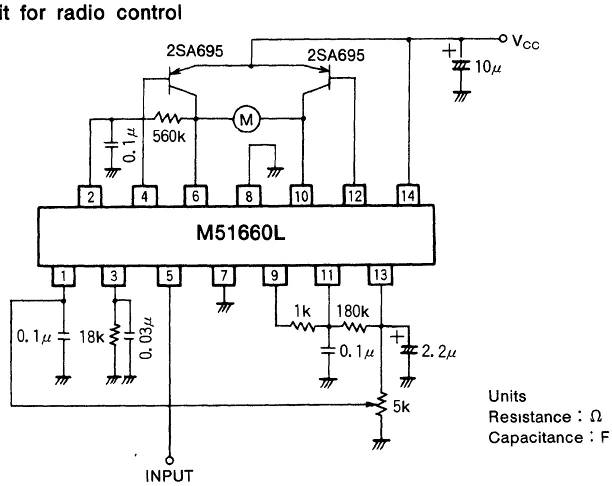


DEAD BAND WIDTH VS DEAD BAND RESISTANCE



APPLICATION EXAMPLE

Servo motor control circuit for radio control



TECHNICAL APPLICATION NOTES
PIN DESCRIPTION

1. **Servo Position Voltage Input Pin (Pin ①)**
   Connect the potentiometer terminal for position detection that follows the output axis. Compare this voltage with the voltage of the triangular wave of pin ② and drive the motor. A capacitor of approximately 0.1μF should be connected for noise prevention.
2. **Timing Capacitor Pin (Pin ②)**
   Connect a capacitor that will generate a triangular wave by constant current charging. A typical value is 0.1μF. Also connect a feedback resistor from the output here.
3. **Timing Resistor (pin ③)**
   Connect a resistor that will determine the value of the constant current of pin ②. A resistor of 18kΩ will yield a current of 1.0mA. A capacitor of approximately 0.03μF should be connected in parallel with the resistor to increase stability.
4. **External PNP Transistor Drive ① (Pin ④)**
   Connect to the base of the external PNP transistor.
5. **Input Pin (Pin ⑤)**
   Operate with a positive pulse of peak value 3V or greater.
6. **Output ① Pin (Pin ⑥)**
   Connect a feedback resistor between this pin and pin ②.
7. **Ground (pins ⑦ and ⑧)**
8. **Error Pulse Output pin (Pin ⑨)**
   Connect a resistor between this pin and pin ⑪. The dead band will change according to the value of this resistor.
9. **Output ② pin (Pin ⑩)**
   This is the output ② pin.
10. **Stretcher Input Pin (Pin ⑪)**
    Connect the capacitor and resistor of the pulse stretcher section.
11. **External PNP Transistor Drive ② (Pin ⑫)**
    Connect to the base of the external PNP transistor.
12. **Regulated Voltage Output Pin (Pin ⑬)**
    This is the output of the internal regulated supply voltage. Make connections from this pin to a potentiometer or pulse stretcher resistor. Connect a capacitor of approximately 2.2μF for stability.
13. **Supply Voltage (Pin ⑭)**
    The supply voltage exhibits uniform characteristics from 3.5V to 7V. Connect a capacitor of approximately 10μF.

M51523AL

DUAL ELECTRONIC VOLUME CONTROL

DESCRIPTION

The M51523AL is a semiconductor integrated circuit containing a dual channel electronic volume control housed in a miniature 14-pin molded plastic zig-zag inline (ZIP) package.

Application of a DC voltage to the control pins permits the attenuation of the left and right channels to be changed as well as changes in the balance. Also included is a temperature-compensated reference voltage supply, enabling the M51523AL to be used as a control voltage source.

FEATURES

- High attenuation capacity ································92dB(typ.)
  (f=1kHz, V_i=150mVrms JIS-A network)
- Low distortion ··· 0.015%(typ.)
  (f=1kHz, V_i=150mVrms at maximum volume)
- Low noise ·· 3.6μVrms(typ.)
  (JIS-A network at minimum volume)
- Good matching between ch1 and ch2
- Includes a balance circuit
- Built-in stabilized power supply circuit makes device immune to fluctuations in supply voltage
- Good temperature characteristics

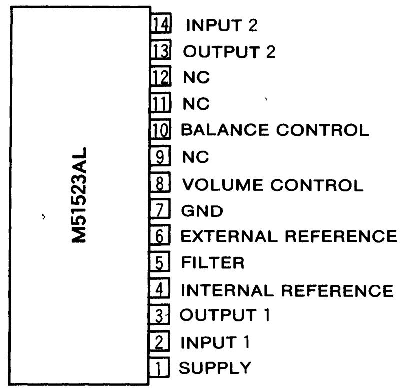
APPLICATION

Volume controls for car stereos, radio cassette recorders, TVs, VTRs, etc.

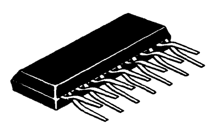
RECOMMENDED OPERATING CONDITIONS

Supply voltage range ······································8~16V
Rated supply voltage ··12V

PIN CONFIGURATION (TOP VIEW)

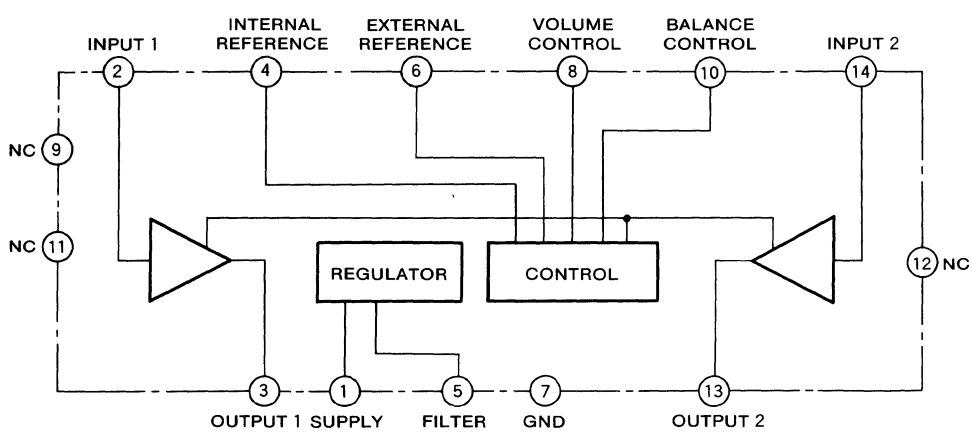


NC : NO CONNECTION



14-pin molded plastic ZIP

BLOCK DIAGRAM



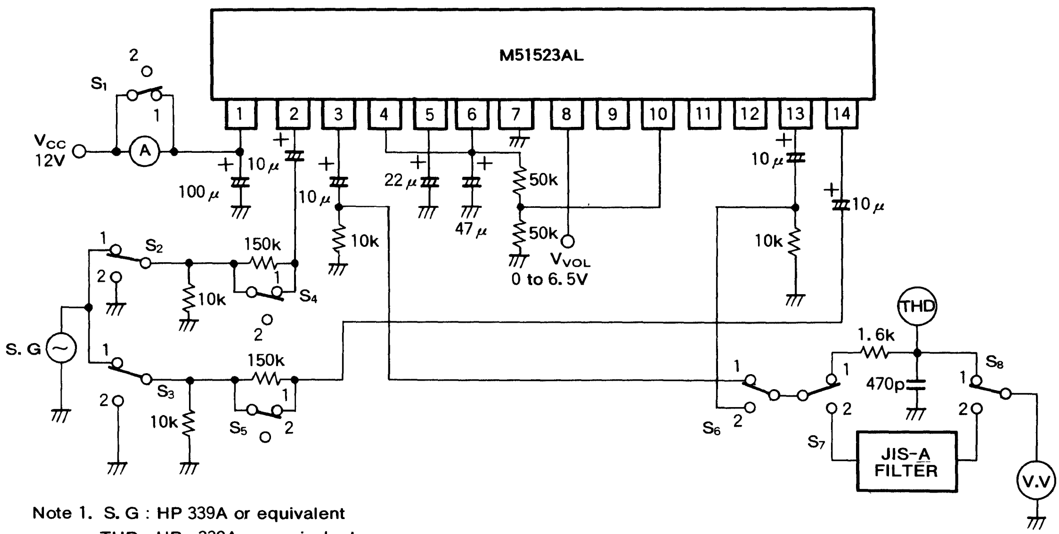
ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage	Quiescent	18	V
I_{CC}	Circuit current		30	mA
P_d	Power dissipation		550	mW
K_θ	Thermal derating	$T_a \geqq 25$℃	5.5	mW/℃
T_{opr}	Operating temperature range		−20～+75	℃
T_{stg}	Storage temperature range		−40～+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=12V, f=1kHz, unless otherwise noted)

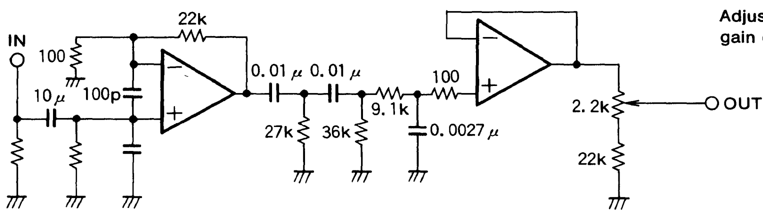
Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
I_{CCO}	Quiescent circuit current	V_{VOL}=0V, V_I=0	7	12	20	mA
ATT	Attenuation level	V_{VOL}=0V, V_I=150mVrms	83	92		dB
C. B	Channel balance	V_{VOL}=2.8V, V_I=1Vrms	−3	0	3	dB
THD	Total harmonic distortion	V_{VOL}=6.5V, V_I=150mVrms		0.015	0.1	%
R_i	Input resistance	$V_{VOL}\doteqdot$6.5V, V_I=1Vrms	50	150		kΩ
$V_{i(max)}$	Maximum input voltage	THD=1%	1.0	1.5		Vrms
N_O	Output noise voltage	V_i=0, JIS-A network		3.6	10	μVrms

TEST CIRCUIT



Note 1. S. G : HP 339A or equivalent
THD : HP : 339A or equivalent
V. V . Kikusui Model 1635 or equivalent
Note 2. A low-noise power supply should be used. (Less than 2μV)

- Where the specified JIS-A filter is not used, the following circuit can be substituted. Note that output is increased by a factor of 100.



Adjust for an IN → OUT gain of 40 dB at 1 kHz.

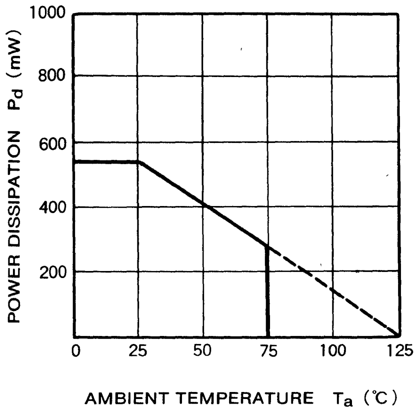
Unit Resistance : Ω
Capacitance : F

TEST METHODS (T_a=25℃, V_{CC}=12V, f=1kHz, unless otherwise noted)

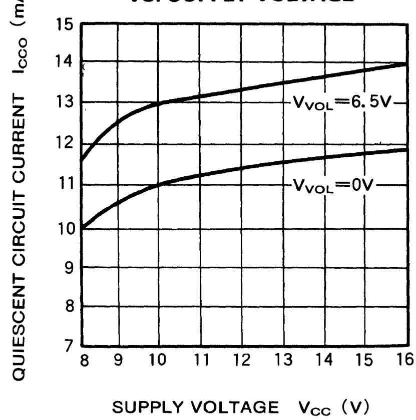
Parameter	Switch condition								Method
	S1	S2	S3	S4	S5	S6	S7	S8	
I_{CCO}	2	2	2	1	1		1	1	Measure with ammeter
ATT	1	1	1	1	1	1 2	1	1	Vary V_{VOL} from 0 to 6.5V and calculate using ATT=20 log(V_O/V_I)dB
C. B	1	1	1	1	1	1 2	1	1	Channel balance at V_{VOL}=2.8V
THD	1	1	1	1	1	1 2	1	1	At f=1kHz, V_i=150mVrms, and maximum volume, measure with distortion meter
R_I	1	1	1	1→2 1	1 1→2	1 2	1	1	Taking output V_O1 at S4=1, and output V_O2 at S_4=2, calculate using R_I=150/(V_O1/V_O2−1)kΩ
$V_{i(max)}$	1	1	1	1	1	1 2	1	1	At f=1kHz, the input voltage required to produce a THD of 1% at maximum volume
N_O	1	2	2	1	1	1 2	2	2	AT minimum volume level, R_g=10kΩ, JIS-A filter

TYPICAL CHARACTERISTICS (T_a=25℃, V_{CC}=12V, f=1kHz, unless otherwise noted)

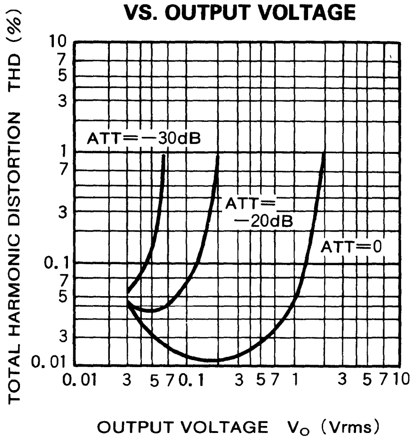
THERMAL DERATING (MAXIMUM RATING)



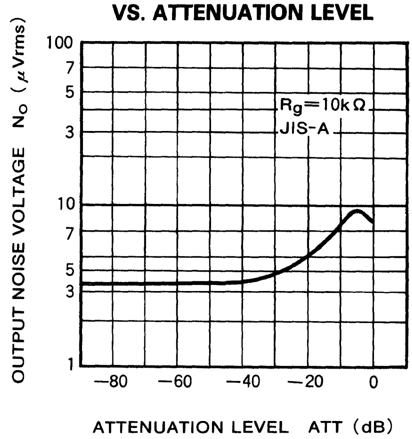
QUIESCENT CIRCUIT CURRENT VS. SUPPLY VOLTAGE



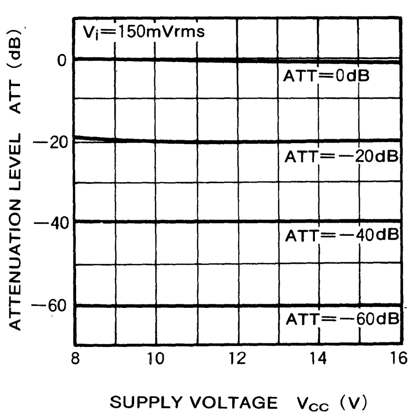
TOTAL HARMONIC DISTORTION VS. OUTPUT VOLTAGE



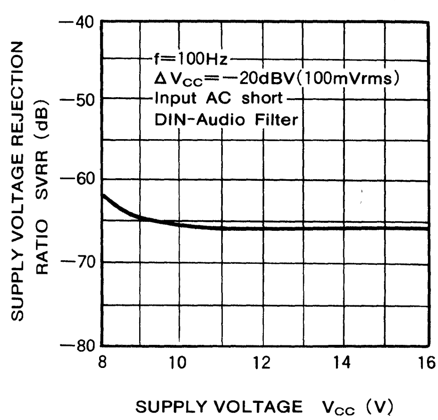
OUTPUT NOISE VOLTAGE VS. ATTENUATION LEVEL

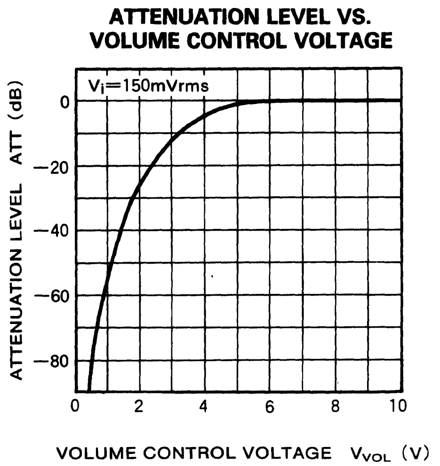


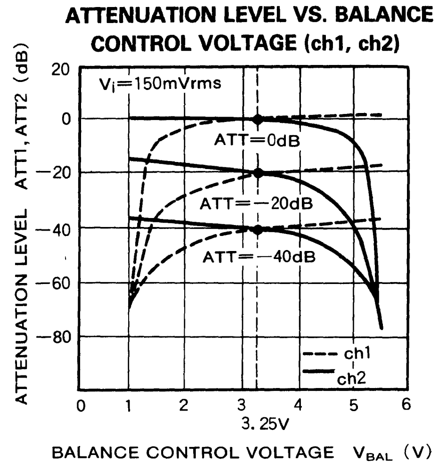
ATTENUATION LEVEL VS. SUPPLY VOLTAGE

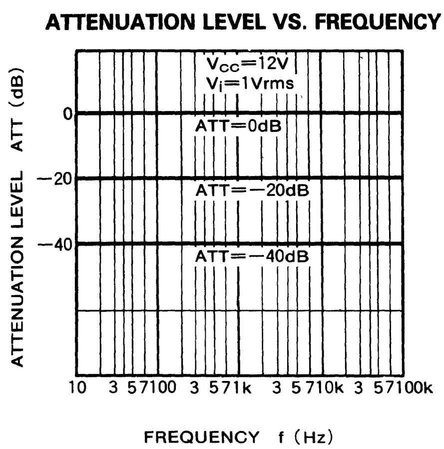


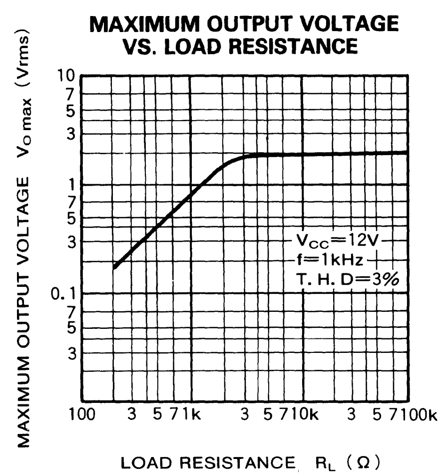
SUPPLY VOLTAGE REJECTION RATIO VS. SUPPLY VOLTAGE







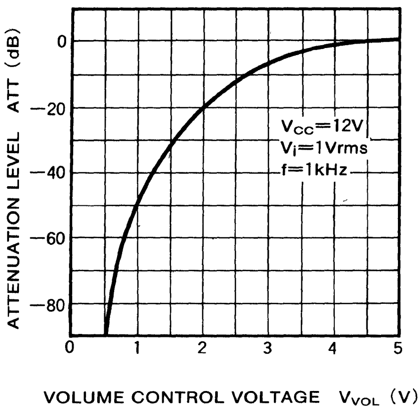




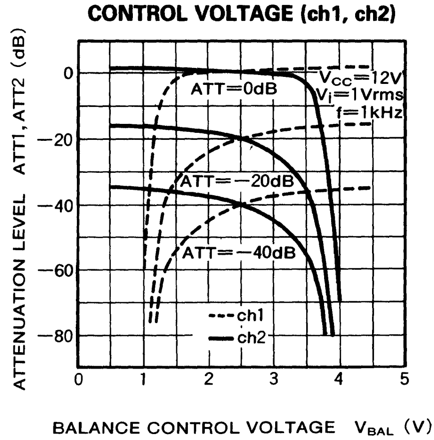
The attenuation characteristics and balance characteristics will change with the application of voltage to Pin ⑥. When the volume control voltage is equial to the Pin ⑥ voltage, there will be maximum volume. When the balance control voltage is half of the Pin ⑥ voltage, the balance will be centered.

The attenuation level characteristics and balance characteristics for an applied voltage of 5V to Pin ⑥ are shown in the following graphs.

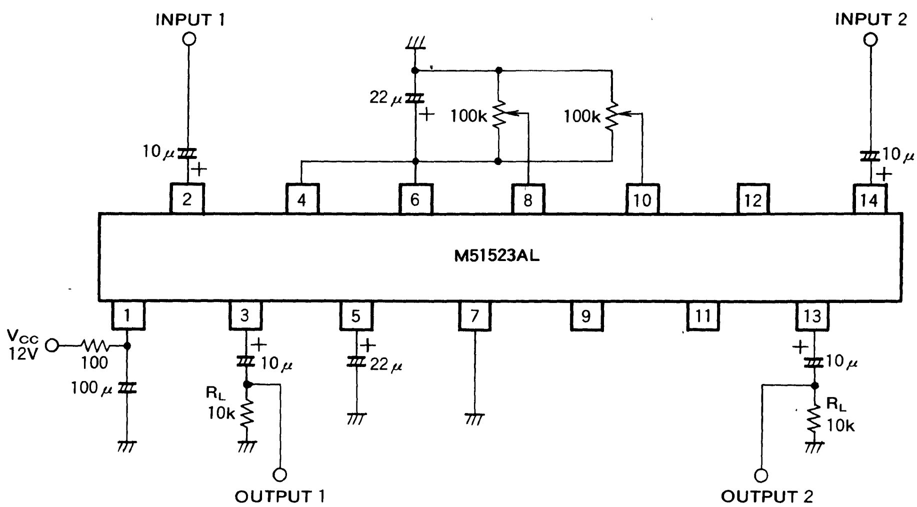
ATTENUATION LEVEL VS. VOLUME CONTROL VOLTAGE



ATTENUATION LEVEL VS. BALANCE CONTROL VOLTAGE (ch1, ch2)



APPLICATION EXAMPLE



Unit Resistance : Ω
Capacitance : F

MITSUBISHI ELECTRIC

ZERO-CROSS POINT SWITCH

DESCRIPTION

The M5172L is a semiconductor integrated circuit designed for use in zero-point ignition temperature control circuits. It consists of a rectifier circuit, zero-point synchronous pulse generator circuit, temperature adjustment circuit using a differential amplifier, and a pulse generator circuit that is used in safety circuit.

The built-in zero-point ignition circuit and differential amplifier can operate directly from commercial power supply voltage through a resistor of 10k (at 100Vrms AC), permitting the M5172L to be widely applied in temperature control circuits using thyristors.

FEATURES

- Can be driven directly from commercial power supply voltage (100Vrms AC)
- Built-in zero-point ignition control circuit
- Can compensate for line voltage and line freguency fluctuations
- Includes a pulse generator circuit for a safety circuit

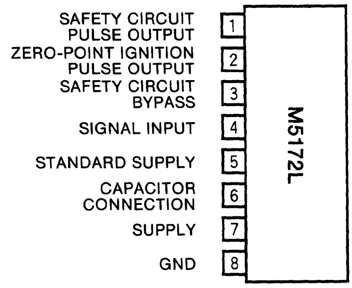
APPLICATION

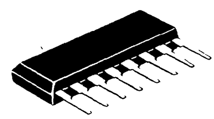
Temperature control circuit for electric blankets, zero-point ignition circuit for thyristors, and all kinds of temperature control ciocuits.

RECOMMENDED OPERATING CONDITIONS

AC supply voltage range ············· 90~110Vrms(50~60Hz)
Rated AC supply voltage ···················· 100Vrms(50~60Hz)
(Note that a resistor of 10k or greater (≧2W) should be connected between pin ⑦ and the AC supply voltage.

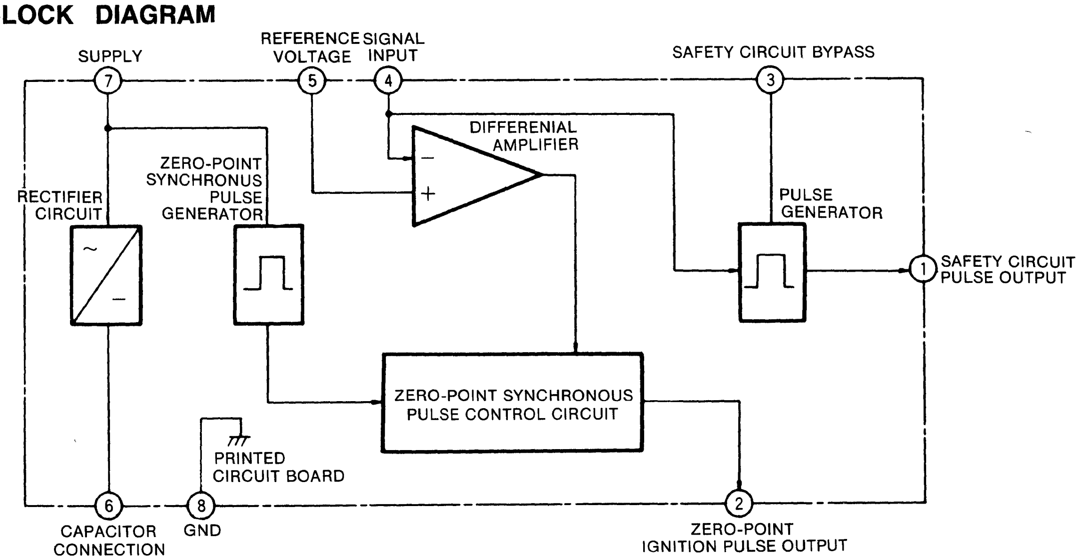
PIN CONFIGURATION (TOP VIEW)





8-pin molded plastic SIP

BLOCK DIAGRAM



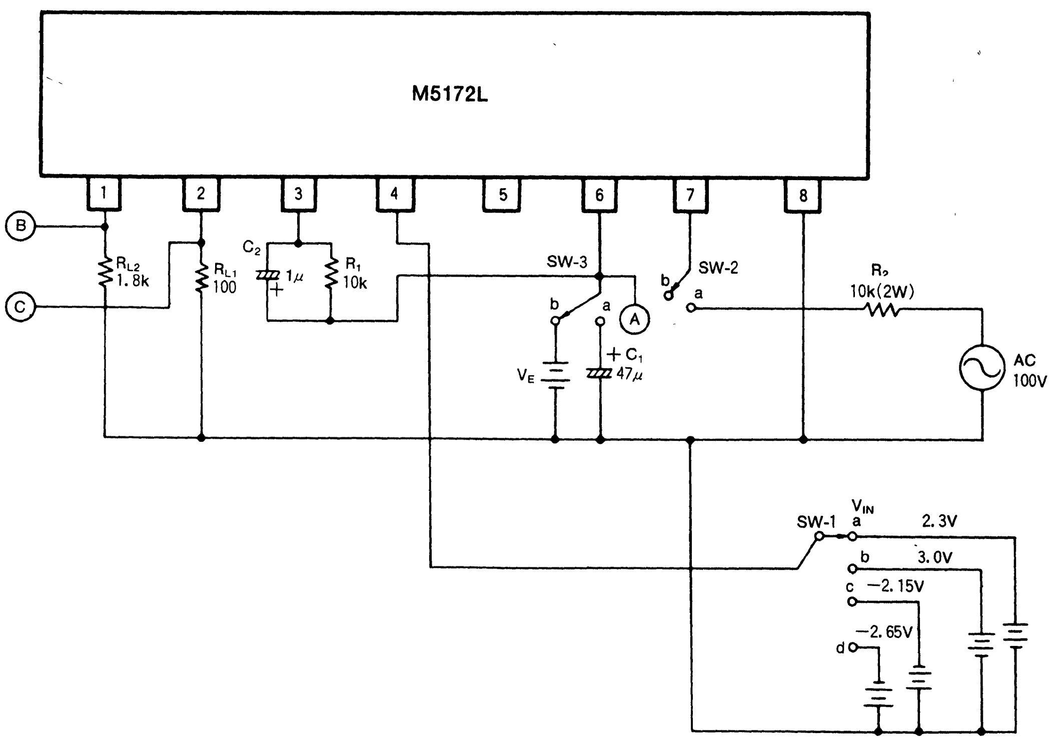
ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage (between pins ⑦ and ⑧)		10	V
$I_{⑦}$	Pin ⑦ sink current		10	mA
P_d	Power dissipation		360	mW
K_θ	Thermal derating	T_a≧25℃	3.5	mW/℃
Topg	Operating temperature range		−20～+60	℃
Tstg	Storage temperature range		−20～+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
V_{DC}	Rectification current (between pins ⑥ and ⑧)	C_1=47μF, R_2=10kΩ	5.85		6.9	V
V_{TH-T}	Differential amplifier ON level	V_E=5.9V	2.3	2.7	3.0	V
V_{TH-S}	Safety circuit ON level	V_E=5.9V	−2.65	−2.4	−2.15	V
$V_{OH(T)}$	Zero-point synchronous pulse peak value	R_{L1}=100Ω, V_E=5.9V	0.65			V
$V_{OH(S)}$	Safety circuit output pin "H" level	R_{L2}=1.8kΩ, V_E=5.9V	0.59			V

TEST CIRCUIT



Unit
Resistance : Ω
Capacitance : F

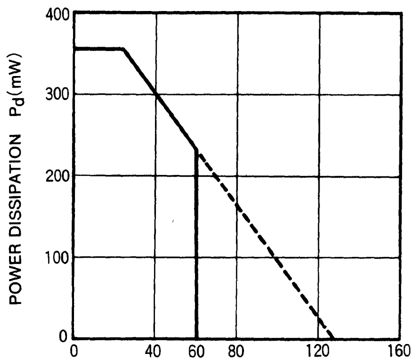
TEST METHODS

Symbol	SW-1	SW-2	SW-3	Measurement point
V_{DC}	a	a	a	A
V_{TH-T}	a b	b	b	C
V_{TH-T}	c d	b	b	B
$V_{OH(T)}$	a	b	b	C
$V_{OH(S)}$	d	b	b	B

TYPICAL CHARACTERISTICS

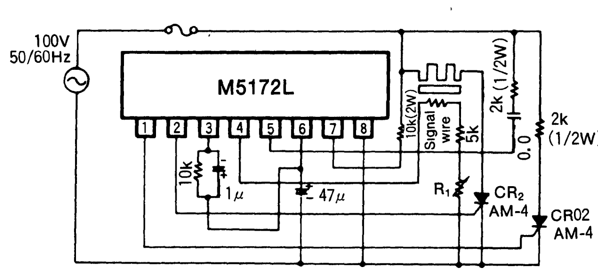
(T_a=25℃, unless otherwise noted)

THERMAL DERATING (MAXIMUM RATING)



APPLICATION EXAMPLES

(1) Electric Blanket Temperature Control Circuit

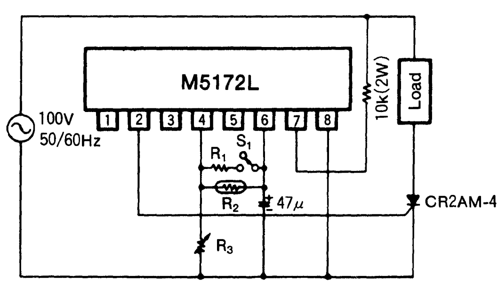


Unit

Resistance : Ω

Capacitance : F

(2) Thyristor Zero-Point Ignition Circuit



R_2 : NTC thermistor 10k

S_1 : OFF Only when thermistor used

S_1 : ON Linear compensation of thermistor

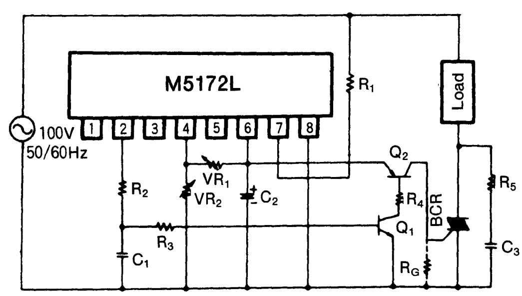
R_1' : 10kΩ

Unit

Resistance : Ω

Capacitance : F

(3) BCR Zero-Point Ignition Circuit



R_1 : 10kΩ (2W) R_2 : 1kΩ (1/4W) R_3 : 10kΩ (1/4W)

R_4 : 1kΩ (1/4W) R_5 : 100Ω (1/2W) C_1' : 0.068μF(50WV)

C_2 : 220μF(25WV) C_3 : 0.1μF(400WV) Q_1 : 2SC712-D

Q_2 : 2SA696-D BCR : BCR3AM~BCR25A

M51743P

SEQUENCE CONTROLLER

DESCRIPTION

The M51743P is a semiconductor integrated circuit designed for use as sequence controller for oil combustion systems. It consists of five comparators and two voltage regulation circuits.

Three of the comparators can be used for sensor signal monitoring and two can be used for driving relays, etc.

Since one of the comparators for drive applications has a redundant "2" structure, the M51743P is especially suitable for use in oil combustion system, for which sefety operation is required.

FEATURES

- Includes five comparators (three for signal monitoring and two for drive purposes)
- Includes two voltage regulation circuits ······························5.5V (typ), 6.2V (typ)
- Can directly drive relays, lamps, etc,
- Built-in memory function (comparator (2))
- Built-in hysteresis function (comparators (1), (4), (5))
- Redundancy "2" safety circuit design (comparator (5))
- Built-in reference power supply reduces the number of external parts
- Wide supply voltage range ························· 8.5~20V

APPLICATION

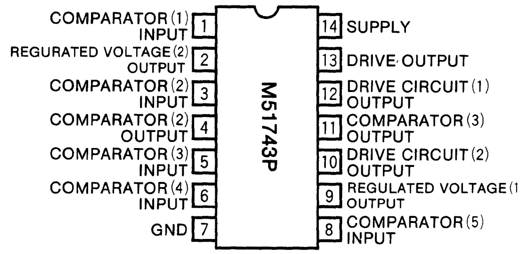
Sequence controller (in oil and gas combustion systems), flame detection circuits.

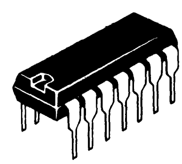
RECOMMENDED OPERATING CONDITIONS

Supply voltage range ································ 8.5~20V

Rated supply voltage ······································ 12V

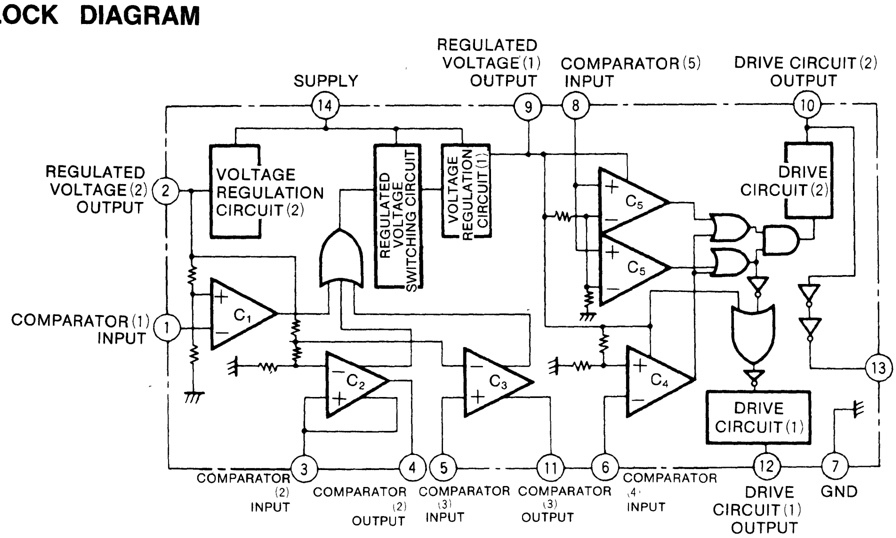
PIN CONFIGURATION (TOP VIEW)





14-pin molded plastic DIP

BLOCK DIAGRAM



PINS ④, ⑩, ⑪, ⑫ : OPEN-COLLECTOR OUTPUT

PIN ⑬ : EMITTER-FOLLOWER OUTPUT

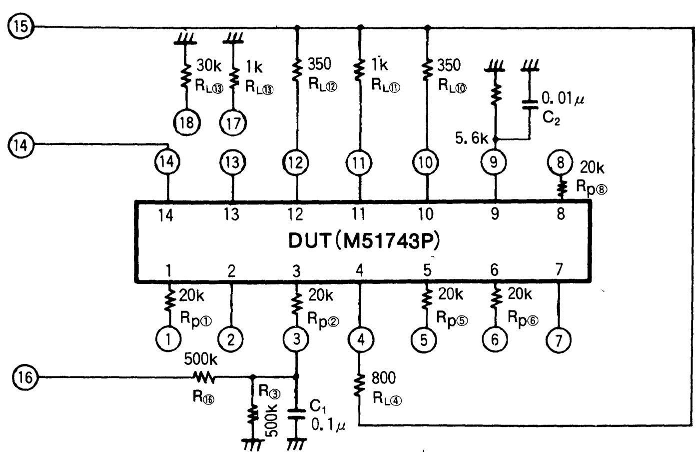
ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		20	V
I_{CC}	Circuit current		22	mA
$I_{L④}$	Pin ④ maximum current	*Instantaneous peak value	70	mA
$I_{L⑩}$	Pin ⑩ maximum current		60	mA
$I_{L⑫}$	Pin ⑫ maximum current		60	mA
P_d	Power dissipation		900	mW
K_θ	Thermal derating	$T_a \geqq 25$℃	9	mW/℃
Topr	Operating temperature range		−20～+65	℃
Tstg	Storage temperature range		−40～+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=15V)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
$V_{O(1)}$	Voltage regulation circuit (1) output	Pin ⑩, pin ⑫ ON state	5.0	5.5	6.3	V
$V_{O(2)}$	Voltage regulation circuit (2) output		5.0	6.1	6.9	V
$I_{CC(I)}$	Circuit current (I)	$V_⑥$=1.2V, $V_⑧$=3V	6	14	20	mA
$I_{CC(II)}$	Circuit current (II)	$V_⑥$=4.5V	2	10	17	mA
$V_{ON(1)}$	Comparator (1) ON voltage		3.8	4.4	5.3	V
$V_{OFF(1)}$	Comparator (1) OFF voltage		3.0	3.5	4.6	V
$I_{IN(1)}$	Comparator (1) input current	$V_①$=5.1V		0.15	0.6	μA
$V_{ON(2)}$	Comparator (2) ON voltage		1.5	2.0	2.8	V
$V_③$	Pin ③ clmp voltage	$R_③$=500kΩ	4.9	5.75	6.3	V
$V_{sat④}$	Pin ④ output saturation voltage	$R_{L④}$=800Ω	0.9	1.12	1.5	V
$V_{ON(3)}$	Comparator (3) ON voltage		2.5	3.3	4.1	V
$I_{IN(3)}$	Comparator (3) input current	$V_⑤$=4V		0.15	0.5	μA
$V_{sat⑪}$	Pin ⑪ output saturation voltage	$R_{L⑪}$=1kΩ, $V_⑤$=4.1V	1.3	1.83	3.0	V
$V_{REF I(4)}$	Comparator (4) reference voltage (I)		3.3	3.84	4.5	V
$V_{REF II(4)}$	Comparator (4) reference voltage (II)		2.9	3.55	3.9	V
$I_{IA(4)}$	Comparator (4) input current	$V_⑥$=2.5V		50	250	nA
$V_{ON(5)}$	Comparator (5) ON voltage		2.0	2.3	2.7	V
$V_{OFF(5)}$	Comparator (5) OFF voltage		1.6	2.0	2.3	V
$I_{IN(5)}$	Comparator (5) input current	$V_⑧$=2.5V		0.1	0.35	μA
$V_{sat⑩(1)}$	Pin ⑩ output saturation voltage (1)	$R_{L⑩}$=350Ω, V_{CC}=10V		0.3	0.9	V
$V_{sat⑫(1)}$	Pin ⑫ output spturation voltage (1)	$R_{L⑫}$=350Ω, V_{CC}=10V		0.3	0.9	V
$V_{OH⑬}$	Pin ⑬ output voltage	$R_{L⑬}$=1kΩ	7.5			V

TEST CIRCUIT



Unit
Resistance : Ω
Capacitance : F

TEST METHODS

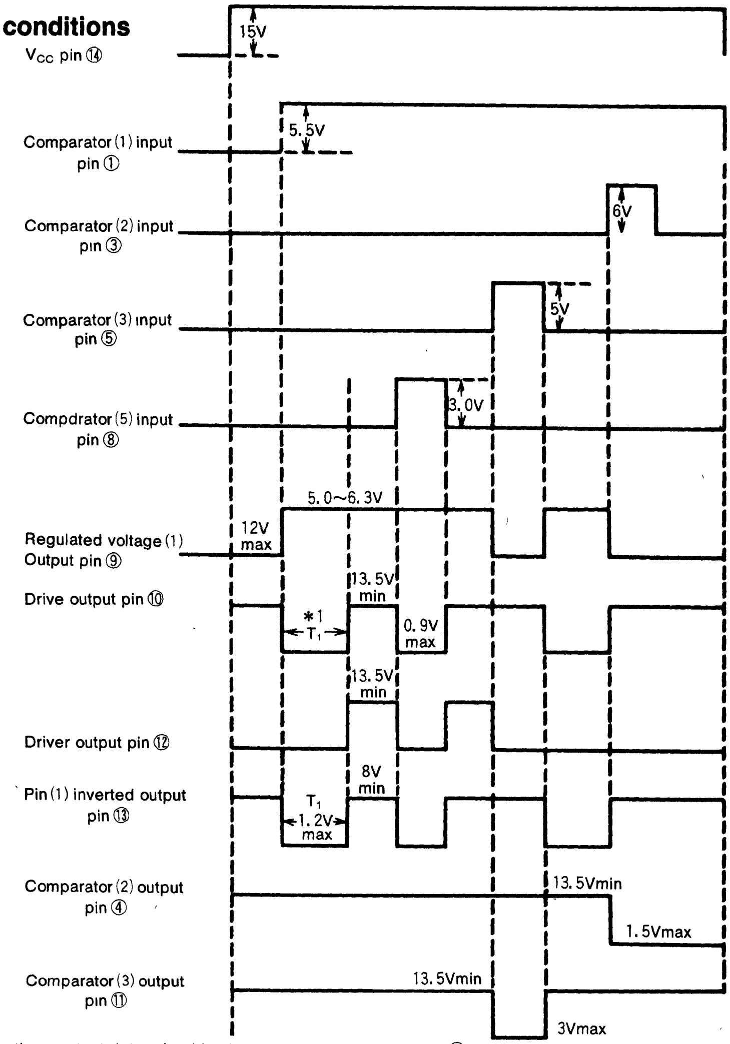
Symbol	Pin No. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Measurement point
$V_{O\ (1)}$	②*1	①	GND		GND	1.2V	GND	GND	Ⓜ*2				⑰	15V	15V		⑬		⑨
$V_{O\ (2)}$	5.2	Ⓜ				1.2V							⑰	15V			⑬		②
$I_{CC\ (1)}$						1.2V		3V					⑱	Ⓜ 15V				⑬	⑭
$I_{CC(II)}$						4.5V							⑱	Ⓜ 15V				⑬	⑭
$V_{ON\ (1)}$	1.3V 3.8V					1.2V			Ⓜ				⑰	15V			⑬		⑨
$V_{OFF\ (1)}$	4.6V 3.0V								Ⓜ										⑨
$I_{IN\ (1)}$	Ⓜ 5.1V		GND																①
$V_{ON\ (2)}$	②	①				1.2V			Ⓜ										⑨
$V_{③}$			Ⓜ					GND											③
V_{sat} ④				Ⓜ	GND	1.2V		GND											④
$V_{ON\ (3)}$			GND		4.1V 2.5V				Ⓜ										⑨
$I_{IN\ (3)}$					Ⓜ 4V														③
V_{sat} ⑪					4V	1.2V					Ⓜ								⑪
$V_{REF\ I\ (4)}$					GND	4.1V 3.3V				Ⓜ									⑩
$V_{REF\ II\ (4)}$						3.9V 2.9V				Ⓜ				15V					⑩
V_{sat} ⑫ (1)						4.5V		2.6V				Ⓜ	⑰	10V					⑫
V_{OH} ⑬								2.6V					⑰ Ⓜ	15V					⑬
$I_{IN\ (4)}$						Ⓜ 2.5V							⑰						④
$V_{ON\ (5)}$						4.5V		2.7V 2.0V				Ⓜ							⑫
$V_{OFF\ (5)}$								2.3V 1.6V				Ⓜ							⑫
$I_{IN\ (5)}$								2.5V						15V					⑤
V_{sat} ⑩ (1)	②	①	GND		GND	4.5V	GND	2.6V		Ⓜ			⑰	10V	15V		⑬		⑩

*1 : ○ indicates pin number
*2 : Ⓜ indicates measurement pin

M51743P OPERATION TIME CHART

Input application conditions

Output waveform



* 1 : T_1 is the timer output determined by the external connection of pin ⑥

M51743P INPUT/OUTPUT TRUTH TABLE
Operation comparators (1), (2), (3)

	Pin No.	State			
Input	Pin ①	0*1	1	1	1
	Pin ③	0	0	1	0
	Pin ⑤	0	0	0	1
Output	Pin ⑨	0	1	0	0
	Pin ⑩	1*2	0*4	1	1
	Pin ⑫	0*2	0*4	0	0
	Pin ⑬	1*3	0*4	1	1
	Pin ④	1*2	1	0	1
	Pin ⑪	1*2	1	1	0

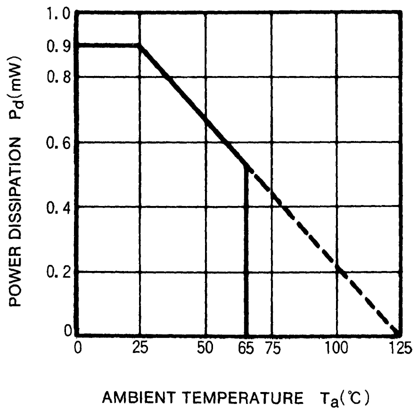
* 1 : "1" and "0" indicate the "H" and "L" voltage levels of the pins
* 2 : Pins ⑩, ⑫, ④, ⑪ are ON at "0" and OFF at "1" (open-collector output)
* 3 : Pin ⑬ is ON at "1" and OFF at "0" (emitter-follower output)
* 4 : Will be 0 or 1 depending on the condition of comparators (4) and (5)

Operation comparators (4), (5)

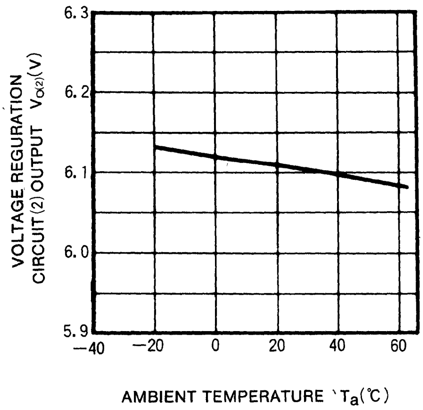
	Pin No	State							
Input	Pin ⑨	1	1	1	1	0	0	0	0
	Pin ⑥	0	1	0	1	0	1	—	—
	Pin ⑧	0	0	1	1	—	—	0	1
Output	Pin ⑩	0	1	0	0	1	1	1	1
	Pin ⑫	0	1	0	0	0	0	0	0
	Pin ⑬	0	1	0	0	1	1	1	1

TYPICAL CHARACTERISTICS (T_a=25℃, V_{CC}=9V, unless otherwise noted)

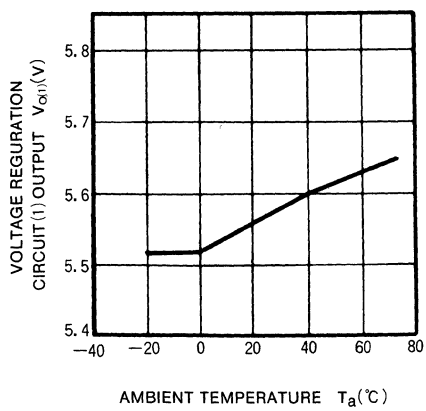
THERMAL DERATING (MAXIMUM RATING)



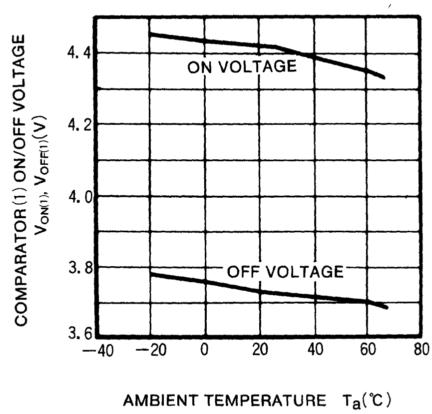
VOLTAGE REGULATION CIRCUIT (2) VS. AMBIENT TEMPERATURE



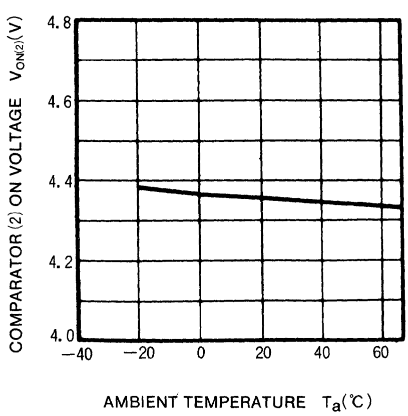
VOLTAGE REGULATION CIRCUIT (1) AMBIENT TEMPERATURE



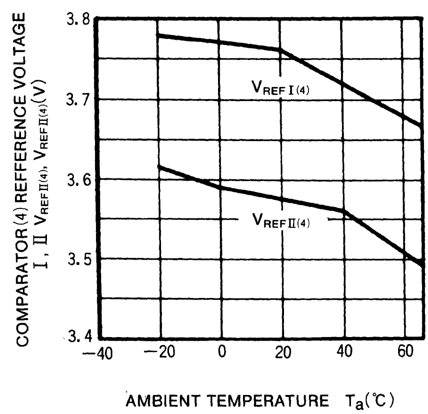
COMPARATOR ON/OFF VOLTAGE VS. AMBIENT TEMPERATURE



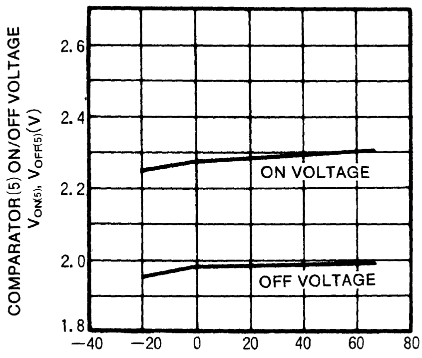
COMPARATOR (2) ON VOLTAGE VS. AMBIENT TEMPERATURE



COMPARATOR (4) REFFERENCE VOLTAGE I, II VS. AMBIENT TEMPERATURE

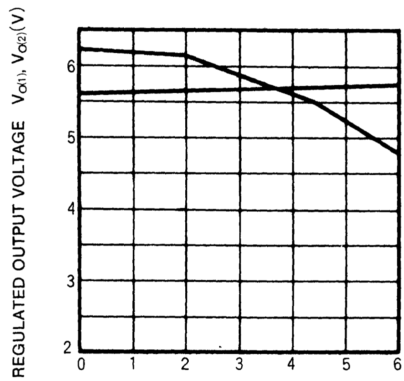


COMPARATOR (5) ON/OFF VOLTAGE VS. AMBIENT TEMPERATURE



AMBIENT TEMPERATURE T_a(℃)

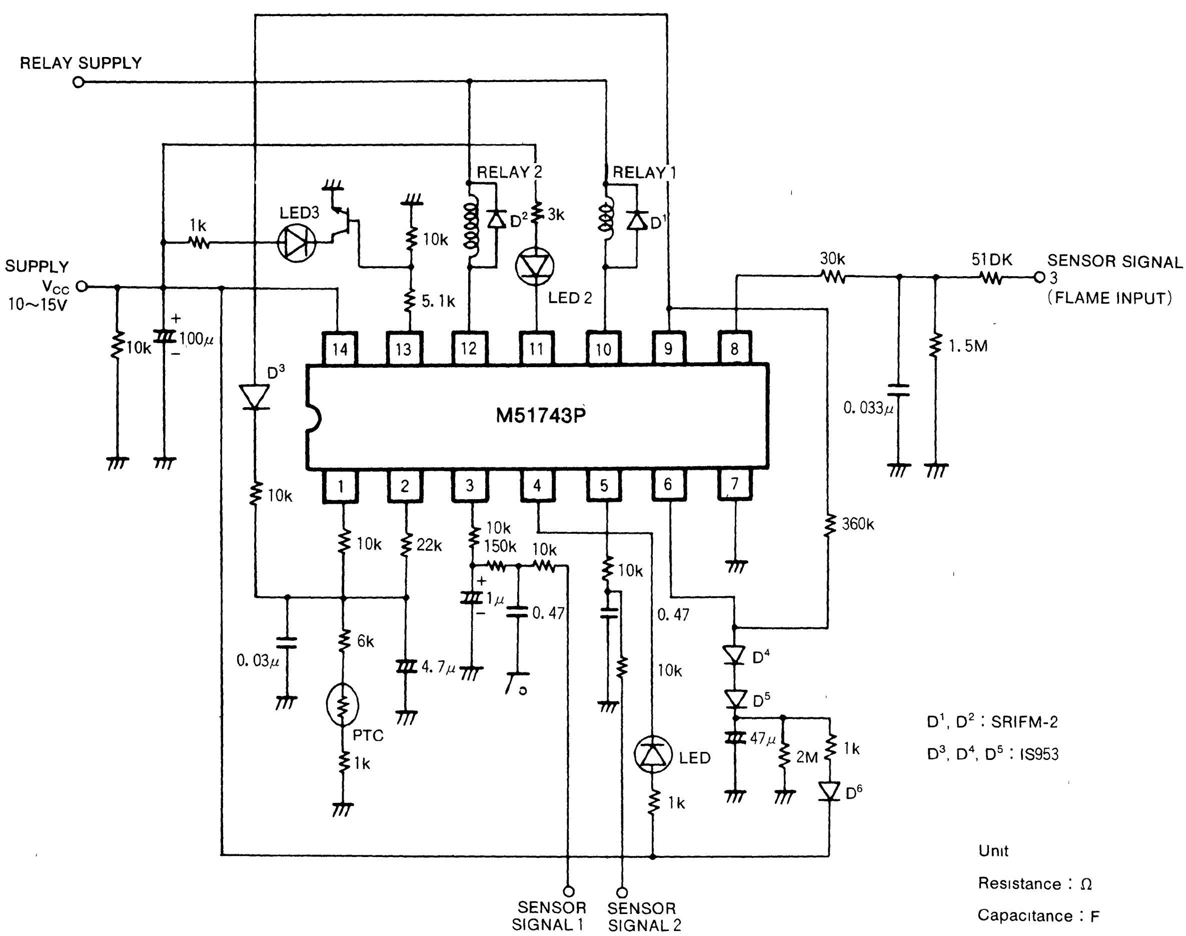
REGULATED OUTPUT VOLTAGE VS. LOAD CURRENT



LOAD CURRENT I_L(mA)

APPLICATION EXAMPLE

Example of using comparator (4) as timer operation



D¹, D² : SRIFM-2
D³, D⁴, D⁵ : IS953

Unit
Resistance : Ω
Capacitance : F

M5174P

FLAME DETECTOR

DESCRIPTION

The M5174P is a semiconductor integrated circuit designed for use in a flame detection circuit.

It consists of a voltage regulation circuit, an input amplifier circuit that amplifies extremely small input currents and drives a thyristor, and a bias circuit that supplies current to a shunt circuit connected in parallel with the load (relay) and the externally-connected capacitor used as a gate trigger for the thyristor circuit. The thyristor circuit drives the external load (relay) and there are two shunt circuits that protect the load (relay) under abnormalities or at quiescence, in addition to an overcurrent protection circuit.

FEATURES

- Includes a fail-safe system (redundancy 2) that permits simple construction of a system featuring a high level of safety
- Includes a voltage regulation circuit and an over-current protection circuit
- Small threshold value of temperature fluctuation of the operating input current
  ······ Characteristic value of the normal temperature 20% (T_a=−20~+60℃)
- High maximum input current ······················ 50μA (max)

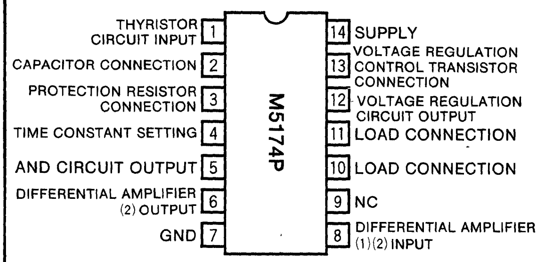
APPLICATION

Flame detection circuits (in oil and gas combustion systems), relay drivers.

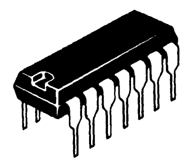
DESCRIPTION OF FALL-SAFE SYSTEM

1. This system uses two differential amplifiers and drives AND and OR circuits by two input signals. Noise on the input can lead to abnormal operation and surges, which can cause circuit destruction. This system can prevent abnormal operation due to such events.
2. Even if the thyristor and AND circuits should be destroyed by a surge or some other cause, the shunt circuit will operate so that load (relay) dose not conduct.
3. The over-current protection circuit prevents the load (relay) form conducting even at times of abnormally high current flow.

PIN CONFIGURATION (TOP VIEW)



NC : NO CONNECTION



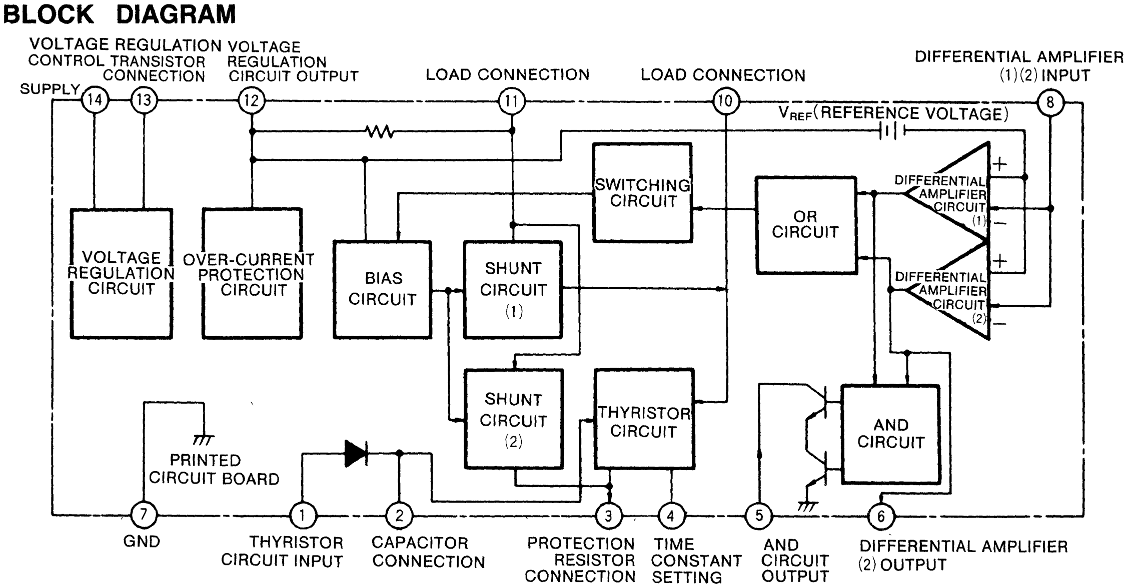
14-Pin molded plastic DIP

RECOMMENDED OPERATING CONDITIONS

Supply voltage range ··· 12~20V

Rated supply voltage ··· 15V

BLOCK DIAGRAM



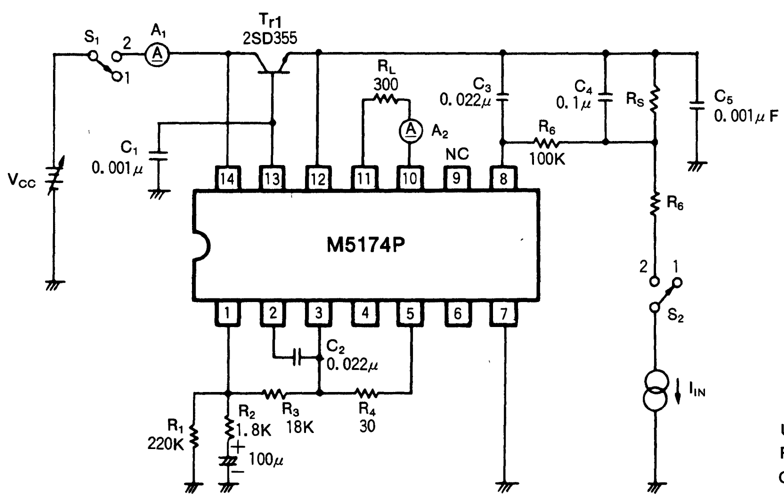
ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage	Stand-by	20	V
I_{CC}	Circuit current		40	mA
I_{IN}	Input current		50	μA
Pd	Power dissipation		650	mW
K_θ	Thermal derating	T_a≧25℃	6.5	mW/℃
Topg	Operating temperature		−20～+60	℃
Tstg	Storage temperature range		−40～+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
V_{CC1}	Supply voltage	Stand-by	12	15	20	V
V_{CC2}		Operating (I_{CC}≦36mA)	12	15	17	V
I_{CC1}	Quiescent circuit current	V_{CC}=15V	7	10	14	mA
I_{CC2}	Operating circuit current	I_L=20mA, V_{CC}=17V		30	36	mA
I_L	Load current	R_L=300Ω, V_{CC}=17V	15			mA
V_{O1}	Voltage regulation circuit output voltage	Quiescent, V_{CC}=12V	9.5	10.3	11.5	V
V_{O2}		Operating, V_{CC}=12V	9.2	10	11.5	V
I_{IN}	Input ON current	R_L=300Ω, V_{CC}=17V, R_S=4.7MΩ	0.48	0.60	0.72	μA
$I_{IN(max)}$	Maximum input current	V_{CC}=17V	50			μA
I_{LS1}	AND circuit short-circuit load current	Quiescent, V_{CC}=15V			5	mA
I_{LS2}	AND Circuit, thyristor circuit short-circuit load current	Quiescent, V_{CC}=15V			8	mA

TEST CIRCUIT



Unit
Resistance : Ω
Capacitance : F

TEST CONDITION

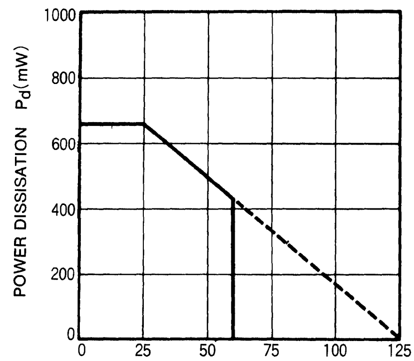
Symbol	S_1	S_1	Measurement point
I_{CC1}	2	1	Note 3 : A_1
I_{CC2}	2	2	A_1
I_L	2	2	Note 2 : A_2
V_{O1}	2	1	Pin (12)
V_{O2}	2	2	Pin (12)
I_{IN}	2	2	A_2
$I_{IN(max)}$	2	2	A_2
Note 3 : I_{LS1}	2	1	A_2
Note 4 : I_{LS2}	2	1	A_2

Note 1. A_1 : Current inflowing from supply V_{CC}
Note 2. A_2 : Current inflowing from pin (11) to pin (10)
Note 3. Short circuit condition between pins (5) and (7)
Note 4. Short circuit condition between pins (5) and (7), (10) and (5)

TYPICAL CHARACTERISTICS

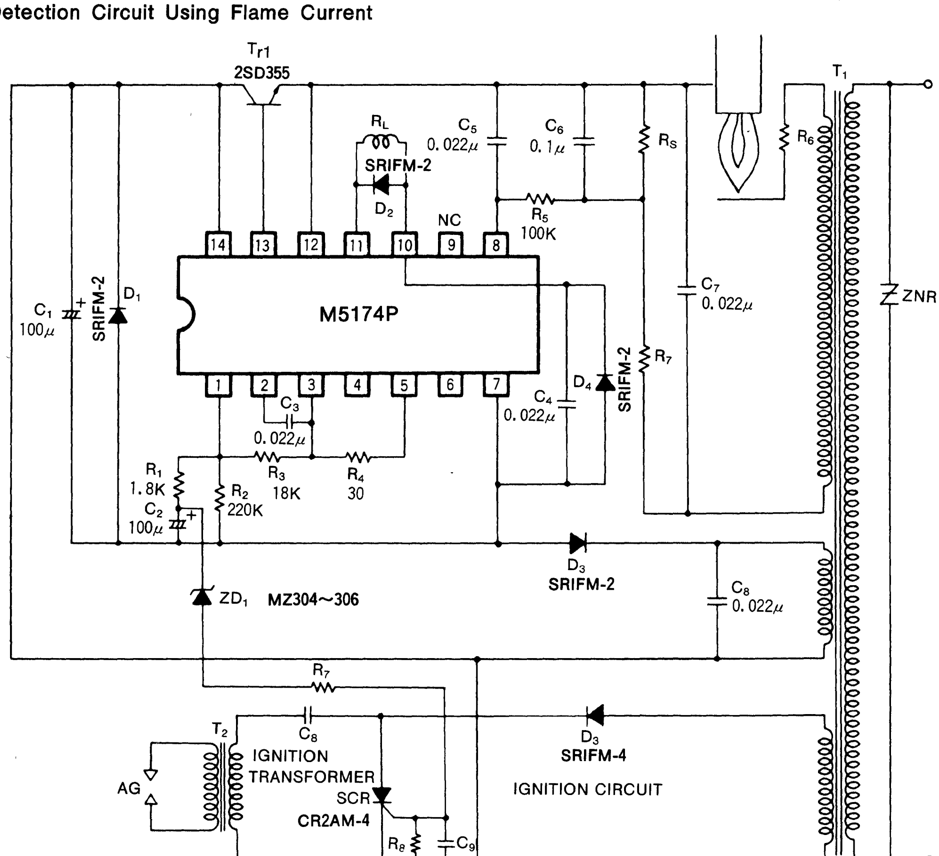
(T_a=25℃, unless otherwise noted)

THERMAL DERATING
(MAXIMUM RATING)



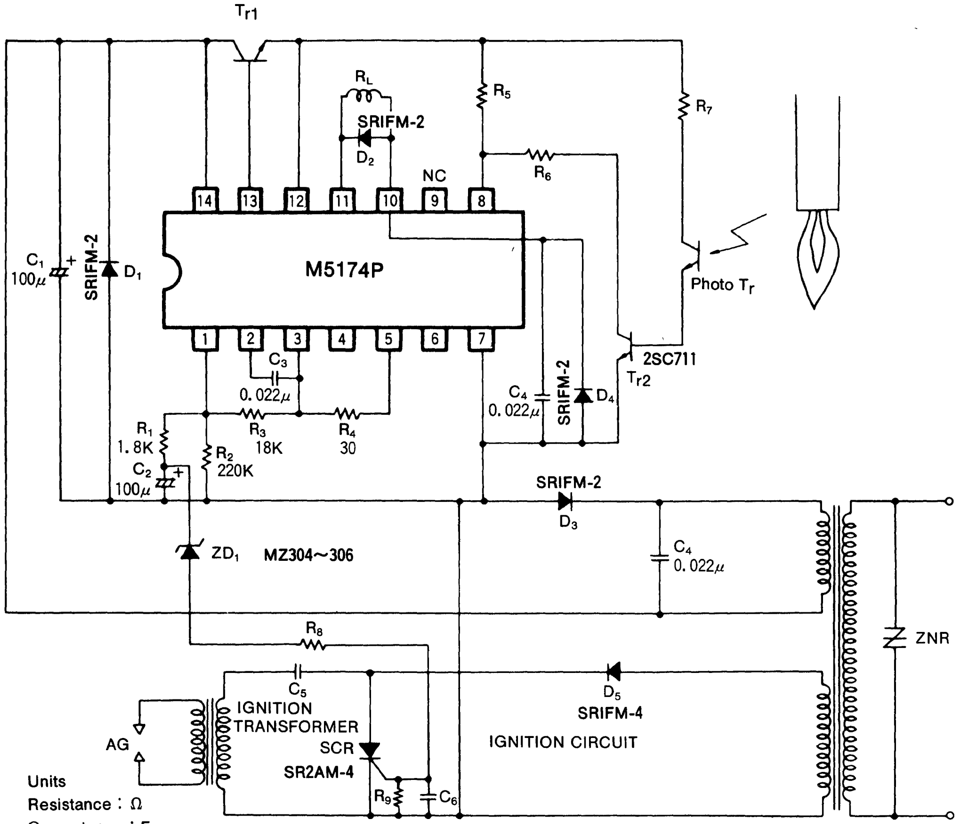
APPLICATION EXAMPLES

(1) Flame Detection Circuit Using Flame Current



Units
Resistance : Ω
Capacitance : F

(2) Flame Detection Circuit Using a Photo Transistor



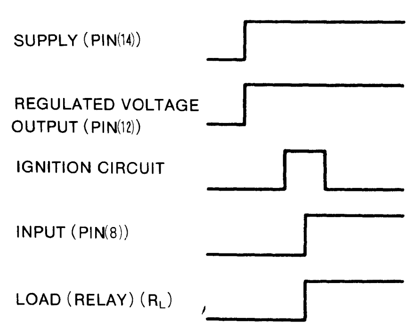
Units
Resistance : Ω
Capacitance : F

MAXIMUM VOLTAGE RATING FOR EACH PIN

Voltage is in reference to ground (pin (7))

Pin	Voltage rating: Negative	Voltage rating: Positive	Pin condition
①	−80V	50V	1.8KΩ between GND, 100μF connected
②	−20V	60V	0.022μF connected between pin (3)
③	−20V	30V	18KΩ connected between pin (1)
④	−40V	70V	Open
⑤	−15V	40V	30Ω connected between pin (3)
⑥	−15V	10V	Open
⑦	Ground		GND
⑧	−80V	70V	0.022μF connected between pin (12)
⑨	NC		NC
⑩	−20V	20V	0.022μF connected between GND
⑪	−20V	20V	300Ω connected between pin (10)
⑫	−10V	20V	0.022μF connected between pin (8)
⑬	−20V	30V	0.001μF connected between GND
⑭	−20V	50V	Open

TIME SEQUENCE OUTLINE DIAGRAM



M51920P

LOW POWER SUPPLY VOLTAGE INDICATOR, WARNING DRIVER

DESCRIPTION

The M51920P is a semiconductor integrated circuit designed for use as a driver in all types of indicators and warning circuits. It is especially suited for low-voltage operation and one battery can be used to directly drive a buzzer, bell, or lamp. There is also a built-in voltage raising circuit, the use of which permits LED driving. A timer circuit made up of a four-stage divider has also been included, making the M51920P suitable for a wide range of applications.

FEATURES

- Low-voltage operation is possible ····················1.1~1.8V
- Small standby current drain ·····························5μA(typ.)
- Can directly drive a buzzer, bell, lamp, etc. ·· 300mA(typ.)
- LED blinking indication is possible with an external clock
- Built-in 4-stage divider with reset pin, in addition to a buffer circuit

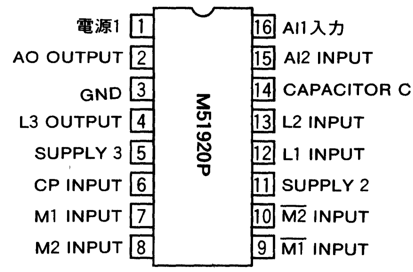
APPLICATION

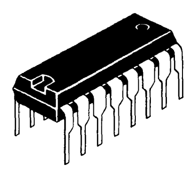
All types of detectors, indicators, and warning circuits.

RECOMMENDED OPERATING CONDITIONS

Supply voltage range ··································1.1~1.8V
Rated supply voltage ··1.5V

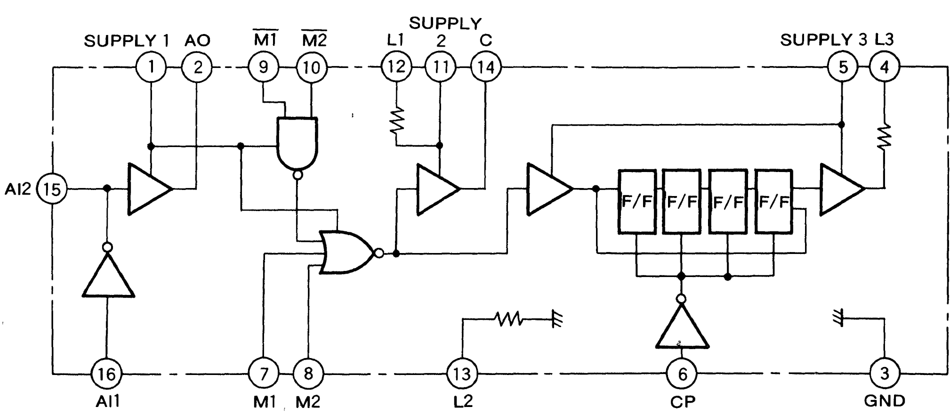
PIN CONFIGURATION (TOP VIEW)





16-pin molded plastic DIP

EQUIVALENT CIRCUIT DIAGRAM



ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

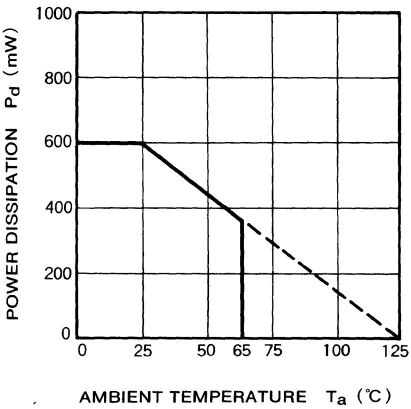
Symbol	Parameter	Conditions	Ratings	Unit
V_{CC1}	Supply voltage		−0.2~2.0	V
V_{CC2}	Supply voltage		−0.2~2.0	V
V_{CC3}	Supply voltage		−0.2~2.0	V
I_{AO}	Pin ② drive current	Output is saturated	300	mA
I_{L3}	Pin ④ drive current	Output is saturated	70	mA
Pd	Power dissipation		600	mW
Topr	Operating temperature range		−15~+65	℃
Tstg	Storage temperature range		−40~+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=1.5V, unless otherwise noted)

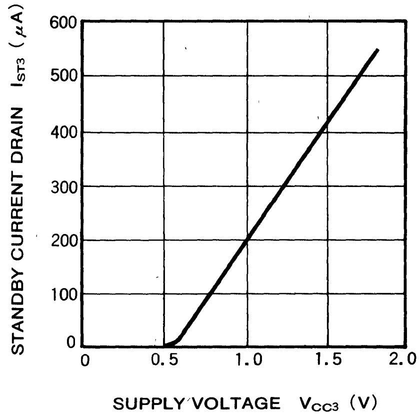
Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage		1.1		1.8	V
I_{ST1}	Standby current drain	V_{CC1}=1.5V, other pins open			5	µA
I_{ST2}		V_{CC1}, V_{CC2}=1.5V, other pins open			10	µA
I_{ST3}		V_{CC3}=1.5V, other pins open, L_3 is "H"		420	630	µA
I_{opr1}	Operating current drain	V_{CC1}=1.5V, I⑯=350µA, other pins open		10	20	mA
I_{opr2}		V_{CC1}=1.5V, AI2=GND, other pins open		10	20	mA
I_{opr3}		V_{CC2}=1.5V, $\overline{M1}$, $\overline{M2}$=GND, other pins open		2	4	mA
I_{opr4}		V_{CC3}=1.5V, $\overline{M1}$, $\overline{M2}$=GND, other pins open		5	10	mA
I_{IH1}	AI1 input pin current	V_{CC1}=1.2V, AI1=1.2V		450	700	µA
I_{IL1}	AI1 input leakage current	V_{CC1}=1.2V, AI1=GND	−1			µA
I_{IH2}	AI2 input leakage current	V_{CC1}=1.2V, AI1=1.2V			1	µA
I_{IL2}	AI2 input pin current	V_{CC1}=1.2V, AI2=GND	−4	−2		mA
I_{IHM1}	M1 input pin current	V_{CC1}, V_{CC2}=1.2V, M1=1.2V		50	75	µA
I_{ILM1}	M1 input leakage current	V_{CC1}, V_{CC2}=1.2V, M1=GND	−1			µA
I_{IHM2}	M2 input pin current	V_{CC1}, V_{CC2}=1.2V, M2=1.2V		50	75	µA
I_{ILM2}	M2 input leakage current	V_{CC1}, V_{CC2}=1.2V, M2=GND	−1			µA
$I_{IH\overline{M1}}$	$\overline{M1}$ input leakage current	V_{CC1}, V_{CC2}=1.2V, $\overline{M1}$=1.2V			1	µA
$I_{IL\overline{M1}}$	$\overline{M1}$ input pin current	V_{CC1}, V_{CC2}=1.2V, $\overline{M1}$=GND	−75	−50		µA
$I_{IH\overline{M2}}$	$\overline{M2}$ input leakage current	V_{CC1}, V_{CC2}=1.2V, $\overline{M1}$=1.2V			1	µA
$I_{IL\overline{M2}}$	$\overline{M2}$ input pin current	V_{CC1}, V_{CC2}=1.2V, $\overline{M2}$=GND	−75	−50		µA
V_{SAT1}	AO output saturation voltage	V_{CC1}=1.2V, R_L=6Ω		0.2	0.3	V
$V_{SAT1'}$	AO output saturation voltage	V_{CC1}=1.2V, R_L=13Ω		0.1	0.2	V
V_{SAT2}	L3 output saturation voltage	V_{CC3}=1.2V, R_L=25Ω		0.3	0.5	V
I_{OH1}	L1 output pin current	V_{CC2}=1.2V, L1=GND	−7.8	−6.0	−4.2	mA
I_{OH2}	C output pin current	V_{CC2}=1.2V, C=GND	−350	−270	−190	µA
I_{OL3}	L2 output pin current	L2=1.2V	190	270	350	µA
I_{LAO}	AO output leakage current	V_{CC1}=1.5V, AI1=GND			1	µA

TYPICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

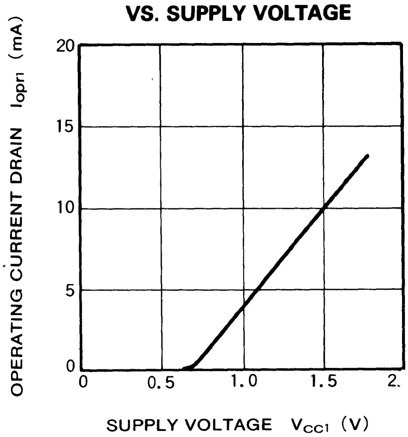
THERMAL DERATING (MAXIMUM RATING)



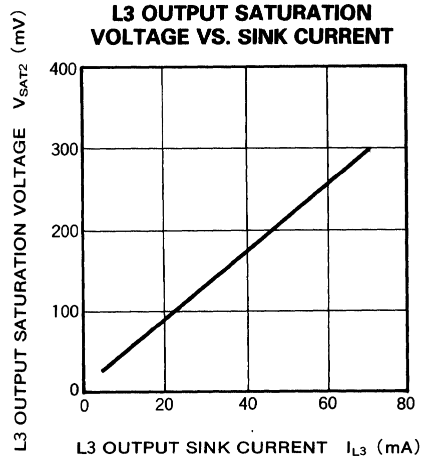
STANDBY CURRENT DRAIN VS. SUPPLY VOLTAGE



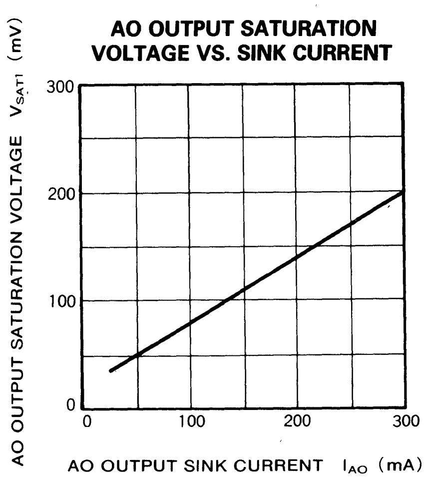
OPERATING CURRENT DRAIN VS. SUPPLY VOLTAGE



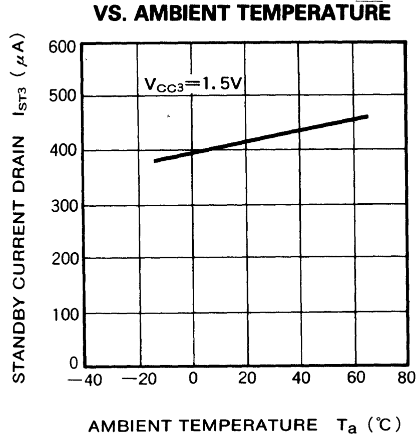
L3 OUTPUT SATURATION VOLTAGE VS. SINK CURRENT



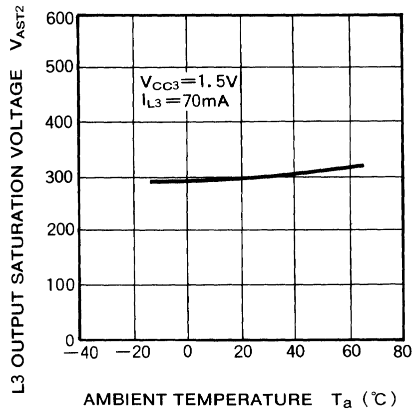
AO OUTPUT SATURATION VOLTAGE VS. SINK CURRENT



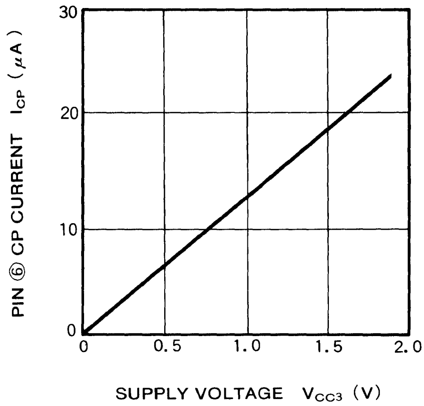
STANDBY CURRENT DRAIN VS. AMBIENT TEMPERATURE



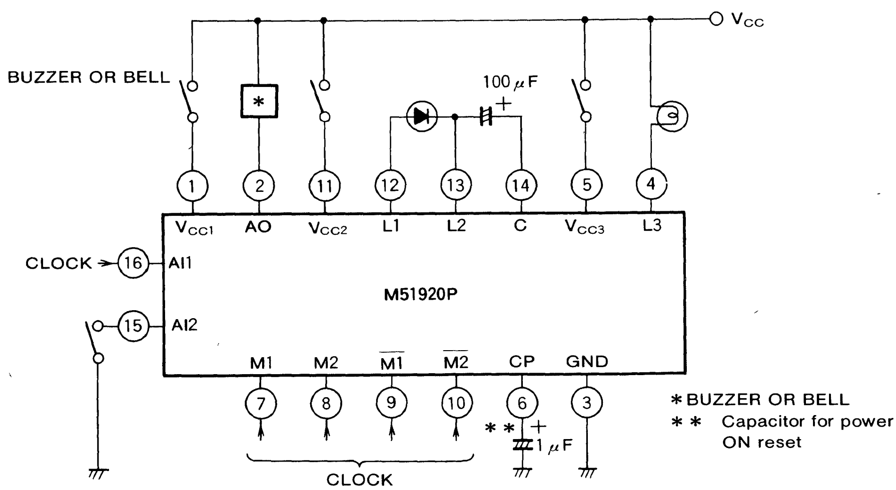
L3 OUTPUT SATURATION VOLTAGE VS. AMBIENT TEMPERATURE



PIN ⑥ CP CURRENT VS. SUPPLY VOLTAGE



APPLICATION EXAMPLE



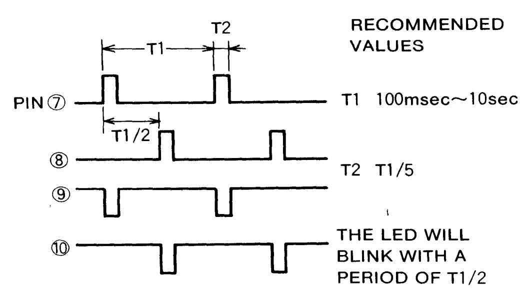
The power supply system is classified as follows: V_{CC1} for buzzer or bell, V_{CC2} for LED drive, and V_{CC3} for timer drive.

FUNCTIONAL DESCRIPTION

A clock signal applied to pin ⑯ will drive the Pin ② buzzer.

A low-level state of pin ⑮ will drive the Pin ② bell.

Applying a clock signal to pins ⑦ and ⑧, or ⑨ and ⑩ will cause the LED to blink on and off.



By applying a clock signal to pins ⑦ and ⑧, or ⑨ and ⑩, pin ④ will go "ON" for only a period of 8·T1 from V_{CC3} ON; thereafter, pin ④ will be "OFF" until V_{CC3} is put on again.

M51950L

CAR AIR CONDITIONER CONTROLLER

DESCRIPTION

The M51950L is a semiconductor integrated circuit designed for use in automobile air conditioner controls.

This device receives a pulse signal (ignition pulse) of a frequency proportional to that of the number of revolutions of the engine, and a temperature detection signal from the thermistor; it generates a control signal that switches the air conditioner on and off.

The M51950L uses supply voltage and a detection circuit, which have little dependency on temperature, permitting highly accurate control.

In addition, housing the device in an SIP has made high-density mounting possible.

FEATURES

- Small number of external parts
- (Number of revolutions) detection supply voltage characteristics ········ 0.1%/V(typ.)
- (Number of revolutions) detection temperature characteristics ········ 100ppm/℃(typ.)
- Thermistor resistance detection supply voltage characteristics ········ 0.02%/V(typ.)

APPLICATION

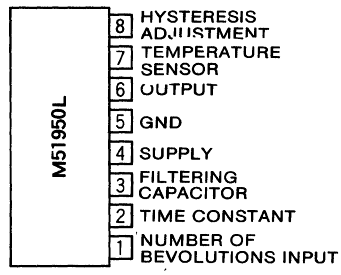
Automobile air conditioners.

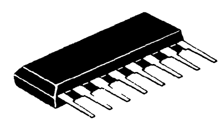
RECOMMENDED OPERATING CONDITIONS

Supply voltage range ········ 10~17V

Rated supply voltage ········ 13.2V

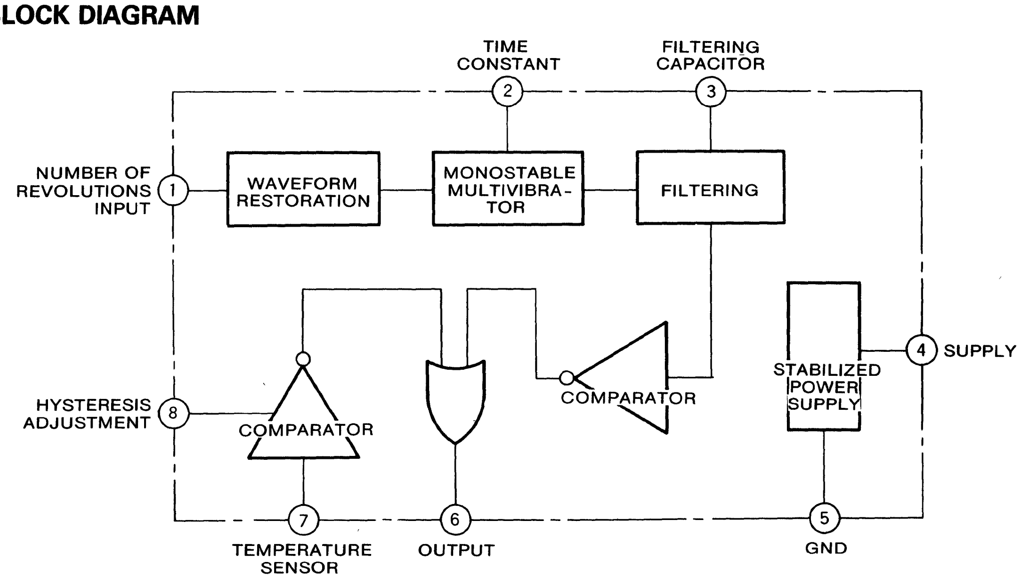
PIN CONFIGURATION (TOP VIEW)





8-pin molded plastic SIP

BLOCK DIAGRAM



MITSUBISHI ELECTRIC

ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		18	V
$V_⑥$	Pin ⑥ voltage	Output OFF	27	V
$I_⑥$	Pin ⑥ sink current	Output ON	30	mA
P_d	Power dissipation		360	mW
K_θ	Thermal derating	$T_a \geqq 25$℃	3.6	mW/℃
T_{opr}	Operating temperature range		−20～+70	℃
T_{stg}	Storage temperature range		−40～+125	℃

ELECTRICAL CHARACTERISTICS 1 (V_{CC}=13.2V, T_a=25℃, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
I_{CC}	Circuit current			3.5	8.0	mA
f_{ON}	Revolution detector ON frequency		330	376	430	Hz
Δf	Revolution detector ON, OFF frequency difference		40	65	90	Hz
R_{thON}	Thermo circuit ON resistance value		5.95	6.45	6.90	kΩ
ΔR_{th}	Thermo circuit ON, OFF resistance value difference		200	230	270	Ω
$V_{⑥ON}$	Pin ⑥ ON voltage			0.10	0.50	V
$V_{⑥OFF}$	Pin ⑥ OFF voltage		12.8	13.2		V
$I_{②in}$	Pin ② sink current		−100	0.02	100	nA
$I_{③in}$	Pin ③ sink current		75	130	200	μA
$I_{⑦in}$	Pin ⑦ sink current			50	500	nA
ΔV_{CH}	Chattering prevention circuit hysteresis width		180	215		mV

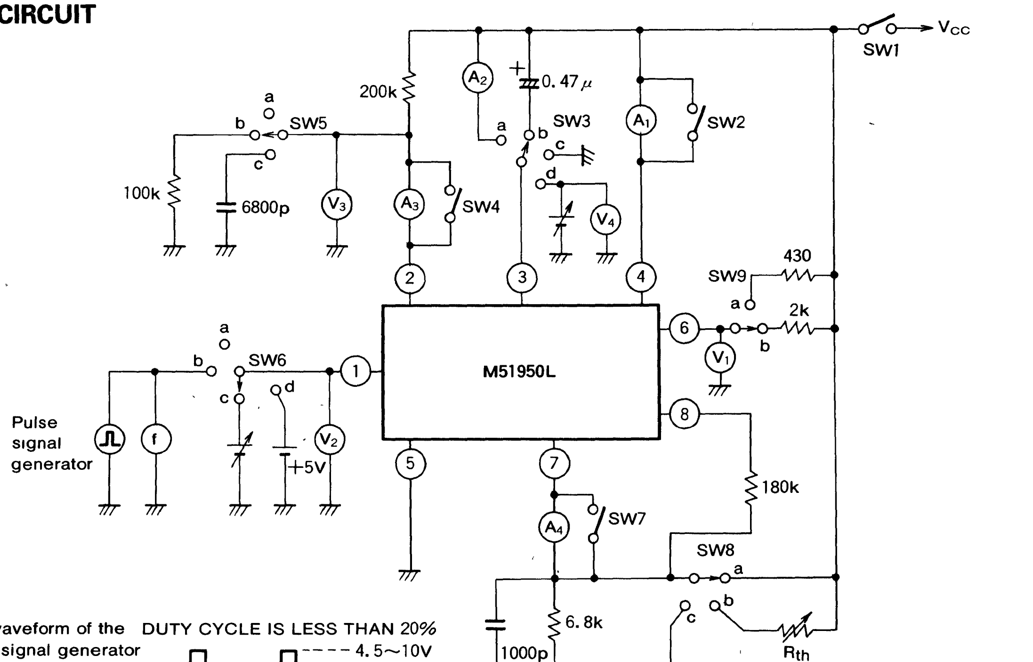
ELECTRICAL CHARACTERISTICS 2 (V_{CC}=10～17V, T_a=25℃, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
$V_{①ON}$	Pin ① ON level			3.0	4.0	V
$V_{①OFF}$	Pin ① OFF level		1.0	2.0		V
f_{ON}	Revolution detector ON frequency		330	376	430	Hz
Δf	Revolution detector ON, OFF frequency difference		40	65	90	Hz
R_{thON}	Thermo circuit ON resistance value		5.80	6.45	7.15	kΩ
ΔR_{th}	Thermo circuit ON, OFF resistance value difference		190	230	280	Ω

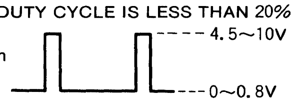
ELECTRICAL CHARACTERISTICS 3 (V_{CC}=13.2V, T_a=10～60℃, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
$V_{①ON}$	Pin ① ON level			3.0	4.5	V
$V_{①OFF}$	Pin ① OFF level		0.8	2.0		V
f_{ON}	Revolution detector ON frequency		320	377.5	440	Hz
Δf	Revolution detector ON, OFF frequency difference		35	65	95	Hz
R_{thON}	Thermo circuit ON resistance value		5.80	6.45	7.15	kΩ
ΔR_{th}	Thermo circuit ON, OFF resistance value difference		185	230	280	Ω

TEST CIRCUIT



The waveform of the pulse signal generator is shown in the diagram at right



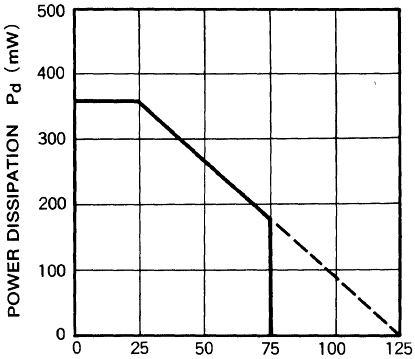
Unit Resistance : Ω
Capacitance : F

TEST METHODS

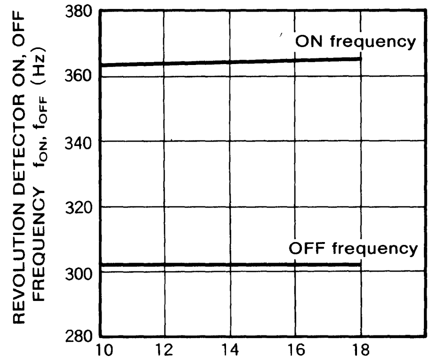
Symbol	Switch conditions									Measurement instrument	Method
	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8	SW9		
I_{CC}	ON	OFF	b	ON	a	a	ON	c	b	A_1	
f_{ON}	ON	ON	b	ON	c	b	ON	a	b	f	While raising the pin ① input signal frequency, the value of f when V_1 changes from "H" to "L"
Δf	ON	ON	b	ON	c	b	ON	a	b	f	While lowering the pin ① input signal frequency, the difference between the values of f and f_{ON} when V_1 changes from "L" to "H"
R_{thON}	ON	ON	c	ON	a	a	ON	b	b		While decreasing R_{th}, the value of R_{th} when V_1 changes from "H" to "L"
ΔR_{th}	ON	ON	c	ON	a	a	ON	b	b		While increasing R_{th}, the difference between the values of R_{th} and R_{thON} when V_1 changes from "L" to "H"
$V_{(6)ON}$	ON	ON	c	ON	a	a	ON	a	a	V_1	
$V_{(6)OFF}$	ON	ON	c	ON	a	a	ON	c	a	V_1	
$I_{(2)in}$	ON	ON	c	OFF	b	d	ON	a	b	A_3	
$I_{(3)in}$	ON	ON	a	ON	b	d	ON	a	b	A_2	
$I_{(7)in}$	ON	ON	c	ON	a	a	OFF	a	b	A_4	
$V_{(1)ON}$	ON	ON	b	ON	c	c	ON	a	b	V_2	While raising V_2 from a low voltage, the value of V_2 when V_3 changes from "L" to "H"
$V_{(1)OFF}$	ON	ON	b	ON	c	c	ON	a	b	V_2	While lowering V_2 from a high voltage, the value of V_2 when V_3 changes from "H" to "L"
ΔV_{CH}	ON	ON	d	ON	a	a	ON	a	b	V_4	The difference between the values of V_4 under the following two conditions (i) While decreasing V_4, the value fo V_4 when V_1 changes from "H" to "L", and (ii) While increasing V_4, the value of V_4 when V_1 changes from "L" to "H"

TYPICAL CHARACTERISTICS (V_{CC}=13.2V, T_a=25℃, unless otherwise noted)

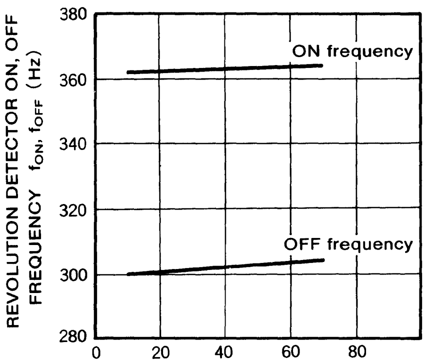
THERMAL DERATING (MAXIMUM RATING)



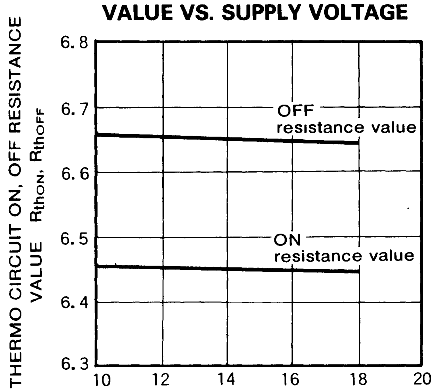
REVOLUTION DETECTOR ON, OFF FREQUENCY VS. SUPPLY VOLTAGE



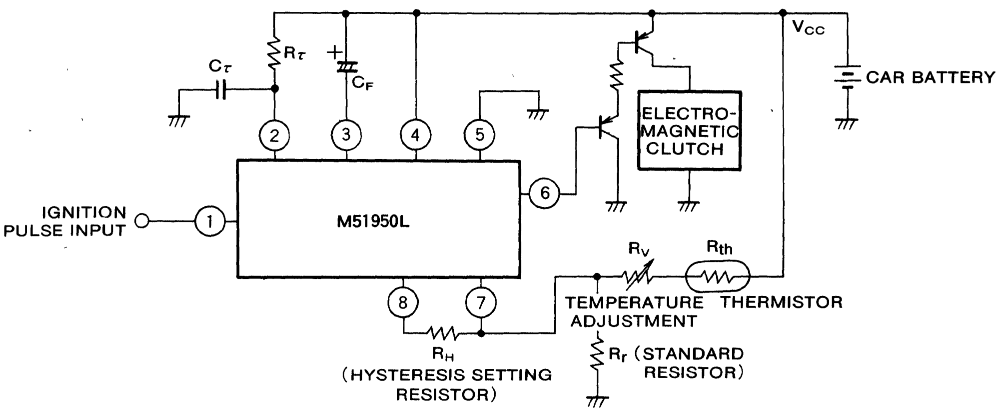
REVOLUTION DETECTOR ON, OFF FREQUENCY VS. AMBIENT TEMPERATURE



THERMO CIRCUIT ON, OFF RESISTANCE VALUE VS. SUPPLY VOLTAGE

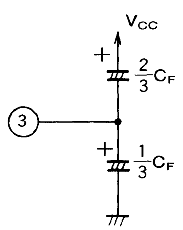


APPLICATION EXAMPLE



NOTES

1. The impedance of Pin ① is over 10kΩ at 5V or greater, and over 3kΩ at 6V or greater.
   Refer to the Limits section of ELECTRICAL CHARACTERISTICS for the input sensitivity.
2. When changing the revolution detector ON frequency, the values of R_τ and C_τ should be changed. Note that the value of R_τ should be between 100kΩ and 300kΩ.
   When the revolution detector ON frequency (f_{ON}) is changed, the revolution detector ON, OFF frequency difference (Δf) will change so that $\Delta f/f_{ON}$ becomes fixed.
3. Determine the value of C_F as follows:
   $$C_F \approx \frac{177}{f_{ON}(Hz)} (\mu F)$$
4. If the circuit operates erroneously due to power supply ripple, distribute C_F between V_{CC} and GND as shown in the diagram below.



5. When changing the thermo circuit ON resistance value, change the value of the standard resistor proportionately.
6. There is an inversely proportional relationship between the hysteresis setting resistance R_H and the thermo circuit ON, OFF resistance value difference (ΔR_{th}).

FLASHER CONTROL (WITH DISCONTINUITY DETECTION FUNCTION)

DESCRIPTION

The M51961L is a semiconductor integrated circuit designed for use in flashers, especially automobile flasher systems.

This device has been designed so that when it is set at a flashing frequency of 85cpm for turn signals or hazard indication, the flashing frequency will increase to 192cpm when the line is broken.

Discontinuity detection is accomplished by a discontinuity detection resistor which is connected between the battery and the lamp.

The threshold value for discontinuity detection is 90mV when V_{CC}=12.8V and is designed to compensate for power supply voltage and temperature chatacteristics affecting lamp current.

FEATURES

- Short time between the turn signal switch turn-on and lamp lighting ·············· 25ms(max.)
- Discontinuity detection threshold value compensates for lamp characteristics
- Small dependency of flashing frequency on power supply voltage and temperature ·············· 1%(typ.) (V_{CC}=7~17V, T_a=−20~60℃)
- Built-in stabilized power supply eliminates effect of power supply ripple on flashing frequency
- Built-in Zener diode for back absorption of relay

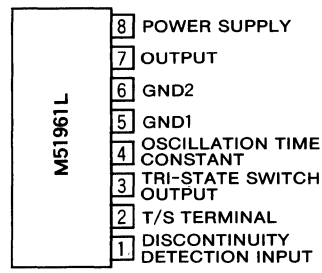
APPLICATION

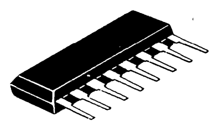
Automobile flashers and lamp discontinuity detection.

RECOMMENDED OPERATING CONDITIONS

Supply voltage range ·············· 9~16V
Rated supply voltage ·············· 12.8V

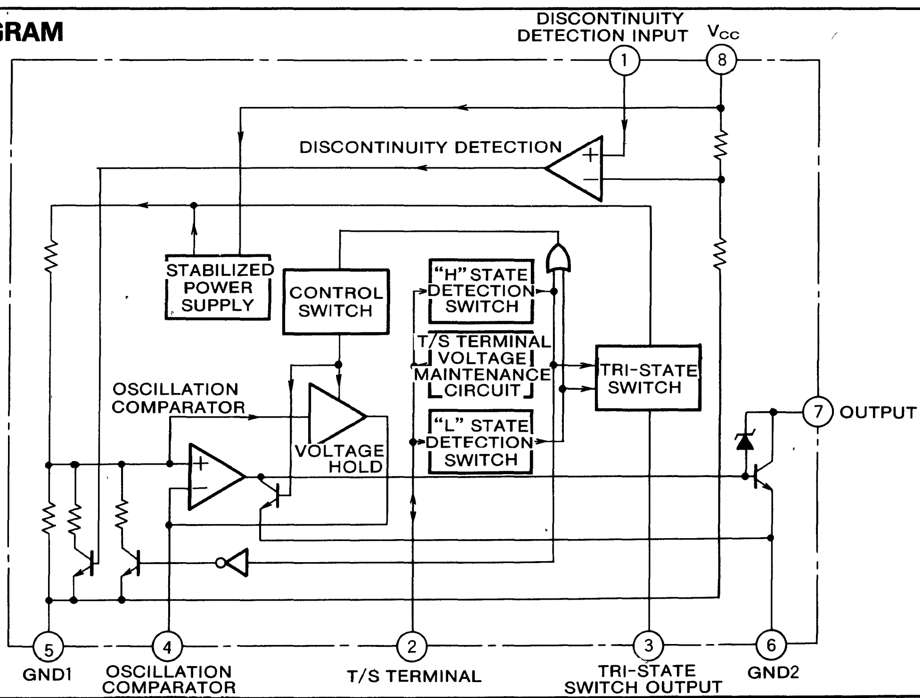
PIN CONFIGURATION (TOP VIEW)





8-pin molded plastic SIP

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

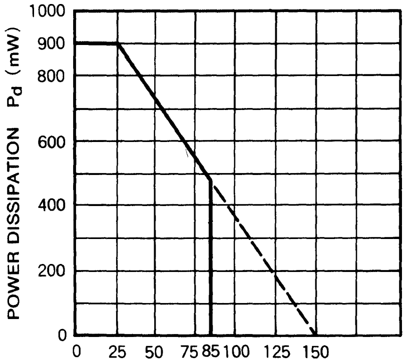
Symbol	Parameter	Conditions	Ratings	Unit
V_{CC1}	Supply voltage 1		18	V
V_{CC2}	Supply voltage 2	Application limited to within 1 minute	24.5	V
BV_O	Output withstand voltage		24.5	V
I_O	Output current		150	mA
V②	Applied voltage on pin ②		$V_{CC}-36V \sim V_{CC}$	V
V①	Applied voltage on pin ①		$0 \sim V_{CC}$	V
P_d	Power dissipation		900	mW
K_θ	Thermal derating	$T_a \geqq 25$℃	7.2	mW/℃
T_{opr}	Operating temperature range		−40～+85	℃
T_{stg}	Storage temperature range		−50～+125	℃

ELECTRICAL CHARACTERISTICS (R_τ=55kΩ, C_τ=10μF, T_a=25℃, V_{CC}=12.8V, unless otherwise noted)

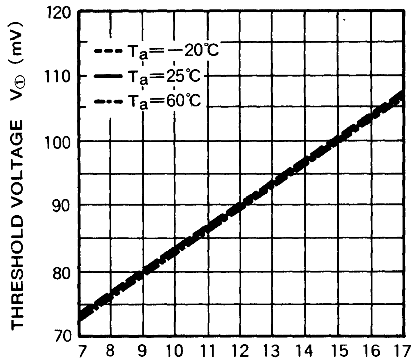
Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage range		7	12.8	17	V
T_S	Lamp light-up starting time	From turn signal switch ON to lamp ON		5	25	ms
N_1	Flashing frequency 1	At turn signal or hazard	81	85	89	cpm
N_2	Flashing frequency 2	At discontinuity	178	192	207	cpm
D_1	Lamp ON duty 1	At turn signal or hazard	41	45	49	%
D_2	Lamp ON duty 2	At discontinuity	33	37	41	%
V①TH	Discontinuity detection threshold value		84	91.3	98.5	mV
I_{CC1}	Circuit current 1	At output OFF		3.4	5.3	mA
I_{CC2}	Circuit current 2	At output ON		8.9	15	mA
V②	Pin ② voltage	Pin ② open	6.0	7.4	9.0	V
V②THH	Pin ② "H" threshold		V(2)+1	9.2	V(2)+2.5	V
V②THL	Pin ② "L" threshold		V(2)−2.5	5.6	V(2)−1	V
I②IN1	Pin ② sink current	When V②=V_{CC}	0.6	0.96	1.6	mA
I②IN2	Pin ② outflow current	When V②=GND	−2.2	−1.36	−0.9	mA
I①IN	Pin ① input current	When V①=V_{CC}		1.6	20	μA
V_{OS}	Output saturation voltage	R_L=120Ω		180	500	mV
I_{OL}	Output leakage current				100	nA
V_{OZ}	Output Zener voltage		26	30	36	V

TYPICAL CHARACTERISTICS (V_{CC}=12.8, T_a=25℃, unless otherwise noted)

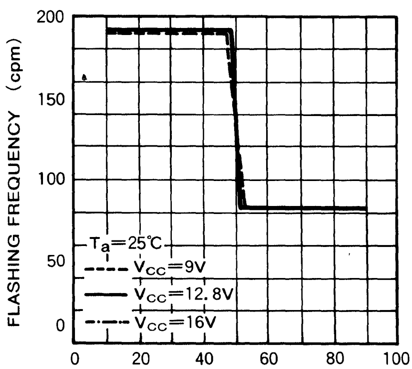
THERMAL DERATING (MAXIMUM RATING)



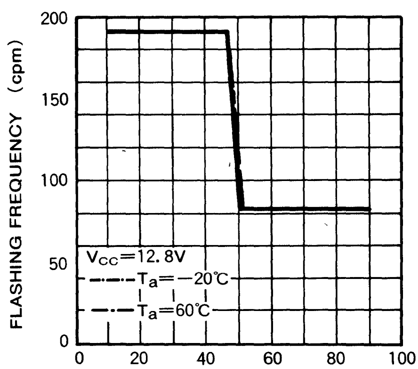
DISCONTINUITY DETECTION THRESHOLD VALUE CHARACTERISTICS



FLASHING FREQUENCY CHARACTERISTICS ①



FLASHING FREQUENCY CHARACTERISTICS ②

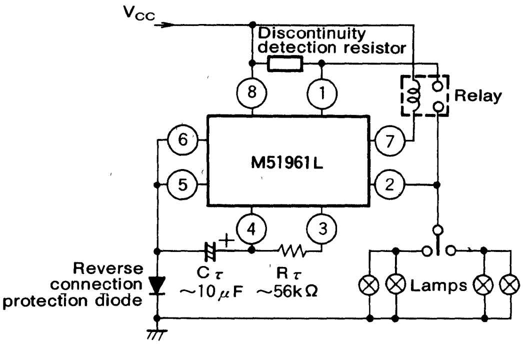


Note 1 For the flashing frequency characteristics the discontinuity detection resistance value has been measured instead of the lamp resistance value.

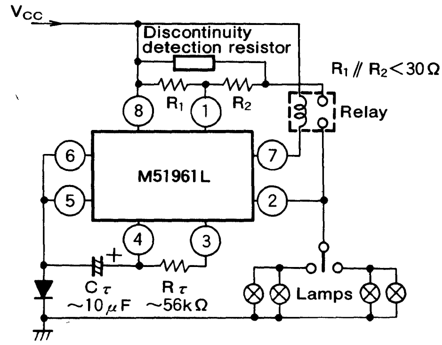
Note 2 In flashing frequency characteristics ②, C_τ and R_τ are measured outside of a constant-temperature tank.

APPLICATION EXAMPLES

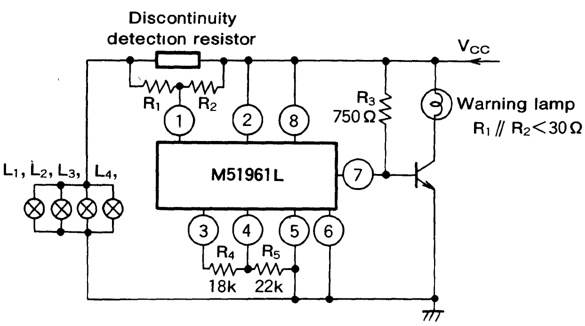
(1) Typical application circuit



(2) Adjustment of the discontinuity threshold value



(3) Discontinuity warning resistor



Unit Resistance : Ω
Capacitance : F

The warning lamp will light when one or more of the four lamps become discontinuous.

MITSUBISHI ELECTRIC

M52670P,FP

4-BIT A-D CONVERTER

DESCRIPTION

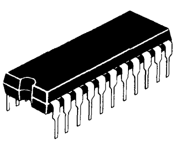
The M52670P,FP are semiconductor integrated circuits developed for use as interfaces to convert and process analog signals into digital signals. They are 4-bit converters for video band signal applications.

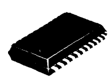
These devices have the following functions when used as parallel-comparison 4-bit A-D converters for video band signals:

1. 4-bit comparators (16)
2. Grey code converter
3. ECL to TTL converter
4. Latch circuit
5. Grey to binary code
6. Sampling clock restoration circuit
7. Underflow output switching circuit

FEATURES

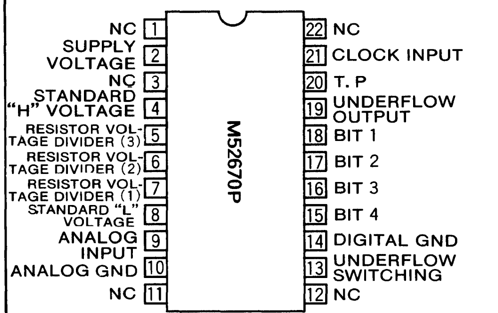
- Sampling rate: 11M samples/sec (max.)
- Output form: Open collector (TTL compatible)
- Expansion to a 5-bit A-D converter: Easily accomplished by joining two units together
- Non-linear error ··· ±1/2LSB

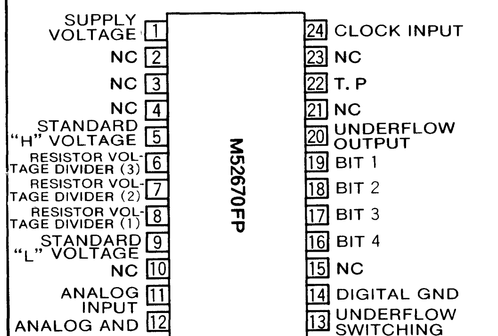




22-pin molded plastic DIP **24-pin molded plastic shrick FLAT**

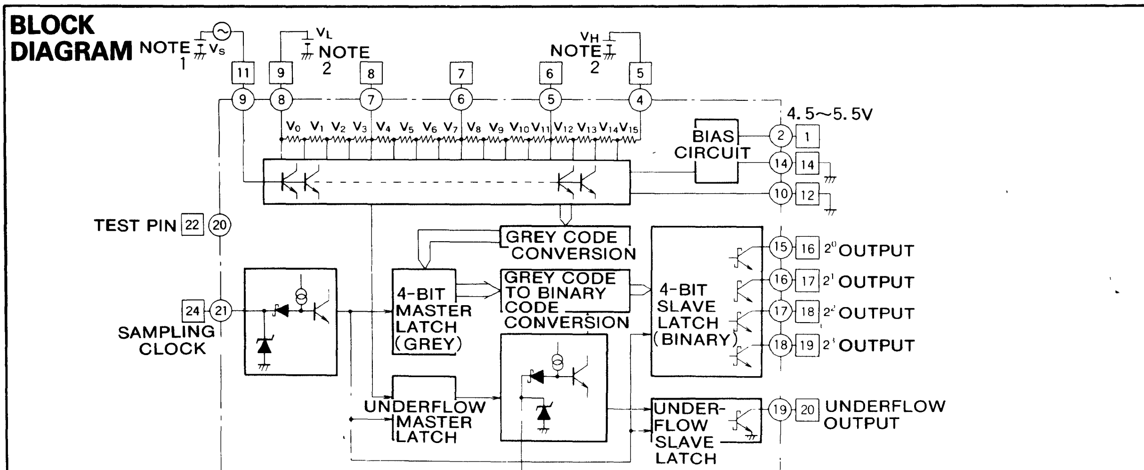
PIN CONFIGURATION (TOP VIEW)





T. P TEST PIN NC : NO CONNECTION

BLOCK DIAGRAM



□ number designates M52670FP
○ numer designates M52670P

UNDERFLOW INPUT 13 (GHD or V_{CC})

Note 1 Set so that the impedance of the drive source is less than 100Ω
Note 2 Set so that the impedance of the drive source is less than 50Ω

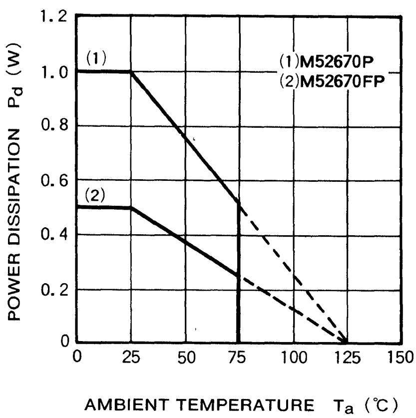
ABSOLUTE MAXIMUM RATINGS (T_a=25℃)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		7.0	V
V_{IN}	Input voltage⑬, ㉑([13], [24])		7.0	V
V_O	Output voltage⑮~⑲([16]~[20])		7.0	V
V_A	Operating supply voltage		4.5~5.5	V
P_d	Power dissipation	( ) designate FP	1000(500)	mW
T_{opr}	Operating temperature range		−10~+75	℃
T_{stg}	Storage temperature range		−40~+125	℃

Note: Numbers inside □ designate M52670FP and numbers inside ○ designate M52670P

TYPICAL CHARACTERISTICS

THERMAL DERATING (MAXIMUM RATING)



ELECTRICAL CHARACTERISTICS (T_a=25℃)

Symbol	Parameter	Test conditions	Limits Min	Limits Typ	Limits Max	Unit
I_{CC}	Circuit current 1	V_{CC}=5.0V, Clock 11MHz		33	48	mA
f_{SC}	Maximum sampling frequency	V_{CC}=5.0V, Duty 50%			11	MHz
V_{IN}⑧[9]	⑧([9]) Minimum input voltage	V_{CC}=5.0V	1.1			V
V_{IN}④[5]	④([5]) Maximum input voltage				V_{CC}−0.7	V
V_{IN}⑨[10]	⑨([10]) Maximum input voltage				V_{CC}−0.7	V
ΔV④[5]-⑧[9]	Minimum input voltage between ④−⑧([5]−[9])				1.0	V
V_{IH}	⑬[13], ㉑[24] Input "H" voltage		2.0			V
V_{IL}	⑬[13], ㉑[24] Input "L" voltage				0.8	V
I_{IN1}	⑬[13], ㉑[24] Input current 1	V_{CC}=5.25V, V_I=2.7V			20	μA
I_{IN2}	⑬[13], ㉑[24] Input current 2	V_{CC}=5.25V, V_I=0.4V			(*1)−0.4	mA
V_{IK}	㉑[24] Input clamp voltage	V_{CC}=4.75V, I_{IN}=−18mA			(*2)−0.5	V
V_{OL1}	⑮[16]−⑲[20] Output voltage 1	When V_{CC}=4.75V, and output "L", I_{OL}=6.0mA			0.5	V
V_{OL2}	⑮[16]−⑲[20] Output voltage 2	When V_{CC}=4.75V, and output "L", I_{OL}=3.0mA			0.4	V
R⑦-⑧, [8]-[9]	Resistance between ⑦−⑧, [8]-[9]		300	400	500	Ω
R⑥-⑦, [7]-[8]	Resistance between ⑥−⑦, [7]-[8]		300	400	500	Ω
R⑤-⑥, [6]-[7]	Resistance between ⑤−⑥, [6]-[7]		300	400	500	Ω
R④-⑤, [5]-[6]	Resistance between ④−⑤, [5]-[6]		300	400	500	Ω

Note 1. Current flowing to the IC is taken as "+", and current flowing out as"−".

2. IC ground is taken as a reference for voltage, while "−" indicates voltage values that are lower than IC ground.

3. Numbers inside □ designate M52670FP and numbers inside ○ designate M52670P

5-BIT EXPANSION METHOD

1. The output form (4 bit) of ⑮—⑲(16—20) with respect to V_S.

a) ⑬13: at GND

	V_S																
		V_0	V_1	V_2	V_3	V_4	V_5	V_6	V_7	V_8	V_9	V_{10}	V_{11}	V_{12}	V_{13}	V_{14}	V_{15}
⑮16	L	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H
⑯17	L	L	L	H	H	L	L	H	H	L	L	H	H	L	L	H	H
⑰18	L	L	L	L	L	H	H	H	H	L	L	L	L	H	H	H	H
⑱19	L	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H
⑲20	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H

b) ⑬13: at V_{CC}

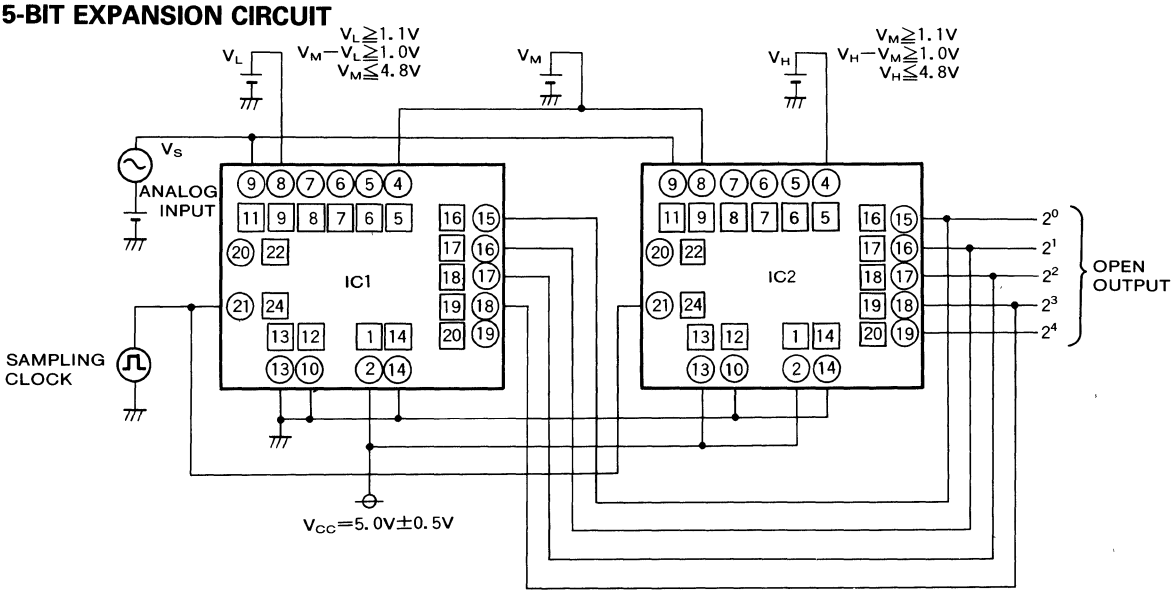
	V_S																
		V_0	V_1	V_2	V_3	V_4	V_5	V_6	V_7	V_8	V_9	V_{10}	V_{11}	V_{12}	V_{13}	V_{14}	V_{15}
⑮16	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H
⑯17	H	L	L	H	H	L	L	H	H	L	L	H	H	L	L	H	H
⑰18	H	L	L	L	L	H	H	H	H	L	L	L	L	H	H	H	H
⑱19	H	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H
⑲20	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H

2. Output form (5 bit)

	V_S																																
	V_L																V_M																
		V_0	V_1	V_2	V_3	V_4	V_5	V_6	V_7	V_8	V_9	V_{10}	V_{11}	V_{12}	V_{13}	V_{14}	V_{15}	V_0	V_1	V_2	V_3	V_4	V_5	V_6	V_7	V_8	V_9	V_{10}	V_{11}	V_{12}	V_{13}	V_{14}	V_{15}
2^0	L	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H
2^1	L	L	L	H	H	L	L	H	H	L	L	H	H	L	L	H	H	L	L	H	H	L	L	H	H	L	L	H	H	L	L	H	H
2^2	L	L	L	L	L	H	H	H	H	L	L	L	L	H	H	H	H	L	L	L	L	H	H	H	H	L	L	L	L	H	H	H	H
2^3	L	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H
2^4	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H

Note. Numbers inside ☐ designate M52670FP and numbers inside ○ designate M52670P

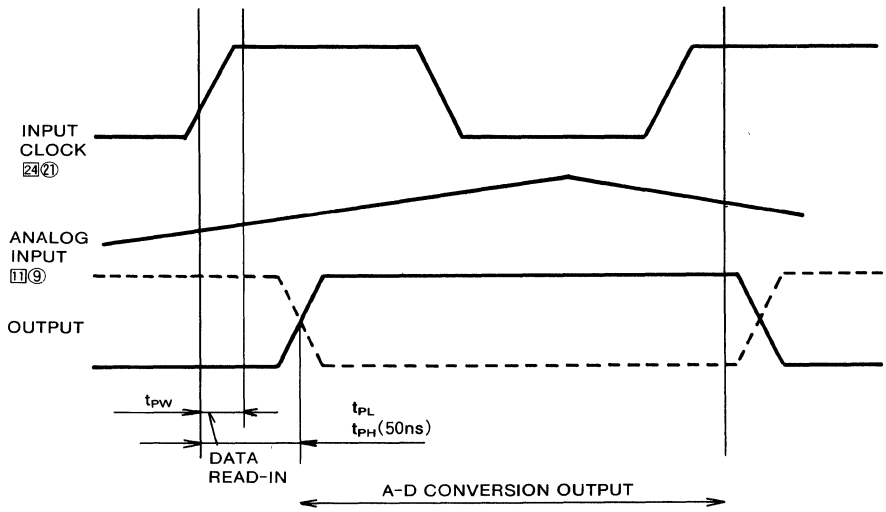
5-BIT EXPANSION CIRCUIT



☐ Numbers inside designate M52670FP
○ Numbers inside designate M52670P

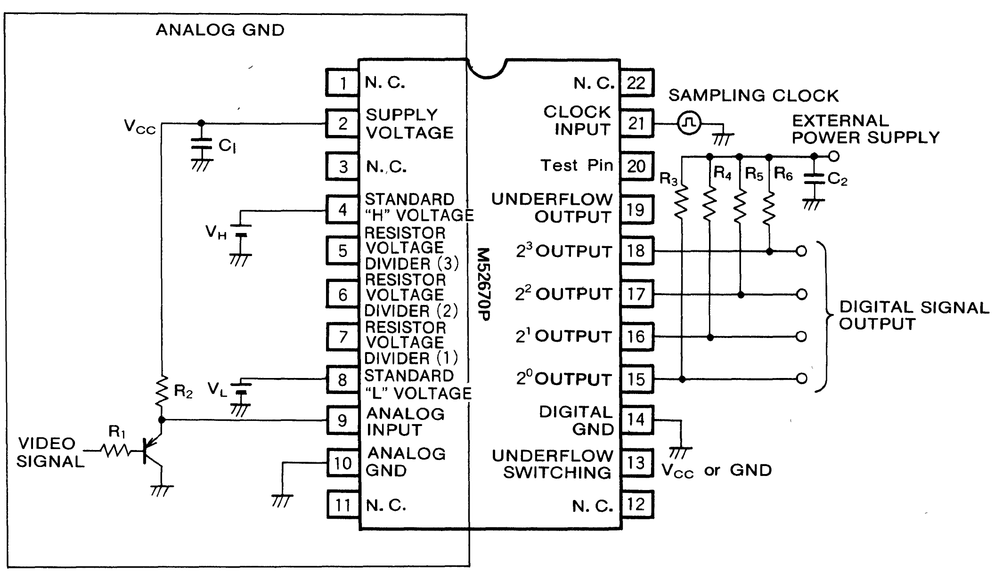
TIMING CHART

TIMING OF SAMPLING CLOCK AND OUTPUT



□ Numbers inside designate M52670FP
○ Numbers inside designate M52670P

APPLICATION EXAMPLE



MITSUBISHI ELECTRIC

DESCRIPTION

The M5109P is a semiconductor integrated circuit consisting of two differential amplifiers, fabricated by making use of complementary symmetry.

Since the two differential amplifiers are part of the same structure and have closely matched characteristics, this devise is suitabule for use in applications reguiring such matched characteristics. A bias diode is built into the device for the convenience of applications.

The high reliability of this device makes it useful in applications such as audio, communications, and control equipment.

FEATURES

- Two differential amplifiers with closely matched characteristics.
- Small input offset voltage ··························5mV(max)
- Small input offset current ·························· 2μA(max)
- Built-in bias diode

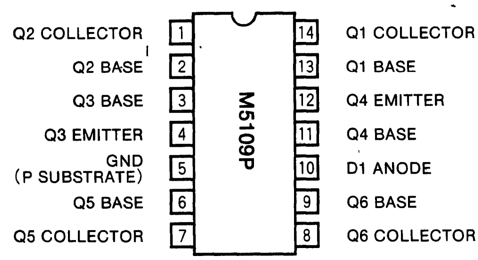
APPLICATION

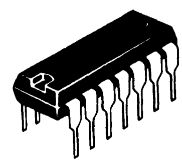
RF/IF amplifiers, double balanced mixer voltage comparators, balanced dual differential amplifiers, and detectors.

RECOMMENDED OPERATING CONDITIONS

Supply voltage range······································2~15V
Rated supply voltage······································ 12V

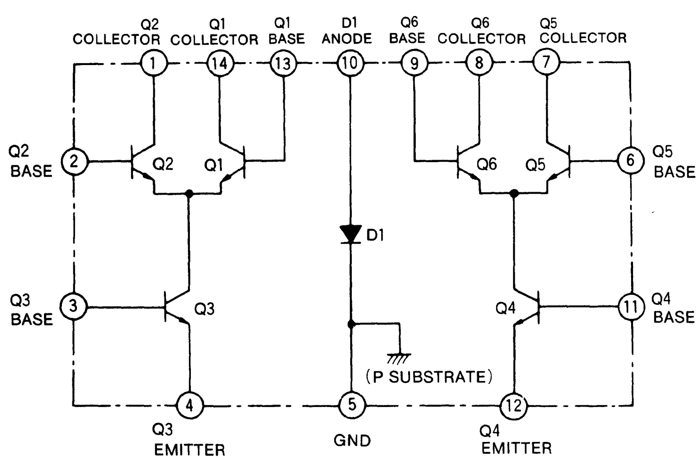
PIN CONFIGURATION (TOP VIEW)





14-pin molded plastic DIP

EOUIVALENT CIRCUIT



ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

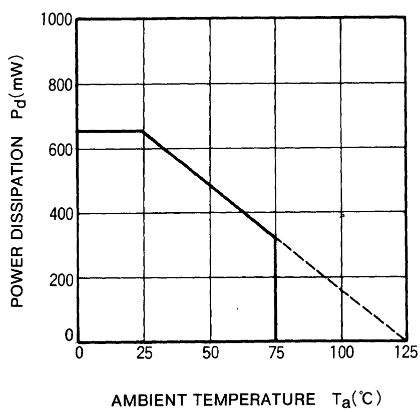
Symbol	Parameter	Conditions	Ratings	Unit
V_{CEO}	Collector-emitter voltage		15	V
V_{CBO}	Collector-base voltage		20	V
V_{EBO}	Emitter-base voltage		5	V
I_C	Collector current		50	mA
P_d	Power dissipation		650	mW
K_θ	Thermal derating	$T_a \geqq 25$℃	6.5	mW/℃
Topg	Operating temperature range		−20～+75	℃
Tstg	Storage temperature range		−40～+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
V_{IO}	Input offset voltage	V_{CE}=3V, I_E=2mA			5	mV
I_{IO}	Input offset current				2	μA
I_{IB}	Input bias current				24	μA
$\frac{I_{C(Q1)}}{I_{C(Q2)}}$ or $\frac{I_{C(Q5)}}{I_{C(Q6)}}$	Differential stage current ratio			1.0		—
I_{CBO}	Collector cuttoff current	V_{CB}=18V, I_E=0			1	μA

TYPICAL CHARACTERISICS (T_a=25℃, unless otherwise noted)

THERMAL DERATING
(MAXIMUM RATING)

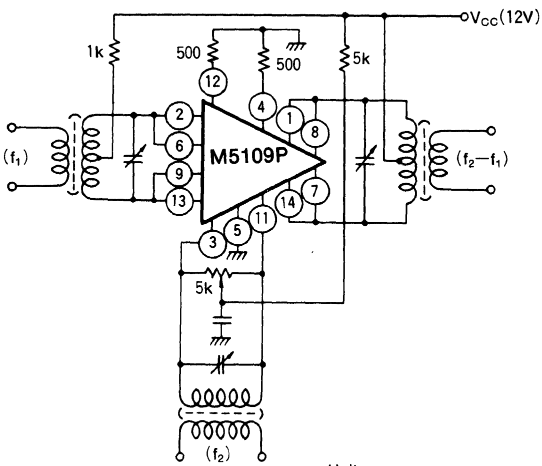


MITSUBISHI ELECTRIC

DUAL DIFFERENTIAL AMPLIFIER

APPLICATION EXAMPLES

(1) Frequency mixer

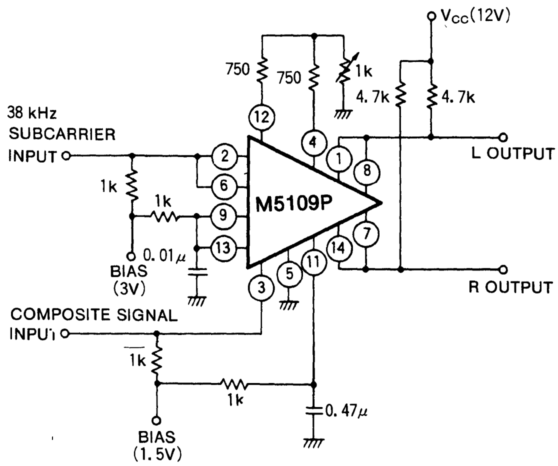


Unit

Resistance : Ω

Capacitance : F

(2) FM Stereo demodulator



M54940P

8-DIGIT FLUORESCENT DISPLAY DRIVER FOR MICROCOMPUTER

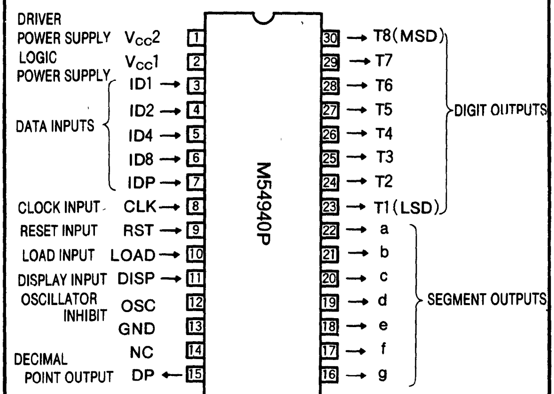
DESCRIPTION
The M54940P, a monolithic integrated circuit fabricated with using an IIL technology, is designed for driving an 8-digit, 7-segment fluorescent display.

FEATURES
- Separated power supplies; 5V (Logic circuit), and 35V (Output circuit)
- Integral scanning oscillator circuit for display

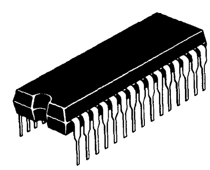
APPLICATIONS
- Micro computer display
- Digital equipment for consumer and Industrial use.

FUNCTION
The M54940P, having a 5-bit×8-digit memory, is a decoder driver for dynamic displaying of a vacuum fluorescent tubes. The data for one digit section is organized into a 4-bit BCD and an 1-bit decimal point. The data memory consists of a shift register and a latch, and is capable of displaying the previous data while the data is being transported.

PIN CONFIGURATION (TOP VIEW)

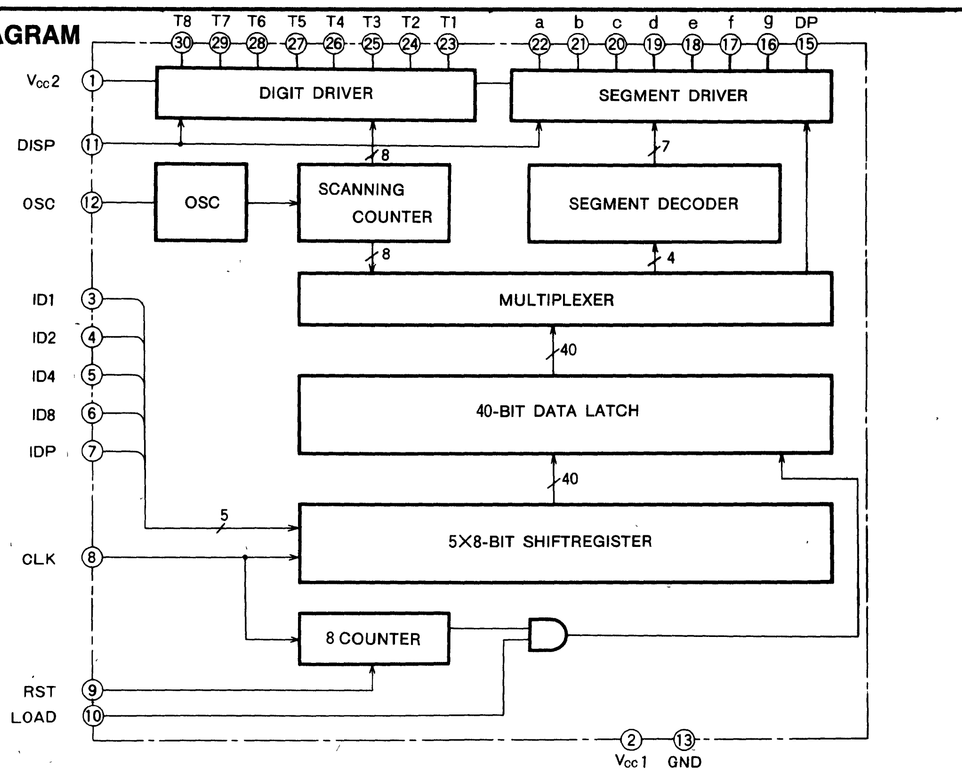


Outline 30P4B NC : NO CONNECTION



30-pin molded plastic DIP(SHRINK)

BLOCK DIAGRAM



MITSUBISHI ELECTRIC

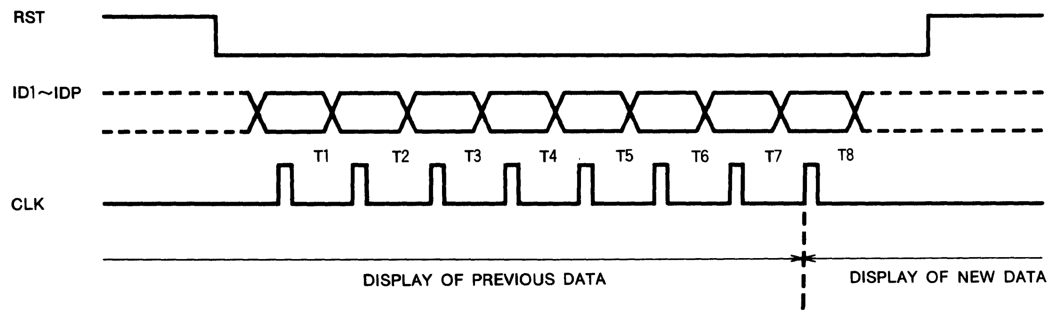
INPUT PIN FUNCTION

1) OSC : External capacitor connecting terminal for the oscillator circuit.
2) ID 1, ID 2, ID 4, ID 8 : BCD Data Input; refer to the numerical Designations-resultant displays for the relation of the input data to the display.
3) IDP : decimal point data Input
4) CLK : Data transport clock Input: the data can be input at a positive-going edge of the CLK
5) RST : Reset Input : the CLK input counter is reset at "H".
6) LOAD : Signal Input to load the data latch with the data of the shift register. The Input LOAD will not be accepted until the 8th CLK Input has been received.
7) DISP : When it is set to "H" it displays. When it is set to "L", the display is inhibitted. During the display inhibition period, both the segment and digit outputs will be at "L".

TIMING CHART

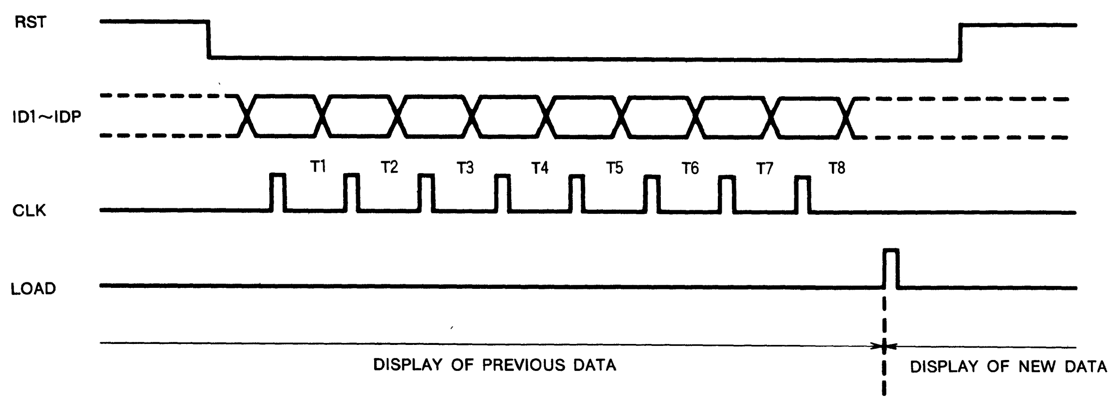
DATA PROGRAMMING

(1) USING CLK AND RST inputs with LOAD=" H ".



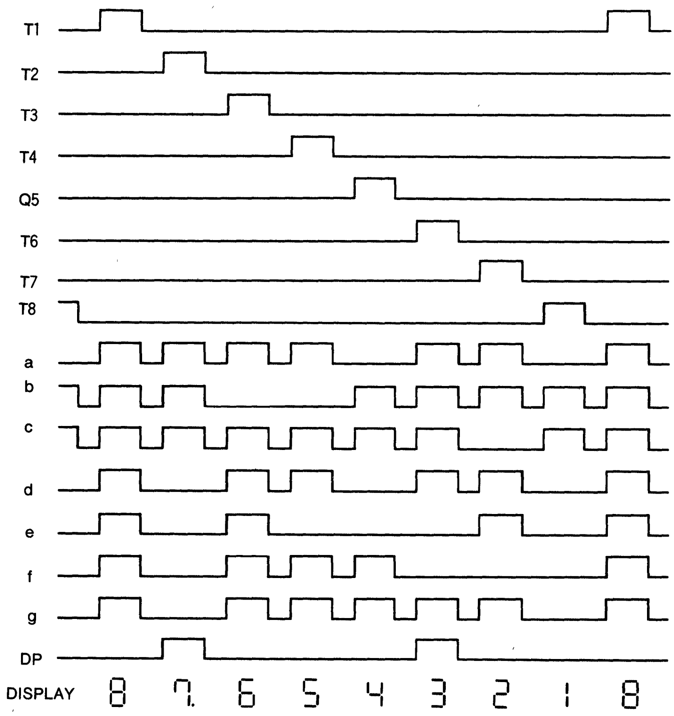
When LOAD is kept at " H ", LOAD is automatically done at the 8th CLK input when RST=" L ".
However, while RST=" L ", if there is a 9th CLK input, the 9th data will be loaded and displayed

(2) Using CLK, RST and LOAD inputs.



After the 8th clock input, the LOAD is valid only in the period while RST=" L ".
Furthermore, if there is 9th CLK input before the LOAD input, the LOAD input is ignored.

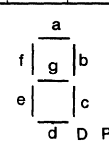
OUTPUT TIMING CHART



NUMERICAL DESIGNATIONS-RESUITANT DISPLAYS

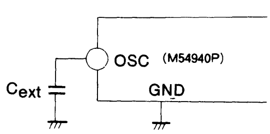
		0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
BCD DATA	ID1	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H
	ID2	L	L	H	H	L	L	H	H	L	L	H	H	L	L	H	H
	ID4	L	L	L	L	H	H	H	H	L	L	L	L	H	H	H	H
	ID8	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H
Display		0	1	2	3	4	5	6	7	8	9	-	E	P	L	¬	Blank

*The decimal point, independent of BCD data, is output when the decimal bit of the corresponding digit is at " H "
Furthermore, when the decimal point bit is set at " H " at plural digits, plural decimal points are displayed.



OSCILLATOR CIRCUIT

1) External connection



2) Oscillation period

$$t_{OSC} \fallingdotseq 20\, C_{ext} \times 10^{-3} [\mu s] \text{ (Typ.)}$$

(Unit of C_{ext}; [pF])

DISPLAYS IMMEDIATELY "AFTER POWER ON."

The display which appears immediately after "power-on" is indefinable. During the period bofore the regular data is transported the display can be erased if DISP input is set at " L ".

ABSOLUTE MAXIMUM RATINGS (T_a=−20~+75℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC1}	Logic supply voltage		−0.3~+9	V
V_{CC2}	Driver supply voltage		−0.3~+38	V
V_I	Input voltage		−0.3~$V_{CC}1$	V
V_O	Output voltage		0~$V_{CC}2$	V
T_{stg}	Storage temperature range		−55~+150	℃
T_{opr}	Operating temperature range		−20~+75	℃
P_d	Power dissipation		600	mW

RECOMMENDED OPERATING CONDITIONS (T_a=−20~+75℃, unless otherwise noted)

Symbol	Parameter	Limits			Unit
		Min	Typ	Max	
V_{CC1}	Logic supply voltage	4	5	7	V
V_{CC2}	Driver supply voltage	10	30	35	V

ELECTRICAL CHARACTERISTICS (T_a=−20~+75℃, $V_{CC}1$=5V, $V_{CC}2$=35V, unless otherwise noted)

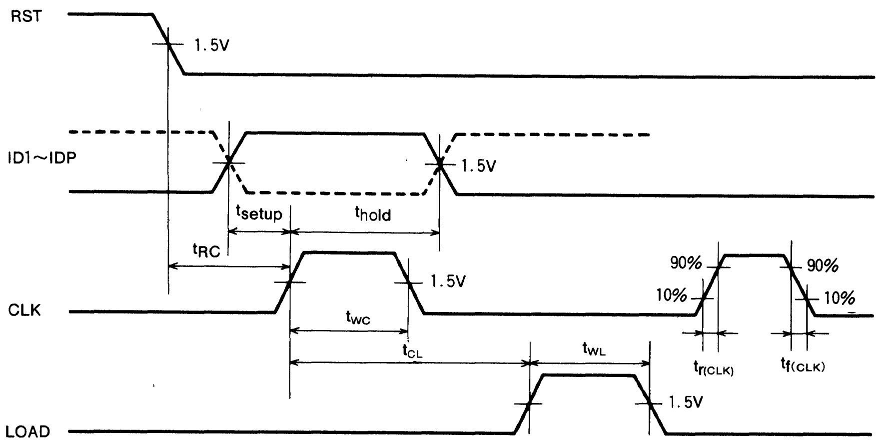
Symbol	Parameter		Test Conditions	Limits			Unit
				Min	Typ	Max	
V_{IH}	" H " Input voltage		V_{CC} 1 =4~7V	2.7		$V_{CC}1$	V
V_{IL}	" L " Input voltage		V_{CC}= 1 =4~7V	0		0.7	V
I_{IH}	" H " Input current		V_{IH}=5V		0	20	μA
I_{IL}	" L " Input current		V_{IL}=0V		−0.25	−0.4	mA
V_{OH}	" H " Output voltage	Digit output	I_{OH}=−10mA	33	33.8		V
		Segment output	I_{OH}=−2mA	33	34		
V_{OL}	" L " Output voltage		I_{OL}=0mA		0	2	V
I_{CC1}	Logic circuit current		Input : open All segment outputs, ON		12	22	mA
I_{CC2}	Driver circuit current		Output : Open All segment outputs : ON		8	14	mA
t_{OSC}	Oscillation Period		C_{ext}=1000pF	10	20	40	μs

*Typical values are measured at 25℃

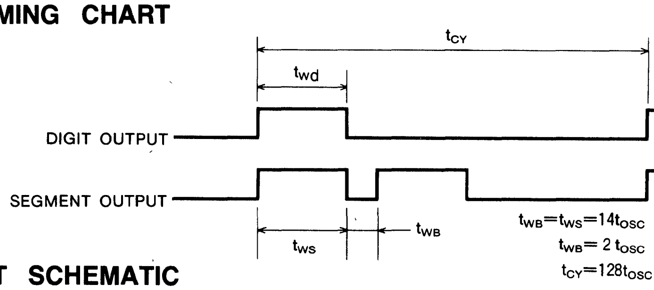
TIMING CHARACTERISTICS (T_a=−20~+75℃, unless otherwise noted)

Symbol	Parameter	Test Conditions	Limits			Unit
			Min	Typ	Max	
f_{CLK}	Clock Frequency				100	kHz
f_{OSC}	Oscillation frequency		10		100	kHz
t_{WC}	Clock pulse width		2			μs
t_{WL}	Load Pulse width		2			μs
t_{setup}	Data setup time (DATA→CLK)		4			μs
t_{hold}	Data Hold time(CLK→DATA)		2			μs
t_{RC}	Reset-clock time(RST→CLK)		4			μs
t_{CL}	Clock-load, time(CLK→LOAD)		4			μs
$t_{r(CLK)}$	Clock pulse rise time				10	μs
$t_{f(CLK)}$	Clock pulse fall time				10	μs

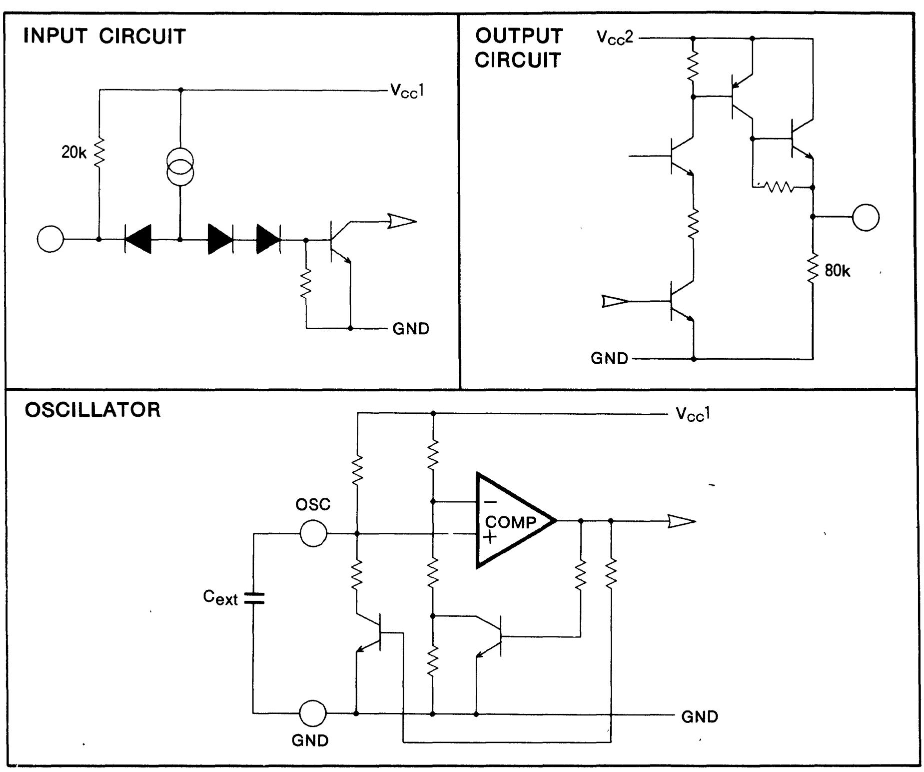
INPUT TIMING CHART



OUTPUT TIMING CHART



I/O CIRCUIT SCHEMATIC



M54570L

TUNER BAND DECODER/DRIVER

DESCRIPTION

The M54570L is a semiconductor integrated circuit capable of switching four bands in TV and VTR tuners.

FEATURES

- Low output saturation voltage ($V_{CE(sat)} \leqq 0.5V$ at $I_O = -35mA$).
- High output sustaining voltage ($BV_{CEO} \geqq 26V$)
- Four-bands switching

APPLICATION

Switching bands in TV and VTR tuners

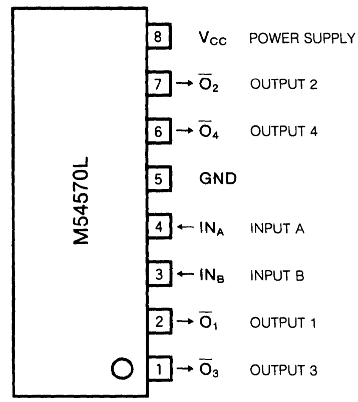
FUNCTIONAL DESCRIPTION

The M54570L is an IC suitable for four-band switching in TV and VTR tuners. Since the output drives the power supply of each tuner band, a low saturation voltage (V_{CC}-V_O) becomes necessary. This need is satisfied through a first stage configured of PNP transistors.

The input, being three-valued logic input, can be switched into 6 output modes as shown in the truth table.

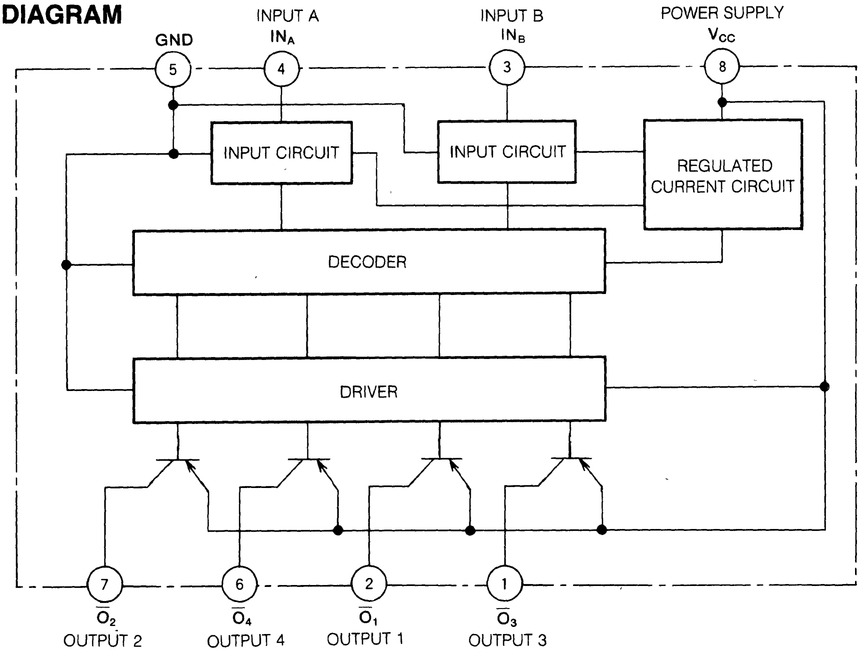
The selection mode can be altered by making a wired OR connection on the outputs when used as a three-band device.

PIN CONFIGURATIONS (TOP VIEW)



Outline 8P5

BLOCK DIAGRAM



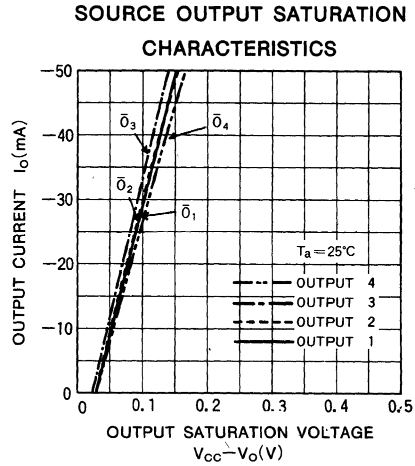
TRUTH TABLE

Input		Output			
IN_A	IN_B	$\overline{O}_1$	$\overline{O}_2$	$\overline{O}_3$	$\overline{O}_4$
0	0	1	1	0	1
0	1	0	0	1	0
1	0	1	1	0	0
1	1	1	0	0	0
1 *	1 *	1	0	0	1
1 *	0	1	1	0	0

Input "0" = 0.4V (max.)
"1" = 4V (min.), 6V (max.)
"1*" = 10V (min.), V_{CC} (max.)

Output "0" = output transistor off-state
"1" = output transistor on-state

TYPICAL CHARACTERISTICS



ABSOLUTE MAXIMUM RATINGS (Ta = 25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		15	V
V_{CEO}	Output sustaining voltage		−0.5~+26	V
V_I	Input voltage		15	V
I_O	Output current		−40	mA
Topr	Operating ambient temperature range		−10~+60	℃
Tstg	Storage temperature range		−55~+125	℃

RECOMMENDED OPERATING CONDITIONS (Ta = 25℃, unless otherwise noted)

Symbol	Parameter		Limits			Unit
			Min	Typ	Max	
V_{CEO}	Output sustaining voltage		0		24	V
I_O	Output current	Outputs 1 and 3	0	−35	−40	mA
		Outputs 2 and 4	0	−20	−25	
V_{IH}	"H" input voltage		4		6	V
V_{IL}	"L" input voltage		0		0.4	V
V_{IH}*	"H*" input voltage		10		V_{CC}	V

ELECTRICAL CHARACTERISTICS (Ta = 25℃, unless otherwise noted)

Symbol	Parameter	Test conditions		Limits			Unit
				Min	Typ	Max	
$I_{O(leak)}$	Output leakage current	V_{CC}=12V, V_O=−12V, output opened				−100	μA
V_{OH}	"H" output voltage	V_{CC}=12V	I_O=−20mA	11.7	11.9		V
			I_O=−35mA (output 1, 3)	11.5	11.9		
I_{IH}	"H" input current	V_{CC}=12V, V_I=4V				10	μA
I_{IH}*A	"H*" input current (input A)	V_{CC}=12V, V_I*=10V			0.63	1.3	mA
I_{IH}*B	"H*" input current (input B)	V_{CC}=12V, V_I*=10V				20	μA
I_{IL}	"L" input current	V_{CC}=12V, V_I=0.4V				−100	μA
I_{CC}	Supply current	V_{CC}=13V, V_{IA}=0V, V_{IB}=4V, output opened			17	28	mA

M54572L

TUNER BAND DECODER/DRIVER

DESCRIPTION

The M54572L is a semiconductor integrated circuit capable of switching four bands in TV and VTR tuners.

FEATURES

- Low output saturation voltage ($V_{CE(sat)} \leqq 0.5V$ at $I_O = -30mA$).
- High output sustaining voltage ($BV_{CEO} \geqq 28V$)
- Four-bands switching

APPLICATION

Switching bands in TV and VTR tuners

FUNCTIONAL DESCRIPTION

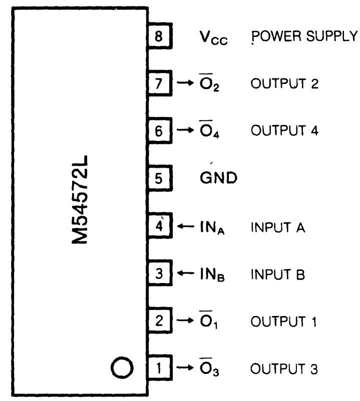
The M54572L is an IC suitable for four-band switching in TV and VTR tuners. Since the output (outputs 1~3) drives the power supply of each tuner band, a low saturation voltage ($V_{CC}-V_O$) becomes necessary. This need is satisfied through a first stage configured of PNP transistors.

Output 4 can be used for changing modes with the same power supply as the NPN transistor has an open collector output.

The input mode can be switched between four modes as shown in the truth table.

The selection mode can be altered by making a wired OR connection to outputs 1 ~ 3 when used as a three-band device.

PIN CONFIGURATIONS (TOP VIEW)



Outline 8P5

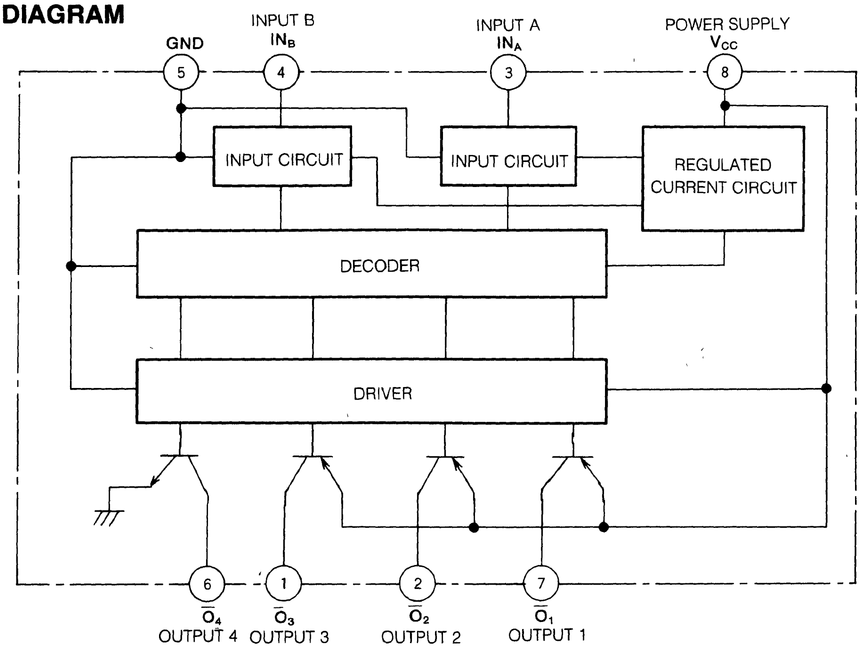
TRUTH TABLE

Input		Output			
IN_A	IN_B	$\overline{O}_1$	$\overline{O}_2$	$\overline{O}_3$	$\overline{O}_4$
0	0	1	Z	Z	Z
0	1	Z	Z	1	Z
1	0	Z	1	Z	Z
1	1	Z	Z	1	0

Input "0" = 1V (max.)
"1" = 3V (min)

Output "0" = current sink
"1" = current source
"Z" = high impedance

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS (T_a = 25℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		18	V
V_{CEO}	Output sustaining voltage		−0.5～+28	V
V_I	Input voltage		18	V
I_{SO}	Output source current	$\bar{O}1$～$\bar{O}3$	−40	mA
I_{SI}	Output sink current	$\bar{O}4$	40	mA
Topr	Operating ambient temperature range		−10～+60	℃
Tstg	Storage temperature range		−55～+125	℃

RECOMMENDED OPERATING CONDITIONS (T_a = 25℃, unless otherwise noted)

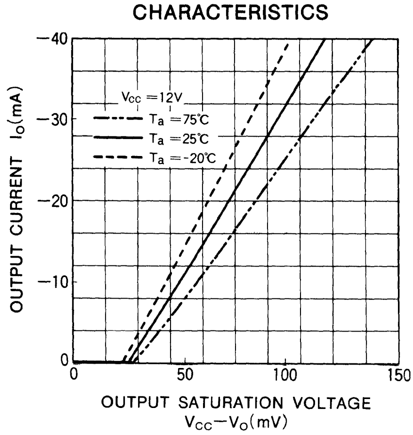
Symbol	Parameter		Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage		12		15	V
V_{CEO}	Output sustaining voltage		0		25	V
I_{SO}	Output source current	$\bar{O}1$～$\bar{O}3$	0		−30	mA
I_{SI}	Output sink current	$\bar{O}4$	0		30	mA
V_{IH}	"H" input voltage		3		V_{CC}	V
V_{IL}	"L" input voltage		0		1	V

ELECTRICAL CHARACTERISTICS (T_a = 25℃, V_{CC} = 12V, unless otherwise noted)

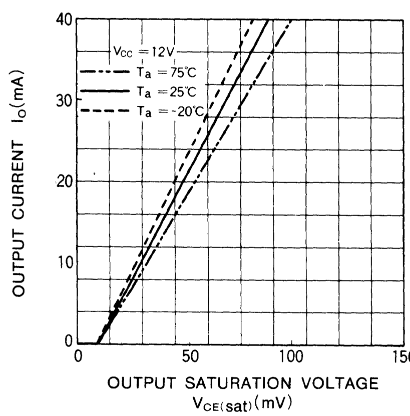
Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
$I_{SO(leak)}$	Source output leakage current	V_{SO}=−12V			−100	μA
$I_{SI(leak)}$	Sink output leakage current	V_{SI}=25V			100	μA
V_{SOH}	Source output "H" voltage	I_{SO}=−30mA	11.5	11.8		V
V_{SIL}	Sink output "L" voltage	I_{SI}=30mA		0.2	0.5	V
I_{IH}	"H" input current	V_I=3V			10	μA
I_{IL}	"L" input current	V_I=1V			−100	μA
I_{CC}	Supply current	V_{CC}=13V, V_{IA}=3V, V_{IB}=0V, output opened			28	mA

TYPICAL CHARACTERISTICS

SOURCE OUTPUT SATURATION CHARACTERISTICS



SINK OUTPUT SATURATION CHARACTERISTICS



M54573L

TUNER BAND DECODER/DRIVER

DESCRIPTION

The M54573L is a semiconductor integrated circuit capable of switching three bands in TV and VTR tuners.

FEATURES

- Low output saturation voltage ($V_{CE(sat)} \leqq 0.5V$ at $I_O = -30mA$).
- High output sustaining voltage ($BV_{CEO} \geqq 28V$)

APPLICATION

Switching bands in TV and VTR tuners

FUNCTIONAL DESCRIPTION

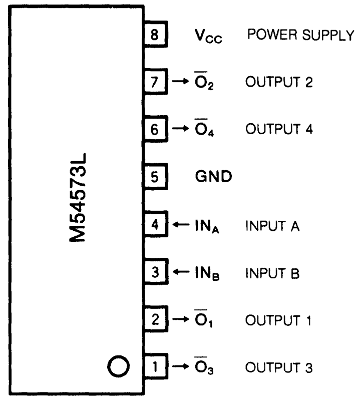
The M54573L is an IC suitable for three-band switching in TV and VTR tuners. Since the output (outputs 1~3) drives the power supply of each tuner band, a low saturation voltage ($V_{CC} - V_O$) becomes necessary. This need is satisfied through a first stage configured of PNP transistors.

Output 4 can be used for changing modes with the same power supply as the NPN transistor has an open collector output.

The input mode can be switched between three modes as shown in the truth table. The "o", "1" mode and the "1", "1" mode are the same modes.

The selection mode can be altered by making an OR connection on outputs 1~3.

PIN CONFIGURATIONS (TOP VIEW)



Outline 8P5

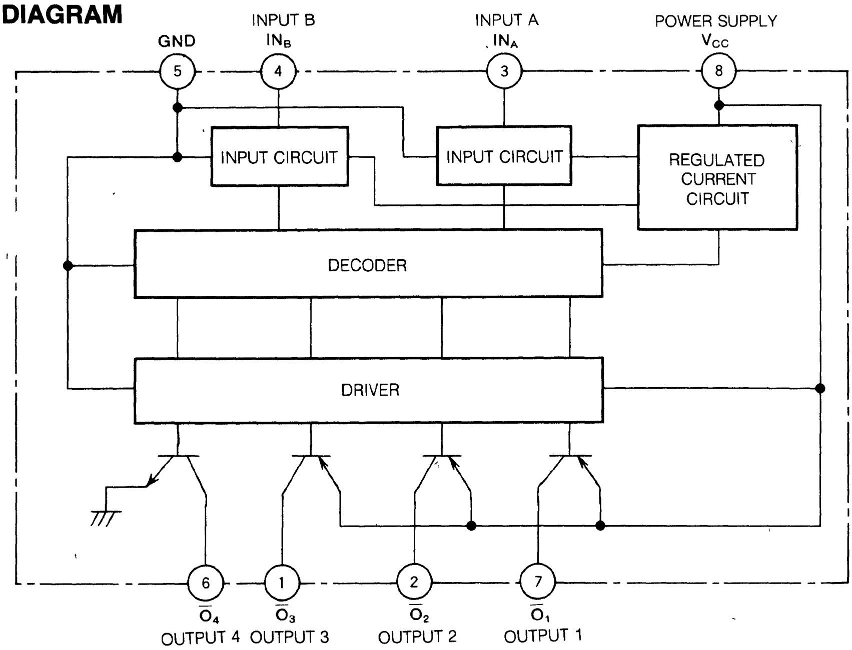
TRUTH TABLE

Input		Output			
IN_A	IN_B	$\overline{O}_1$	$\overline{O}_2$	$\overline{O}_3$	$\overline{O}_4$
0	0	1	Z	Z	0
0	1	Z	Z	1	0
1	0	Z	1	Z	Z
1	1	Z	Z	1	0

Input "0" = 1V (max)
"1" = 3V (min.)

Output "0" = current sink
"1" = current source
"Z" = high impedance

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS ($T_a = 25$℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		18	V
V_{CEO}	Output sustaining voltage		−0.5～+28	V
V_I	Input voltage		18	V
I_{SO}	Output source current	$\overline{O}1$～$\overline{O}3$	−40	mA
I_{SI}	Output sink current	$\overline{O}4$	40	mA
Topr	Operating ambient temperature range		−10～+60	℃
Tstg	Storage temperature range		−55～+125	℃

RECOMMENDED OPERATING CONDITIONS ($T_a = 25$℃, unless otherwise noted)

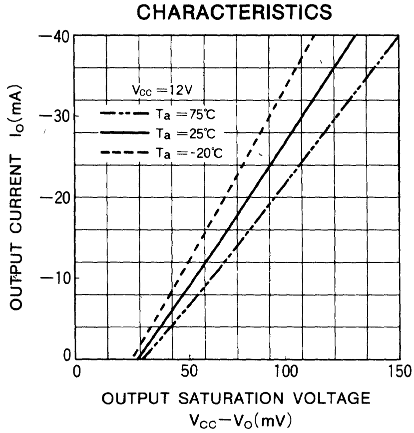
Symbol	Parameter		Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage		12		15	V
V_{CEO}	Output sustaining voltage		0		25	V
I_{SO}	Output source current	$\overline{O}1$～$\overline{O}3$	0		−30	mA
I_{SI}	Output sink current	$\overline{O}4$	0		30	mA
V_{IH}	"H" input voltage		3		V_{CC}	V
V_{IL}	"L" input voltage		0		1	V

ELECTRICAL CHARACTERISTICS ($T_a = 25$℃, $V_{CC} = 12V$, unless otherwise noted)

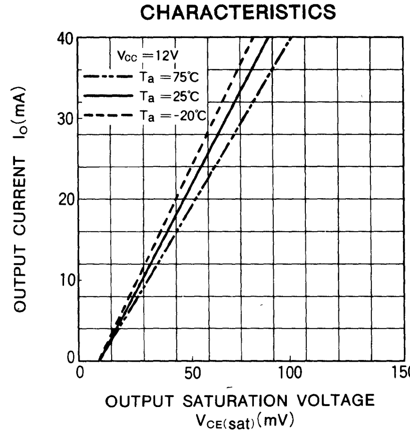
Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
$I_{SO(leak)}$	Source output leakage current	V_{SO}=−12V			−100	μA
$I_{SI(leak)}$	Sink output leakage current	V_{SI}=25V			100	μA
V_{SOH}	Source output "H" voltage	I_{SO}=−30mA	11.5	11.8		V
V_{SIL}	Sink output "L" voltage	I_{SI}=30mA		0.2	0.5	V
I_{IH}	"H" input current	V_I=3V			10	μA
I_{IL}	"L" input current	V_I=1V			−100	μA
I_{CC}	Supply current	V_{CC}=13V, V_{IA}=3V, V_{IB}=0V, output opened			28	mA

TYPICAL CHARACTERISTICS

SOURCE OUTPUT SATURATION CHARACTERISTICS



SINK OUTPUT SATURATION CHARACTERISTICS



M54847AP

2-DIGIT BCD-7SEGMENT DECODER/DRIVER

DESCRIPTION
The M54847AP is a semiconductor integrated circuit consisting of an IIL 2 digit BCD-7 segment decoder/driver.

FEATURES
- Direct drive of LEDs (common cathode type. No need for current limiting resistors, segment current: 10mA max.)
- Direct drive of fluorescent character displays (Segment withstand output is −25V max at V_{CC}=5V.)
- Data input in both serial and parallel formats
- Brightness control input enables continuous LED brightness adjustment.

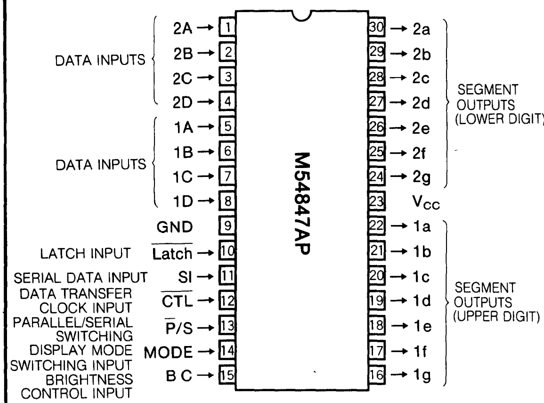
APPLICATION
TV channel display

FUNCTIONAL DESCRIPTION
The M54847AP is a 2 digit BCD-7 segment decoder/driver for static drive of LED and fluorescent character displays. The following display modes are possible.

MODE I Numerical display of 00 ~ 99

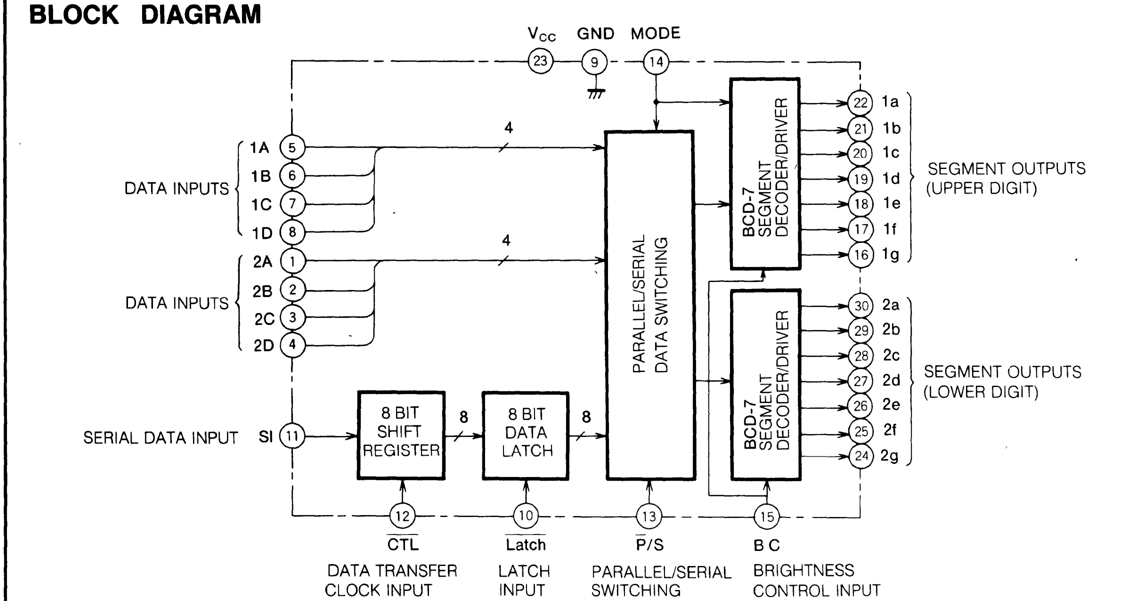
MODE II Numerical display of 0 ~ 39, and AU, CA, --

PIN CONFIGURATION (TOP VIEW)



Outline 30P4B

BLOCK DIAGRAM



OPERATING DESCRIPTION

- **Display mode**

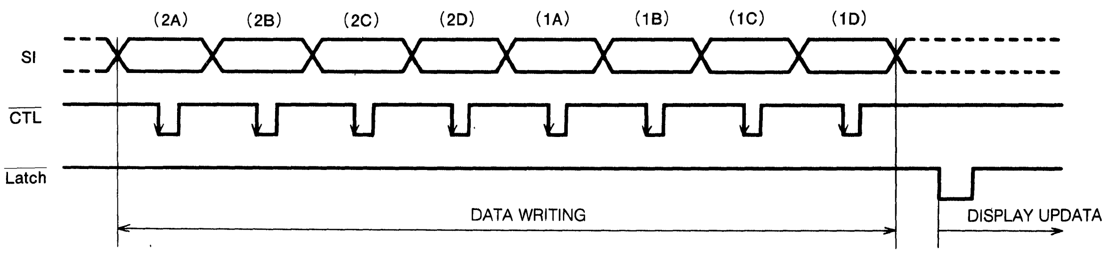
(1) When the mode switching input is high, both digits are driven in accordance with Function Table I.

(2) When the mode switching input is low, input 1C and 1D become the character data inputs, driving the display in accordance with Function Table II.

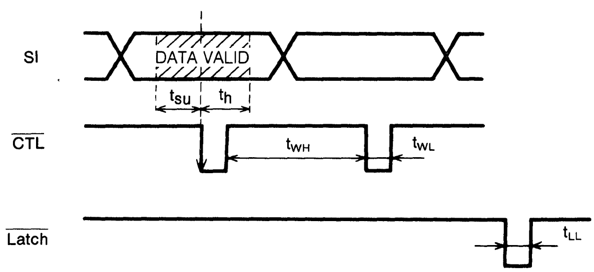
- **Serial input data writing**

Data 2A→2D and 1A→1D is read sequentially by the low edge of $\overline{CTL}$. After all 8 bits are loaded in the shift register, the display is updated by switching $\overline{Latch}$ input to low.

SERIAL DATA WRITING



INPUT TIMING DIAGRAM



MINIMUM VALUES
$t_{su} = 20\mu s$
$t_h = 20\mu s$
$t_{WH} = 30\mu s$
$t_{WL} = 10\mu s$
$t_{LL} = 10\mu s$

FUNCTION TABLE I

Data input				Segment output							Display
A	B	C	D	a	b	c	d	e	f	g	
L	L	L	L	H	H	H	H	H	H	L	0
H	L	L	L	L	H	H	L	L	L	L	1
L	H	L	L	H	H	L	H	H	L	H	2
H	H	L	L	H	H	H	H	L	L	H	3
L	L	H	L	L	H	H	L	L	H	H	4
H	L	H	L	H	L	H	H	L	H	H	5
L	H	H	L	H	L	H	H	H	H	H	6
H	H	H	L	H	H	H	L	L	L	L	7
L	L	L	H	H	H	H	H	H	H	H	8
H	L	L	H	H	H	H	H	L	H	H	9
L	H	L	H	L	L	L	L	L	L	H	-
H	H	L	H	H	L	L	H	H	H	H	E
L	L	H	H	H	L	L	H	H	H	L	C
H	L	H	H	L	L	L	L	L	L	L	Blank
L	H	H	H	L	L	H	H	H	L	H	o
H	H	H	H	L	L	L	L	L	L	L	Blank

FUNCTION TABLE II

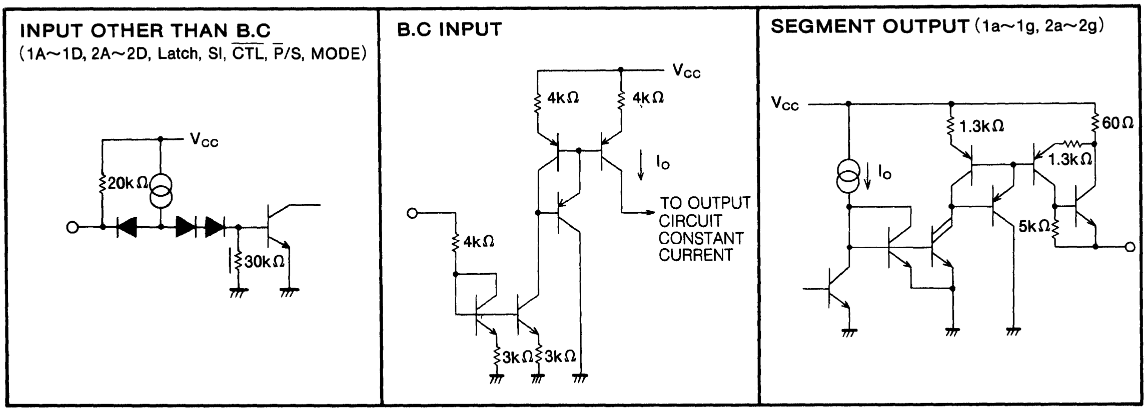
Data input		Other data 1A, 1B 2A~2D	Display	
1C	1D		First digit	Second digit
L	L	X	−(Note 1)	−(Note 1)
H	L	X	C	A
L	H	X	A	U
H	H	—	(Note 2)	(Note 3)

Note 1 : Only segment g lights.
2 : When both 1C and 1D inputs are high, first digit display blanking or numerical display of 1, 2 or 3 is determined by 1A, 1B input state.

Data input				Segment output							Display
1A	1B	1C	1D	1a	1b	1c	1d	1e	1f	1g	
L	L	H	H	L	L	L	L	L	L	L	Blank
H	L	H	H	L	H	H	L	L	L	L	1
L	H	H	H	H	H	L	H	H	L	H	2
H	H	H	H	H	H	H	H	L	L	H	3

Note 3 : Other digit codes are identical to those in function table I.

I/O CIRCUIT DIAGRAM



ABSOLUTE MAXIMUM RATINGS ($T_a = -10 \sim +60°C$, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		$-0.5 \sim +7$	V
V_I	Input voltage		$-0.5 \sim +V_{CC}$	V
$V_{CC}-V_O$	Voltage between supply and output		$-0.5 \sim +35$	V
Topr	Operating temperature		$-10 \sim +60$	℃
Tstg	Storage temperature		$-40 \sim +125$	℃
P_d	Power dissipation	$T_a = 60°C$	800	mW

RECOMMENDED OPERATING CONDITIONS ($T_a = -10 \sim +60°C$, unless otherwise noted)

Symbol	Parameter	Conditions	Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage		4.5	5	6	V
Iseg	Segment current				−10	mA
V_O	Output withstand voltage when output is off				−25	V

ELECTRICAL CHARACTERISTICS ($T_a = -10 \sim +60°C$, unless otherwise noted)

Symbol	Parameter	Test conditions		Limits			Unit
				Min	Typ	Max	
V_{IH}	High input voltage	$V_{CC} = 4.5 \sim 6V$		2		V_{CC}	V
V_{IL}	Low input voltage	$V_{CC} = 4.5 \sim 6V$		0		0.6	V
I_{IH}	High input current	$V_{CC} = 6V$	B.C input	0.5	0.75	1.2	mA
		$V_{IH} = 6V$	Inputs other than B.C			50	μA
I_{IL}	Low input current	$V_{CC} = 6V$	B.C input			50	μA
		$V_{IL} = 0V$	Inputs other than B.C	−280	−400	−650	
Iseg	Segment output current	$V_{CC} = 5V$, $V_O = 2V$, B.C pin is connected to V_{CC}.		−10			mA
Islk	Segment leak current	$V_{CC} = 5V$, $V_O = -25V$				−50	μA
I_{CC1}	Supply voltage	$V_{CC} = 6V$, All inputs and outputs are open			4	8	mA

Note 4 : All typical values are at $V_{CC} = 5V$, $T_a = 25°C$.

M54970P

9-BIT SERIAL-INPUT,LATCHED DRIVER

DESCRIPTION

The M54970P is a semiconductor integrated circuit of I^2L structure containing a serial input to serial/parallel output 9-bit shift register and latch as well as an output driver.

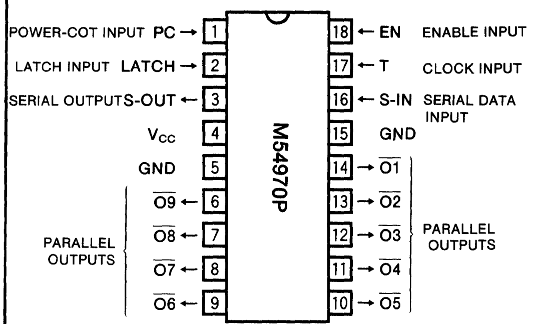
FEATURES

- Serial input to serial/parallel output
- Cascade connections possible through serial output
- Enable input for output control
- Power-cut input
- Driver : Withstand voltage ························ $BV_{CEO} \geqq 20V$
  Large drive current ·············· ($I_{O(max)}=300mA$)
- Wide operating temperature range ···· $T_a=-20 \sim +75°C$

APPLICATION

Thermal printer head dot driver Serial-to-parallel conversion

PIN CONFIGURATION (TOP VIEW)



Outline 18P4

FUNCTIONAL DESCRIPTION

The M54970P consists of a 9bit D-type flip-flop, the output of which is connected to 9 latches.

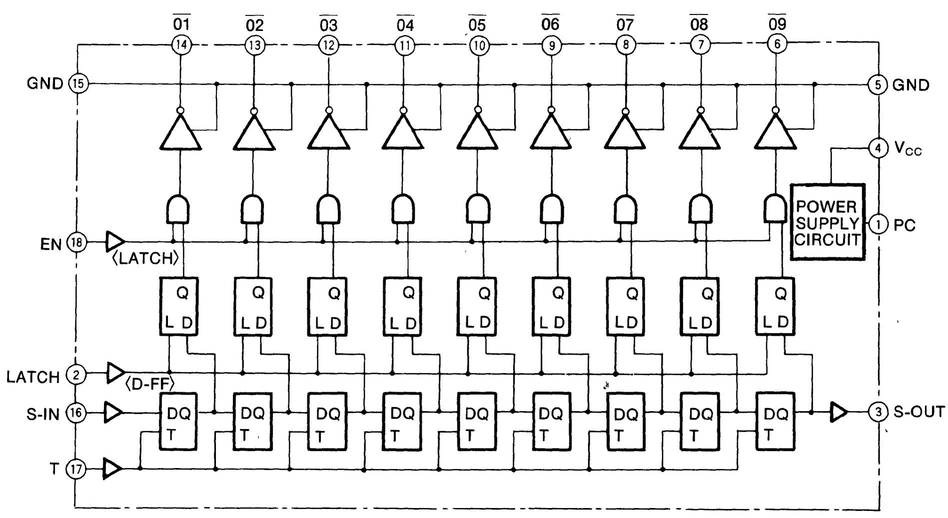
When data is applied to the serial data input (S-IN) and a clock pulse is applied to clock input (T), an "L" to "H" change of the clock will cause the data input signals to enter the internal shift registers and the data in the shift registers will be shifted in order.

Using a number of M54970P units for bit expansion in series will entail connecting serial output (S-OUT) to S-IN of the next-stage M54970P.

In parallel output, when the power-cut input and latch input are set to "H" and the output-control input (enable input EN) is "H", a clock pulse changing from "L" to "H" will cause the serial data input signal to appear at output $\overline{O1}$, and the data will be shifted in order at outputs $\overline{O2} \sim \overline{O9}$.

The parallel output will yield a signal that is inverted with respect to the serial data input.

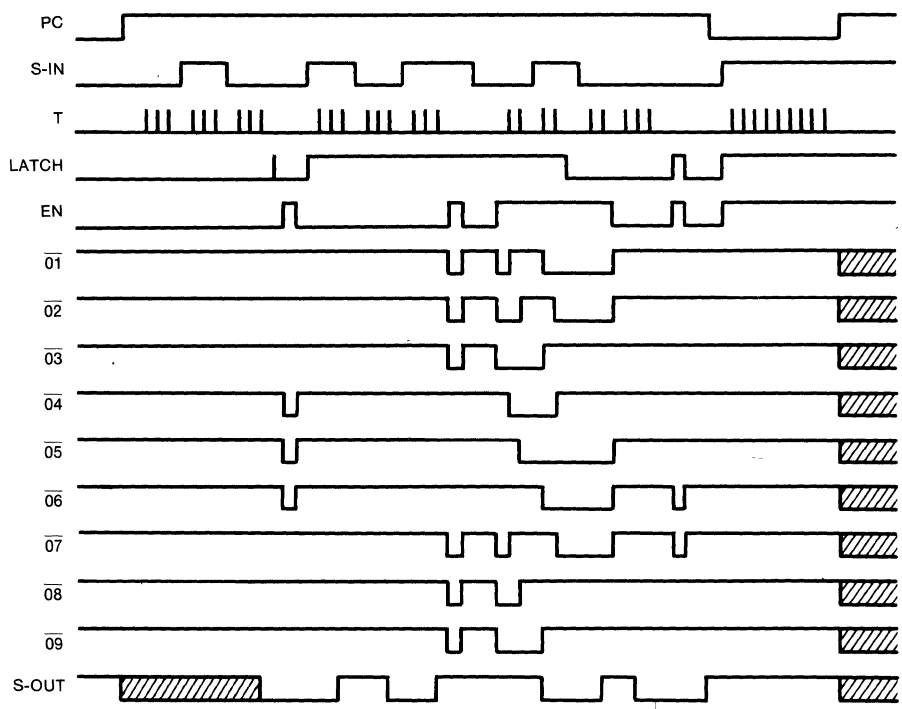
BLOCK DIAGRAM



MITSUBISHI ELECTRIC

Setting the LATCH input to "L" will prevent data from entering the latch.
When the EN input is set to "L", all outputs ($\overline{01}\sim\overline{09}$) will be set to OFF. Since the internal logic state of the IC is uncertain at power-on time, set the EN input to "L" (and outputs $\overline{01}\sim\overline{09}$ will be set to OFF) until the input data is set and the internal logic state has been detrmined.
The power will be cut when the power-cut input is set to "L", and since the data of the shift registers and latches are not maintained in this state, it will be necessary to input data again in order to set the output following a change of PC input from "L" to "H".

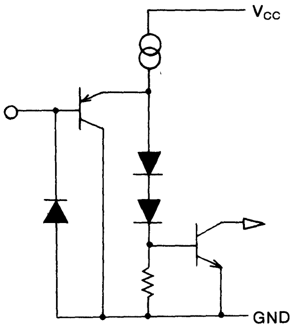
TIMING CHART



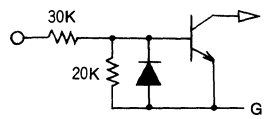
*The state of the shaded areas is uncertain

INPUT/OUTPUT EQUIVALENT CIRCUIT SCHEMATICS

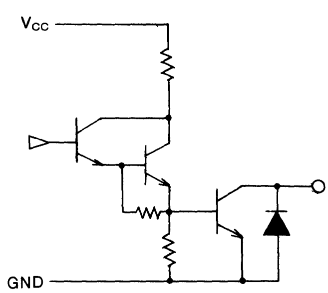
1 T, S-IN, LATCH INPUTS



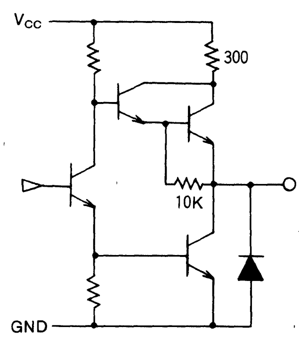
2 PC, EN INPUTS



3 $\overline{O1}$~$\overline{O9}$ OUTPUTS



4 S-OUT OUTPUT



ABSOLUTE MAXIMUM RATINGS (T_a=−20℃~+75℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		−0.5~+8	V
V_I	Input voltage		−0.5~+10	V
V_O	Output voltage	Output is OFF	−0.5~+20	V
I_O	Output current		350	mA
P_d	Power dissipation	T_a=25℃	1.25	W
Topr	Operating temperature range		−20~+75	℃
Tstg	Storage temperature range		−55~+125	℃

RECOMMENDED OPERATING CONDITIONS (T_a=−20~+75℃, unless otherwise noted)

Symbol	Parameter	Conditions	Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage		4.5	5.0	5.5	V
V_O	Applied output voltage	When output is OFF			20	V
I_O	Output current (per circuit)	Alloutputs ON simultaneously Duty cycle less than 30%			300	mA

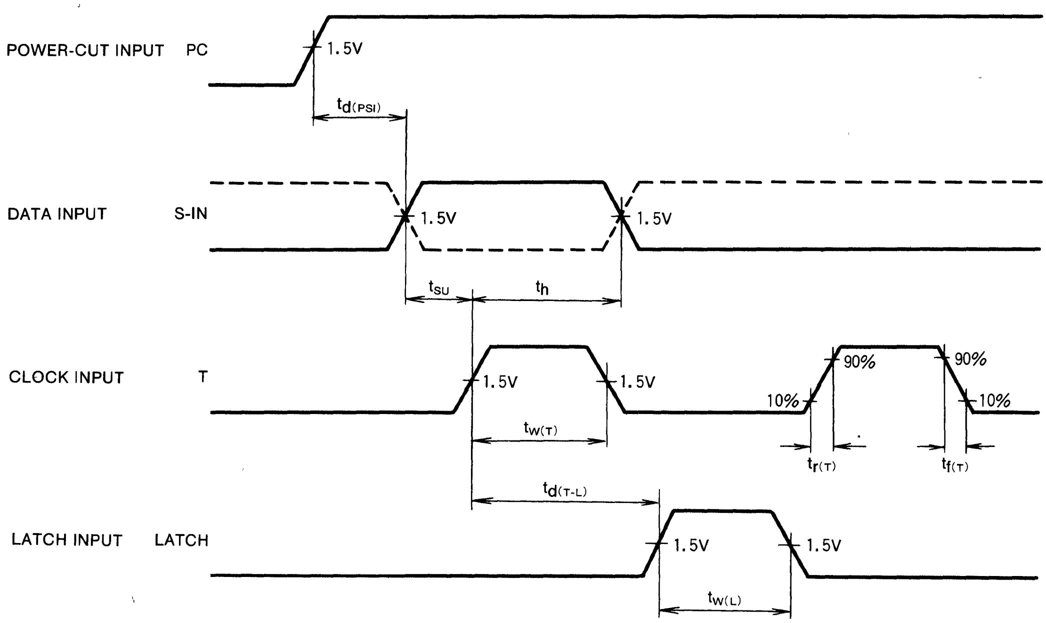
ELECTRICAL CHARACTERISTICS (T_a=+25℃, unless otherwise noted)

Symbol	Parameter	Pin	Test conditions	Limits			Unit
				Min	Typ	Max	
V_{IH}	"H" input voltage	2, 16, 17	T_a=−20~+75℃	2.2		V_{CC}	V
V_{IL}	"L" input voltage	2, 16, 17	T_a=−20~+75℃	0		0.8	V
V_{IH}	"H" input voltage	1, 18	T_a=−20~+75℃	2.2		V_{CC}	V
V_{IL}	"L" input voltage	1, 18	T_a=−20~+75℃	0		0.8	V
I_{IH}	"H" input current	2, 16, 17	V_{CC}=5.5V, V_{IH}=2.4V			10	μA
I_{IL}	"L" input current	2, 16, 17	V_{CC}=5.5V, V_{IL}=0.4V			−50	μA
I_{IH}	"H" input current	1, 18	V_{CC}=5.5V, V_{IH}=5.5V			250	μA
			V_{CC}=5.5V, V_{IH}=2.4V			100	
I_{IL}	"L" input current	1, 18	V_{CC}=5.5V, V_{IL}=0V			−10	μA
V_{OH}	"H" output voltage	3	V_{CC}=4.5V, I_{OH}=−400μA	2.4			V
V_{OL}	"L" output voltage	3	V_{CC}=4.5V, I_{OL}=8mA			0.4	V
V_{OL}	"L" output voltage	6~14	V_{CC}=4.5V, I_{OL}=300mA			0.6	V
I_{CC1}	Supply current	4	V_{CC}=5.5V, power-cut is ON			10	μA
I_{CC2}	Supply current	4	V_{CC}=5.5V, EN is "L"		10	15	mA
I_{CC3}	Supply current	4	V_{CC}=5.5V, all outputs are ON		90	130	mA
$I_{O(leak)}$	Output leakage current	6~14	V_{CC}=5.5V, V_{OH}=20V			100	μA

REQUIRED TIMING CONDITIONS (T_a=−20~+75℃, unless otherwise noted)

Symbol	Parameter	Conditions	Limits			Unit
			Min	Typ	Max	
$f_{(T)}$	Clock frequency	Input duty cycle 40~60%			1	MHz
$t_{W(T)}$	Clock pulse width		0.4			μS
$t_{W(L)}$	Latch pulse width		0.4			μS
t_{SU}	Data setup time		0.2			μS
t_h	Data hold time		0.3			μS
$t_{d(T-L)}$	Clock-latch time		1			μS
$t_{r(T)}$	Clock pulse rise time				0.5	μS
$t_{f(T)}$	Clock pulse fall time				0.5	μS
$t_{d(P-SI)}$	Power-cut input → data input setting tiwe	Hold EN input at "L" when PC input is changed from "L" to "H"	2			μS

VOLTAGE WAVEFORM

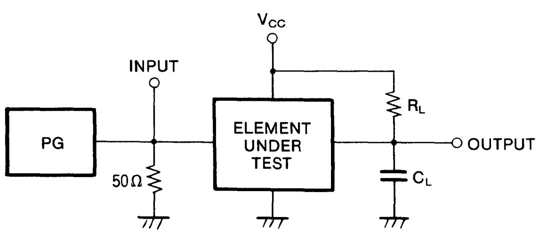


MITSUBISHI ELECTRIC

SWITCHING CHARACTERISTICS (T_a=25℃, V_{CC}=5V)

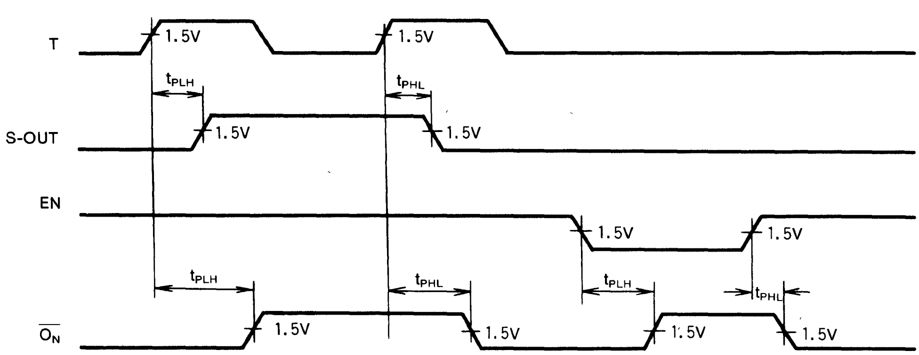
Symbol	Parameter	Conditions	Limits			Unit
			Min	Typ	Max	
t_{PLH}	"L-H" output propagation time (Input T to output S-OUT)	V_{IH}=3V V_{IL}=0V R_L : S-OUT=2KΩ R_L : $\overline{O_N}$=100Ω (N=1~9) C_L=15pF (Note 1)			0.7	μS
t_{PHL}	"H-L" output propagation time (Input T to output S-OUT)				0.8	μS
t_{PLH}	"L-H" output propagation time (Input T to output $\overline{O_N}$)				5	μS
t_{PHL}	"H-L" output propagation time (Input T to output $\overline{O_N}$)				1	μS
t_{PLH}	"L-H" output propagation time (Input EN to output $\overline{O_N}$)				10	μS
t_{PHL}	"H-L" output propagation time (Input EN to output $\overline{O_N}$)				1	μS

(Note 1) TEST CIRCUIT



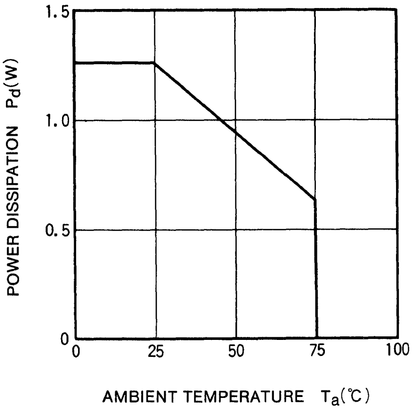
Input waveform is taken as t_r≦50ns and t_f≦50ns

(VOLTAGE WAVEFORM)

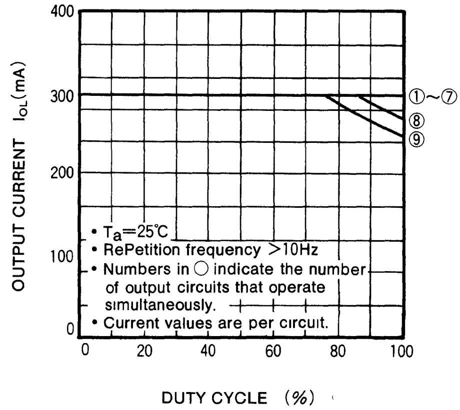


TYPICAL CHARACTERISTICS

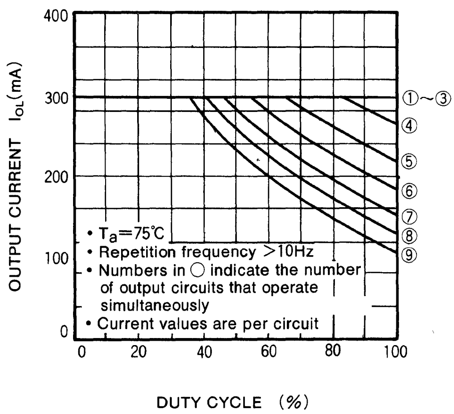
THERMAL DERATING



DUTY CYCLE VS PERMISSIBIE OUTPUT CURRENT



DUTY CYCLE VS PERMISSIBLE OUTPUT CURRENT



M54975P

BI-CMOS 8-BIT SERIAL-INPUT,LATCHED DRIVER

DESCRIPTION

The M54975P is a semiconductor integrated circuit fabricated using Bi-CMOS technology. It contains a serial input to serial/parallel output 8-bit shift register and latch as well as a bipolar 8-bit parallel-output driver.

FEATURES

- Serial input to serial/parallel output
- Cascade connections possible through serial output
- Latch circuit included for each stage
- Enable input for output control
- Low supply current .... $I_{CC} \geqq 10\mu A$ at standby
- Serial input/output level is compatible with standard CMOS
- Driver : Withstand voltage .... $BV_{CEO} \geqq 30$
  Large drive current .... ($I_{O(max)}$=300mA)
- Wide operating temperature range .... T_a=−20~+75℃

APPLICATION

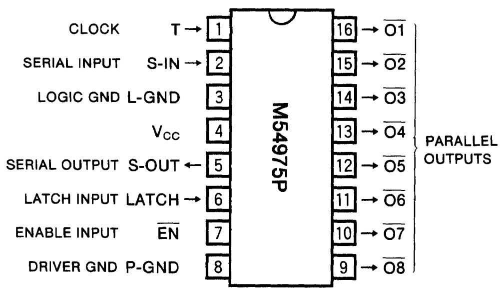
- Thermal printer head dot driver
- Serial-to parallel conversion
- Relay, solenoid driver

FUNCTION DESCRIPTION

The M54975P consists of an 8-bit D-type flip-flop, the output of which is connected to 8 latches.

When data is applied to the serial data input (S-IN) and a clock pulse is applied to clock input (T), an "L" to "H" change of the clock will cause the data input signals to enter the internal shift registers and the data in the shift registers will be shifted in order.

PIN CONFIGURATION (TOP VIEW)



Outline 16P4

Using a number of M54975P units for bit expansion in series will entail connecting serial output (S-OUT) to S-IN of the next-stage M54975P.

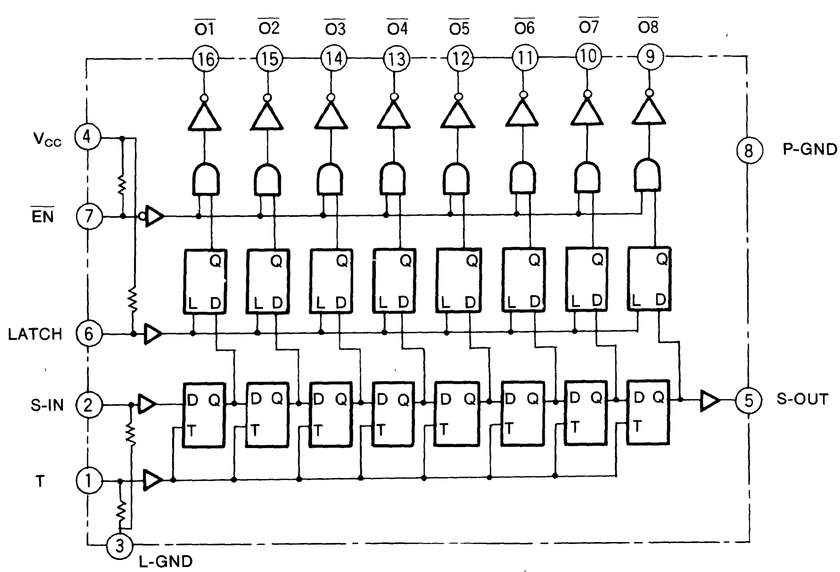
In parallel output, when the latch input is set to "H" and the output-control input (enable input $\overline{EN}$) is "L", a clock pulse changing from "L" to "H" will cause the serial data input signal to appear at output $\overline{O1}$, and the data will be shifted in order at outputs $\overline{O2}$~$\overline{O8}$.

The parallel output will yield a signal that is inverted with respect to the serial data input.

Setting the LATCH input to "L" will prevent data from entering the latch.

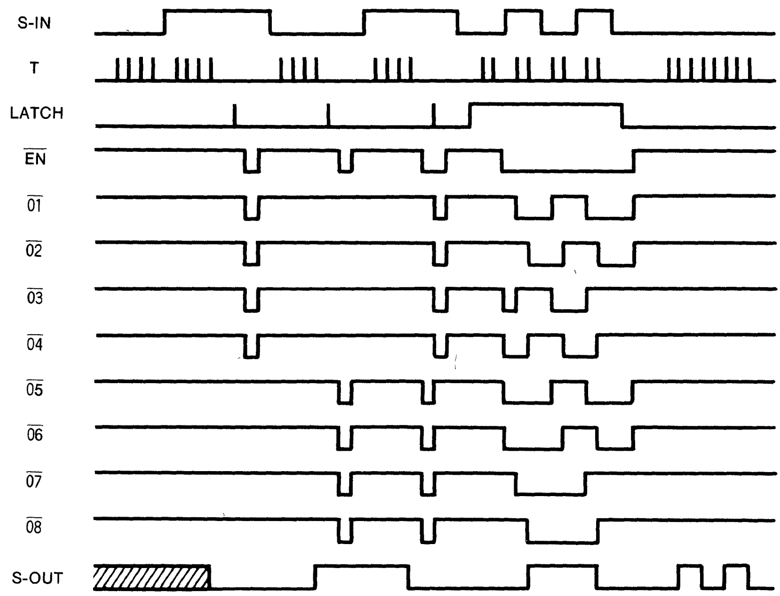
When the $\overline{EN}$ input is set to "H", all outputs ($\overline{O1}$~$\overline{O8}$) will be set to OFF. Since the internal logic state of the IC is uncertain at power-on time, set the $\overline{EN}$ input to "H" (and out-

BLOCK DIAGRAM



puts $\overline{O1}$~$\overline{O8}$ will set to OFF) until the input data is set and the internal logic state has been determined.
L-GND is the ground of the CMOS logic circuit section and P-GND is the ground for the output driver section ($\overline{O1}$~$\overline{O8}$), which is made up of bipolar transistors that are capable of driving large currents.

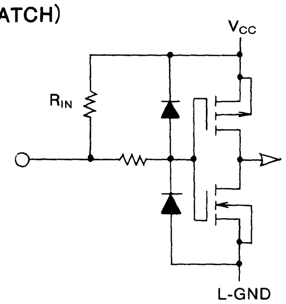
TIMING CHART



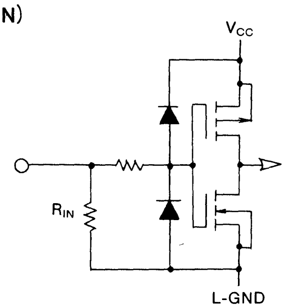
*The stage of the shaded areas is uncertain.

INPUT/OUTPUT CIRCUIT SCHEMATICS

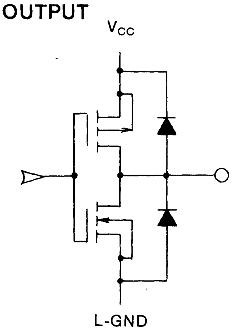
1 INPUT WITH PULL-UP RESISTOR ($\overline{EN}$, LATCH)



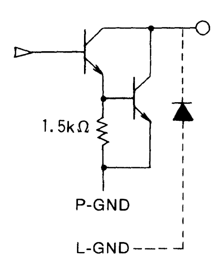
2 INPUT WITH PULL-DOWN RESISTOR (T, S-IN)



3 SERIAL OUTPUT (S-OUT)



4 PARALLEL OUTPUT ($\overline{O1}$~$\overline{O8}$)



ABSOLUTE MAXIMUM RATING (T_a=−20~+75℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		−0.5~+8	V
V_I	Input voltage		−0.5~V_{CC}+0.5	V
V_O	Output voltage	S-OUT	−0.5~V_{CC}+0.5	V
		$\overline{O1}$~$\overline{O8}$: Output is OFF	−0.5~+30	
I_O	Output Current	$\overline{O1}$~$\overline{O8}$: Output is ON	350	mA
P_d	Power dissipation	T_a=25℃	1.25	W
Topr	Operating temperature		−20~+75	℃
Tstg	Storage temperature range		−55~+125	℃

RECOMMENDED OPERATING CONDITIONS (T_a=−20~+75℃ unless otherwise noted)

Symbol	Parameter	Conditions	Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage		4	5	6	V
V_O	Applied output voltage	$\overline{O1}$~$\overline{O8}$: When output is OFF			30	V
I_O	Output current (per circuit)	$\overline{O1}$~$\overline{O8}$: All outputs ON simultaneously Duty cycle less than 15%			300	mA

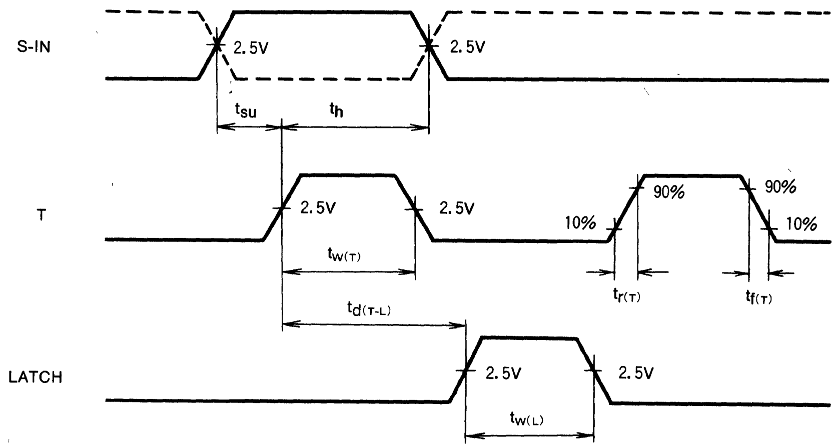
ELECTRICAL CHARACTERISTICS (T_a=+25℃, V_{CC}=5V, unless otherwise noted)

Symbol	Parameter	Pin	Conditions	Limits			Unit
				Min	Typ	Max	
V_{IH}	"H" input voltage	1, 2 6, 7	T_a=−20~+75℃	0.7V_{CC}		V_{CC}	V
V_{IL}	"L" input voltage			0		0.3V_{CC}	V
R_{IN}	input resistance			50		—	kΩ
V_{OH}	"H" output voltage	5	$\vert I_O \vert \leq 1\mu A$	4.9		—	V
V_{OL}	"L" output voltage			—		0.1	V
I_{OH}	"H" output current		V_{OH}=4.5V	−100		—	μA
I_{OL}	"L" output current		V_{OL}=0.4V	400		—	μA
V_{OL1}	"L" output voltage	9~16	I_{OL}=100mA	—		1.2	V
V_{OL2}			I_{OL}=200mA	—		1.4	V
V_{OL3}			I_{OL}=300mA	—		1.6	V
I_{OLK}	Output leakage current		V_O=30V	—		50	μA
I_{CC1}	Supply current	4	Inputs free, all driver outputs OFF	—		10	μA
I_{CC2}			Driver output : 1 circuit ON	—		1.7	mA

REQUIRED TIMING CONDITIONS (T_a=−20~+75℃, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
$f_{(T)}$	Clock frequency	Input duty cycle 40~60%			2	MHz
$t_{W(T)}$	Clock pulse width		200			nS
$t_{W(L)}$	Latch pulse width		200			nS
t_{su}	Data setup time		100			nS
t_h	Data hola time		100			nS
$t_{d(T-L)}$	Clock-latch time		400			nS
$t_{r(T)}$	Clock pulse rise time				500	nS
$t_{f(T)}$	Clock pulse fall time				500	nS

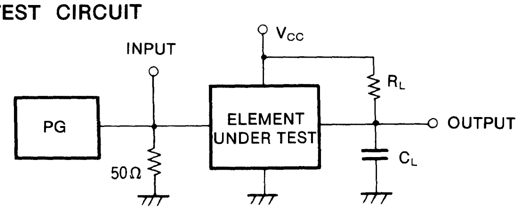
VOLTAGE WAVEFORM



SWITCHING CHARACTERISTICS (T_a=+25℃, V_{CC}=5V)

Symbol	Parameter	Conditions	Limits Min	Limits Typ	Limits Max	Unit
t_{PLH}	"L-H" output propagation time (Input T to output S-OUT)	V_{IH}=5V V_{IL}=0V R_L : S_{OUT}=∞ R_L : $\overline{O_N}$=100Ω (N=1~8) C_L=15pF (Note 1)			0.3	μS
t_{PHL}	"H-L" output propagation time (Input T to output S-OUT)				0.3	μS
t_{PLH}	"L-H" output propagation time (Input T to output $\overline{O_N}$)				10	μS
t_{PHL}	"H-L" output propagation time (Input T to output $\overline{O_N}$)				2	μS
t_{PLH}	"L-H" output propagation time (Input EN to output $\overline{O_N}$)				10	μS
t_{PHL}	"H-L" output propagation time (Input EN to output $\overline{O_N}$)				2	μS

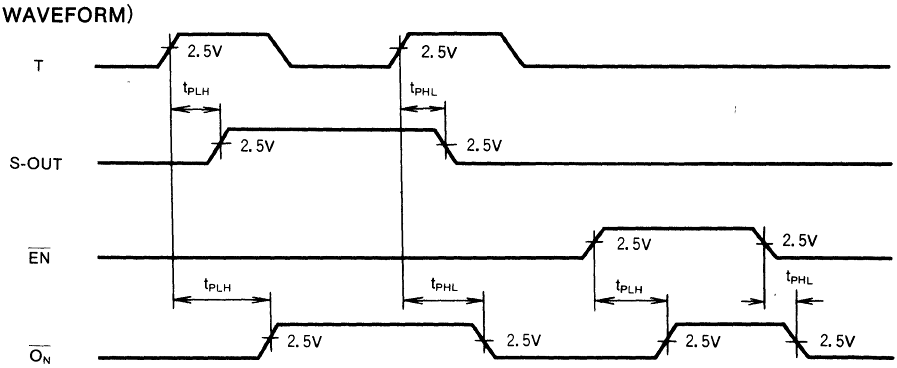
(Note 1) TEST CIRCUIT



Input waveform is taken as $t_r \leqq 20ns$ and $t_f \leqq 20ns$

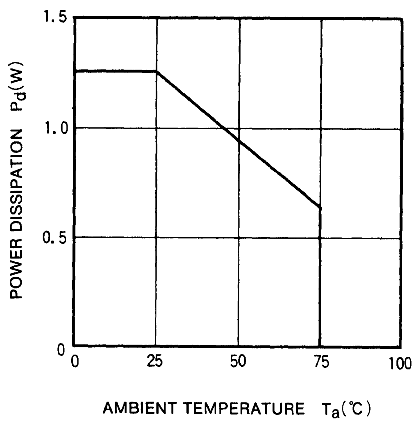
C_L includes wiring stray capacitance and probe input capacitance.

(VOLTAGE WAVEFORM)

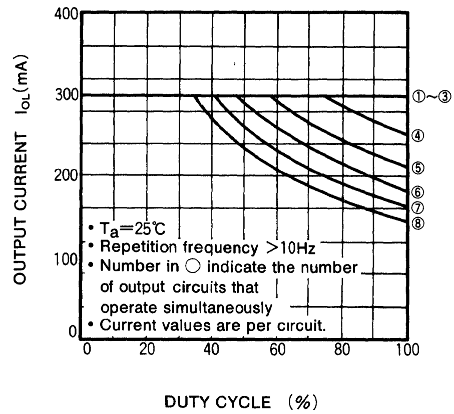


TYPICAL CHARACTERISTICS

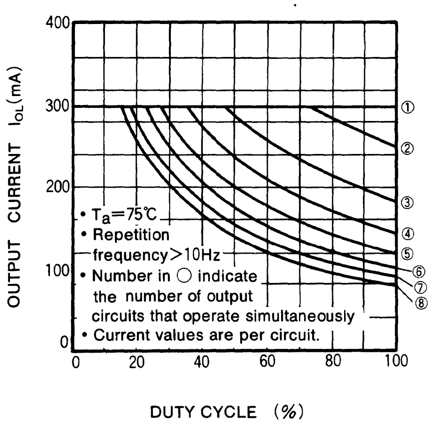
THERAL DREATING



DUTY CYCLE VS PERMISSIBLE OUTPUT CURRENT



DUTY CYCLE VS PERMISSIBLE OUTPUT CURRENT



M54976P

BI-CMOS 8-BIT PARALLEL-INPUT LATCHED DRIVER

DESCRIPTON

The .M54976P is a semiconducnductor integrated circuit fabricated using Bi-CMOS technology. It contains 8 output drivers of latch and bipolar structure.

FEATURES

- Enable input for output control
- Low supply current ····················· $I_{CC} \leqq 10\mu A$ at standby
- Input level is compatible with standard CMOS
- Driver : Withstand voltage ························· $BV_{CEO} \geqq 30$
  Large drive current ·············· ($I_{O(max)} = 300mA$)
- Wide operating temperature range ···· $T_a = -20 \sim +75$℃

APPLICATION

- Printer head dot driver
- Relay, polenoid driver

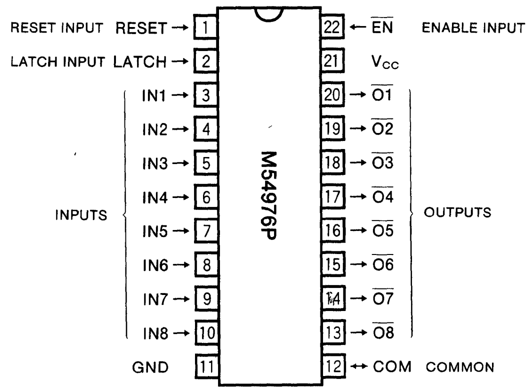
FUNCTIOAL DECRIPTION

When data is applied to inputs IN1-IN8 and LATCH input is set to "H", the data will be latchedance with the truth table. Note that when an "H" signal is applied to the RESET input, the latch will maintain the reset state.

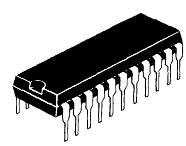
When the $\overline{EN}$ input is set to "L" and the data maintained in the latch are "H", the corresponding output will be ON and become "L".

When both the LATCH and RESET inputs are "L", the latch will maintain the prior state irrespective of input signals IN1-IN8.

PIN CONFIGURATION (TOP VIEW)

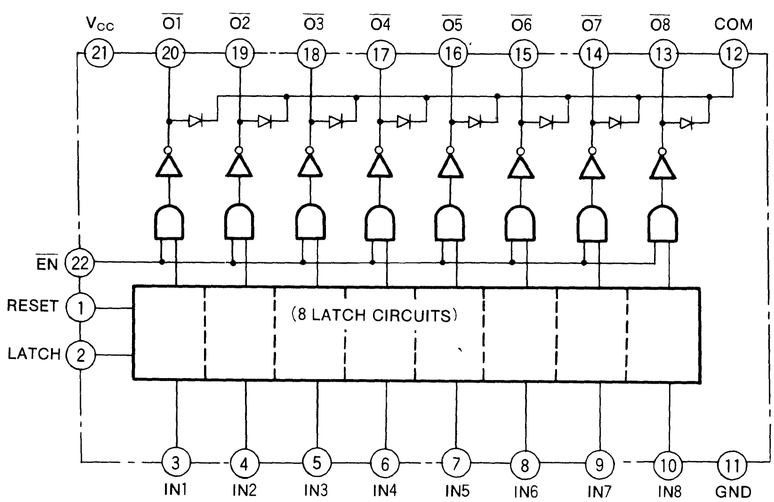


Outline 22P4



22-pin molded plastic DIP

BLOCK DIAGRAM

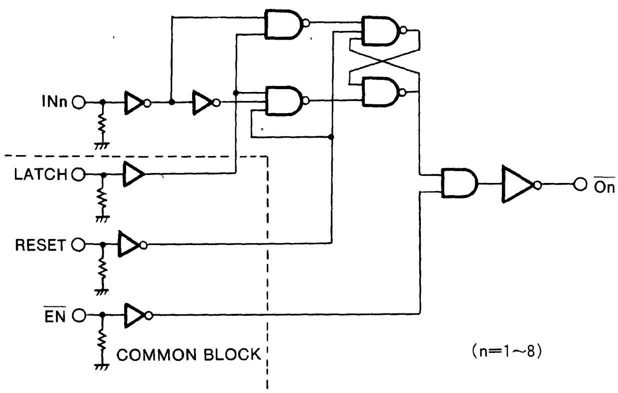


TRUTH TABLE

INPUTS				OUTPUT $\overline{On}$	
INn	LATCH	RESET	$\overline{EN}$	t-1	t
L	H	L	L	X	H
H	H	L	L	X	L
X	X	H	X	X	H
X	X	X	H	X	H
X	L	L	L	L	L
X	L	L	L	H	H

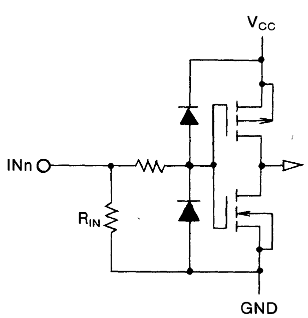
L : "L" level
H : "H" level
X : Irrelevant
t-1 : Previous state
t : Present state
Output H is in the OFF state
Output L is in the ON state

LOGIC DIAGRAM (1 CIRCUIT)

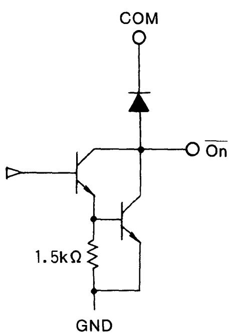


INPUT/OUTPUT EQUIVALENT CIRCUIT SCHEMATICS

1 INPUT CIRCUIT



2 OUTPUT CIRCUIT



ABSOLUTE MAXIMUM RATINGS (T_a=−20℃~+75℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		−0.5~+8	V
V_I	Input voltage		−0.5~V_{CC}+0.5	V
V_O	Output voltage	Output is OFF	−0.5~+30	V
I_O	Output current	Output is on	350	mA
P_d	Power dissipation	T_a=25℃	1.42	W
Topr	Operating temperature range		−20~+75	℃
Tstg	Storage temperature range		−55~+125	℃

RECOMMENDED OPERATING CONDITIONS (T_a=−20~+75℃, unless otherwise noted)

Symbol	Parameter	Conditions	Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage		4	5	6	V
V_O	Applied output voltage	When output is OFF			30	V
I_O	Output current (per circuit)	Alloutputs ON simultaneously Duty cycle less than 25%			300	mA

ELECTRICAL CHARACTERISTICS (T_a=+25℃, V_{CC}=5V, unless otherwise noted)

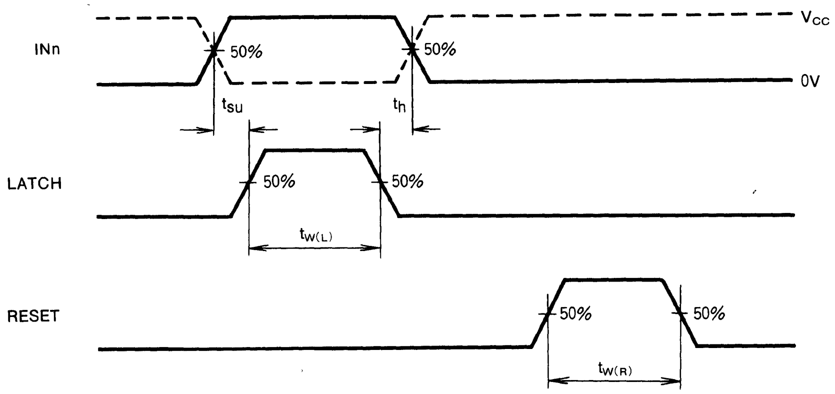
Symbol	Parameter	Pin	Test conditions	Limits			Unit
				Min	Typ	Max	
V_{IH}	"H" input voltage	1~10 22	T_a=−20~+75℃	0.7V_{CC}		V_{CC}	V
V_{IL}	"L" input voltage			0		0.3V_{CC}	V
R_{IN}	Input resistance			50			kΩ
V_{OL1}	"L" output voltage	13~20	I_{OL}=100mA			1.2	V
V_{OL2}			I_{OL}=200mA			1.4	V
V_{OL3}			I_{OL}=300mA			1.6	V
I_{OLK}	Output leakage current	13~20	V_O=30V			50	μA
V_F	Clamp diode forward current	13~20	I_F=300mA			2	V
I_R	Clamp diode reverse current		V_R=30V			50	μA
I_{CC1}	Supply current	21	All inputs are 0V, all outputs OFF			10	μA
I_{CC2}			Output : 1 circuit ON			1.4	mA

BI-CMOS 8-BIT PARALLEL-INPUT LATCHED DRIVER

REQUIRED TIMING CONDITIONS (T_a=−20~+75℃, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
$t_{W(L)}$	Latch pulse width		0.1			μS
$t_{W(R)}$	Reset pulse width		0.1			μS
t_{su}	Data setup time		0			μS
t_h	Data hold time		0.1			μS

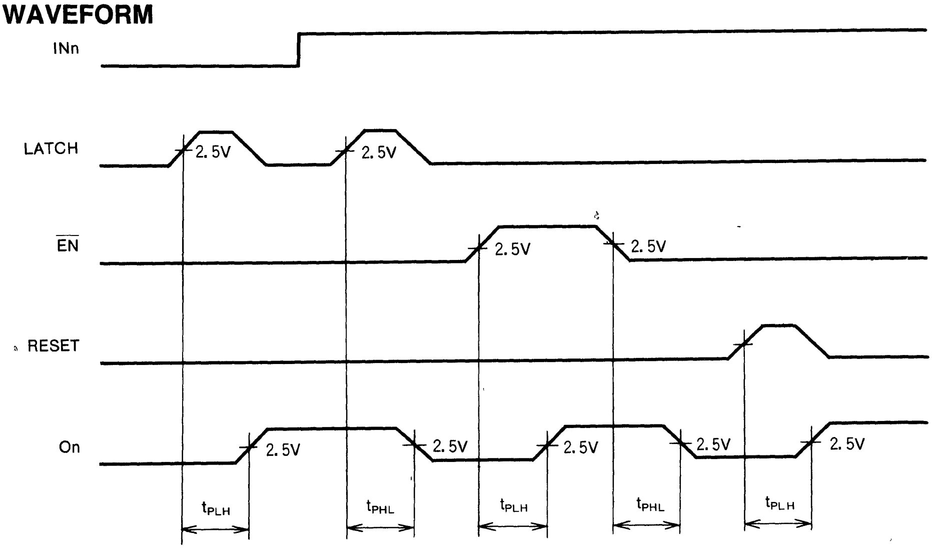
VOLTAGE WAVEFORM



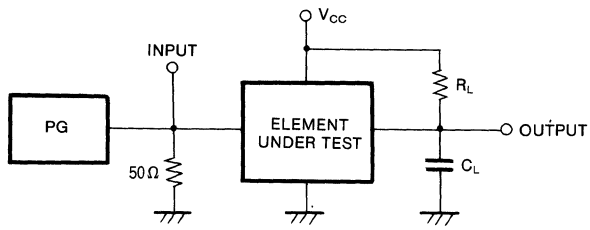
SWITCHING CHARACTERISTICS (T_a=+25℃, V_{CC}=5V)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
t_{PLH}	"L-H" output propagation time (Input LATCH to output $\overline{On}$)	V_{IH}=5V, V_{IL}=0V, R_L=100Ω, C_L=15pF (Note 1)		(0.6)	2	μS
t_{PHL}	"H-L" output propagation time (Input LATCH to output $\overline{On}$)			(0.1)	0.5	μS
t_{PLH}	"L-H" output propagation time (Input $\overline{EN}$ to output $\overline{On}$)			(0.6)	2	μS
t_{PHL}	"H-L" output propagation time (Input $\overline{EN}$ to output $\overline{On}$)			(0.1)	0.5	μS
t_{PLH}	"L-H" output propagation time (Input RESET to output $\overline{On}$)			(0.6)	2	μS

VOLTAGE WAVEFORM

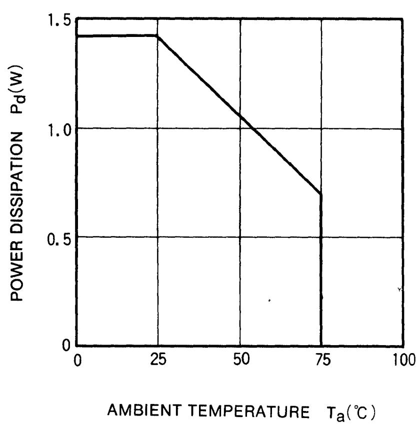


(Note 1) TEST CIRCUIT

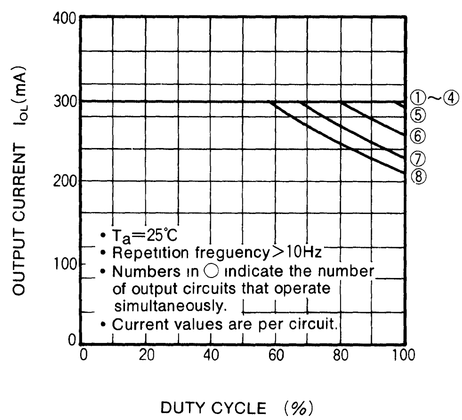


• Input waveform is taken as $t_r \leqq 20ns$ and $t_f \leqq 20ns$
• C_L includes wiring stray capacitance and probe input capacitance.

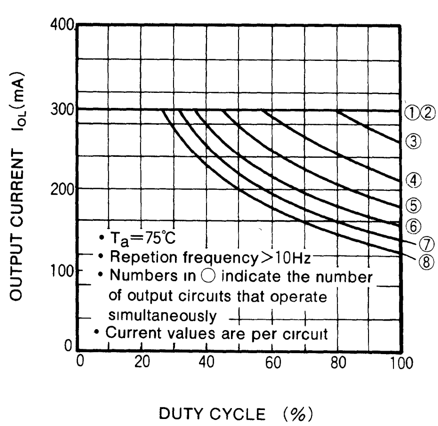
THERMAL DERATING



DUTY CYCLE VS PERMISSIBLE OUTPUT CURRENT



DUTY CYCLE VS PERMISSIBLE OUTPUT CURRENT



M54977P

BI-CMOS 12-BIT SERIAL-INPUT, LATCHED DRIVER

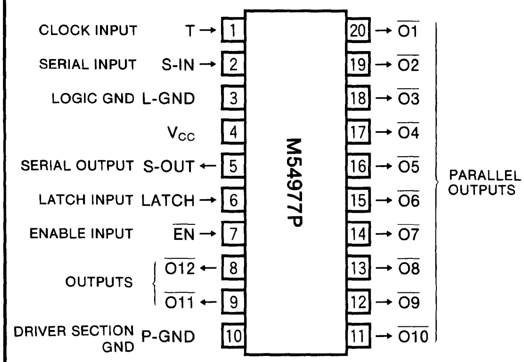
DESCRIPTION

The M54977P is a semiconductor integrated circuit fabricated using Bi-CMOS technology. It contains a serial input to, serial/parallel output 12-bit shift register and latch as well as a bipolar 12-bit parallel-output driver.

FEATURES

- Serial input to serial/parallel output
- Cascade connections possible through serial output
- Latch circuit included for each stage
- Enable input for output control
- Low supply current .... $I_{CC} \geqq 10\mu A$ at standby
- Serial input/output level is compatible with standard CMOS
- Driver : Withstand voltage .... $BV_{CEO} \geqq 30$
  Large drive current .... ($I_{O(max)} = 200mA$)
- Wide operating temperature range .... $T_a = -20 \sim +75$℃

PIN CONFIGURATION (TOP VIEW)



Outline 20P4

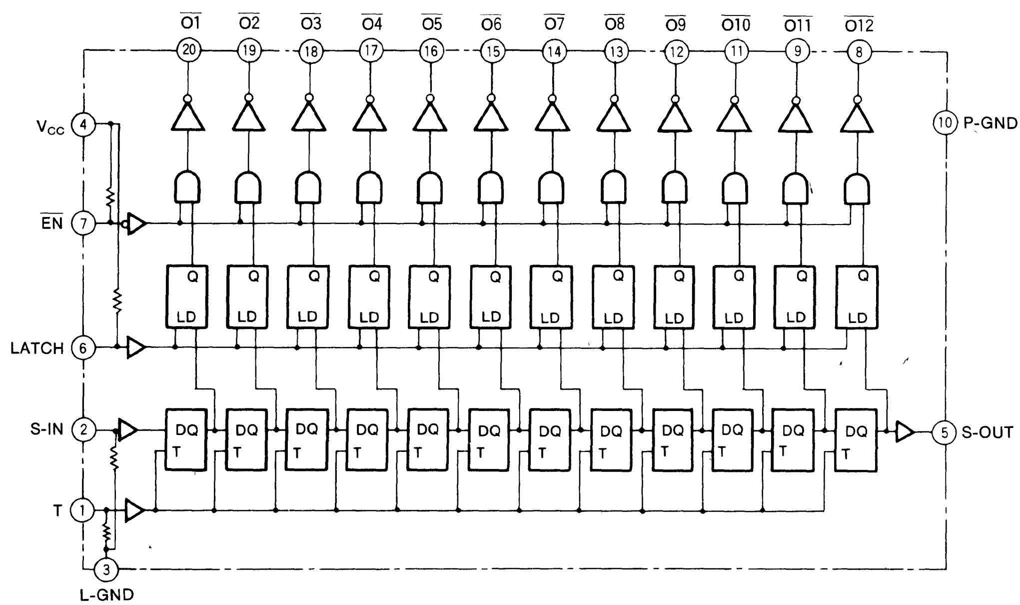
APPLICATION

- Thermal printer head dot driver
- Serial-to parallel conversion
- Relay, solenoid driver

FUNCTION DESCRIPTION

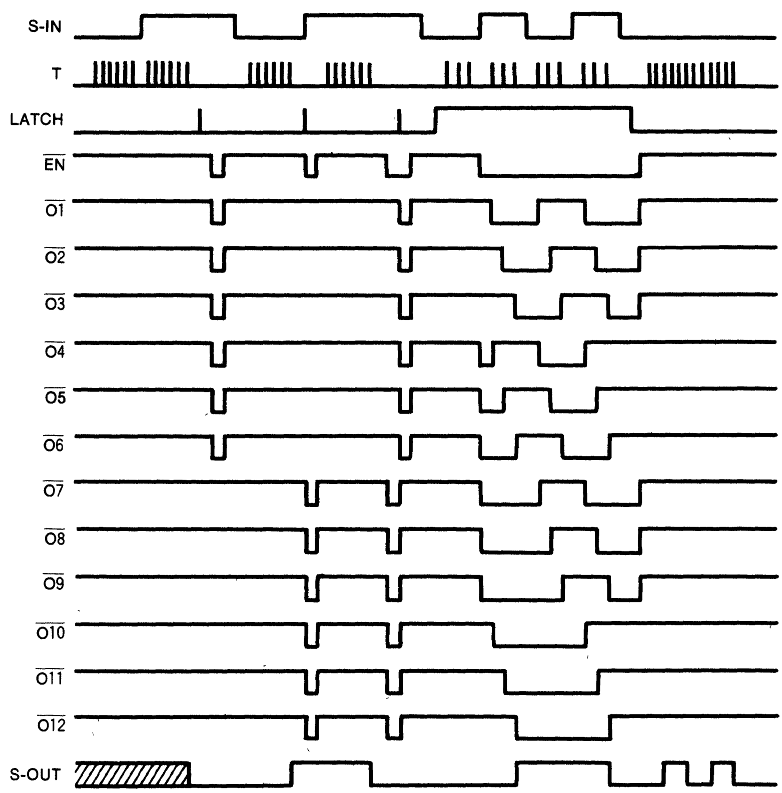
The M54977P consists of an 12-bit D-type flip-flop, the output of which is connected to 12 latches.
When data is applied to the serial data input (S-IN) and a clock pulse is applied to clock input (T), an "L" to "H" change of the clock will cause the data input signals to enter the internal shift registers and the data in the shift registers will be shifted in order.
Using a number of M54977P units for bit expansion in series will entail connecting serial output (S-OUT) to S-IN of the next-stage M54977P.
In parallel output, when the latch input is set to "H" and the output-control input (enable input $\overline{EN}$) is "L", a clock pulse changing from "L" to "H" will cause the serial data input signal to appear at output $\overline{O1}$, and the data will be shifted in order at outputs $\overline{O2} \sim \overline{O12}$.

BLOCK DIAGRAM



The parallel output will yield a signal that is inverted with respect to the serial data input.
Setting the LATCH input to "L" will prevent data from entering the latch.
When the $\overline{EN}$ input is set to "H", all outputs ($\overline{O1}$~$\overline{O12}$) will be set to OFF. Since the internal logic state of the IC is uncertain at power-on time, set the $\overline{EN}$ input to "H" (and outputs $\overline{O1}$~$\overline{O12}$ will set to OFF) until the input data is set and the internal logic state has been determined.
L-GND is the ground of the CMOS logic circuit section and P-GND is the ground for the output driver section ($\overline{O1}$~$\overline{O12}$), which is made up of bipolar transistors that are capable of driving large currents.

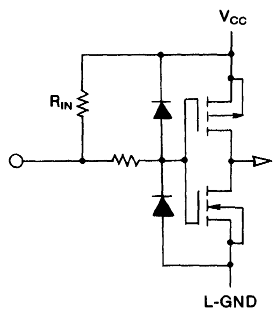
TIMING CHART



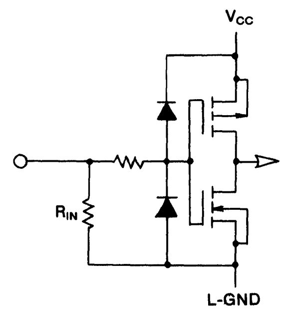
*The stage of the shaded areas is uncertain.

INPUT/OUTPUT CIRCUIT SCHEMATICS

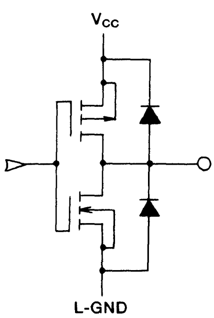
1 INPUT WITH PULL-UP RESISTOR
($\overline{EN}$, LATCH)



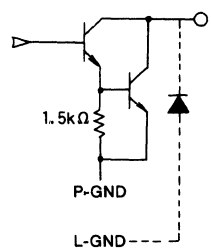
2 INPUT WITH PULL-DOWN RESISTOR
(T, S-IN)



3 SERIAL OUTPUT
(S-OUT)



4 PARALLEL OUTPUT
($\overline{O1}$~$\overline{O12}$)



ABSOLUTE MAXIMUM RATING (T_a=−20~+75℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		−0.5~+8	V
V_I	Input voltage		−0.5~V_{CC}+0.5	V
V_O	Output voltage	S-OUT	−0.5~V_{CC}+0.5	V
		$\overline{O1}$~$\overline{O12}$: Output is OFF	−0.5~+30	
I_O	Output Current	$\overline{O1}$~$\overline{O8}$: Output is ON	250	mA
P_d	Power dissipation	T_a=25℃	1.25	W
Topr	Operating temperature		−20~+75	℃
Tstg	Storage temperature range		−55~+125	℃

RECOMMENDED OPERATING CONDITIONS (T_a=−20~+75℃ unless otherwise noted)

Symbol	Parameter	Conditions	Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage		4	5	6	V
V_O	Applied output voltage	$\overline{O1}$~$\overline{O12}$: When output is OFF			30	V
I_O	Output current (per circuit)	All outputs ON simultaneously Duty cycle less than 20%			200	mA

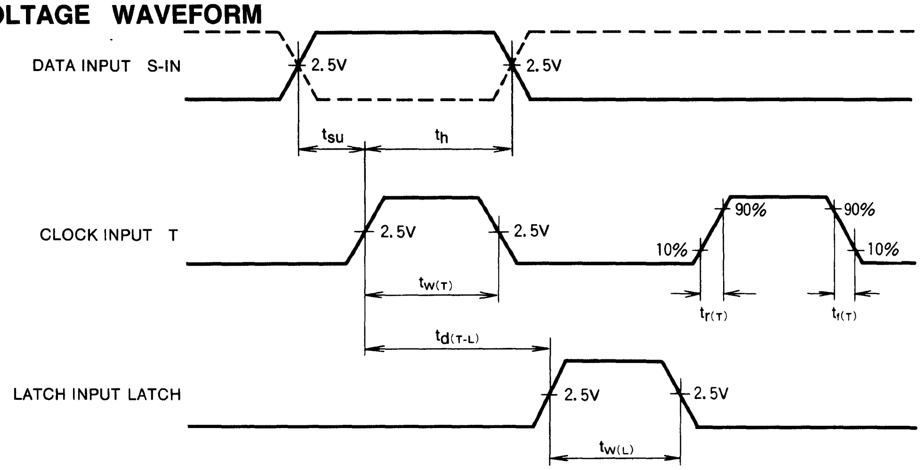
ELECTRICAL CHARACTERISTICS (T_a=+25℃, V_{CC}=5V, unless otherwise noted)

Symbol	Parameter	Pin	Conditions	Limits			Unit
				Min	Typ	Max	
V_{IH}	"H" input voltage	1, 2 6, 7	T_a=−20~+75℃	0.7V_{CC}		V_{CC}	V
V_{IL}	"L" input voltage			0		0.3V_{CC}	V
R_{IN}	input resistance			50		—	kΩ
V_{OH}	"H" output voltage	5	$\mid I_O \mid$ ≦1μA	4.9		—	V
V_{OL}	"L" output voltage			—		0.1	V
I_{OH}	"H" output current	5	V_{OH}=4.5V	−100		—	μA
I_{OL}	"L" output current		V_{OL}=0.4V	400		—	μA
V_{OL1}	"L" output voltage	8, 9 11~20	I_{OL}=100mA	—		1.2	V
V_{OL2}			I_{OL}=200mA	—		1.4	V
I_{OLK}	Output leakage current		V_O=30V	—		50	μA
I_{CC1}	Supply current	4	Inputs free, all driver outputs OFF	—		10	μA
I_{CC2}			Driver output : 1 circuit ON	—		1.25	mA

REQUIRED TIMING CONDITIONS (T_a=−20∼+75℃, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits Min	Limits Typ	Limits Max	Unit
$f_{(T)}$	Clock frequency	Input duty cycle 40∼60%			2	MHz
$t_{W(T)}$	Clock pulse width		200			nS
$t_{W(L)}$	Latch pulse width		200			nS
t_{su}	Data setup time		100			nS
t_h	Data hola time		100			nS
$t_{d(T-L)}$	Clock-latch time		400			nS
$t_{r(T)}$	Clock pulse rise time				500	nS
$t_{f(T)}$	Clock pulse fall time				500	nS

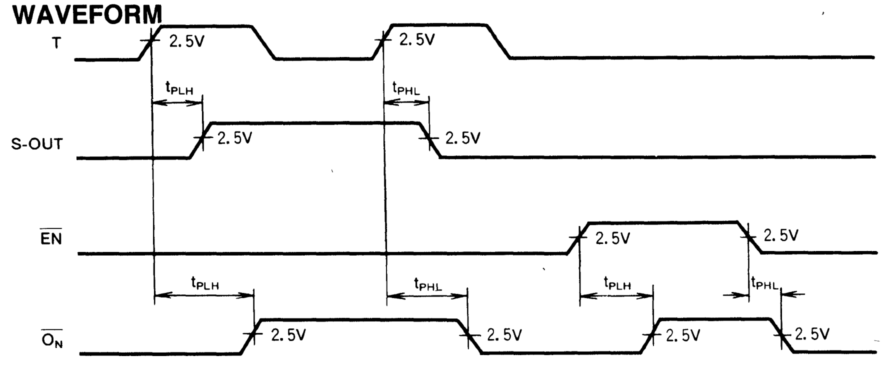
VOLTAGE WAVEFORM



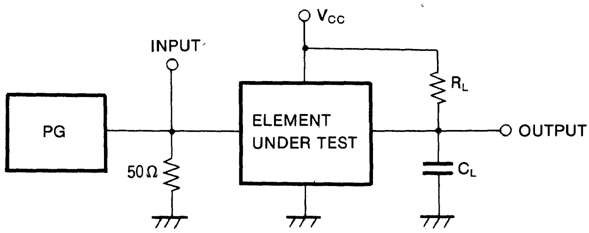
SWITCHING CHARACTERISTICS (T_a=+25℃, V_{CC}=5V)

Symbol	Parameter	Conditions	Limits Min	Limits Typ	Limits Max	Unit
t_{PLH}	"L-H" output propagation time (Input T to output S-OUT)	V_{IH}=5V, V_{IL}=0V, R_L : S_{-OUT}=∞, R_L : $\overline{O_N}$=100Ω (N=1∼8), C_L=15pF (Note 1)		(0.15)	0.3	μS
t_{PHL}	"H-L" output propagation time (Input T to output S-OUT)			(0.15)	0.3	μS
t_{PLH}	"L-H" output propagation time (Input T to output $\overline{O_N}$)			(2)	10	μS
t_{PHL}	"H-L" output propagation time (Input T to output $\overline{O_N}$)			(0.5)	2	μS
t_{PLH}	"L—H" output propagation time (Input EN to output $\overline{O_N}$)			(2)	10	μS
t_{PHL}	"H-L" output propagation time (Input EN to output $\overline{O_N}$)			(0.5)	2	μS

VOLTAGE WAVEFORM



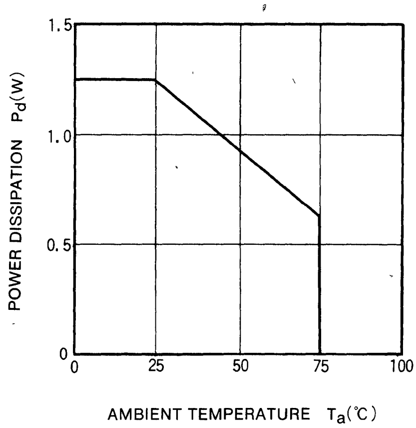
(Note 1) TEST CIRCUIT



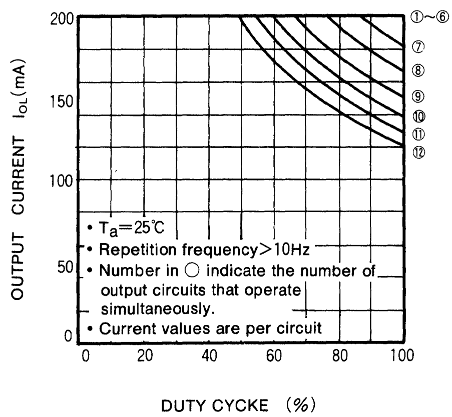
• Input waveform is taken as $t_r \leqq 20ns$ and $t_f \leqq 20ns$
C_L includes wiring stray capacitance and probe input capacitance.

TYPICAL CHARACTERISTICS

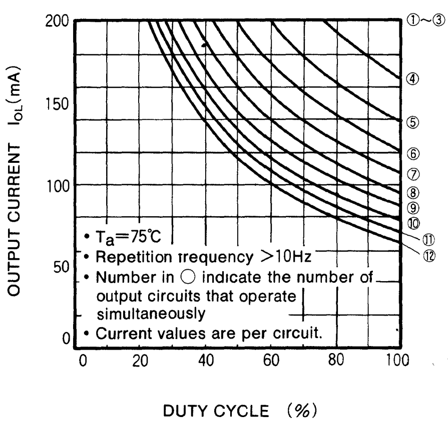
THERAL DREATING



DUTY CYCLE VS PERMISSIBLE OUTPUT CURRENT



DUTY CYCLE VS PERMISSIBLE OUTPUT CURRENT



M50800-XXXSP/M50802-XXXP

SINGLE-CHIP CMOS SPEECH SYNTHESIZER

DESCRIPTION

The M50800-XXXSP/M50802-XXXP, are single chip CMOS PARCOR speech synthesizers and contain a speech data, ROM, a clock generator, a D-A converter and a speaker drive circuit.

The differences among the M50800-XXXSP/M50802-XXXP are shown in the following table. The M50800-XXXSP will be discussed below.

Type	Number of words selection	Outline
M50800-XXXSP	64 (max)	28-pin, plastic DIP (LEAD PITCH 1.78mm)
M50802-XXXP	32 (max)	24-pin, plastic, DIP flat

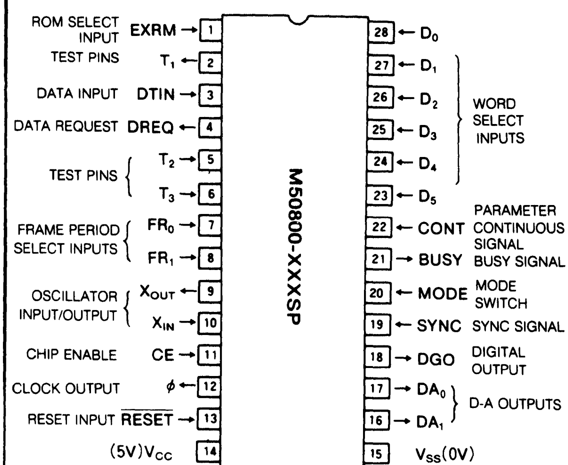
FEATURES

- Speech synthesis time .... 20 seconds (max)
- Number of words selection .... 64 words (max)
- Melody generation possible .... 70 seconds (max)
- Built-in speaker drive circuit
- Built-in D-A converter .... ± 7-bits PWM method
- Low power dissipation due to CMOS process
  - Supply current in operating .... 2mA (max)
  - in stand-by .... 10μA (max)
- Built-in clock generator

APPLICATION

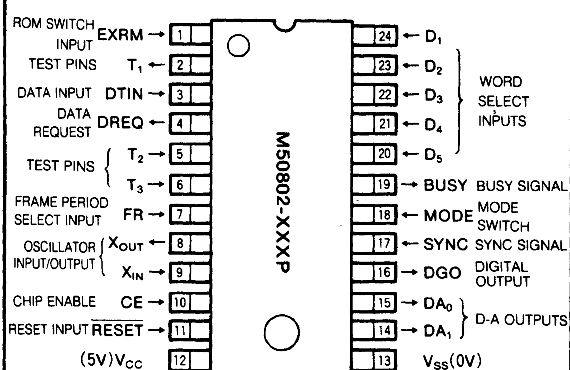
- Home appliances
- Teaching aid
- Watches, cameras, desk-top calculators
- Alarms

PIN CONFIGURATION (TOP VIEW)



Outline 28P4B

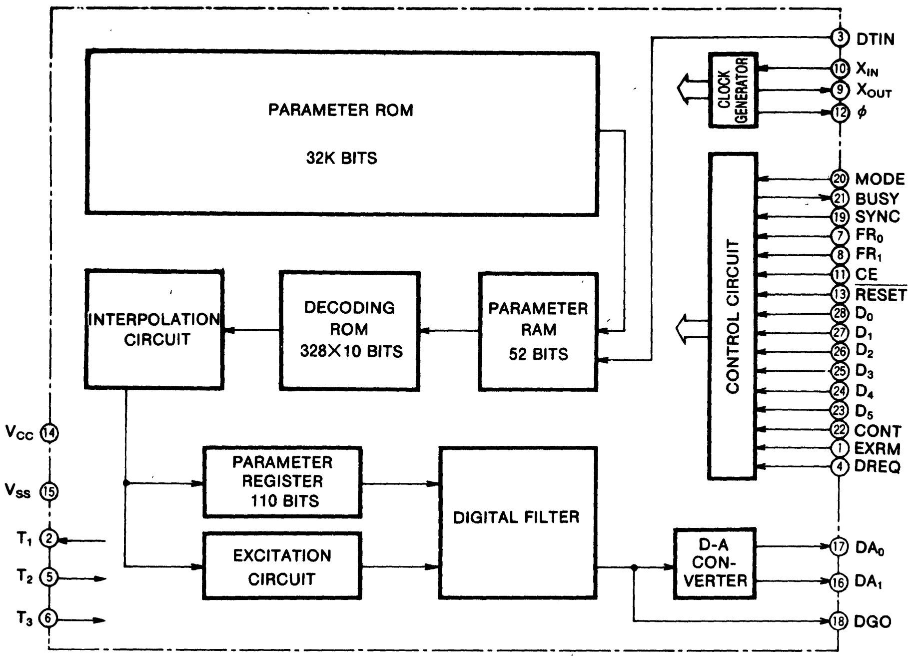
PIN CONFIGURATION (TOP VIEW)



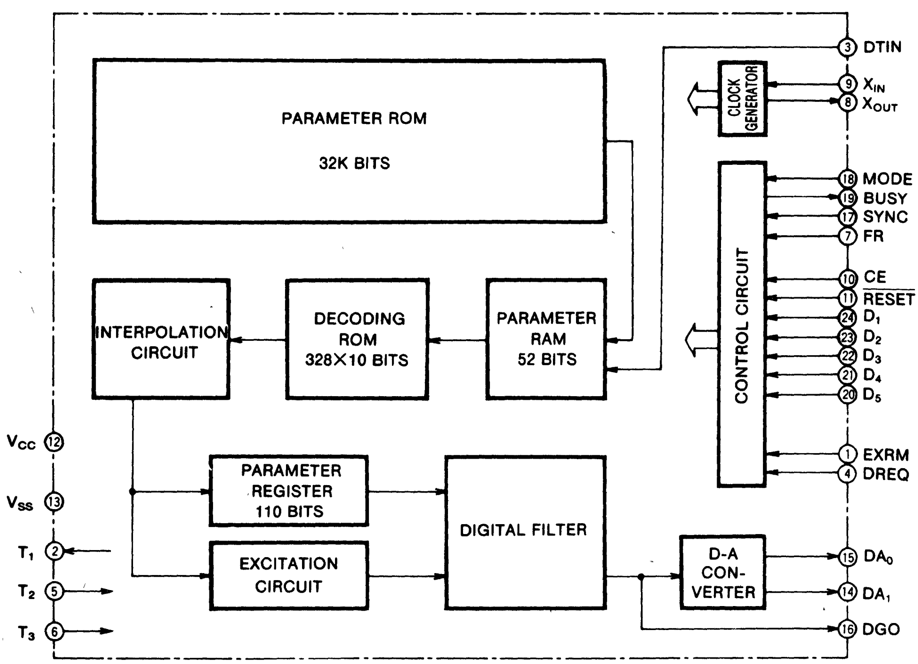
Outline 24P2W

BLOCK DIAGRAM

M50800-XXXSP



M50802-XXXP



PIN DESCRIPTION

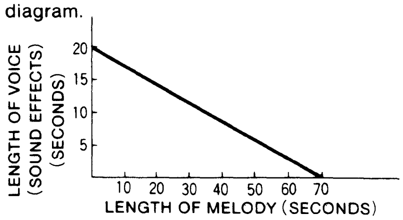
Pin	Name	Input or Output	Pull-down resistor Yes/No	Function
$D_0 \sim D_5$	Word select input	Input	Option	In the keyboard input mode, when any of $D_0 \sim D_5$ are set to high, speech synthesis begins A maximum of 63 words can be designated When using microcomputer control, a maximum of 64 word addresses can be set.
SYNC	Sync signal	Input		When using microcomputer control, the SYNC signal initiates $D_0 \sim D_5$ address read, starting speech synthesis.
MODE	Mode switch	Input	Yes	Selects microcomputer or keyboard control modes
BUSY	Busy signal	Output		High during speech synthesis and RESET processes
FR_0 FR_1	Frame period select	Input		Used to select frame length (7.5, 10, 15 or 20ms)
CONT	Parameter continuous signal	Input	Yes	In the melody mode, tone production continues while with the CONT pin low and discontinues when it is set to high
$\overline{RESET}$	Reset input	Input		Clears internal registers and mutes D/A converter at power on
CE	Chip enable	Input		When set to low disconnects chip power (stand-by mode), when set to high connects chip power (operation mode)
DA_0 DA_1	D/A output	Output		±7 bit PWM speech signal output
X_{IN} X_{OUT}	Oscillator	Input Output		Terminals for connecting ceramic resonator
ϕ	Clock output	Output		200kHz clock output signal
EXRM	Internal/external ROM select input	Input		ROM select input When high, external ROM is used
DTIN	Data input	Input		Used for speech data input from external ROM
DREQ	Data request	Output		Data request signal for external ROM
DGO	Digital output	Output		The digital speech signal output
$T_1 \sim T_3$	Test pins	Input/Output		During operation, T_1 is open and set T_2 and T_3 are set low

BASIC FUNCTION BLOCKS

Parameter ROM

A 4096 word × 8 bits constructed mask ROM, it stores speech parameters.

There is enough memory storage for about 20 seconds of voice and sound effects and in the case of melody about 70 seconds. Voice, sound effects and melody can be stored together. In this case each length of time can be calculated by the following diagram.



Parameter RAM

This has 52bits capacity for temporary storage of one frame of speech parameters (amplitude, pitch, and K-parameters)

Decoding ROM

Decodes the speech parameters that had been coded by the parameter RAM. It has 328 words × 10 bits construction.

Interpolation Circuit

Provides a linear interpolation of K-parameters, pitch and amplitude every 2.5ms.

Exitation Circuit

Having both a pulse generator and a white noise generator, it generates voiced and unvoiced sounds.

Parameter Register
A register used to temporarily store data which has been linearly interpolated.

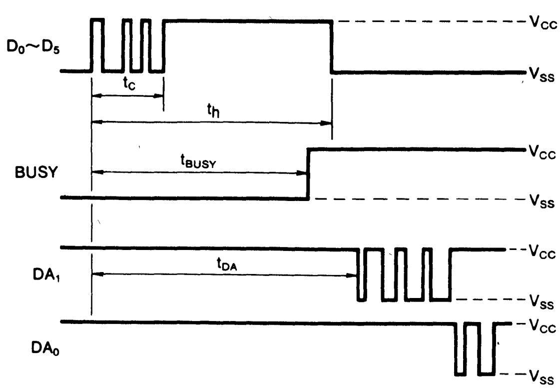
Digital Filter
It is a 14 bit 10 stage lattice digital filter.

Control Circuit
According to the external input, it controls LSI operation.

Mode Select
Depending on mode select signal MODE and internal/external ROM switch signal EXRM, three kinds of mode may be selected as shown in the following diagram.

Mode	MODE	EXRM	Use
Key input mode	H	L	Suitable for use when not editing phrases is necessary.
Microcomputer control mode	L	L	Suitable for use when the editing of phrases is necessary
External memory mode	L	H	For use when an external memory such as EPROM and RAM is used.

Pin Conditions of Key Input Mode
(1) MODE pin ············Connect with V_{CC}.
(2) SYNC pin ············Connect with V_{SS}.
(3) T_2,T_3 pins, EXRM pin, DTIN pin ·········Connect with V_{SS}.
(4) Pins $D_0 \sim D_5$ (word selection inputs) ············When any of these pins are set high speech synthesis begins automatically.
(5) Input/output timing chart

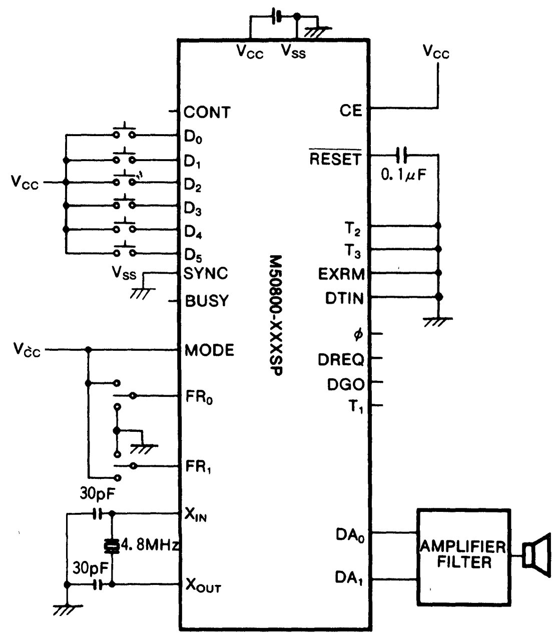


Timing Requirements

Symbol	Parameter	Min	Max	Unit
t_C	Key debounce protection time	5		ms
t_h	Data hold time	30		ms
t_{BUSY}	Busy output delay	25	50	ms
t_{DA}	Speech output delay	70		ms

f_{OSC} = 4.8MHz

Application Example in the Key Input Mode



Pin Conditions of Microcomputer Control Mode

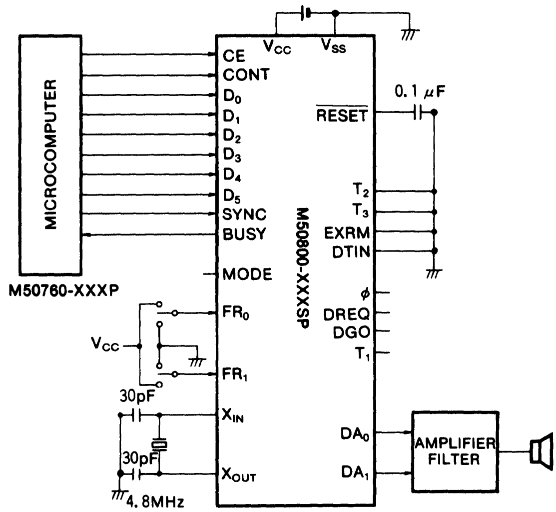
(1) MODE ······Open (Pull-down resistance)

(2) T_2, T_3 pins, EXRM pin, DTIN pin ······Connect with V_{SS}.

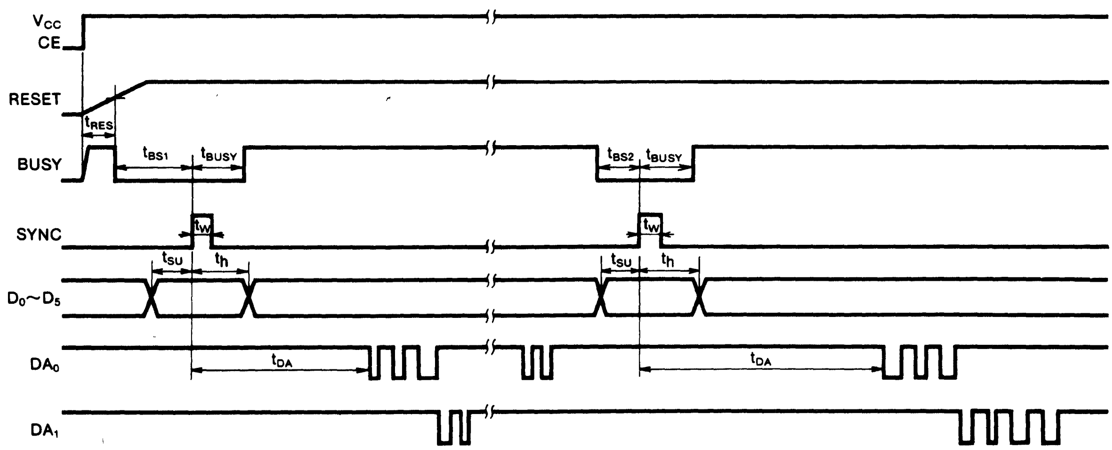
(3) $D_0 \sim D_5$ pins ······Select 64 kinds of words.

(4) SYNC pin ······Data of $D_0 \sim D_5$ is latched and speech generation is commenced in the "High-level" at more than 15μs. If the power supply or CE input is switched on for the next speech output, it is necessary to delay the SYNC input a minimum of 400μs after the BUSY output goes low.

Application Example in the Microcomputer Control Mode



(5) Input/Output timing chart



Timing Requirements

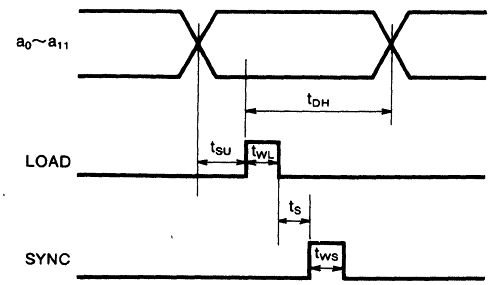
Symbol	Parameter	Min	Max	Unit	Notes
t_{RES}	Reset time	5		ms	
t_{SU}	Data set up time	0		μs	
t_h	Data hold time	25		μs	
$t_{W(SYNC)}$	SYNC pulse width	15		μs	
t_{BS1}	SYNC pulse output delay	400		μs	After the power supply or CE input is switched.
t_{BS2}		0		μs	Except above condition.
t_{BUSY}	BUSY output delay	10	20	μs	
t_{DA}	Speech output delay	40	60	ms	

Note : Designate the single voice generation as a mask option, when the LSI is used in the microcomputer control mode.

Pin Conditions of External Memory Mode

1. MODE pin ······Open (microcomputer mode)
2. EXRM pin ······Connect with V_{CC}.
3. Word select pin ······Open $D_0 \sim D_5$ and word select is performed by setting the first address to the external address counter.
4. SYNC pin ······Generates speech in the "High-level".
5. DTIN pin ······Receives serial data from external ROM.
6. DREQ pin ······Output read pulse of external ROM data.

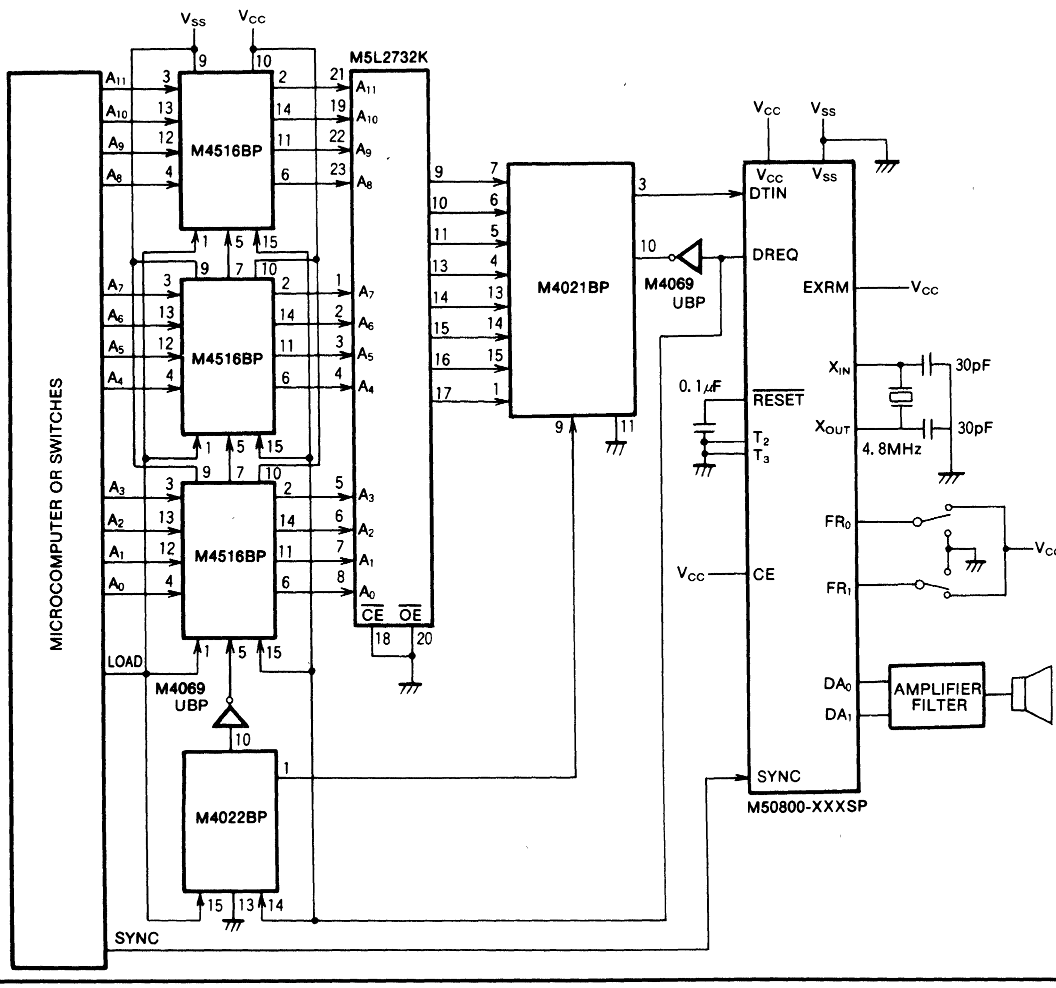
7. Timing chart



Timing Requirement

Symbol	Parameter	Min	Max	Unit
t_{SU}	Data set up time	1		μs
t_{DH}	Data hold time	2		μs
t_{WL}	LOAD pulse width	1		μs
t_S	LOAD SYNC pulse interval	0		μs
t_{WS}	SYNC pulse width	15		μs

Application Example in the External Memory Mode



MITSUBISHI ELECTRIC

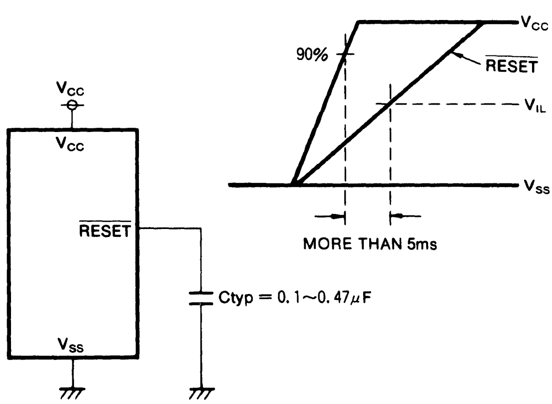
INPUT/OUTPUT PINS

Chip Enable Pin (CE)

CE	Function
L	When input is low-level, internal power supply is turned off and device enters stand-by condition Under this stand-by mode, $D_0 \sim D_5$ are high impedance, and BUSY, DA_0, and DA_1 are high.
H	When input is high-level internal power supply is turned on. At this time a reset signal is automatically generated and device enters power-on-initialization sequence.

Reset Pin (RESET)

The reset pin must become low-level in more than 5ms after power has been applied and the supply voltage has reached 90%.

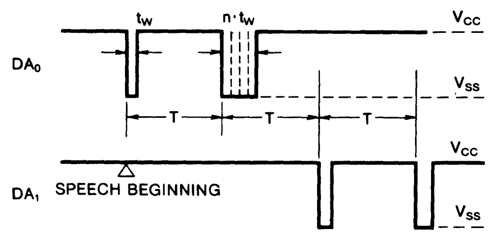


Busy Pin (BUSY)

The output of this pin becomes high-level during each of following. Voice generation, power-on-initialization and stand-by. If the BUSY singnal is high-level, the voice generation start signal has no effect.

D-A Output Pin (DA_0, DA_1)

D-A output is PWM (pulse width modulation) and outputted from pin DA_0 when positive and pin DA_1 when negative.



T : SAMPLING PERIOD 100μs (Typ)

t_W : MINIMUM PULSE WIDTH 830ns (Typ) f_{OSC} = 4 8MHz

Frame Period Select (FR_0, FR_1 ·· M50800-XXXSP) (FR ············ M50802-XXXP)

M50800-XXXSP

FR_0	FR_1	Frame length	Bit rate b/s (Note 1)
H	H	20ms	2650(Max.)
L	H	15ms	3533(Max.)
L	L	10ms	5300(Max.)
H	L	7.5ms	7067(Max)

M50802-XXXP

FR	Frame length	Bit rate b/s (Note 1)
H	20ms	2650(Max)
L	10ms	5300(Max.)

Note 1 : Where f_{OSC} = 4.8MHz

The standard frame length is 20ms.

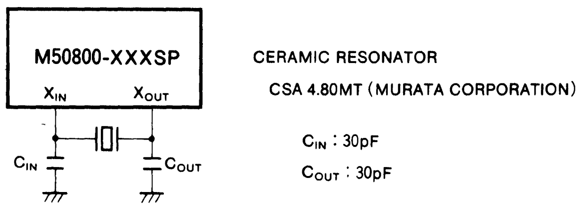
Speech speed depends on frame length. For example when frame length is set to 15ms in analysis and frame period select is set to 20ms in synthesis, speech speed is 33% slow. When frame period select is set to 10ms, 33% fast.

Clock Generator

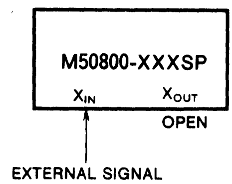
The device contains a clock generator which can generate a clock signal when a ceramic resonator is connected externally between the clock output and input pins (X_{IN}, X_{OUT}).

When a clock signal from an external source is being used, connect the source of the clock oscillator to pin X_{IN} and open pin X_{OUT}.

Circuit examples are given below.



Externally connected ceramic resonator circuit



External clock input circuit

Mask Option

The following mask options are available, specifiable at the time of ordering maskings.

(1) Continuous/Single voice generation selecting specification. This option is available when the LSI is used only in key input mode. The single voice generation as a mask option must be designated when the LSI is used in the microcomputer control mode.

Continuous voice generation :

Voice generation continues as long as $D_0 \sim D_5$ is kept continuously high-level in the key input mode.

Single voice generation :

Voice generation occurs only once even if $D_0 \sim D_5$ is kept continuously high-level in the key input mode or SYNC is kept continuously high-level in the microcomputer control mode. To generate the voice again it is necessary to return either the $D_0 \sim D_5$ or the SYNC to low-level one time and then to high-level again.

(2) Specifications concerning the inclusion or exclusion of pull-down resistors for the word select input pins $D_0 \sim D_5$

ELECTRICAL CHARACTERISTICS OF THE M50800-XXXSP/M50802-XXXP
ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage	With respect to the V_{SS} pin	−0.3~7	V
V_I	Input voltage		−0.3~7	V
P_d	Maximum power dissipation	$T_a = 25°C$	150	mW
T_{opr}	Operating temperature		−10~70	°C
T_{stg}	Storage temperature		−40~125	°C

RECOMMENDED OPERATING CONDITIONS ($T_a = -10\sim70°C$, unless otherwise noted)

Symbol	Parameter	Limits			Unit
		Min	Typ	Max	
V_{CC}	Supply voltage	2.4	5	5.5	V
V_{SS}	Supply voltage	0	0	0	V
f_{OSC}	Oscillation frequency		4.8		MHz

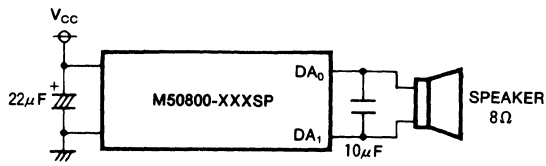
ELECTRICAL CHARACTERISTICS ($T_a = -10\sim70°C$, f = 4.75~4.85MHz, $V_{CC} = 4.5\sim5.5V$, unless otherwise noted)

Symbol	Parameter	Conditions	Limits			Unit
			Min	Typ	Max	
V_{OH}	High-level output voltage	$I_{OH} = 0.1mA$	$V_{CC}-0.8$			V
V_{OL}	Low-level output voltage	$I_{OL} = 0.4mA$			0.8	V
I_{OH}	High-level output current	DA_0, DA_1, $V_{OH} = V_{CC}-0.4V$	1			mA
I_{OL}	Low-level output current	DA_0, DA_1, $V_{OL} = 0.4V$	1.6			mA
I_{DA}	D/A output current	Resistor between DA_0 and DA_1 10Ω at $V_{CC} = 5V$		40		mA
I_{OC}	Supply current (in operation)	Unloaded input/output			2	mA
I_{SC}	Supply current (stand-by)	Unloaded input/output			10	μA
I_{IL}	Input leak current	$V_I = 0\sim V_{CC}$			±1	μA
R_I	Pull-down resistor	$V_I = V_{CC}$		100		kΩ
V_{IH}	High-level input voltage		$V_{CC}-1$		V_{CC}	V
V_{IL}	Low-level input voltage		0		1	V

Example of Speaker Driving Circuits

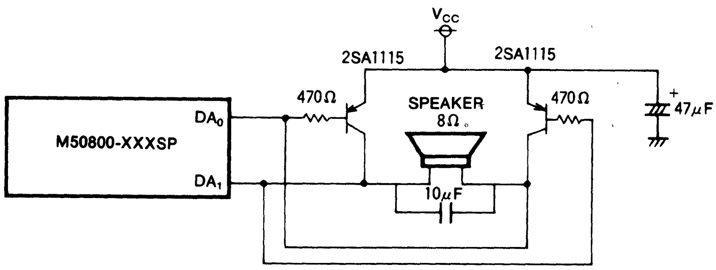
(a) Direct drive

Maximum output power=10mW typ. (V_{CC}=5V)



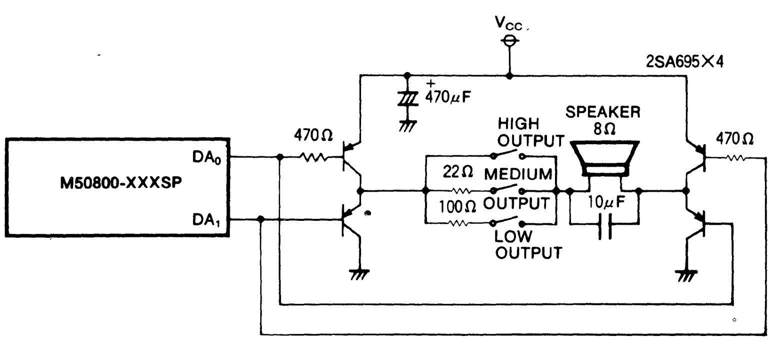
(b) Using an amplifier

Maximum output power=20mW typ. (V_{CC}=5V)



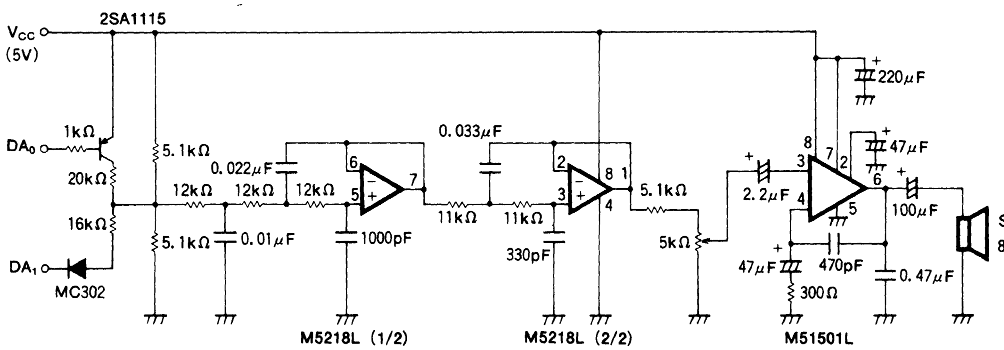
Maximum output power=500mW typ. (V_{CC}=5V)

With volume control

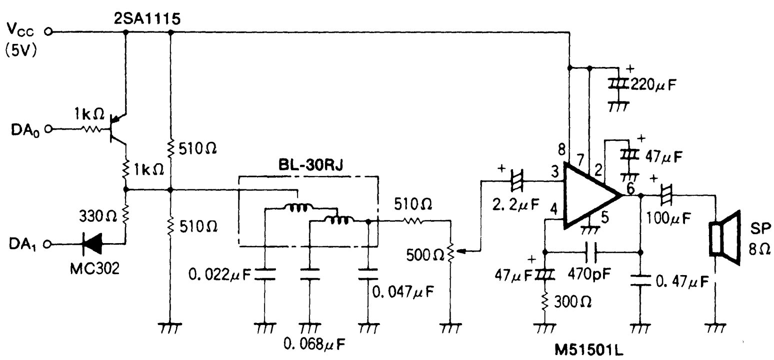


(c) Filter amplifier circuit

(1) Operational amplifier used as a filter amplifier circuit
Maximum output power=200mW typ. (V_{CC}=5V)



(2) L device used as a filter amplifier circuit
Maximum output power=200mW typ. (V_{CC}=5V)



BL-30RJ : Made by KOURINGIKEN CORPORATION

METHOD OF ORDERING SPEECH ANALYSIS AND MASK ROM

Steps Taken in Ordering

(1) Decisions concerning specifications
Decide the specifications concerning the content of the speech, the language, the speaker,etc.

(2) Ordering
When ordering, ensure that the necessary information has been entered in both the speech Analysis Request Form and Speech List. Be sure to also include the musical score if a melody is necessary.

(3) Recording
A recording of the original speech is made in a studio using an experienced narrator. Attendance is permitted for either confirmation or giving speech instructions.

(4) Analysis
Speech parameters of the voice are analized through use of a voice analysis system centered on a MELCOM 70/40 minicomputer in the Mitsubishi Speech Center. The data is written on a EPROM, and along with the Analysis Approval Form and Masking Approval Form is forwarded the customer.

(5) Sound evaluation
The delivered EPROM is inserted in either Mitsubishi's voice evaluation board or a similar device and the quality of the synthesized speech is confirmed. If the quality is found to be acceptable, the Analysis Approval Form and the Masking Approval Form are to be signed and returned to Mitsubishi.

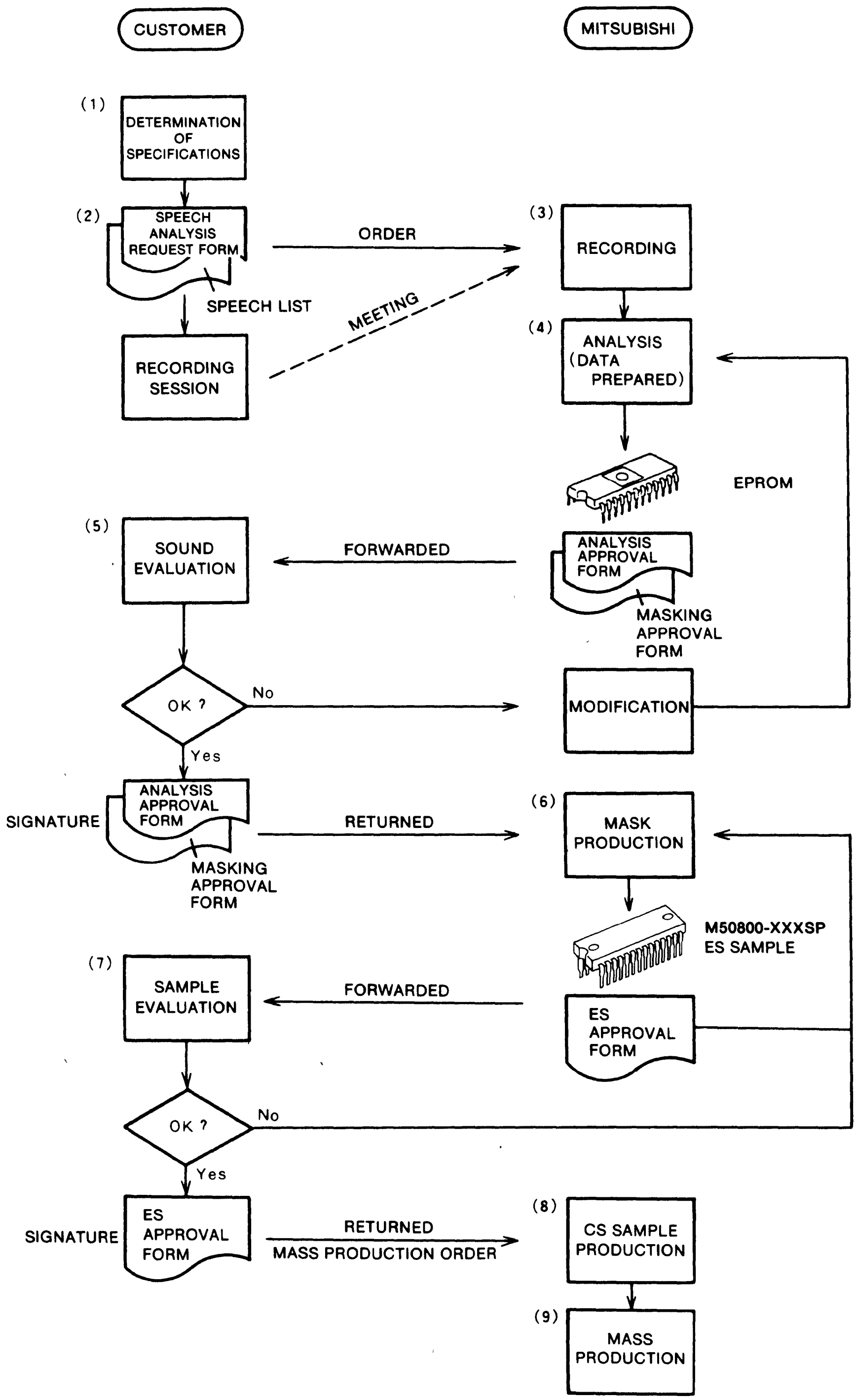
(6) Mask production
A MASK ROM is produced from the EPROM data. An ES sample for the confirmation of electrical characteristics is sent along with an ES. Approval Form to the customer.

(7) Sample evaluation
If results of ES sample evaluation prove to be acceptable the ES Approval Form is to be signed and returned to Mitsubishi.

(8) CS sample production
This is a sample having the same characteristics as the mass produced device.

(9) Mass production
After production of the CS sample mass production is begun.

ORDERING FLOW CHART



MITSUBISHI SPEECH SYNTHESIZER LSI
M50800-XXXSP
M50802-XXXP
SPEECH ANALYSIS REQUEST FORM

Customer		Signature
Company name ______________		Prepared
Company address ______________	Tel ______	
Company contact ______________	Data ______	Approved

1. Specifications

Recording
(necessary/unnecessary)

— Language ____________ Sex ____________

Analysis
(necessary/unnecessary)

- Sampling frequency ____________ KHz (10KHzTYP)
- Frame period ____________ ms (20msTYP)
- Length of speech ____________ seconds
- Length of melody ____________ seconds
- Voice evaluation board (necessary/unnecessary)

Mask
(necessary/unnecessary)

2. Schedule

	Recording →	Analysis completion →	Analysis and masking approval →	ES →	CS →	MP
Disired date (month/day)	(/)	(/)	(/)	(/)	(/)	(/)
		EPROM 1 set		____ unit(s)	____ unit(s)	____ unit(s) /month

Lot ____________ unit(s)

Mitsubishi Entry Column

Parameter	Type	Order number	Amount	Cost	Order date	Completion date	Transfer of money
Recording	VOICE-SOFT	00-38-					
Analysis	VOICE-SOFT	00-38-					
Voice evaluation board	VOICE-SOFT	00-38-					
Mask	VOICE-MASK						

Notes

Mask ROM number	

M50800-XXXSP
M50802-XXXP SPEECH LIST

No.	Address						Speech content
	D5	D4	D3	D2	D1	D0	

M50805-XXXP,FP/M50806-XXXP,FP

SINGLE-CHIP CMOS SPEECH SYNTHESIZER

DESCRIPTION

The M50805-XXXP, FP/M50806-XXXP, FP, are single chip C-MOS PARCOR speech synthesizers and contain a speech data, ROM, a clock generator, a D-A converter and a speaker drive circuit.

The differences among the M50805-XXXP, FP/M50806-XXXP, FP are shown in the following table. The M50805-XXXP will be discussed below.

Type	Operating supply voltage range	Outline
M50805-XXXP	$V_{CC}=3.0\sim5.5V$	22 pin, plastic DIP
M50805-XXXFP	$V_{CC}=3.0\sim5.5V$	24 pin, plastic DIP
M50806-XXXP	$V_{CC}=2.1\sim3.5V$	22 pin, plastic DIP
M50806-XXXFP	$V_{CC}=2.1\sim3.5V$	24 pin, plastic DIP

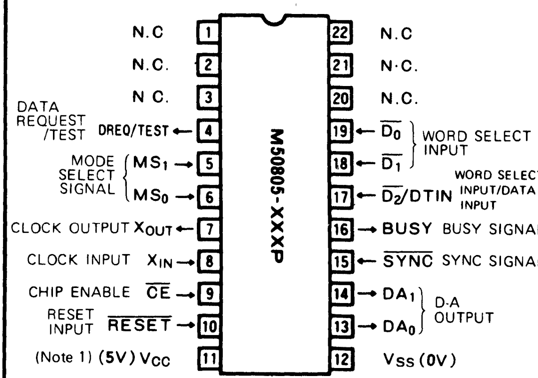
FEATURES

- Speech synthsis time .... 5 seconds (max)
- Number of words selection .... 8 (max)
- Melody generation possible .... 20 seconds (max)
- Automatic power down function
- Built-in speaker drive circuit
- Built-in D-A converter .... ±6 bits PWM method
- Low power dissipation due to C-MOS process
  Supply current in operating ... 2mA (max)
  in standby .... 10μA (max)
- Built-in clock generator

APPLICATION

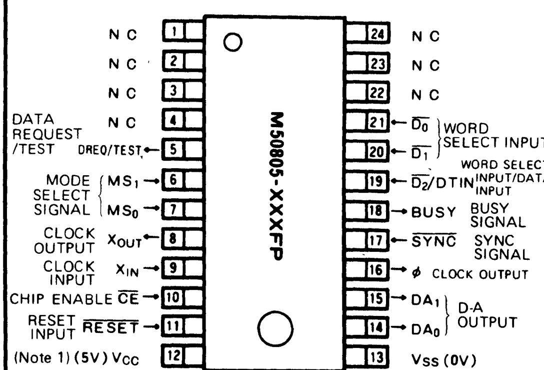
- Home appliances
- Toys
- Watches, cameras, desk-top calculators
- Alarms

PIN CONFIGURATION (TOP VIEW)



Outline 22P4 (M50805-XXXP)
(M50806-XXXP)

Note 1 For M50806-XXXP, FP the value is 3V

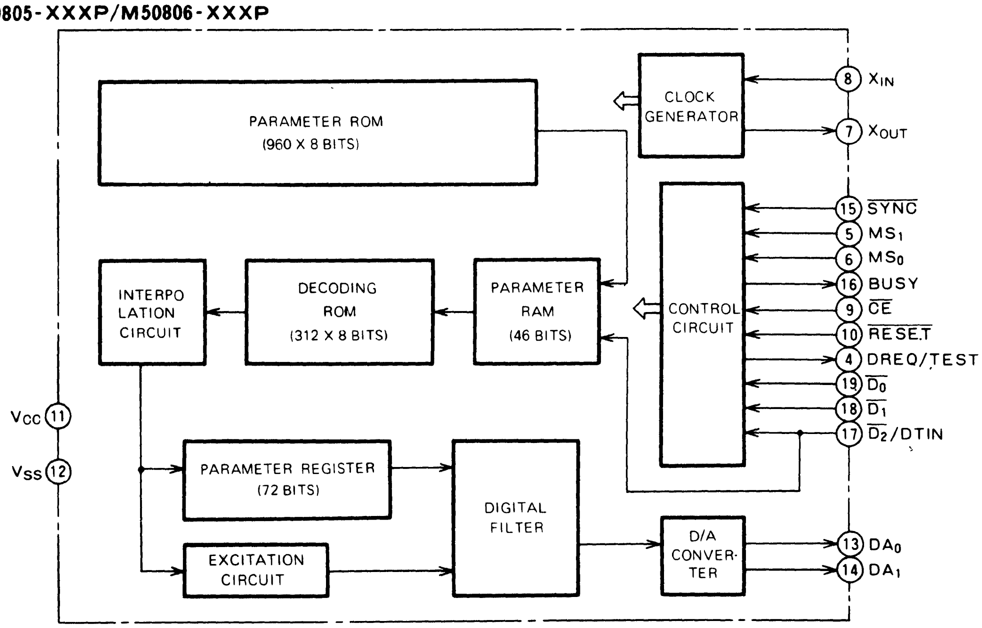


Outline 24P2W (M50805-XXXFP)
(M50806-XXXFP)

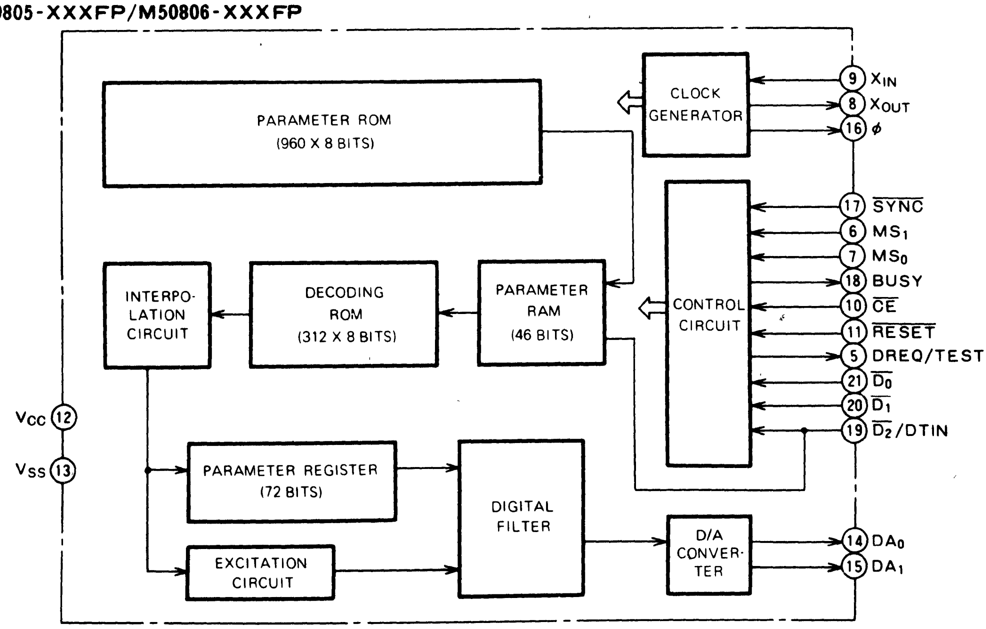
NC NO CONNECTION

BLOCK DIAGRAM

M50805-XXXP/M50806-XXXP



M50805-XXXFP/M50806-XXXFP



PIN DESCRIPTION

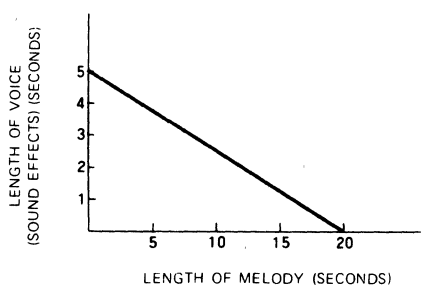
Pin	Name	Input or output	Pull-up resistor Yes/No	Function
V_{CC}	Supply voltage input	Input		Positive voltage supply pin
V_{SS}	Supply voltage input	Input		Ground pin
MS_0, MS_1	Mode select signal	Input		Depending on the MS_0, MS_1 signal there are 4 modes that may be selected, key input mode, microcomputer control mode, external memory mode and test mode
$\overline{D_0}$, $\overline{D_1}$	Word select input	Input	Option	When in the key input mode, voice generation begins whenever $\overline{D_0}$, $\overline{D_1}$, or $\overline{D_2}$ becomes low-state A maximum of 7 words may be designated When in the microcomputer control mode, a maximum of addresses for 8 words may be designated with $\overline{D_0}$, $\overline{D_1}$, $\overline{D_2}$ When in the external memory mode, speech parameters are inputted via DTIN
$\overline{D_2}$/DTIN	Word select input/data input			
$\overline{SYNC}$	Synchronous signal	Input	Option	When in microcomputer control mode, the SYNC signal initiates $\overline{D_0}$ ~ $\overline{D_2}$ address read, starting voice generation When in external memory mode, voice generation is started
BUSY	Busy signal	Output		Output signal pin for indicating that voice generation is in progress
$\overline{CE}$	Chip enable	Input		When the pin CE is high-level, the internal power supply is off and, when low-level, the internal power supply is on
DA_0, DA_1	D-A output	Output		±6 bit PWM output
X_{IN}	Clock input	Input		These pins are for connection to a ceramic resonator for the clock generator, or they can be connected to an external resist ance R for CR clock generation When using an external clock input, connect the oscillator source to X_{IN} pin and open X_{OUT}
X_{OUT}	Clock output	Output		
DREQ/TEST	Data request/test	Output		This is the data request signal output pin for external memory During test mode this is the test output pin
$\overline{RESET}$	Reset input	Input	Yes	When power input is first applied the internal registers are cleared and D-A output is muted
ϕ (M50805-XXXFP, M50806-XXXFP)	Clock output	Output		160kHz clock output pin

BASIC FUNCTION BLOCKS

Parameter ROM

A 960 word x 8 bit constructed mask ROM, it stores speech parameters.

There is enough memory storage for about 5 seconds of voice and sound effects and in the case of melody about 20 seconds. Voice, sound effects and melody can be stored together. In this case each length of time can be calculated by the following diagram.



Parameter RAM

This has 46 bit capacity for temporary storage of one frame of speech parameters (amplitude, pitch, and K-parameters)

Decoding ROM

Decodes the speech parameters that had been coded by the parameter RAM. It has 312 word x 8 bit construction.

Interpolation Circuit

Provides a linear interpolation of K-parameters, pitch and amplitude every 2.5ms.

Exitation Circuit

Having both a pulse generator and a white noise generator, it generates voiced and unvoiced sounds.

Parameter Register

A register used to temporarily store data which has been linearly interpolated.

Digital Filter

It is a 12 bit 8 stage lattice digital filter.

Control Circuit

According to the external input, it controls LSI operation.

Mode Select Signal MS_0, MS_1

Depending on MS_0, and MS_1, four kinds of mode may be selected as shown in the following diagram.

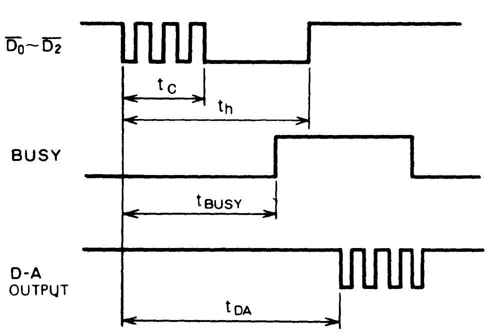
Mode	MS_0	MS_1	Use
Key input mode	H	L	Suitable for use when not editing phrases is necessary
Microcomputer control mode	L	L	Suitable for use when the editing of phrases is necessary
External memory mode	L	H	For use when an external memory such as EPROM and RAM is used
Test mode	H	H	For test purposes

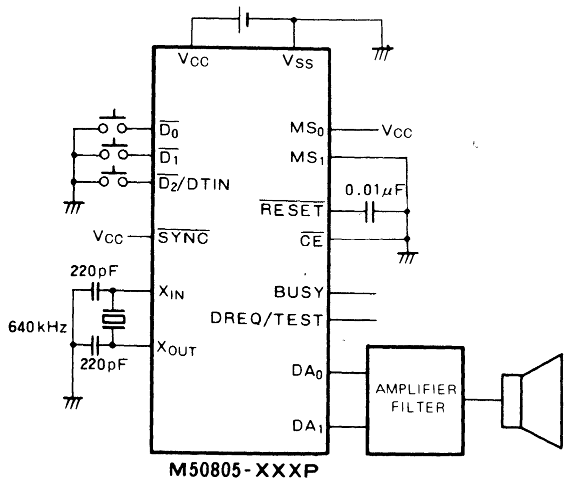
(1) Key Input Mode

Pin conditions

- Mode select signal pins ..... MS_0 is connected to V_{CC} and MS_1 to V_{SS}.
- $\overline{SYNC}$ pin .... connects to V_{CC}.
- $\overline{CE}$ pin .... connects to V_{SS}.
- $\overline{D_0} \sim \overline{D_2}$ pins .... when any of these pins is low-level, speech generation begins automatically. Seven kinds of phases may be selected.

Input/output timing chart





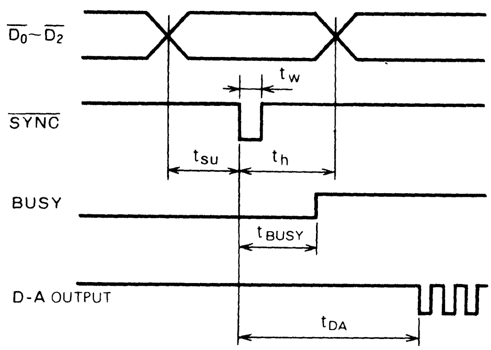
Symbol	Parameter	Min	Typ	Max	Unit
t_C	Key debounce protection time	5			ms
t_h	Data hold time	50			ms
t_{BUSY}	BUSY output delay	50			ms
t_{DA}	Speech output delay	100			ms

(2) Microcomputer Control Mode

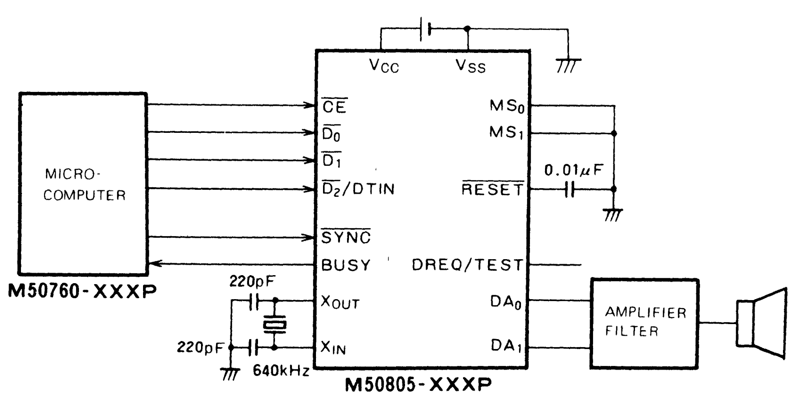
Pin conditions

- Mode select signal pins . . . Both MS_0 and MS_1 are connected to V_{SS}.
- $\overline{SYNC}$ signal . . . . When it becomes low-level for 18μs, data of both $\overline{D_0} \sim \overline{D_2}$ is latched and speech generation begins.
- $\overline{D_0} \sim \overline{D_2}$ pins . . . . Eight kinds of phrases may be selected.

Input output Timing chart



Symbol	Parameter	Min	Typ	Max	Unit
t_{su}	Data setup time	0			μs
t_h	Data hold time	25			μs
$t_{w(SYNC)}$	SYNC pulse width	18			μs
t_{BUSY}	BUSY output delay	12		25	μs
t_{DA}	Speech output delay	40		60	ms

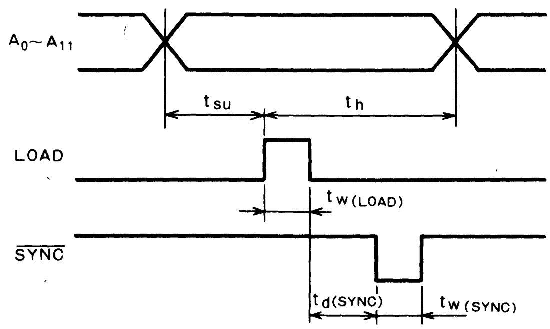


(3) External Memory Mode

Pin conditions

- Mode select signal pins . . . MS_0 is connected to V_{SS} and MS_1 to V_{CC}.
- $\overline{SYNC}$ pin . . . . When it becomes low-level for more than 18μs, speech generation begins.
- $\overline{D_2}$/DTIN pin . . . . Receives serial data from external ROM.
- DREQ/TEST pin . . . . . . Outputs the read pulse for external ROM data
- $\overline{D_0}$, $\overline{D_1}$ pins . . . . Connected to V_{CC}.

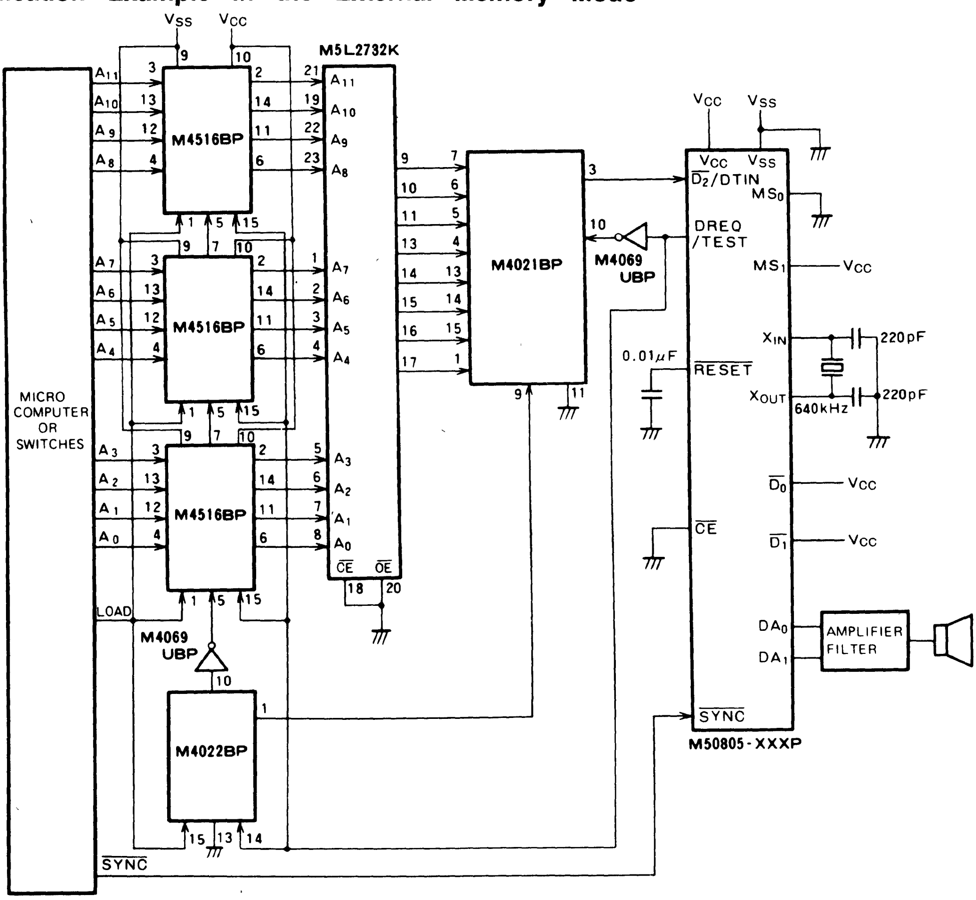
Input timing chart



Timing Requirement

Symbol	Parameter	Min	Typ	Max	Unit
t_{su}	Data set up time	1			μs
t_h	Data hold time	2			μs
$t_{w(LOAD)}$	LOAD pulse width	1			μs
$t_{d(SYNC)}$	SYNC delay time	0			μs
$t_{w(SYNC)}$	SYNC pulse width	18			μs

Application Example in the External Memory Mode



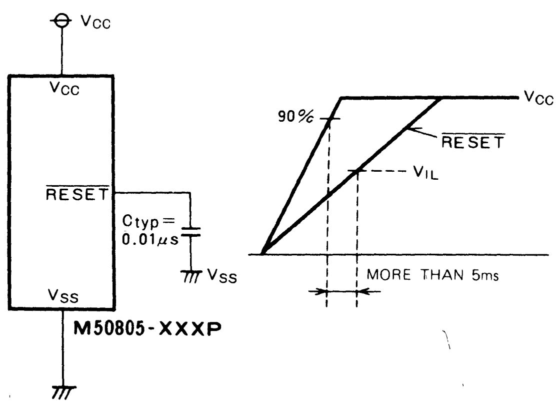
Input/Output Pins

Chip enable pin (CE)

$\overline{CE}$	Mode	Function
H	All modes	When input is high-level, internal power supply is turned off and device enters standby condition In standby, both DA_0 and DA_1 become high-level
L	Microcomputer control mode/ external memory mode	When input is low-level, internal power supply is turned on At this time a reset signal is automatically generated and device enters power on-initialization sequence
	Key input mode	The internal power supply is turned on after receiving key input At this time a reset signal is automatically generated and device enters power on-initialization sequence After voice generation has ceased, automatic power down circuit operates and device enters key input waiting state While in the waiting state, BUSY becomes low-level and both DA_0 and DA_1 become high-level

Reset Pin ($\overline{RESET}$)

The reset pin must become low-level in more than 5ms after power has been applied and the supply voltage has reached 90%.

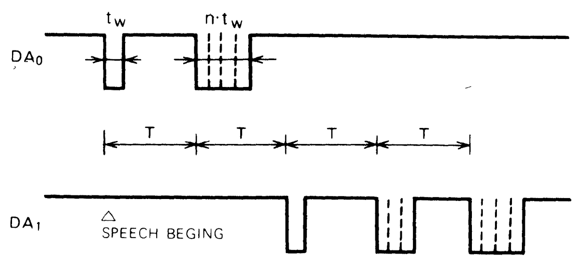


Busy Pin (BUSY)

Mode	BUSY output
Microcomputer control mode External memory mode	The output of this pin becomes high-level during each of the following Voice generation, power-on-initialization and standby It is necessary to ensure that the BUSY signal is low-level prior to generating the voice start signal If the BUSY signal is high-level, the voice generation start signal has no effect
Key input mode	The output of this pin becomes high-level during voice generation and low-level during power-on-initialization and while in the waiting condition It is necessary to ensure that the BUSY signal is low-level prior to generating the voice start signal If the BUSY signal is high-state, the voice start signal has no effect

D-A Output Circuit (DA_0, DA_1)

D-A output is PWM (pulse width modulation) and outputted from pin DA_0 when positive and pin DA_1 when negative.



T SAMPLING PERIOD 100μs (Typ)

t_W MINIMUM PULSE WIDTH 1 56μs (Typ) f_{OSC} = 640kHz

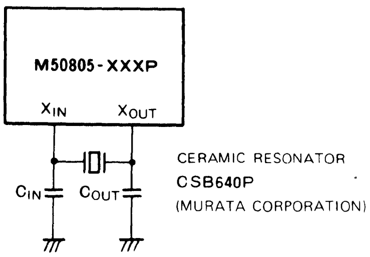
Clock Generator

The device contains a clock generator which can generate a clock signal when either a ceramic resonator or resistor is connected externally between the clock output and input pins (X_{IN}, X_{OUT}).

When a clock signal from an external source is being used, connect the source of the clock oscillator to pin X_{IN} and open pin X_{OUT}. Designate whether or not a ceramic resonator or a resistor will be used in the clock oscillator circuit as a mask option.

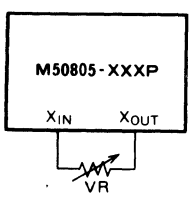
Circuit examples are given below.

Externally connected ceramic resonator circuit



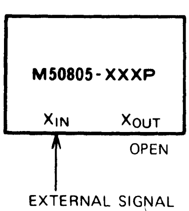
	M50805-XXXP/FP	M50806-XXXP/FP
C_{IN}	220pF	100pF
C_{OUT}	220pF	100pF

Externally connected resistor



VR : 200kΩ

External clock input circuit



EXTERNAL CLOCK INPUT CIRCUIT

MASK OPTION

The following mask options are available, specifiable at the time of ordering maskings.

(1) Continuous/single voice generation selecting specification

Continuous voice generation:

Voice generation continues as long as $\overline{D_0} \sim \overline{D_2}$ is kept continuously low-level in the key input mode or $\overline{SYNC}$ is kept continuously low-level in the microcomputer control mode.

Single voice generation:

Voice generation occurs only once when the above conditions are met. To generate the voice again it is necessary to return either the $\overline{D_0} \sim \overline{D_2}$ or the $\overline{SYNC}$ to high-level one time and then to low-level again.

(2) Specifications concerning the inclusion or exclusion of pull-up resistors for the word select input pins $\overline{D_0}$, $\overline{D_1}$, $\overline{D_2}$, and the synchronous signal $\overline{SYNC}$.

(3) Specifications concerning whether or not a ceramic resonator or a resistor will be used in the oscillator circuit.

ELECTRICAL CHARACTERISTICS OF THE M50805-XXXP/M50805-XXXFP

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage	With respect to the V_{SS} Pin	−0.3~7	V
V_I	Input voltage	With respect to the V_{SS} Pin	−0.3~7	V
Pd	Maximum power dissipation	Ta=25°C	150	mW
Topr	Operating temperature		−10~70	°C
Tstg	Storage temperature		−40~125	°C

RECOMMENDED OPERATING CONDITIONS (Ta=−10~70°C, unless otherwise noted)

Symbol	Parameter	Limits Min	Limits Typ	Limits Max	Unit
V_{CC}	Supply voltage	3	5	5.5	V
V_{SS}	Supply voltage	0	0	0	V
f_{OSC}	Oscillation frequency		640		kHz

ELECTRICAL CHARACTERISTICS (Ta=−10~70°C, f_{OSC}=640±20kHz, V_{CC}=3~5.5V, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits Min	Limits Typ	Limits Max	Unit
V_{OH}	High level output voltage BUSY, DREQ/TEST	I_{OH}=0.1mA	V_{CC}-0.8			V
V_{OL}	Low level output voltage BUSY, DREQ/TEST	I_{OL}=0.4mA			0.8	V
I_{OH}	High-level output current DA_0, DA_1	$V_{OH}=V_{CC}-0.4V$	1			mA
I_{OL}	Low level output current DA_0, DA_1	V_{OL}=0.4V	1.6			mA
I_{DA}	D/A output current	Resistor between DA_0 and DA_1 10Ω at V_{CC}=5V		45		mA
I_{OC}	Supply current (in operation)	Unloaded input/output			2	mA
I_{SC}	Supply current (standby)	Unloaded input/output			10	μA
I_{IL}	Input leak current	$V_I=0\sim V_{CC}$			±1	μA
R_I	Pull-up resistor $\overline{D_0}\sim\overline{D_2}$	$V_I=V_{SS}$, V_{CC}=5V		180		kΩ
R_I	Pull-up resistor $\overline{SYNC}$	$V_I=V_{SS}$, V_{CC}=5V		300		kΩ
V_{IH}	High-level input voltage	V_{CC}=4~5.5V	V_{CC}-1		V_{CC}	V
V_{IL}	Low level input voltage	V_{CC}=4~5.5V	0		1	V

ELECTRICAL CHARACTERISTICS OF THE M50806-XXXP/M50806-XXXFP

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Conditions	Limits	Unit
V_{CC}	Supply voltage	With respect to the V_{SS} pin	−0.3~7	V
V_I	Input voltage		−0.3~7	V
Pd	Maximum power dissipation	Ta=25°C	150	mW
Topr	Operating temperature		−10~70	°C
Tstg	Storage temperature		−40~125	°C

RECOMMENDED OPERATING CONDITIONS (Ta=−10~70°C, unless otherwise noted)

Symbol	Parameter	Limits			Unit
		Min	Typ	Max	
V_{CC}	Supply voltage	2.1	3	3.5	V
V_{SS}	Supply voltage	0	0	0	V
f_{OSC}	Oscillation frequency		640		kHz

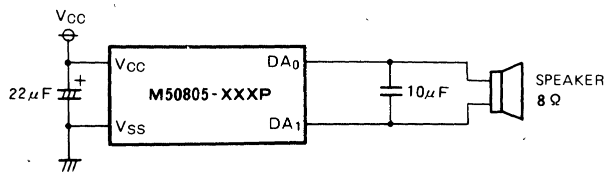
ELECTRICAL CHARACTERISTICS (Ta=−10~70°C, f_{OSC}=640±20kHz, V_{CC}=2.1~3.5V, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
V_{OH}	High-level output voltage BUSY, DREQ/TEST	I_{OH}=0.1mA	V_{CC}-0.8			V
V_{OL}	Low-level output voltage BUSY, DREQ/TEST	I_{OL}=0.4mA			0.8	V
I_{OH}	High-level output current DA_0, DA_1	$V_{OH}=V_{CC}-0.4V$	0.5			mA
I_{OL}	Low-level output current DA_0, DA_1	V_{OL}=0.4V	0.8			mA
I_{DA}	D/A output current	Resistor between DA_0 and DA_1 10Ω at V_{CC}=3V		20		mA
I_{OC}	Supply current (in operation)	Unloaded input/output			1	mA
I_{SC}	Supply current (standby)	Unloaded input/output			10	μA
I_{IL}	Input leak current	$V_I=0\sim V_{CC}$			±1	μA
R_I	Pull-up resistor $\overline{D_0}\sim\overline{D_2}$	$V_I=V_{SS}$, V_{CC}=3V		320		kΩ
R_I	Pull-up resistor $\overline{SYNC}$	$V_I=V_{SS}$, V_{CC}=3V		560		kΩ
V_{IH}	High-level input voltage		¾V_{CC}		V_{CC}	V
V_{IL}	Low-level input voltage		0		¼V_{CC}	V

APPLICATION CIRCUIT EXAMPLES

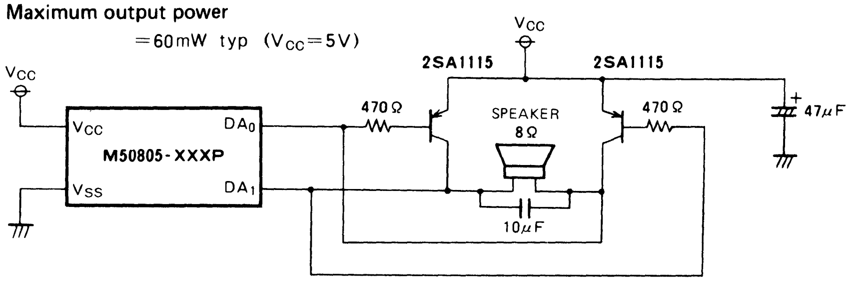
Speaker Drive Circuit

a) Direct drive
Maximum output power
= 10mW typ (V_{CC} = 5V)

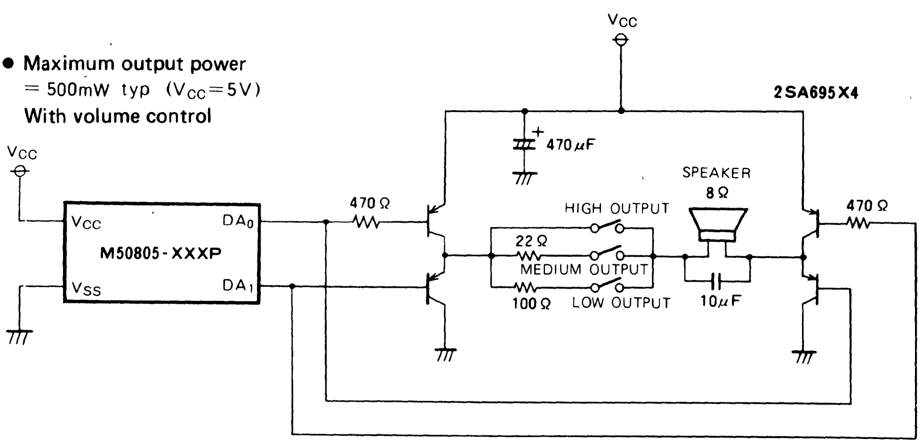


b) Using an amplifier

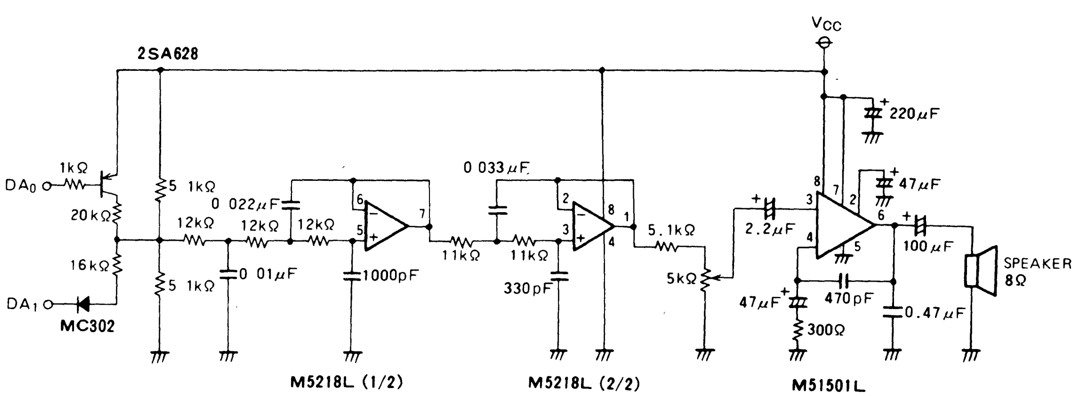
- Maximum output power
= 60mW typ (V_{CC} = 5V)



- Maximum output power
= 500mW typ (V_{CC} = 5V)
With volume control



c) Filter amplifier circuit
Operational amplifier used as a filter amplifier circuit
Maximum output power = 200mW typ. (V_{CC}=5V)



METHOD OF ORDERING SPEECH ANALYSIS AND MASK ROM

Steps taken in ordering

(1) Decisions concerning specifications
Decide the specifications concerning the content of the speech, the language, the speaker, etc.

(2) Ordering
When ordering, ensure that the necessary information has been entered in both the speech Analysis Request Form and Speech List. Be sure to also include the musical score if a melody is necessary.

(3) Recording
A recording of the original speech is made in a studio using an experienced narrator. Attendance is permitted for either confirmation or giving speech instructions.

(4) Analysis
Speech parameters of the voice are analized through use of a voice analysis system centered on a MELCOM 70/40 mini-computer in the Mitsubishi Speech Center. The data is written on a EPROM, and along with the Analysis Approval Form and Masking Approval Form is forwarded to the customer.

(5) Sound evaluation
The delivered EPROM is inserted in either Mitsubishi's voice evaluation board or a similar device and the quality of the synthesized speech is confirmed. If the quality is found to be acceptable, the Analysis Approval Form and the Masking Approval Form are to be signed and returned to Mitsubishi.

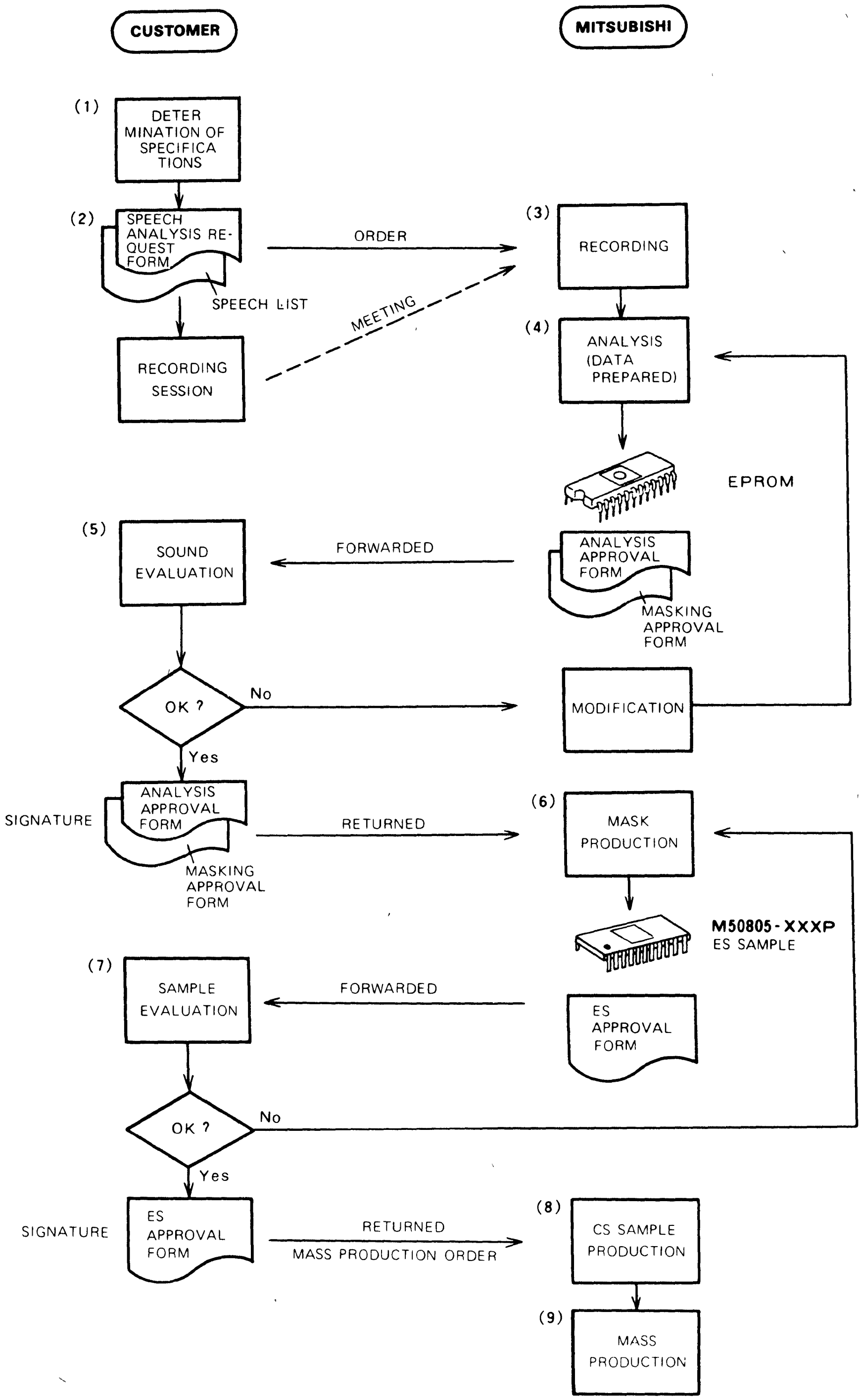
(6) Mask production
A MASK ROM is produced from the EPROM data. An ES sample for the confirmation of electrical characteristics is sent along with an ES Approval Form to the customer.

(7) Sample evaluation
If results of ES sample evaluation prove to be acceptable the ES Approval Form is to be signed and returned to Mitsubishi.

(8) CS sample production
This is a sample having the same characteristics as the mass produced device.

(9) Mass production
After production of the CS sample mass production is begun.

ORDERING FLOW CHART



MITSUBISHI SPEECH SYNTHESIZER LSI
M50805-XXXP, FP
M50806-XXXP, FP
SPEECH ANALYSIS REQUEST FORM

Customer	Signature
Company name ______	Prepared
Company address ______ Tel ______	
Company contact ______ Date ______	Approved

1. Specifications

Recording
(necessary/unnecessary)
└── Language ______ Sex ______

Analysis
(necessary/unnecessary)
└── Length of speech ______ seconds
├── Length of melody ______ seconds
└── Voice evaluation board (necessary/unnecessary)

Mask
(necessary/unnecessary)

2. Schedule

	Recording →	Analysis completion →	Analysis and masking approval →	ES →	CS →	MP
Desired date (month/day)	(/)	(/)	(/)	(/)	(/)	(/)
		EPROM 1 set		______ unit(s)	______ unit(s)	______ unit(s) /month

Lot ______ unit(s)

Mitsubishi Entry Column

Parameter	Type	Order number	Amount	Cost	Order date	Completion date	Transfer of money
Recording	VOICE-SOFT	00-38-					
Analysis	VOICE-SOFT	00-38-					
Voice evaluation board	VOICE-SOFT	00-38-					
Mask	VOICE-MASK						

Notes

Mask ROM number	

M50805-XXXP, FP / M50806-XXXP, FP SPEECH LIST

No.	Address			Speech content	Notes
	$\overline{D_2}$	$\overline{D_1}$	$\overline{D_0}$		
1	H	H	L		
2	H	L	H		
3	H	L	L		
4	L	H	H		
5	L	H	L		
6	L	L	H		
7	L	L	L		
8	H	H	H		

CONTACT ADDRESSES FOR FURTHER INFORMATION

JAPAN
Semiconductor Marketing Division
Mitsubishi Electric Corporation
2-3, Marunouchi 2-chome
Chiyoda-ku, Tokyo 100, Japan
Telex: 24532 MELCO J
Telephone. (03) 218-3473
(03) 218-3499
Facsimile: (03) 214-5570

Overseas Marketing Manager
Kita-Itami Works
4-1, Mizuhara, Itami-shi,
Hyogo-ken 664, Japan
Telex: 526408 KMELCO J
Telephone: (0727) 82-5131
Facsimile: (0727) 72-2329

HONG KONG
Ryoden Electric Engineering Co, Ltd.
22nd fl, Leighton Centre
77, Leighton Road
Causeway Bay, Hong Kong
Telex: 73411 RYODEN HX
Telephone (5) 7907021
Facsimile. (852) 123-4344

SINGAPORE
MELCO SALES SINGAPORE PTE. LTD
230 Upper Bukit Timah Road #03-01/15
Hock Soon Industrial Complex
Singapore 2158
Telex: RS 20845 MELCO
Telephone: 4695255
Facsimile: 4695347

TAIWAN
MELCO-TAIWAN CO., Ltd.
1st fl, Chung-Ling Bldg,
363, Sec. 2, Fu-Hsing S Road,
Taipei R O C.
Telephone: (02) 735-3030
Facsimile (02) 735-6771
Telex: 25433 CHURYO "MELCO-TAIWAN"

U.S.A.
NORTHWEST
Mitsubishi Electronics America, Inc
1050 East Arques Avenue
Sunnyvale, CA 94086, U.S A
Telex 172296 MELA SUVL
Twx: 910-339-9549
Telephone (408) 730-5900
Facsimile: (408) 730-4972

SOUTHWEST
Mitsubishi Electronics America, Inc
991 Knox Street
Torrance, CA 90502, U.S.A.
Telex: 664787 MELA TRNC
Telephone: (213) 515-3993
Facsimile: (213) 324-6578

SOUTH CENTRAL
Mitsubishi Electronics America, Inc
2105 Luna Road, Suite 320
Carrollton, TX 75006, U.S A.
Telephone: (214) 484-1919
Facsimile (214) 243-0207

NORTHERN
Mitsubishi Electronics America, Inc
15612 Highway 7 #243
Minnetonka, MN 55345, U.S A.
Telex: 291115 MELA MTKA
Telephone (612) 938-7779
Facsimile: (612) 938-5125

NORTH CENTRAL
Mitsubishi Electronics America, Inc
800 N Bierman Circle
Mt. Prospect, IL 60056, U.S A
Telex: 270636 MESA CHIMPCT
Telephone: (312) 298-9223
Facsimile (312) 298-0567

NORTHEAST
Mitsubishi Electronics America, Inc
200 Unicorn Park Drive
Woburn, MA 01801, U S A
Telex: 951796 MELA WOBN
Twx. 710-348-1229
Telephone (617) 938-1220
Facsimile: (617) 938-1075

MID ATLANTIC
Mitsubishi Electronics America, Inc
Two University Plaza
Hackensack, NJ 07601, U S.A
Telex: 132205 MELA HAKI
Twx. 710-991-0080
Telephone: (201) 488-1001
Facsimile: (201) 488-0059

SOUTH ATLANTIC
Mitsubishi Electronics America, Inc
6575 The Corners Parkway
Suite 100
Norcross, GA 30092, U S A
Twx: 910-380-9555
Telephone. (404) 662-0813
Facsimile (404) 662-5208

SOUTHEAST
Mitsubishi Electronics America, Inc.
Town Executive Center
6100 Glades Road #210
Boca Raton, FL 33433, U S A
Twx: 510-953-7608
Telephone (305) 487-7747
Facsimile: (305) 487-2046

WEST GERMANY
Mitsubishi Electric Europe GmbH
Headquarters
Gothear Str 6
4030 Ratingen 1, West Germany
Telex 8585070 MED D
Telephone: (02102) 4860
Facsimile: (02102) 486-115

Munich Office:
Arabellastraße 31
8000 München 81, West Germany
Telex: 5214820
Telephone: (089) 919006-09
Facsimile: (089) 9101399

FRANCE
Mitsubishi Electric Europe GmbH
65 Avenue de Colmar Tour Albert 1er
F-92507 Rueil Malmaison Cedex,
France
Telex: 202267 (MELCAM F)
Telephone: (01) 7329234
Facsimile (01) 7080405

ITALY
Mitsubishi Electric Europe GmbH
Centro Direzionale Colleoni
Palazzo Cassiopea 1
20041 Agrate Brianza I-Milano
Telephone: (039) 636011
Facsimile: (039) 6360120

SWEDEN
Mitsubishi Electric Europe GmbH
Lastbilsvägen 6B
5-19149 Sollentuna, Sweden
Telex. 10877 (meab S)
Telephone (08) 960468
Facsimile (08) 966877

U.K.
Mitsubishi Electric (U.K.) Ltd.
Hertford Place, Denham Way,
Maple Cross, Rickmanworth, Herts,
WD3 2BJ, England, U K.
Telex: 916756 MEUKG
Telephone. (923) 770000
Facsimile: (923) 775282

AUSTRALIA
Mitsubishi Electric Australia Pty. Ltd
73-75, Epping Road, North Ryde,
P.O Box 1567, Macquarie Centre,
N S W, 2113, Australia
Telex: MESYD AA 26614
Telephone: (02) (888) 5777
Facsimile (02) (887) 3635

MITSUBISHI DATA BOOK
GENERAL PURPOSE ICs

October, First Edition 1986

Editioned by
Committee of editing of Mitsubishi Semiconductor Data Book

Published by
Mitsubishi Electric Corp., Semiconductor Division

MITSUBISHI SEMICONDUCTORS
GENERAL PURPOSE ICs 1987

MITSUBISHI ELECTRIC CORPORATION
HEAD OFFICE: MITSUBISHI DENKI BLDG., MARUNOUCHI, TOKYO 100. TELEX: J24532 CABLE: MELCO TOKYO

Revised publication, effective Oct. 1986,
superseding publication H-C5267-A of Jan. 1984.
Specifications subject to change without notice.

H-D9405-C KI-8705 Printed in Japan (ROD)