

8010B
8030B
ELECTRONIC COUNTER

DANA LABORATORIES, INC.
18912 VON KARMAN AVENUE
IRVINE, CALIFORNIA 92715



TELEPHONE (714) 833-1234
TELETYPE 910-595-1136
TELEX 678-341

PUBLICATION DATE: JUNE 1978

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Before undertaking any maintenance procedure, whether it be a specific troubleshooting or maintenance procedure described herein or an exploratory procedure aimed at determining whether there has been a malfunction, read the applicable section of this manual and note carefully the WARNING and CAUTION notices contained therein.

The equipment described in this manual contains voltages hazardous to human life and safety and which is capable of inflicting personal injury. The cautionary and warning notes are included in this manual to alert operator and maintenance personnel to the electrical hazards and thus prevent personal injury and damage to equipment.

If this instrument is to be powered from the AC Mains through an autotransformer (such as a Variac or equivalent) ensure that the instrument common connector is connected to the ground (earth) connection of the power mains.

Before operating the unit ensure that the protective conductor (green wire) is connected to the ground (earth) protective conductor of the power outlet. Do not defeat the protective feature of the third protective conductor in the power cord by using a two conductor extension cord or a three-prong/two-prong adapter.

Maintenance and calibration procedures contained in this manual sometimes call for operation of the unit with power applied and protective covers removed. Read the procedures carefully and heed Warnings to avoid "live" circuit points to ensure your personal safety.

Before operating this instrument.

1. Ensure that the instrument is configured to operate on the voltage available at the power source. See Installation section.
2. Ensure that the proper fuse is in place in the instrument for the power source on which the instrument is to be operated.
3. Ensure that all other devices connected to or in proximity to this instrument are properly grounded or connected to the protective third-wire earth ground.

ERRATA SHEET
MAY 1, 1976

1. Pages 5-20 through 5-37, Signal Flow schematics and assembly.

These drawings show Signal Flow only.

For correct values of components, and placement of parts on assembly drawing, refer to pages 6-4 through 6-7, schematic and assembly for the Switch board.

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SPECIFICATIONS

FREQUENCY MEASUREMENTS to 150 MHz	
Frequency Range: dc coupled:	0 to 150 MHz
ac coupled:	10 Hz to 150 MHz
Accuracy:	± 1 count \pm reference error
Input:	Channel A
Input Characteristics:	
Sensitivity*, sinewave:	50 mV rms to 100 MHz; 100 mV rms to 150 MHz
Sensitivity, pulse:	150 mV peak; 4 nsec minimum width
Impedance:	1 megohm shunted by 25 pF
Maximum input: (without damage)	250V rms or 300V peak on all ranges except 150V rms or 200V peak to 1 MHz on 1V range
Voltage ranges:	1, 10, 100 selectable
Trigger level:	Continuously adjustable to $\pm 300\%$ of input voltage range
Trigger slope:	+ or -, selectable
Preset condition:	0 trigger level
Measurement Time:	1 μ sec to 100 seconds, selectable in decade steps
Display:	8 digits (optional 9 digits), KHz or MHz
Self Check:	10 MHz

FREQUENCY MEASUREMENTS to 550 MHz (Model 8030B)	
Frequency Range: ac coupled:	1 MHz to 550 MHz
Accuracy:	± 1 count \pm reference error
Input:	Channel C
Input Characteristics:	
Sensitivity, sinewave:	50 mV rms (1 mV with optional 030 prescaler)
Impedance:	50 ohms nominal
Maximum Input: (operating)	1V rms
Maximum Input: (without damage)	5V rms
Automatic Gain Control:	26 dB without adjustment (60 dB with option 030)

*Derate 10 dB above 50 MHz if equipped with Option 010

TIME INTERVAL MEASUREMENTS	
Range:	100 nsec to 10^9 sec (10^{10} sec with option 004)
Resolution:	100 nsec
Accuracy:	± 1 count \pm reference error \pm trigger error*
Input:	
separate mode:	Channel A start and Channel B stop
common mode:	Channel A start and stop
Input Characteristics:	Channel A and B same as described in Frequency Ratio Mode
Display:	μ sec, msec, sec

TIME INTERVAL AVERAGE	
Range:	150 psec to 10 sec (100 sec with option 004)
Accuracy:	\pm reference error ± 2 nsec \pm (trigger error* ± 100 nsec) $\sqrt{\text{No. of Intervals Averaged}}$
Input:	same as time interval
Intervals Averaged:	1 to 10^8 , selectable in decade steps
Display:	nsec, μ sec
Min. Time between Stop & Start:	200 nsec

FREQUENCY RATIO MEASUREMENTS	
Frequency Range:	
Input F _A	0 to 150 MHz
Input F _B	0 to 10 MHz
Ratio Range:	10^{-8} to 10^8 (10^9 sec with option 004)
Multiplier:	F _B scaled by 1 to 10^9 selectable in decade steps
Accuracy:	± 1 count of F _A \pm trigger error of F _B multiplier
Display:	Dimensionless

*Trigger error $< \frac{0.0025 \mu\text{sec}}{\text{Signal Slope V}/\mu\text{sec}}$

SPECIFICATIONS continued

PERIOD MEASUREMENTS	
Range:	100 nsec to 10^9 sec (10^{10} sec with option 004)
Resolution:	100 nsec
Accuracy:	± 1 count \pm reference error \pm trigger error**
Input:	Channel A
Display:	μ sec, msec, and sec

PERIOD AVERAGE	
Range:	100 nsec to 10 sec (100 sec with option 004)
Accuracy:	± 1 count \pm reference error \pm $\frac{\text{trigger error}^{**}}{\text{No. of periods averaged}}$
Input:	Channel A
Periods Averaged:	1 to 10^8 selectable in decade steps
Display:	nsec, μ sec, msec

TOTALIZE MEASUREMENTS	
Frequency Range:	0 to 150 MHz
Input:	Channel A
Count Range:	0 to 10^8 (10^9 sec with option 004)
Accuracy:	± 1 count/gate

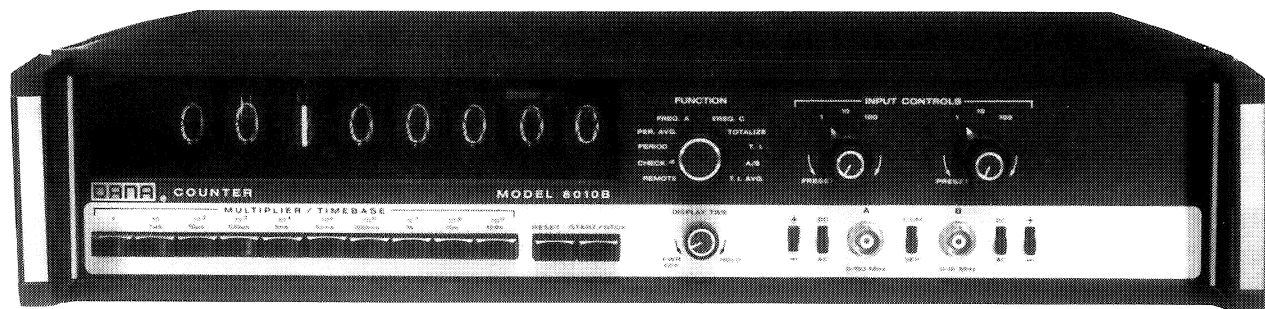
SCALING	
Frequency Range:	0 to 150 MHz
Scaling Range:	10 to 10^{10} selectable in decade steps

GENERAL SPECIFICATIONS	
Internal Reference Oscillator Characteristics:	
Aging Rate:	$< 3 \times 10^{-7}$ per month
Temperature Stability:	$\pm 2.5 \times 10^{-6}$, 0°C to $+50^\circ\text{C}$
Voltage Stability:	$\pm 1 \times 10^{-7}$, with 10% line voltage variation
Time Base:	.01 Hz to 10 MHz selectable in decade steps
Output:	10 MHz square wave, buffered, TTL compatible
External Reference:	1, 5, or 10 MHz 1V rms into 1 kilohm; selectable by internal/external switch
Marker Output:	Negative-going pulse, 15 volt amplitude, rear BNC, duration equal to channel A trigger point to channel B trigger point
Display:	Long-life digital display tubes; 8 standard, 9 optional (option 004)
Input/Output Connectors:	BNC
Operating Temperature:	0° to 50°C
Line Voltage:	50 Hz to 400 Hz; $115\text{V} \pm 10\%$
Power Requirement:	60 watts maximum
Weight:	Net, 15 pounds; shipping, 20 pounds
Dimensions: (HxWxD)	3-15/32 x 16-3/4 x 14 inches; 88 x 425 x 356 millimeters

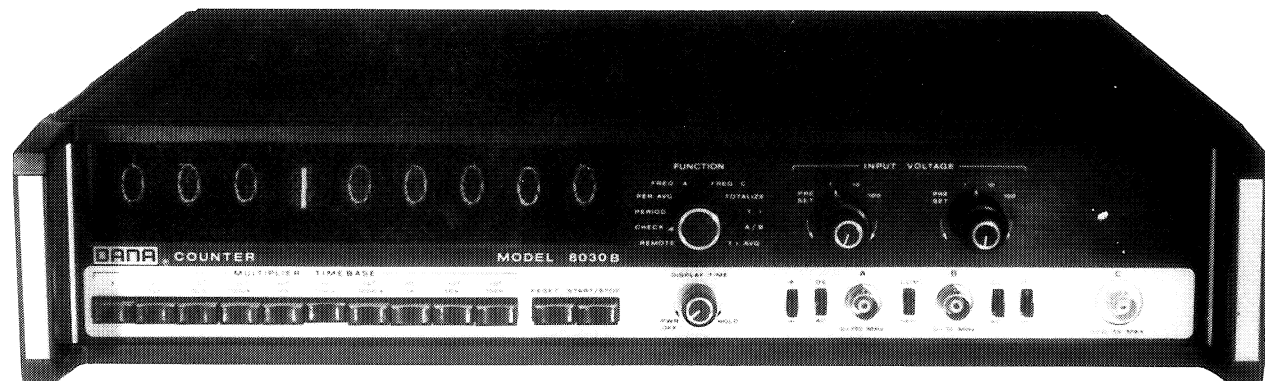
$$**\text{Trigger error} \leq \frac{0.3}{(S/N)Fa}$$

where S/N equals signal to noise ratio and Fa equals frequency.

OSCILLATOR OPTIONS			
	Option 050	Option 200	Option 300
Aging Rate/day:	—	1×10^{-9}	5×10^{-10}
Aging Rate/month:	1×10^{-7}	3×10^{-8}	1.5×10^{-8}
Temperature Stability, 0° to 50°C:	$\pm 5 \times 10^{-7}$	$\pm 5 \times 10^{-9}$	$\pm 5 \times 10^{-9}$
±10% line voltage stability:	$\pm 5 \times 10^{-8}$	$\pm 5 \times 10^{-9}$	$\pm 5 \times 10^{-9}$
Warmup*:	1 hour	72 hours	96 hours
*Time to reach aging specification after 24 hours off.			



8010B



8030B

Figure 1.1 - Models 8010B and 8030B

SECTION 1

GENERAL DESCRIPTION

1.1 SCOPE.

1.2 This manual contains installation, operation, and maintenance instructions for the Dana Models 8010B, 8020B, and 8030B electronic counters (figure 1.1). All models and optional features are covered; therefore, all descriptions may not apply to a particular instrument.

1.3 GENERAL DESCRIPTION.

1.4 Each model in the 8000B Series is self-contained for its intended range of applications. No external or plug-in accessories are required. All models have a minimum of four measurement modes: Frequency, Period, Multiple Period Average, and Totalize. Additional measurement modes of Time Interval, Time Interval Average, and Frequency Ratio are available in certain models. All models operate at frequencies up to 150 MHz. The Model 8030B operates at RF frequencies. The capability of each model is shown in table 1.1.

1.5 An eight digit display and a high stability reference oscillator provides the standard counter with capability to make meaningful frequency measurements to an accuracy up to 1 part in 10^8 . For more demanding applications, a nine digit display and correspondingly higher stability reference oscillators, are available as options.

1.6 The standard temperature compensated crystal oscillator (TCXO) in the counter serves as an ideal reference in a general purpose counter. The average aging rate is 3×10^{-7} per month. Since no temperature controlled oven is used, extended warmup times are not required when moving the counter from one location to another.

1.7 Time Interval Measurements.

1.8 The use of low noise FET input circuitry provides 50 millivolt sensitivity to 100 MHz with a constant 1 megohm input impedance on both the start and stop input channels. The input circuitry includes a three-position attenuator and controls for: trigger level, slope, and coupling, so that triggering can be optimized for non-sinusoidal waveforms.

1.9 Because of high stability input amplifiers, trigger levels will drift less than 5% of full scale over a 10°C temperature range and 200 hours of operating time after initial setting. Frequency adjustments to the counter are not necessary during the instrument warmup period or when changes in temperature occur.

1.10 While making a time interval measurement, it is often useful to observe the waveform under test with an oscilloscope. The counter's marker output may be connected to most oscilloscopes to provide a continuous brightening of that portion of the waveform between the start measurement point and the stop point.

1.11 With time interval average capability in the 8010B and 8030B, measurement accuracy and resolution can be improved when measuring repetitive signals. Propagation delays through integrated circuits can be measured to accuracies better than 150 ps when input signal is asynchronous with respect to the counter timebase.

1.12 Two analog outputs are provided on all models with time interval capability for accurately monitoring trigger level settings. The 50% point and 10% - 90% rise time points can be set accurately by measuring the analog voltage outputs with a digital voltmeter.

Table 1.1 - Measurement Capability

Model	Totalize	Period	Period Average	Freq to 150 MHz	Freq to 550 MHz	Ratio	Time Interval	Time Interval Average
8010B	X	X	X	X		X	X	X
8030B	X	X	X	X	X	X	X	X

1.13 RF Measurements.

1.14 The Model 8030B has RF measurement capability. This counter features RF amplifiers capable of meaningful measurements as low as 50 mV with the standard prescaler, or as low as 1 mV (-47 dBm) with an optional prescaler (Option 030). Low level, RF signals can therefore be measured without external amplification.

1.15 To measure frequencies between 1 and 550 MHz, the operator simply connects the unknown signal to the input and reads the result. By using a prescaler, both the need for manual tuning and possibility of an incorrect setting have been eliminated. Triggering is automatically optimized for input signal amplitude from 50 millivolts to one volt with the standard prescaler, or from 1 mV to 1 volt with an optional prescaler.

1.16 A wide-band automatic gain control, coupled with excellent sensitivity, enable the carrier frequency of an amplitude modulated signal to be measured. Full accuracy is maintained with greater than 90% amplitude modulation (99% with optional prescaler). Frequency modulated carriers can also be measured as long as the frequency components are within the 1 to 550 MHz bandwidth.

1.17 The Model 8030B is equipped with a 550 MHz prescaler. The prescaler maintains the stability and accuracy of the basic 150 MHz counter at radio frequencies. Only 40 milliseconds are required to measure 550 MHz to a resolution of 2 parts in 10^{-7} . This fast measurement time is due to the prescaler's capability to divide the input signal and multiply the measurement time by four.

1.18 OPTIONS.

1.19 All options on the 8000B Series counters should be ordered at the time of purchase. However, the Option 030 RF prescaler (1 mV sensitivity, 10 MHz to 500 MHz) and the Rack Mount Adaptor may be added at anytime.

1.20 Rack Mounting Adaptors, Option 003.

1.21 Rack mounting adaptors are used where the instrument is to be installed in a relay-rack or cabinet.

1.22 Ninth-Digit Readout, Option 004.

1.23 The 9th Digit Readout adds one more digit to the eight digit counter. The 9th Digit increases the accuracy to 1 part in 10^9 .

1.24 Systems Interface, Options 008/009.

1.25 The systems interface, which includes BCD and remote programming input, is available for all counters. The Option 008 features single line control of function, time base, external gate, +/- slope, hold, and reset and provides analog control of trigger level. The Option 009 features BCD encoded commands for control of function, time base, channel range and trigger level and provides single line control of external gate, +/- slope, hold, reset, separate/common, and ac/dc. Analog control of trigger level is also provided.

1.26 All remote programming and BCD outputs are compatible with TTL logic levels. This allows the Series 8000B counters to be interfaced directly to control and recording devices without requiring level shifting and buffer circuitry. The operation and installation of the options is described in the 008/009 Interface Manual 980469.

1.27 Rear Input, Option 010.

1.28 The Rear Input provides the user a rear-panel connector for Frequency A, Frequency B and Frequency C (not in Model 8010B) input signals. The Rear Input option reduces the sensitivity of Frequency A 10 dB above 50 MHz.

1.29 Prescaler (1 mV Sensitivity, 10 MHz to 500 MHz), Option 030.

1.30 The Option 030 Prescaler is available on the Model 8030B. It replaces the standard Prescaler and offers sensitivity as low as 1 mV (-47 dBm). Maximum usable input is 1 volt rms and 5V rms without damage to the prescaler.

1.31 TCXO, Option 050.

1.32 The Option 050 Temperature-Compensated Crystal Oscillator offers a lower aging rate per month, and better voltage and temperature stability than the standard TCXO oscillator.

1.33 Oven Oscillator, Option 200 & 300.

1.34 The Option 200 oven oscillator provides an ultra-stable timebase - extending the time between calibrations and serving as a secondary frequency standard. The oven oscillator is in continuous operation whenever the counter is attached to the power line. The Option 300 is the same as the Option 200 with half the aging rate.

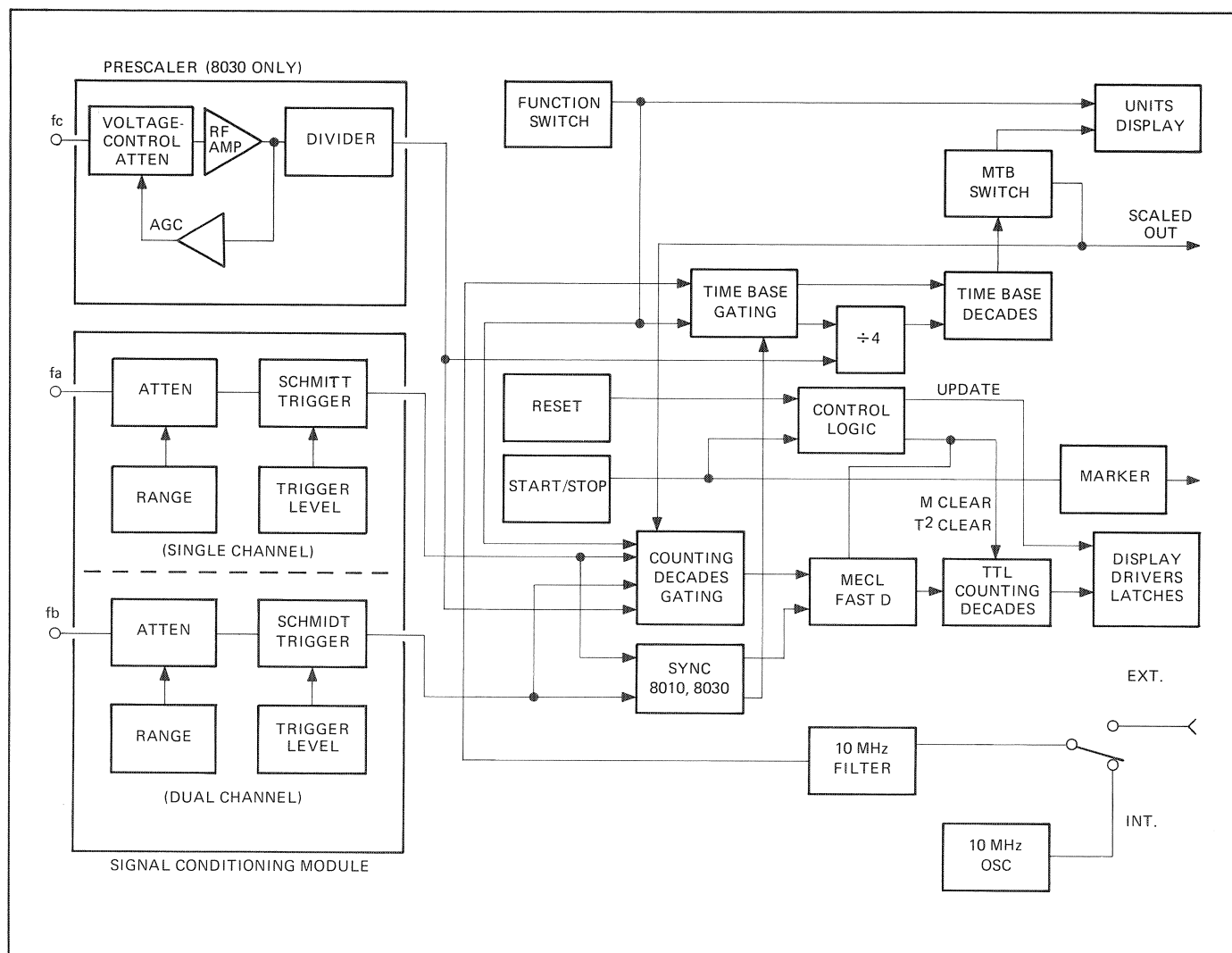


Figure 1.2 - Block Diagram

1.35 ELECTRICAL DESCRIPTION.

1.36 A basic block diagram of the instrument is shown in figure 1.2. Input channels A and B are identical through the attenuator and signal conditioning amplifiers. The input is routed through the BNC input connectors and through the AC/DC coupling switch to the attenuator. The attenuator has three positions: X1 range, X10 range, and X100 range. The attenuator output is applied to the signal conditioning amplifier through an overload circuit that protects the circuitry if an "overload" voltage is applied.

1.37 The signal conditioning amplifier is a low-drift decoupled Schmitt trigger circuit. Any point on the input waveform can be selected to trigger the Schmitt circuit by front panel controls: the +/- switch selects either positive or negative slope and the INPUT CONTROLS select the amplitude. Output pulses generated by the Schmitt trigger circuit are applied to the Steering Logic and to the Marker Generator.

1.38 The Marker circuit provides a marker pulse used to intensity-modulate an oscilloscope display. It starts when channel A triggers and terminates when channel B triggers. The pulse represents a precise measurement of the time between channel A and channel B. The oscilloscope trace displays the point where the time measurement starts and terminates. The trigger levels can be adjusted very accurately with the use of the oscilloscope.

1.39 Frequency C (except in Model 8010B) is applied directly to the Prescaler that contains a voltage-controlled attenuator (VCA), RF amplifier, and two high frequency divide-by-two circuits. The dividers scale the input frequency by a factor of four. This is necessary to reduce the frequency to that acceptable by the ECL logic. The voltage-controlled attenuator and RF amplifiers combine to provide automatic ranging over input amplitude variations of 60 dB throughout the operating frequency.

**Table 1.2 - Logic Functions of Multiplier
Timebase (M/TB) Per Mode**

Mode of Operation	Function of MTB switches
Frequency A	Selects gate time
Frequency C	Selects gate time
Period	Selects reference frequency to be counted
Period Average	Selects number of periods to be averaged
Time Interval	Selects the reference frequency to be counted during the time interval A to B
Time Interval Average	Selects number of periods to be averaged
Ratio A/B	Selects number of periods of channel B input to be used as the gate time
Self Test	Selects gate time

1.40 Reference Conditioning receives a reference frequency from either the internal reference oscillator or from the External Reference input. External reference inputs of 1 MHz, 5 MHz, or 10 MHz are buffered, amplified, and applied to a Schmitt trigger circuit to produce harmonics at 10 MHz. A filter rejects frequencies other than 10 MHz. The reference signal is passed on to the digital logic section.

1.41 The counting and multiplier timebase steering logic routes the inputs to the proper set of decades corresponding to the selected operating mode of the instrument. It "steers" the inputs upon commands from the FUNCTION switch.

1.42 Signals to the Control Logic Section are generated by logic in the following blocks in figure 1.2: Multiplier/Timebase (M/TB) Decades and Start/Stop Logic. The M/TB Decades consist of eight TTL decade counters which, together with Start/Stop Logic, inputs from the Steering Logic, M/TB switches on front panel, and the function switch, control operation of the Control Logic. The circuits combine to perform the functions listed in table 1.3 for each operating mode. The M/TB Decades supply a scaled output to a rear panel connector in the Totalize mode. The output is $1/10N \times$ input frequency, where N is the Multiplier setting on the front panel.

1.43 The M/TB switch and the FUNCTION switch operates in conjunction with the Decimal Point Logic and Units Logic to provide proper annunciators and decimal point locations. They also control other logic contributing to the functions listed in table 1.2.

1.44 Timing of the counter is governed by the Control Logic. After the counter is "armed", it opens the Gate upon command of the Start/Stop Logic. After the Gate goes low, two additional pulses are generated: a Prop-Delay (proper delay) pulse and a Display Time pulse. The Prop-Delay allows for settling time of the accumulated count in the counter decades before Update and Print commands are generated. The Display Time pulse, with width determined by the front panel DISPLAY TIME control, controls the length of time that the accumulated count is displayed before the decades are cleared in preparation for a new count.

1.45 The DISPLAY TIME control on the front panel performs three functions. The CCW position removes power from the display tubes and disables the $\pm 18V$ and $+5V$ supplies. The CW position HOLD allows the meter to hold a measured count indefinitely. Mid-range of the control provides a continuously variable sample rate from 30 msec to over 5 seconds.

1.46 The STORAGE Switch is a two-position switch (storage-off, storage-on) located on the rear panel. When the switch is in the ON position, the display is continuous and changes only when the measurement is different from that counted during the previous measurement cycle. The OFF position disables the display storage so that the accumulation of the count can be observed by the operator. The RESET switch on the front panel enables the operator to start a new measurement cycle.

1.47 The START/STOP switch on the front panel manually generates the Start/Stop commands to the main gate. This switch is used in Totalize mode.

1.48 The Readout assembly is made up of eight in-line display devices with decimal inputs, five annunciator lamps and a main gate annunciator. The count is displayed by the display devices with correctly positioned decimal points and annunciator indicators (nsec, μ sec, sec, KHz, and MHz). The gate annunciator indicates the opening and closing of the main gate.

1.49 The counting decades consist of one high-speed decade made up of ECL (emitter-coupled-logic) and seven TTL decade counters. Each decade applies the accumulated count data in BCD format to the Latches and Drivers. The latches are D-type flip-flops which can store a count for an indefinite period of time. When the STORAGE switch is on, the display is continuous and changes only when the measurement is different from that counted during the previous measurement time. The drivers are BCD-to-ten-line decoders that provide a decoded decimal output to light the corresponding numeral on the readout tube.

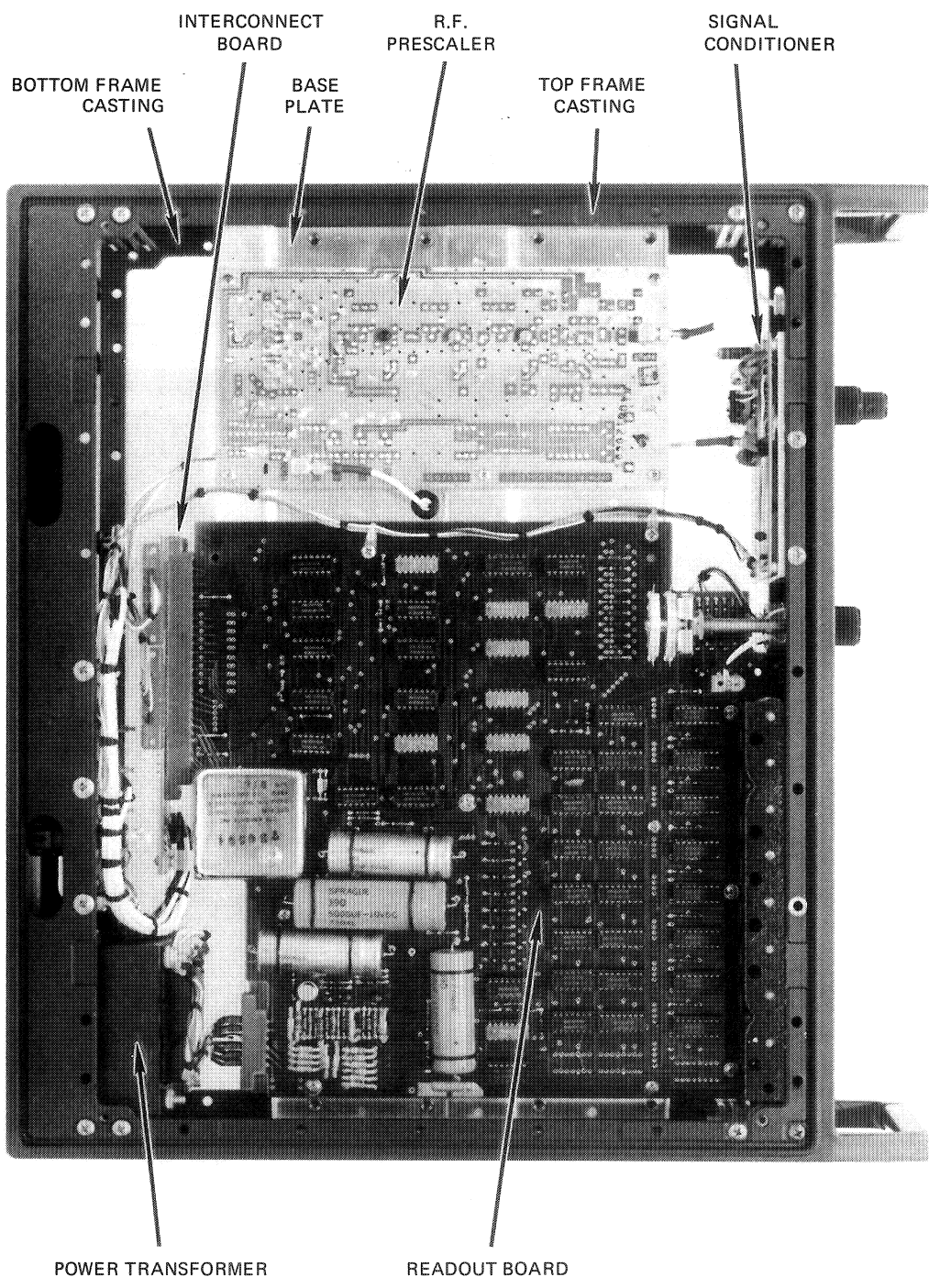


Figure 1.3 - Top View

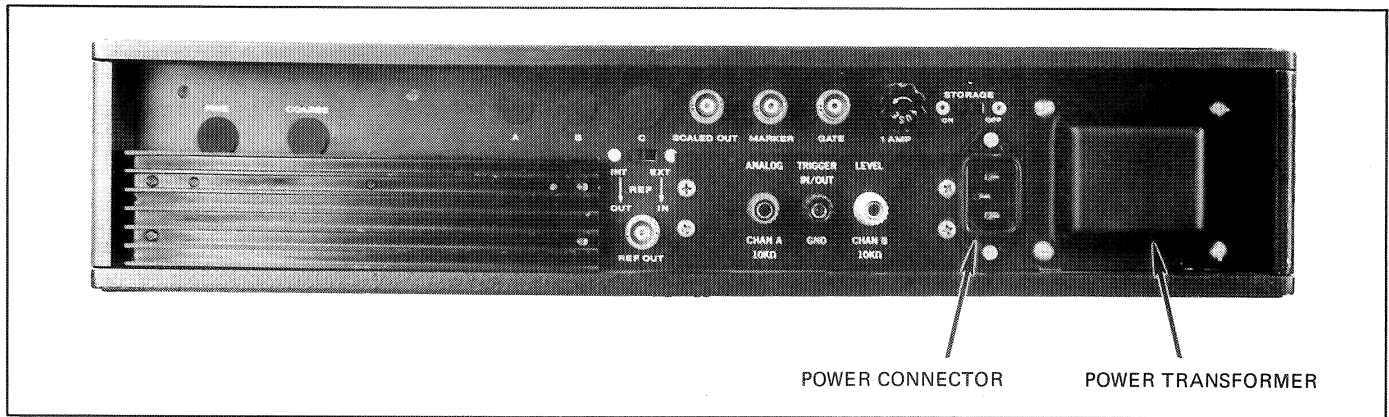


Figure 1.4 - Rear Panel

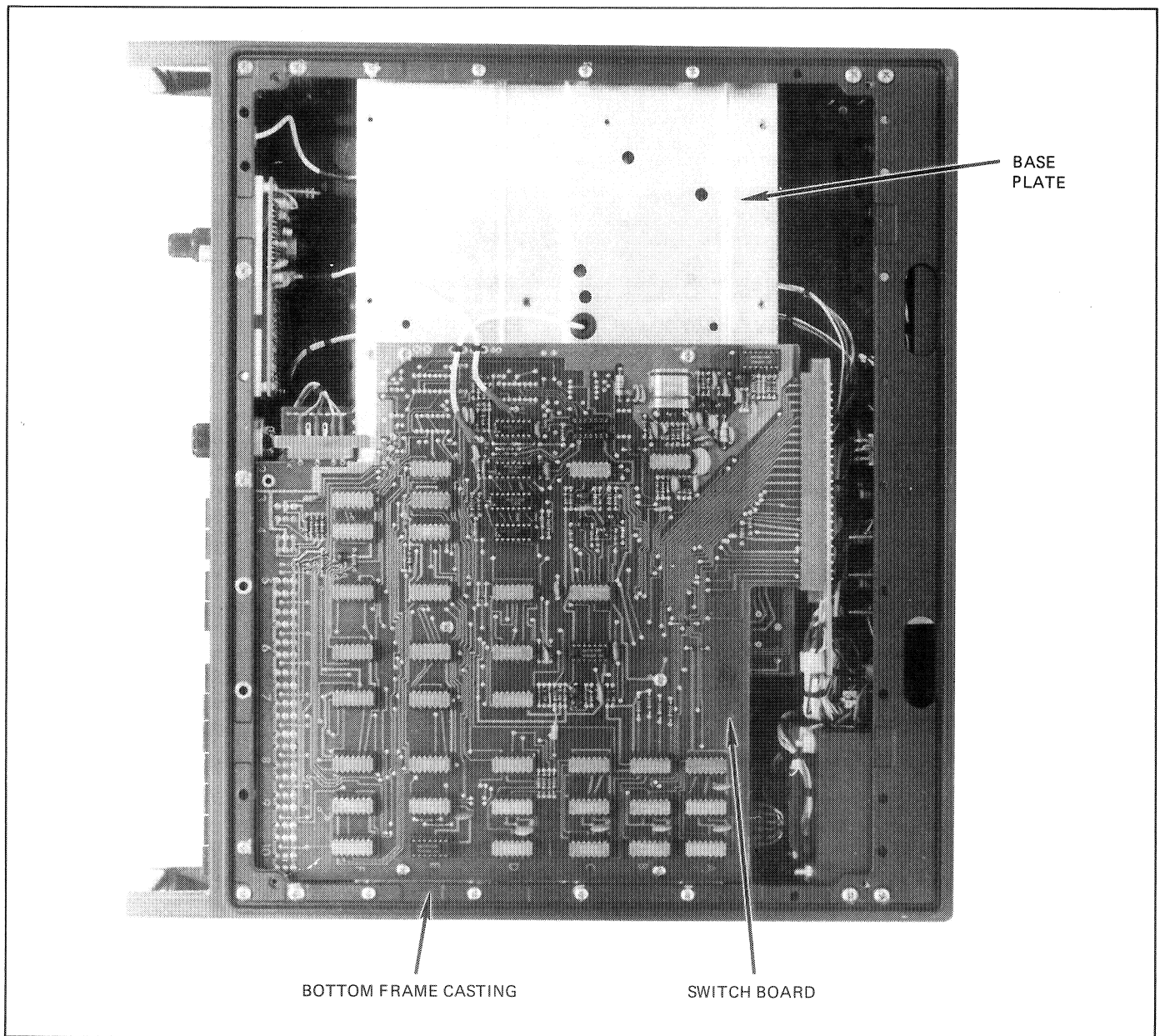


Figure 1.5 - Bottom View

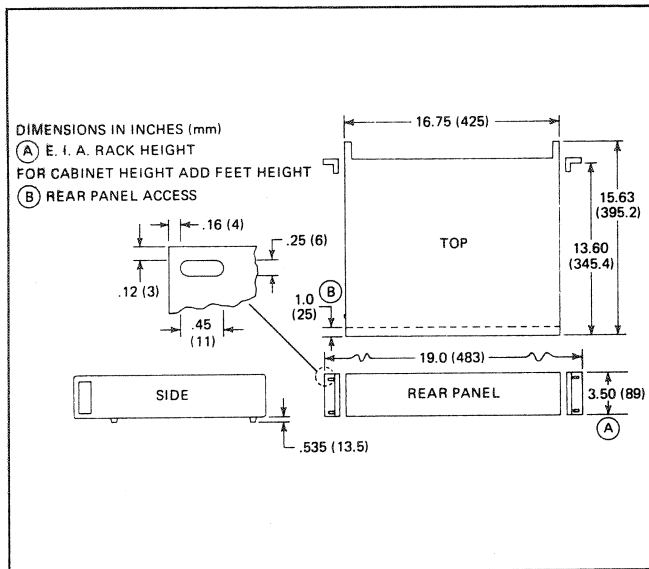


Figure 1.6 - Dimensions

1.50 MECHANICAL DESCRIPTION.

1.51 A top view of the counter is shown in figure 1.3. The counter shown (8030B) is equipped with the RF pre-scaler mounted on the base plate. The Readout board is mounted on the top of the base plate. The Interconnect board connects the Readout board and the Switch board together electrically at the rear of the Readout and Switch board. The signal conditioner is attached to the front panel. The power transformer and rear panel are one assembly. The rear panel (figure 1.4) assembly is clamped between the top and bottom frame castings.

1.52 The bottom view of the counter is shown in figure 1.5. The Switch board is mounted on the base plate. The base plate is attached to the bottom frame casting.

1.53 A dimensional outline of the 8000B series counter is shown in figure 1.6.