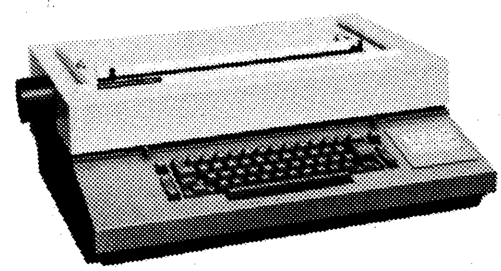
PERIPHERALS for TRS-80

IBM 725 ASCII/SELECTRIC PRINTER

- Full-size 15" Carriage; 15 cps print speed.
- Includes 3 built-in ASCII to IBM translation tables for different type balls. Other tables programmable.
- Plugs to Line Printer Port and runs from "LPRINT" and "LLIST" commands. (No programming necessary.)
- LOCAL mode allows manual use of typewriter keyboard, stops print-out for paper change, etc.
- Software-compatible with ELECTRIC PENCIL™ and SCRIPSIT™ word processor programs.



- Ship wt. 75 lbs. **PRICE, cleaned & adjusted** **$895.00**
- Optional Forms Tractor for pin-feed paper (used) . . . . **$ 95.00**
- Optional Direct Connect Port to TRS-80 40-pin Bus . . . . **$ 75.00**

COMPUTER INTERFACE

The POS 725 ASCII/Selectric Printer includes a 6' long cable and 34-pin connector to the TRS-80 Expansion Interface Centronics Line Printer Port. Installation with your TRS-80 is as simple as plugging the two units together.

The TRS-80 Model Two utilizes a different style cable connector for its line printer port. Please specify *whether cable required is for Model One or Model Two.*

The TRS-80 owner who does not have the expansion interface can purchase the optional Direct Connect Printer Port to the TRS-80 40-pin bus. The 40-pin cable connector from the Selectric will plug to *either* the TRS-80 keyboard computer next to the Reset button *or* to the Expansion Interface 40-pin Quick Printer Port.

PROGRAMMING

No programming is required to send any upper-case or lower-case ASCII character to the Selectric to be printed. A programmable memory chip in the Selectric will translate ASCII characters sent from the TRS-80 into the appropriate IBM code for the characters found on the more common IBM type balls. Three translation tables are programmed by POS into each Selectric: 1) Standard Correspondence (office style keyboard); 2) EBCDIC (data processing style keyboard), and; 3) Standard Correspondence APL (upper-case alphabet plus programming symbols for APL language). Up to five additional tables may be programmed by the user for different style type balls (foreign language characters, scientific notation, etc.). POS will program tables as requested by the user for a fee of $25 per table.

WARRANTY

Each Selectric printer is warranted as follows:

a) 15-day return privilege for full refund if unit is unsatisfactory for any reason other than abuse by customer.
b) 30-day warranty for parts & labor if unit is returned to POS for work (POS will make service calls in the San Francisco Bay Area within a 50 mile radius of Palo Alto).
c) 90-day parts warranty — POS will replace without charge, defective parts which are returned to POS within 90 days of date of purchase.

POS will pay one-way shipping on units returned under warranty.

SERVICE

Any IBM office typewriter technician can service the mechanical parts of the printer, as the IBM Model 725 Selectric used in each unit has not been physically altered other than by having plates, solenoids, and switches screwed to the underside of the typewriter frame. Some service companies will offer an annual contract to work on the unit; all IBM service representatives will do work to the mechanism on a parts and labor basis.

DOCUMENTATION

Full documentation is included without the extra charge: installation and testing procedures, theory of operation, service manual, and schematic diagrams.

DEALER and GROUP DISCOUNTS

Pacific Office Systems offers discounts of 20% to 30% to dealers and groups who purchase five or more units for delivery within a 90-day period. Contact POS for current discount and delivery schedules.

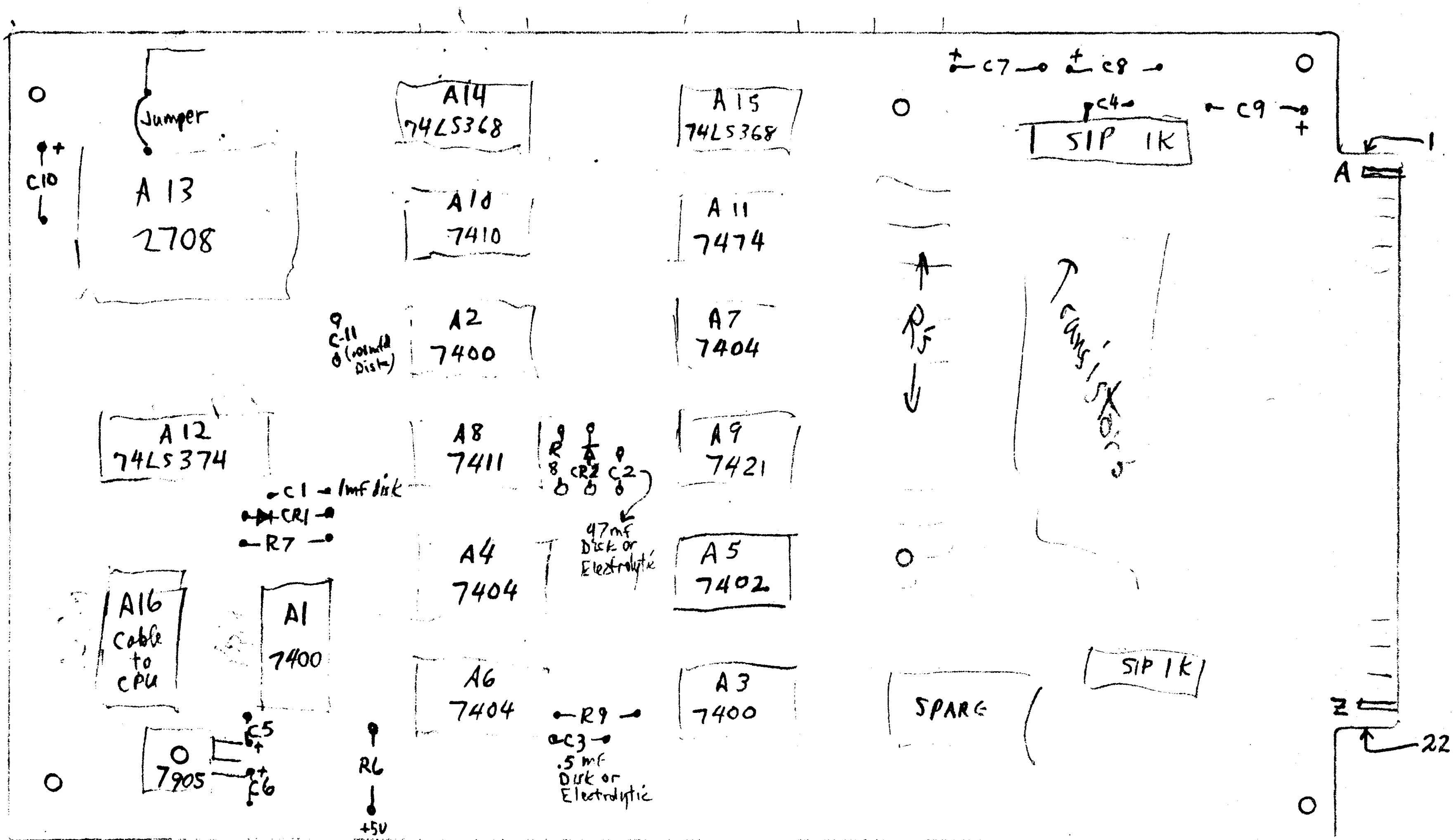
Pacific Office Systems

2265 Old Middlefield Way • Mountain View, CA 94020 • (415) 493-7455

IBM 735 I/O SELECTRIC ASCII PRINTER INTERFACE

	SIGNAL LINES TO PRINTER FROM POS ASCII INTERFACE CARD	Card Pin No.	EBCD Model 1980/1971 75-Pin Connector	Model 2970	EBCD 50-Pin Connector	Std. Corres. 50-Pin Connector
1	R-1 Magnet Driver	E	59	h1 (N1B13)	E	E
2	R-2 " "	F	11	h3 (M1B03)	F	F
3	R-2A " "	D	14	g7 (M1D04)	D	D
4	R-5 " "	H	53	h5 (N1B12)	H	H
5	T-1 " "	C	17	g5 (M1B04)	C	C
6	T-2 " "	A	21	g1 (M1D05)	A	A
9	C/R " "	P	23	d1 (N1B05)	P	P
	Index " "	R	20	d3 (N1D05)	R	R
11	Space " "	M	16, 56	s4 (N1B04)	m	M
10	BackSpace " "	N	27		N	N
12	Tab " "	L	13		L	L
15	Keyboard Lockout " "	K	33	c5 (M1D07)	K	K
7	Check " "	B	56	(N1D12)	B	B
13	Upper Case " "	S	63		S	S
14	Lower Case " "	T			T	T
37	Sense u/c Shift Mode	22	5 ?	N/O (N1D02)	Z	Z
34	Sense L/c Shift Mode	Z	50	N/C (N1D13)	h	h
	~~Sense Keyboard Locked Out~~	17 U		?	k m,	k m,
17/45	Sense Printer Ready	21, Y	30, 47	(N1B10)?	a, Y	a, Y
37	Sense Shift Contacts (U/C)	18	5	?	E E	E E
34	" " " (L/C)	V 19	50	?	F F	F F b
18/39, 20, 21	Sense Busy Contacts	W	2, 41, 35	(N1B09)?	b c	, c
—	+ 24 Volts To Magnets	8, J	—	—	J	J
—	+ 12 Volts to printer	7	80	t3	—	—
41	+ 48 Volts To Magnets	8, J	74	h7( )	J—	J—
40	Signal Ground	20, X	79, 82	t1, t6	d, X	d, X
	+5 Volts To Printer	6				
	-12 Volts To Power Supply	9				
	LOCAL Switch	3				
	REMOTE Switch	4				
	RESET Switch	5				
	Type I Switch	1				
	Type II Switch	2				
			64			
	Chassis Ground	—	75		HH	HH

C3 = Busy Strobe Delay
C2 = Shift Feedback Delay
C1 = Data Strobe



C1 : 1mfd disk (non-polar!)
C2 : .5mfd Tantalum
C3 : 47mfd tantalum
C4, 5, 6, 7, 8, 9, 10 : 22 mfd, 15V tantalum
C11, etc: {.01mfd / .1mfd} Disk bypass caps.
R8 - 2K, 1/4W Resistor
R1-7, R9-35 1K Resistor, 1/4 watt.

COMPONENT SIDE VIEW

POS - IBM 735 I/O SELECTRIC
ASCII PRINTERS INTERFACE

Reference only Re 735 I/O SELECTRIC

IBM 725 SELECTRIC with ASCII PARALLEL INTERFACE

CONTENTS

1.0 INTRODUCTION

The GTE/IS I/O Selectric typewriter and the Pacific Office Systems ASCII Parallel Interface form a versatile print-only computer system. This system provides easy micro-computer interfacing via a standard eight-bit parallel port with two additional control lines. Usually, no additional system programming is required to support the printing operations. The Selectric can also operate as a stand-alone typewriter. Additional features include:

- Stored code conversions for up to eight different type spheres
- Possible code conversions from ASCII or any other 0-8 bit binary code.
- Automatic upper/lower case control
- Ability to stop and resume printing without loss of characters
- Keyboard lockout during print operations
- Reset key for recovery from system errors
- Prints at maximum printer speed — no null characters or timing loops
- Standard typewriter operation
- No loss of function or ease of local use
- Interchangeable type spheres
- Interchangeable carbon and fabric ribbons
- Full 15 inch carriage — IBM model 725 Selectric typewriter

2.0 INSTALLATION

Before beginning the installation and operation verification, check that all of the packing material has been removed from the typewriter mechanism. Any foreign material in the mechanism could cause severe damage. Check also for loose, broken, bent parts or other shipping damage. The following sections describe the proper steps for installing the printing system. If a problem is encountered in any step of the procedure, refer to the TROUBLE SHOOTING section.

2.1 MANUAL OPERATION AND CHECK

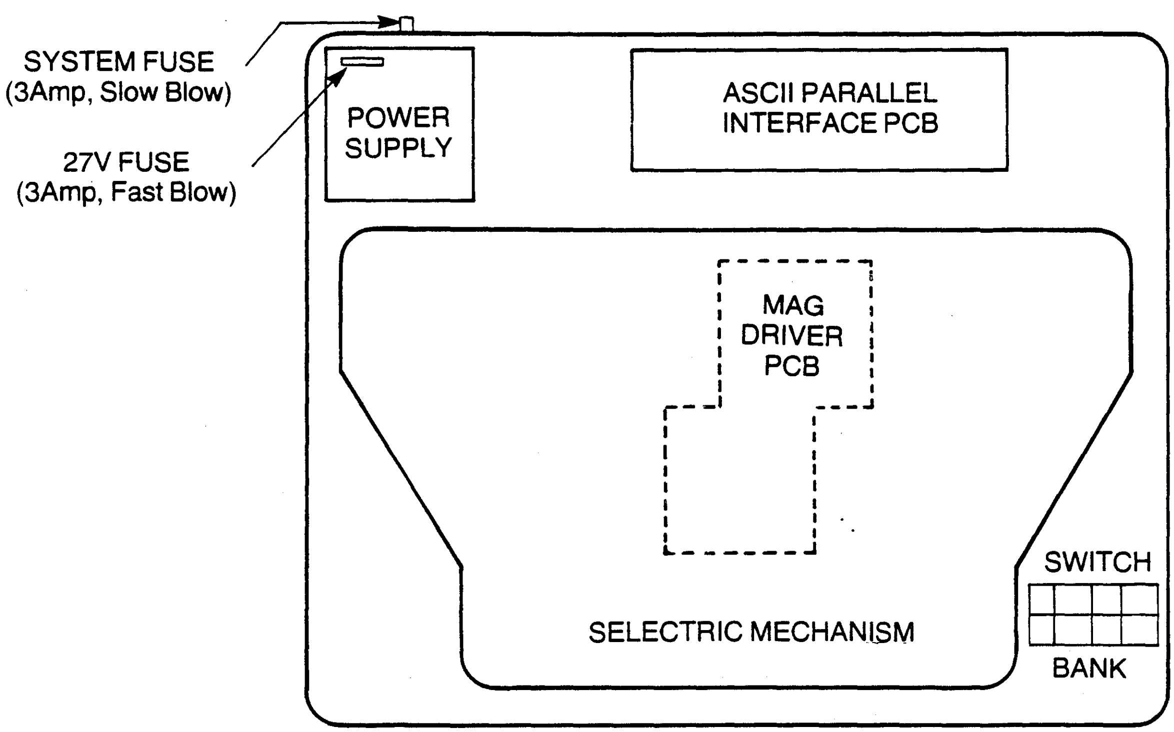
2.1.1 Before plugging in the typewriter, verify that all the connectors are firmly seated on the magnet driver card (under the printing mechanism), the interface card (rear of the printing mechanism), and on the power supply module (rear left of the printing mechanism). Refer to figure 1.

2.1.2 Install the System 3A Slo-Blow fuse. Check that the 3A Fast-Blow fuse is installed on top of the power supply. The position is shown in figure 1.

2.1.3 Plug in the printer and turn the power on. The RESET lamp should light. Don't worry about the other lamps.

2.1.4 Press the LOCAL button so that its light is on.

2.1.5 Verify that the typewriter is working normally in the LOCAL MODE. Check all of the functions: Return, Index, Tab, Shift, Backspace, and Space. Also check the operation of the printing characters.



SYSTEM LAYOUT
FIGURE 1

2.1.6 Press the LOCAL button. The light should go off.
2.1.7 Verify that the return key and the letter keys (A-Z) are locked. Also, check that the shift no longer affects the rotation of the type sphere.
2.1.8 If any problems have been encountered, refer to the TROUBLE SHOOTING section. Otherwise, all is in order and the next step is to make the connection to the computer.

2.2 REQUIREMENTS FOR COMPUTER CONNECTION

The connection from the computer to the typewriter is made through an eight-bit parallel data port (The data lines do not need to be bi-directional since only output is used). Two additional control lines are also needed. These handle the data exchange timing between the two devices. One line signals the computer that the Selectric is ready to print another character. The other line from the computer signals the Selectric to initiate printing action. Both the data and control lines use standatd TTL Logic levels. Positive logic levels are used which are defined as: High (logic 1) = +5 Volts and Low (logic 0) = 0 Volts.

2.3 WIRING THE MICRO-COMPUTER CONNECTOR CABLE

The first task is to examine your CPU parallel port documentation. It should tell about the logic levels and the polarity of the data and control signals. If your documentation is poor, do not despair since all the information required can be derived using an oscilloscope. (This is definitely the hard way!). For wiring the interconnect cable, you should use the 16 pin DIP header and cable supplied. Purchase a suitable connector for your computer parallel printer port. Wire it according to the following sections and Figure 2. Be careful to connect the proper strand in the ribbon cable from the DIP header since the wires are not in pin #1-16 order. The order across the ribbon cable is pin #'s 16, 1, 15, 2, 14, 3, 13, 4, 12, 5, 11, 6, 10, 7, 9 and 8.

INTERFACE TO COMPUTER

U5 pin #	Signal
1	Data Bit 0
1	Data Bit 1
3	Data Bit 2
4	Data Bit 3
5	Data Bit 4
6	Data Bit 5
7	Data Bit 6
8	Data Bit 7
9	Ground
10	Ground
11	Ground
12	$\overline{\text{Busy}}$ output to CPU
13	Busy output to CPU
14	*Strobe input from CPU (U5 pins 15 and 16 must be connected)
15	(Jumpered to U5 pin 16 if Strobe input used.)
16	*$\overline{\text{Strobe}}$ input from CPU

*Note: Only 1 Strobe signal and one Busy signal is to be used.

FIGURE 2

2.3.1 DATA LINES

The parallel output data lines should be verified as positive logic with non-inverted data. Positive logic can be checked by sending a zero (all bits zero) to the parallel output port and verifying that the transmitted data is also zero in every bit position. If your parallel port does indeed use positive logic, simply connect the appropriate data lines to the interface as shown in Figure 1.

2.3.1 If your computer system inverts the data, there are two possible solutions. One is to connect inverters to each data line in order to derive positive logic. IC's that could be used are the octal bus driver 74LS240 or two 74LS14 chips. Take +5V and ground from the interface board and connect an inverter in series with each data line. This can be easily done on the unused area of the Selectric interface board. The other option is to recode the EPROM on the interface. Refer to the section ASCII to IBM SELECTRIC CODE CONVERSION for details before proceeding.

2.3.2 DATA STROBE LINE

Check the polarity of the control line from the computer that signals the start of a character print action. It is called the STROBE line at the Selectric port. See figure 2 to decide on the proper STROBE line polarity.

2.3.2.1 If the CPU transmits a high active STROBE signal, connect U5 pins #15 and 16 together. Then use pin #14 as the STROBE Input.

2.3.2.2 If the CPU transmits a low active $\overline{\text{STROBE}}$ signal, use pin #16 as the STROBE Input.

2.3.3 PRINTER BUSY LINE

The BUSY line from the printer is a signal to the computer that the Selectric is not available to print another character. From your parallel port documentation, decide whether the computer senses the peripheral as "busy" at a logic high or low level. If BUSY is active at a high logic level, connect the BUSY line, interface pin #13, to the computer.

2.3.3 If BUSY is active at a low logic level, connect the inverted BUSY line ($\overline{\text{BUSY}}$) pin #12 to the computer.

2.3.4 GROUND LINES

Connect the ground pins #9, 10 and 11 to the computer ground. Finally, recheck your wiring since a mistake could endanger the life of your integrated circuits. This completes the interconnect cable wiring.

2.3.5 The completed cable is connected between the computer parallel port and the U5 DIP socket located on the parallel interface board. Refer to the Interface Card Assembly Diagram, figure , for the location of U5 socket. Verify that pin 1 of the cable is mated to pin 1 of the DIP socket.

2.4 REQUIRED MICRO-COMPUTER PROGRAMMING

Many computer operating systems have a built-in capability to operate a parallel printer port. For these systems no additional programming is required; the simple command things like "SET OUTPUT=PORT#N", where port#N is the parallel printing port should direct all subsequent output to the Selectric. Some systems have special commands that output directly to the printer, for example, BASIC on the TRS80 uses the LPRINT command. However, some sytems will require a simple driver program. The driver controls the timing of the data exchange between the computer and the Selectric. Before you can start to write the driver, you should understand the timing considerations of the interface. For most micro-computer systems, the timing sequence will be either Handshake mode or Pulse mode. Both can be used with this system. A detailed description is in the following sections.

2.4.1 HANDSHAKE MODE

The Handshake mode of operation is the most reliable form of data exchange between the computer and the Selectric. This mode enables the computer to receive an acknowledgement from the printer that the data has been accepted and that the printing action has begun. The sequence of events is a follows (refer to figure 3):

SOURCE	ACTION
1. Computer	checks to see if the interface is busy
2. Computer	outputs data
3. Computer	sets strobe line active
4. Interface	responds with printer "BUSY"
5. Computer	sets strobe inactive
6. Interface	if strobe is inactive, resets busy line when printing is complete
Computer	checks if interface is busy (back to step 1)

The driver program for the Handshake mode of operation should follow this sequence:

1. Check if the printer BUSY line is active
2. If BUSY active, wait until it is ready (not BUSY)
3. Send data
4. Set the STROBE line to its active state
5. Check if printer BUSY line is active

An optional step would be to time the delay between the STROBE line set active (step #4) and the printer setting the BUSY line active (step #5). In this way, the printer operation can be quickly verified and an error message generated if necessary.

2.4.2 PULSE MODE

The Pulse mode of operation checks the status of the printer and sends the data and a short duration STROBE pulse if the printer is not busy. The computer is not able to check if the printer received the data. However, this is usually not a problem for most applications, as the interface will not accept new data until the print operation for the previous character is completed. The following is a typical sequence of actions using the Pulse mode of operations (refer to figure 4):

SOURCE	ACTION
1. Computer	Checks status of printer
2. Computer	If not busy, sends data
3. Computer	Sends STROBE pulse
4. Computer	Checks status of printer (back to step 1.)

The driver program for the Pulse mode of operation should follow the sequence:

1. Wait for printer to be ready (not BUSY).
2. Send data
3. Send STROBE pulse
4. Return to main program

2.4.3 TIMING REQUIREMENTS

t(set-up) = 15ns

This is the time the data must be valid before the strobe line is allowed to go active.

5(hold) = 0ns

The time after the strobe is active that the data must remain valid.

t(width) = 30ns

This is the time that the STROBE must stay in its active state to insure that the printer will initiate a print action.

HANDSHAKE MODE:

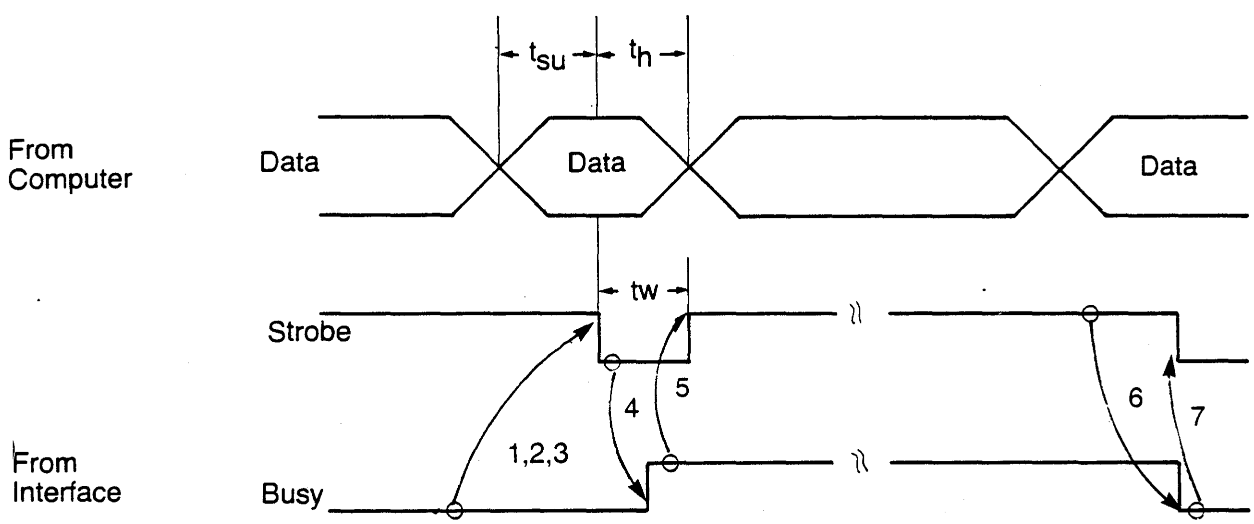


FIGURE 3

PULSE MODE:

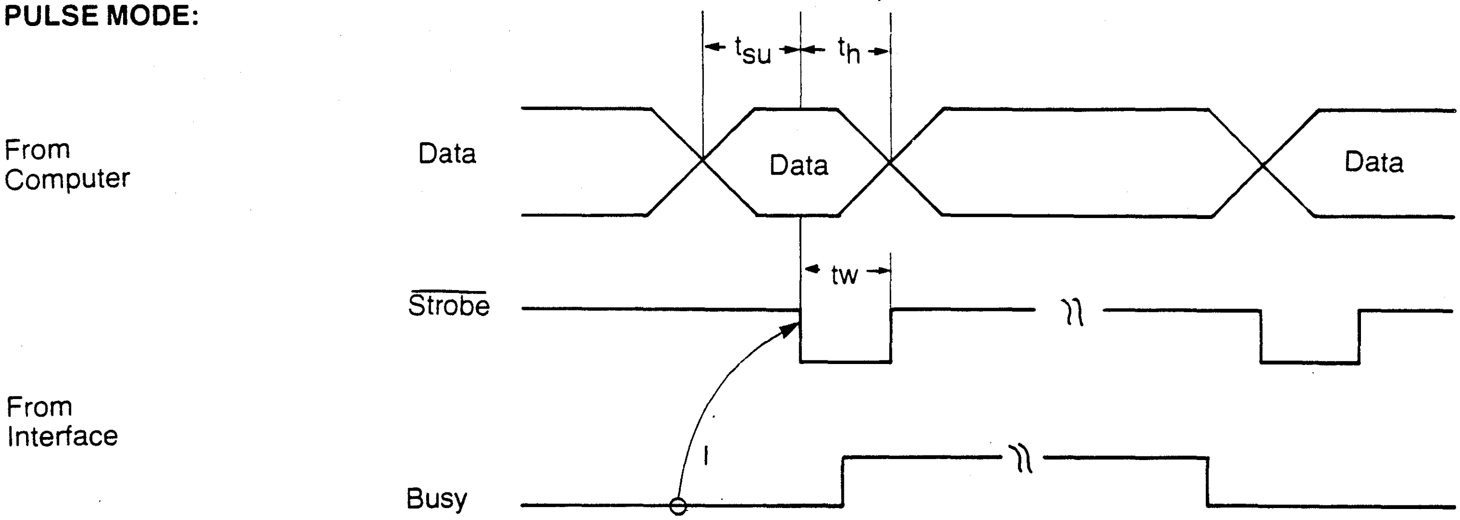


FIGURE 4

3.0 OPERATION

The Selectric typewriter system operates in two modes: Local (manual keyboard entry) and Remote (computer sending data to be printed). Each is discussed below.

3.1 LOCAL OPERATION

Press the LOCAL key so its light is on. This sets the typewriter in the local mode and permits standard typewriter operation. All the keys should print normally and all the functions like return, shift, tab, space and index should be operational. If the keyboard does not unlock, press the RESET button. This will disable the interface circuitry, permitting local operation. If the typewriter still does not operate properly, refer to the TROUBLE SHOOTING section.

3.2 REMOTE OPERATION

Press the LOCAL button so that its light is off; this puts the typewriter into the REMOTE Operation mode. Using the TYPE Keys, select the proper code for type sphere on the Selectric. The Selectric system is now ready for printing characters from the computer.

To initiate a REMOTE Printing action, use either the typewriter driver program or the computer system print commands. When a long listing is being printed, it is sometimes convenient to be able to stop the printing without terminating the listing completely. This is possible by pressing the LOCAL key so that its light is on. This stops all action and permits new paper to be installed, manual typing, or other actions that require the printer to be stopped. To restart the printing, simply press the LOCAL key again so that is light is off (REMOTE mode).

3.3 CONTROL SWITCHES

Remote

REMOTE mode is entered by turning off the LOCAL light. In remote mode the computer controls all functions of the Selectric. The keyboard will be locked with the exception of the TAB and SPACE switches. These should not be operated in the remote mode.

Local

The Selectric may be put into Local mode at any time without loss of characters, even during remote operation. In Local, all typewriter operation is under manual keyboard control; to the computer the printer appears busy.

Reset

Press Reset to reset the circuitry of the interface card in REMOTE mode in event of system fault. Light is normally ON.

Type Sphere Select

Two manual switches, TYPE 1 and TYPE 2, are used to select ASCII-to-IBM code conversion tables (located in the 2708 EPROM on the interface circuit card) for up to four different type spheres. For convenience, the machine operator should label each type sphere the same as the switch which selects its correct decoding table (example: type sphere "1" to correspond to TYPE 1 switch ON.).

TYPE 1 and TYPE 2 switches control input logic levels on pins 9 and 10 of the 2708 EPROM, setting these lines inactive when lighted. Pins 9 and 10 select Low and High memory addresses for the starting address of conversion tables located in the EPROM, as follows:

1) TYPE 1 and TYPE 2 ON = Address 000
2) TYPE 1 ON only = Address 256
3) TYPE 2 ON only = Address 512
4) TYPE 1 and TYPE 2 OFF = Address 768

Each conversion table occupies 128 memory locations in the EPROM, leaving room for additional conversion tables which could be added to the EPROM to be selected by computer control (see Section on ASCII to IBM SELECTRIC CODE CONVERISON.)

Tab

An important function for programming is the Selectric mechanical TAB setting. The Selectric Tab Clear/Set key allows the operator to mechanically set locations horizontally across the page to which the type carriage will jump when the Tab solenoid is initialized. Some computers or computer programs act in a similar way; that is, one "Tab" signal causes the cursor to jump to a specific location on the page or video display. Other computers/programs use the "Tab" function to move the cursor incrementally a preset number of spaces across the display (not to a preset address on the display.) This is really the "Repeat Space" function and not "Tab". The user is advised to coordinate the Selectric TAB function with the function of Tab on his CPU. You will probably also find it helpful, if possible, to establish a preset tab pattern on the Selectric (such as 20, 40, 60, 80 etc.), and not to deviate from such a standard thereafter. Otherwise documents prepared at different times may have different Tab settings and may not p[illegible] correctly at a later date when Tabs are set another way.

4.0 ASCII TO IBM SELECTRIC CODE CONVERSION

Conversion of 7-bit ASCII alphanumeric characters to Selectric machine code for moving the typeball is carried out in a series of steps described below. Focal point on the ASCII interface circuit card is the Programmable Read-Only Memory chip (EPROM) U-3 which can be encoded with several conversion tables each 128 bytes long (representing all possible patterns of 7-bits of binary data.) The EPROM chip has 10 incoming lines. Two are used by the manual "TYPE 1" and "TYPE 2" switches on the Selectric to select the starting point of the conversion table (address 0 = both ON; address 256 = type 1 On; address 512 = Type 2 ON; address 768 = Both Off.) Eight lines come from the computer. When 7-bit ASCII is transmitted from the computer, seven lines are used to select 128 addresses starting at the point specified by the position of the TYPE switches. One of the 10 lines is not specified, and could be used by the computer to select other starting points for conversion tables at addresses 128, 384, 640 and 896. A total of 8 conversion tables of 128 chracters each can be contained on the EPROM, addressable by manual and computer control. Alternatively, 4 conversion tables of 256 characters could be programmed, each having 128 ASCII characters plus up to 128 graphics characters.

4.1 ASCII CHARACTER SET

The ASCII code consists of 96 printing and 32 non-printing characters each of which is assigned a value from 0 to 127. These 128 characters can be expressed as decimal numbers (0 to 127), as 7-bit binary code (0000000 to 1111111) as hexadecimal code (00 to 7F), etc.

In a typical microcomputer system 8-bit binary code is used to represent both data and addresses in the architecture of the hardware ("machine language" code.) The 7-bit ASCII code fits well into those parameters, with the hexadecimal code used as a shorthand representation of the actual binary code.

Below are tables of equivalencies showing the ASCII characters in sequential order, their decimal values, their 7-bit binary values, and their hexadecimal values. These last values also correspond to memory **addresses** in the 2708 EPROM used to translate ASCII code to IBM Selectric Tilt-Rotate code for operating the printer mechanism. The 8-bit codes required for driving the Selectric printer are stored as binary **data** at the memory locations corresponding to the ASCII equivalents.

Of course, not all ASCII characters have an equivalent Selectric typeball character, nor are all type ball characters represented in the ASCII character set. The tables below show the equivalencies between the ASCII character set and 3 common Selectric type balls: #029 standard correspondence, #963 EBCDIC, and #987/988 APL. These conversion tables are programmed in the 2708 EPROM on the interface circuit card as tables "Type 1 and Type 2 ON", "Type 1 ON" and "Type 2 ON", respectively, for both correspondence code and EBDIC code typewriters.

4.2 SELECTRIC TYPE SPHERE CHARACTER SET

The Model 725 Selectric can utilize any correspondence or BCD/EBCD code IBM type sphere. However, only if typewriter and type sphere are of the same code will the alphanumeric characters (A-Z, 0-9) of the keyboard match the characters being printed by the type ball. When printing is controlled by the computer, of course, the typewriter keyboard is irrelevant, and any type sphere can be used so long as an appropriate ASCII-to-type sphere code conversion table can be programmed into the interface EPROM.

The ASCII character set contains 96 printing characters. A Selectric type sphere contains a maximum of 88 printing characters, with the consequence that not all ASCII characters can be represented by any one Selectric type sphere. Print-outs of three standard type spheres showing the type styles and characters represented are found in the figure below. Each of these type spheres is available from Pacific Office Systems and its ASCII code conversion table is contained in the 2708 EPROM as encoded by POS.

Some IBM type spheres contain characters which are not included in the ASCII set (APL type ball is a good example). For such type balls a convention may be adopted to "create" an equivalent ASCII character.

For a computer which can generate graphics characters on its video display the user can examine the bit pattern of the created character to see if it can be matched to any memory address in the EPROM. The memory address would then be programmed with the tilt-rotate code of the Selectric type sphere character, and the new translation table located by the Type 1 and Type 2 switches on the Selectric.

An alternative method would be to map the code of the Selectric type sphere back to the keyboard of the computer. This is done by simply typing all computer keys — lower case, upper-case and control keys — and noting what the Selectric prints when one of the standard code conversion tables is used (such as the #029 type ball code for all other correspondence code type balls.) Then place decals on the sides of the key tops which generate the special characters, and remember which translation table to match with the type ball.

4.3 EPROM ENCODING

A factory-fresh 2708 EPROM has 1024 locations (addresses) each containing eight data bits which are set at binary 1. When the EPROM is "programmed", some of the data bits are changed to 0's and the rest remain 1's. In the ASCII Selectric interface circuit card, a seven (or eight) bit code from the computer enters the EPROM and is routed to the address having the same bit pattern. At that address the programmed data bits emerge as an 8-bit pattern en route to the printer mechanism. Of these 8 data bits, DB6 dictates whether the Selectric will print a character or initiate a control function. Data bits 0 to 5 control which character is printed or what motion is carried out, as follows (note that all data signals are <0 true, that is, active at 0 volts.):

Coding of EPROM (U3)

DB7	DB6	DB5	DB4	DB3	DB2	DB1	DBØ
U/C	0	$\overline{T2}$	$\overline{T1}$	$\overline{R5}$	$\overline{R2A}$	$\overline{R2}$	$\overline{R1}$

Printing Character

DB7	DB6	DB5	DB4	DB3	DB2	DB1	DBØ
Ø	1	$\overline{\text{No Action}}$	$\overline{\text{TAB}}$	$\overline{\text{BKSP}}$	$\overline{\text{SPACE}}$	$\overline{\text{INDEX}}$	$\overline{\text{RETURN}}$

Control Function

FIGURE 5

The Tilt-Rotate codes needed to select each printing character for the most common Correspondence code and BCD code type balls are shown in Figure X on page 1-3 of the Typewriter Electrical Mechanical Adjustments Manual. You will note that for both EBCDIC and correspondence code typewriters the codes for control functions (Space, Backspace, Carriage Return, Index and Tab) are identical. Only the keys which select **printing characters** are encoded differently for EBCDIC and correspondence mechanisms. Within the line of correspondence or EBCDIC code type balls, nearly all have the alphanumeri cal characters (A-Z, 0-9) in the same positions, with variations only as to punctuation and occasionally graphics symbols in place of upper case alpha characters. Consequently, in order to create additional conversion tables in the EPROM you may need only a few changes from the standard tables for #029 (correspondence) and #963 (EBCDIC) type spheres shown below.

Conventions have been adopted with respect to certain ASCII characters. You may wish to adopt different conventions by re-encoding the EPROM.

1. For ASCII printing characters which are not found on a type ball, the code for "space" has been used in the conversion table, which allows the user to manually insert the character on the typed page later.
2. ASCII Characters "back space" and "DEL" have both been translated to Selectric "Backspace".
3. "Carrier Return" in ASCII moves the carrier to the left margin but does not advance the paper, which is carried out separately by the "Line Feed" signal. The Selectric cannot implement C/R without L/F (although ASCII L/F or "Vert. Tab" can be carried out separately by the Selectric "Index" character.)

   The convention we have adopted is to translate ASCII 'C/R' and "F/F" (Form feed) to Selectric "C/R", ~~to provide no translation for ASCII "C/R~~", and to translate ASCII "Vertical Tab" as Selectric "Index".
4. ASCII numeral "1" has been translated as Selectric lower case "L" (1), so that the Selectric options characters found on some type balls at the position normally used by numeral 1 can be included in the conversion table. Example: Typeball#007 has [ ].
5. ASCII "{" and "}" (left and right curly brackets) sometimes represented as "←" and "→", and have been so translated in conversion tables for type balls having "←" and "→".
6. Selectric type ball characters not found in the 128 charater ASCII set have been listed separately with the Tile-rotate data code required to select the character. The user can then insert the data codes for these characters at ASCII memory addresses of his choice. One method is to place the characters **within** one of the 128 characters conversion tables at addresses corresponding to unused ASCII symbols and then marking the CPU keyboard at the corresponding location by a decal placed on the side of the keytop. Another method is to extend the conversion table from 128 to 256 characters by use of ASCII data bit 7 in the memory address, and place the unusual Selectric character translations at addresses 128-256 opposite their computer **graphics** counterparts (which can also be generated by use of DB7 in systems capable of displaying graphics characters.)

4.4 EPROM PROGRAMMING

If you wish to re-program your 2708 EPROM to add or change conversion tables, be sure to go through the following steps.

Determine whether the type ball you wish to encode on the EPROM is EBCDIC or Correspondence Code by typing with it on a Selectric whose code is known.

2. Look at ASCII/Selectric Conversion Table, figure 6, to determine the differences between your type ball and the "standard" type balls (#029 for Correspondence code; #963 for EBCDIC Code). To do this place the type ball on your Selectric and type all keys in the order they appear **on the Conversion Table (Selectric type ball side). Be sure to use the EBCD table for an EBCD type ball, and vice versa for Correspondence Code.**
3. **Circle all typed characters which are not exactly the same as the conversion table — even if they are simply relocated in the table (such as punctuation marks) or upper-case instead of lower-case, etc. Location** in the table is the important factor here.
4. For all characters which are simply *relocated* in the table:
   a) Erase old Selectric binary hex code for the character.
   b) Insert the Selectric binary hex code found at the old location of the desired character in the place where the desired character is now found. See example:
5. For Selectric characters which do not appear in the table for standard EBCD and Correspondence Code type balls, but do appear in the ASCII table, use same procedure as step 4, placing a new code opposite the ASCII character on the Selectric side of the table.
6. For Selectric characters which do not appear in the ASCII character set, note the ASCII character which is opposite the new Selectric character, and place a decal on the side of the computer key which generates that character. Do not change the conversion talbe. (Option: extend the conversion table in length from 128 to 256 characters and place the non-ASCII characters in the extended portion of the table, as discussed in section 4.3.6 above).
7. Select the starting address for the new conversion table from the space available in the EPROM (one of the 8 addresses listed in section 4.0 above).
8. Program the EPROM (U-3) with the data for the new conversion table, or send the information to Pacific Office Systems for programming (not free — call for prices before sending material! (415) 493 7455.)
9. Mark the new type ball with a number or letter corresponding to the type switches and/or software code used to locate the new table in the EPROM.

ld Table:

ASCII Character	...	EPROM Binary Hex Data Address	Data	...	#209 Selectric Character	New Type Ball Character
!		21	28		!	
"		22	A1		"	
#		23	81		#	#
$		24	86		$	$
%		25	8A		%	!
...		...	...		...	...

New Table:

ASCII Character	...	EPROM Binary Hex Data Address	Data	...	#209 Selectric Character	New Type Ball Character
!		21	8A		!	!

5.0 THEORY OF OPERATION

The Selectric printing system is composed of three primary components: the printing mechanism, the magnet driver board and the parallel interface board (refer to Figure 1). The combination of the magnet driver board and the printing mechanism permit all the mechanical operations of the typewriter to be controlled electrically. The Parallel interface board is the timing coordinator and code converter between the computer and the combination of magnet driver board and printing mechanism. The two boards also provide electrical signals which describe the operative status of the mechanism.

5.1 IBM SELECTRIC PRINTER MECHANISM

The printer mechanism is a standard IBM model 725 office typewriter that has been modified by GTE/Information Systems with actuating solenoids (magnets) and with sense circuitry. The solenoids permit initiation of all the mechanical actions. Switches have also been added so that the status of mechanical actuators can be monitored. Typical switch information is upper/lower case, printing action complete, tab key, and others. The solenoids are positioned to initiate actions like tab, carriage return, index, space, back space and print cycle. Solenoids are also used to set the mechanism into the proper position to print a character.

The Selectric printing mechanism uses a nickel-plated plastic element which is mechanically tilted and rotated so that the element has four tilt positions and eleven rotate positions. The four tilt positions are called T-0, T-1,T-2, and T-3. There are two tilt solenoids which control the tilt of the element. The tilt solenoids are denoted T1 and T2. The four tilt positions above are obtained by activatig solenoids T1 and T2, T2 only, T1 only, and none respectively. The solenoids are activated by bringing a TTL compatible input on the magnet driver card under the Selectric to a high logic level. The eleven rotate positions are controlled by four solenoids labeled R1, R2, R2A, and R5. Activating these solenoids causes the element to be rotated one, two, two, and five positions respectively from a fully counterclockwise position. Thus all eleven rotate positons can be obtained by activating some combination of the four rotate solenoids. If more than one solenoid is active, the rotations are additive. Thus activating solenoids R1 and R5 produces a rotation of six positions. These forty-four tilt-rotate combinations cover one-half of the element. An additional forty-four positions are provided by rotating the rest position of the element 180 degrees. This is done by activating the shift solenoid — via another TTL input on the magnet-driver card.

A character is printed by setting the appropriate TTL levels for the bail codes — the name given to the combinations of tilt and rotate. After about 50 msec. (to give the solenoids time to position their respective bails) the cycle clutch must be activated. This TTL signal must be high for about 20 msec. The cycle clutch drives the Selectric mechanism causing the positioned element to impact the platen and print a character. The control functions each require about a 20 msec. TTL high signal to activate them. Return and tab may require up to about a second to complete depending on the distance the carrier (the name of the thing that carries the element) must move. The shift solenoid also requires extra time to settle after a change.

Upon completion of a print cycle the filter follower switch is activated which sends a TTL High signal through the Mag Driver PCB to the Interface PCB, thereby resetting the Printer Busy line to allow the interface to accept another character for printing. Micro-switches attached to the control functions of the Selectric provide similar signals upon completion of the control operations, except for Tab. One-shot Q-1 on the interface PCB provides a one second delay for each Tab character, which is estimated to be sufficient for most printing applications.

5.2 MAGNET DRIVER CARD

The Magnet Driver board is the electrical buffer for the switch and solenoid circuits of the printing mechanism. Each solenoid has a driver circuit that can be operated by a TTL voltage level. The buffer also isolates the large inductive load of the magnets from the driving circuit. The switch lines are all debounced using a standard RS flip-flop. This provides the controlling circuitry with a smooth transition on all signal changes without any undesirable noise or noise spikes.

5.3 ASCII PARALLEL INTERFACE CARD

The Parallel Interface card coordinates the timing synchronization between the computer and the printing mechanism and generates all the sequenced control signals to operate the typewriter functions. Also, the conversion from computer code (i.e. ASCII, etc.) to mechanical typewriter code is completed here. For ease of understanding, this board is broken into five sub-sections (refer to figure 7): Synchronization logic, data latch and code conversion, magnet driver controller, control action generator, and print action generator. Each sub-section is discussed separately in the following sections.

5.3.1 SYNCHRONIZATION LOGIC

This is the main coordinator of the computer interface and all of the mechanical typewriter actions. A typical event sequence is:

1. The computer transmits a print initiate signal: STROBE
2. Data latch signal is generated
3. Interface "BUSY" signal sent to computer.
4. After a 1us delay an internal data valid signal is generated
5. Printer mechanism signals the end of an action cycle
6. Internal valid data signal is reset
8. Interface circuit is ready for another event sequence

The specific synchronization logic components are U8, U9, U13, and U16 (refer to Figure 8). U8 pins 8 and 11 form an RS flip-flop that is set upon receipt of a "STROBE" signal. R24 and C5 generate the 1us delay before enabling the internal data valid signal. The delay is necessary to allow the EPROM (used for code conversions) time for the data to settle. U8 pin 8 is connected to the preset input of U9, a D flip-flop used as an RS flip-flop. The D input is connected to ground so that the clock input can be used as an edge-triggered reset input. The clock input is connected to the AND function of all the action complete switch outputs of the typewriter mechanism. R23 and C4 slow down the action complete signal to compensate for minor mechanical misadjustments of the switches. The clear input of the D flip-flop is used only when the ACTION bit of the EPROM (used for non-printing characters like the ASCII NAK signal) is set. It will reset the interface if it detects a non-printing character. U16 pins 6 and 3 are connected as a RS flip-flop used to debounce the LOCAL front panel button. If the LOCAL button is actuated, three functions are performed: the interface "BUSY" signal is locked in the busy state, the keybvoard is mechanically unlocked and a reset signal is sent to the case control of the Print action generator. The keyboard unlock and case reset signals from the LOCAL switch are not transmitted until the current print action is complete (U10 pin 8). This reset holdoff prevents any characters from being lost if the LOCAL button is pressed during a computer transmisssion. The BUSY signal is enabled for three conditions: mechanical action in progress, LOCAL mode or STROBE signal active. The STROBE signal must be inactive before the BUSY signal can go inactive as shown in the handshake mode of operation.

5.3.2 DATA LATCH AND CODE CONVERSION

This section is composed of only two IC's, U2 and U3. U2 is an edge triggered D latch that stores the data bus information from the computer upon receipt of the data latch signal from the synchronization logic block. This prevents computer bus noise from interfering with the interface operation. U3, the EPROM (Erasable Programable Read Only Memory) stores the data conversion table for the interface. The computer bus is used as the address and the EPROM output is the required control signals. Refer to the section on EPROM coding for further details.

5.3.3 MAGNET DRIVER CONTROLLER

This section is composed of two tri-state driver IC's, U1 and U4. The two chips are used to gate the driver signals to the Magnet driver board. U1 gates the tilt and rotate signals when a character is being printed and U4 gates the control action signals such as carriage return, space and tab. Both chips are enabled by their respective action generator module. The resistors are used in series with the driver outputs to limit the current into the Magnet driver board.

5.3.4 CONTROL ACTION GENERATOR

The control action generator handles all of the non-printing typewriter actions: TAB, SPACE, BACKSPACE, INDEX, RETURN and CONTROL ACTION. CONTROL ACTION requires some explanation. It is used as the translation of non-printing characters received from the computer that cannot be mechanically carried out, such as the ASCII NAK. The control action generator circuit is composed of five sections using U11 and U15 pin 6 (refer to figure 9).

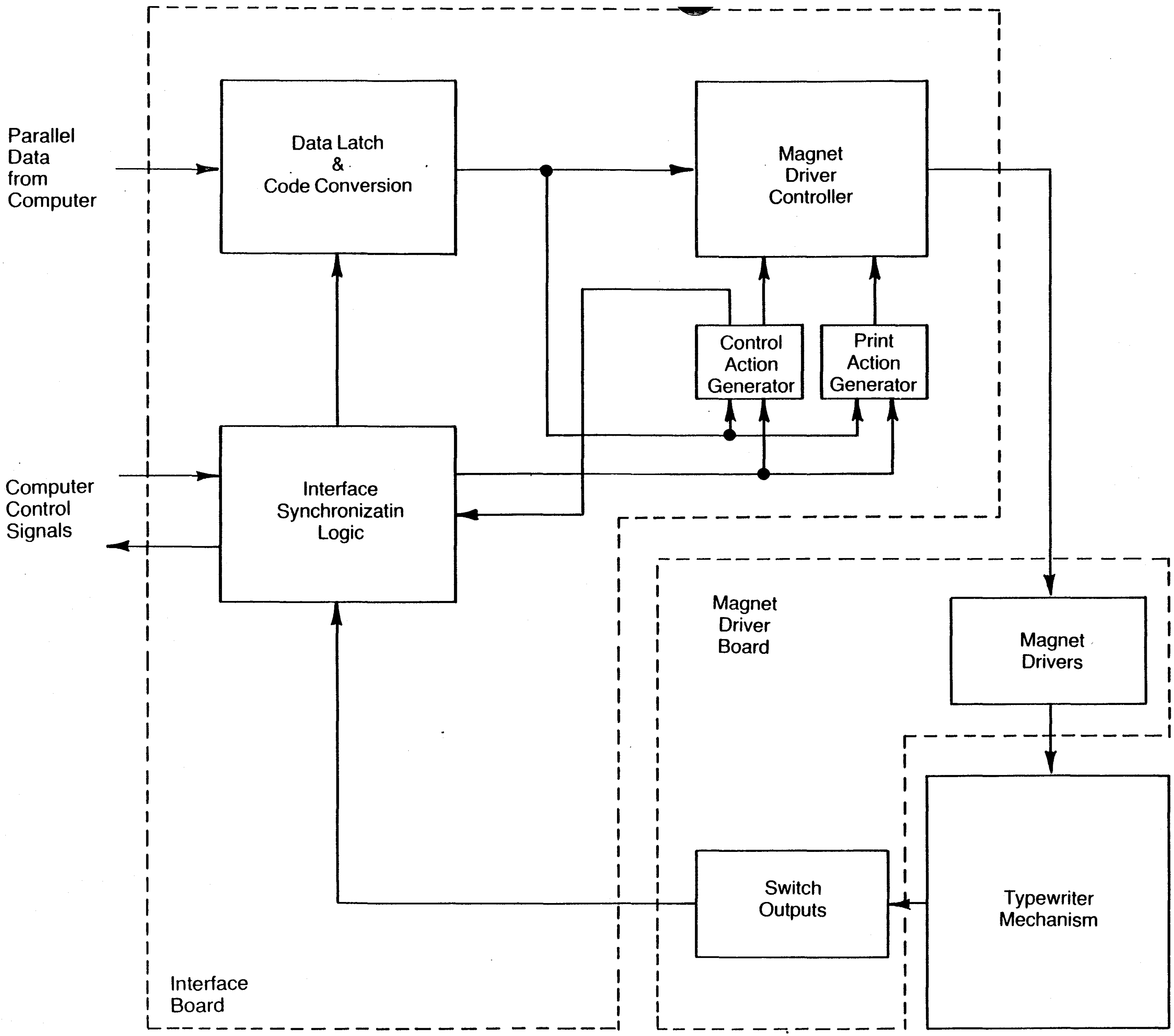
The control action detector simply monitors data bit 6 from the EPROM (the control/print signal.) If the data valid signal is active and the control signal is active, a control sequence is initiated. U11 pin 12 is a 10ms pulse that activates the Magnet driver controller. The pulse length is limited so that the solenoids are not overdriven (which could cause them to burn out.) U11 pin 5 initiates the tab action delay if the tab detector senses a tab character (EPROM bit 4). The mechanical tab action on the printing mechanism is the only cycle that does not have a switch that signals that the action is complete. Therefore, the delay generator is set for the maximum possible time for the tab action to be complete, then a reset signal is sent to the synchronization logic. The CONTROL ACTION detector simply signals the synchronization logic to reset if a non-printing character is detected.

5.3.5 PRINT ACTION GENERATOR

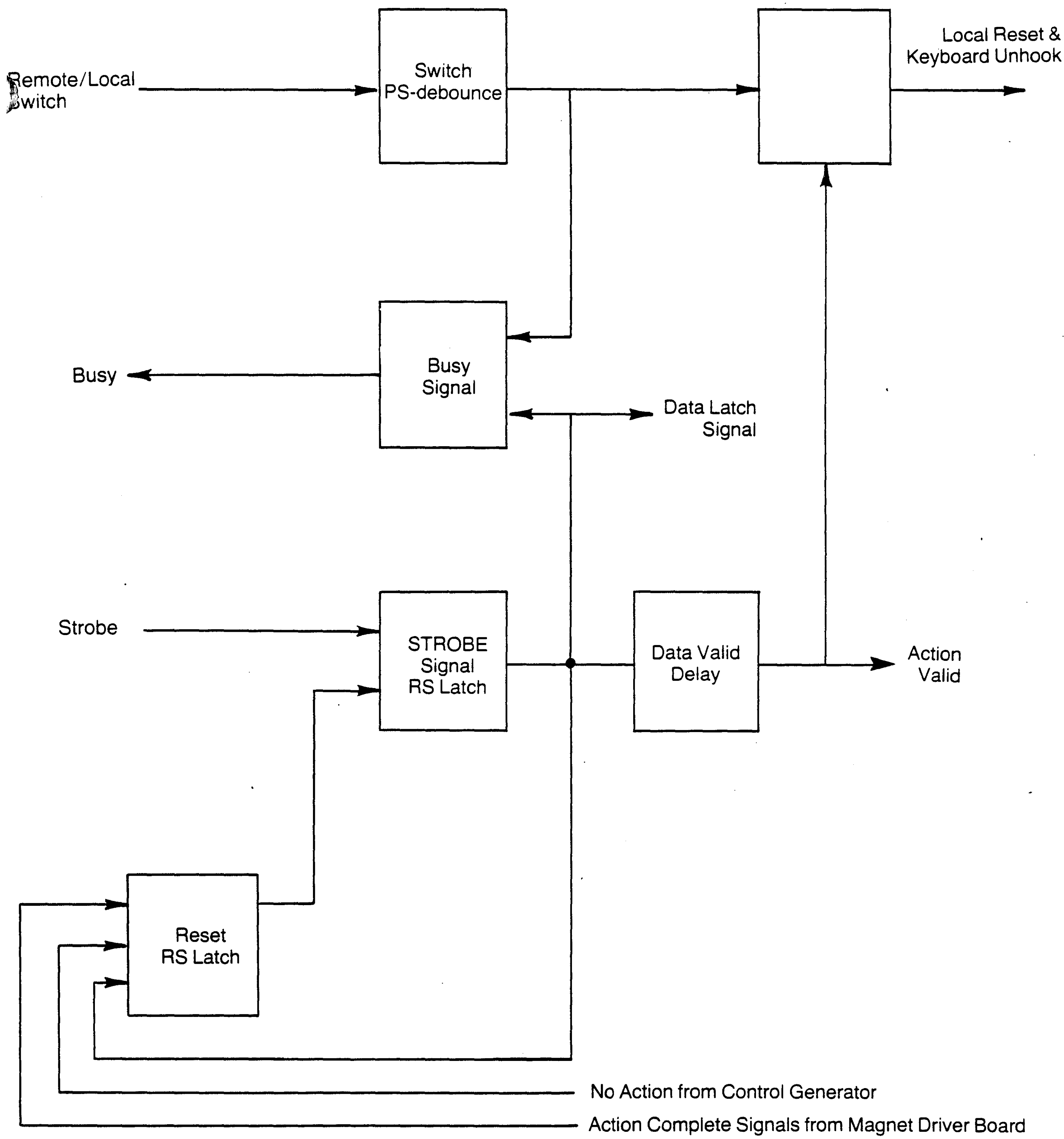
The six sections of the Print Action Generator generate the cycle clutch drive (this initiates the mechanical printing cycle), upper/lower case drive and the drive signal to enable the tilt and rotate action (refer to Figure 10). U9 is a D flip-flop used to store the status of the current upper/lower case selection. Through the use of U7 and U10 the desired case is compared to the current mechanical case and a change is initiated if necessary. No printing action will commence until the case switches signal that the type sphere is in the proper position. This hold-off is accomplished by inhibiting the cycle clutch drive. The tilt and rotate delay is initiated when a character print action is signaled (EPROM bit 6=0); the delay is for 20ms allowing the tilt and rotate position to be established before the print cycle is initiated. The mechanical print cycle is the time when the type sphere actually strikes the platen. The cycle drive time is limited so that multiple characters are not printed and no solenoid damage is caused.

A typical print action sequence is as follows:

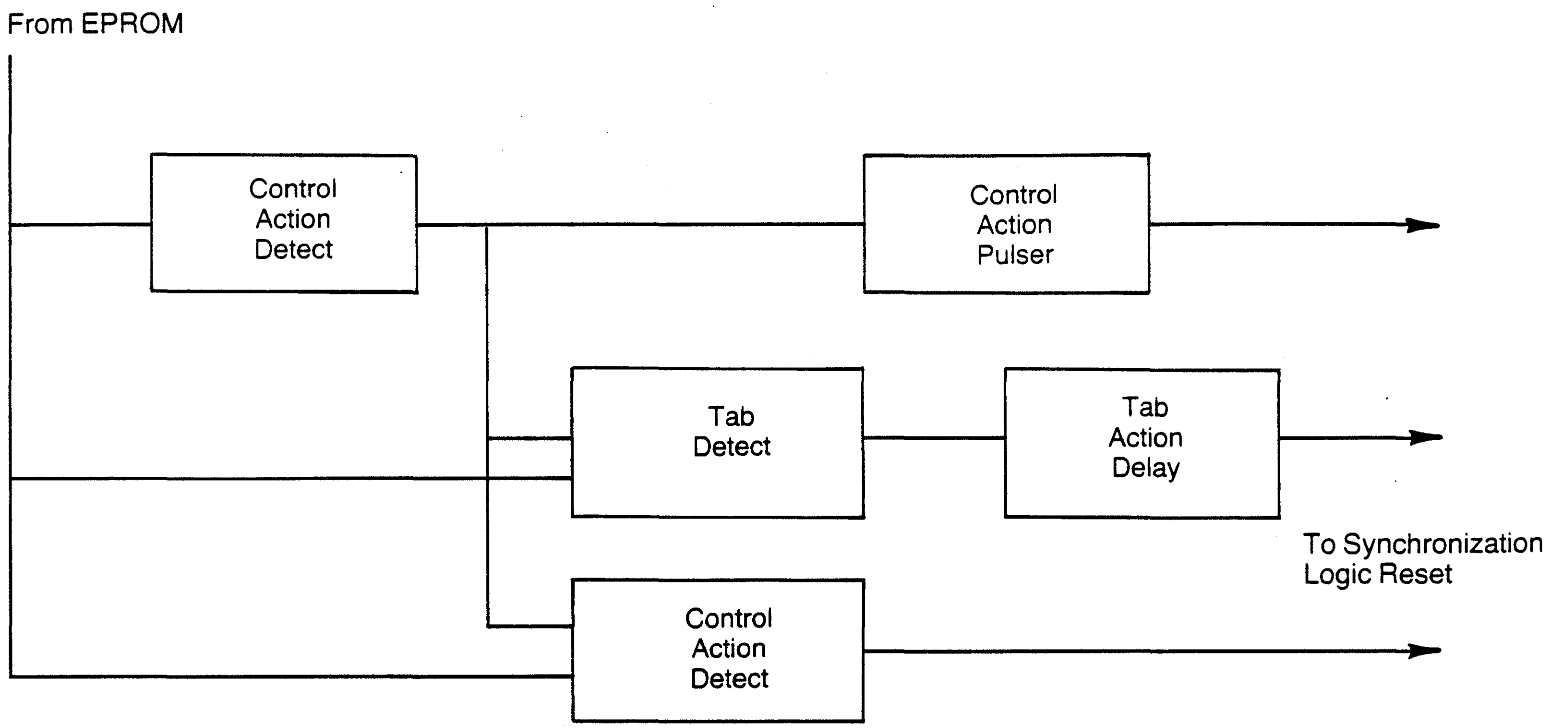
1. Printing character is detected
2. Tilt and rotate drive is enabled
3. Tilt and rotate delay is started
4. The desired character case is stored
5. The desired case is compared with current mechanical case
6. Cycle drive is held off until proper mechanical case is detected
7. Cycle drive enabled
8. Character mechanically printed
9. Ready for another character.



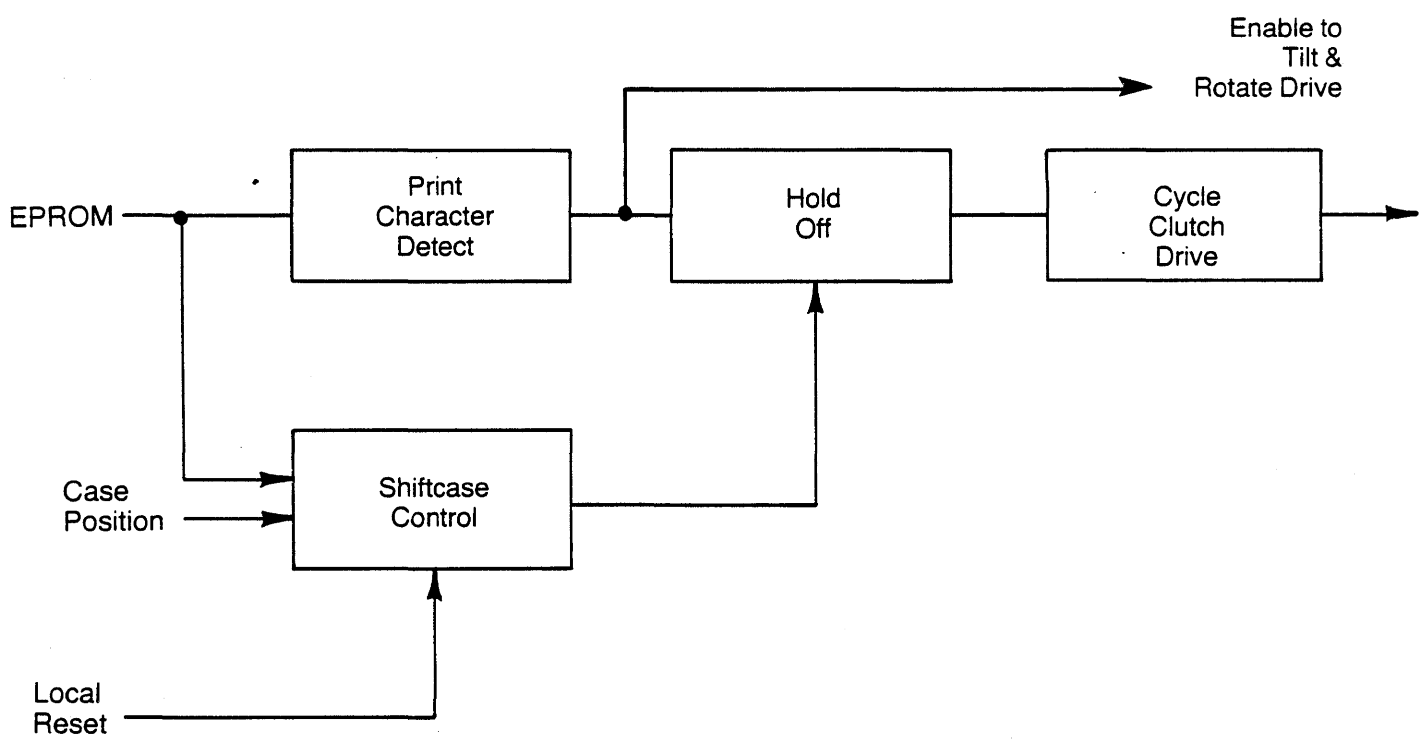
SYSTEM BLOCK DIAGRAM
FIGURE 7



INTERFACE SYNCHRONIZATION LOGIC
FIGURE 8



CONTROL ACTION GENERATOR
FIGURE 9



PRINT ACTION GENERATOR
FIGURE 10

6.0 TROUBLE-SHOOTING HINTS

Computers and electronic equipment involve thousands of moving (and non-moving) parts, any one of which, if malfunctioning, may prevent an important part of your system from working. In fact, with so many parts, it is a small miracle that any computer system will function for an extended period of time without technical attention. Nevertheless, after a system has been assembled and tested initially, most subsequent problems occur from minor oversight, loose connectors, wrong switch settings, etc. You will inevitably encounter your share of these small headaches during the process of using and understanding your system.

When the blankety-blank machine won't work right, the first thing to do is to put aside all thoughts of deadlines and requirements for the machine, and clear your mind to focus attention on the machine itself (even if this means preparing to learn something you hoped you would never have to understand!) Any other attitude will probably make your problems worse. Perhaps you can satisfy yourself with the thought that even big systems like IBM have problems, as we have all experienced.

6.1 REPAIR EQUIPMENT

The required equipment for trouble shooting this system is a volt ohm meter (VOM) and mechanical tools like a screw driver. Access to an oscilloscope is highly beneficial and may save a great deal of trouble-shooting time.

6.2 SYSTEM DIAGNOSIS

Figuring out what part of your system works and what part doesn't is the highest priority. Calmly survey the scene and *look for simple things first.* If nothing works there is probably a break or a short in the power line somewhere. Keep in mind the power requirements for different parts of the system:

1) Lamps require +5VDC and ground only.
b) Typewriter keyboard alphanumeric keys require only 110VAC (no DC voltages needed.)
c) Typewriter function keys Tab, Shift, C/R and Index require 110VAC, +5VDC for logic, and +24VDC for driving their solenoids (LOCAL mode.)
d) EPROM U-3 requires +12VDC as well as +5VDC.
e) The 44-pin cable connector to the mag driver circuit card carries +5V at one end and +27V at the other end. *Be careful not to put this connector on upside down or you will short out I.C.'s and transistors on the mag driver card.*

Generally, only one element of your system will be faulty. Be careful, in manipulating the system, to identify that element and not to introduce other faults. In particular, avoid moving the typewriter mechanism until you are sure that a problem resides under it. The checklist below is designed to permit methodical analysis while disturbing the entire system as little as possible.

6.3 TROUBLE SHOOTING CHECKLIST

To isolate a problem, use the following steps as a guide.

1. Check that the typewriter is firmly connected to a 110 volt AC outlet.
2. Check that the power switch is in the ON position.
3. Check that the system fuse is not blown (refer to figure 1).
4. Check that the +27 volt fuse is not blown (refer to figure 1).
5. Verify that all the power supply voltages are correct (refer to figure 9). (+24V is unregulated and may show any voltage from 25V to 30V.)
6. Check that the power supply connector is firmly seated.
7. Check that the magnet driver connector is firmly seated and right side up.
8. Check that the interface board connector is firmly seated and right side up.
9. Check that the LOCAL light is on (LOCAL mode).
10. Press RESET button.
11. Type characters on keyboard. Verify that keyboard is not locked out.
12. Press TAB key and verify carriage movement across the page.
13. Press SHIFT key and verify typesphere rotation.
14. Press LOCAL key so its light is out. (REMOTE operation)
15. Press SHIFT key and RETURN key and verify *no movement* of element or carriage.
16. Check that all IC's on Interface board are firmly seated.
17. Check computer connection and cable for continuity and proper pin connections.

At any point where assistance would be helpful, please call PACIFIC OFFICE SYSTEMS:
(415) 493-7455
— Call collect if within warranty period of unit —

SYMPTOM/DIAGNOSIS/REMEDY EXAMPLES

Following are examples of common problems you may encounter, starting with simple installation events and proceeding to more sophisticated situations. Refer to the GTE/IS Typewriter Electrical-Mechanical Adjustments Manual for assistance in adjusting the solenoids and micro-switches located under the typewriter mechanism.

6.4.1

Symptom: No Switch Bank Lights.

Diagnosis: Lights require +5V and ground

Remedy: Check for continuity and proper voltage levels between power supply and switch bank.

6.4.2

Symptom: Local mode — keyboard of typewriter locked out.

Diagnosis: Keyboard lockout magnet is activated at wrong time. This function is controlled by circuitry on the interface card.

Remedy: Review THEORY OF OPERATION, Section 5.3 and trace line for lockout function. If circuit is OK, then tilt typewriter to service position and look for short circuit on mag driver card or solenoid wires.

6.4.3

Symptom: Local Mode — Alphanumeric keys type OK, but there are no control functions (Shift, Tab, C/R, Space, Bksp, Index.)

Diagnosis: 110 VAC activates the typewriter keyboard except for some of the function keys, which are solenoid-driven through the magnet driver PCB. (Tab and Shift signals pass also through the interface card.)

Remedy: Check for +24 VDC power to magnets (fast-blow fuse on power supply; brown wires from P/S.) Check for +5VDC to mag driver PCB to carry signals activating the magnet driver transistors. Check Red and Black wires from power supply for continuity and proper voltage levels to the mag driver card.

6.4.4

Symptom: Local Mode — Tab or Shift keys don't work.

Diagnosis: These functions differ from Space, Bksp, Index and C/R in that their driver circuitry passes through the interface circuit card.

Remedy: Review THEORY OF OPERATION, section 5.3, and trace through circuitry for these functions on the interface circuit card. If no cure is found, tilt typewriter to service position and look for short circuit on magnet driver card or wires to solenoids; then look for micro-switch bent or maladjusted to be closed (no click when its lever is depressed and raised.)

6.4.5

Symptom: Local Mode — Typewriter keys stay down when pressed.

Diagnosis: Return spring has been dislodged.

Remedy: Tilt typewriter to service position and look underneath front of keyboard for dislodged spring.

6.4.6

Symptom: Local Mode — Typewriter prints dashes between typed characters.

Diagnosis: Dash (-) is the default character printed when print cycle is initiated and the type ball has not been positioned to print a character.

Remedy: Call an IBM typewriter technician to adjust the Selectric mechanism.

6.4.7

Symptom: Remote Mode (Local Mode OK) — Printer types wrong characters.

Diagnosis: Signals are getting through to the printer, so system is basically OK. Check to see that TYPE 1 & 2 switches are set correctly for the type sphere on the typewriter. If switches are set correctly, there is a possibility that signals are being garbled by interface circuit card (refer to THEORY OF OPERATION, section 5.3), but greater likelihood is that printer solenoids are out of adjustment.

Remedy: Write down characters that are not being printed correctly and look for patterns corresponding to the Selectric mechanical Tilt-Rotate codes (Table 1-1, p. 1-4, GTE/IS Typewriter . . . Adjustments Manual.)) Tilt the typewriter up into the service position and watch the solenoids actuate during a print routine to see if any one is visibly inactive, burned out, etc. Make adjustments per GTE/IS Adjustments Manual.

6.4.8

Symptom: Remote Mode (Local Mode OK) — printer hangs up after one character is printed or one of the control functions has been completed.

Diagnosis: "Printer not busy" signal is probably not getting back to CPU following a print cycle or a control function; or the signal is sent by the printer *too soon* and CPU transmits new data before printer is ready to print it, with the consequence that the new data is passed through the Interface PCB too soon to be recognized by the printer, which can't print nor send back the subsequent "printer not busy" signal which the CPU is waiting for. The "printer not busy" signal is generated by the microswitches on the bottom of the Selectric (except for TAB), and then passes through the Interface card back to the CPU. Note that a separate switch is utilized for each control function (including UC/LC sense), whereas only one switch is used to sense the end of a print cycle for all printed characters.

Remedy: Push RESET Key. If pushing RESET allows another character to be printed, then the printer micro-switches are probably working but out of adjustment. If RESET has no effect, then no signal at all is getting back to the CPU, either because the micro-switch is not generating a signal or because the interface PCB is blocking it. Try sending all the different control functions from the CPU to the Selectric, two at a time, as well as some printing characters. This will allow you to see if only one or two of the microswitches are not working properly or if the interface PCB as a whole is not working. Refer to the Interface PCB Circuit Diagram and Section 5.3, Theory of Operation. Refer to the GTE/IS Typewriter Adjustments Manual.

6.4.9

Symptom: REMOTE Mode (LOCAL Mode OK) — Selectric prints characters but won't do control functions (TAB, Space, Bksp, C/R, Index, etc.)

Diagnosis: The interface PCB multiplexes data signals from the CPU, sending printing characters through one circuit and control characters through another.

Remedy: Replace I.C.'s U-11, U-15 and U-4. Check EPROM U-3, data bit 6.

6.4.10

Symptom: REMOTE Mode (LOCAL Mode OK) — Selectric *won't* print characters but *will* do control functions.

Diagnosis: See 6.4.9 above

Remedy: Replace U-14, U-15, and U-1

6.4.11

Symptom: REMOTE Mode (LOCAL Mode OK) — Selectric prints characters but won't change from lower-case to upper-case and vice versa.

Diagnosis: The U/C - L/C sense switch on the bottom of the Selectric generates a signal with each printed character, which is then passed through the interface PCB.

Remedy: Replace I.C.'s U-7, U-9, U-10. Check switch output levels from Selectric.

6.4.12

Symptom: REMOTE Mode (LOCAL Mode OK) — Selectric inoperative for *both* printing characters and control functions.

Diagnosis: This is a difficult situation as there are many possible problems and few clues to work from. Use the checklist below as a guide while you systematically check each part of the system.

1) Check that CPU is sending both data signals and the write strobe signal.
2) Check that cable is wired correctly and connected properly at both ends (pin 1 is located at the upper right-hand corner of the DIP socket U-5.)
3) Check that EPROM U-3 is seated correctly and that *both* TYPE Lights are on (to select location "00" in the EPROM).
4) Using a Volt Ohm Meter (VOM) set to read DC voltages in the 5-10 volt range, ground the black lead and touch the red lead to one of the traces on top of the interface PCB between U-5 (cable connector) and U-2. Push both TYPE lights OFF and send a long sequence of data from the CPU. The meter should fluctuate from 0 to about 5 volts as data signals pass into the interface card from the CPU. If this works, push both TYPE lights ON and see what happens. If signals are still present, the CPU "thinks" that the printer is printing and is sending data. If no signals are registered on the meter, press RESET key and see if the Selectric responds.
5) Check voltages to the EPROM U-3 for +12VDC, -5VDC, +5VDC and Ground. (Refer to Interface Circuit Diagram for pinout information for U-3.)
6) Replace I.C. U-2. Test for presence of data signals at points between U-5, U-2, U-3, U-1 and U-4 while the CPU is transmitting data signals.
7) Replace other I.C.'s on interface card, look for physical damage to components, broken wires, etc. Call for assistance!

WIRE LIST

MD = Magnet Driver Circuit Card

I = Interface Circuit Card Connector J1

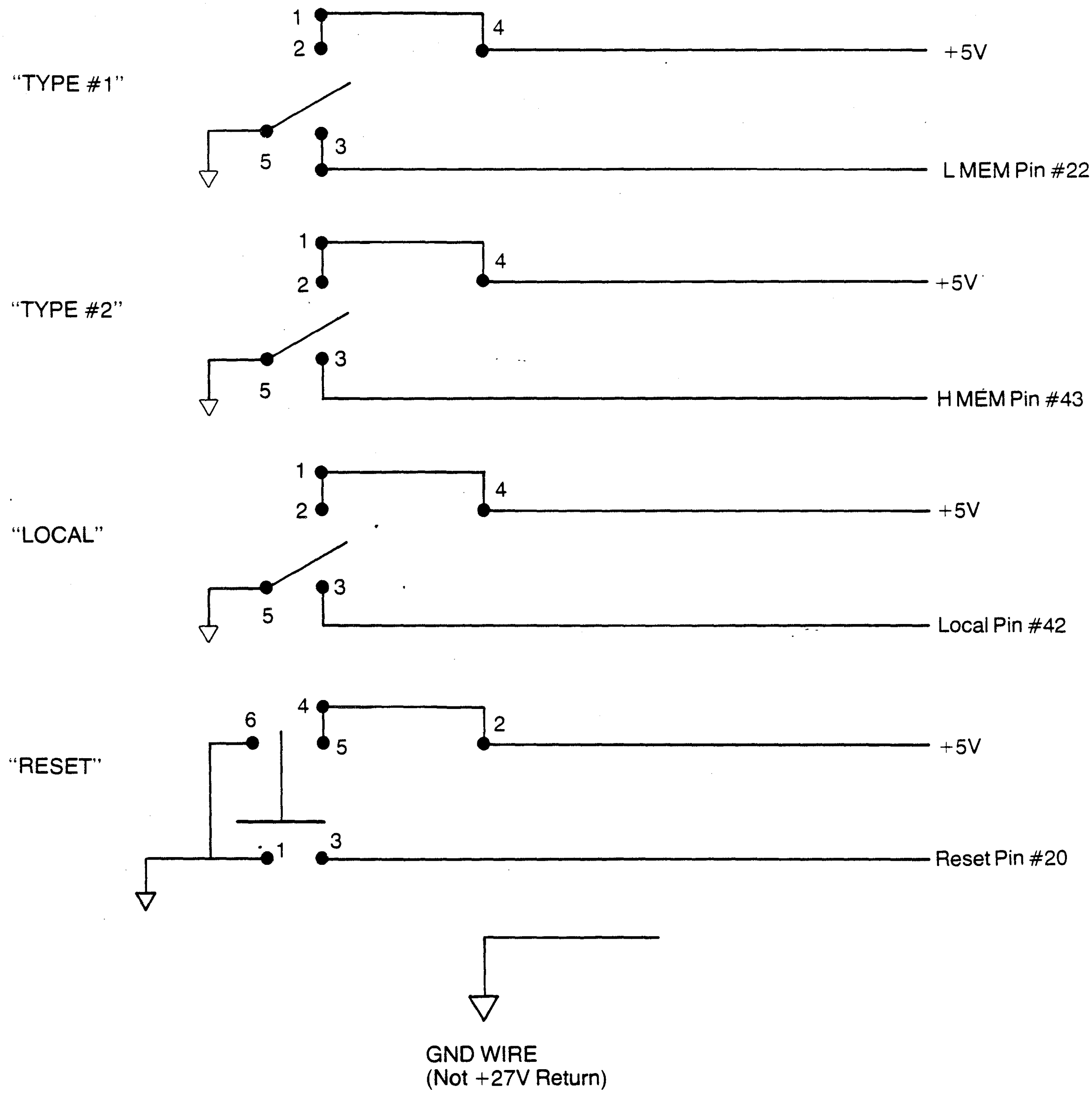
P = Power Supply

SB = Switch Bank

Source	Destination	Gauge	Signal
I1	MD-18	24	T2MD
I2	MD-R	24	R5MD
I3	MD-V	24	Back Space MD
I4	MD-T	24	Index MD
I5	MD-19	24	R2A MD
I6	MD-17	24	Tab MD
I7	MD-8	24	Lower Case SW
I8	MD-12	24	Shift MD
I9	MD-13	24	Key Bd Lock MD
I10	MD-6	24	$\overline{\text{Space}}$
I11	MD-J	24	$\overline{\text{Index}}$
I12	MD-16	24	Cycle MD
I13			NC
I14	P - 6	18	+5 Supply
I15	P - 2	18	Ground
I16	P - 4	18	+12 Supply
I17	P - 5	18	-12 Supply
I18		18	NC
I19	P - 7	18	(-27) Return
I20	SB	24	Reset
I21	SB	24	Remote
I22	SB	24	L Mem
I23 A	MD-20	24	T1 MD
I24 B	MD-P	24	R1 MD
I25 C	MD-U	24	C/R MD
I26 D	MD-S	24	Space MD
I27 E	MD-N	24	R2 MD
I28 F	MD-K	24	$\overline{\text{Tab SW}}$
I29 H	MD-7	24	Upper Case SW
I30 J	MD-9	24	Shift-SW
I31 K	MD-F	24	$\overline{\text{BK Space}}$
I32 L	MD-H	24	$\overline{\text{C/R}}$
I33 M	MD-5	24	F/S Follower
I34 N			N/C
I35 P			N/C
I36 R	P - 6	18	+5 Supply
I37 S	P - 2	18	Ground
I38 T	P - 4	18	+12 Supply
I39 U	P - 5	18	-12 Supply
I40 V			N/C

WIRE LIST (con't)

Source	Destination	Gauge	Signal
I41 W	SB	18	Lamp Drv
I42 X	SB	24	Local
I43 Y	SB	24	H-Mem
I44 Z			
P - 2	MD - 1	18	Ground
P - 6	MD - 2	18	+5V
P - 7	MD - 21	18	27V Retrun (-27V)
P - 9	MD - 22	18	+27V
P - 2	MD - B	18	Ground
P - 7	MD - Y	18	27V Return (-27V)
P - 9	MD - Z	18	+27V



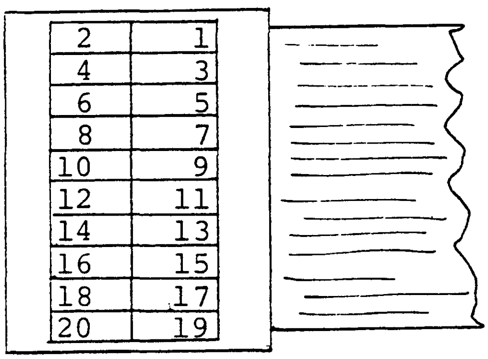
SWITCH BANK WIRE DIAGRAM
FIGURE 15

APPLE II PARALLEL PRINTER INTERFACE CARD

CABLE INSTRUCTIONS

Set Apple cable on a flat surface oriented so that the connector pin-holes face up. (See Figure 1.) This is a 20 strand cable.

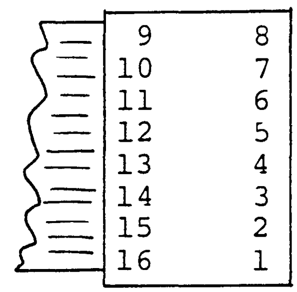
Set the Pacific Office Systems cable on a flat surface near the Apple cable oriented so that the pins face down and the numbers on the connector face up. This is a 16-strand cable.



APPLE CABLE

PINS TO BE CONNECTED

APPLE	SIGNAL	SELECTRIC
20, 1	GND	9, 10, 11
2	ACK/BSY	13
8	STROBE	16
10	DB0	1
11	DB1	2
12	DB2	3
13	DB3	4
14	DB4	5
15	DB5	6
16	DB6	7
17	DB7	8

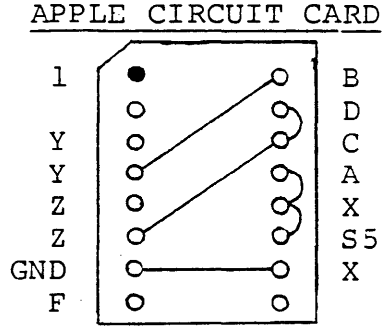


SELECTRIC CABLE

FIGURE 1

Separate the wire strands at the ends of each cable for a distance of about 2" and strip the insulation from about ½" at each end. Insert about 1" of heat shrink tubing over each strand fo wire to be connected. Twist together the strands from each cable as indicated in Figure 1. Solder the connected strands if a soldering iron is available, for increased strength and better electrical contact. Test each connection for continuity from end to end of the cable with an Ohmmeter. Slide the head shrink tubingover the exposed bare wire and shrink it with a small flame. Your cable is complete. Figure 2 below shows the Jumper Configuration Block wiring diagram to be installed on the Apple Printer Interface Card.

APPLE CIRCUIT CARD



"Printer Busy" signal is Hi True (+5V)

"ACK" (Printer Not Busy) is Lo True (0V)

"Data Strobe" signal is Lo True (0V)

Data Bits are Hi True (+5V)

STR-ACK

FIGURE 2

SELECTRIC PRINTER TO SOL-20 PARALLEL PORT, CABLE DIAGRAM

PRINTER INTERFACE CONNECTOR U5 PIN #	SIGNAL DESCRIPTION	SOL-20 PARALLEL PORT PIN #
1	DB 0	25
2	DB 1	24
3	DB 2	23
4	DB 3	22
5	DB 4	21
6	DB 5	20
7	DB 6	19
8	DB 7	18
9, 10, 11, 14*	GND	1,2
16	$\overline{\text{DATA STROBE}}$/$\overline{\text{POL}}$	17
13	PRINTER BUSY/$\overline{\text{PXDR}}$	16
15*	+5V/POE	15

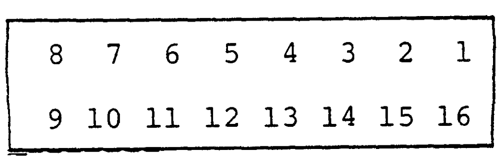
"Printer Busy" signal is Hi True (+5V)

"$\overline{\text{Data Strobe}}$" signal is Lo Ture (0V)

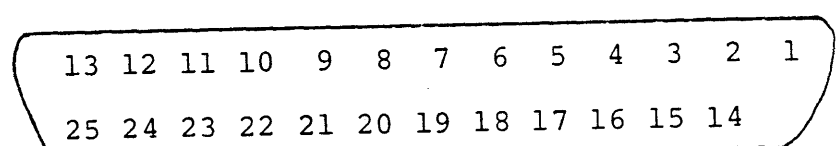
"POE" (Par allel Output Enable) is tied Hi (Always +5V)

Data Bits are Hi True (+5V)

* When Pin 14 is grounded, Pin 15 is driven Hi (+5V)



PRINTER CONNECTOR U-5
(TOP VIEW)



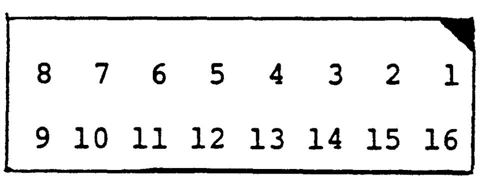
SOL-20 PARALLEL PORT (REAR VIEW)

SELECTRIC PRINTER TO TRS-80 CABLE DIAGRAM
(FOR EXPANSION INTERFACE LINE PRINTER PORT)

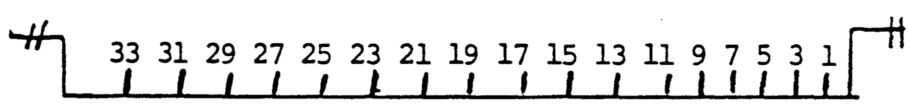
Printer Interface Connector U5 Pin #	Signal Description	Expansion Interface Line Printer Port J4 Pin #
1	DBØ	3
2	DB1	5
3	DB2	7
4	DB3	9
5	DB4	11
6	DB5	13
7	DB6	15
8	DB7	17
9,10,11	Gnd	4, 6, 8
12,15,16	Gnd	10,12,14
13	Busy	21
14	$\overline{\text{Data Strobe}}$	1

"Pinter Busy" signal is Hi true (+5V)

"$\overline{\text{Data Strobe}}$" signal is Lo true (0V)
Data bits are Hi true (+5V)



Printer Connector U-5
(Top View)



TRS-80 Expansion Interface
Line Printer Port J-4
(Top View)

COMPONENTS LIST, INTERFACE CIRCUIT CARD

Assembly Diagram Component Number	Description	Quantity
U1, 4	74LS268 Hex Buffer tri-state	2
U2	74LS374 D-Latch	1
U3	2708 EPROM	1
U6, 12	74LS14 Hex Schmidt invertor	2
U7,8,10, 15, 16	74LS132 Quad 2in Schmidt Nand	5
U9	74LS74 Dual D-FF	1
U11, 14	74LS123 Dual one-shot (must not be National Semiconductor)	2
U13	74LS30 8 in Nand	1
~~Q1, 2~~	~~2N2222~~ Optional	2
R1 - 21, 28	10K ¼W	21
~~R22~~	~~43K ¼W~~ Optional	1
R24, 25	1K ¼W	3
R26	¼W 1.8kΩ	1
R27	¼W 1.0kΩ	1
R29	50K ¼W	1
R30	91 Ohm 3/4W	1
~~L1 - 3~~	~~.15 Micro Henry choke I=2.4Amp~~ (optional)	3
VR1	5.1V Zener Diode ½W	1
CR1, 2	Schottky or Germanium Diode Switching Diode IN4148	2
C1, 2	33 uf solid Tantalum capacitor, 10V	2
C3	10 uf solid tantilum capacitor 20V	1
C9, 10	22uf Tantalum capacitor 25V	3
C5, 6, 7, 8, 11 C15 - 19	.01 ceramic disc capacitor 100V	9
C12 - 14	200 uf 25V electrolytic capacitor	3
	16 pin DIP socket	1
	24 pin DIP socket	1

C4 4.7 uf cap.

R23 220Ω, ¼ watt

	ASCII CODE			SELECTRIC CODES #029		#963		#987		#	
Char.	Decimal Value	Binary Value	Hexadec. Add.	Hex. Data	Sel. Char	Hex. Data	Sel. Char.	Hex. Data	Sel. Char.	Hex. Data	Sel. Char
I	73	1001001	49	AB	I	BE	I	2B	I		
J	74	1001010	4A	B8	J	A0	J	38	J		
K	75	1001011	4B	9B	K	A9	K	1B	K		
L	76	1001100	4C	96	L	A1	L	16	L		
M	77	1001101	4D	A0	M	AA	M	20	M		
N	78	1001110	4E	99	N	A2	N	19	N		
O	79	1001111	4F	A6	O	AB	O	26	O		
P	80	1010000	50	BA	P	A3	P	3A	P		
Q	81	1010001	51	BB	Q	A6	Q	3B	Q		
R	82	1010010	52	A2	R	AE	R	22	R		
S	83	1010011	53	AE	S	99	S	2E	S		
T	84	1010100	54	98	T	91	T	18	T		
U	85	1010101	55	91	U	9A	U	11	U		
V	86	1010110	56	A1	V	92	V	21	V		
W	87	1010111	57	AF	W	9B	W	2F	W		
X	88	1011000	58	90	X	93	X	10	X		
Y	89	1011001	59	BE	Y	96	Y	3E	Y		
Z	90	1011010	5A	88	Z	9E	Z	08	Z		
[	91	1011011	5B	80	l	5B	SP	32	]		
\	92	1011100	5C	5B	SP	5B	SP	B6	\		
]	93	1011101	5D	00	±	5B	SP	2A	[		
^	94	1011110	5E	5B	SP	5B	SP	8E	^		
_	95	1011111	5F	BF	_	A8	_	B1	_		
`	96	1100000	60	5B	SP	5B	SP	5B	SP		
a	97	1100001	61	23	a	30	a	23	A		
b	98	1100010	62	1F	b	39	b	1F	B		
c	99	1100011	63	13	c	31	c	13	C		
d	100	1100100	64	12	d	3A	d	12	D		
e	101	1100101	65	1A	e	32	e	1A	E		
f	102	1100110	66	31	f	3B	f	31	F		
g	103	1100111	67	30	g	33	g	30	G		
h	104	1101000	68	1E	h	36	h	1E	H		
i	105	1101001	69	2B	i	3E	i	2B	I		
j	106	1101010	6A	38	j	20	j	38	J		
k	107	1101011	6B	1B	k	29	k	1B	K		
l	108	1101100	6C	16	l	21	l	16	L		
m	109	1101101	6D	20	m	2A	m	20	M		
n	110	1101110	6E	19	n	22	n	19	n		
o	111	1101111	6F	26	o	2b	o	26	O		
p	112	1110000	70	3A	p	23	p	3A	P		
q	113	1110001	71	3B	q	26	q	3B	Q		
r	114	1110010	72	22	r	2E	r	22	R		
s	115	1110011	73	2E	s	19	s	2E	S		
t	116	1110100	74	18	t	11	t	18	T		
u	117	1110101	75	11	i	1A	u	11	U		
v	118	1110110	76	21	v	12	v	21	V		
w	119	1110111	77	2F	w	1B	w	2F	W		
x	120	1111000	78	10	x	13	x	10	X		
y	121	1111001	79	3E	y	16	y	3E	Y		
z	122	1111010	7A	08	z	1E	z	08	Z		
{	123	1111011	7B	5B	SP	5B	SP	28	←		
|	124	1111100	7C	5B	SP	9F	|	A0	|		
}	125	1111101	7D	5B	SP	5B	SP	A8	→		
~	126	1111110	7E	5B	SP	5B	SP	98	~		
DEL	127	1111111	7F	57	Bksp	57	Bksp	57	Bksp		
				8B	¢	BF	¬	9F	⊥		
				A8	¼	98	¢	93	∩		
				28	½			92	⌊		
				80	±			9A	∊		
				00	1			B0	∇		
				A9	.u/c			9E	Δ		
				B3	,u/c			AB	ι		
								B8	∘		
								96	⎕		
								99	⊤		
								A6	○		
								A2	⍴		
								AE	⌈		
								91	↓		
								A1	∪		
								AF	⍵		
								90	⊃		
								BE	↑		
								88	⊂		
								89			

ASCII CODE				SELECTRIC CODES							
				#029		#963		#987		#	
Char.	Decimal Value	Binary Value	Hexadec. Address	Hex. Data	Sel. Char.	Hex. Data	Sel. Char.	Hex. Data	Sel. Char.	Hex. Data	Sel. Char.
NULL	0	0000000	00	FF		FF		FF			
SOH	1	0000001	01	FF		FF		FF			
STX	2	0000010	02	FF		FF		FF			
ETX	3	0000011	03	FF		FF		FF			
EOT	4	0000100	04	FF		FF		FF			
ENQ	5	0000101	05	FF		FF		FF			
ACK	6	0000110	06	FF		FF		FF			
BEL	7	0000111	07	FF		FF		FF			
BKSP	8	0001000	08	57	BkSp	57	BkSp	57	BkSp		
HTab	9	0001001	09	4F	Tab	4F	Tab	4F	Tab		
LF	10	0001010	0A	FF		FF		FF			
VTab	11	0001011	0B	5D	Index	5D	Ind.	5D	Ind.		
FF	12	0001100	0C	FF		FF		FF			
C/R	13	0001101	0D	5E	C/R	5E	C/R	5E	C/R		
SO	14	0001110	0E	FF		FF		FF			
SI	15	0001111	0F	FF		FF		FF			
DLE	16	0010000	10	FF		FF		FF			
DC1	17	0010001	11	FF		FF		FF			
DC2	18	0010010	12	FF		FF		FF			
DC3	19	0010011	13	FF		FF		FF			
DC4	20	0010100	14	FF		FF		FF			
NAK	21	0010101	15	FF		FF		FF			
SYNC	22	0010110	16	FF		FF		FF			
EBT	23	0010111	17	FF		FF		FF			
CAN	24	0011000	18	FF		FF		FF			
EM	25	0011001	19	FF		FF		FF			
SUB	26	0011010	1A	FF		FF		FF			
ESC	27	0011011	1B	FF		FF		FF			
FS	28	0011100	1C	FF		FF		FF			
GS	29	0011101	1D	FF		FF		FF			
RS	30	0011110	1E	FF		FF		FF			
US	31	0011111	1F	FF		FF		FF			
SPACE	32	0100000	20	5B	SP	5B	SP	5B	SP		
!	33	0100001	21	80	!	AF	!	5B	SP		
"	34	0100010	22	AA	"	8F	"	5B	SP		
#	35	0100011	23	81	#	OF	#	5B	SP		
$	36	0100100	24	86	$	2F	$	5B	SP		
%	37	0100101	25	8A	%	82	%	5B	SP		
&	38	0100110	26	82	&	38	&	A3	α		
'	39	0100111	27	2A	'	8B	'	9B	'		
(	40	0101000	28	8F	(	8E	(	B2	(		
)	41	0101001	29	8E	)	88	)	AA	)		
*	42	0101010	2A	83	*	86	*	BA	*		
+	43	0101011	2B	B9	+	B8	+	3F	+		
,	44	0101100	2C	33	,	1F	,	33	,		
-	45	0101101	2D	3F	-	28	-	BF	-		
.	46	0101110	2E	29	.	3F	.	29	.		
/	47	0101111	2F	36	/	10	/	36	/		
Ø	48	0110000	30	OE	O	08	0	OE	0		
1	49	0110001	31	16	1	00	1	00	1		
2	50	0110010	32	09	2	09	2	09	2		
3	51	0110011	33	01	3	01	3	01	3		
4	52	0110100	34	06	4	0A	4	06	4		
5	53	0110101	35	oA	5	02	5	0A	5		
6	54	0110110	36	0B	6	0B	6	0B	6		
7	55	0110111	37	02	7	03	7	02	7		
8	56	0111000	38	03	8	06	8	03	8		
9	57	0111001	39	0F	9	0E	9	0F	9		
:	58	0111010	3A	B2	:	8A	:	A9	:		
;	59	0111011	3B	32	;	81	;	B3	;		
<	60	0111100	3C	5B	SP	89	<	81	<		
=	61	0111101	3D	39	=	80	=	8A	=		
>	62	0111110	3E	5B	SP	83	>	82	>		
?	63	0111111	3F	B6	?	90	?	BB	?		
@	64	1000000	40	89	@	18	@	5B	SP		
A	65	1000001	41	A3	A	B0	A	23	A		
B	66	1000010	42	9F	B	B9	B	1F	B		
C	67	1000011	43	93	C	B1	C	13	C		
D	68	1000100	44	92	D	BA	D	12	D		
E	69	1000101	45	9A	E	B2	E	1A	E		
F	70	1000110	46	B1	F	BB	F	31	F		
G	71	1000111	47	B0	G	B3	G	30	G		
H	72	1001000	48	9E	H	B6	H	1E	H		

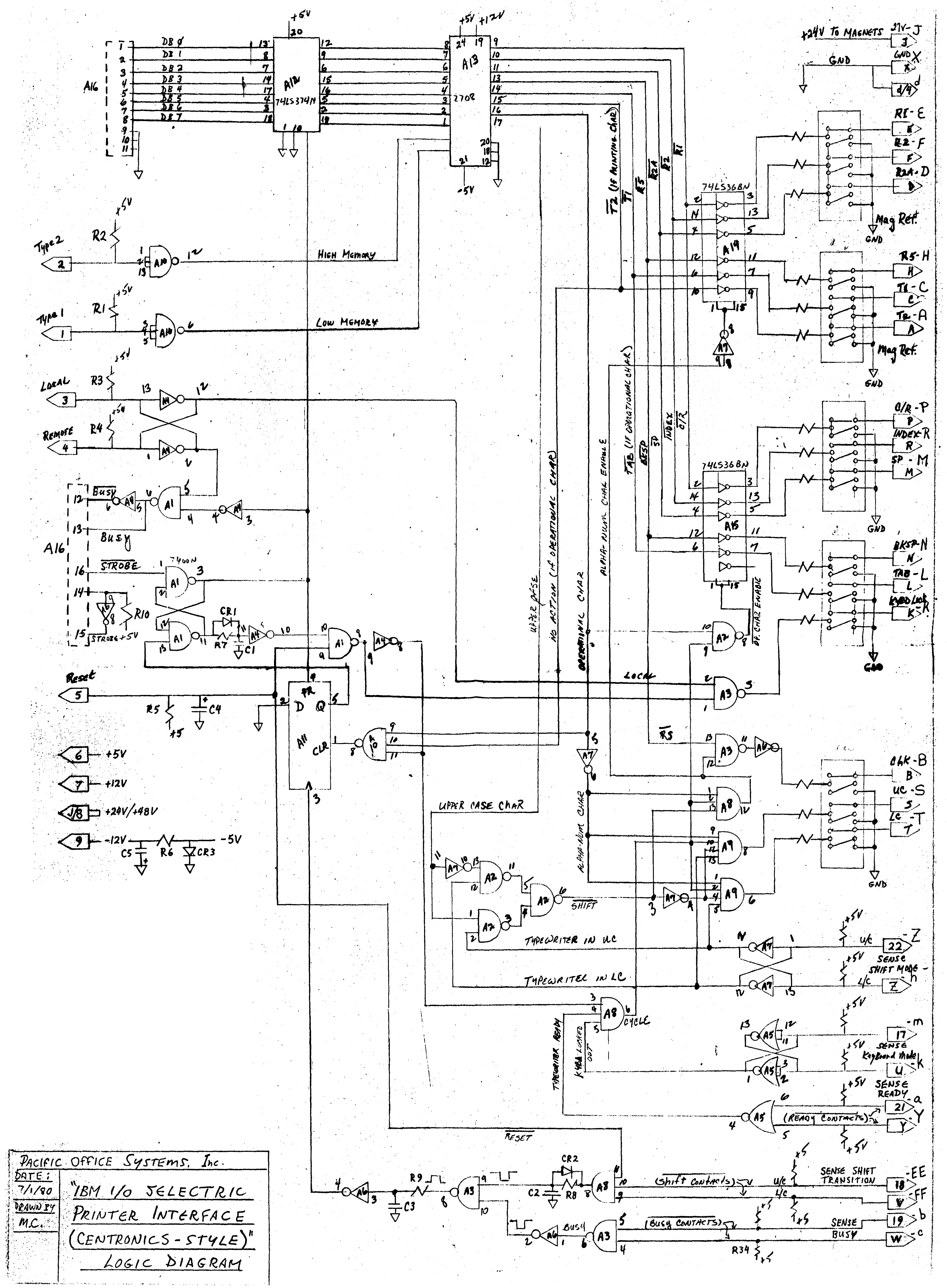

PACIFIC OFFICE SYSTEMS, Inc.
DATE: 7/1/80
DRAWN BY M.C.
"IBM I/O SELECTRIC PRINTER INTERFACE (CENTRONICS-STYLE)" LOGIC DIAGRAM
A16
A12 74LS374N
A13 2708
74LS368N
+24V TO MAGNETS
GND
Mag Ret.
High Memory
Low Memory
Type 2
Type 1
LOCAL
REMOTE
BUSY
STROBE
STROBE +5V
Reset
+5V
+12V
+24V/+48V
-12V
-5V
UPPER CASE CHAR
ALPHA-NUM CHAR
OPERATIONAL CHAR
NO ACTION (IF OPERATIONAL CHAR)
UPPER CASE
SHIFT
TYPEWRITER IN UC
TYPEWRITER IN LC
SENSE SHIFT MODE
CYCLE
TYPEWRITER READY
KYBD LOCKED OUT
SENSE KEYBOARD MODE
SENSE READY
(READY CONTACTS)
RESET
(SHIFT CONTACTS)
SENSE SHIFT TRANSITION
(BUSY CONTACTS)
SENSE BUSY

Figure 1-22 shows a block diagram of the 1971 power supply. The input is 115 volts or 208/230 volts 60 Hz ac. The outputs are: +48 volts dc, +12 volts dc and -12 volts dc. The +48 volts is used in the 1980 I/O printer. The +12 and -12 volts are used by the SLT electronics. The power supply also supplies the power-on reset, described in an earlier section.

Relay K1, besides providing Power On Reset, also sequences the power supply by causing both +12 and -12 volts to come up and power-on reset to occur before allowing 48 volts to be applied to the I/O magnets. This is accomplished by the K1-1 point.

Refer to FEMDM, page 0160, for the schematic of power supply.

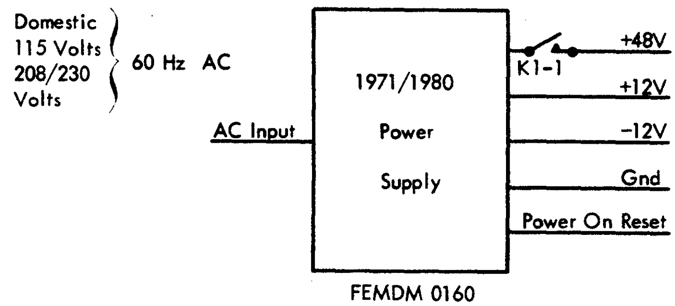
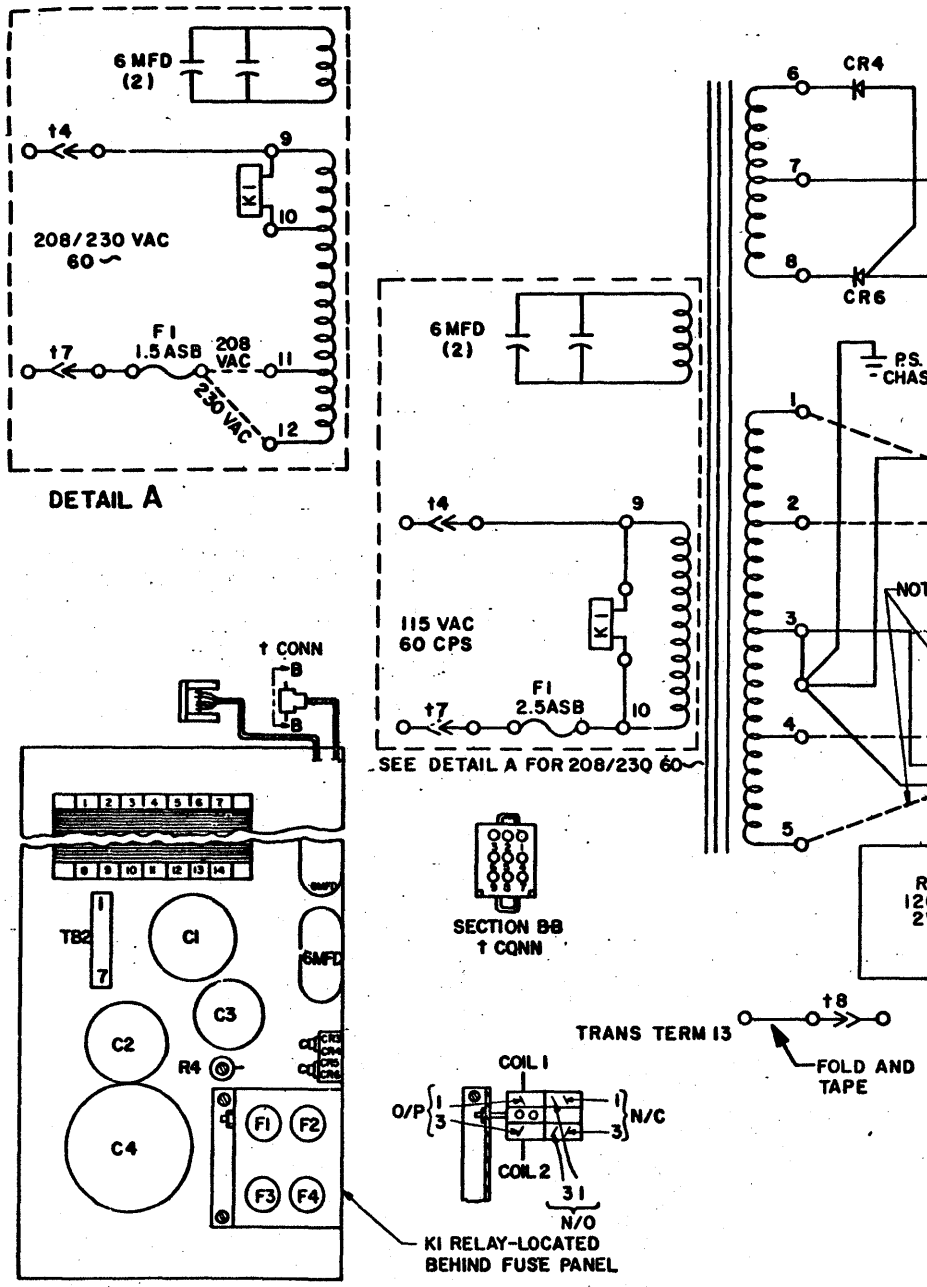
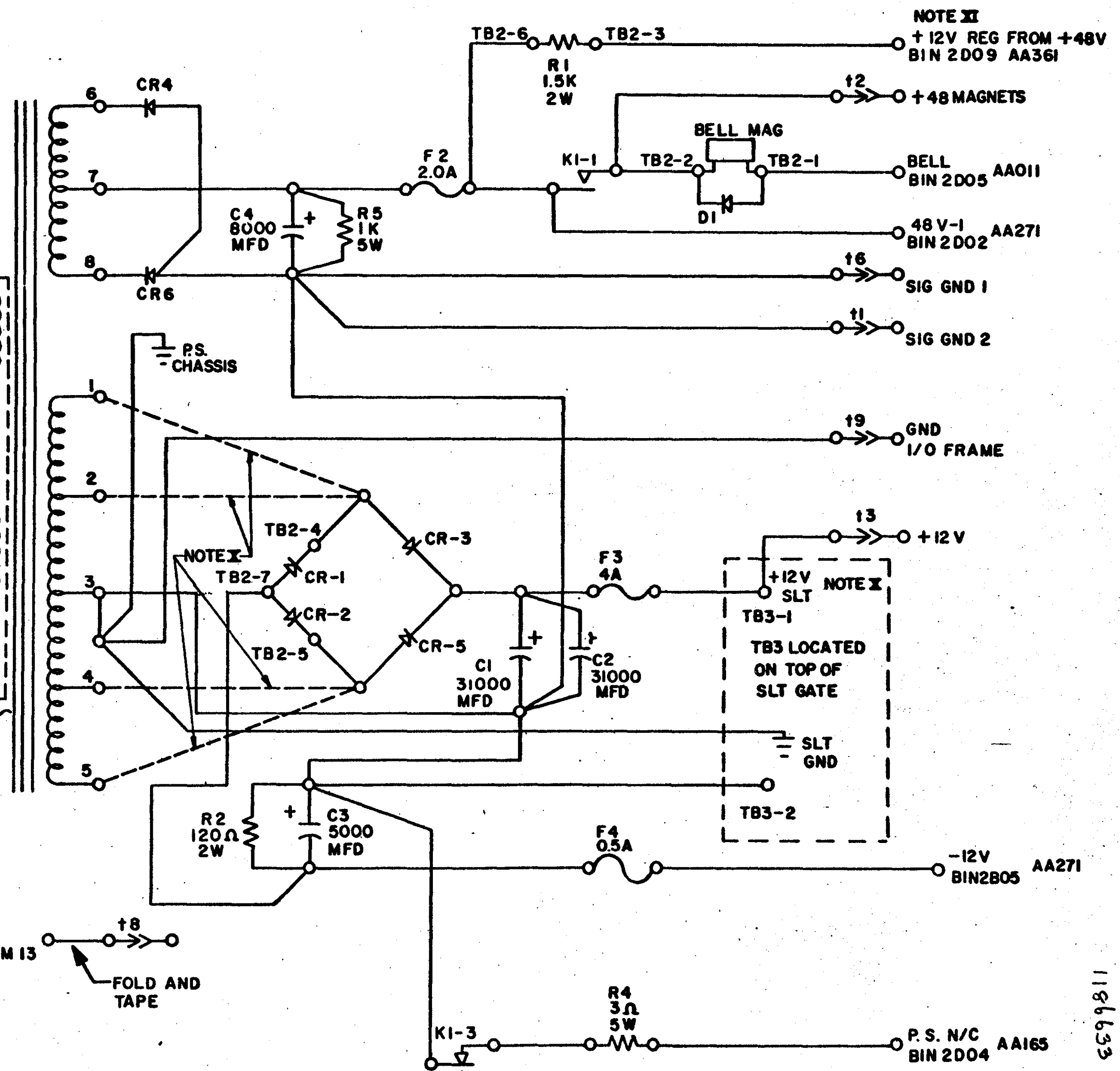


Figure 1-22. Power Supply





NOTE
X IF THE +12V SLT SUPPLY VOLTAGE IS BELOW +11.7V DC, CHANGE THE TRANSFORMER TAPS ON THE SECONDARY WINDING FROM POSITIONS 2 AND 4 TO POSITIONS 1 AND 5 IF NOT DONE ALREADY
XI +12V REG WILL BE +48V WHEN SLT CARD 5807368 IS USED

DATE	E.C. NO.	DATE	E.C. NO.	POWER SUPPLY SCHEMATIC
16 FEB 67	50688I-M			
AUG 67	306767			PART NO. 1186633 PAGE NO. 0100
DEC 67	306846			IBM 1971
JUN68	307158			

1186633

POW SUPP-0100

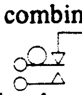
CORRESPONDENCE I/O WIRING
Contacts shown in their normal positions with all clutches latched and with shift cam detented in lower case.

Circuit Notes

1. Magnet common (pin "J") normally connected to Negative (Output).
2. Pin X normally connected to Negative for Input and feedback voltage.
3. Pins "n" and "y" must be externally connected to utilize C1 contact for gating. Terminal "n" should be used to control the state of a gating trigger to "y" if input current exceeds 300 ma.
4. Pins "a" and "b" offer optional access to the N/O or N/C side of the print and functional feedback contacts. Pin "b" provides a timing signal for the limiting of the magnet's energized period.

KEY
Alphebetic characters (A, a, etc.) correspond to AMP Connector positions.

Alpha Numeric combinations (a2, b2, etc.) are terminal block positions.



Indicates operation by cam or by other mechanical timing means.

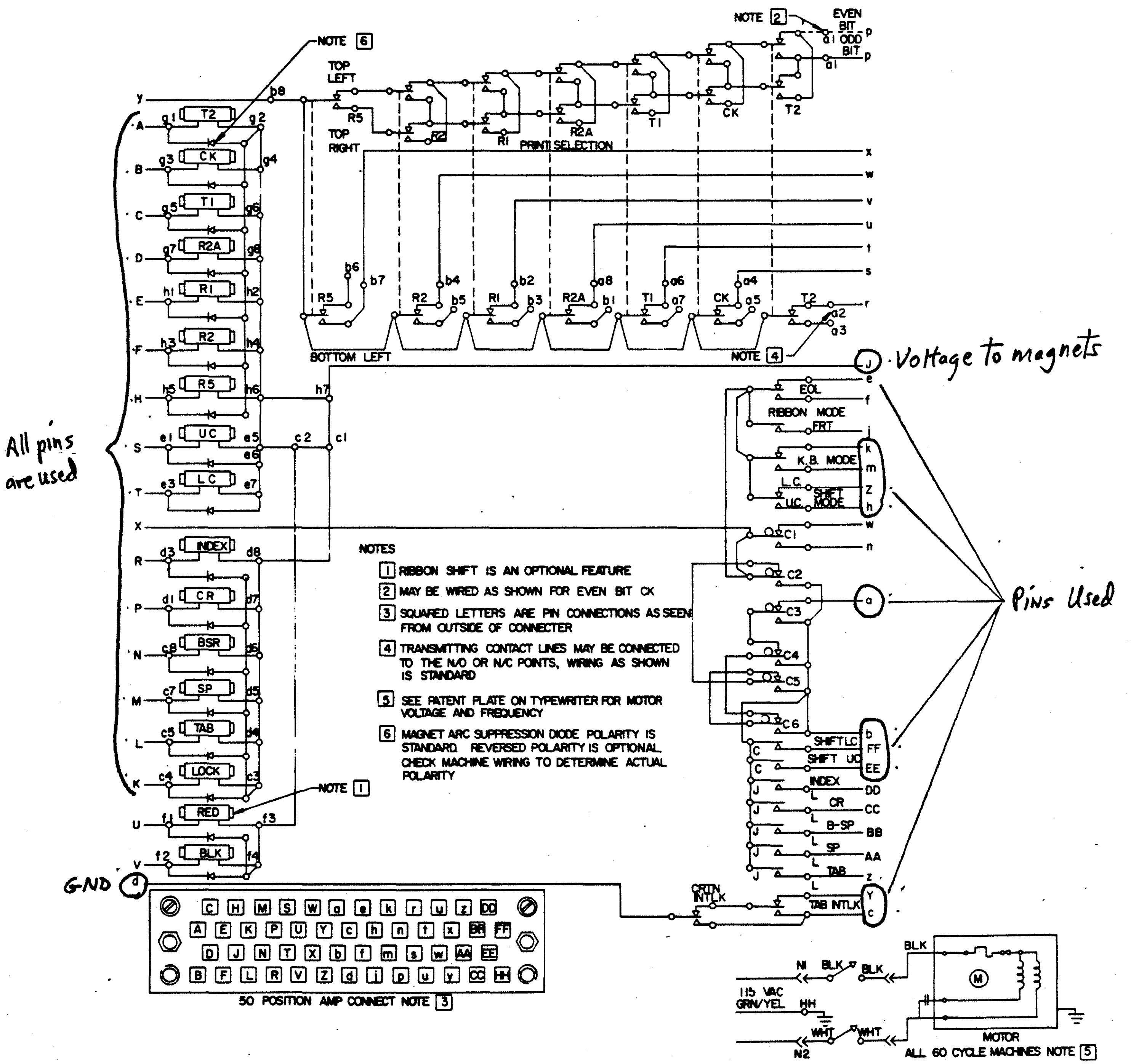


Figure 16 – Correspondence I/O Wiring

BCD I/O WIRING

Contacts shown in their normal positions with all clutches latched and with shift cam detented in lower case.

Circuit Notes –

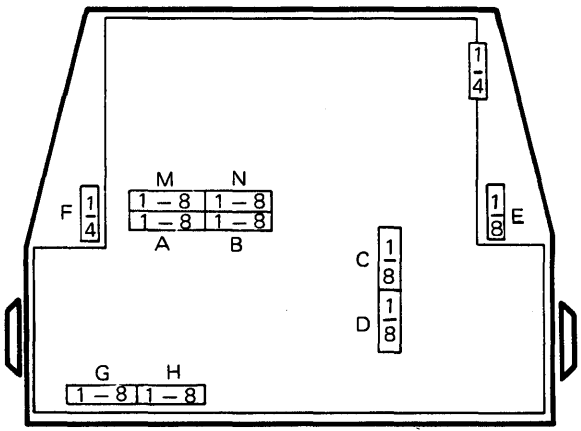
1. Magnet common (pin "J") normally connected to Negative (Output).
2. Pin X normally connected to Negative for Input and feedback voltage.
3. Pins "n" and "y" must be externally connected to utilize C1 contact for gating. Terminal "n" should be used to control the state of a gating trigger to "y" if input current exceeds 300ma.
4. Pins "a" and "b" offer optional access to the N/O or N/C side of the functional feedback contacts. Pin "b" provides a timing signal for the limiting of the magnet's energized period.
5. The Keyboard Lock Solenoid is offered as either "Energized" or "De-energized" keyboard lock. Option should be specified on order.

Key –

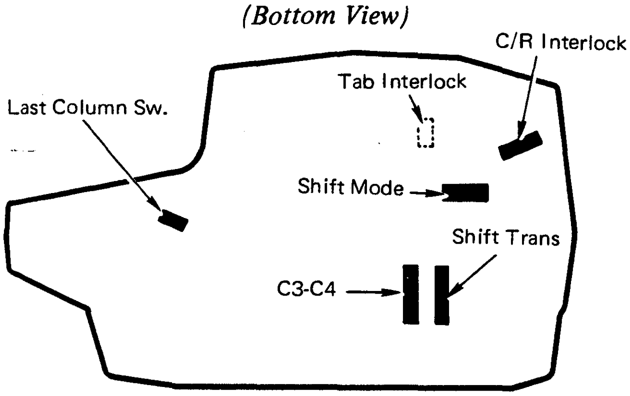
1. Alphabetic characters (A,a, etc.) correspond to AMP Connector positions.
2. Alpha Numeric combinations (a2,b2, etc.) are terminal block positions.

Indicates operation by cam or by other mechanical timing means.

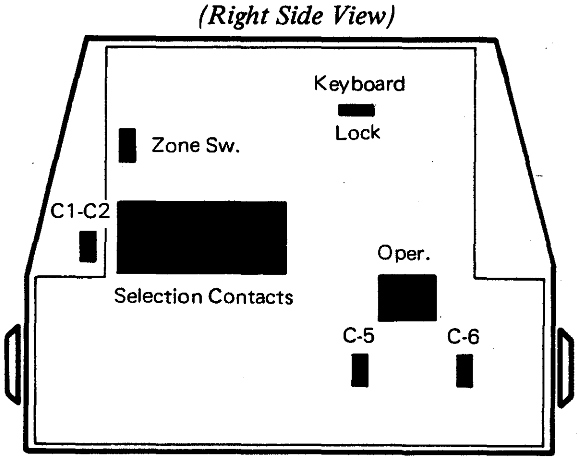
I/O CONTACT & TERMINAL BLOCK LOCATIONS



(Bottom View)



(Right Side View)



(Bottom View)

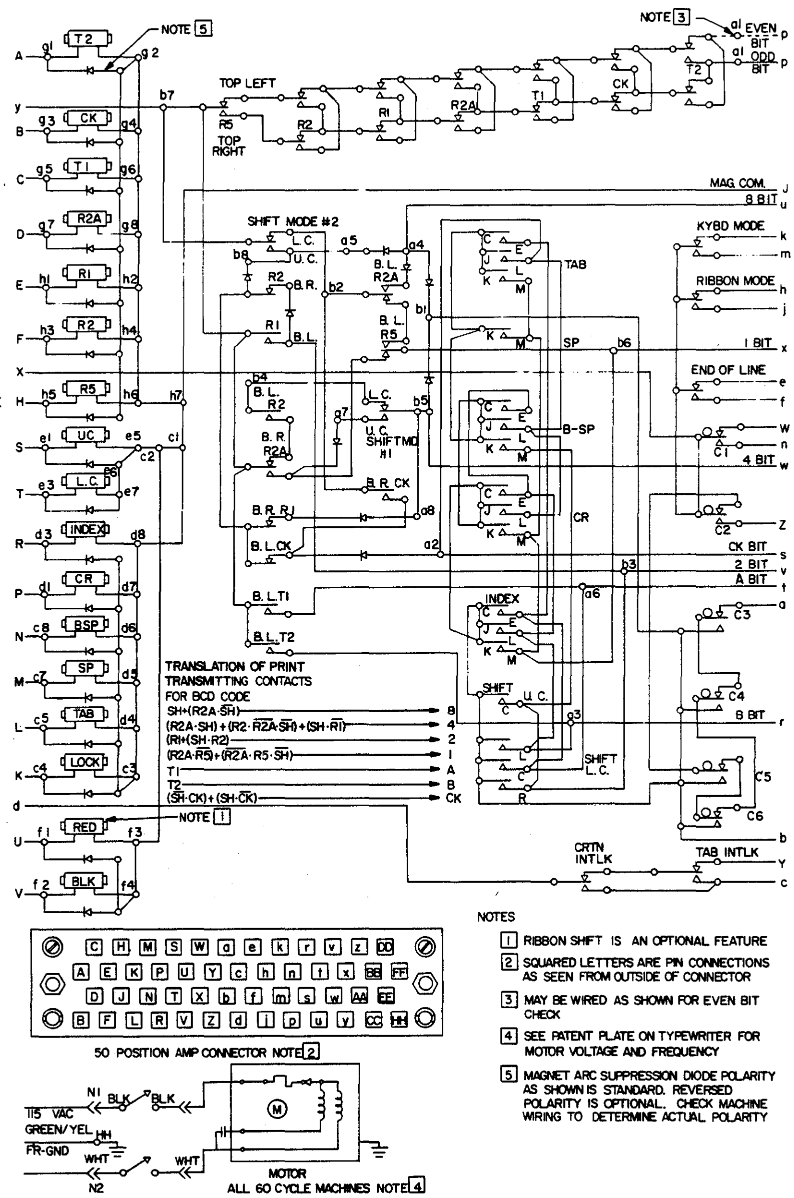


Figure 23 – BCD I/O Wiring, Contact And Terminal Block Locations

MT/ST-I/O CIRCUITRY

The circuitry for the MT/ST-I/O is a variation of the correspondence I/O. The following is a general explanation of the major differences.

Parity Contacts – Parity checking, in the MT/ST, is performed in the console. Therefore, the parity contacts are not installed in the I/O. On early level machines, the contacts were installed but were not connected.

Selection Transmit Contacts – The selection transmit contacts are connected so they complete a circuit when operated. The negative 5 contact is reversed. This is opposite to the correspondence machine where the selection transmit contacts "break" a circuit when operated.

Shift Contacts – The shift contacts will be discussed in three parts; shift mode contacts, transmit contacts, and feedback contacts.

Shift Mode Contacts – The MT/ST shift mode contact assembly (Figure 24) differs in that it includes a third set of contacts called shift mode 3. The purpose of shift mode 3 is to ensure a shift down operation if the output operation is stopped for any reason, other than power failure, while the I/O is still in upper case.

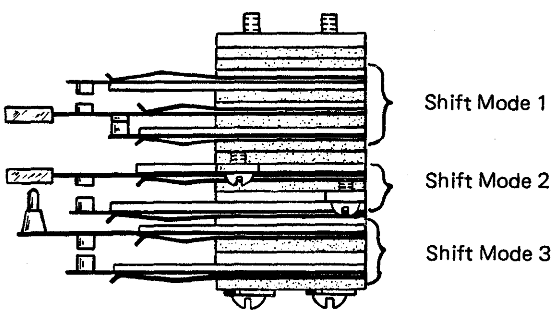


Figure 24

Shift Transmit Contacts – The shift transmit contacts have been eliminated. The MT/ST recognizes that a shift operation has taken place by constantly monitoring the shift mode contacts.

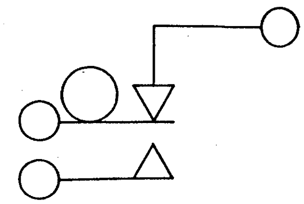
Feedback Contacts – The C-3 and C-4 feedback contacts have been eliminated on the MT/ST-I/O. Early level I/O's still have the feedback contacts installed, but the contacts may not be connected.

MT/ST-I/O WIRING

Key

Numeric characters (1, 2, etc.) correspond to AMP Connector Positions.

Alpha Numeric combinations (a2, b2, etc.) are terminal block positions.



Indicates Operation By Cam Or By Other Mechanical Timing Means

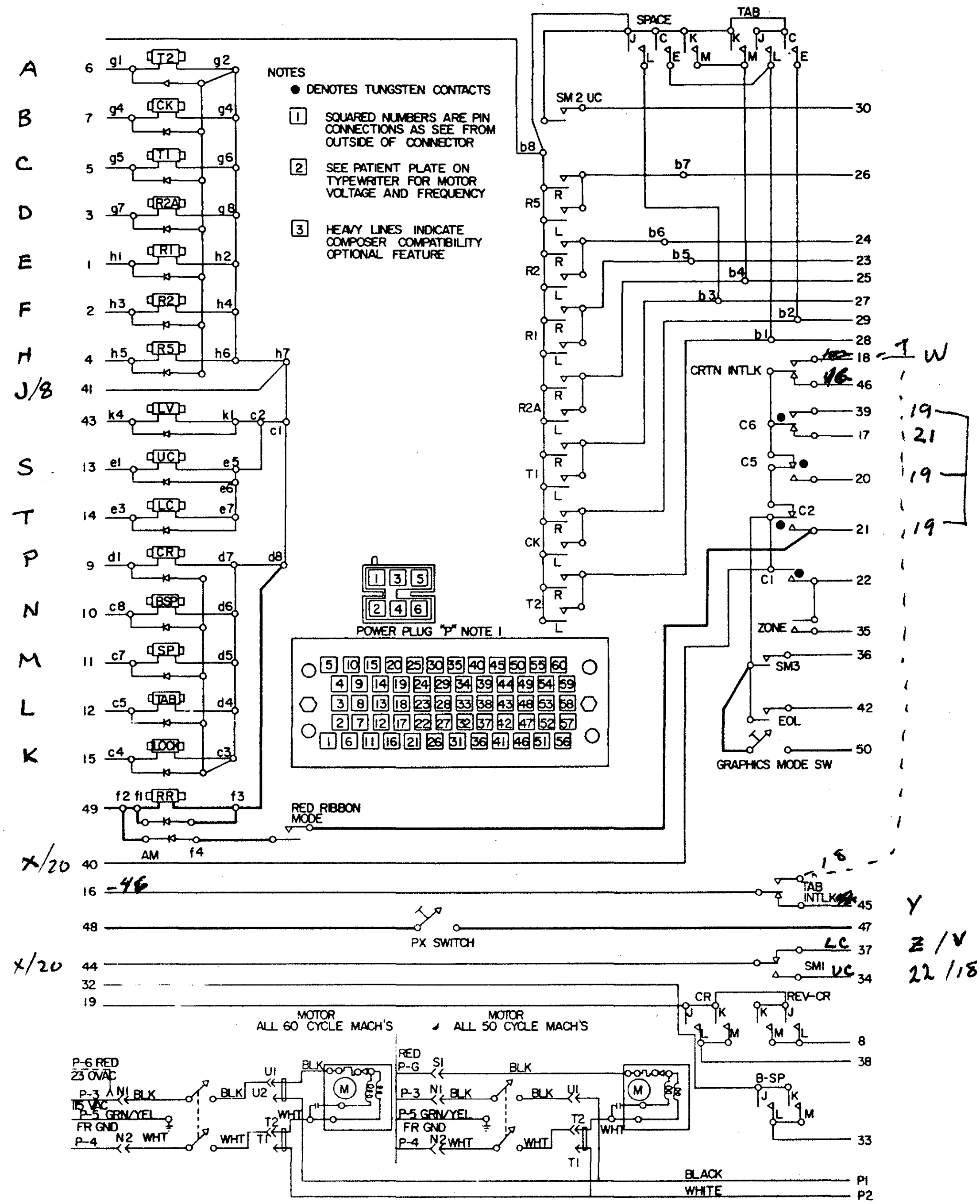


Figure 27 – MT/ST I/O Wiring