PUBLICATION NO. 980448

8010B
8030B
ELECTRONIC COUNTER

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

DANA®

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

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WARRANTY

Within one year of purchase, Dana Laboratories will repair or replace your instrument, at our option, if in any way it is defective in material or workmanship. All parts and labor charges will be paid by Dana Laboratories. Just call Dana Product Service at (714)833-1234 collect in California, for assistance. We will advise the proper shipping address for your prepaid shipment. Your instrument will be returned to you freight prepaid.

PROPRIETARY NOTICE

FOR YOUR SAFETY

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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FREQUENCY MEASUREMENTS to 150 MHz	
Frequency Range:	
dc coupled:	0 to 150 MHz
ac coupled:	10 Hz to 150 MHz
Accuracy:	±1 count ±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 ±300% of input voltage range
Trigger slope:	+ or −, selectable
Preset condition:	0 trigger level
Measurement Time:	1 μsec 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 ±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 ±reference error ±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:	μsec, msec, sec

TIME INTERVAL AVERAGE	
Range:	150 psec to 10 sec (100 sec with option 004)
Accuracy:	$\pm$reference error ± 2 nsec $\pm \frac{(\text{trigger error}^* \pm 100\text{ nsec})}{\sqrt{\text{No. of Intervals Averaged}}}$
Input:	same as time interval
Intervals Averaged:	1 to 10^8, selectable in decade steps
Display:	nsec, μsec
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 ± $\frac{\text{trigger error of } F_B}{\text{multiplier}}$
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 ±reference error ±trigger error**
Input:	Channel A
Display:	μsec, msec, and sec

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

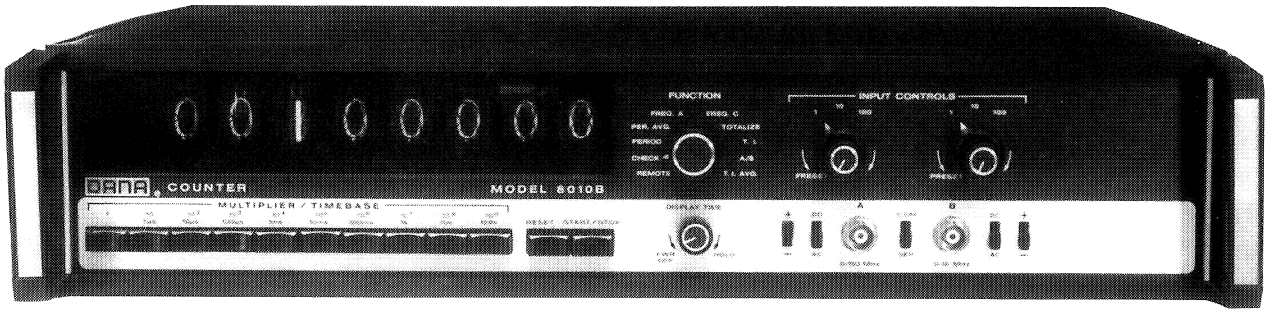
SCALING	
Frequency Range:	0 to 150 MHz
Scaling Range:	10 to 10^{10} selectable in decade steps

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°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; 115V ± 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

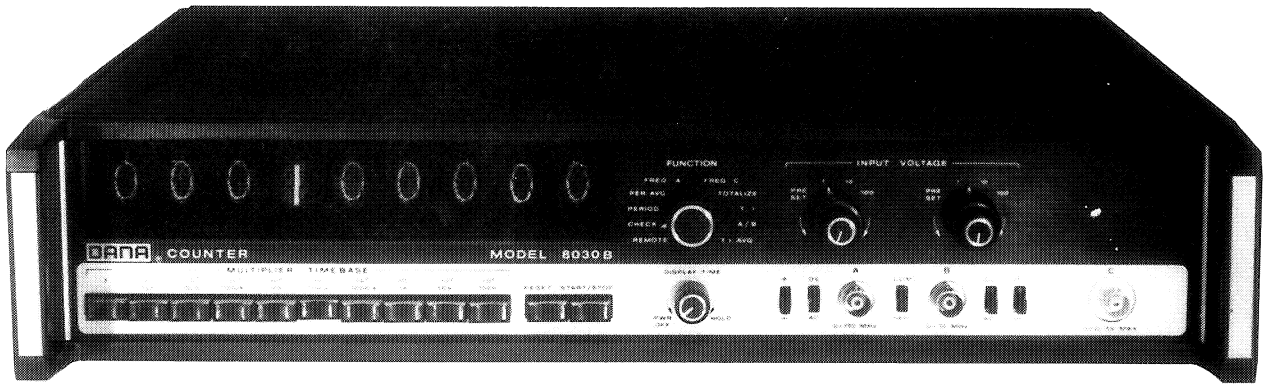
**Trigger error $\leq \frac{0.3}{(S/N)Fa}$

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

OSCILLATOR OPTIONS			
	Option 050	Option 200	Option 300
Aging Rate/day:	–	$1x10^{-9}$	$5x10^{-10}$
Aging Rate/month:	$1x10^{-7}$	$3x10^{-8}$	$1.5x10^{-8}$
Temperature Stability, 0° to 50°C:	$\pm5x10^{-7}$	$\pm5x10^{-9}$	$\pm5x10^{-9}$
±10% line voltage stability:	$\pm5x10^{-8}$	$\pm5x10^{-9}$	$\pm5x10^{-9}$
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^{o}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.

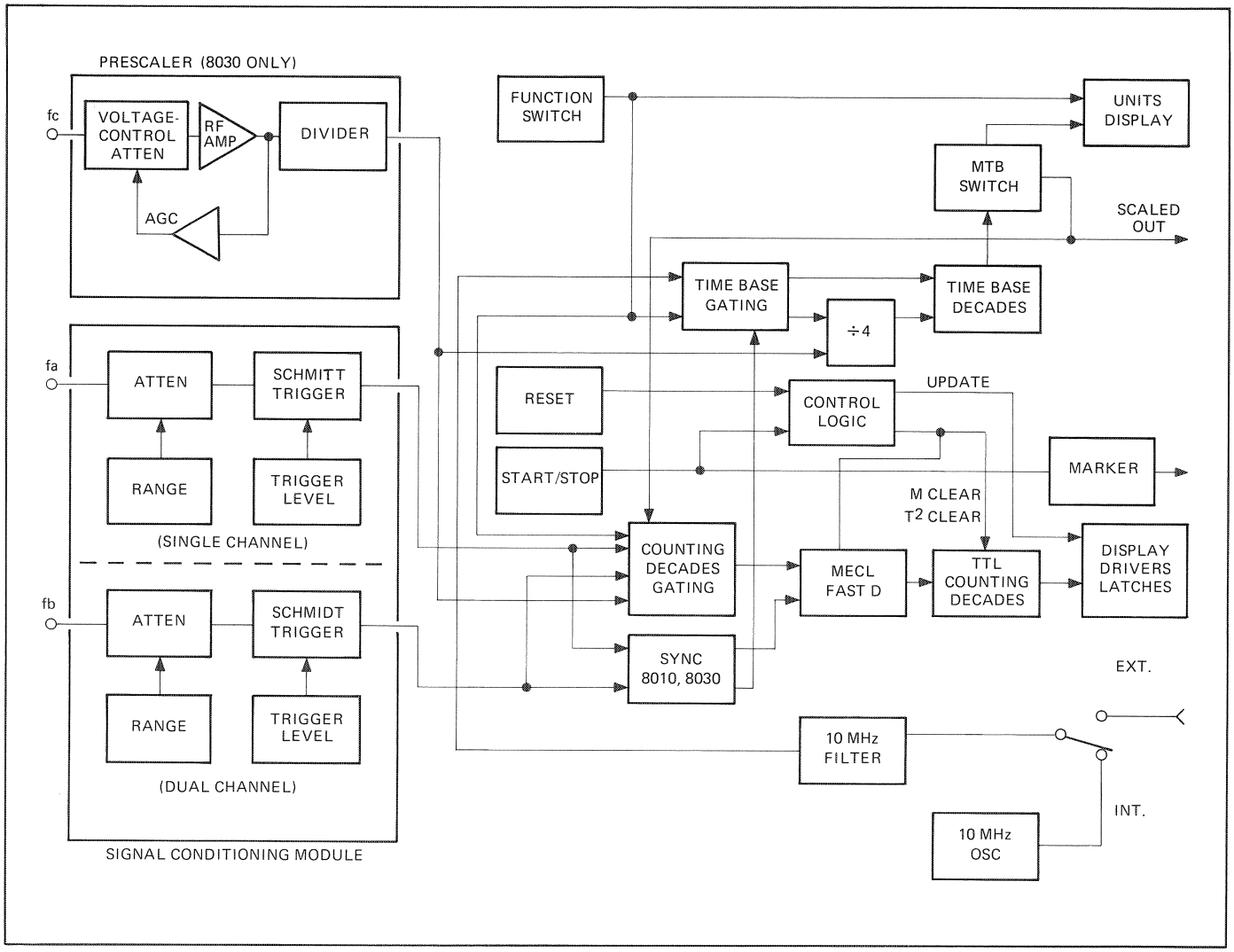


Figure 1.2 - Block Diagram

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 dc-coupled 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 x 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 ±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, μsec, 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 a 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.

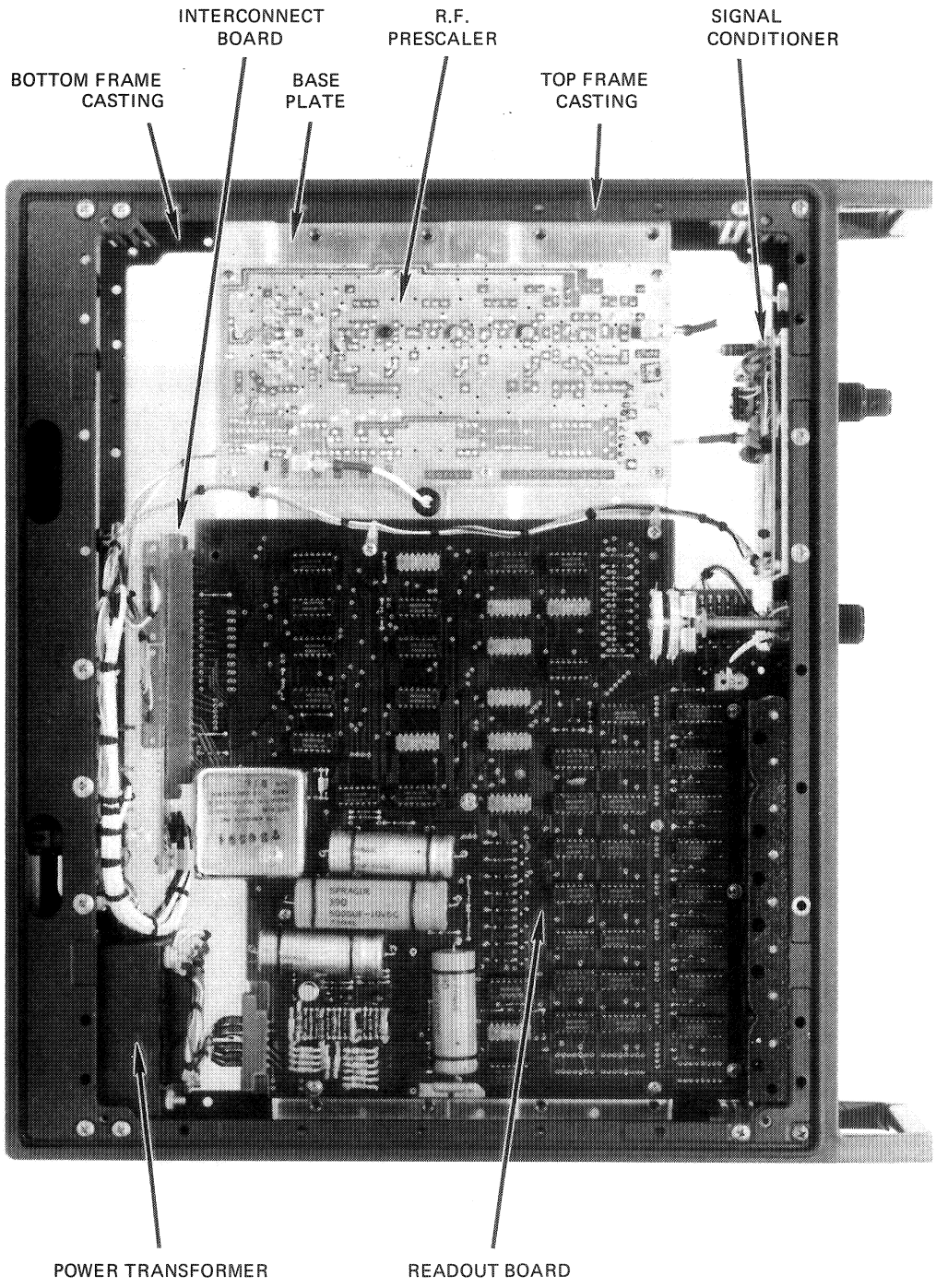


Figure 1.3 - Top View

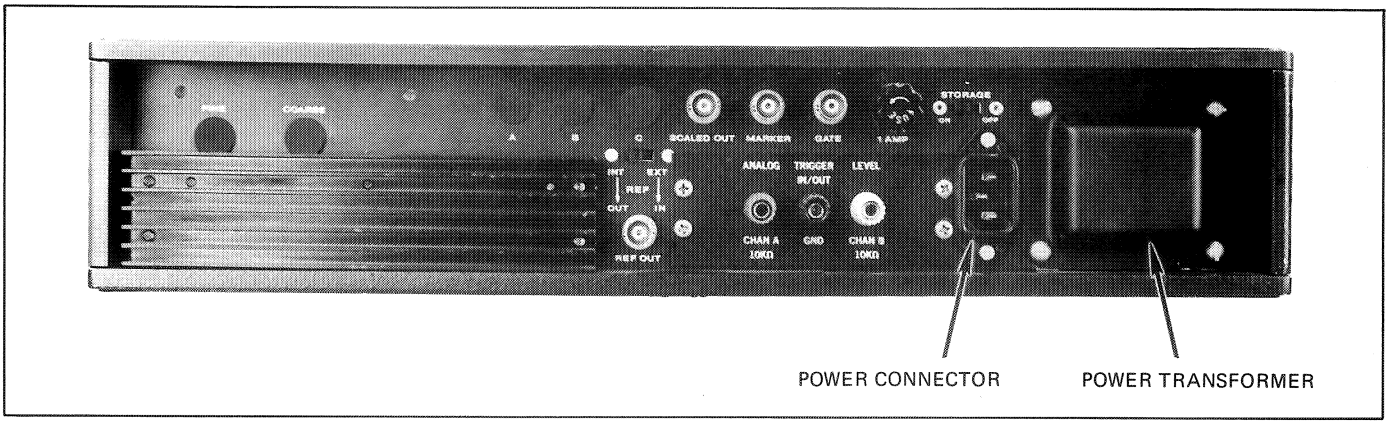


Figure 1.4 - Rear Panel

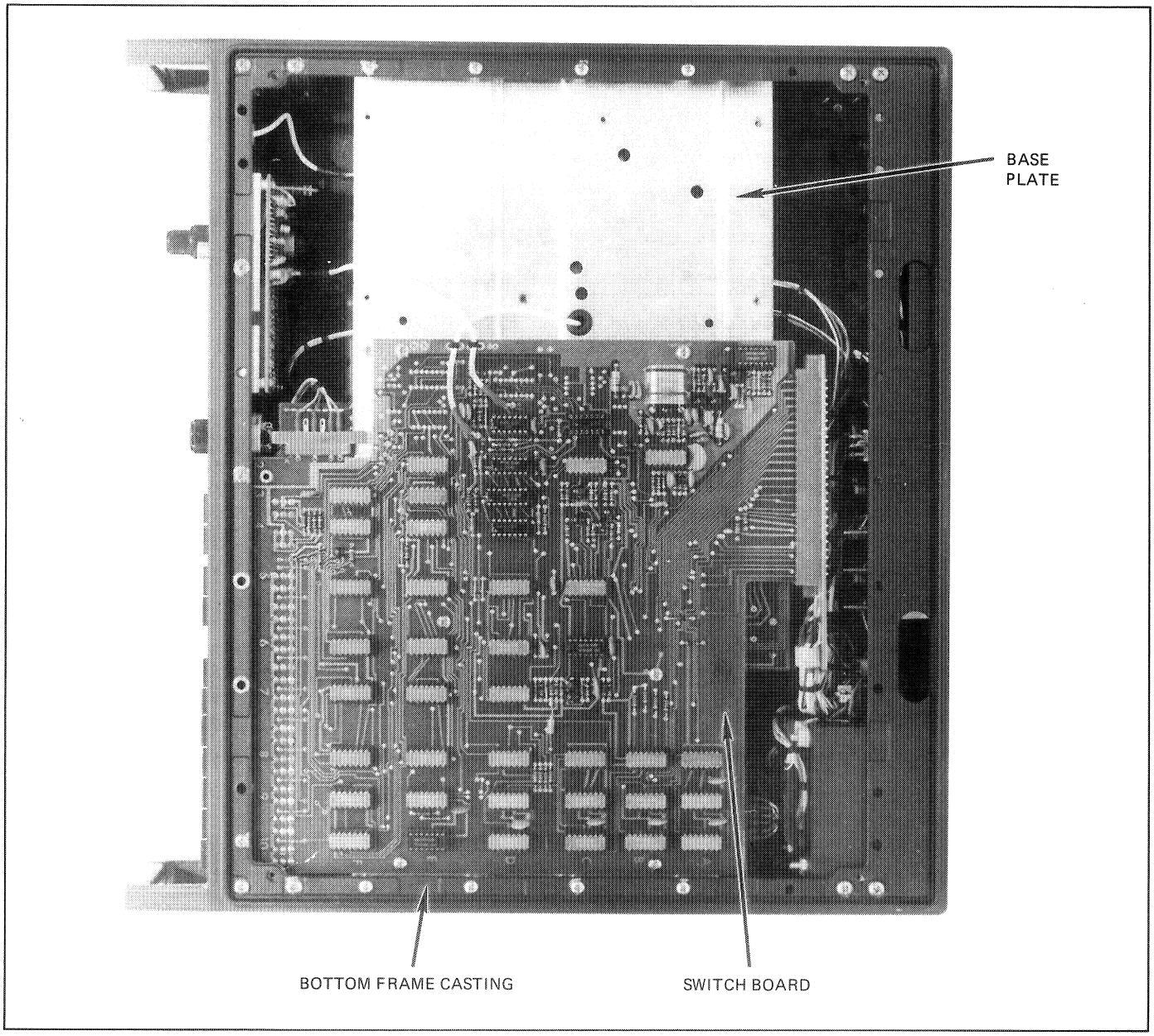


Figure 1.5 - Bottom View

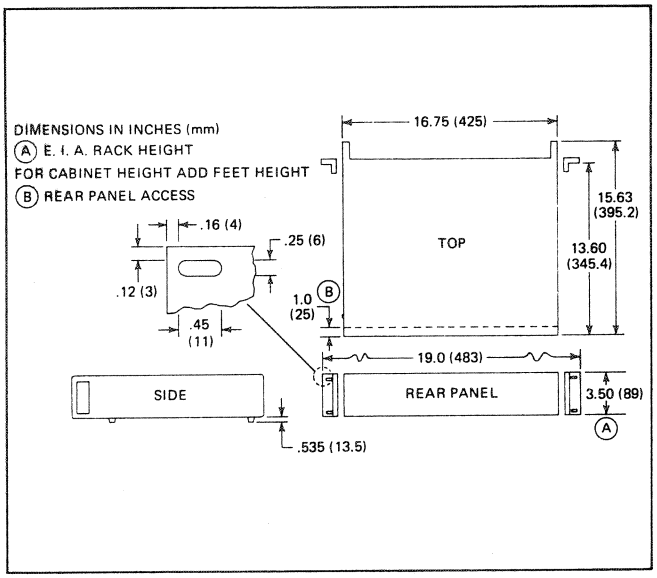


Figure 1.6 - Dimensions

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 prescaler 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.

SECTION 2 INSTALLATION & OPERATION

2.1 UNPACKING AND INSPECTION

2.2 The Series 8000B Counter is packed in a molded plastic-foam form within a cardboard carton for shipment. The plastic form holds the Counter securely in the carton and absorbs any reasonable external shock normally encountered in transit. Prior to unpacking, examine the exterior of the shipping carton for any signs of damage. Carefully remove the Counter from the carton and inspect the exterior of the instrument for any signs of damage. If damage is found, notify the carrier immediately.

2.3 Included with the Counter packed in the container are the instruction manual, Dana Part Number 980448, and power cord 403530. Counters which are equipped with remote programming and BCD output (Option 008 systems interface) are shipped with three mating connectors, 600698, and keys included.

2.4 BENCH OPERATION.

2.5 Each Counter is equipped with a tilt bail or "kickstand" to enable the front of the instrument to be elevated for convenient bench use. The tilt bail is attached to the two front supporting "feet" at the bottom of the instrument. For use, the bail is pulled down to its supporting position.

2.6 RACK MOUNTING.

2.7 The instrument can be mounted in a standard 19-inch rack with the optional rack-mounting flanges (403402, includes attaching hardware). To install the flanges, proceed as follows:

a. With instrument on its side, remove four Phillips-head screws holding bottom cover. Remove cover. Remove screws holding feet (and bail) in place. Replace bottom cover.

b. Place one of the supplied screws through each of the two holes in the mounting flange (figure 2.1). Thread a securing nut onto each screw just enough to attach it to the screw (approximately one turn).

c. Place the mounting flange onto the mounting slot in the instrument side panel so that the securing nuts fit entirely into the slot. Be sure the rack-mount slots on the flange are toward the front of the instrument.

d. Tighten screws. The securing nuts will rotate and hold the flange securely in place.

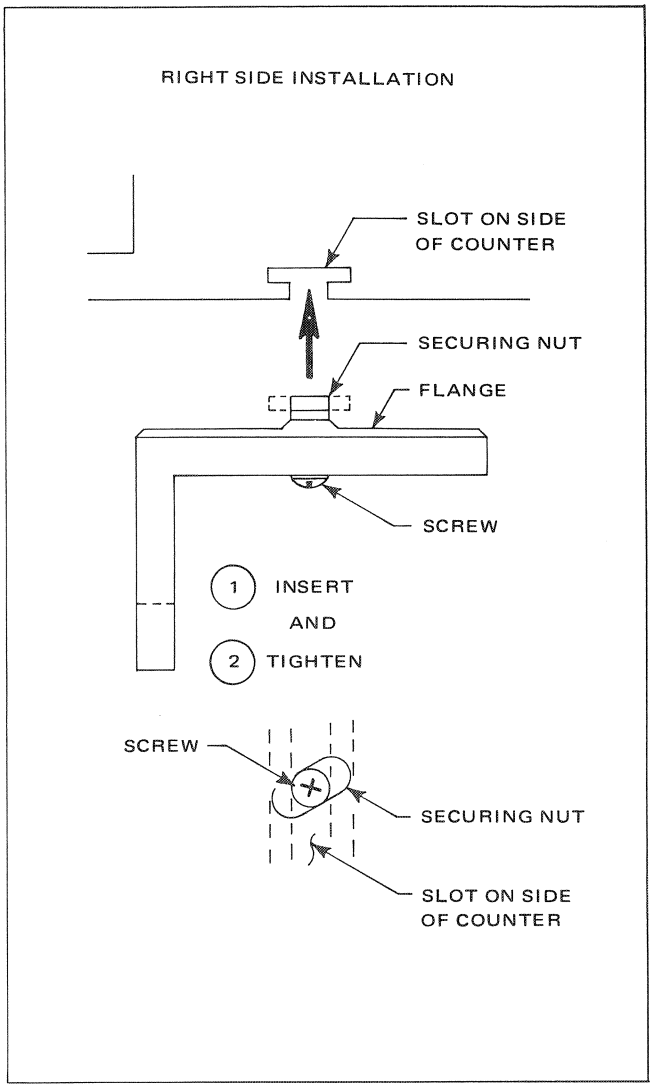


Figure 2.1 - Rack Mount Installation

2.8 POWER CONNECTIONS.

WARNING

Disconnect the instrument from the AC Power source before attempting to change power connections. Potentially lethal voltages are exposed when covers are removed.

2.9 Power requirements for domestic units are 115V ± 10%, 50 to 400 Hz. Power consumption is 60 watts maximum. All 8000B series counters are adaptable for 230V operation. Figure 2.2 shows input wiring for 230V ± 10% line voltage.

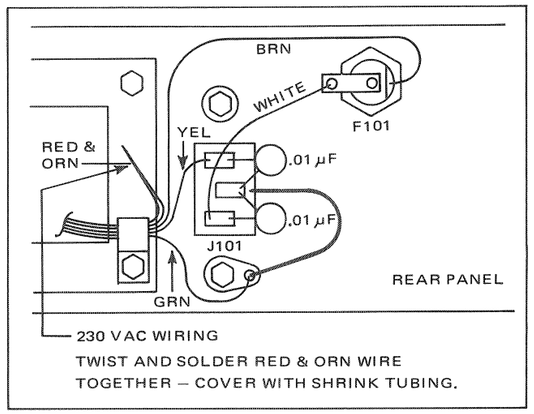


Figure 2.2 - 230V Operation

2.10 Power Cable.

2.11 A standard power cable having a three-pin plug is supplied with the counter. The cord connects to the power connector J101. The ground pin (round) is attached to the main frame of the counter. It is important that this pin be connected to a good quality earth ground.

2.12 Fuse.

2.13 The power fuse holder is located on the rear panel of the counter. A .75 amp 3AG fuse is used.

2.14 REMOTE PROGRAMMING AND BCD OUTPUT.

2.15 Information on the programming and output options available for the 8000B series Counters is provided in Manual No. 980469, Systems Interface for the 8000B series Counter.

2.16 OPERATING PROCEDURES.

2.17 Table 2.1 describes the function of each operating control and each connector on the instrument. Tables 2.2 through 2.9 describe procedures for operating the instrument in each of the measurement modes.

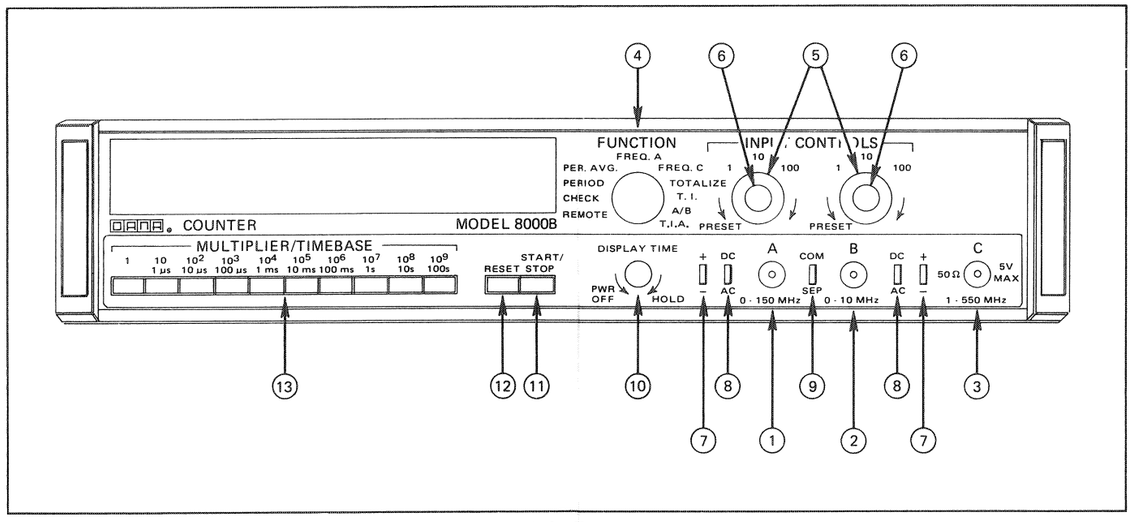


Figure 2.3 - Front Panel

Table 2.1 - Controls and Connectors (see figure 2.3)

input connectors (BNC type)	(1) A INPUT	Used for each function except FREQ C (500 MHz). It accepts up to 250V RMS or 300V peak on all ranges except 150V RMS or 200V peak to 1 MHz on 1V range without damage.
	(2) B INPUT	Always used in conjunction with Channel "A" for making ratio and time interval measurements. It accepts up to 250V RMS or 300V peak on all ranges except 150V RMS or 200V peak to 1 MHz on 1V range without damage.
	(3) C INPUT*	Used in the FREQ C mode only. It accepts frequencies from 1 MHz to 550 MHz and amplitudes from 50 mV to 1V. It accepts a maximum of 5V without damage. This input has no trigger controls because the slope is always set for +; the coupling is always AC; the level is set at the 0 crossing; and the attenuator is automatic.

Control	Position	Action
(4) FUNCTION (rotary switch)	REMOTE	This puts the FUNCTION switch, MULTIPLIER/TIME BASE controls, RESET and START/STOP switches, and the +/– slope switches under remote digital programming control, regardless of what position they are in at the time. The trigger level may be remotely programmed using an analog voltage. To do this, it is necessary for the trigger level control to be set at zero or for the attenuator to be in PRESET. The AC/DC coupling switch, the SEP/COM switch and the attenuator cannot be programmed.
	CHECK	In this mode, the counter measures its internal 10 MHz reference. The rear panel scaled output provides a TTL squarewave with a frequency equal to 10 MHz divided by the multiplier setting.
	PERIOD	In this mode, the amount of time for one period of the input waveform is measured.
	PER. AVG.	In this mode, a number of input waveform periods are averaged and measured. The number of periods is determined by the multiplier control.
	FREQ A	In this mode, the frequency on the A channel input is measured.
	FREQ C*	In this mode, the frequency on the C channel input is measured.
	TOTALIZE	In this mode, the number of events occurring between the start and stop command is totaled.
	T.I.	In this mode, the time interval between two electrical events is measured. The start point is determined by the A trigger controls and the stop point by the B trigger controls.
	A/B	In this mode, the ratio of the frequency applied at the A input to the frequency applied at the B input is measured.
	T.I. AVG.	In this mode, the time interval between two repetitive electrical events can be averaged and measured. The number of time intervals measured is determined by the multiplier control.
INPUT CONTROLS		The purpose of the controls is to set the point on the incoming waveform that causes a trigger pulse to be sent to the counting logic. In the frequency mode, it is necessary to send one trigger pulse during each cycle of the input signal; the number of such trigger pulses received during a gate time determines the frequency measured.

*Not in 8010B

Table 2.1 - Controls and Connectors (Continued)

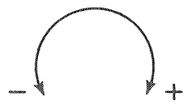
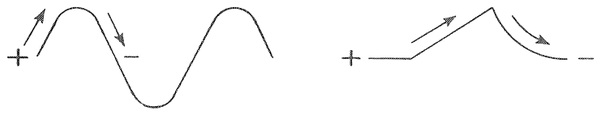
Control	Position	Action
(5) Trigger Range (outer switch)	1	Couples the input signal conditioner directly. Maximum usable signal is ±3 volts peak.
	10	Attenuates the input voltage by ten or 20 dB. Maximum usable signal is ±30 volts peak.
	100	Attenuates the input signal by one hundred or 40 dB. Maximum usable signal is ±300 volts peak.
		The trigger range also adjusts a special circuit that is designed to prevent false counts due to noise superimposed on the waveform being measured. This special circuit is called the trigger hysteresis. When the trigger range is in the 100V range it prevents all false counts due to superimposed noise of amplitude up to 2.5 volts peak to peak. In the 10V range, the protection is 250 mV; in the 1V range, it is 25 mV. It is therefore most desirable to have the range control set to the highest range possible for any given measurement – the higher the range, the greater the hysteresis protection.
(6) Trigger Level (inner control)		The level control provides continuous adjustment of the trigger amplitude from –300% of the trigger range setting to +300%. (If the trigger range control is set on the 10V range, for example, the trigger level control can be adjusted to cause triggering between –30V and +30V.)
	PRESET	When making frequency measurements, the waveform being measured is usually a low amplitude sinewave. Because this waveform is so widely encountered, a PRESET position has been included at which the counter triggers at a point ≤ ±5% of range.
(7) +/– Slope (slide switch)		Selects which slope of the incoming waveform is to trigger the counter (positive or negative). 
	"+"	Causes triggering on the positive-going slope.
	"–"	Causes triggering on the negative-going slope.
(8) AC/DC Coupling (slide switch)	DC	Couples the input signal directly to the signal conditioner. Signal conditioner responds to dc signal changes. Used for time interval measurements.
	AC	Couples the input signal via a capacitor. Signal conditioner responds to periodic AC waveforms. Used for Frequency, Period, and Period AC measurements.
(9) COM/SEP	COM	(Common.) Directs the input signal from input A to channel A and channel B. Used for time interval and multiple time interval average measurements.
	SEP	(Separate.) Connects channel A to channel A input and connects channel B to channel B input.

Table 2.1 - Controls and Connectors (Continued)

Control	Position	Action
(10) DISPLAY TIME (rotary control with switch)	PWR OFF	(Power off.) Turns off the output of the +5 volt, and ±18 volt regulators. Turns off the +150 volts to the display tubes.
	DISPLAY TIME	Applies power to all circuits. Provides a 30 ms (CCW) to 5 second (CW) display time interval between measurements.
	HOLD	Programs the counter to take one measurement. Displays and stores that measurement until RESET is depressed or the position of the DISPLAY TIME control is changed.
(11) START/STOP (momentary pushbutton switch)	Depressed momentarily	This switch is used in the totalize mode. When pushed the first time, the counter starts counting; pushed the second time, the counter stops counting and holds the reading.
(12) RESET	Depressed momentarily	Resets the digital counter to all zeros, arms the counter for a new reading. Commands a new reading anytime.
(13) MULTIPLIER/TIME-BASE Switches (pushbutton switches)	Top row of numbers: 1 10 10^2 10^3 10^4 10^5 10^6 10^7 10^8 10^9	In Period Average and Time Interval Average modes, the numbers represent the multiplier. This indicates the number of periods or time intervals over which the measurement will be averaged. The higher the multiple, the greater the resolution and the slower the measurement time. In Frequency Ratio mode (A/B), the numbers indicate the number of cycles of the channel B (denominator) signals used to make the ratio measurement. The greater the number of cycles, the greater the resolution and the slower the measurement time.
	Lower row of numbers: 1 μs 10 μs 100 μs 1 ms 10 ms 100 ms 1s 10s 100s	In Frequency mode, the numbers select the time base control. This controls the time the internal gate is open. The longer the gate is open, the greater the resolution, and the slower the measurement time. In Period and Time Interval modes, the numbers indicate the reference frequency to be counted during the gate time. The shorter the time base selected, the greater the resolution; therefore, the left most button is usually selected for these operating modes.

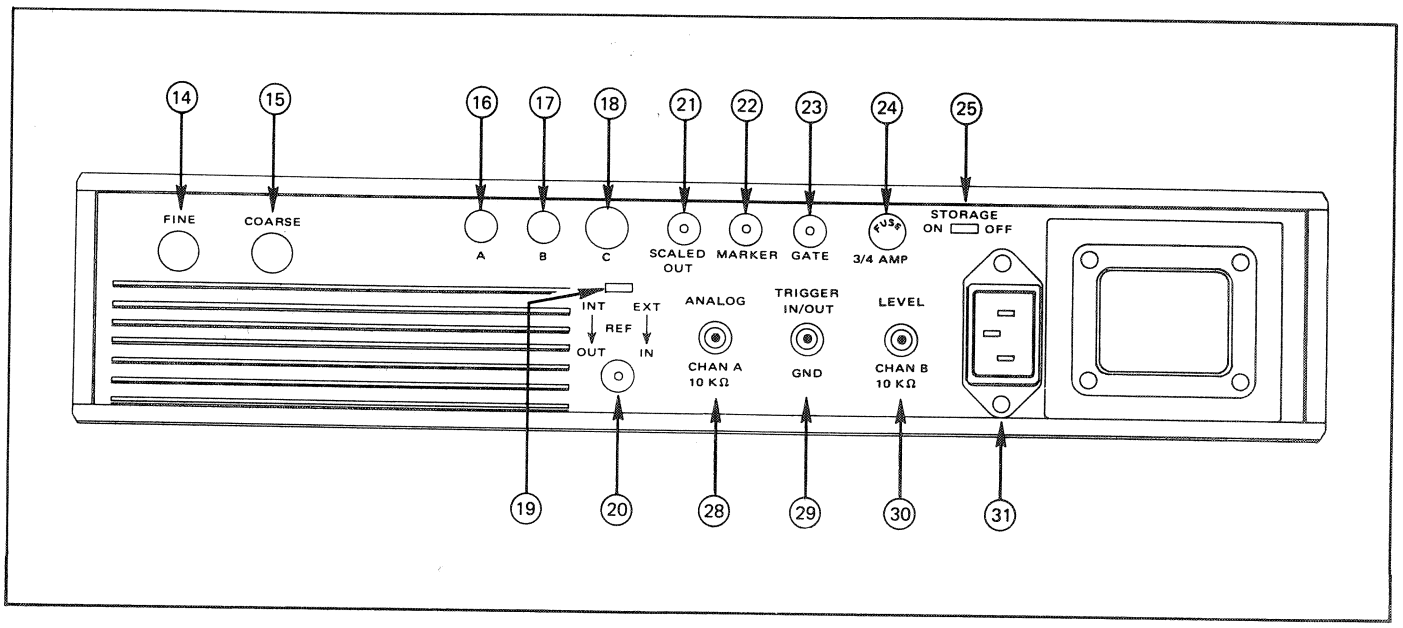


Figure 2.4 - Rear Panel

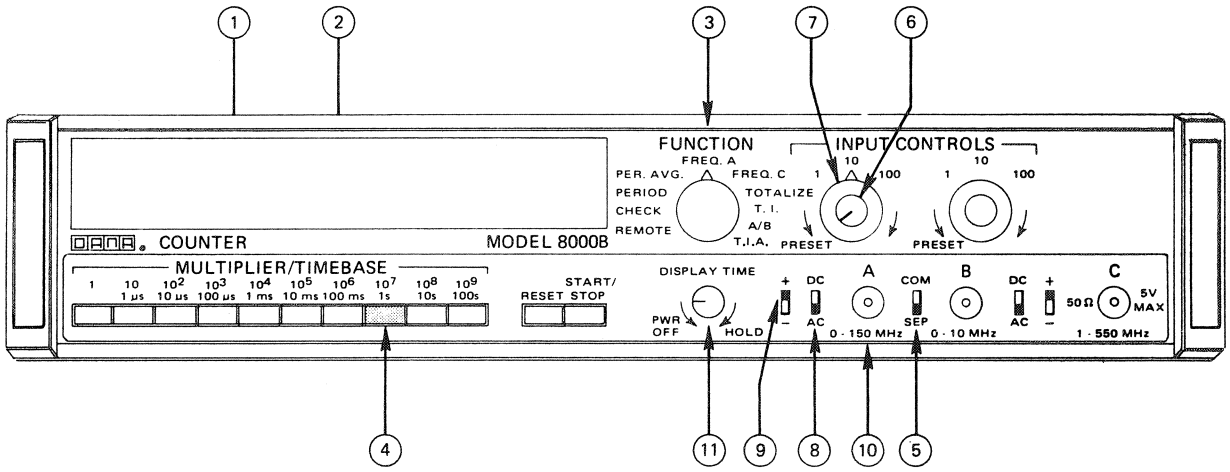
Table 2.1 - Controls and Connectors (Continued)

REAR PANEL (see figure 2.4)

(14) FINE		Access hole used in the FINE adjustment of the ovenized oscillator Option 200. See Calibration.
(15) COARSE		Access hole used in the COARSE adjustment of the ovenized oscillator Option 200. See Calibration.
(16) "A" (BNC connector)		Provides rear input for channel A. Used in Option 010 rear input. Degrades sensitivity by 10 dB above 50 MHz.
(17) "B" (BNC connector)		Provides rear input for channel B. Used in Option 010 rear input.
(18) "C"* (BNC connector)		Provides rear input for channel C. Used with Option 010 rear input.
(19) INT/EXT REF. (slide switch)	INT (Internal)	Routes the internal reference oscillator to the reference filter and to the reference BNC connector.
	EXT (External)	Routes the external reference oscillator from the reference BNC connector to the reference filter circuit.
(20) REF (BNC connector)		Used as internal reference oscillator output when the REF switch is in INT position. Used as external input to reference filter when switch is in EXT position. The counter will accept 1, 5, and 10 MHz external reference.
(21) SCALED OUT (BNC connector)		Provides a SCALED OUTput of the input in Totalize mode.
(22) MARKER OUT (BNC connector)		Provides a negative 18 volt output starting with trigger A and ending with trigger B. Used to modulate the Z axis of an oscilloscope.
(23) GATE (BNC connector)		Provides a positive true GATE output capable of driving five TTL loads.
(24) FUSE		Provided for the protection of internal circuits in the counter. Located on the rear panel. 3 AG, 3/4 AMP.
(25) STORAGE (slide switch)	OFF	Allows the counter to continuously update the display. Automatically off in the Totalize mode.
	ON	Allows the counter to store information and periodically updates the display.
(28) ANALOG, CHAN A		Used to measure or program a trigger level to channel A.
(29) TRIGGER IN/OUT GND		Used as a ground return for channel A and B trigger level input and output.
(30) ANALOG, CHAN B		Used to measure or program a trigger level to channel B.
(31) Power Connector		A three pin connector used for power input. Third pin is power ground.

*Not in 8010B

Table 2.2 - Frequency Measurement 0 - 150 MHz

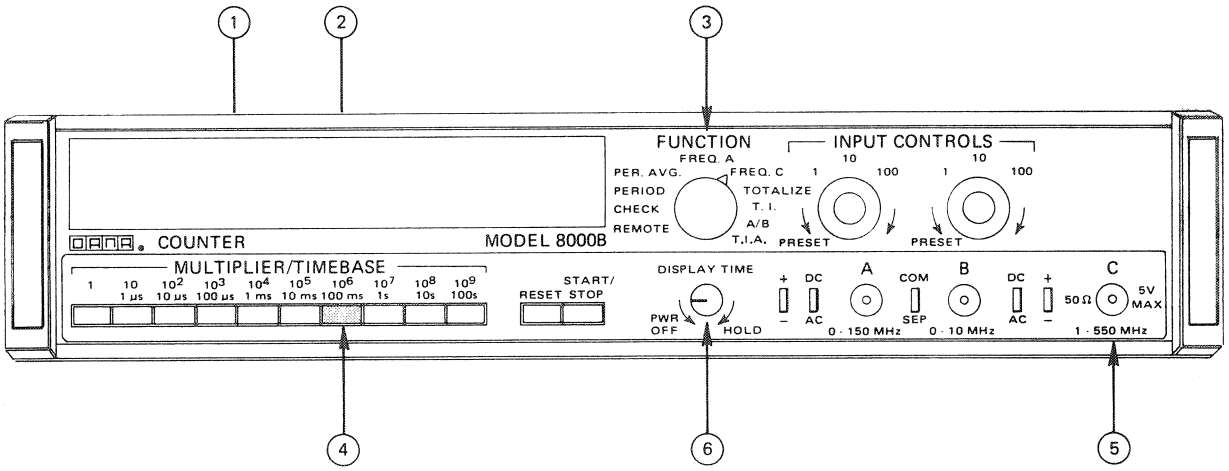


1. Connect AC power.
2. Set STORAGE switch to the ON position.
3. Set the FUNCTION switch to FREQUENCY A.
4. Set the TIMEBASE switch to desired gate time.
5. Set the SEP/COM to SEP.
6. Set channel A level control to desired trigger level or to PRESET to trigger at ≡(0) zero volts.
7. Set INPUT CONTROL range switch to be compatible with the input signal amplitude (1, 10 or 100 volt range).
8. Set AC/DC coupling to AC or DC.
9. Set the A slope to (+) plus.
10. Connect input signal (0 to 150 MHz) to channel A input jack. Note: Max. input 250V RMS or 300V peak.
11. Set DISPLAY TIME to a convenient display interval.

Example: Input frequency to be measured is 600 hertz at 8 volts peak to peak. The TIMEBASE is set to 1 second. Input voltage range is set to 10 volts, trigger level to PRESET, slope to plus and AC/DC to AC. Display will be .000600 MHz with 1 hertz resolution. Change the TIMEBASE to 10 second, the display will be .6000 kHz with 0.1 hertz resolution. Change the TIMEBASE to 100 sec and the display will be .60000 kHz with 0.01 hertz resoltuion.

NOTE: A much faster reading would be to use the PERIOD mode and measure the period of the frequency.

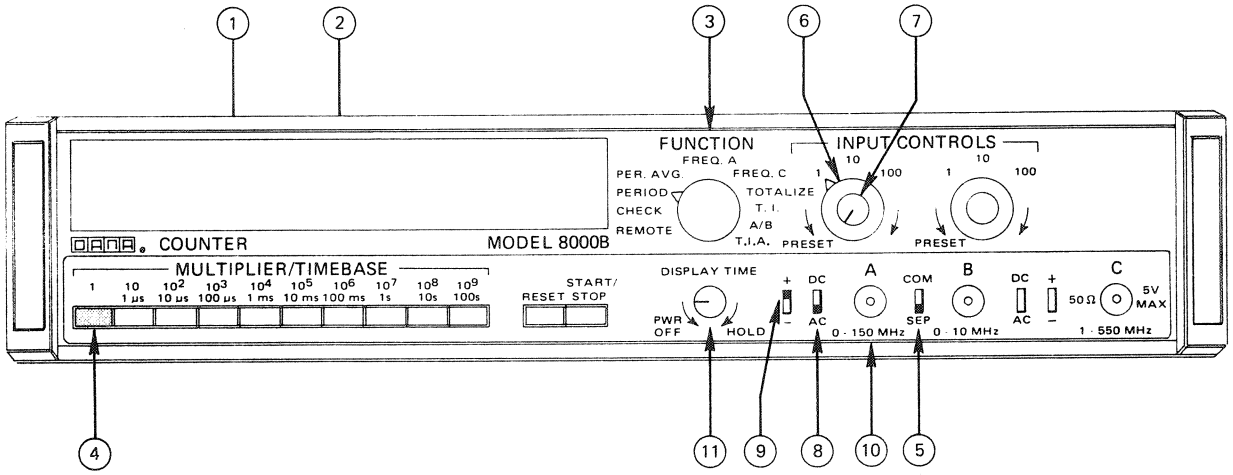
Table 2.3 - Frequency Measurement 1 - 550 MHz (Not in 8010B)



1. Connect AC power.
2. Set STORAGE switch to the ON position.
3. Set the FUNCTION switch to FREQUENCY C.
4. Set the TIMEBASE switch to the desired gate time.
5. Connect the input signal from 1 to 550 MHz (10 to 500 MHz with Option 030) in frequency to channel C input. Note: Max. input operating input is 1V RMS. Max. input without damage is 5V RMS.
6. Set DISPLAY TIME to a convenient display interval.

Example: Input frequency to be measured is 200 MHz at .5V rms. The TIMEBASE is set to 100 milliseconds. The trigger level setting is automatic in the FREQUENCY C function. The display will be 200.00000 MHz with 10 hertz resolution. Gate time is expanded by 4 in this mode of operation (i.e., a 100 ms gate selected on front panel will actually be 400 milliseconds).

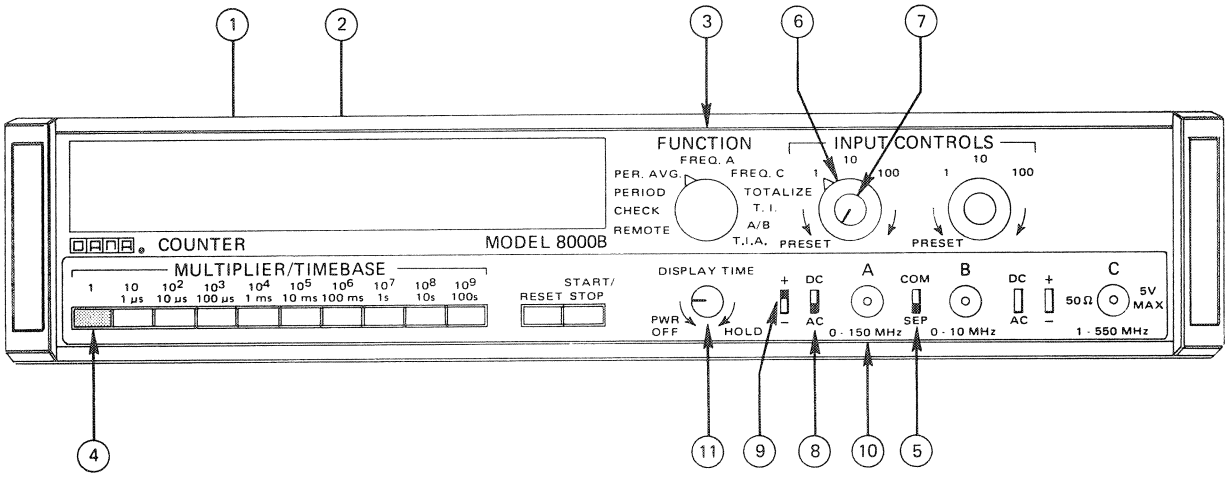
Table 2.4 - Period Measurements



1. Connect AC power.
2. Set STORAGE switch to the ON position.
3. Set the FUNCTION switch to PERIOD.
4. Set the TIMEBASE switch to the desired time units to be counted.
5. Set the SEP/COM to SEP.
6. Set the channel A INPUT CONTROL range switch to be compatible with the input signal amplitude.
7. Set the channel A trigger level control to the desired trigger level or to PRESET to trigger at ≡(0) zero volts.
8. Set the AC/DC coupling to AC or DC on channel A.
9. Set the A slope to (+) plus or (–) minus.
10. Connect the input signal (0 to 10 MHz) to channel A input jack.
11. Set DISPLAY TIME to a convenient display interval.

Example: Input PERIOD to be measured is 1 millisecond at 1V peak. The TIMEBASE is set to 1. The channel A INPUT CONTROL switch is set to the 1-volt range, trigger level is set to the PRESET position and AC/DC is set to AC. The display will be 0001000.0 microseconds with 100 nanoseconds resolution.

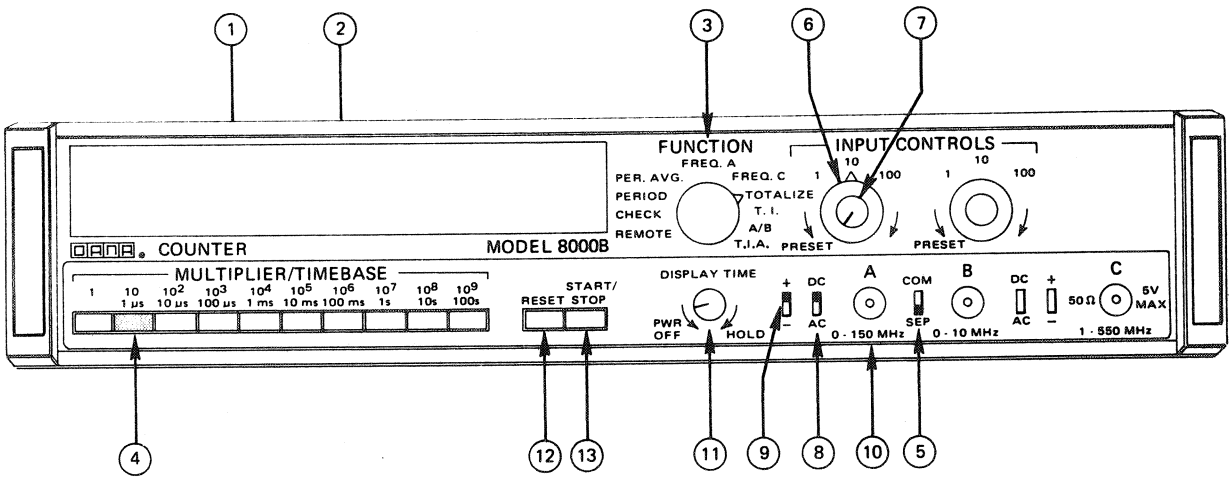
Table 2.5 - Period Average Measurements



1. Connect the AC power.
2. Set the STORAGE switch to the ON position.
3. Set the FUNCTION switch to PERIOD AVERAGE.
4. Set the MULTIPLIER switch to the desired time multiplier position.
5. Set the SEP/COM switch to SEP.
6. Set the channel A INPUT CONTROL range switch to match the input signal amplitude.
7. Set the channel A level control to the desired trigger level or to PRESET to trigger at ≅(0) zero volts.
8. Set the AC/DC coupling to AC or DC on channel A.
9. Set the channel A slope to (+) or (–) minus.
10. Connect the input signal (0 to 10 MHz) to channel A input jack.
11. Set DISPLAY TIME to a convenient display interval.

Example: Input period to be measured is 1 millisecond at 1V peak. The TIME BASE is set to 1. The channel A input voltage range switch is set to the 1 volt range, the trigger level is set to the PRESET position and AC/DC is set to AC. The display is 0001.0000 milliseconds with 100 nanoseconds resolution. Depress the 10 multiplier switch. The display will be 001.00000 ms with 10 nanosecond resolution.

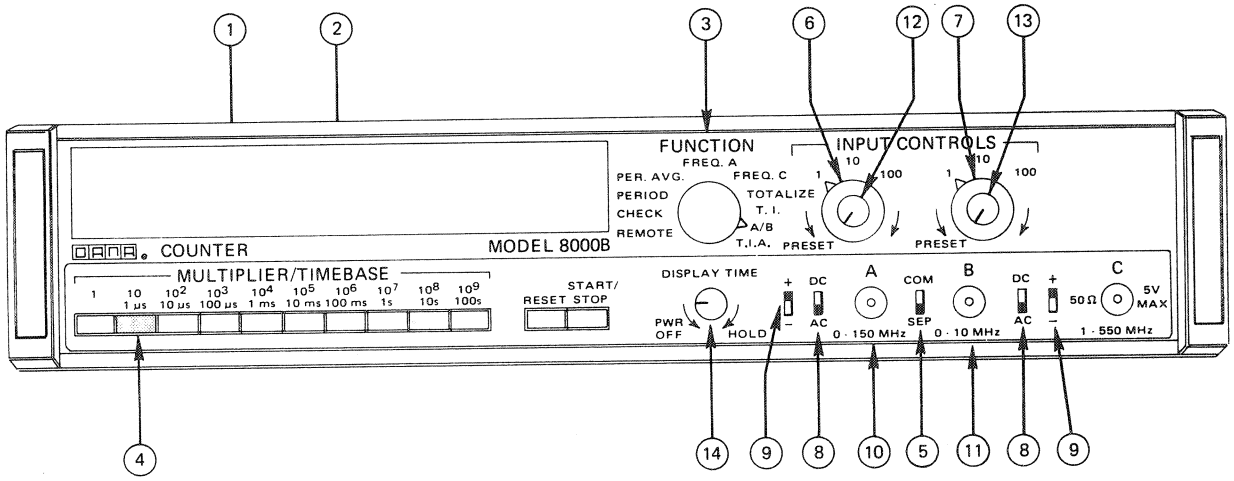
Table 2.6 - Totalize



1. Connect the AC power.
2. Set the STORAGE switch to the ON position. Note: storage automatically disabled.
3. Set the FUNCTION switch to the TOTALIZE position.
4. Set the MULTIPLIER switch for the scaled output desired.
5. Set the SEP/COM switch to the SEP position.
6. Set the channel A INPUT CONTROL range switch to match the input signal amplitude.
7. Set the channel A level control to the desired trigger level or to PRESET to trigger at ≅ (0) zero volts.
8. Set the AC/DC coupling to AC or DC on channel A.
9. Set the channel A slope to (+) plus or (–) minus.
10. Connect the input signal (0 to 150 MHz) to channel A input jack.
11. Turn DISPLAY TIME clockwise to any position. It is not operative in this mode.
12. Depress the RESET switch.
13. To start the count, depress the START/STOP momentary switch. To stop the count, depress the START/STOP switch again.

Example: A series of electrical events is to be counted. They are 10V peak in amplitude and have a rate of 10 kHz. A scaled output is needed at 10 Hz. Set the channel A input voltage range switch to the 10V range, the trigger level to PRESET position, and the AC/DC to AC. The MULTIPLIER switch is set to 10. The count is initiated by depressing the START button. The SCALED OUT will be 10 Hz.

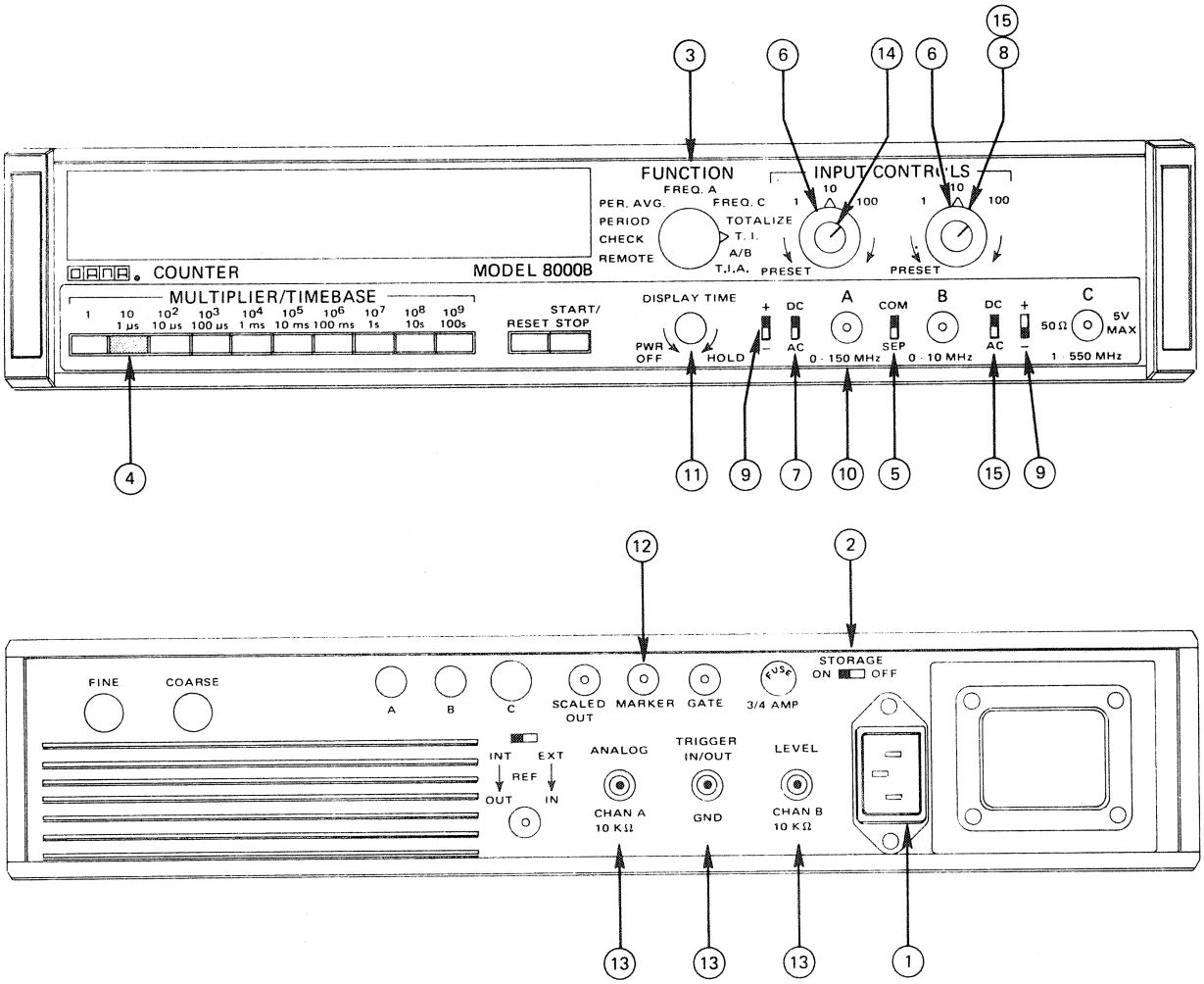
Table 2.7 - A/B Ratio



1. Connect the AC power at the rear panel.
2. Set the STORAGE switch to the ON position.
3. Set the FUNCTION switch to the A/B position.
4. Set the MULTIPLIER switch for the multiplier desired.
5. Set the SEP/COM switch to the SEP position.
6. Set the channel A INPUT CONTROL range switch to match the input signal amplitude.
7. Set the channel B INPUT CONTROL range switch to match the input signal amplitude.
8. Set channel A and B coupling to AC or DC.
9. Set channel A and B slope to (+) plus or (–) minus.
10. Connect the higher frequency input (0 - 150 MHz) to channel A.
11. Connect the lower frequency input (0 - 10 MHz) to channel B.
12. Set the channel A trigger level control to the desired trigger level or to the PRESET to trigger at ≅(0) zero volts.
13. Set the channel B trigger level control to the desired trigger level or to PRESET to trigger at ≈(0) zero volts.
14. Set DISPLAY TIME to a convenient display interval.

Example: The ratio of two frequencies, 100 kHz and 1 kHz, are to be measured. The 100 kHz signal is applied to channel A. The 1 kHz signal is applied to channel B. The 1 MULTIPLIER is depressed. The SEP/COM is set to the SEP position. Both A and B trigger levels are set to PRESET position. The display indicates ratio directly. Ratio equals frequency A divided by frequency B times the multiplier. The display is 00000100. Depress the 10 multiplier. The display is 00001000. Depress the 10^2 multiplier. The display is 00010000.

Table 2.8 - Time Interval



1. Connect the AC power.
2. Set the STORAGE switch to the ON position.
3. Set the FUNCTION switch to the TIME INTERVAL position.
4. Set the TIMEBASE switch to the desired TIME BASE position.
5. Set the SEP/COM switch to the COM position.
6. Set the channel A and B INPUT CONTROL range switch to be compatible with the input signal amplitude.
7. Set channel A AC/DC coupling switch to desired setting.
8. Set channel B AC/DC coupling switch to AC and trigger level to PRESET.
9. Set +/– slope switches to desired setting.
10. Connect input signal (0 to 10 MHz) to channel A input.
11. Set DISPLAY TIME to a convenient display interval.
12. To use the MARKER of the counter, tee-off the input signal of channel A input and connect to vertical input of oscilloscope. Connect MARKER output of counter to Z axis of oscilloscope.

continued

Table 2.8 - Time Interval (continued)

(*13) Connect two DC voltmeters capable of reading ±30 VDC to the ANALOG TRIGGER LEVEL outputs. Use the following formula to determine the trigger level voltage.

$$TL = \frac{VR}{10}$$

Where: TL = trigger level
V = voltmeter reading
R = Input control range

Example: The meter reading is 5 volts on the Input Control range 1.

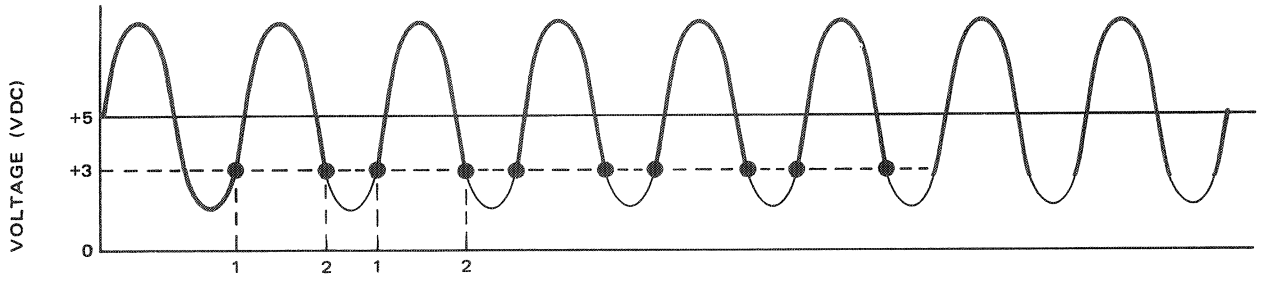
$$TL = \frac{5\,(1)}{10} = .5 \text{ volts}$$

(14) Adjust channel A trigger level control to desired "start" trigger voltage.

(15) Set channel B AC/DC to desired setting and adjust trigger level to desired "stop" trigger voltage.

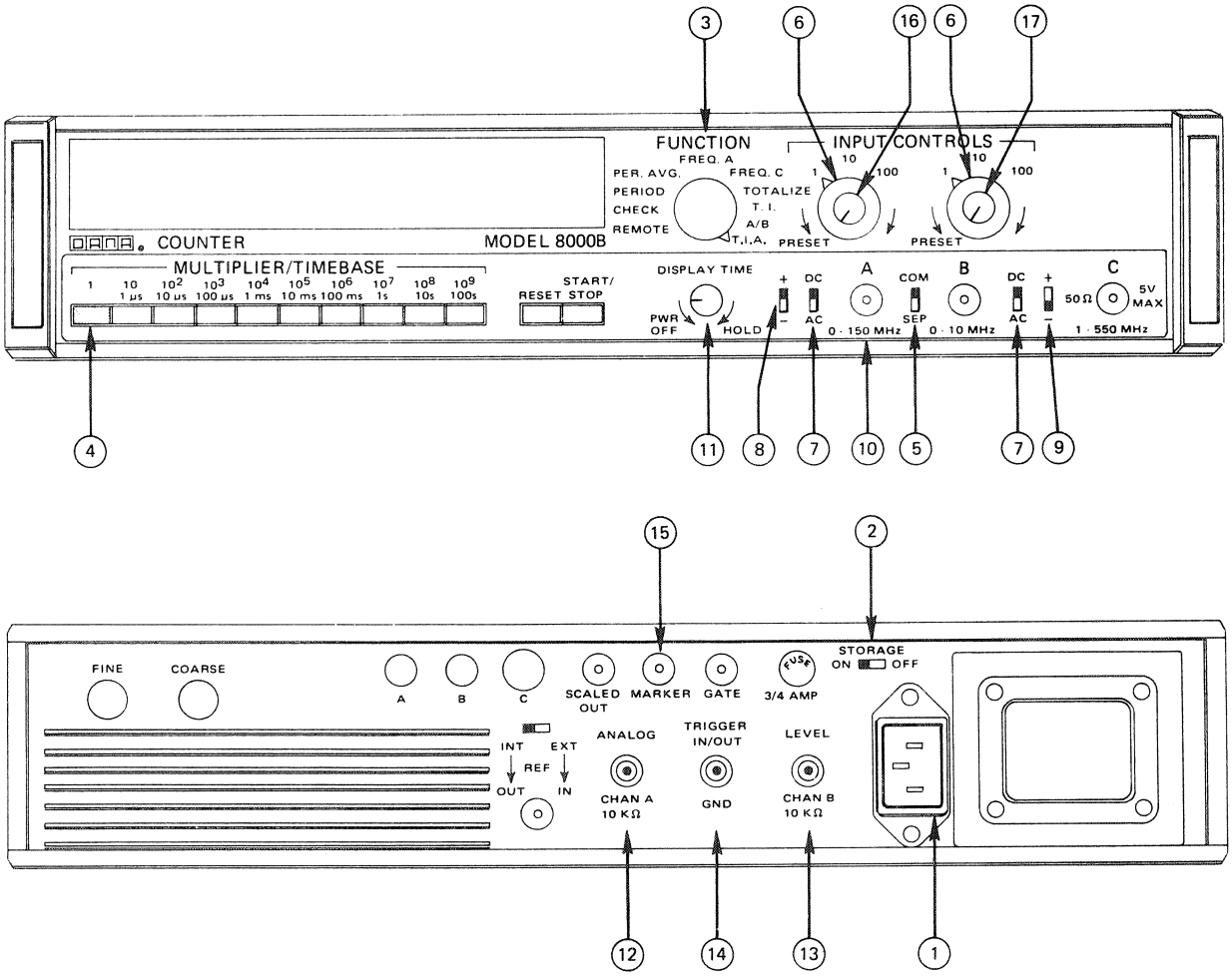
*Two features are provided in the 8000B counters to aid in setting the front panel controls. These features are the MARKER and the trigger level voltage connectors located on the rear panel. The use of these features is optional.

Example: The input waveform is a 1 kHz 5V peak to peak waveform riding on a 5 volt DC voltage. It is desired to measure the portion of the PERIOD which exist above 3 volts. See figure. Set the TIMEBASE to 1 μsec. Set the SEP/COM to COM. Set the channel A and B input voltage range to 10 volts. Set the A and B coupling to DC. Set the channel A slope to plus and channel B slope to (–) minus. Connect the voltmeters and oscilloscope to the counter as before. Adjust the A trigger level to trigger at 3 VDC on the plus slope. Adjust the B trigger level to trigger at 3 VDC on the minus slope. The period that is measured is intensified on the oscilloscope. The display is 0000746.0 μsec.



1. A TRIGGER LEVEL + SLOPE
2. B TRIGGER LEVEL – SLOPE

Table 2.9 - Time Interval Average



1. Connect the AC power.
2. Set the STORAGE switch to the ON position.
3. Set the FUNCTION switch to the TIME INTERVAL AVERAGE position.
4. Set the MULTIPLIER switch to the desired multiplier position.
5. Set the SEP/COM switch to the COM position.
6. Set the channel A and B INPUT CONTROL range switch to be compatible with the input signal amplitude.
7. Set channel A AC/DC coupling switch to desired setting.
8. Set channel B AC/DC coupling switch to AC and trigger level to PRESET.
9. Set +/– slope switches to desired setting.
10. Connect the input signal (0 to 2.5 MHz) to channel A input.
11. Set DISPLAY TIME to a convenient display interval.
12. To use the MARKER of the counter, tee-off the input signal of channel A input and connect to vertical input of oscilloscope. Connect MARKER output of counter to Z axis of oscilloscope.

continued

Table 2.9 - Time Interval Average (continued)

(*13) Connect two DC voltmeters capable of reading ±30 VDC to the ANALOG TRIGGER LEVEL outputs. Use the following formula to determine the trigger level voltage.

$$TL = \frac{VR}{10}$$

Where: TL = trigger level
V = voltmeter reading
R = Input control range

Example: The meter reading is 5 volts on the Input Control range 1.

$$TL = \frac{5\,(1)}{10} = .5 \text{ volts}$$

(14) Adjust channel A trigger level control to desired "start" trigger voltage.

(15) Set channel B AC/DC to desired setting and adjust trigger level to desired "stop" trigger voltage.

*Two features are provided in the 8000B counters to aid in setting the front panel controls. These features are the MARKER and the trigger level voltage connectors located on the rear panel. The use of these features is optional.

Example: It is desired to measure the positive pulse width of a 5 kHz square wave. Set the MULTIPLIER to 1. Set the SEP/COM to COM. Set the A and B coupling to DC. Set the A slope to (+) plus and the B slope to (–) minus. Set the A and B trigger levels to PRESET. The display is 0000100.0 μsec. The resolution is 100 ns. Depress the MULTIPLIER 10 and the display is 000100.00 μsec. The resolution is 10 ns.

NOTE: In time interval average mode, the input signals must be repetitive and asynchronous with the counter's reference oscillator (10 MHz). If the input signal approaches a sub-harmonic of the reference frequency, a greater number of time intervals will have to be averaged to achieve good accuracy. The accuracy is found by the following formula.

$$\pm\text{reference error} \pm 2 \text{ nsec} \pm \frac{(\text{trigger error} \pm 100 \text{ nsec})}{\sqrt{\text{Number of Intervals Averaged}}}$$

where: $\text{trigger error} = \dfrac{.0025\ \mu\text{sec}}{\text{signal slope (V/}\mu\text{sec)}}$

SECTION 3 PERFORMANCE CHECK

3.1 INTRODUCTION.

3.2 This procedure is designed to insure that the instrument is operating properly and within its specifications. If any of the readings are not within tolerance, refer to the calibration procedure. If the instrument fails to operate properly, refer to the troubleshooting procedure.

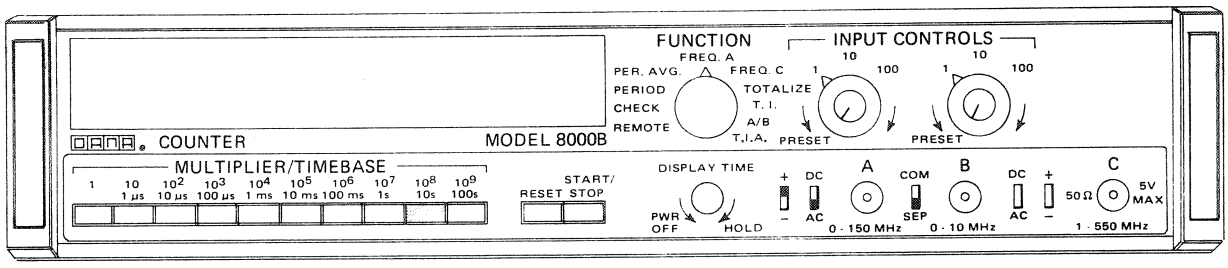
3.3 RECOMMENDED TEST EQUIPMENT.

3.4 Test equipment recommended for the Performance check is listed in table 3.1. Procedures are described in tables 3.2 through 3.11.

Table 3.1 - Required Equipment

Instrument Type	Required Specification	Recommended Instruments
Frequency Standard	1 MHz, 5 MHz, or 10 MHz	
Oscilloscope	150 MHz Bandwidth	TEK 454
Voltmeter	10 mVDC to 200 VDC	Dana 4300
Sine Wave Generator	2 Hz – 10 MHz	Dana 7010
VHF Signal Generator	10 – 150 MHz	HP8654A
VHF Signal Generator	1 – 550 MHz (Not required for 8010B)	HP8654A
Alignment Tool	.075" Hex (nonmetallic)	General Cement 9300
Alignment Tool	Blade (nonmetallic)	
Sampling Voltmeter	0 – 600 MHz	HP3406
50Ω Feedthru		TEK 011-049
BNC "T" Connectors		
50Ω Tee Connector		HP1022A
2 – BNC to GR Adapters		

Table 3.2 - Reference Oscillator Stability



DISPLAY TIME: Power on/CCW position

FUNCTION Switch: FREQ A

TIME BASE: 10 sec

SLOPE A: (+) Plus

A COUPLING: AC

INPUT VOLTAGE RANGE: 1 Volt

TRIGGER LEVEL A: PRESET

SEP/COM Switch: SEP

STORAGE Switch: ON

REFERENCE Switch: INT

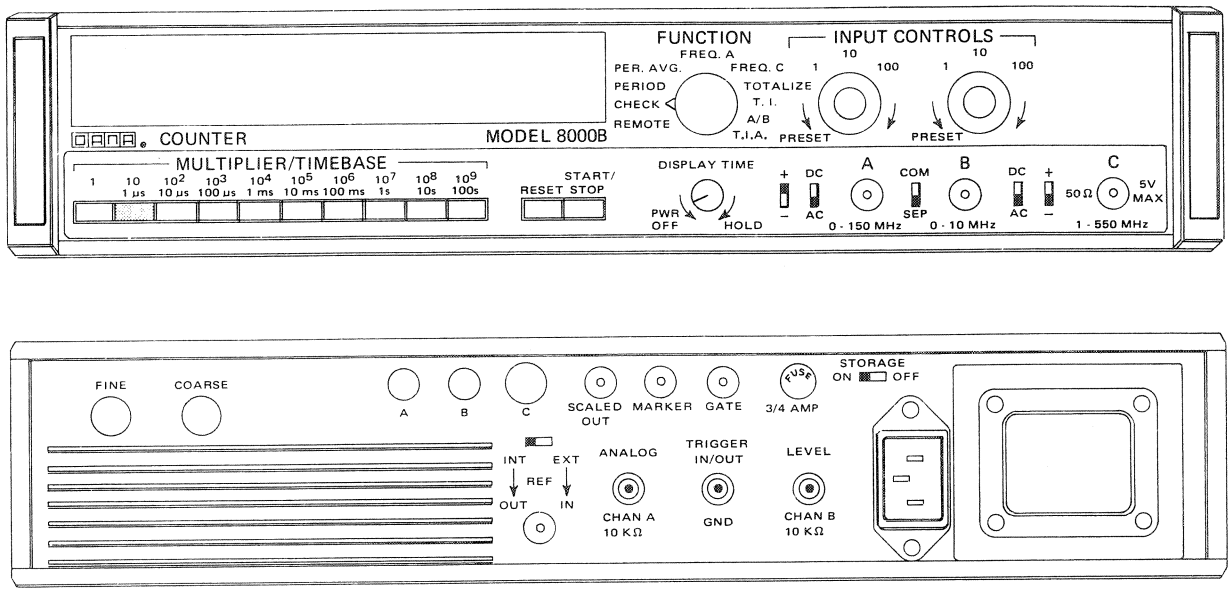
1. Set the controls as shown above.
2. Allow the counter to warmup for 1 hour, except with Option 200, which is 72 hours. Do not remove covers.
3. Connect a 1 MHz at 1V RMS Frequency Standard to Frequency Input A.
4. The difference between the Internal Counter Reference oscillator and the 1 MHz Frequency Standard can be determined by the following formula (20 000 000, – Reading in counts) = the Internal oscillator frequency in hertz.

Typical Counter Reference Oscillator Difference for Standard Oscillator

Display	Internal Reference Oscillator
999.9950 kHz	10000.050 kHz
999.9975	10000. 025
1000.0000	10000.000
1000.0025	9999.975
1000.0050	9999.950

5. To calibrate the counter to a Frequency Standard, refer to the Calibration section.
6. To determine long term stability, operate the counter continuously for at least 1 month. The stability is as follows: Standard Oscillator, $<3 \times 10^{-7}$ per month, Option 050 1×10^{-7} per month, Option 200 1×10^{-9} per day.
7. To measure line voltage stability, use a Variac to vary the line voltage $\pm 10\%$ and measure the frequency difference. The line stability is as follows: Standard Oscillator $\pm 1 \times 10^{-7}$, Option 050 $\pm 5 \times 10^{-8}$, Option 200 $\pm 2 \times 10^{-9}$.
8. To measure temperature stability, vary the temperature from 25°C to 0°. Allow the reading to stabilize and note the reading. Increase the temperature to 50°C and allow the reading to stabilize. The temperature stability 0° to 50°C is as follows: Standard Oscillator $\pm 2.5 \times 10^{-6}$, Option 050 $\pm 5 \times 10^{-7}$, and Option 200 $\pm 5 \times 10^{-9}$.
9. Check the Reference Oscillator output by connecting an oscilloscope to the REF. OUT jack on the rear of the counter. An output of >2.0V peak to peak at 10 MHz is normal.

Table 3.3 - Counting Decades and Multiplier/Timebase Decades



DISPLAY TIME: Power on/CCW position

FUNCTION Switch: CHECK

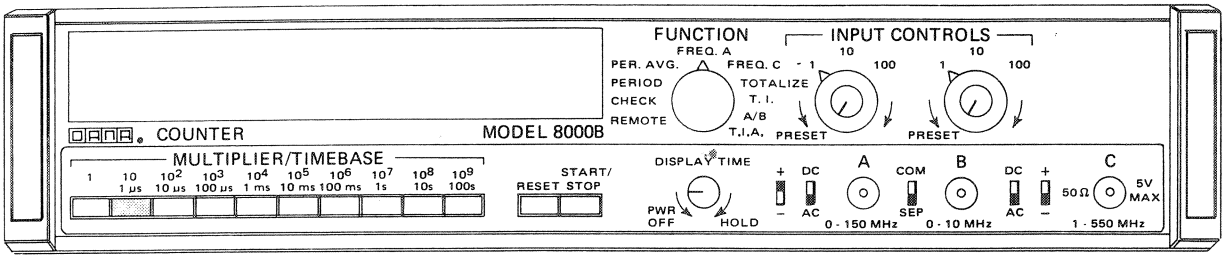
TIME BASE: See chart

STORAGE Switch: ON

REFERENCE Switch: INT

Timebase	Display	Tolerance
1 μs	000000010	± 1 count
10	000000100	± 1 count
100	000001000	± 1 count
1 ms	000010000	± 1 count
10	000100000	± 1 count
100	001000000	± 1 count
1 sec	010000000	± 1 count
10	100000000	± 1 count
100	000000000	± 1 count
9th digit option		

Table 3.4 - Decimal Point and Units



DISPLAY TIME: Power on/CCW position

FUNCTION Switch: Set for each check

TIME BASE: See table below

STORAGE Switch: ON

REFERENCE Switch: INT

Timebase	DISPLAY			
	FREQ A	Units	FREQ C (Not in 8010B)	Units
1 μsec	000000000	MHz	000000000	MHz
10	00000000.0	MHz	00000000.0	MHz
100	0000000.00	MHz	0000000.00	MHz
1 ms	000000.000	MHz	000000.000	MHz
10	00000.0000	MHz	00000.0000	MHz
100	0000.00000	MHz	0000.00000	MHz
1s	000.000000	MHz	000.000000	MHz
10	00000.0000	kHz	00.0000000	MHz
100	0000.00000	kHz	0.00000000	MHz
9th digit option				

PERIOD
TIME INTERVAL

Multiplier Selected	Display	Units
1	00000000.0	μsec
10	000000000	μsec
10^2	0000000.00	msec
10^3	00000000.0	msec
10^4	000000000	msec
10^5	0000000.00	sec
10^6	00000000.0	sec
10^7	000000000	sec
10^8	000000000	–
10^9	000000000	–
9th digit option		

continued

Table 3.4 - Decimal Point and Units (continued)

PERIOD AVERAGE

Multiplier Selected	Display	Units
1	00000.0000	msec
10	0000.00000	msec
10^2	000.000000	msec
10^3	00000.0000	μsec
10^4	0000.00000	μsec
10^5	000.000000	μsec
10^6	00000.0000	nsec
10^7	0000.00000	nsec
10^8	000.000000	nsec
10^9	000000000	—
9th digit option →		

TIME INTERVAL AVERAGE

Multiplier Selected	Display	Units
1	000000000.0	μsec
10	00000000.00	μsec
10^2	000000000	nsec
10^3	000000000.0	nsec
10^4	00000000.00	nsec
10^5	000000.000	nsec
10^6	00000.0000	nsec
10^7	0000.00000	nsec
10^8	000.000000	nsec
10^9	00.0000000	nsec
9th digit option →		

TOTALIZE
A/B RATIO

Verify that no annunciators except the gate are lit when any multiplier button is depressed.

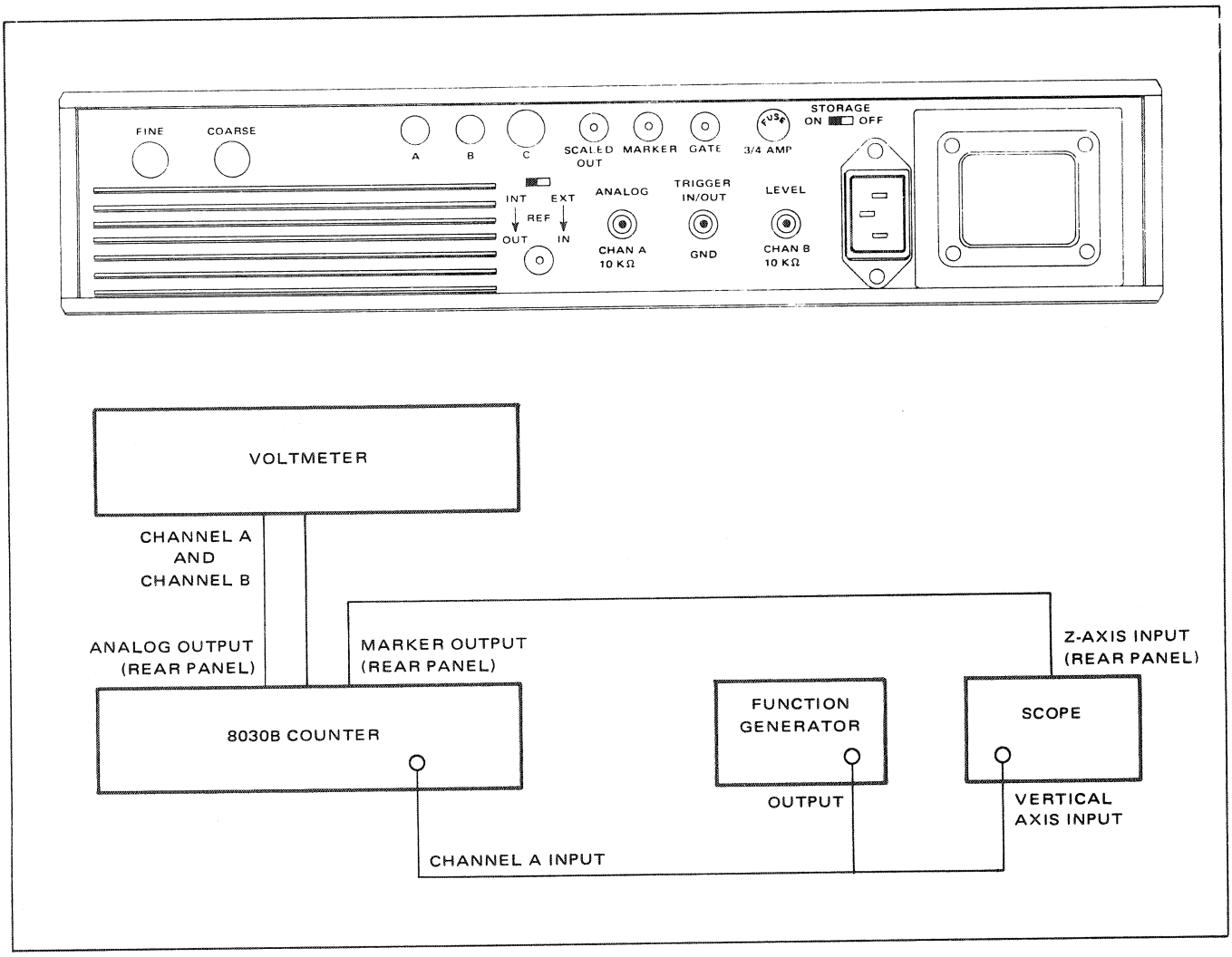
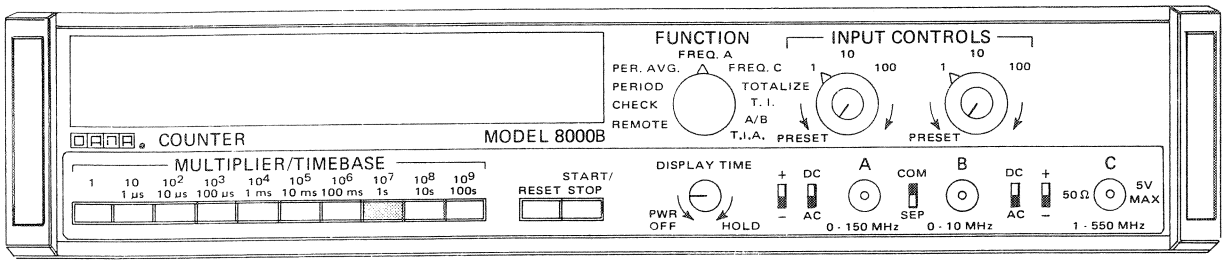


Figure 3.1 - Input Control and Marker Check Connections

Table 3.5 - Input Controls and Marker



DISPLAY TIME: Power on/CCW position
FUNCTION: FREQ A
TIME BASE: 1 second
SLOPE A: Minus (–)
SLOPE B: Minus (–)
COUPLING A: AC
STORAGE: ON (rear panel)

COUPLING B: AC
INPUT RANGE CONTROL A: 1
INPUT RANGE CONTROL B: 1
TRIGGER LEVEL A: PRESET
TRIGGER LEVEL B: PRESET
SEP/COM: COM

1. Set counter controls as shown above.

2. Connect Function Generator output to Input A on the counter. Also connect the Function Generator to the vertical input on an oscilloscope. Refer to figure 3.1 for all connections.

3. Adjust the Function Generator to 100 Hz at 4V peak to peak sine wave. Adjust the oscilloscope for a trace.

4. Connect voltmeter to the channel A Analog Output on the rear panel of the counter. For counters with Option 008, Systems Interface, connect to J110-S and J110-15.

5. Verify that the marker initiation is ±50 mVDC on the negative slope. Vary the channel A trigger level control and verify the marker initiation is variable over +3 volts to –3 volts on the negative slope of the sine wave.

6. Return channel A trigger level to the Preset position. Change channel A slope to (+) plus. Verify that the marker initiation is ±50 mVDC on the positive slope. Vary channel A trigger level control and verify the marker initiation is variable over +3 volts to –3 volts on the positive slope of the sine wave on the oscilloscope.

7. Return the channel A trigger level to Preset and the channel A slope to (–) minus.

8. Connect a voltmeter to the channel B Analog Output on the rear panel of the counter. For counters with Systems Interface, connect to J110-N and J110-15.

9. Verify that the marker termination is ±50 mVDC on the negative slope. Vary the channel B trigger level control and verify that the marker termination is variable over +3 volts to –3 volts on the negative slope of the sine wave.

10. Return channel B trigger level to Preset position. Change channel B slope to (+) plus. Verify that the marker termination is ±50 mVDC on the positive slope. Vary channel B trigger level control and verify the marker initiation is variable over +3 volts to –3 volts on the positive slope of the sine wave on the oscilloscope.

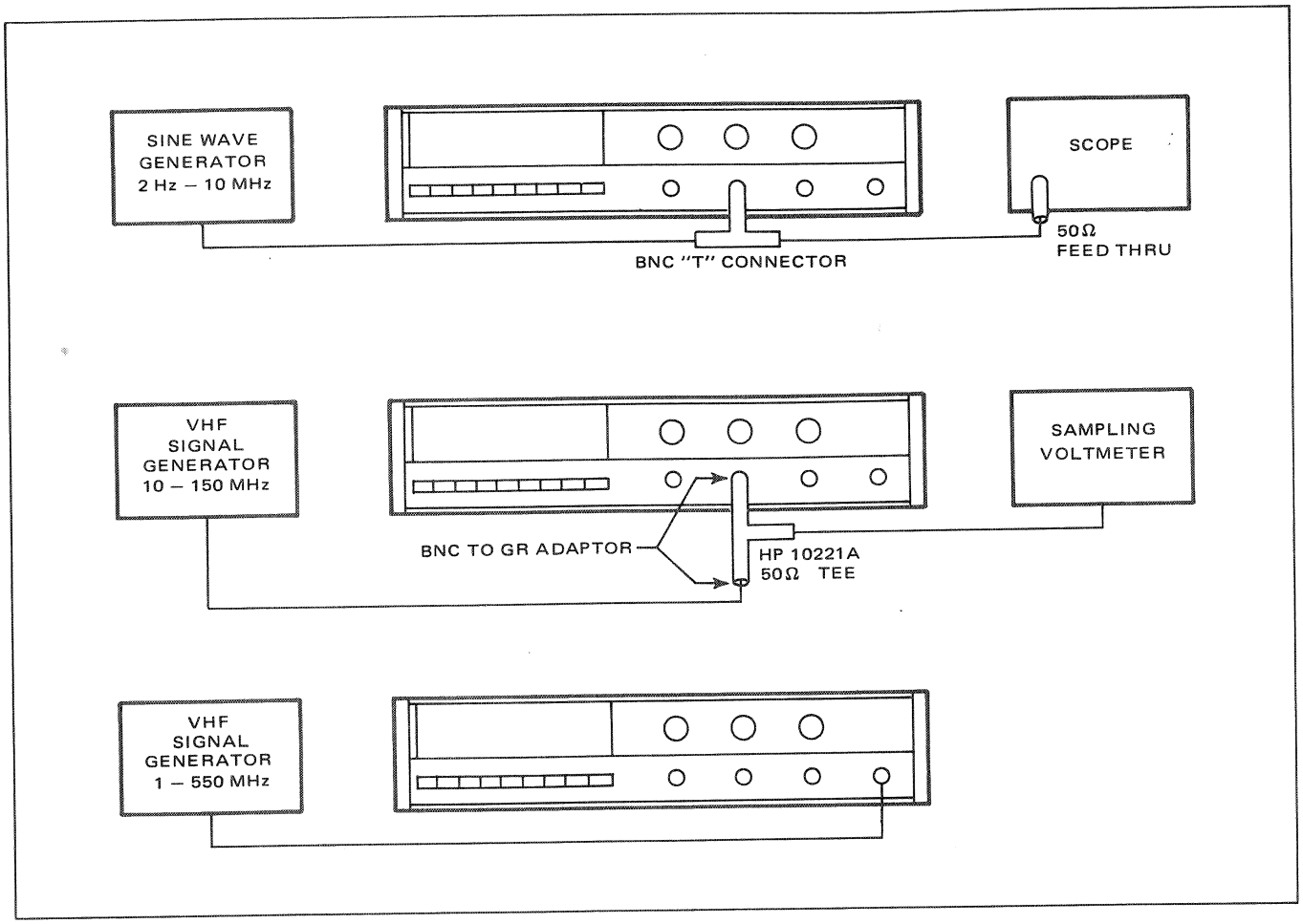
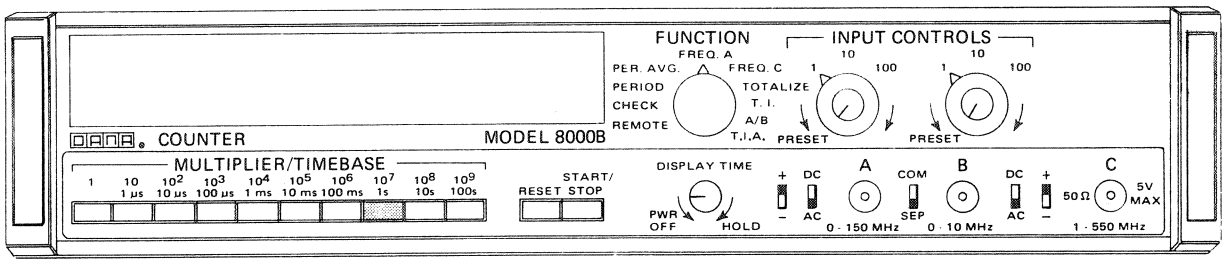


Figure 3.2 - Frequency Response Check Connections

Table 3.6 - Frequency Response and Sensitivity



DISPLAY TIME: Power on/CCW position
FUNCTION: FREQ A
TIME BASE: 1 second
SLOPE A: (+) Plus
SLOPE B: (+) Plus
COUPLING A: AC
STORAGE: ON

COUPLING B: AC
INPUT RANGE CONTROL A: 1
TRIGGER LEVEL CONTROL A: PRESET
INPUT RANGE CONTROL B: 1
TRIGGER LEVEL CONTROL B: PRESET
SEP/COM: SEP

1. Set controls as shown above.

2. Connect a BNC "T" connector to channel A input. Connect a sine wave generator (2 Hz – 10 MHz) and an oscilloscope to the "T" connector. Use a 50 ohm termination at the vertical input to the oscilloscope. Refer to figure 3.2 for hookup.

3. Adjust the sine wave generator between 10 Hz to 10 MHz maintaining 50 mV RMS output. Verify that the counter displays the frequency through this range. Change the A slope to (–) minus. Verify that the counter displays the frequency through this range.

4. Replace the sine wave generator with a VHF signal generator. Connect generator as shown in figure 3.2 and adjust for a 50 mV RMS output.

5. Set the Time Base to 1 second and the A slope to (+) plus.

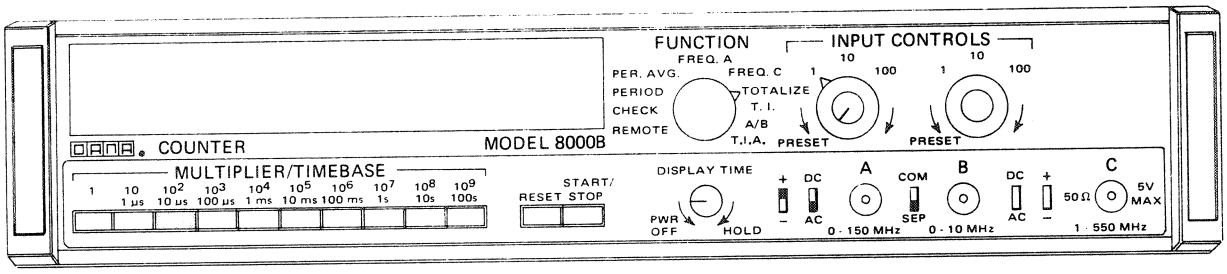
6. Vary the signal generator from 10 MHz to 100 MHz. Verify that the counter displays the frequency.

7. Set the output of the VHF signal generator to 100 mV RMS. Vary the signal generator from 100 MHz to 150 MHz. Verify that the counter displays the frequency.

8. Frequency C Models 8020B, 8030B. Change the function to Frequency C. Connect the VHF signal generator as shown in figure 3.2 and set the output to 50 mV RMS (for Option 030, set the output to 1 mV RMS). Vary the VHF signal generator between 1 MHz and 550 MHz (for Option 030, 10 MHz to 500 MHz).

9. The counter should display all frequencies in this range.

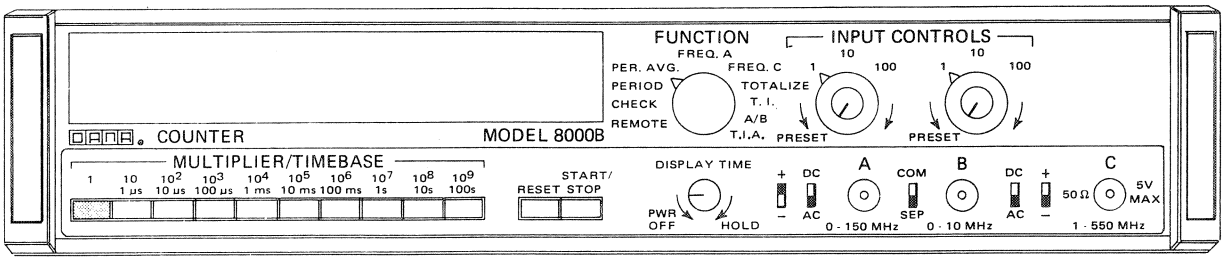
Table 3.7 - Totalize



DISPLAY TIME: Power on/CCW
FUNCTION: TOTALIZE
MULTIPLIER: 10^2
INPUT VOLTAGE RANGE A: 1
TRIGGER LEVEL A: PRESET

1. Set the counter controls as shown above.
2. Connect test oscillator to the counter at Input A. Set the oscillator output to .5V RMS at a frequency of 1 MHz.
3. Connect an oscilloscope to the scaled output jack on the counter rear panel.
4. Push the Reset on the counter. The display should read all zeros. Push the Start/Stop button. The display should totalize.
5. The scaled out should be a series of pulses with an amplitude of greater than 2V P.P. The scaled out repetition rate will be 1 kHz.
6. Depress the Start/Stop again. Totalizing should stop and the accumulated count should be displayed.
7. Push the Reset button and the display should be all zeros.

Table 3.8 - Period and Period Average



DISPLAY TIME: Power on/CCW
FUNCTION: PERIOD
MULTIPLIER: 1

INPUT VOLTAGE RANGE: 1
INPUT TRIGGER LEVEL A: PRESET

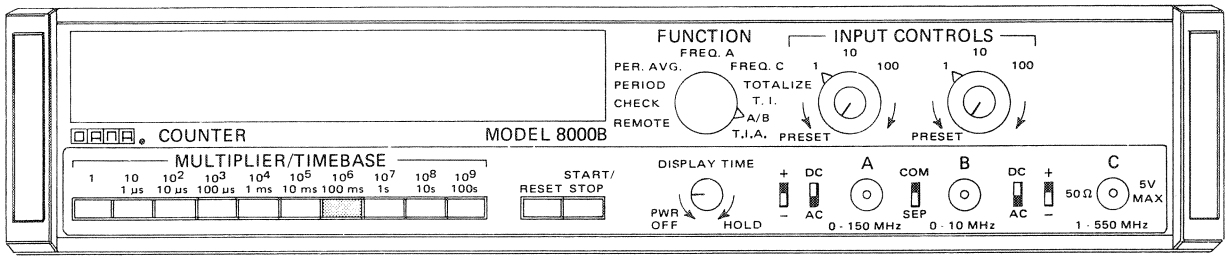
PERIOD

1. Set the counter controls as shown above.
2. Connect a test oscillator to Input A. Adjust the output of the oscillator to .5V RMS.
3. Vary the test oscillator frequency between 10 Hz and 10 MHz. The counter will display the period of the frequency.

PERIOD AVERAGE.

1. Set the Function switch to Period Average. Set the multiplier to 10.
2. Vary the test oscillator frequency between 10 Hz and 10 MHz.
3. The counter will display the period by taking the average period of the periods averaged.

Table 3.9 - A/B Ratio

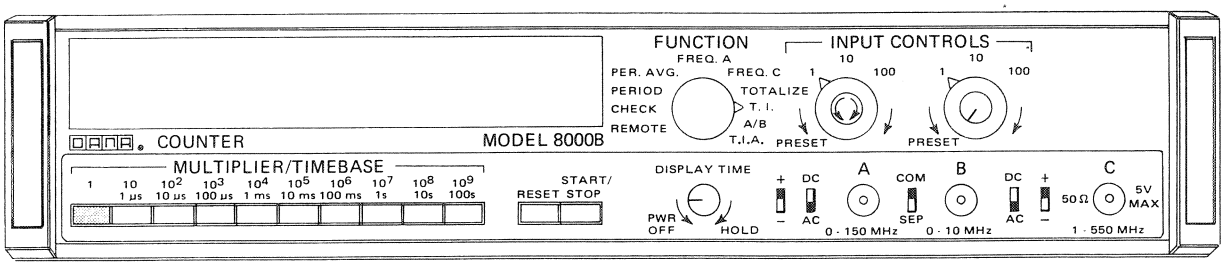


DISPLAY TIME: Power on/CCW
FUNCTION: A/B
MULTIPLIER: 10^6
SLOPE (A and B): (+) Plus
COUPLING (A and B): AC
INPUT VOLTAGE RANGE (A and B): 1
SEP/COM: COM
STORAGE: ON
TRIGGER LEVEL (A and B): PRESET

A/B RATIO

1. Set controls as shown above.
2. Adjust test oscillator output to 10 MHz at 100 mV RMS.
3. Connect test oscillator to Input A.
4. Counter should display 1000000 counts.

Table 3.10 - Time Interval and Time Interval Average



DISPLAY TIME: Power on/CCW
FUNCTION: T. I.
MULTIPLIER: 1
SLOPE A: (+) Plus
SLOPE B: (+) Plus
COUPLING A: AC
COUPLING B: AC

INPUT VOLTAGE RANGE A: 1
INPUT VOLTAGE RANGE B: 1
SEP/COM: COM
STORAGE: ON
TRIGGER LEVEL A: Adjust
TRIGGER LEVEL B: PRESET

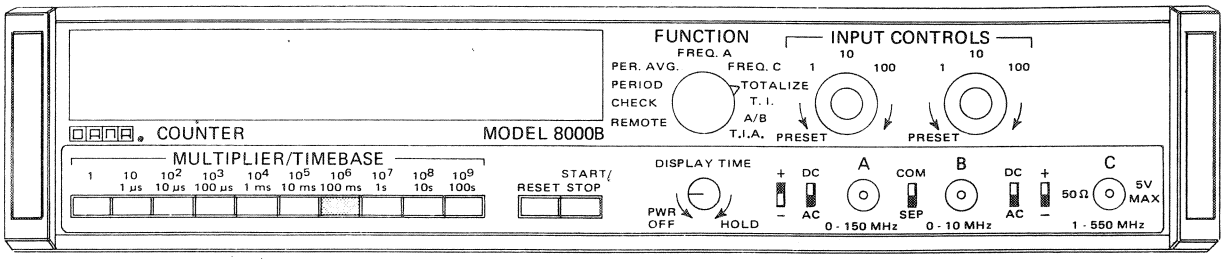
TIME INTERVAL

1. Set controls as shown above.
2. Connect pulse generator output and oscilloscope to a "T" connector. Connect the "T" connector to the input "A" on the counter. Use a 50 ohm feed through on the input to the oscilloscope.
3. Adjust the pulse generator output to 900 kHz repetition rate, with a 200 nanosecond pulse width at 1V peak to peak.
4. The counter will display the period of the waveform.
5. Set slope B to (–) minus. The counter will display pulse width.

TIME INTERVAL AVERAGE

6. Set the function to T.I. AVG., and the multiplier to 10^3.
7. The counter will display the pulse width of the input waveform.
8. Set the slope B to (+) plus. The counter will display the period of the input waveform.

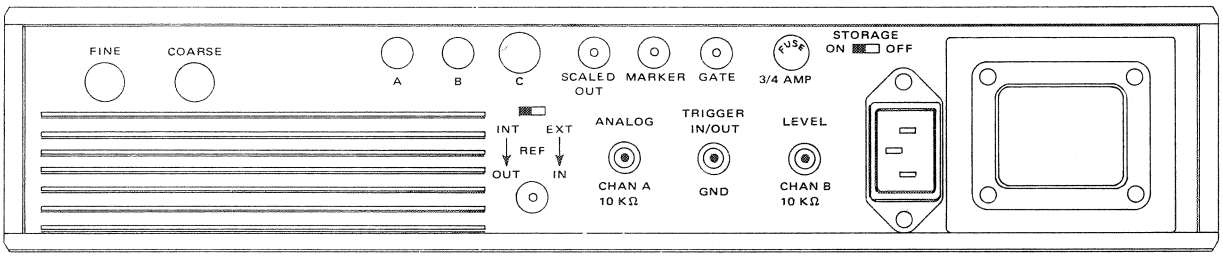
Table 3.11 - Display Time and Gate Output



DISPLAY: Power on/CCW

FUNCTION: TOTALIZE

1. Set controls as shown above.
2. Connect the vertical input of an oscilloscope to the gate output on the counter rear panel.
3. Press Reset and check that the gate output is low.
4. Press Start/Stop and check that the gate output is greater than 2V.
5. Press Start/Stop again and check that the gate output is low.
6. Set the Function switch to Frequency A and the Time Base to 100 msec.
7. Vary the Display Time and check that the repetition rate changes from approximately 30 milliseconds to 5 seconds.



4.1 GENERAL.

4.2 This section covers the theory of operation of the Series 8000B Counter. Operation of the unit is dependent on the measurement mode selected. For this reason, general operating principles of each mode of operation are described first followed by individual circuit descriptions. Where circuitry differences occur between models, the models covered are identified.

4.3 Drawings in this section are included for explanation only. For specific reference designators, wiring details, etc., refer to the complete schematics in Section 6.

4.4 MEASUREMENT MODES.

4.5 Figures 4.2 through 4.11 summarize the basic principles of each operating mode in simplified form. Any point (positive or negative) on the input waveform can be selected to trigger the generation of pulses to the main gate.

4.6 The block labeled "counter" refers to both a high-speed decade on the Switch board and the display counter. The high-speed decade divides its input by 10 and advances the display counter. It also updates the least-significant readout position (figure 4.1).

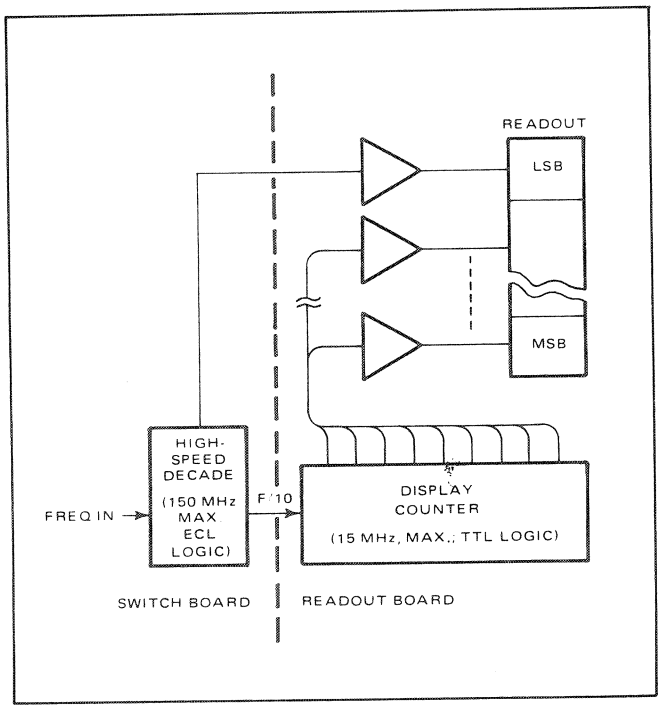


Figure 4.1 - Counter Definition

4.7 The "Display" block includes quad-latches and drivers for each of the readout positions (bits), and the readout tubes.

4.8 The "Reference Frequency" block can be either an external reference frequency or the internally generated reference frequency. The internal reference includes the reference oscillator (on Readout board), and the reference conditioning circuits (on the Switch board).

4.9 "Main Gate" refers to the logic that generates the signal $\overline{\Delta t}$. This signal controls the times at which the counter begins or stops counting. Counter operation is dependent on the mode of operation and other selections made by the operation (timebase, input trigger level, etc).

4.10 Self-Check Mode.

4.11 The Self-Check mode of operation (figure 4.2) enables the operator to check for proper operation of the counter. The reference frequency is used for two purposes. It is counted by the counter during the measurement time and it generates the time base frequency that produces the gating signal. Proper operation of the counter is determined by varying the time base and observing the readout (see Section 3, table 3.3).

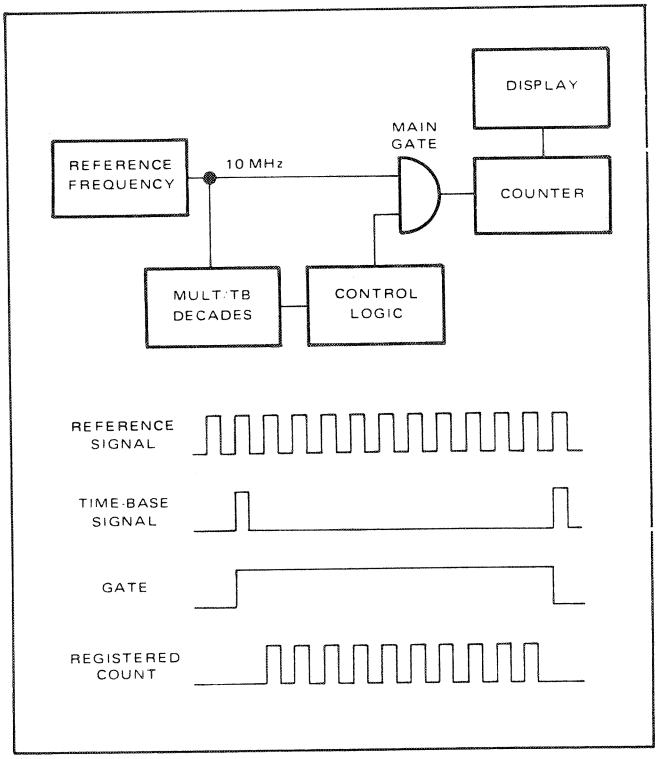


Figure 4.2 - Self-Check Mode

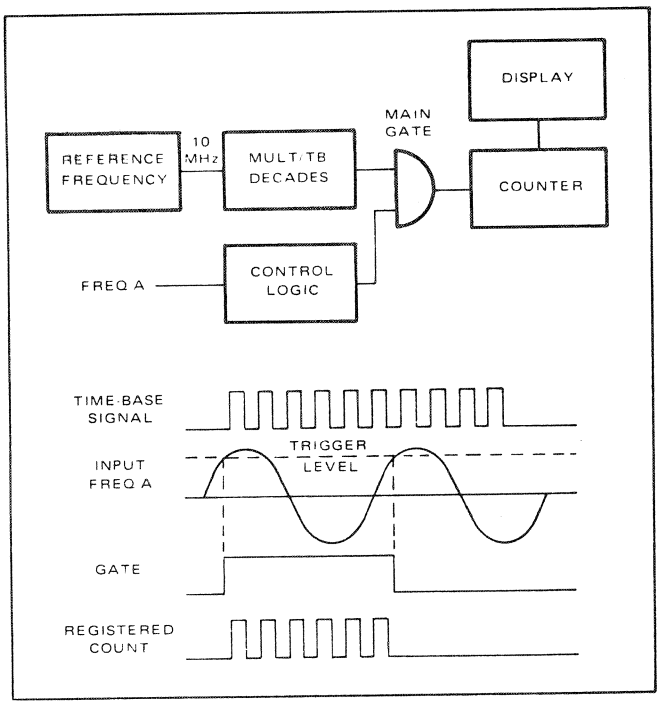


Figure 4.3 - Period Mode

4.12 Period Mode.

4.13 Period is the inverse of frequency. Therefore, frequency A is applied to the control logic and the reference frequency is connected to the multiplier/timebase decades (figure 4.3).

4.14 Clock pulses are derived by dividing down the 10 MHz reference oscillator output. The specific decade division is determined by the setting of the MULTIPLIER/ TIMEBASE switches. The output of the M/TB decades is presented to the input of the counter. Trigger pulses resulting from two consecutive signals from input A are applied to the control logic. The first trigger pulse opens the main gate; the next pulse closes it. During "gate open" time, the counter counts the applied clock pulses. The count is displayed on the readout directly in microseconds, milliseconds, or seconds, according to the MULTIPLIER/ TIMEBASE switch setting.

NOTE

Low Frequencies may be determined more accurately by measuring period rather than frequency directly. This is because the longer period of a low frequency allows more counts to accumulate in a period measurement. Therefore, resolution and accuracy are both improved.

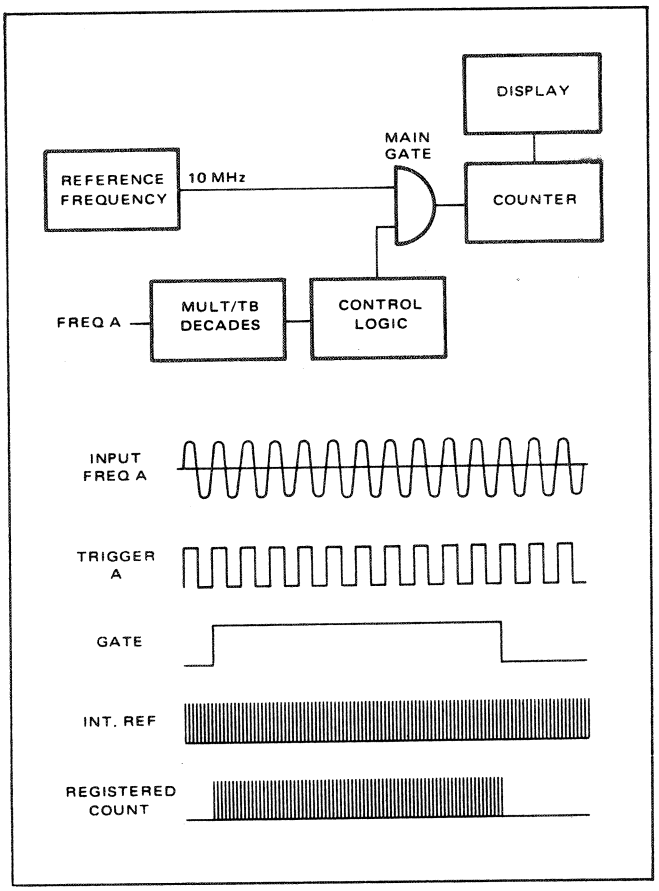


Figure 4.4 - Period Average Mode

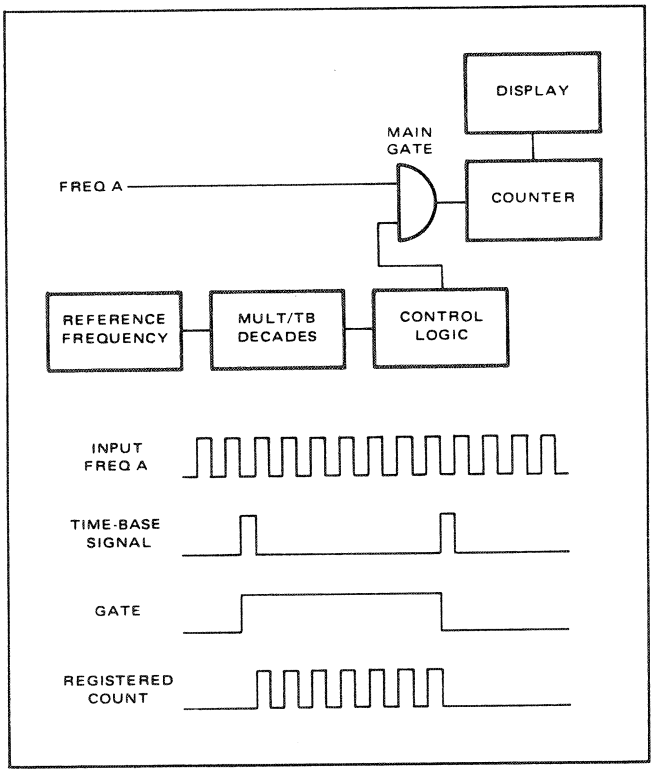


Figure 4.5 - Frequency "A" Mode

4.15 Period Average Mode.

4.16 Period Average mode is used to obtain increased resolution and accuracy over period measurements. The more periods over which a signal is averaged, the greater the accuracy of the measurement.

4.17 In this mode of operation (figure 4.4), the reference oscillator is routed directly to the main gate and the unknown frequency is routed through the multiplier/time base decades to the control logic which, in turn, controls the main gate. The pulses occurring during main "gate open" are counted, stored, and an accurate readout measurement is displayed. The "gate open" period is determined by the setting of the MULTIPLIER/TIMEBASE switches.

4.18 Frequency A Mode.

4.19 During direct frequency measurements, the counter compares the unknown frequency against the known reference frequency (figure 4.5).

4.20 Input signal F_a is routed to the main gate of the counter. The internal reference supplies a 10 MHz signal through the multiplier/time base decades and through the control logic to control the main gate.

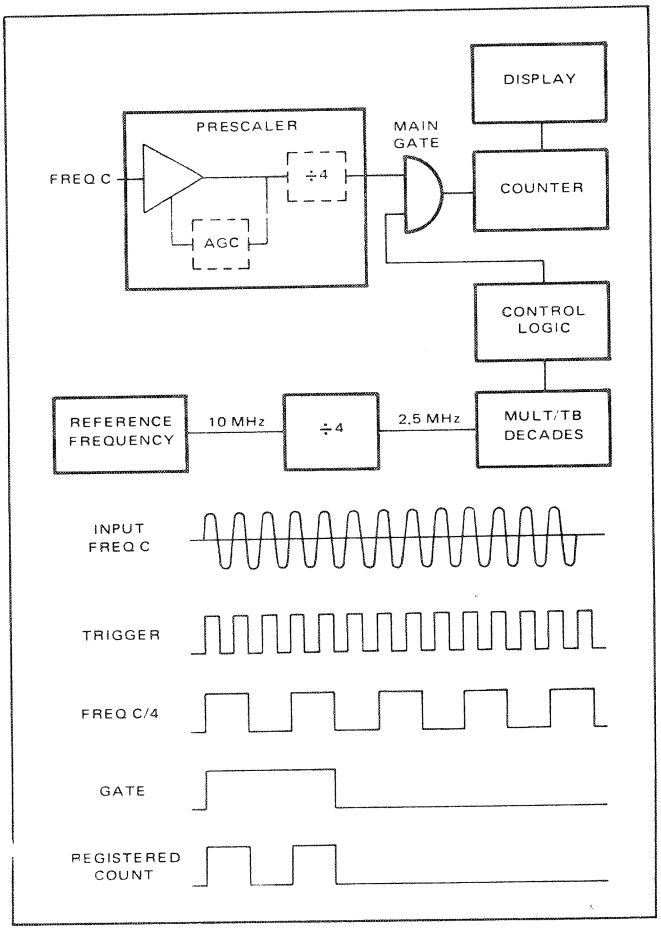


Figure 4.6 - Frequency C Mode

4.21 The number of input pulses accumulated during the main "gate open" interval is a measurement of the input frequency. The count obtained is displayed on the readout. This display may be retained until such a time as a new sample is ready to be displayed.

4.22 Frequency C Mode. (Not available in Model 8010B.)

4.23 In the Frequency C mode, the unknown frequency is applied to the main gate through the prescaler. The prescaler includes an amplifier, automatic gain control circuit, and a divide-by-four circuit (figure 4.6).

4.24 The AGC circuit maintains the required amplifier gain which alleviates the need for manual trigger and range control. The divide-by-four circuit is necessary to reduce the unknown frequency to a frequency which the main counter circuitry can count. The reference frequency is also divided by four to enable direct readout. The actual gate time is four times the selected time base.

4.25 Totalize Mode.

4.26 In Totalize mode, the main gate is controlled by the manual START/STOP switch on the front panel of the instrument or external START/STOP commands (figure 4.7).

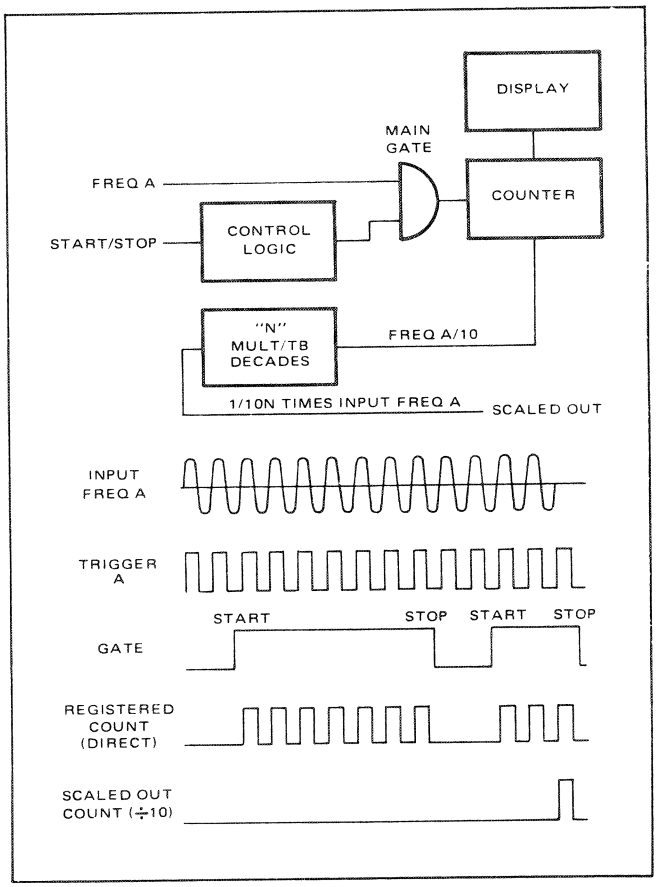


Figure 4.7 - Totalize Mode

4.27 With the first Start/Stop command, the control logic opens the main gate allowing the input pulses to be totalized by the counter. Simultaneously, a continuous update is supplied to the flip-flops which make up the display latches. The counter readout then represents the input pulses received during the interval between "start" and "stop". External start/stop commands may be applied via the REMOTE connector if equipped with the systems interface option.

4.28 In this mode, the instrument delivers a scaled output frequency to a connector on the rear panel, SCALED OUT. The output is the input signal frequency scaled by 1/10N where N is the multiplier setting.

4.29 Time Interval Mode.

4.30 The Time Interval mode of operation allows measurement of the time between two electrical events to a maximum resolution of 100 nanoseconds (figure 4.8). The first event (start) is connected to channel A and opens the gate. The second event (stop) is connected to channel B and closes the gate. These signals control the main gate through the control logic. Slope and trigger level controls on the front panel allow variable trigger levels on the + or – slope of the input waveforms. Pulses from the 10 MHz reference oscillator are routed to the multiplier/timebase decades and to the main gate.

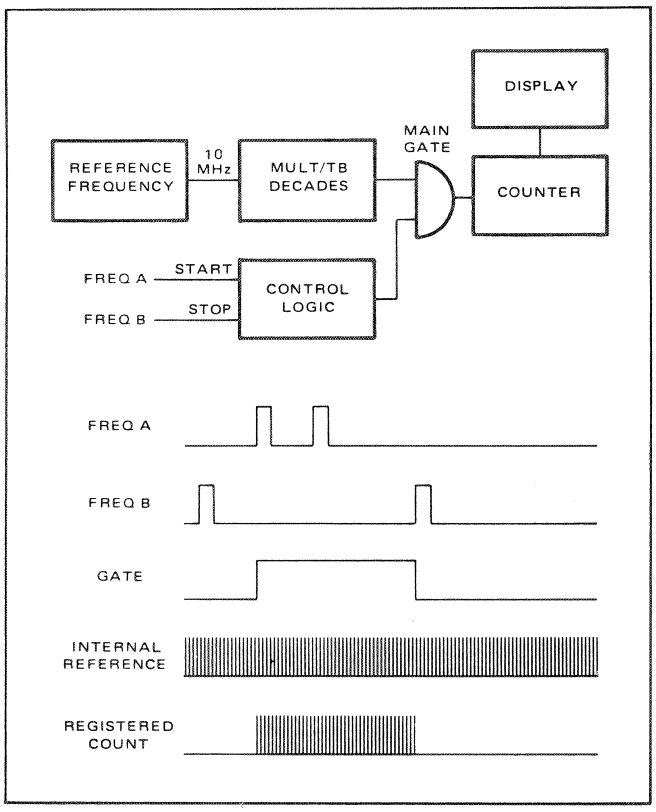


Figure 4.8 - Time Interval Mode

4.31 The pulses occurring during the main gate are counted and displayed. Channel A can be triggered after the channel B trigger in 30 ms on a single time interval measurement.

4.32 Time Interval Average.

4.33 Similar to the Time Interval mode of operation, the Time Interval Average mode measures the count accumulated during a multiple of intervals (figure 4.9). It then averages the count by shifting the decimal point and displaying the result. This mode of operation makes it possible to achieve greater resolution and accuracy when measuring time intervals. The A trigger point can follow the B trigger point as close as 200 nanoseconds.

> **NOTE**
>
> In T.I. Average mode, the input signals must be repetitive and asynchronous with the counter's time base.

4.34 A/B (Ratio) Mode.

4.35 This mode is identical in function to the frequency measurement modes, but substitutes an external signal for the reference frequency (figure 4.10).

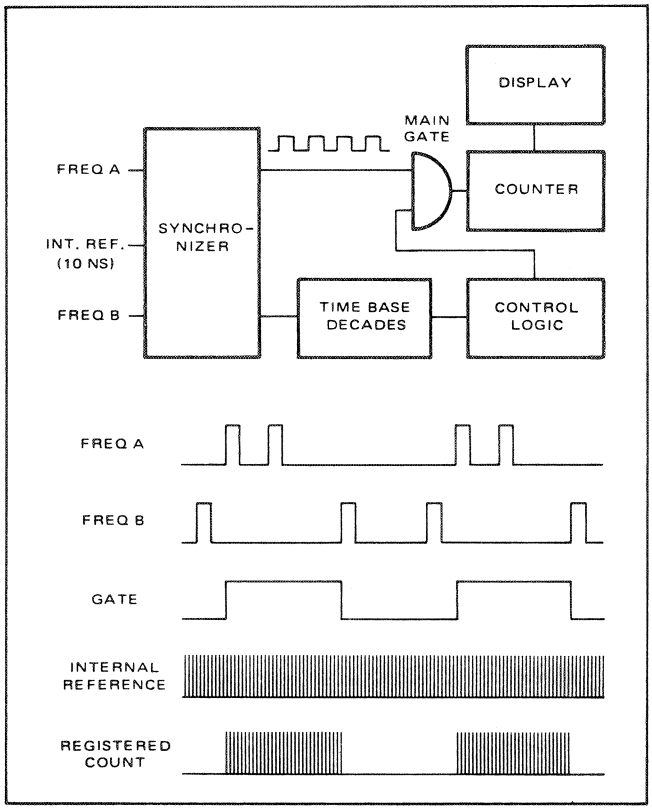


Figure 4.9 - Time Interval Average Mode

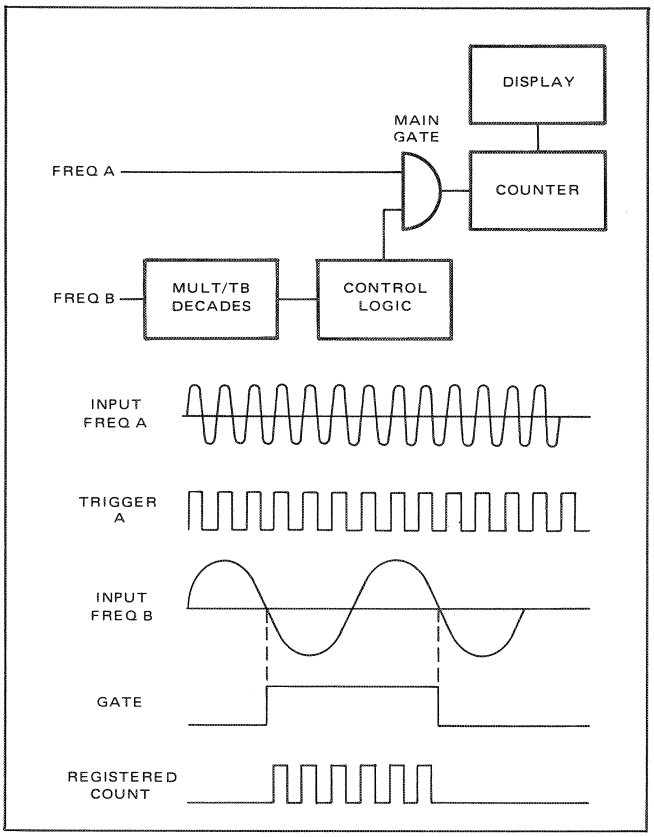


Figure 4.10 - A/B Ratio Mode

4.36 The higher of the two frequencies which are to be measured is connected to input A; the lower frequency to input B. Input B is applied to the multiplier/timebase decades. The higher the multiplier/timebase selected, the greater the resolution and the longer the measurement time. Two successive trigger pulses derived from the multiplier/timebase decades applied to input B open and close the main gate. During the "gate open" interval, the counter counts the trigger pulses derived from input A and the ratio Fa/Fb is then displayed on the readout.

4.37 CIRCUIT DESCRIPTIONS.

4.38 A block diagram of the counter is shown in figure 4.11. The circuit descriptions to follow make reference to the schematics in Section 6 as well as to partial schematics within this section.

4.39 Prescaler (Schematic: figures 6.13 and 6.15). Not available in Model 8010B.

4.40 The Prescaler provides the signal conditioning function for channel C. It accepts frequencies from 1 MHz to 550 MHz (10 MHz to 500 MHz with 030 option), automatically controls the amplitude of the signal, and divides the frequency of the signal by a factor of four. The scaling reduces the incoming signal to a rate compatible with the

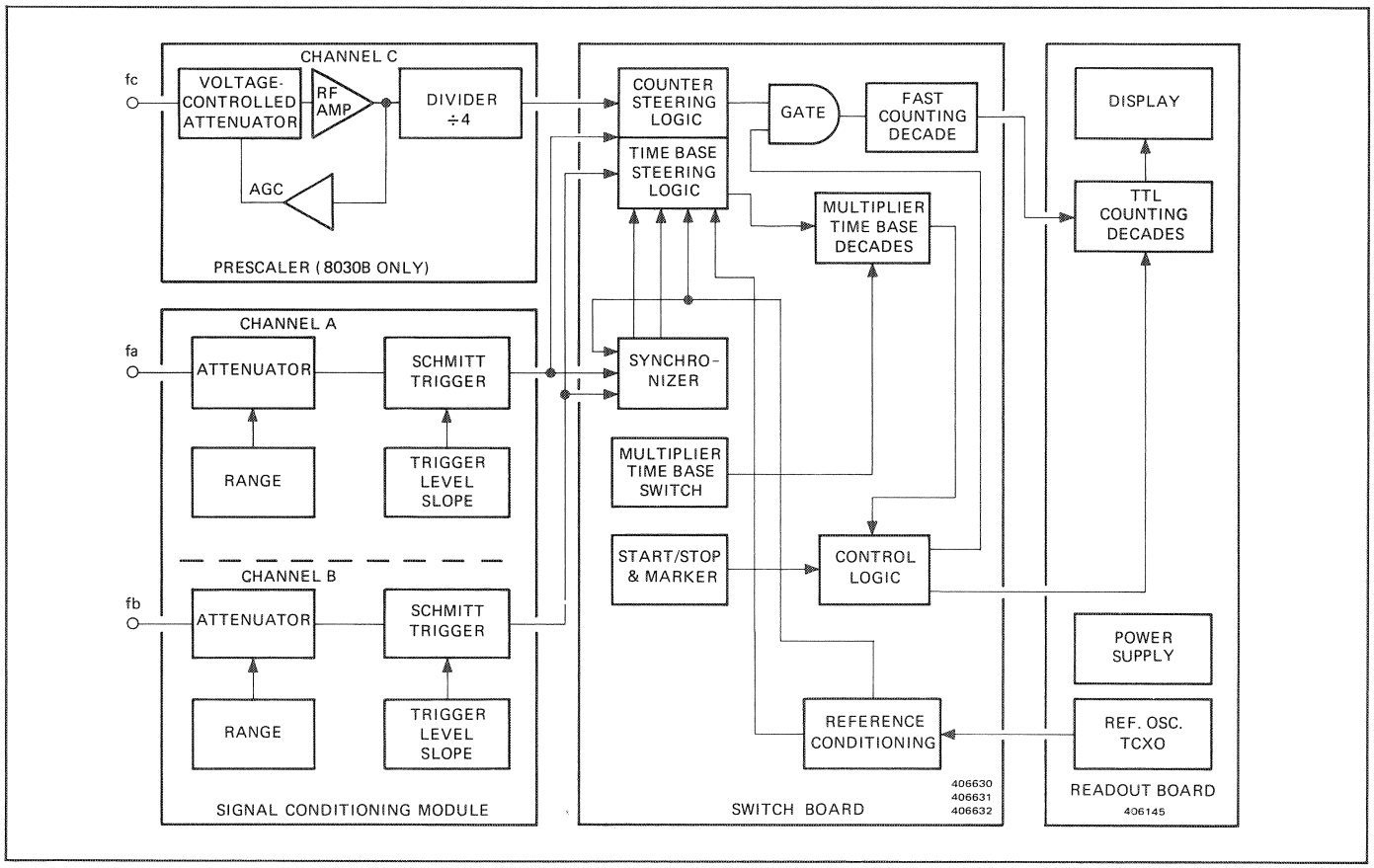


Figure 4.11 - Functional Block Diagram (All Models)

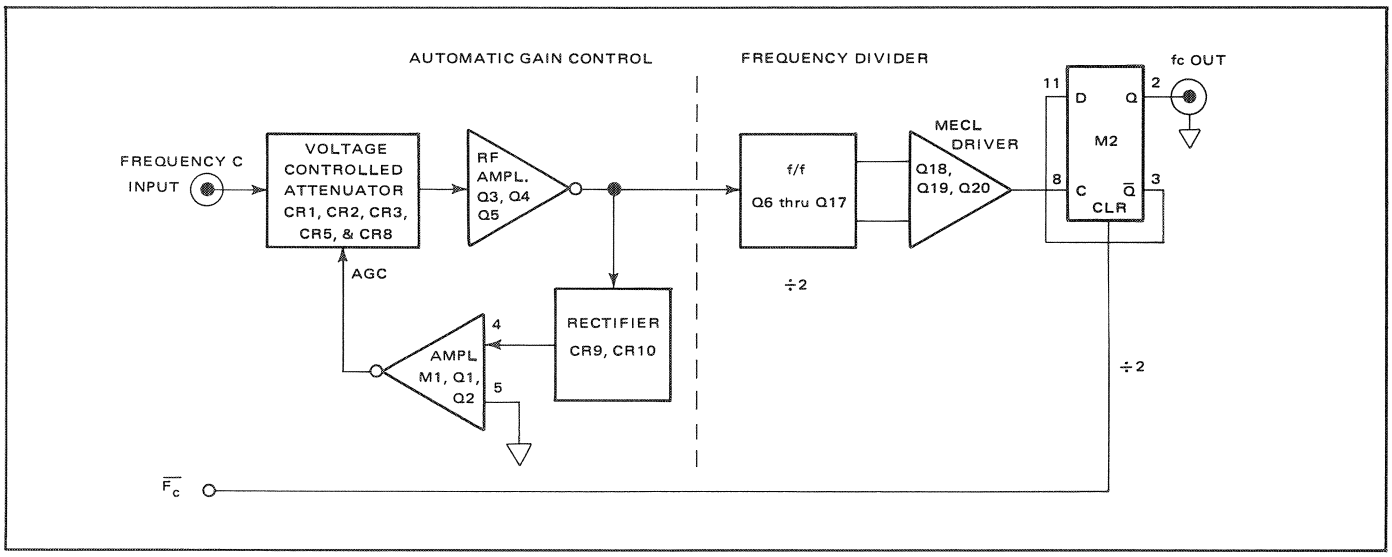


Figure 4.12 - 550 MHz Prescaler

high-speed decades. The circuitry, shown simplified in figure 4.12, is divided into two sections: the automatic gain control section (including the attenuator) and the frequency divider section.

4.41 AUTOMATIC GAIN CONTROL.

4.42 The "C" input signal from the input connector passes through the voltage-controlled attenuator to the RF amplifier. The attenuator consists of two diodes in series with the signal path and three diodes shunting the signal path. With no signal from the AGC amplifier (M1), series diodes CR2 and CR5 are forward-biased providing a low impedance signal path while shunting diodes CR1, CR3, and CR8 are back-biased and provide little attenuation to the signal. As the AGC signal goes negative, series diodes CR2 and CR5 conduct less, increasing their apparent impedance while the diodes in shunt begin conducting and attenuating the signal. The signal from the attenuator passes through the three-stage amplifier (Q3, Q4, and Q5) which increases the signal level to approximately 200 mV rms. The AGC circuit maintains 200 mV rms at the bases of Q11 and Q14.

4.43 The output of the amplifier is applied to the divider section and to a voltage rectifier circuit consisting of diodes CR9 and CR10. The rectifier produces a positive dc voltage level proportional to the RF level of the amplifier output which, after amplification and inversion by differential amplifier M1, controls the attenuator. The gain control circuit holds the signal level of the amplifier input to approximately 50 mV (1 mV with option 030). With option 030, operation is the same as described for the standard Prescaler, but an additional stage of amplification is included (see schematic, figure 6.15).

4.44 FREQUENCY DIVIDER.

4.45 This portion of the Prescaler consists of a discrete transistor flip-flop, a driver circuit (Q18, Q19, and Q20), and a ECL* type D flip-flop, M2. The discrete transistor flip-flop consists of transistors Q6 through Q17. The function of this circuit is to divide the frequency of the signal by two. At low frequency operation, the information is transferred so fast (on the positive edge of the pulse) that it is possible for the flip-flop to go into oscillation at a natural resonate frequency of 300 MHz. A Skew circuit is employed to guard against self oscillation.

4.46 The driver stage for the discrete flip-flop consists of Q8, Q11, Q14, and Q17. The level at which transistors Q8 and Q11 switch is the same at all frequencies. The level at which transistors Q14 and Q17 switch is controlled by the skew circuit consisting of C35, CR16, R55, R59, and C38. The output of the skew circuit is frequency dependent. At frequencies below 300 MHz, the current path is from −18V through resistors R59, R55, and diode CR16 to ground. This biases Q17 at −.2V. Below 300 MHz, the input signal has to overcome the −.2V bias on Q17 base before the flip-flop toggles. As the frequency goes above 300 MHz, the impedance of capacitor C35 decreases and the signal coupled by C35 increases in amplitude. The signal is rectified by CR16. As the frequency continues to increase, capacitor C38 charges to a higher DC level (approaching zero) removing the −.2 volts bias.

4.47 Diodes CR11 through CR14 are level shifters which increase the rise and fall time of the discrete flip-flop. The output of the discrete flip-flop is amplified by Q18, Q19,

*emitter-coupled logic

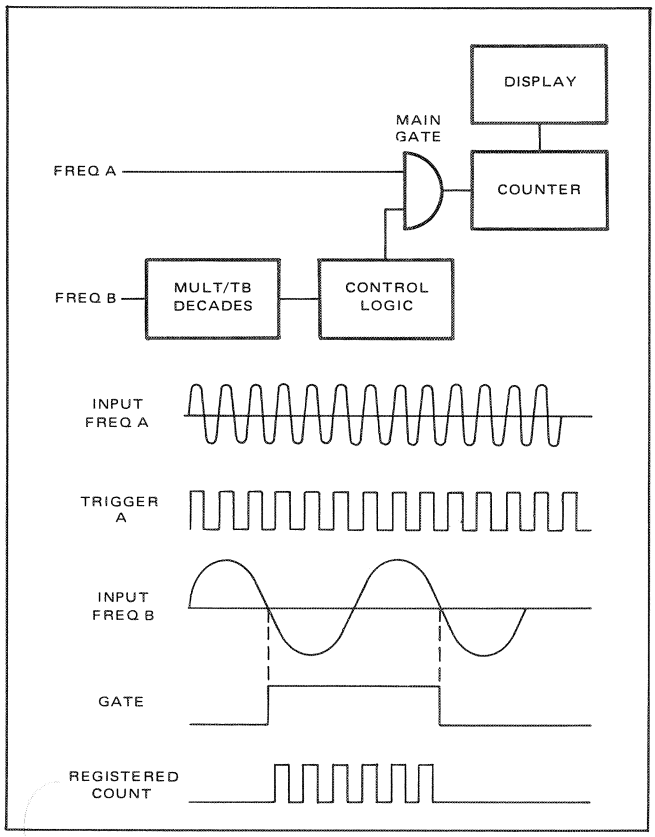


Figure 4.10 - A/B Ratio Mode

4.36 The higher of the two frequencies which are to be measured is connected to input A; the lower frequency to input B. Input B is applied to the multiplier/timebase decades. The higher the multiplier/timebase selected, the greater the resolution and the longer the measurement time. Two successive trigger pulses derived from the multiplier/timebase decades applied to input B open and close the main gate. During the "gate open" interval, the counter counts the trigger pulses derived from input A and the ratio Fa/Fb is then displayed on the readout.

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4.38 A block diagram of the counter is shown in figure 4.11. The circuit descriptions to follow make reference to the schematics in Section 6 as well as to partial schematics within this section.

4.39 Prescaler (Schematic: figures 6.13 and 6.15). Not available in Model 8010B.

4.40 The Prescaler provides the signal conditioning function for channel C. It accepts frequencies from 1 MHz to 550 MHz (10 MHz to 500 MHz with 030 option), automatically controls the amplitude of the signal, and divides the frequency of the signal by a factor of four. The scaling reduces the incoming signal to a rate compatible with the

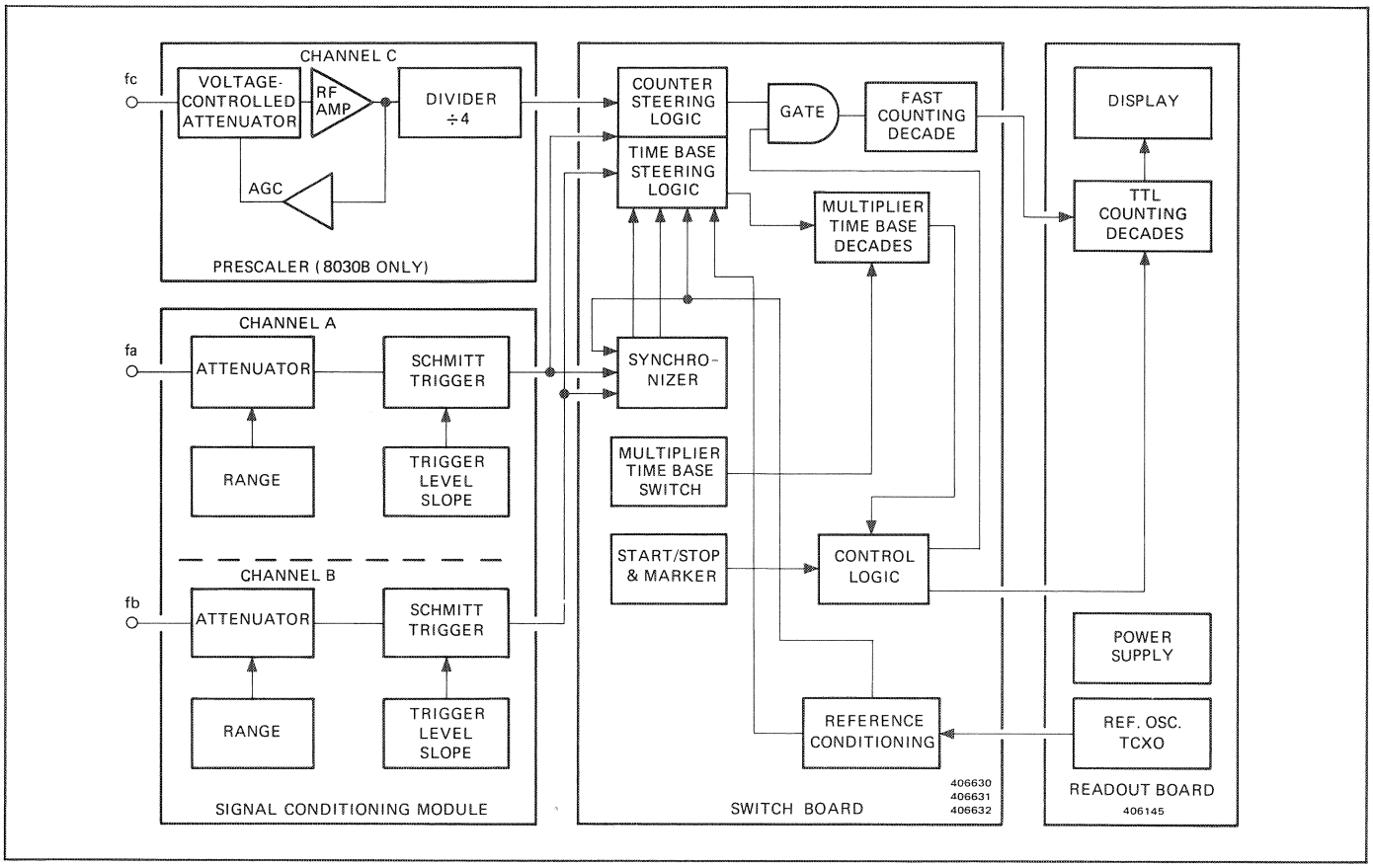

Figure 4.11 - Functional Block Diagram (All Models)

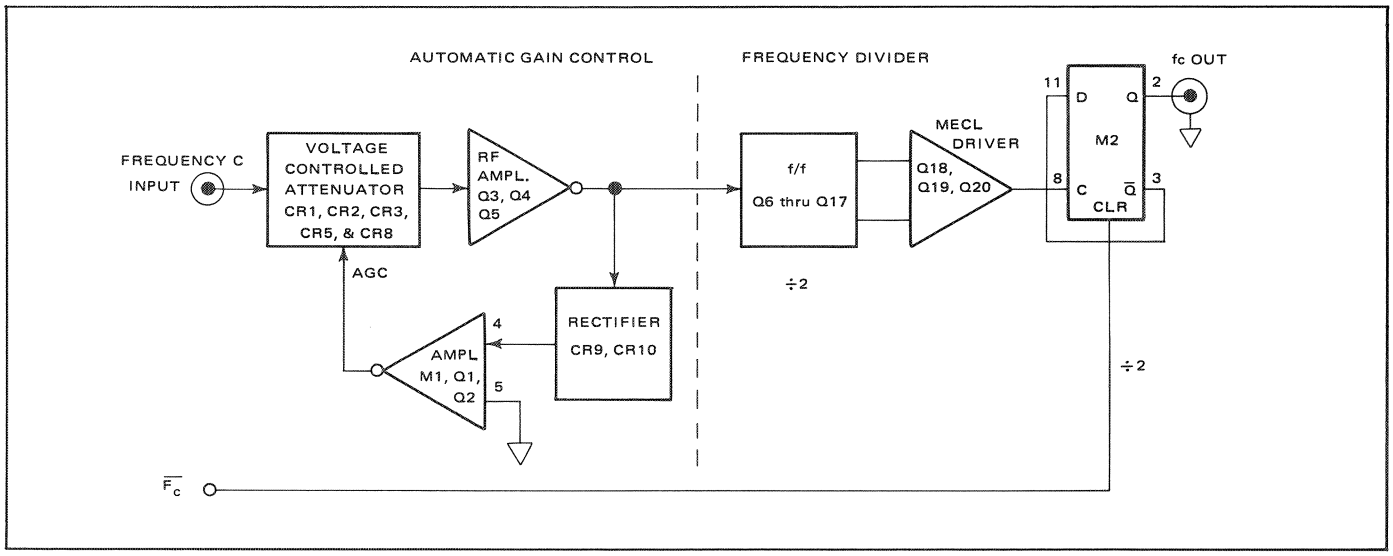

Figure 4.12 - 550 MHz Prescaler

high-speed decades. The circuitry, shown simplified in figure 4.12, is divided into two sections: the automatic gain control section (including the attenuator) and the frequency divider section.

4.41 AUTOMATIC GAIN CONTROL.

4.42 The "C" input signal from the input connector passes through the voltage-controlled attenuator to the RF amplifier. The attenuator consists of two diodes in series with the signal path and three diodes shunting the signal path. With no signal from the AGC amplifier (M1), series diodes CR2 and CR5 are forward-biased providing a low impedance signal path while shunting diodes CR1, CR3, and CR8 are back-biased and provide little attenuation to the signal. As the AGC signal goes negative, series diodes CR2 and CR5 conduct less, increasing their apparent impedance while the diodes in shunt begin conducting and attenuating the signal. The signal from the attenuator passes through the three-stage amplifier (Q3, Q4, and Q5) which increases the signal level to approximately 200 mV rms. The AGC circuit maintains 200 mV rms at the bases of Q11 and Q14.

4.43 The output of the amplifier is applied to the divider section and to a voltage rectifier circuit consisting of diodes CR9 and CR10. The rectifier produces a positive dc voltage level proportional to the RF level of the amplifier output which, after amplification and inversion by differential amplifier M1, controls the attenuator. The gain control circuit holds the signal level of the amplifier input to approximately 50 mV (1 mV with option 030). With option 030, operation is the same as described for the standard Prescaler, but an additional stage of amplification is included (see schematic, figure 6.15).

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4.47 Diodes CR11 through CR14 are level shifters which increase the rise and fall time of the discrete flip-flop. The output of the discrete flip-flop is amplified by Q18, Q19,

*emitter-coupled logic

and Q20. The signal is applied to ECL flip-flop M2. The reset line of M2 is controlled by $\overline{Fc}$. When Frequency C is selected $\overline{Fc}$ is false, M2 is released from the reset state and divides the frequency of the signal by two. The signal (now divided by four) is fed to the input gate of the steering logic. When $\overline{Fc}$ is true, Frequency C is not selected and the flip-flop M2 output is held in the reset state.

4.48 Signal Conditioning Module (Schematic: figure 6.2).

4.49 In Model 8020B, the Signal Conditioning Module conditions the signal to be compatible with ECL logic and establishes the trigger level of the channel A input. In Models 8010B and 8030B, an additional (and basically identical) module is used for conditioning the channel B input.

4.50 In dual-channel models, the input to the channel B Signal Conditioning Module comes from either of two sources depending on the position of the SEP/COM switch. In the COM (common) position, the B input signal is from the channel A input connector (and common with A). In SEP (separate), the signal is from the B input connector (figure 4.13).

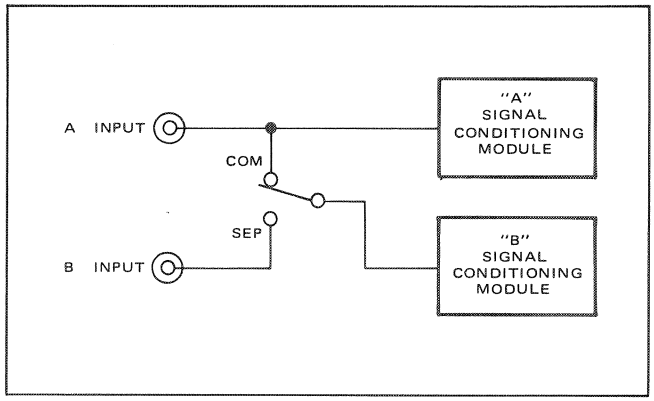


Figure 4.13 - SEP/COM Switch

4.51 Since the modules are identical for channels A and B, only channel A Signal Conditioning is described.

4.52 CHANNEL A ATTENUATOR (figure 4.14).

4.53 With the AC/DC coupling switch set to AC, the signal applied to input A flows through capacitor C1; with DC selected, the capacitor is bypassed through the coupling switch, S207. The signal flows through the attenuator according to the range selected. In the 1-volt range, the signal passes directly through the INPUT VOLTAGE range switch; in the 10-volt range, the signal is attenuated by a factor of 10 (20 dB); and in the 100 volt range, the signal is attenuated by a factor of 100 (40 dB). From the range switch, the signal passes through 100-kilohm resistor R4 in parallel with 47 pfd capacitor C2 to the signal conditioning network.

4.54 SCHMITT TRIGGER.

4.55 As shown in figure 4.14, the signal from the channel A attenuator (f_a in) flows through emitter follower circuits Q1 and Q2. Transistors Q4 and Q8 form a gain stage to drive the input side of a Schmitt trigger consisting of transistors Q3, Q5, Q6, and Q7. The signal from the attenuator is prevented from exceeding ±4 volts by clamp zener diodes CR1, CR2 and diodes CR3 and CR4. The trigger level of the trigger circuit is determined by the potential applied to the input of the follower circuits consisting of Q9 and Q10. With PRESET selected (the extreme counter-clockwise position of the front panel trigger level

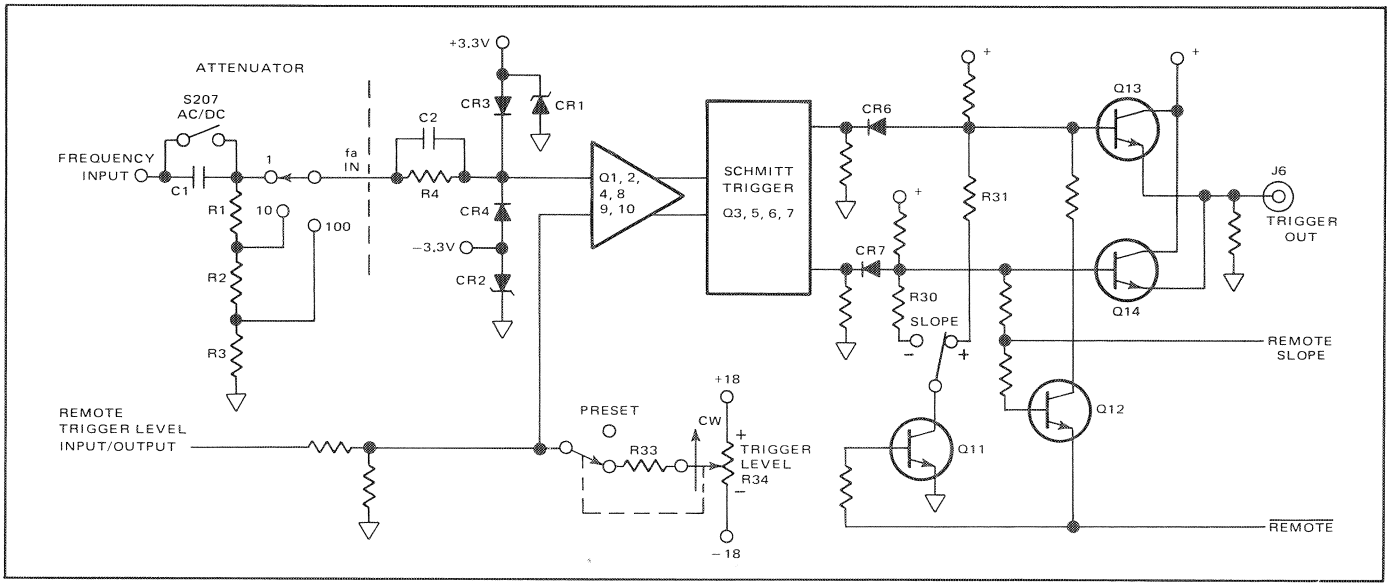


Figure 4.14 - Signal Conditioning Block Diagram

control) and assuming no remote level input, the trigger level is approximately zero volts (0 VDC ± 5% of the input voltage range selected). With PRESET out, the trigger level is adjustable by the trigger level control across ±300% of the range selected. The trigger level may be monitored by connecting a voltmeter across the analog output on the rear panel.

4.56 SLOPE.

4.57 The trigger circuit generates two outputs (180° out of phase) which are gated through diode CR6 or diode CR7, depending on the position of the +/– slope switch. With + slope selected, the anode of diode CR6 is held low through R31 and Q11. A positive pulse is generated during the positive-going edge of the input signal and passes through CR7, through Q14 to connector J6. With – slope selected, the anode of diode CR7 is held low through R30 and Q11. A positive pulse, generated during the negative-going edge of the input signal, passes through CR6 through Q13 to connector J6. When Remote is not selected, transistor Q11 is conducting and the signal that appears at J6 is determined by the position of the +/– (slope) switch on the front panel. In Remote, Q11 is off and Q12 determines the signal at J6.

4.58 Switch Board Assembly (Schematic: figure 6.4).

4.59 The Switch board assembly is one of two large printed circuit boards mounted to the base plate. The Switch board is accessible from the bottom of the counter. The switch board contains the following circuits: time base decades and switches, counter and time base steering logic, fast counting decade, control logic, reference conditioning, and a synchronizer circuit. Each circuit is described in the following paragraphs.

4.60 REFERENCE CONDITIONING CIRCUIT.

4.61 The Reference Conditioning circuitry converts the reference signal to a 10 MHz square wave and routes it to the steering circuits. This circuit processes a reference signal supplied either from the internal frequency source or from an external frequency standard through rear panel connector J106. The source is selected by the rear panel REF switch S102. The internal frequency source is a self-contained, temperature-compensated oscillator located on the Readout board. The external reference (1, 5, or 10 MHz) must be capable of delivering 1 volt RMS at connector J106 (input impedance is 1K ohm). With the REF switch set to the EXT position, an external signal is fed to the input of the conditioning circuitry and the signal path from the internal frequency source is open; with the INT position selected, the internal frequency source is supplied to the input of the conditioning circuitry and the output of the conditioning circuitry is routed to connector J106 for use as a secondary standard source.

4.62 The circuit is shown in simplified form in figure 4.15. The signal from the REF switch is shaped by the limiting action of inverter MA2 and applied to the Schmitt trigger circuit consisting of two inverters (MA2). The output is a square wave. The trigger output is differentiated through a capacitor-resistor combination (C37, R98) and the negative spikes from the differentiated signal are applied to the crystal filter circuitry (Q19, Y1). This circuit produces a 10 MHz damped oscillation that is sustained by input spikes at 10 MHz or by subharmonics at 1 and 5 MHz. The

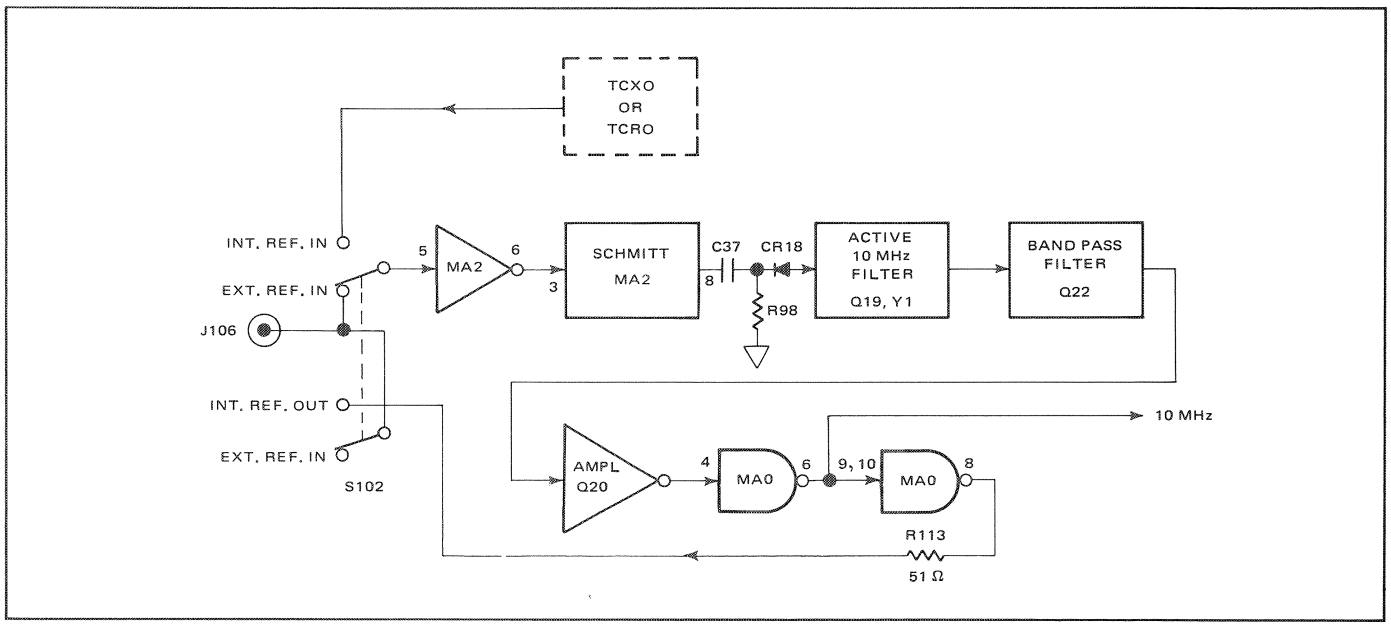


Figure 4.15 - Reference Conditioning Circuit

active filter output is applied to the bandpass filter, increasing the amplitude of the signal and removing the harmonics. The signal then flows through amplifiers Q20, Q21 and four NAND gates (MA0), two of which are used as inverters. The output of the first gate (MA0-6) is routed to the steering circuits in the instrument, the output of the second gate (MA0-8) passes through resistor R113 and the INT position of the reference switch to connector J106.

4.63 FAST COUNTING DECADE (Figure 6.4).

4.64 The Fast Counting Decade consists of four high-speed counters (MD2, MD3, and MD4) interconnected to form a divide-by-ten circuit. The BCD outputs of the counter are buffered and inverted through transistors Q3, Q4, Q5, and Q6 and routed to the quad latch ME9, driver MF9, and the least-significant digit readout of the Readout board. The buffered 4 and 8 bits from the decade are combined in NAND gate MC5 to form a quasi-square output (fa/10) with a frequency equal to 1/10 of the decade input signal. The counter is controlled by a gate signal applied to clock input C1 in the first flip-flop MD2. When C1 is false, the pulses at the clock input C2 are counted; when C1 is true, the flip-flop is inhibited. The gate control line connected to C1 is designated $\overline{\Delta t}$.

4.65 COUNTER STEERING LOGIC.

4.66 This circuitry routes signals to the input of the fast-counting decade according to the measurement mode selected. Signal flow through the circuit is shown in figure 4.16a through c.

4.67 Ratio, Totalize and Frequency A Modes (figure 4.16a).

4.68 Lines from the Ratio, Totalize and Frequency A positions of the FUNCTION switch are applied to a three-input NAND gate, MF5. The line for the selected mode is pulled low by the FUNCTION switch selection. The output of MF5 is high biasing CR1 and CR2 such that the f_a signal flows through CR1 and CR2 to MD1. MD1 is a ECL* four-input OR gate. The signal on pin 3 of MD1 causes the output of MD1 to change state (all other inputs to MD1 are low). The signal is routed to the clock input of MD2, a type D ECL flip-flop. Flip-flops MD2, MD3A, MD3B, and MD4 form a divide-by-ten fast-counting decade divider. The output of the fast counting decade drives the display counter on the Readout board and updates the least-significant digit of the readout.

4.69 Period and Time Interval Modes (figure 4.16b).

4.70 Signal flow in Period or Time Interval mode is as follows. Period or Time Interval is selected by the

*emitter-coupled logic

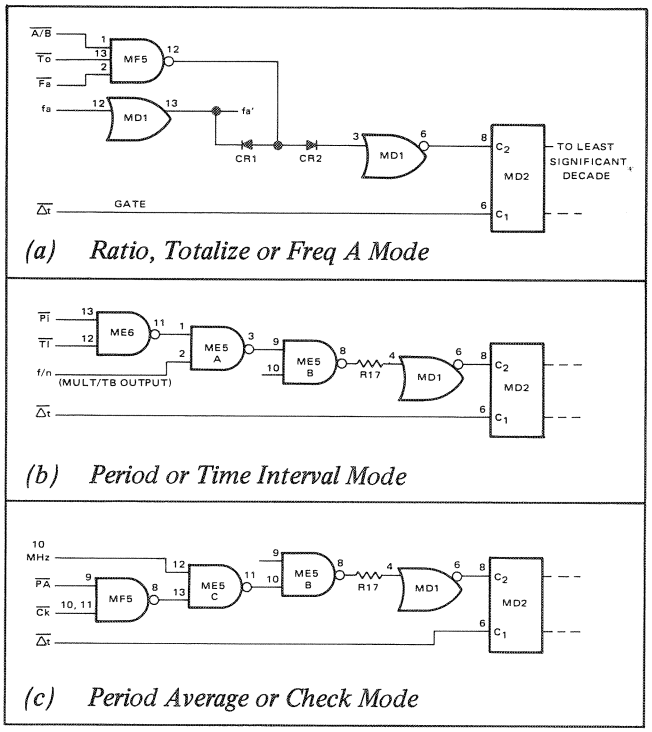


Figure 4.16 -Counter Steering Logic

FUNCTION switch, and one of the two lines, $\overline{PI}$ or $\overline{TI}$, is pulled to ground. These lines are connected to a two-input Nand gate, ME6. The output of ME6 goes high and is connected to the input to ME5A, a two-input Nand gate. The second input to ME5A is f/n. When the input line, pin 1, to ME5A is high, f/n is gated through ME5A and inverted. The signal is applied to the input (pin 9) of ME5B. The second input, pin 10, is high and the signal f/n is inverted through ME5B. The output of ME5B, f/n, goes to pin 4 of MD1, an ECL four-input NOR gate. The other three inputs to MD1 are low. The output of MD1 is routed to the clock input of the fast counting decade (MD2-8). The time that the counts are allowed to accumulate in the fast counting decade is controlled by $\overline{\Delta t}$ (main gate).

4.71 Period Average and Check (figure 4.16c).

4.72 Signal flow in Period Average or Check mode is as follows. Period Average or Check is selected by the FUNCTION switch, and one of the two lines, $\overline{PA}$ or $\overline{Ck}$, is pulled to ground. $\overline{PA}$ and $\overline{Ck}$ are connected to the inputs of a three-input Nand gate, MF5. The output of MF5 is high. The signal from MF5 is connected to two-input Nand gate, ME5C. The other input is connected to the 10 MHz Reference. The output of ME5C, (10 MHz) is connected to the input of a two-input Nand gate, ME5B. The other input to ME5B is high. The output of ME5B (10 MHz) is connected to the input of a four input ECL Nor gate, MD1. The other three inputs are low. The output of MD1 is routed to the clock input of the fast-counting decades (MD2-8).

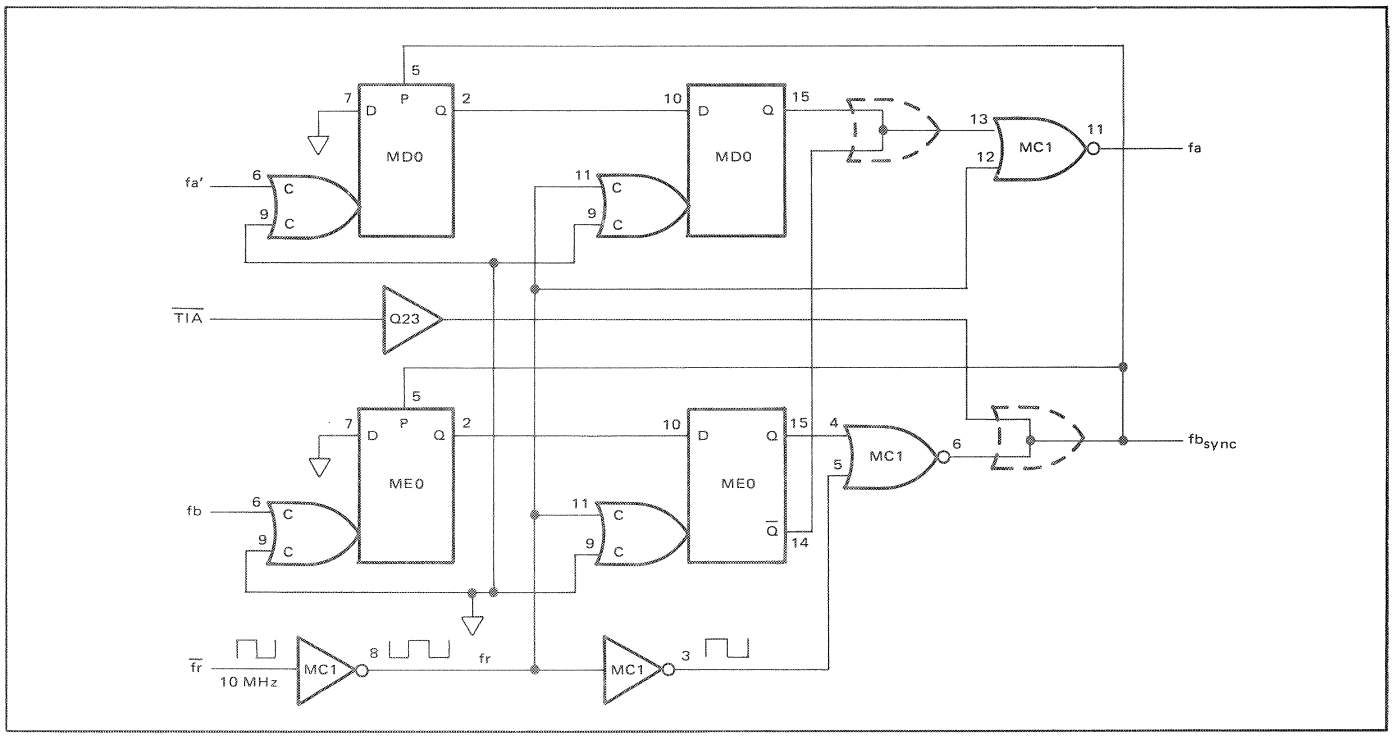


Figure 4.17 - Synchronizer Block Diagram

4.73 SYNCHRONIZER

4.74 The synchronizer circuit is utilized when the Time Interval Average mode is selected. The TIA mode averages a predetermined number of intervals. Two different types of gates are required: a synchronized gate to eliminate the ±1 count error for each interval averaged and a main gate to select the predetermined number of intervals to be averaged. Figure 4.17 shows a block diagram of the synchronizer and the timing diagram is shown in figure 4.18.

4.75 In Time Interval Average mode, the synchronizer will not be enabled until signal f_b SYN pulse occurs.

4.76 The first pulse on channel B (f_b) is routed to the synchronizer and is gated (MC1-6) with the reference signal. The signal f_b SYN, synchronous with the reference signal, is routed to the time base decades. This first f_b SYN pulse causes the time base decades to change from nines to zeros and produces the first f/n pulse. Signal f/n is routed to the START flip-flop in the control logic. The START flip-flop is set by the Start pulse which opens the main gate and generates $\overline{\Delta t}$.

4.77 The synchronizer is now ready to initiate a synchronized gate. The next pulse from channel A is routed to the synchronizer and allows the next reference pulse to open the synchronous gate (MC1-11). The output of the synchronous gate (10^7 counts per second) is routed to the counting decades. Since the main gate is already open because of the previous f_b SYN, the counting decades count the pulses. This is the start of the A-to-B interval measurement.

4.78 The next pulse to arrive on channel B produces f_b. Signal f_b is routed to the synchronizer and allows the next reference pulse to terminate the synchronous gate. The number of f_b SYN pulses to the time base decades required for the second f/n to be generated is dependent on the multiplier setting of the MULTIPLIER/TIMEBASE switches. If the "1" multiplier is selected, f/n is produced with the current f_b SYN pulse. If the "10" multiplier is selected, ten f_b SYN pulses must accumulate in the time base decade before the second f/n is generated. If f/n is not generated before f_a arrives, the pulses from the reference signal do not accumulate in the counter. Signal $\overline{f/n}$ is routed to the STOP flip-flop. The main gate and $\overline{\Delta t}$ are terminated with the second f/n. The display time flip-flop is reset for the display timeout. At the end of the display timeout, the update pulse is generated and the counter decades are reset to zero for a new measurement.

4.79 When the TIA mode is selected, Q23 is turned off releasing the Preset inputs to flip-flops MD0-5 and ME0-5. The output of transistor Q23 and the output of gate MC1-6 form a wired OR gate. The Q outputs of MD0 and ME0 have previously been preset. The Q outputs of MD0-15 and ME0-15 disable gates MC1-13 and MC1-4. Signal f_b

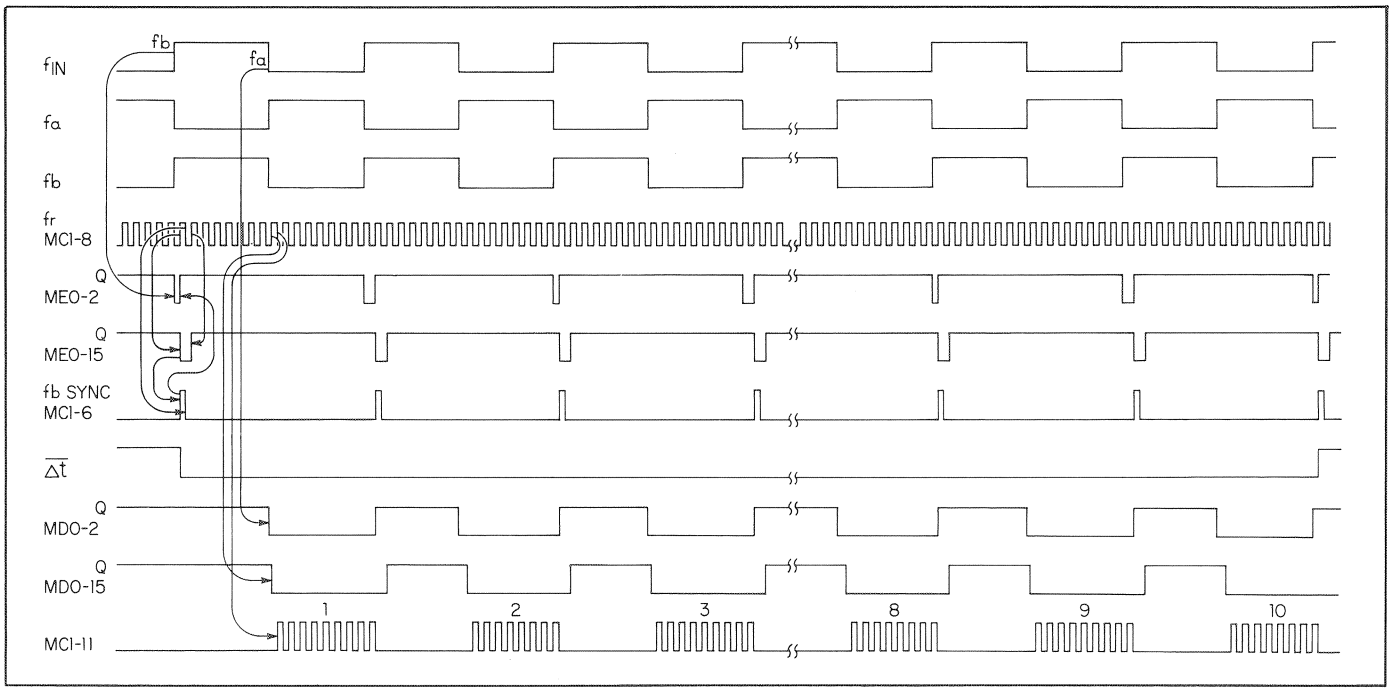


Figure 4.18 - Synchronizer Timing Diagram

clocks the low D input of ME0-7 to the Q output of ME0-2. On the next positive clock (fr) from inverter MC1-8, the low D input on ME0-10 is clocked to the Q output of ME0-15. The low Q output enables gate MC1-4. The reference clock now is inverted and appears at MC1-6. The high output of MC1-6, (f_b SYN) presets the Q outputs of flip-flops MD0-2 and ME0-2 high. Note that the Q output of MD0-2 is high because f_a has not clocked the low D input to the Q output (MD0-2). Signal f_b SYN goes to the multiplier time base decades. The trailing edge of the first f_b SYN causes the outputs of the multiplier time base decades to change state and open the main gate $\overline{\Delta t}$.

4.80 On the next positive clock pulse from inverter MC1-8, the high D input to ME0-10 is clocked to the Q output disabling the gate MC1-6 forming the trailing edge of f_b SYN. The output of gate MC1-6 goes low. The signal f_a arrives at the input to flip-flop MD0 and clocks the low D input to the Q output. The next positive output from inverter MC1-8 clocks the low D input of MD0-10 to the Q output enabling the synchronous gate MC1-11. The reference clock via MC1-8 and MC1-11 flows to the counting decades. Signal f_b arrives at the input to ME0-6 and clocks the low D input to the Q output. The next positive clock pulse from MC1-8 clocks the low D input to the Q output of ME0-15. The Q output of MD0-14 is connected to the Q output of MD0-15 and forms another wired OR gate. $\overline{Q}$ of ME0-14 causes the Q output of MD0-15 to go low disabling MC1-11 and stopping the reference clock to the counting decades. At the same time, gate MC1-6 is enabled for one clock pulse which presets flip-flops MD0-5 and ME0-5, and generates f_b SYN. Signal f_b SYN generates a stop pulse which causes the main gate to close, generation of the update pulse, and a clear to be generated clearing the counting decades. The process begins over again after timeout and the arrival of f_b, then f_a, in that order.

4.81 MULTIPLIER TIME BASE SWITCH LOGIC.

4.82 The interlocking pushbutton switches select one of ten decade divider outputs. The time base decades divide the signal applied to the input by 1, 10, 10^2, 10^3, 10^4, 10^5, 10^6, 10^7, 10^8, or 10^9. The outputs are selectable by the MULTIPLIER/TIME BASE switches. The MULTIPLIER/TIME BASE switch selected pulls the line low. The low level is routed to an inverter through a decoupling diode. The high output is connected to a two-input NAND gate. The other input of the NAND gate is connected to one of the ten outputs of the time base decades. If a multiplier of 10^2 through 10^9 is selected, the output signal of the nand gate is routed through a reclocking circuit. The reclocking circuit is necessary to remove the propogation delays developed in the time base decades. The 1 and 10 multipliers are routed around the reclocking circuit via two nand gates. The output of the gate is the frequency applied to the time base decades divided by the multiplier or f/n.

4.83 Signal f/n is used as a start/stop pulse within the counter and delivered to the rear panel as Scaled Out. Signal f/n is always produced with the first pulse applied to the time base decades and the first pulse is not dependent on the multiplier selected. The time base decades are reset to the nine state at the end of display time when $\overline{T^2\,CLEAR}$ goes low. When the first pulse is applied to the time base

decades, the output of the decades changes from all nines to all zeros. Thus, a change of state of output f/n is produced from any one of the ten multiplier switch positions.

4.84 The signal f/n is derived from various input signals to the time base decades. The reference oscillator (10 MHz) is applied to the input of the time base decades in the Check, Frequency A, Period and Time Interval modes. Selection of the MULTIPLIER/TIME BASE switches determines the repetition rate of f/n. Frequency A is applied to the input in Period Average mode. Selection of the switches determines the number of periods of f_a to be measured before f/n is generated. Frequency B is applied to the input in Ratio and Time Interval Average modes. Selection of the switches selects the number of periods of f_b input to be counted before f/n is generated. Frequency A divided by

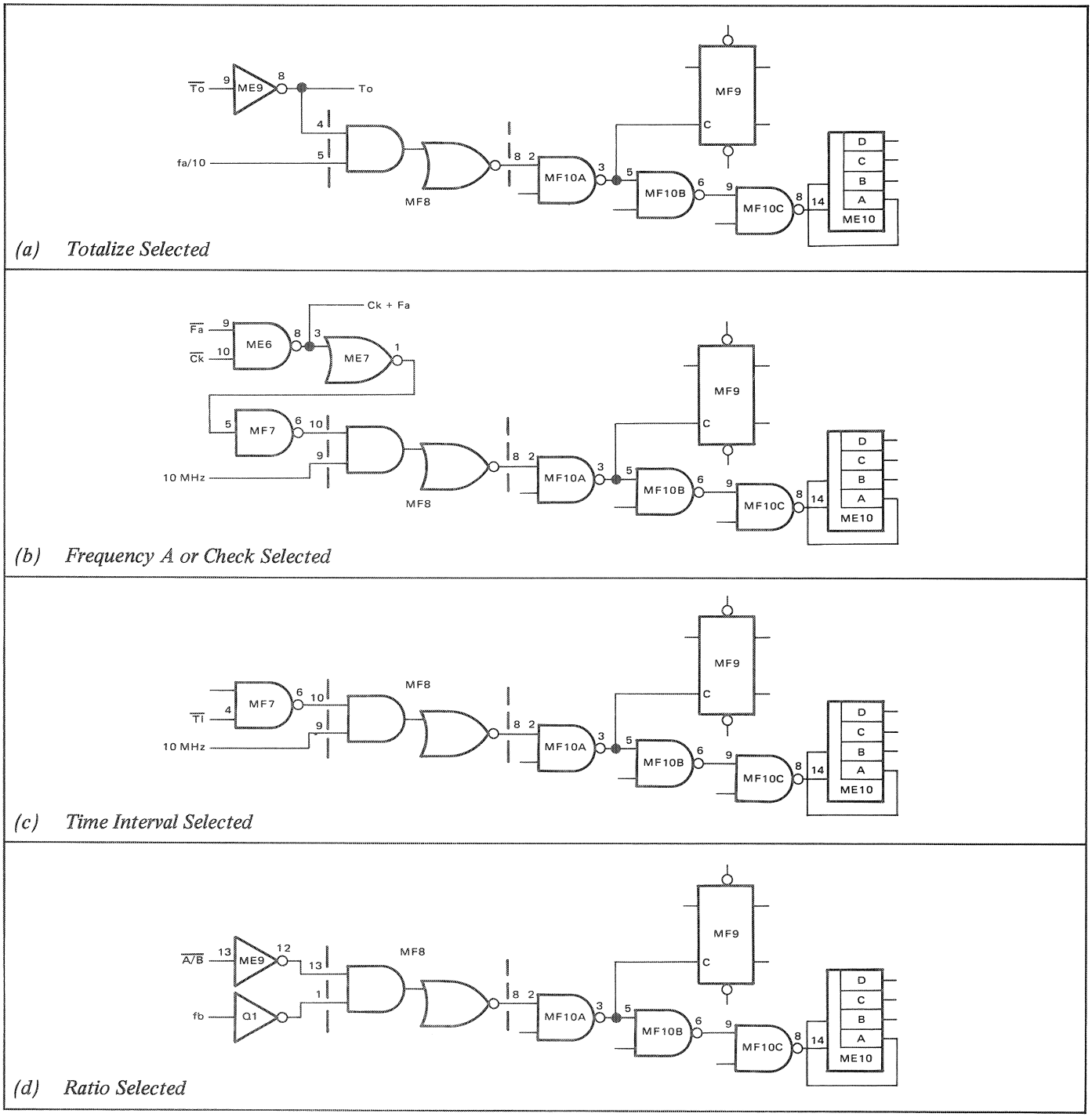


Figure 4.19 - Time Base Steering Logic

continued on page 4-13

ten (f_a/10) is applied to the input in the Totalize mode. Selection of the switches determines the scaling factor of f/n. The reference oscillator divided by four is applied to the time base decades in the Frequency C mode. Selection of the switches determines the repetition rate of f/n. Signal f/n is used for the start/stop pulses which establish the gate time.

4.85 TIME BASE STEERING LOGIC.

4.86 This circuitry routes signals to the time base divider circuit according to the measurement mode selected. Signal flow through the circuit is shown in figure 4.19a through h.

4.87 Totalize Mode.

4.88 Signal flow through the Time Base Steering logic in the Totalize Mode (figure 4.19a) is as follows. The Totalize mode is selected by the FUNCTION switch and $\overline{TO}$ is pulled to ground. $\overline{TO}$ is connected through inverter ME9 to an expandable 4-wide 2-input Nor gate, MF8. The output of MF8 is routed through Nand gates MF10A, and MF10C. The output of MF10C is applied to the clock input to the time base decades (MF9-14).

4.89 Frequency A or Check Mode.

4.90 Signal flow through the Time Base Steering logic in the Frequency A or Check mode is as follows (figure 4.19b). Frequency A or Check mode is selected by the FUNCTION switch which pulls one of the two lines $\overline{FA}$ or $\overline{Ck}$ to ground. These two lines are connected to Nand gate ME6. The output of ME6 (Ck + Fa) is connected to Nor gate ME7. The signal (Ck + Fa) is inverted through ME7. The output of ME7 is applied to Nand gate MF7. The output of MF7 is tied to pin 10 of a expandable 4-wide 2-input Nor gate MF8. The input of MF8 is high, thus enabling gate MF8. The 10 MHz reference, connected to pin 9 of MF8, passes on through MF10A, MF10B, MF10C, to the time base decades.

4.91 Time Interval Mode (Not in Model 8020B).

4.92 Signal flow through the Time Base Steering logic in the Time Interval mode is as follows (figure 4.19c). Time Interval is selected by the FUNCTION switch which pulls the TI line to ground. The $\overline{TI}$ line is connected to the input to Nand gate MF7. The other input, being high, causes the output of MF7 to be high. The output of MF7 is connected to one of two inputs to Nand gate MF8. The other input to MF8 is the 10 MHz reference. Since this gate is enabled, the 10 MHz reference passes through to MF10A, MF10B, MF10C, and to the time base decades.

4.93 Ratio Mode (Not in Model 8020B).

4.94 The signal flow through the Time Base Steering logic in Ratio mode is as follows (figure 4.19d). Ratio (A/B) is selected by the FUNCTION switch. The switch pulls the A/B line down to ground. The $\overline{A/B}$ line is routed to Inverter ME9. The output of ME9 is applied to pin 13 of MF8. The other input (pin 1) is tied to transistor Q1. When Q1 is on, pin 1 of MF8 is high and gate MF8 is enabled. The signal, f_b, passes through MF8 to MF10A, MF10B, and MF10C to the time base decades.

4.95 Time Interval Average Mode.

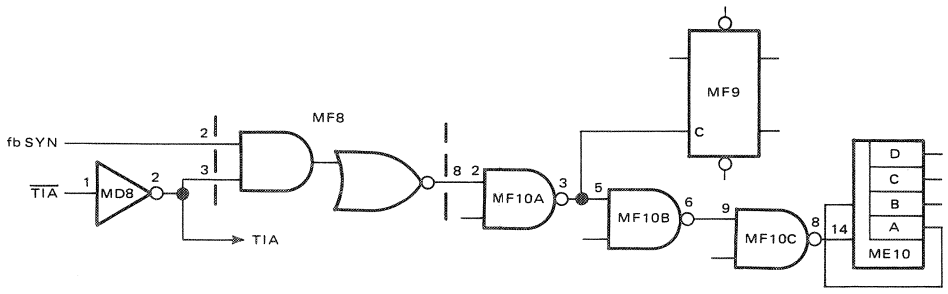
4.96 The signal flow through the Time Base Steering logic in the Time Interval Average mode is as follows (figure 4.19e). The Time Interval Average mode is selected by the FUNCTION switch which pulls the $\overline{TIA}$ line down to ground, the $\overline{TIA}$ line is connected to Inverter MD8. The output of MD8, is connected to pin 3 of MF8. The other input of MF8 pin 2 is connected to f_b SYN. With gate MF8 enabled, f_b SYN signal passes through MF8 to MF10A, MF10B, and MF10C to the time base decades.

4.97 Period Average Mode.

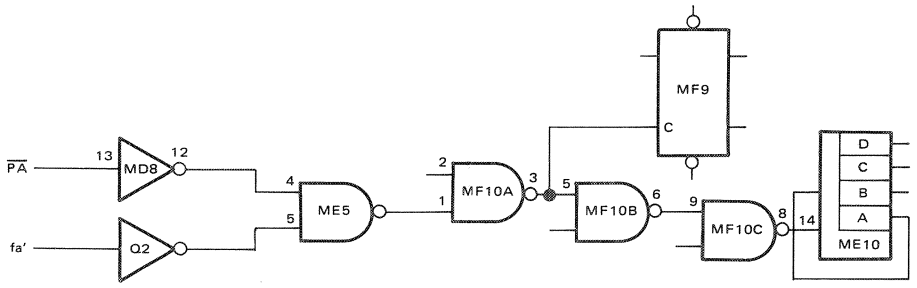
4.98 The signal flow for the Time Base Steering in Period Average mode is as follows (figure 4.19f). The Period Average mode is selected by the FUNCTION switch, which pulls the $\overline{PA}$ line low at the input of inverter MD8. The output of MD8 is connected to one input of Nand gate ME5. The other input of ME5 is connected to fa'. Signal fa' passes through ME5 to MF10A. Nand gate MF10A is enabled and fa' is applied to MF10B and MF10C, to the time base decades.

4.99 Frequency C and Period Modes.

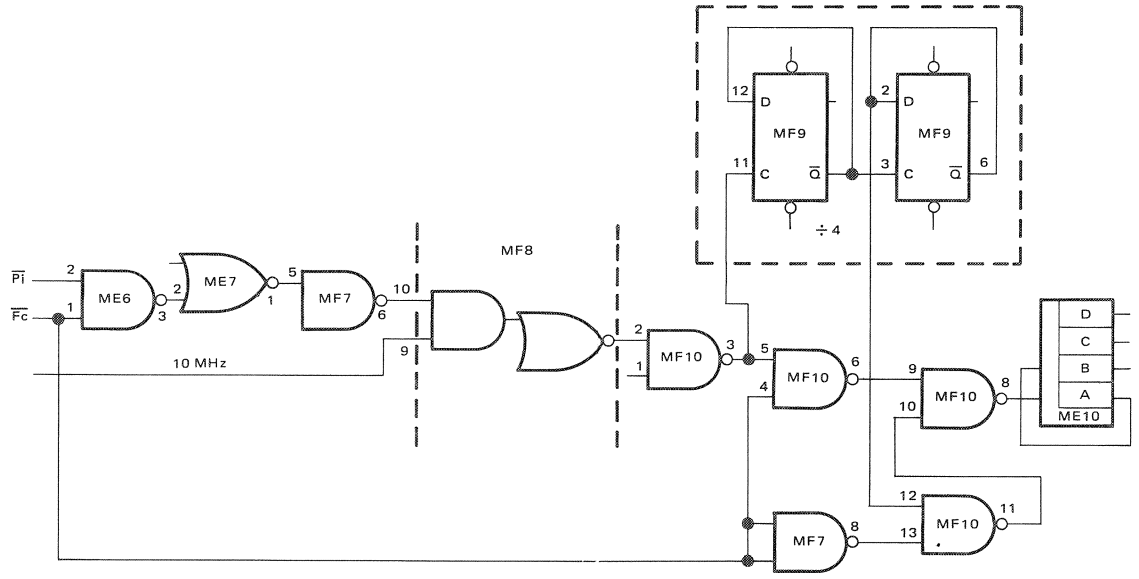
4.100 The signal flow for the Time Base Steering in Frequency C and Period modes is as follows (figure 4.19h). Frequency C or Period is selected by the FUNCTION switch. The FUNCTION switch pulls one of the two control lines, $\overline{Fc}$ or $\overline{Pi}$, low. Both lines are connected to Nand gate ME6. The output of ME6 is high and is connected to Nor gate ME7. The output of ME7 is connected to Nand gate MF7 and is low. The output of MF7 is connected to pin 10 of MF8 and is high. This enables the 10 MHz reference to pass through MF8 to Nand gate MF10A. The signal flow in the Period mode is from MF10A to MF10B, to MF10C, to the time base decades. The signal flow in Frequency C mode is from MF10A to a type D flip-flop, MF9, connected as a divide-by-four counter. The output of MF9 is applied through Nand gate MF10D to MF10C and to the time base decades.



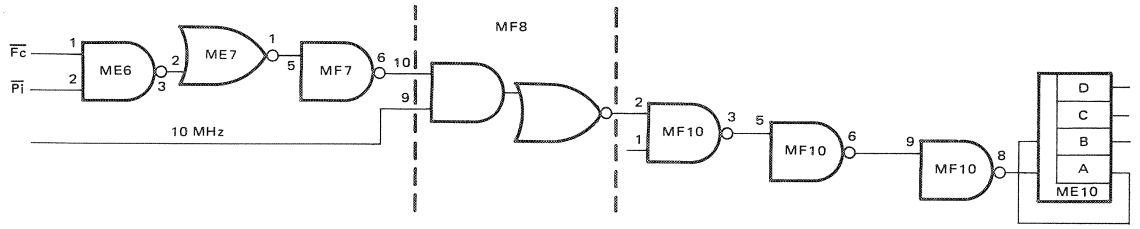
(e) Time Interval Average Selected



(f) Period Average Selected



(g) Frequency C Selected



(h) Period Selected

Figure 4.19 - Time Base Steering Logic

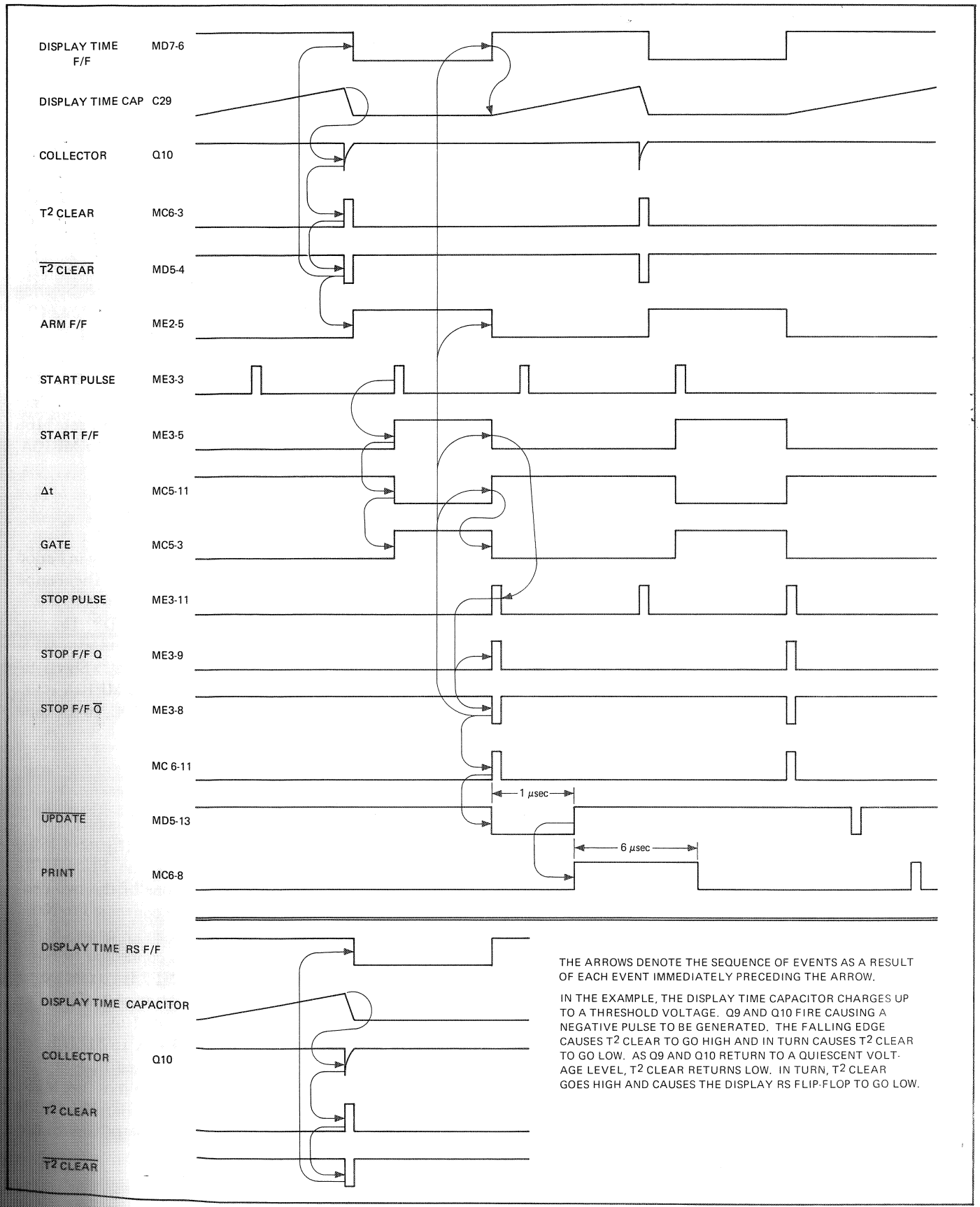


Figure 4.20 - Control Logic Timing

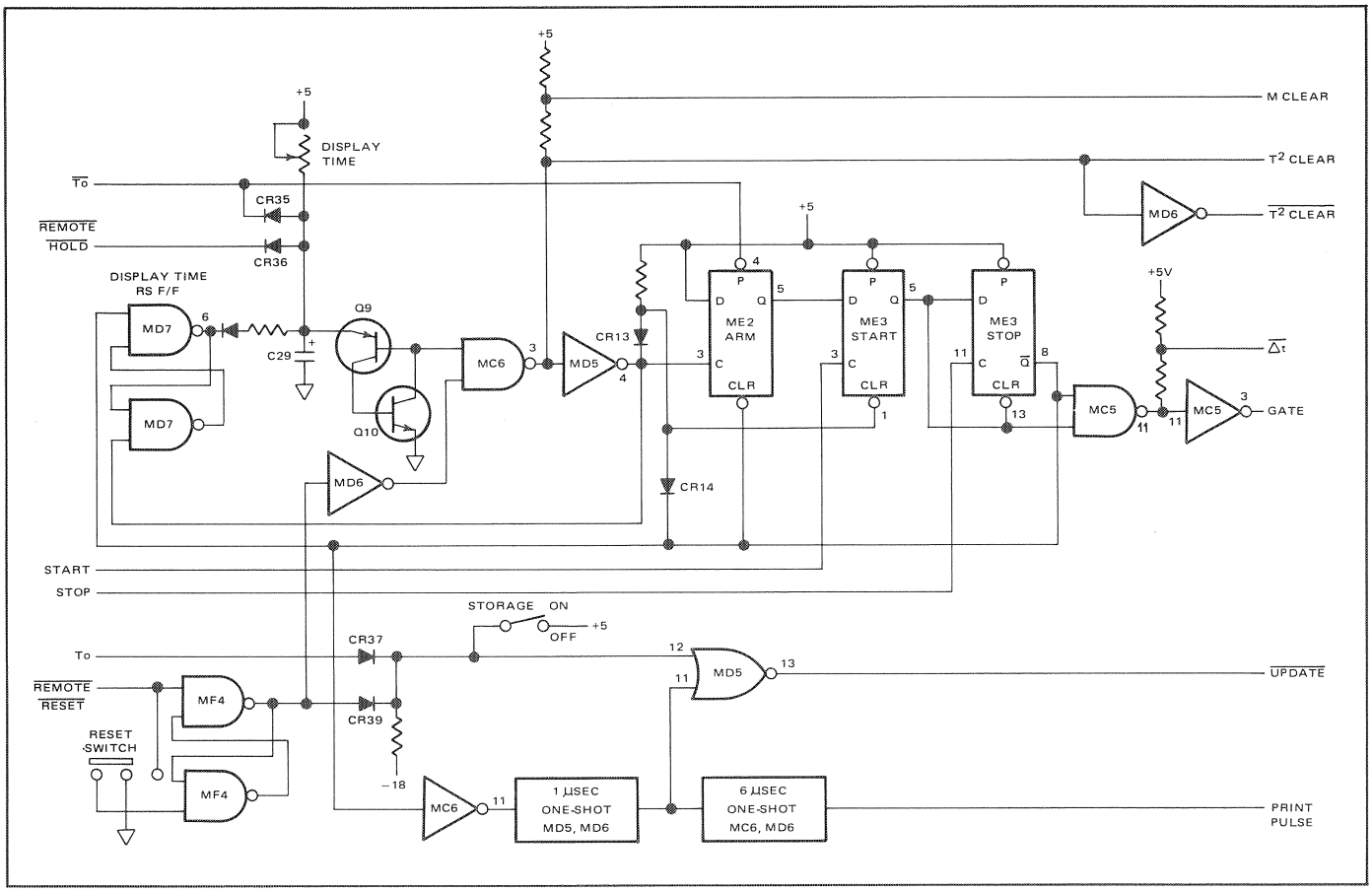


Figure 4.21 - Block Diagram Control Logic

4.101 CONTROL LOGIC.

4.102 This circuitry controls the timing sequence for the balance of the instrument; it generates the main gate control signal ($\overline{\Delta t}$). The timing sequence is illustrated in the timing diagram of figure 4.20, the circuitry is shown simplified in figure 4.21. With the DISPLAY TIME control set to produce periodic readings (not in the HOLD position), the operating sequence for all modes, except Totalize, begins when MD7-6 goes high. The display time integrating capacitor C29 charges at a rate dependent on the setting of the DISPLAY TIME control. When the voltage across C29 reaches approximately +3.7 volts, a latching circuit (Q9 and Q10) fires. Gate output MC6-3 goes high and inverter output MD5-4 goes low, resetting the display time RS flip-flop MD7. The voltage across C29 is discharged, Q9 and Q10 is reset, and MC6-3 goes low. From the previous reading, ME2-5 is low, ME3-5 is low and ME3-8 is high. An inverted T^2 CLEAR pulse (MC6-3), generated by the display time circuit, is fed to the clock input of a type D flip-flop ME2-3 and sets ARM (ME2-5) high on the trailing edge of the pulse. The instrument is now ready to measure. A START pulse to ME3-3 (clock) sets the Q output (ME3-5) high, causing $\overline{\Delta t}$ to go low (MC5-11) and MAIN GATE (MC5-3) to go high and enables STOP flip-flop so it will respond to the next STOP pulse.

4.103 When a STOP pulse is received at ME3-11 (clock), ME3-8 goes low causing $\overline{\Delta t}$ to go high and MAIN GATE to go low. The same ME3-8 signal is inverted and fires the 1-microsecond one-shot (MD5, MD6). The output of the one-shot is inverted through MD5 to produce the $\overline{\text{UPDATE}}$ pulse. At the same time, ME3-5 is reset low (through CR14 to ME3-1) which causes ME3-8 to reset high (through ME3-13). At the completion of the 1-microsecond one-shot, a 6-microsecond one-shot (MC6, MD6) fires. The output is inverted by MC6 to form the PRINT pulse used with Systems Interface, Option 008.

4.104 In the Totalize mode, the operation of the circuitry is the same with the following exceptions: the selection of Totalize sets MD5-12 true through CR37, causing MD5-13 to go false ($\overline{\text{UPDATE}}$). This allows the accumulation of pulses in the counter to be continuously monitored by the operator. Also, pin 4 of ME2 is held to ground, presetting Pin 5 of ME2 (ARM) to high and the display time circuit is disabled through CR35. The Start/Stop pulses are generated manually by the START/STOP switch on the front panel or

electrically through the external gate line (EXT. GATE) and perform the same function as the internally generated pulses in the other measurement modes. However, since the ARM line is held high as long as the instrument is in the Totalize mode, the Totalize measurement may be started and stopped as many times as desired.

4.105 The reset circuit (MF4) is used to reset the Counting Decades. In REMOTE HOLD, for modes other than Totalize, the reset commands a new reading.

4.106 START/STOP LOGIC.

4.107 The Start/Stop logic generates the Start and Stop pulses used by the control logic to control the main gate. The Start pulse is used to set the Start flip-flop (in the control logic) which initiates the gate. The Stop pulse sets the Stop flip-flop. The output of the Stop flip-flop terminates the gate. The routing of the signals is shown in figure 4.22a through e.

4.108 Totalize Mode (figure 4.22a).

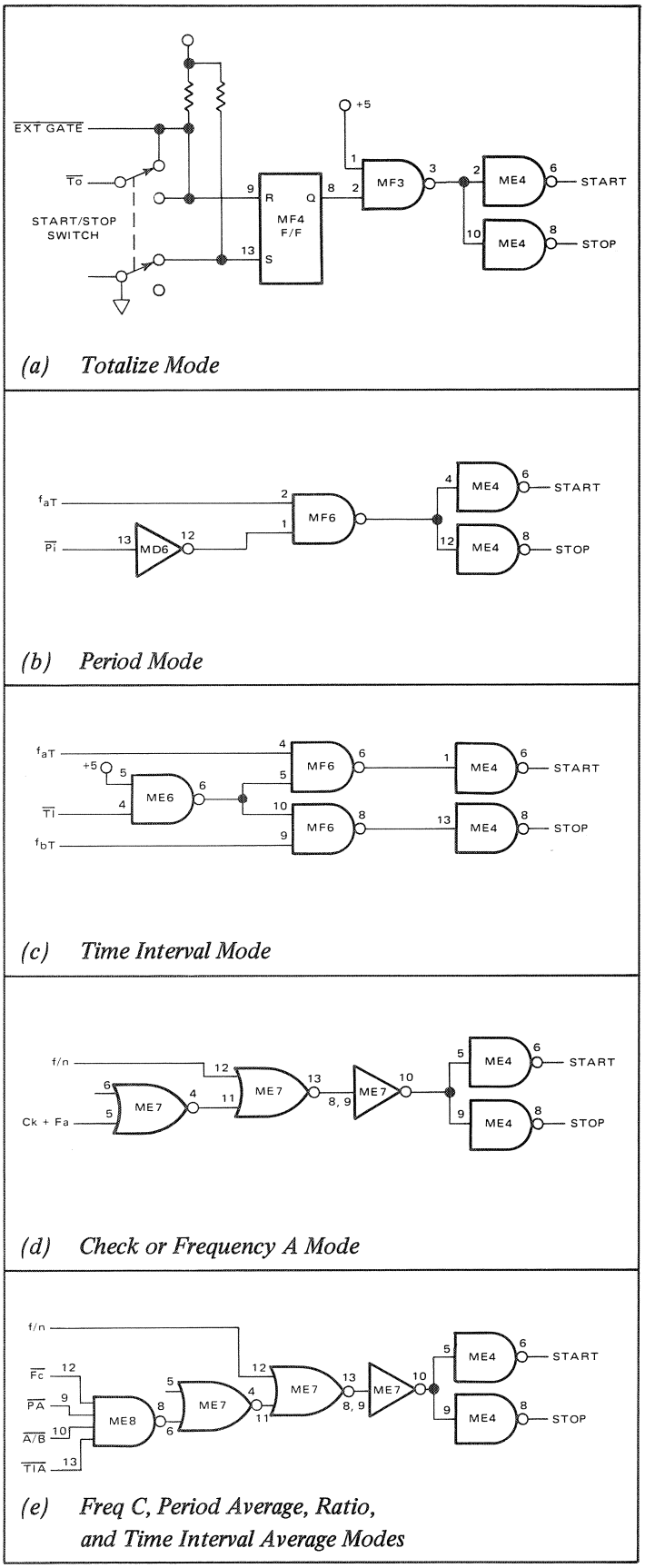
4.109 In the Totalize mode the start pulse is initiated by the START/STOP switch or by the external gate line pulled to common. The START/STOP switch and the external gate lines are tied to the input of an RS flip-flop (MF4) made from two cross-coupled nand gates. The output of the flip-flop is low when the START/STOP switch is not depressed. When the switch is depressed, the inhibit is removed and the flip-flop output goes high. The output stays high as long as the switch is depressed or the external gate line is pulled to common. The output of the flip-flop is tied to inverter MF3. The output of the inverter is connected to two four-input nand gates. The gate is initiated on the first Start/Stop command and terminated on the second.

4.110 Period Mode (figure 4.22b).

4.111 In the Period mode, the $\overline{Pi}$ line is low causing the output of inverter MD6 to enable nand gate MF6. The rising edges of f_{aT} (frequency A at TTL level), produces Start and Stop pulses for the control logic.

4.112 Time Interval Mode (figure 4.22c).

4.113 In the Time Interval mode, the $\overline{TI}$ line is low. $\overline{TI}$ is inverted through ME6-6 which enables Nand gates MF6-6 and MF6-8. When Frequency A triggers and f_{aT} rises, it causes the output of MF6-6 to go low. This causes a Start to be generated at the output of ME4. When Frequency B triggers and f_{bT} rises, it causes the output of MF6-8 to go low. This causes a Stop to be generated at the output of ME4-8.



(a) Totalize Mode

(b) Period Mode

(c) Time Interval Mode

(d) Check or Frequency A Mode

(e) Freq C, Period Average, Ratio, and Time Interval Average Modes

Figure 4.22 - Start/Stop Signal Flow

4.114 Check or Frequency A Mode (figure 4.22d).

4.115 In the Check or Frequency A mode, Ck + Fa is high and is connected to Nor gate ME7-5. The other input to ME7-6 is low. The output of ME7-4 is low and is connected to Nor gate ME7-11. The other input to ME7-12 is connected to the scaled output (f/n). The scaled output is the reference oscillator frequency divided by the time base decade selection.

4.116 Frequency C, Period Average, Ratio, and Time Interval Average Modes (figure 4.22e).

4.117 In the Frequency C, Period Average, Ratio, and Time Interval Average modes, one of the inputs ($\overline{Fc}$, $\overline{PA}$, $\overline{A/B}$, $\overline{TIA}$) to Nand gate ME8 is selected and pulled low. The output of ME8-8 goes high and Nor gate ME7-4 goes low enabling Nor gate ME7-13. The gate is initiated when f/n goes low via the Start pulse at ME4-6. The next time f/n goes low the gate is terminated via the Stop pulse at ME4-8.

4.118 MARKER LOGIC (figure 4.23).

4.119 The MARKER output provides a negative 18-volt pulse starting when channel A triggers and stopping when B triggers. It is used for increasing the intensity of an oscilloscope trace.

4.120 The circuit consists of two D-type flip-flops (ME1) driving a voltage level shift circuit (Q16, Q17). Channel A input (f_{aT}) sets ME1-6 low causing Q16 to turn off. In turn, Q17 turns off producing a −18 volt output at the collector of Q17. A trigger from the channel B input (f_{bT}) sets the second half of ME1. Q resets ME1-6 high causing transistors Q16 and Q17 to saturate and producing a collector output of about zero volts for the marker output at J103.

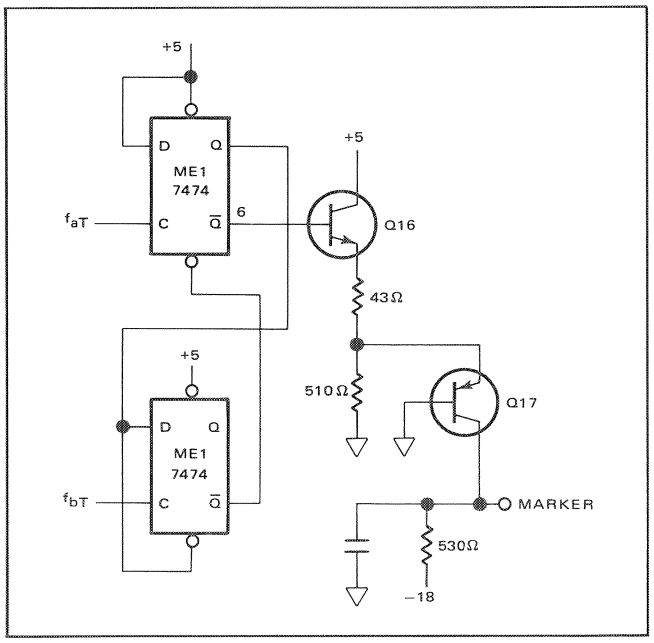


Figure 4.23 - Marker Logic

4.121 Readout Board.

4.122 The readout board assembly is one of two large printed circuit boards mounted to the base plate. The readout board is accessible from the top of the counter. The readout board contains the following circuits; the reference oscillator, the power supply, the function switch, the display tubes, the TTL counting decades, and the storage.

4.123 COUNTER/DISPLAY.

4.124 The counter and display circuit counts, stores and displays the number of pulses received from the high-speed decade on the switch board. The counter consists of seven decade counters (type 7490), eight quadruple bistable latches (type 7475), eight numeric display tube drivers (type 7441), and eight numeric display tubes. An additional tube, driver, latch, and decade are included in instruments having the 9th digit, Option 004. Transistor Q1 controls the update inputs of all the quad latches. A low update signal from the control logic allows each latch to assume the same level as the decade counter to which it is connected. A high update signal allows the latches to store the information. The T^2 CLEAR line (when low) resets the decade counters to zero.

4.125 POWER SUPPLY.

4.126 The power supply (figure 4.24) provides all voltage levels for the operation of the instruments and standby power (with power OFF selected) for the continuous operation of the optional frequency source (with instruments equipped with Option 200). All supplies except the +150 volt supply are regulated.

4.127 The +150V supply is used by the gas tube display and derived from a +250 volt full wave bridge circuit. Current limiting resistor R60 drops the voltage to the tubes to approximately +150 volts when the tubes are conducting. With power OFF, the +150 line is opened.

4.128 The +28 volt supply is used only for the optional frequency reference (Option 200) and is derived from a tapped secondary full wave rectified circuit and discrete 28-volt regulator.

4.129 The −18-volt supply is used throughout the instrument and is derived from a −28 volt full wave rectified supply and a regulator consisting of zener CR20 and transistors Q26 and Q101. Referring to the schematic, Q26 and

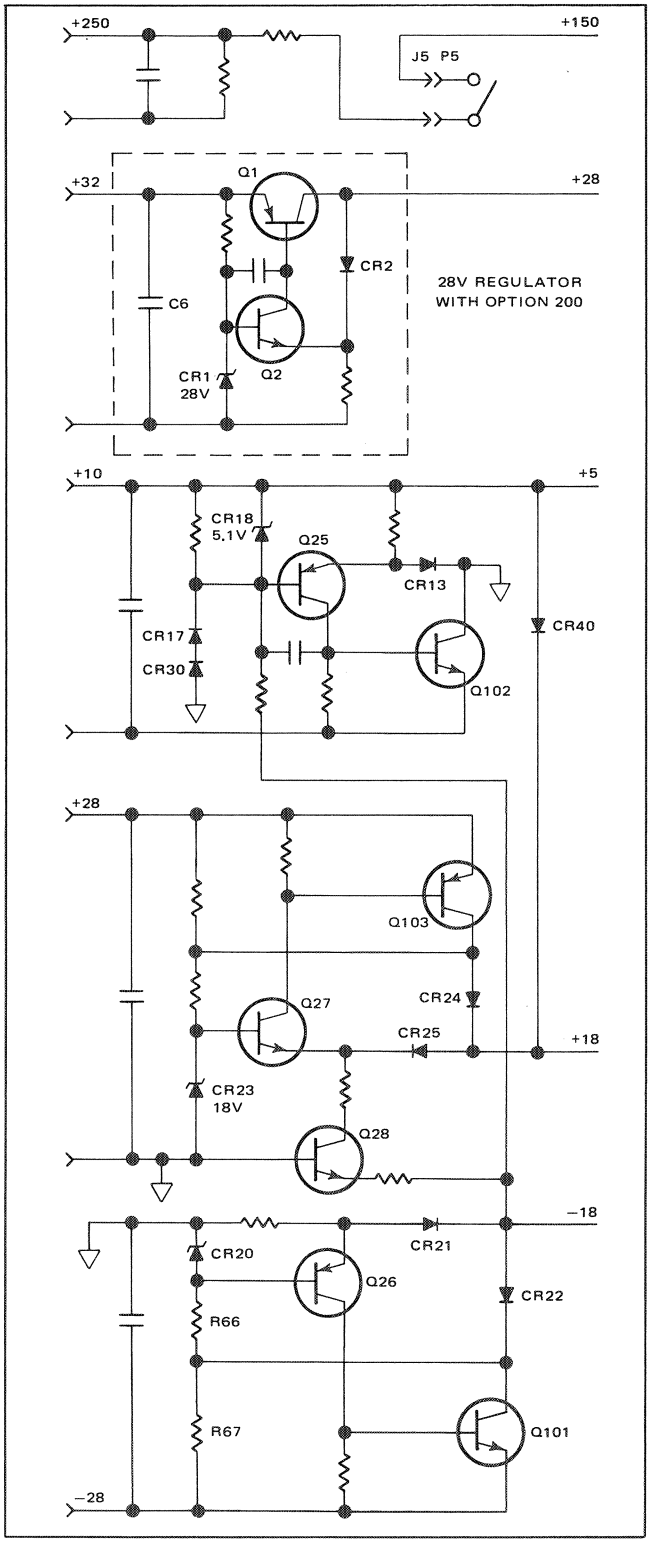


Figure 4.24 - Power Supply

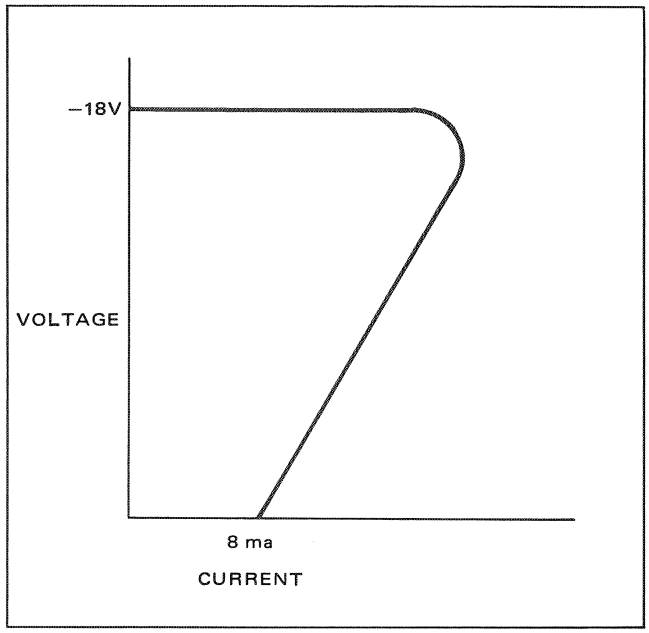


Figure 4.25 - Characteristic of -18V Regulator

CR20 (18 volt zener) form a 12 milliamp current generator with resistors R66 and R67 supplying current to the zener. The base of Q101 is driven by the current generator causing Q101 to conduct heavily pulling the output towards -28 volts through diode CR22. At -18 volts, diode CR21 starts conducting causing the current generator to lessen the output and at this point stability is reached. When the power switch is set to OFF the -18 volt supply is shorted to ground. The voltage at the cathode of CR22 turns off Q26 by depriving CR20 of idling current and the short circuit current folds back to approximately 8 ma as shown in figure 4.25.

4.130 The +18 volt supply is also used throughout the instrument and is derived from a +28 full wave rectified circuit. The regulator circuit, consisting of transistors Q27, Q28, Q103, and 18 volt zener CR23, operates in the same manner as the -18 volt supply. Transistor Q28 functions as a switch and turns off the +18 supply when the -18 volt supply goes to ground (instrument is shut off).

4.131 The +5 volt supply is used by all of the digital circuitry. The regulator operates in the same manner as the ±18 volt supplies but uses a 5-volt zener. The current for the zener is supplied through resistor R63 from the -18 volt supply.

SECTION 5 MAINTENANCE

5.1 INTRODUCTION.

5.2 This section contains maintenance information for the counter. Included are TTL theory, ECL theory, diode gate theory, signal flow in all modes of operation, troubleshooting, and diagrams to localize, isolate and locate defective components. Performance check procedures are not included in this section, but can be found in Section 3.

5.3 RECOMMENDED TEST EQUIPMENT.

5.4 Test equipment recommended for maintaining, troubleshooting, and servicing the counter is listed in table 5.1. Test equipment with equivalent characteristics may be substituted for equipment listed.

5.5 CALIBRATION.

5.6 Internal Reference Oscillator Adjustment.

5.7 The following procedures are given for adjustment of the counter's internal reference oscillator. One of three different reference oscillators may be used in the counter. The reference oscillators are as follows:

a. Standard Temperature-Compensated Crystal Oscillator (TCXO); Dana part number 730551

b. Option 050 Temperature-Compensated Crystal Oscillator (TCXO); Dana part number 730578

c. Option 200 Temperature-Compensated Reference Oscillator (TCRO); Dana part number 730228

5.8 For standard and option 050 reference oscillators, perform the following set-up procedures.

a. Set the counter controls as follows:

Control	Setting
DISPLAY TIME	about 9 o'clock
FUNCTION	FREQ A
TIMEBASE	10 second
A Slope	Plus (+)
A Coupling	DC
A Trigger Level	PRESET
SEP/COM	SEP
STORAGE	ON
REF	INT OUT
A Input Voltage Range	10

Table 5.1 - Required Equipment

Instrument Type	Required Specification	Recommended Instruments
Frequency Standard	1 MHz, 5 MHz, or 10 MHz	
Oscilloscope	150 MHz Bandwidth 500 MHz Bandwidth	TEK 454 TEK 7900
Voltmeter	10 mVDC to 200 VDC	Dana 4300
Sine Wave Generator	2 Hz – 10 MHz	Dana 7010
VHF Signal Generator	10 – 150 MHz	HP8654A
VHF Signal Generator	1 – 550 MHz (Not required for 8010B)	HP8654A
Pulse Generator	4 ns pulsewidth	Datapulse 112
Alignment Tool	.075" Hex (nonmetallic)	General Cement 9300
Alignment Tool	Blade (nonmetallic)	
Sampling Voltmeter	0 – 600 MHz	HP3406
BNC "T" connector		
50Ω Tee connector		HP 10221A
2 – BNC to GR Adaptors		

b. Connect a 1 MHz frequency standard to A input.

c. Allow 1 hour time for the counter temperature to stabilize.

d. The difference between the internal reference oscillator and the 1 MHz frequency standard can be determined by the following formula:

Internal Oscillator Frequency = (20,000,000 – Counter Reading). See table 5.2.

Table 5.2 - Reference Oscillator Error

Counter Display	Internal Reference Osc.
999.9950 kHz	10000.050 kHz
999.9975 kHz	10000.025 kHz
1000.0000 kHz	10000.000 kHz
1000.0025 kHz	9999.975 kHz
1000.0050 kHz	9999.950 kHz

5.9 ADJUSTMENT PROCEDURE – STANDARD TCXO.

WARNING

Removal of covers exposes potentially lethal voltages. Avoid contact with internal electrical connections while unit is connected to AC power source.

a. Apply power to the counter for one hour before attempting TCXO adjustment (see paragraph 5.8). Remove the top cover (see paragraph 5.18, "Access to P.C. Boards"). Locate the TCXO located on the Readout assembly near the rear of the counter (see figure 6.5, Readout Layout). Remove the #6 metal or nylon cap screw on the top of the reference oscillator. Use a nonmetallic alignment tool for adjustment. Some oscillators require a hexagon .075 dia. alignment tool, and others require a blade type.

b. Insert the proper adjustment tool into the #6 screw hole on the top of the reference oscillator. Adjust the TCXO until the display reads 1000.0000 kHz. Wait ten seconds and readjust the TCXO if the first adjustment was not correct. Remove the adjustment tool.

c. After the initial adjustment, replace the cap screw and the top cover. Allow 30 minutes for temperature stabilization and recheck the reading.

5.10 ADJUSTMENT PROCEDURE – OPTION 050 TCXO.

5.11 Allow the counter to temperature stabilize for one hour before adjustment and verify one hour after adjustment. Follow the procedures outlined in paragraph 5.9.

5.12 ADJUSTMENT PROCEDURE – OPTION 200 TCRO.

5.13 The object of the following procedures is to determine short term drift of the TCRO as well as to adjust the frequency. The adjustments are the COARSE and FINE controls on the rear panel. *Use only a non-metallic blade type adjustment tool for these adjustments.*

a. Set the counter controls as described in paragraph 5.8a.

b. Allow the counter to temperature stabilize for 72 hours before calibration. (It is not necessary to turn the power on during the warmup and stabilization period. The TCRO is an oven oscillator which operates from a separate +28 volt supply.) Set DISPLAY TIME to about 9 o'clock one hour before adjustment.

c. Connect a 1 or 5 MHz Frequency Standard to channel 1 of a dual channel oscilloscope. Trigger the oscilloscope on channel 1 only. Set the oscilloscope sweep rate to .02 μs per cm.

d. Connect a BNC cable to the counter INT OUT connector J106 on the rear panel. Set the REF switch S102 to the INT OUT position. Connect the other end of the BNC cable to the second channel of the oscilloscope. The oscilloscope display should indicate a stationary and a moving waveform. The moving waveform is the counter reference oscillator.

e. Remove the nylon cap screws. Adjust the COARSE adjustment (rear panel, see figure 6.8) and then the FINE adjustment until as near a completely stable waveform as possible is obtained. The channel 2 waveform will be drifting to the left or right. If the channel 2 waveform is moving to the left, the internal reference oscillator is higher in frequency than the frequency standard. If the channel 2 waveform moves to the right, the internal reference oscillator is lower in frequency than the frequency standard.

f. To determine the drift rate, measure the time it takes the oscilloscope pattern to drift the width of one cycle on channel 2. Note: 1 cycle equals 5 divisions on the oscilloscope. The oscillator drift can be determined from figure 5.1.

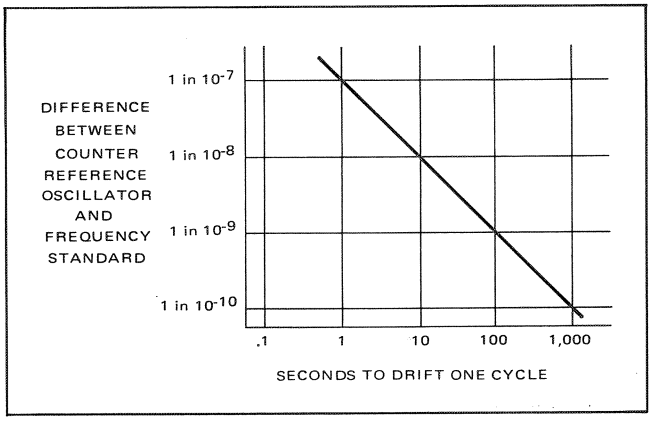


Figure 5.1 - Oscillator Drift

5.14 SIGNAL CONDITIONING CALIBRATION – CHANNEL A.

a. Set the controls as follows:

Control	Setting
A Slope	(+) Plus
A Coupling	AC
MULTIPLIER/TIMEBASE	1 second
A Trigger Level	PRESET
A Voltage Input Range	1
SEP/COM	SEP
FUNCTION	FREQ A
DISPLAY TIME	about 9 o'clock

b. Apply power to the counter 1 hour before adjustment. Do not remove the top or bottom covers during warmup.

c. Apply a 10 MHz 100 mV rms signal to channel A input. Use a DC coupled oscilloscope with .5V/cm sensitivity to compare logic levels at MD1-12 and MD2-8 on the switch board assembly. Refer to figure 6.3, Switch Board Layout, for locations.

d. Adjust the ECL level pot R17A (figures 5.3 and 6.1) so the logic levels at MD1-12 are the same as the logic levels at MD2-8.

e. Connect a 150 MHz, 40 mV RMS signal to channel A input.

f. While observing the signal at MD1-12, switch the channel A slope between (+) plus and minus (–). Note the DC voltage shift between + and – slopes. Adjust the offset pot R20A for a minimum DC shift. Notice that with no DC shift, a permissible change in peak-to-peak amplitude may occur. The signal at MD1-12 is shown in figure 5.2. The signal output in either slope must be a minimum of .4 volts peak-to-peak.

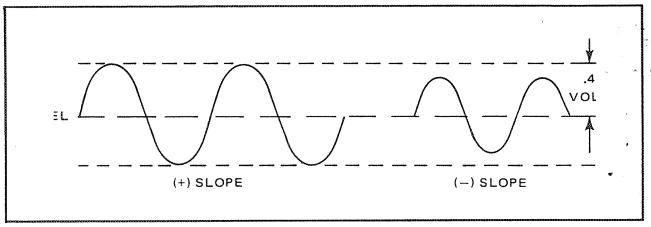


Figure 5.2 - Signal Conditioner Output

h. Check the sensitivity over the band in both + and – slopes. Nominal sensitivities are as follows:

50 mV RMS to 100 MHz, 100 mV RMS to 150 MHz.

g. Place channel A in – slope. Increase signal level to insure that the proper reading is displayed by counter. Incrementally decrease input signal level until an improper reading is observed. Then adjust R17A for the correct reading. Continue this process until maximum sensitivity is obtained.

i. Final check and adjustment should be completed after the unit is at ambient temperature with the top and bottom covers on.

5.15 SIGNAL CONDITIONING CALIBRATION – CHANNEL B

a. Set the Controls as follows:

Control	Setting
Slope A	+
Slope B	–
Coupling A	AC
Coupling B	AC
Trigger Level A	PRESET
Trigger Level B	PRESET
Input Range A	1
Input Range B	1
SEP/COM	SEP
FUNCTION	TIA
DISPLAY TIME	about 9 o'clock
MULTIPLIER/TIMEBASE	1 second

b. Apply power to the counter 1 hour before adjustment. Do not remove top and bottom covers during warmup period.

c. Apply a 10 MHz 100 mV rms signal to channel A input. Apply the same signal to a 10 dB Attenuator. Connect the output of the attenuator to channel B input.

d. Monitor the signal output of signal conditioner at ME0-6 on the Switch Board assembly. (figure 6.3)

e. Use a DC coupled oscilloscope with .5V/cm sensitivity and compare logic levels at ME0-6 and MC1-8 on the Switch board.

f. Adjust the ECL level control R17 (figures 5.3 and 6.1) such that the logic levels at ME0-6 are the same as the logic levels at MC1-8.

g. Incrementally decrease input signal level until an improper reading is observed. Then adjust R20 for the correct reading. Continue this process until maximum sensitivity is obtained.

h. Check the sensitivity over the band in both + and – slopes. Nominal sensitivities are: 0 – 10 MHz, 50 mV RMS.

i. Final check and adjustments should be completed after the counter is at ambient temperature with both top and bottom covers on.

5.16 PERIODIC MAINTENANCE.

5.17 To determine if the counter is operating properly within specifications, perform the performance check (Section 3).

5.18 ACCESS TO PC BOARDS.

> **WARNING**
>
> Removal of covers exposes potentially lethal voltages. Avoid contact with internal electrical connections while unit is connected to AC Power source.

5.19 To remove top and bottom covers, proceed as follows:

a. Remove power cord.

> **WARNING**
>
> The power supplies are still active as long as the power cord is plugged into the power AC source.

b. Loosen the four captive screws, one at each corner of the top cover and remove the top cover.

c. Turn the counter upside down. Loosen the four captive screws on the bottom cover and remove the bottom cover.

5.20 PCB REMOVAL.

5.21 When removing the printed circuit board for replacement, repair, and servicing, always remove the AC power cord before disassembly. Refer to figure 5.23, page 5-15 for assembly location.

5.22 RF Assembly (figure 6.12 or 6.14).

a. Remove the six #4 phillips-head screws around the outer edge of the assembly.

b. Disconnect the two subminiature RF connectors.

c. Disconnect P10 at the rear of the counter.

d. On instruments having option 030, remove the five #4 screws holding the RF shield on the component side. Remove shield.

> **CAUTION**
>
> The R.F. assembly is very sensitive to component movement. Do not move any components or recalibration will be necessary.

5.23 Signal Conditioning Assembly (figure 6.1).

a. Remove the trigger level knobs and the input range knobs.

b. Remove the two #6 phillips-head screws on the top of the signal conditioner and one #6 phillips-head screw on the bottom.

c. Remove the subminiature R.F. connectors.

d. Remove the two #6 phillips-head screws holding cable clamps on the cable between the signal conditioner and P9. Remove P9 and remove the assembly.

e. To service the attenuator switch, remove the four #4 phillips-head screws located at each corner of the printed circuit board. The printed circuit board can be moved away from the switch assembly for servicing.

5.24 Readout Assembly (figure 6.5).

a. Remove the interconnection printed circuit assembly from J4.

b. Remove P1 at the left rear of the assembly.

c. Remove P5 and the FUNCTION knob at the right front side.

d. Remove the seven #6 phillips-head screws (one in the center and six around the perimeter of the board). The Readout assembly can now be removed.

5.25 Switch Board Assembly (figure 6.3).

a. Remove the interconnection printed circuit assembly from J2.

b. Unscrew the subminiature RF connectors from the Signal Conditioning assembly and the RF assembly.

c. Remove P3 from J3.

d. Remove the six #6 phillips-head screws, two in the center and four around the perimeter of the printed circuit board. Remove the switch board assembly.

5.26 COMPONENT REPLACEMENT.

5.27 When replacing a circuit board component, use a low heat soldering iron (25 watt). Heat must be used sparingly as damage to the circuit foil may result. Plated-thru holes may be cleaned with a solder remover while heat is applied. The connection should be cleaned with a cleaning solution after the component removal and replacement.

5.28 Integrated Circuit Replacement.

5.29 Integrated circuits can be unplugged and substituted without soldering or assembly removal. The use of special tools to remove IC is not recommended. To remove an IC, place both thumbs on top of the IC and both index fingers at the ends of the IC. Gently rock the IC upward in small steps. Do not "pop" it out in one motion. To replace an IC, be sure the notched end points the same direction as the other ICs on the board. Straighten any bent pins. Align the pins on the IC with the holes in the socket and press the IC in firmly using one or two fingers.

5.30 Identification of Parts.

5.31 All parts are listed in the parts list, Section 7, by assembly. Reference designators are called out on the schematic and can be found on the layout drawings. The Dana part number and description are given in the parts list. All integrated circuits used in the counters are standard 7400 series TTL and ECL that can be purchased from your local supplier. Special parts may be obtained from Dana by writing or calling Product Service at 714-833-1234 collect in California.

5.32 Parts Location.

5.33 The integrated circuits on the Readout and Switch board assemblies are layed out on a grid pattern. Looking at the readout or switch board from the front, the ICs are numbered across the board from left to right, 1 through 12; top to bottom, A through F. Other components are designated by circuit and can be located by the schematic and layout drawing.

5.34 TROUBLESHOOTING.

5.35 This section describes methods for identifying counter troubles and determining the specific corrective action that should be taken. Familiarity with the Operation (Section 3) and Theory of Operation (Section 4) makes troubleshooting easier.

5.36 A malfunction can be rapidly defined to one of four categories.

a. Apparent trouble which is really a misplaced control setting or an erratic external signal.

b. Visual damage such as printed circuit board broken, etc.

c. Analog trouble which requires troubleshooting and component replacement.

d. Digital trouble which requires troubleshooting and IC replacement.

5.37 Repairs which require replacement of soldered-in components can be accomplished rapidly, but caution should be taken against soldering with improper procedures. Solder damage to the printed circuit boards is not covered by Dana's warranty.

5.38 Apparent Troubles.

5.39 Apparent troubles are those which appear to be equipment malfunctions, but are really controls which are misadjusted.

5.40 The counter will not operate if a function is incorrectly selected. For instance, if the unknown frequency is connected to input C and FREQ A function is selected, there will be no reading. Be sure the FUNCTION switch is in the proper mode. If the function has been changed, depress RESET to start a new reading in the new function.

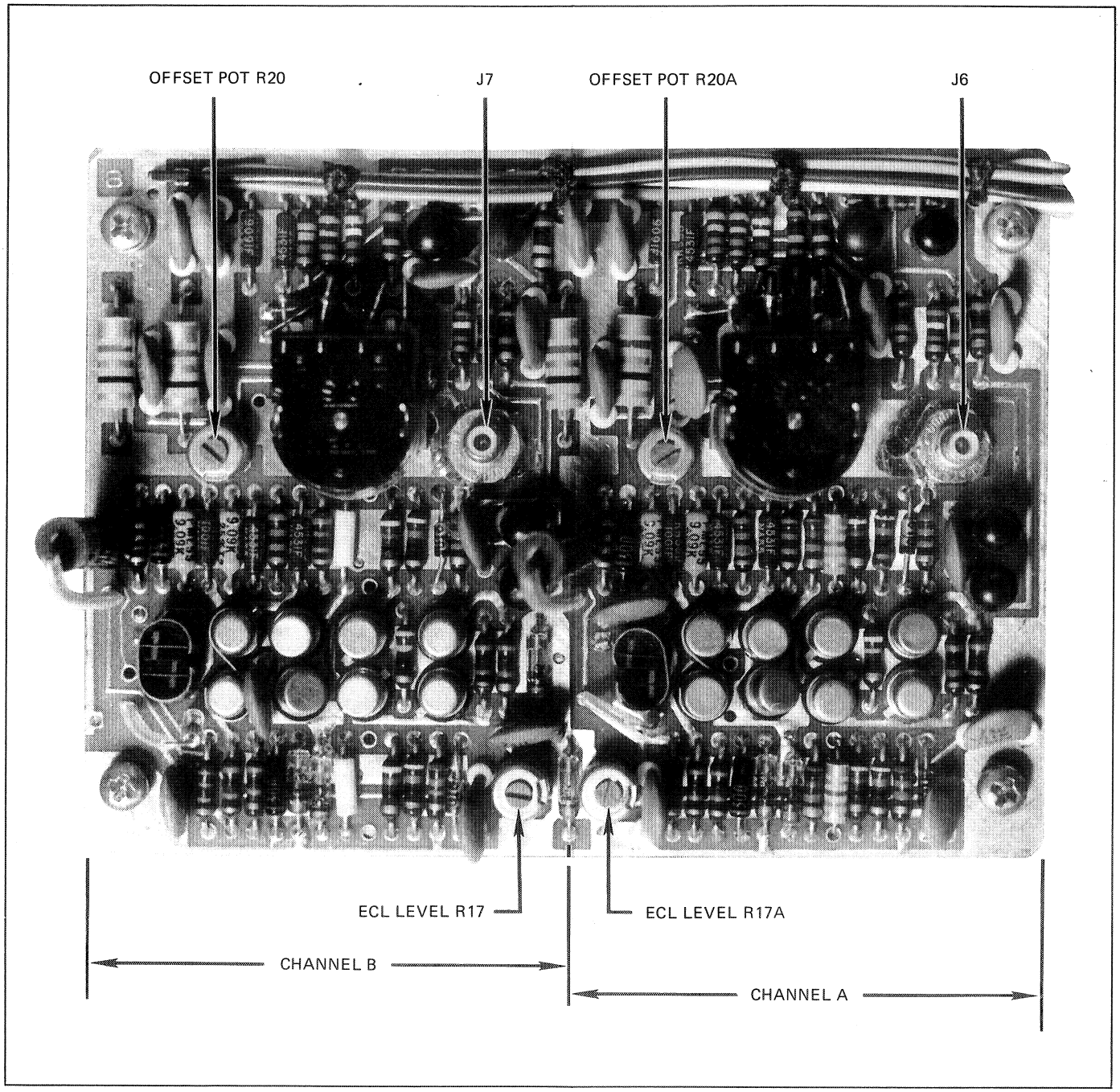


Figure 5.3 - Signal Conditioning Adjustments

Table 5.3 - Front Panel Symptoms

Type of Problem	Refer to Paragraph:
Readout	5.49
Remote Operation	5.64
Self-Check Mode	5.68
Frequency A Mode	5.70
Period Mode	5.73
Period Average Mode	5.75
Frequency C (Not in 8010B)	5.77
Totalize Mode	5.80
Time Interval Mode	5.82
A/B (Ratio) Mode	5.85
Time Interval Average Mode	5.88

5.41 If the input voltage range or trigger level are improperly set, inputs A or B will not operate. Be sure that a measurable signal is present and that controls are set properly for that signal.

5.42 When input C is used (not in 8010B), the automatic gain control will inhibit readings of signals which are less than 50 mV and greater than 1V RMS. Signals will be inhibited if they are outside the measurable band (1.0 MHz to 550 MHz). With Option 030, the automatic gain control will inhibit readings of signals which are less than 1 mV and greater than 1V RMS. Signals will be inhibited if they are outside the measurable band for Option 030 (10 MHz to 500 MHz).

5.43 Due to the sensitivity of input C, open leads which might act as an antenna can cause improper readings. If open leads or probes must be used, it may be necessary to insert a low-pass filter at the counter input to discriminate against unwanted signals received through radiation. Unshielded input signals can cause unwanted signals to override the desired signal. The proper operation of input C can be verified by connecting a signal generator directly to the counter through a shielded 50-ohm terminated cable. Once proper counter operation has been verified, unwanted external signals can be attenuated with a low-phase filter.

5.44 Visual Check.

5.45 A possible source of malfunction could be short or open circuits which disable portions of the counter or load down the power supply, or both. Often these short-circuits can be located by visual inspection. A quick visual check of the counter with the covers removed may reveal foreign metal parts, frayed cable braid, discolored components, etc. which can be easily corrected. Visual checks can be more meaningful after the trouble has been localized.

5.46 Open circuits can also be located visually. Examine connector and wire harnesses for obvious breakage or opens.

5.47 Front Panel Symptoms.

5.48 Localize the trouble to one of the categories listed in table 5.3; then proceed to the appropriate paragraph and follow the suggested procedure.

5.49 READOUT INOPERATIVE.

5.50 If the readout tubes and annunciators do not light, a failure in the 150V supply is indicated. Check the line fuse. It should be .75 amp, 3 AG. If in doubt, measure the AC source at the power transformer T101 to assure that power is getting to the counter. Check the 150-volt supply as follows.

a. Turn power off; remove the power cord at the rear of the counter. The supplies are still active even with the power switch turned off. Remove the top cover and reconnect the power cord.

b. Connect a voltmeter to either side of resistor R60, 3.9K, 3W (figure 6.5). Connect the other lead of the voltmeter to ground (negative side of capacitor C7). The voltage should read about 150 volts DC.

c. Note the action that occurs when the DISPLAY TIME switch is moved clockwise from the PWR OFF position. If the voltage goes very low or to zero, there is a short in the 150V line. If no voltage is present at either side of R60, check the following: R61 (located under C6), C5, CR5 through CR8, and T101.

d. Remove P1 and check for 180 volts RMS AC at points P1-E (blue transformer lead) and P1-D (violet transformer lead).

e. If the high voltage is still not present, check the wire harness for opens or shorts. If no opens or shorts are found, T101 may be defective.

f. If the high voltage is present, reconnect P1 and recheck the 150 volt lines. If the 150 line loads down, locate and eliminate the short on the readout board.

5.51 READOUT TUBE BLURRING.

5.52 If all readout tubes blur, a faulty +5-volt supply voltage is indicated. The 5-volt supply is affected by the other power supplies, so they must all be checked.

5.53 Series regulator transistors for the +5-volt and ±18-volt supplies are mounted on a heatsink on the rear panel. A short to ground in the −18-volt supply turns off the +5-volt and +18-volt supplies. Instruments equipped with Option 200 have a separate +28-volt supply and regulator. A short in this supply also affects the other voltages. It can be measured at J4-X.

5.54 Check the power supply voltages at the points listed below. Refer to figure 6.6 for voltage levels within the power supply.

Power Supply	Measurement Point (figure 6.5)
+5V	J4-20 or CR40 anode
+18V	Cathode of CR40
−18V	Anode of CR22

5.55 If any of the power supply voltages are abnormal, disconnect the load to isolate the trouble to the supply or to the load. If the voltage returns to normal, reconnect the load and selectively unplug the interconnection board, the signal conditioning board, and the prescaler until the source of the overload is located.

5.56 If the trouble appears in only one readout tube, a bad integrated circuit (IC) driver or a bad readout tube is indicated. Driver IC's are 7441's in Row F directly behind the readout tubes. Remove power, and exchange the 7441 behind the bad readout with the neighboring driver. If the trouble moves with the driver (7441), replace the 7441 driver. If the trouble stays when the driver is moved, replace the readout tube. If none of the above solves the problem, inspect the circuit near the tube, driver, or quad latch (7475) for shorts or opens.

5.57 ANNUNCIATORS INOPERATIVE.

5.58 The "gate" and units annunciators are located in front of and below the readout tubes (figure 6.5). They are operated from the +150-volt and +5-volt power supplies. If none of the annunciators light, the power supply is probably faulty. Perform the power supply checkout procedures described in paragraph 5.49.

5.59 If the GATE annunciator does not operate, proceed as follows:

a. Set DISPLAY TIME counterclockwise, just short of the PWR OFF position.

b. Set FUNCTION switch to the CHECK mode.

c. Depress the 100 ms TIMEBASE switch (the GATE light should flash at approximately 130 ms intervals).

d. With an oscilloscope, check at the cathode of CR1 for a pulse going from zero to +4.0 volts. If the pulse is not present, check at J2-4 (see circuit, figure 5.4).

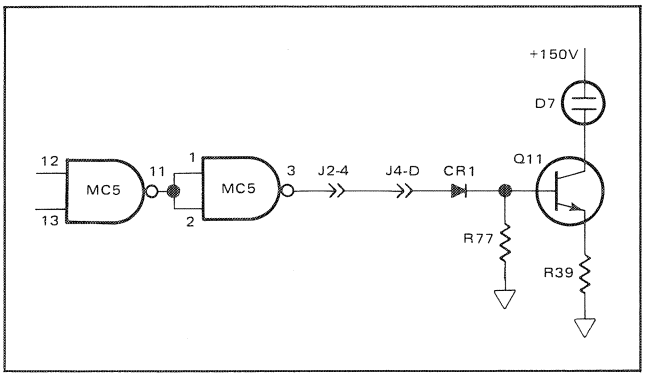


Figure 5.4 - Gate Annunciator

e. If the pulse is not present at J2-4, check the control logic on the Switch board assembly. Verify first that a "start" pulse is being generated.

5.60 If one of the units annunciators does not light, refer to table 5.4. In the table, voltage levels at the inputs and output of gates are listed. If a level differs by ±10% from that listed, the trouble is located between the correct level and the incorrect level. Integrated-circuit drivers in each circuit may be unplugged and exchanged with one of the same type known to be good. If a driver becomes shorted, the corresponding annunciator remains "on". If the driver is open, the annunciator remains "off".

5.61 DECIMAL POINT MALFUNCTION.

5.62 Should any one decimal point not turn on, perform the following decimal point check:

a. Set the FUNCTION switch to FREQ C. Select the 1 μs timebase. No decimal point should be lit. If one is lit, try substituting the readout with the one

Table 5.4 - Units Annunciators Troubleshooting

Annunciator	Function	Select Timebase/Multiplier	Measurement Point	Normal Level	Figure No.
μsec	PERIOD Mode	1 μs	E54 MB11-8	≥2.0 volts	5.5
			MB11-10 MC12-8	≤0.8 volts	
			MB11-11 MB12-3	≥2.0 volts	
			MB12-1	≤0.8 volts	
			MB12-2	≤0.8 volts	
msec	PERIOD Mode	10 μs	E50 MD10-12	≤2.0 volts	5.6
			MD10-13 MD12-8	≤0.8 volts	
			MD12-2	≥2.0 volts	
			MD12-3	≥2.0 volts	
nsec	PER AVG Mode	10^6	E52 MD11-11	≥2.0 volts	5.7
			MD11-13 MC11-8	≤0.8 volts	
			MD11-12	≥2.0 volts	
			MD11-8	≥2.0 volts	
sec	PERIOD Mode	10 ms	E51 MD11-3	≥2.0 volts	5.8
			MD11-1 MC11-6	≤0.8 volts	
			MC11-2	≥2.0 volts	
			MC11-3	≥2.0 volts	
KHz	FREQ A Mode	10s	E53 MB12-8	≥2.0 volts	5.9
			MB12-9 MB12-6	≤0.8 volts	
			MB12-4	≥2.0 volts	
			MB12-5	≥2.0 volts	
MHz	FREQ A Mode	1s	E49 MD10-2	≥2.0 volts	5.10
			MD10-1 MC9-8	≤0.8 volts	
			MC9-1 MA12-6	≥2.0 volts	
			MA12-5 MB8-3	≥2.0 volts	
			MB8-1	≥2.0 volts	
			MB8-2	≥2.0 volts	
			MC9-13	≥2.0 volts	

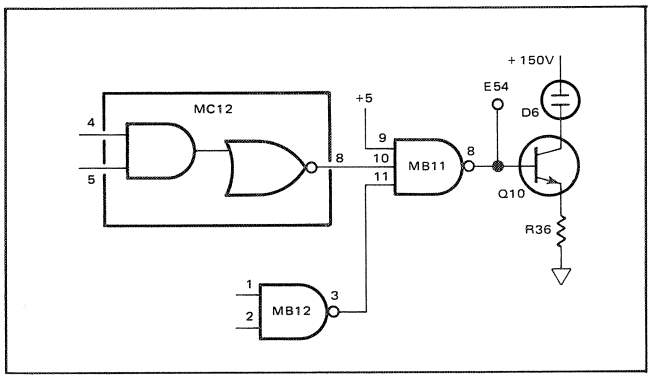


Figure 5.5 - "µsec" Annunciator

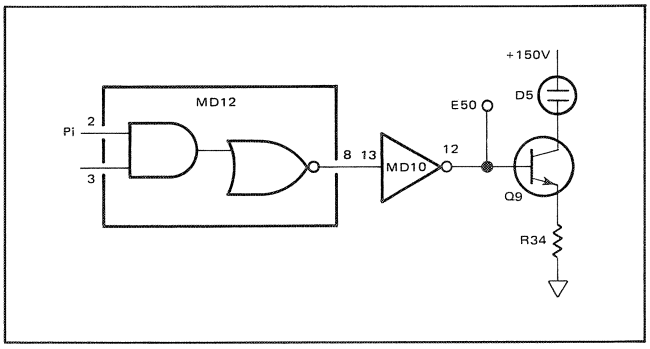


Figure 5.6 - "msec" Annunciator

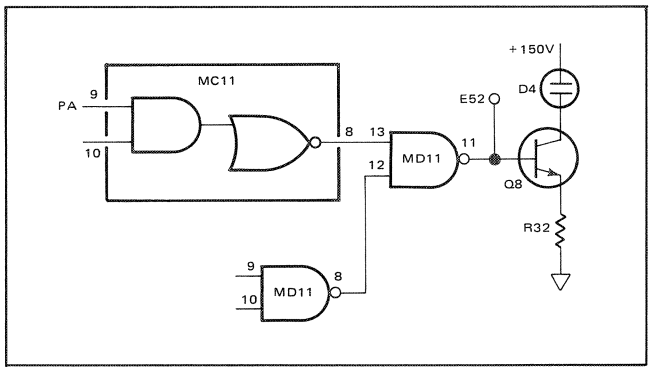


Figure 5.7 - "nsec" Annunciator

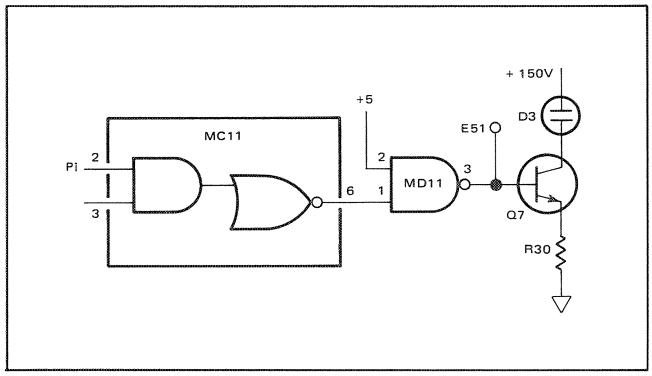


Figure 5.8 - "sec" Annunciator

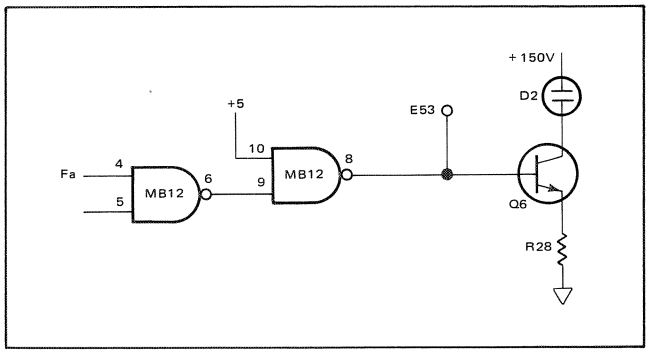


Figure 5.9 - "KHz" Annunciator

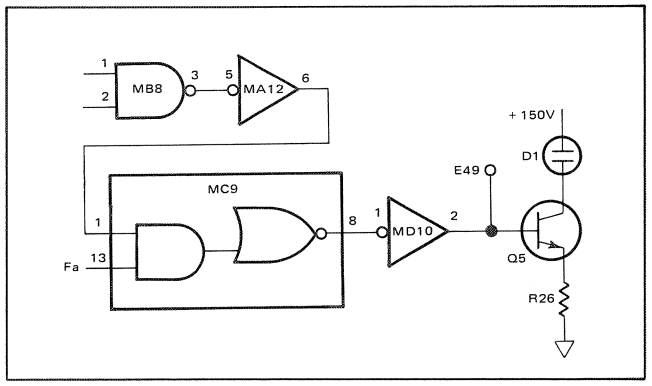


Figure 5.10 - "MHz" Annunciator

next to it. Each decimal point is driven by a transistor which, if open or shorted, causes a decimal point to remain off or on continuously.

b. Depress the 10 µs to 100s TIMEBASE switches; the decimal point should light as shown in table 5.5.

5.63 Procedures for signal tracing through the DP logic are listed in table 5.6.

Table 5.5 - Decimal Point Placement

Timebase	Decimal Point Display								
	V9	V8	V7	V6	V5	V4	V3	V2	V1
10 µs	0	0	0	0	0	0	0	0	.0
100 µs	0	0	0	0	0	0	0	.0	0
1 ms	0	0	0	0	0	0	.0	0	0
10 ms	0	0	0	0	0	.0	0	0	0
100 ms	0	0	0	0	.0	0	0	0	0
1s	0	0	0	.0	0	0	0	0	0
10s	0	0	.0	0	0	0	0	0	0
100s	0	.0	0	0	0	0	0	0	0
	↑	DP8	DP7	DP6	DP5	DP4	DP3	DP2	DP1

Models with Option 004 (9th digit)

Table 5.6 - Troubleshooting Procedure - DP Logic

Decimal Pt.	Select Timebase	Measurement Point(s)	Normal Level	Figure No.
DP1	10 μs	E70 MC7-6	≥2.0 volts	5.11
		MC7-5 MA9-8	≤0.8 volts	
		MA9-4 MA9-5	≥2.0 volts	
DP2	100 μs	E71 CR26 anode CR27 anode	≥2.0 volts	5.12
		MC7-11	≥2.0 volts	
		MC7-12 MC8-6	≥2.0 volts	
		MC7-13 MB9-8	≤0.8 volts	
		MB9-4 MB9-5	≥2.0 volts	
DP3	1 ms	E72 MB7-12	≥2.0 volts	5.13
		MB7-13 MC9-6	≤0.8 volts	
		MC9-4 MC9-5	≥2.0 volts	
DP4	10 ms	E73 MB7-6	≥2.0 volts	5.14
		MB7-5 MA10-8	≤0.8 volts	
		MA10-4 MA10-5	≥2.0 volts	
DP5	100 ms	E74 MB7-4	≥2.0 volts	5.15
		MB7-3 MB10-8	≤0.8 volts	
		MB10-2 MB10-3	≥2.0 volts	
DP6	1s	E75 MC7-8	≥2.0 volts	5.16
		MC7-9 MC10-6	≤0.8 volts	
		MC10-2 MC10-3	≥2.0 volts	
		MC8-8 MC7-10	≥2.0 volts	

Table 5.6 - Troubleshooting Procedure - DP Logic (continued)

Decimal Pt.	Select Timebase	Measurement Point(s)	Normal Level	Figure No.
DP7	10s	E76 MB7-2	≥2.0 volts	5.17
		MB7-1 MC10-8	≤0.8 volts	
		MC10-1 MC10-13	≥2.0 volts	
		MA12-12	≥2.0 volts	
DP8	100s	E77 MB7-10	≥2.0 volts	5.18
		MB7-11 MC8-3	≤0.8 volts	
		MC8-1 MC8-2	≥2.0 volts	
		MA7-10	≥2.0 volts	

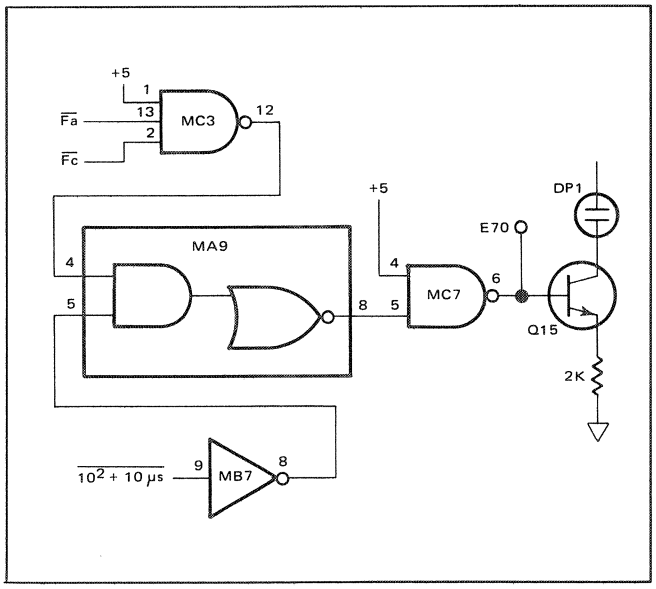


Figure 5.11 - DP1 Decimal Point Logic

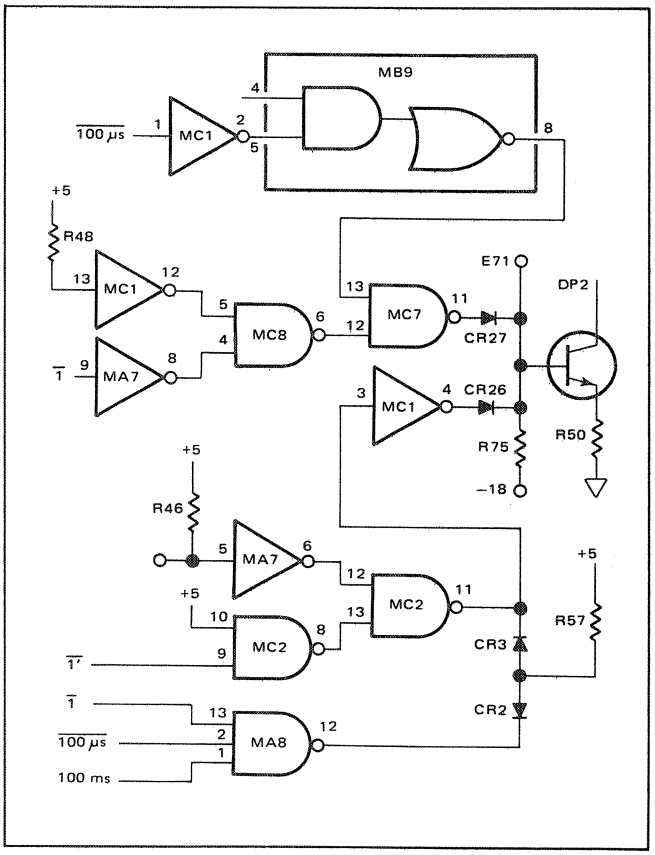


Figure 5.12 - DP2 Decimal Point Logic

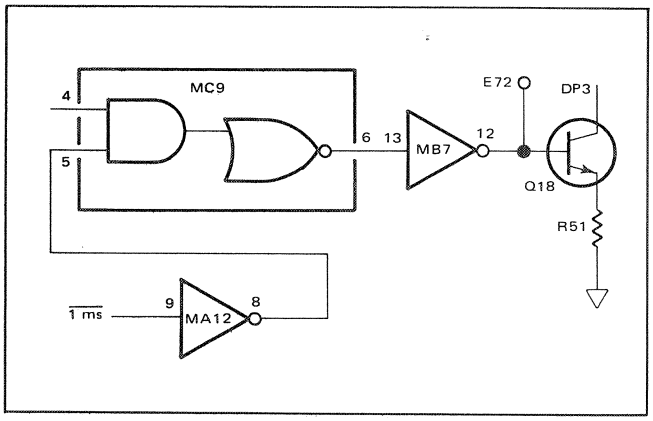


Figure 5.13 - DP3 Decimal Point Logic

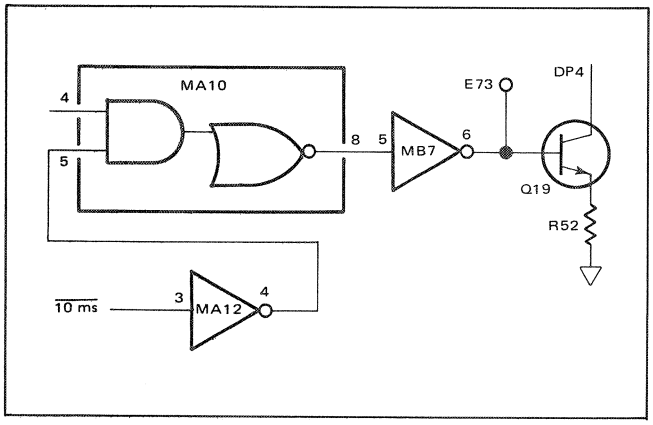


Figure 5.14 - DP4 Decimal Point Logic

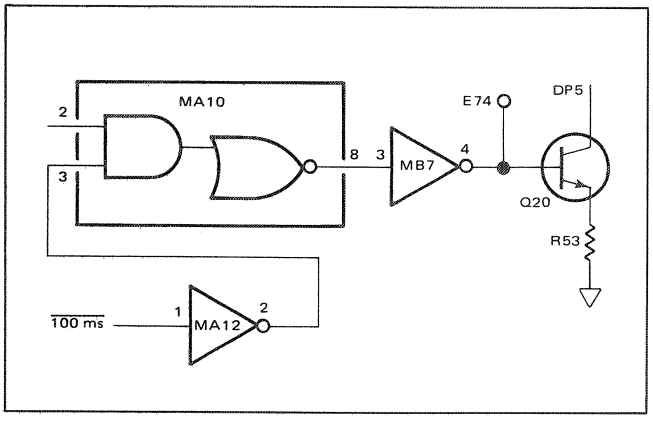


Figure 5.15 - DP5 Decimal Point Logic

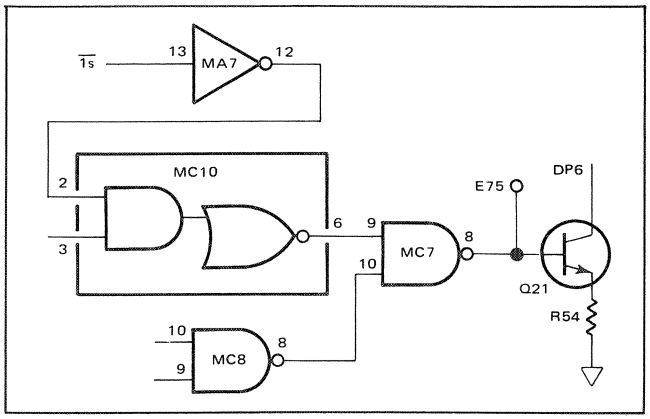


Figure 5.16 - DP6 Decimal Point Logic

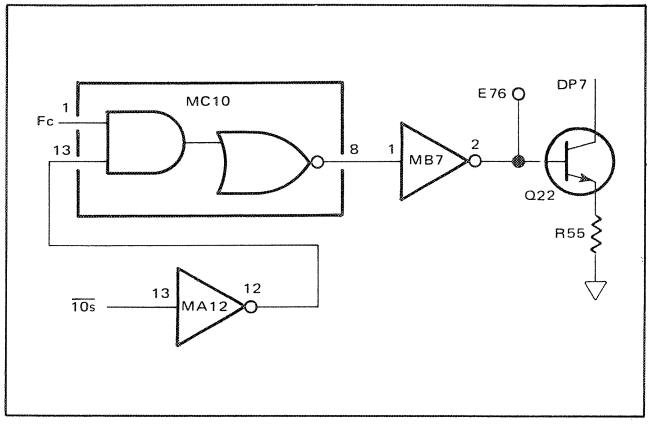


Figure 5.17 - DP7 Decimal Point Logic

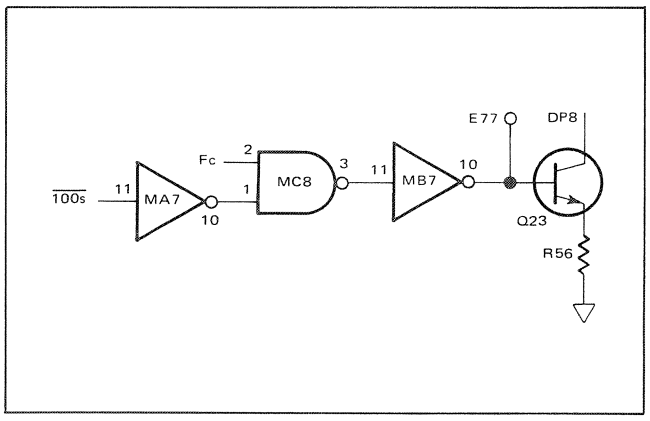


Figure 5.18 - DP8 Decimal Point Logic

5.64 Faulty Remote Operation.

5.65 Normally, problems occurring with the remote programming option occur also in local operation. Verify that transistor Q7 on the Switch board turns off with REMOTE selected. If Q7 operates properly, a malfunction can be traced by following the procedures for troubleshooting a specific operating mode. Also verify that there are no opens or wiring errors in the external circuits.

5.66 Faulty Operation In One Mode.

5.67 Figures 5.25 through 5.33 show the signal flow through the instrument in each mode of operation. Logic levels are given at significant check points to assist in signal tracing.

5.68 CHECK MODE (Figure 5.25).

5.69 In Check mode, the reference oscillator frequency is routed to the counting decades and to the timebase decades.

5.70 FREQUENCY A MODE (Figure 5.28).

5.71 The signal for Frequency A mode is routed through the Signal Conditioning assembly where the trigger slope and trigger point are selected. Attenuation of the signal also takes place in the attenuator section of the signal conditioning. Frequency A (f_a) is routed to the counting decades. The time that the counting decades are allowed to count is controlled by the Reference Oscillator, Timebase Decades, and the Control Logic. Be sure that the FUNCTION switch is positioned to FREQ A and that the range and trigger level controls are set correctly.

5.72 Connect an oscilloscope to E2 and E1 on the Switch board assembly. Connect a signal to the Frequency A input and adjust the counter accordingly. An ECL square wave should be seen varying between 3.4V and 4.2 volts dc. Try moving the trigger level control over its range. If no signal is found, the trouble is in the Attenuator or Signal Conditioning Module. Refer to the schematic of the Signal Conditioning module for troubleshooting (figure 6.2).

5.73 PERIOD MODE (Figure 5.26).

5.74 The signal in the Period mode is routed through the Attenuator and the Signal Conditioning assembly where the trigger slope and trigger level are selected. The signal (f_a) is routed to the Control Logic which controls the time that the counting decades are allowed to count the Reference Oscillator or a frequency division of the Reference Oscillator. Follow the procedure in paragraph 5.72. If the signal is present at E2 and E1, refer to the Period Signal Flow schematic for gate levels and signal flow.

5.75 PERIOD AVERAGE MODE (Figure 5.27).

5.76 The signal in Period Average mode is routed through the Attenuator to the Signal Conditioning assembly and to the Multiplier Timebase Decades. The output of the Timebase Decades (f/n) goes to the start/stop logic and on to the Control Logic which controls the counting decades. The Reference Oscillator is routed to the fast counting decades. The counting decades are controlled by Δt. Δt's time is determined by f_a and the multiplier selected on the front panel. Follow the procedure in paragraph 5.72. If the signal is present at E_2 and E_1, refer to the Period Average Signal Flow schematic for gate levels and signal flow.

5.77 FREQUENCY C MODE (Figure 5.29, not in 8010B).

5.78 Frequency C is much like Frequency A operation. The signal is connected to the Frequency C input and routed into the Frequency C RF Assembly. The signal is amplified. The amplification is controlled by an automatic gain control circuit (AGC). The signal is divided by two through a discrete flip-flop and divided again by two through a ECL flip-flop. The signal is routed to E4 and E3 on the Switch board assembly. The signal (f_c) goes to a ECL gate and to the counting decades. The Reference Oscillator is gated through to a divide-by-four flip-flop to the Timebase Decades.

5.79 To determine if the Frequency C signal reaches the Switch board, connect an oscilloscope to E4 and E3 on the Switch board. Set the FUNCTION switch to FREQ C. Connect a signal to Input C. A ECL square wave should be seen on the oscilloscope varying between 3.4V and 4.2 volts dc. If no signal is found, the trouble is in the Frequency C RF assembly. Refer to figure 6.12 or 6.13 or figures 6.14 and 6.15 for Option 030 (1 mV, 10 MHz – 500 MHz) for the schematic of the RF assembly.

5.80 TOTALIZE MODE (Figure 5.30).

5.81 The signal in the Totalize mode is routed through the A input to the Attenuator and Signal Conditioning Module where the trigger level and slope are selected. The output of the Signal Conditioner is gated to the counting decades. The counting decades are controlled by the manual start/stop circuit which develops Δt, the gate time for the

count. The input signal divided by 10 ($f_a/10$) is routed to the Timebase Decades and to the scaled output connector for external use.

5.82 TIME INTERVAL MODE (Figure 5.31).

5.83 The signals in the Time Interval mode are routed through the A and B inputs to the A and B Signal Conditioning Modules. The Signal Conditioning circuits determine the trigger points and trigger slope. The output of A is at E2 and E1 on the Switch board. The output of B is at E6 and E5 on the Switch board. The Reference Oscillator is gated to the Multiplier Timebase Decades. The Multiplier Timebase Decades are gated to the counting decades. The counting decades are controlled by the Control Logic which is controlled by the stop/start logic. The signal from input A determines the start time and the input B signal determines the stop time. The start and stop circuits define the gate time.

5.84 Verify that the input controls are set correctly. Observe E2 and E1, and E6 and E5 to determine that a square wave pulse is being generated at the correct time. If a signal is not present, refer to the Signal Conditioning schematic, figure 6.2.

5.85 A/B (RATIO) MODE (Figure 5.32).

5.86 The signals in the Ratio mode are routed through the Inputs A and B. The signal from Input A goes to the Attenuator and Signal Conditioning circuits where the trigger level and slope are selected. The output of the A Signal Conditioner (f_a) is routed to the counting decades. The output of B Signal Conditioner (f_b) is routed to the Multiplier Timebase Decades and to the Control Logic. The Control Logic starts and stops the counting decades.

5.87 Verify that there is a signal at the output of the A Signal Conditioner (E2, E1). Verify that there is also a signal at the output of the B Signal Conditioner (E6, E5). If either of these signals are missing, refer to the Signal Conditioner schematic, figure 6.2.

5.88 TIME INTERVAL AVERAGE MODE (Figure 5.33).

5.89 The signals in the Time Interval Average mode are routed through Inputs A and B. The signals are attenuated at the Attenuator. The trigger level and the slope are selected in the A and B signal conditioners. Signals f_a and f_b are routed to the Switch board at points E2 and E1 (A) and E6 and E5 (B). Signal f_a is routed to two type-D flip-flops. The signal is synchronized with the Reference Oscillator. When signal f_a goes high, the reference clock enables the counting decades. Signal f_b is synchronized with the Reference Oscillator and disables the reference clock to the counting decades at the end of the incoming signal. Signal f_b also produces f_b SYN which goes to the Timebase Decades. Signal f_b SYN is generated once per measurement period. Thus, the Timebase Decades count f_b SYN. Depending on the multiplier selected, 1 to 10^9, one measurement or 1000 million measurements will be made and averaged.

5.90 Verify that the signals f_a and f_b, at ECL levels, appear at points E2 and E1 (A), and E6 and E5 (B). If a signal is not present, check the controls for proper setting. Refer to figure 6.2 for schematic of the Signal Conditioner. If both signals f_a and f_b are present, refer to the signal flow schematic.

5.91 Troubleshooting The Signal Conditioning Assembly.

> **WARNING**
>
> Removal of covers exposes potentially lethal voltages. Avoid contact with internal electrical connections while unit is connected to AC Power source.

5.92 For disassembly refer to paragraph 5.23. Follow the calibration procedures in paragraphs 5.14 and 5.15 (dual channel). If this does not reveal the problem, refer to the schematic, figure 6.2. Voltage levels and signal level are given on the schematic.

5.93 Channel A and channel B (except on 8020B) are schematically the same. The reference designators are suffixed with an "A" in the channel A circuits. To verify that Q1 and Q10 are matched to each other, proceed as follows:

a. Ground the bases of Q4 and Q8.

b. Measure between the bases of Q2 and Q9. Verify the operation of R20; the voltage should vary from negative, through zero, to positive. If this voltage range cannot be obtained, either Q1 and Q10 are not matched or there is a component failure in the circuit.

5.94 The following pairs of transistors in this circuit are matched as indicated.

Q4 and Q8; V_{be} (base-to-emitter voltage)

Q2 and Q9; V_{be} (base-to-emitter voltage)

Q1 and Q10; R_{ds} (resistance, drain-to-source)

5.95 Troubleshooting The RF Assembly.

5.96 For disassembly, refer to paragraph 5.22. Note: *Do not move any components unless that component is known to be defective.* The RF Assembly is very sensitive to component location. Recalibration will be required if a component is replaced in a critical area. Voltage levels are

given on the schematic figures 6.13 or 6.15. However, it is recommended that the RF assembly be returned to Dana's Product Service for repair and calibration.

5.97 BASIC LOGIC DEFINITION.

5.98 TTL Logic.

5.99 A majority of the integrated circuits used in the 8000B counters are TTL type integrated circuits. TTL circuits operate up to ≅15 MHz. The basic Nor function is shown in figure 5.19. Logic levels are:

Logical 0: ≤.8V Logical 1: ≥2.0V

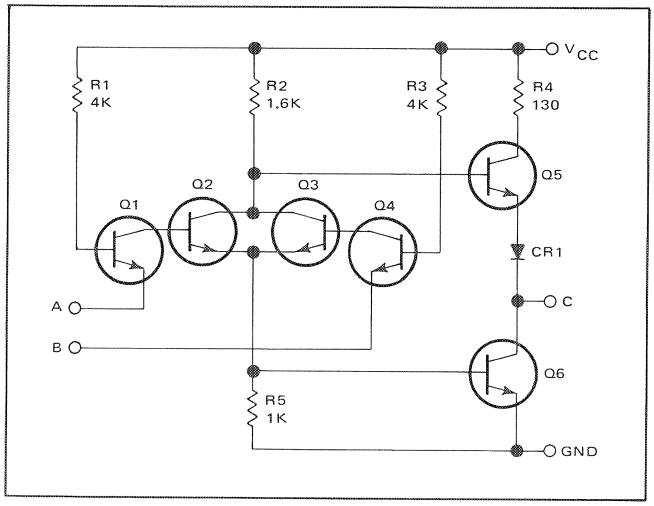


Figure 5.19 - Basic TTL Nor Gate

5.100 The Nor gate is comprised of six transistors. The two input transistors, Q1 and Q4, are used as diode or gates (figure 5.20). Transistors Q2 and Q3 are voltage phase inverters. Transistors Q5 and Q6 form a totem-pole output. The totem-pole circuit has a low output resistance for both a high and low level.

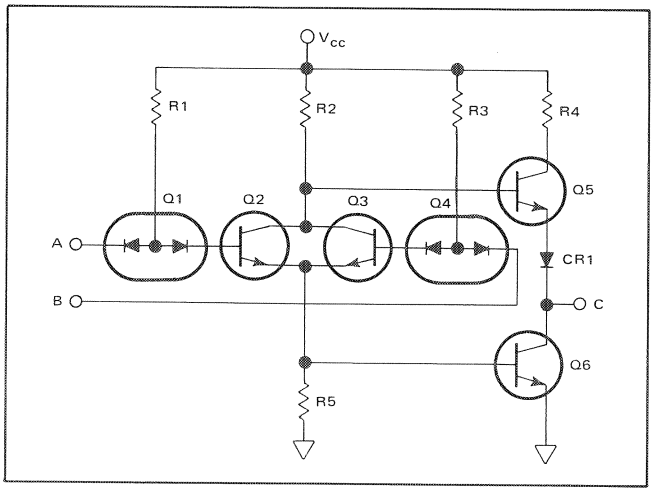


Figure 5.20 - Equivalent Circuit

5.101 Assume a Logical "0" level exists at both A and B inputs. Transistor Q1 and Q4 are conducting. Therefore, the collectors of Q1 and Q4 are at logical "0" level. The logical "0" level from the collectors of Q1 and Q4 are applied to the bases of Q2 and Q3 causing them to turn off. The collectors of Q2 and Q3 are connected together and to the base of Q5. The logical "1" on the base of Q5 causes Q5 to conduct. Output C is connected to the emitter of Q5 via CR1. Diode CR1 prevents an indeterminate output. The output of the Nor gate is two diode drops (1.4V) lower than the base voltages of Q5 or 3.6V.

5.102 Assume a logical "1" level is applied to input A. Base current for Q2 is supplied through R1 and the base-collector junction of Q1. Transistor Q2 is turned on. The collector of Q2 is connected to the base of Q5 and turns Q5 off. The emitter of Q2 is connected to the base of Q6. Q2 supplies base current to Q6 base; therefore Q6 is turned on and output C is low.

5.103 A logical "1" level applied to either or both inputs A or B result in a logical "0" level at output C. The truth table is shown in table 5.7.

Table 5.7 - Truth Table

A	B	C
1	1	0
1	0	0
0	1	0
0	0	1

5.104 Emitter Coupled Logic (ECL).

5.105 BASIC NOR FUNCTION.

5.106 A number of ECL integrated circuits are used in the counter. ECL circuits are used wherever high-speed switching is required. The basic Nor function is shown in figure 5.21. Logic levels used are:

Logical 0: 3.5V Logical 1: 4.2V

5.107 The gate is comprised of differential amplifier Q2 and Q3, input transistors Q1 and Q2, and emitter follower output transistor Q4. Transistor Q3 and resistors R3 and R4 form a fixed bias circuit.

5.108 Assume Logical "0" levels exist at both A and B inputs. Transistors Q1 and Q2 are cut off; therefore, the collectors of Q1 and Q2 are at a logical "1" level. The logical "1" level from the collectors of Q1 and Q2 is applied

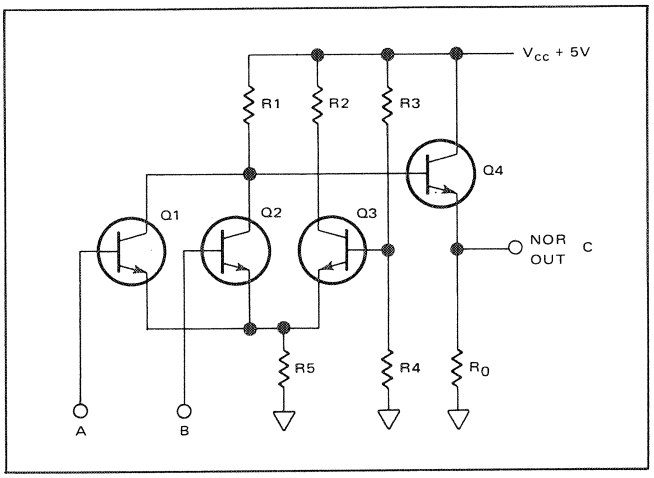


Figure 5.21 - Basic ECL Nor Gate

to the base of Q4, causing Q4 to conduct. The output at the emitter of Q4 is a logical "1" level (output C).

5.109 Assume that a logical "1" level is applied to input A. Transistor Q1 conducts and a logical "0" level results at the Q1 collector due to the drop across R1. The logical "0" level is applied to the base of Q4 causing Q4 to cut off providing a logical "0" level at output C.

5.110 A logical "1" level applied to either or both input A or B results in a logical "0" level at output C. The circuit therefore performs a Nor function; the truth table is shown in table 5.8.

Table 5.8 - ECL NOR Truth Table

A	B	C
0	0	1
1	0	0
0	1	0
1	1	0

5.111 DIODE GATE.

5.112 The purpose of a diode gate (figure 5.22) is to control a ECL level signal with a TTL gate. The diode gate is much faster than TTL logic and speed is required in these circuits. Diode CR2 is always in forward conduction with the current provided through resistor R2 from V. The state of CR1 depends on the output of TTL gate. If the TTL gate is high, the CR1 conducts. If the TTL gate is low, then CR1 is reverse-biased and the signal is not transferred from

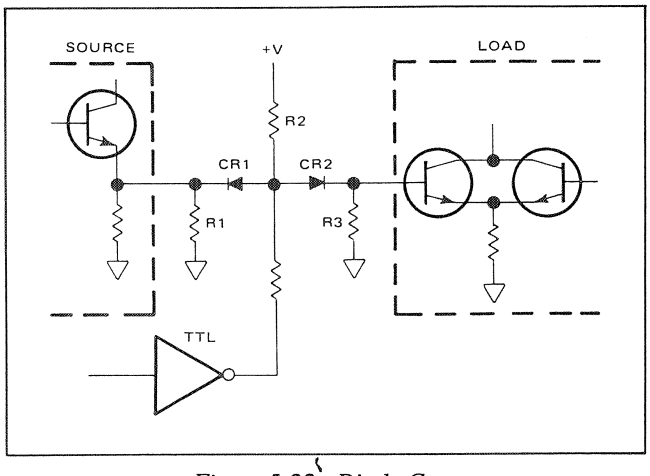


Figure 5.22 - Diode Gate

the source to the load. If the output of the TTL gate and CR1 is forward biased, a low insertion loss signal path is provided between the source and the load. DC levels are maintained between the source and load as shown in table 5.9 due to CR1 and CR2 being connected back-to-back.

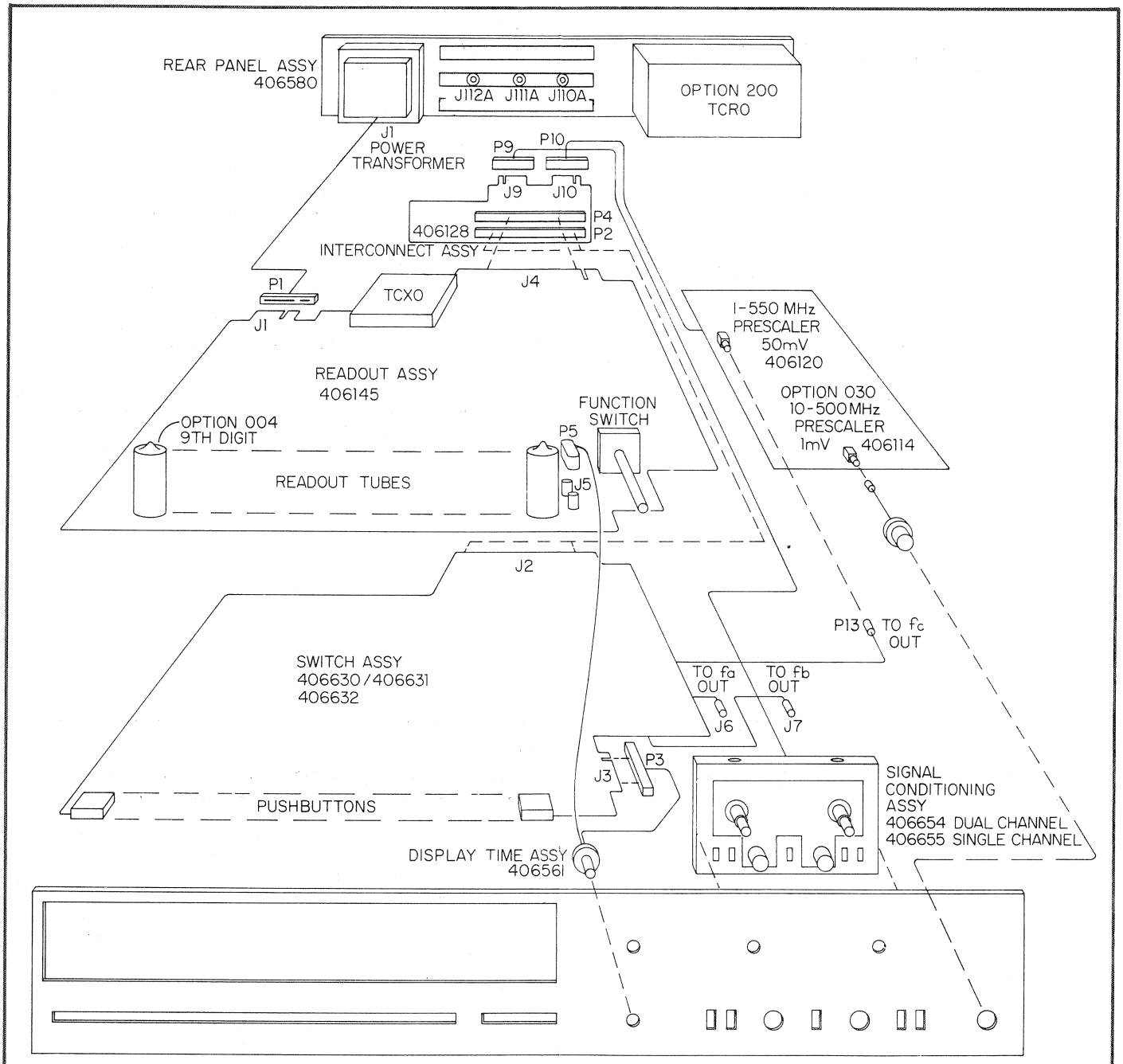
Table 5.9 - DC Levels

	TTL Gate High		TTL Gate Low	
V Source Output	3.4	4.2	3.4	4.2
V Load Input	3.4	4.2	3.14	3.14

5.113 BOARD REVISION.

5.114 Every effort is made to keep the manual concurrent with the instrument despite changes to the design, which are an inevitable adjunct of the manufacturing process. The manual is updated and periodically reprinted throughout the year. In between printings, Addendums and Errata Sheets are added to the manual if required to implement the reprinted copy.

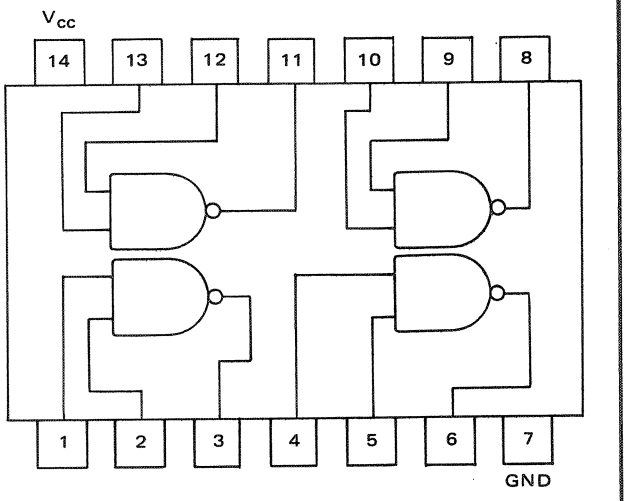
5.115 Any design change is accompanied by an updating of a board revision. Such change could be as simple as a revised hole size or as complex as major modifications of the circuitry. The revision of a board is indicated by the letter preceding the assembly number stamped on the board; the revision of the assembly drawing in Section 6 or on an Errata Sheet is indicated by the letter following the assembly number, located below the drawing. Comparing the revision letters can indicate how closely the drawing corresponds to the board.



ASSEMBLY NAME	MODEL	
	8010B	8030B
SIGNAL CONDITIONING	406654	406654
SWITCH BOARD	406631	406632
READOUT BOARD	406145	406145
REAR PANEL	406580	406580
550 MHz PRESCALER	NOTE ONLY 1 PRESCALER PER COUNTER	406120
500 MHz PRESCALER OPTION 030		406114
DISPLAY TIME CONTROL	406561	406561
INTERCONNECT BOARD	406128	406128
FRONT PANEL	730552	730555

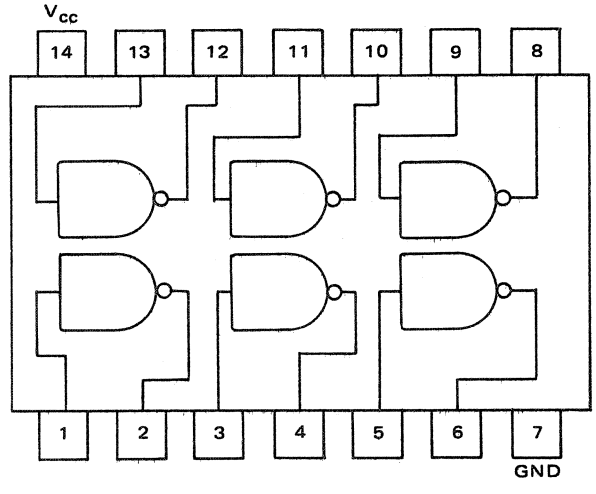
Figure 5.23 - Exploded View

7400 / 74H00
QUADRUPLE 2-INPUT POSITIVE NAND GATE



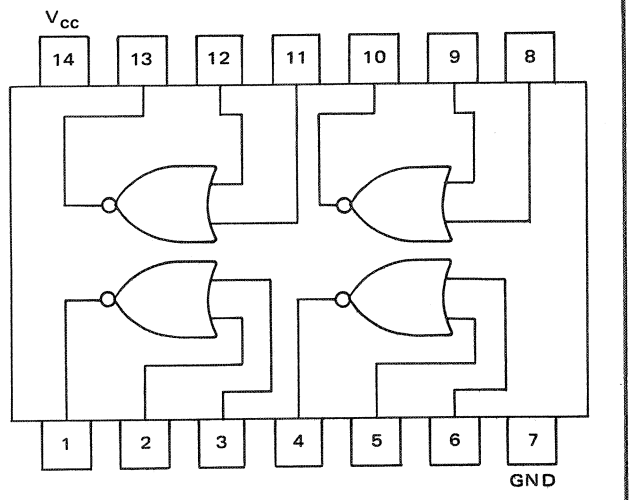
A	B	C
1	1	0
0	1	1
1	0	1
0	0	1

7404
HEX INVERTER



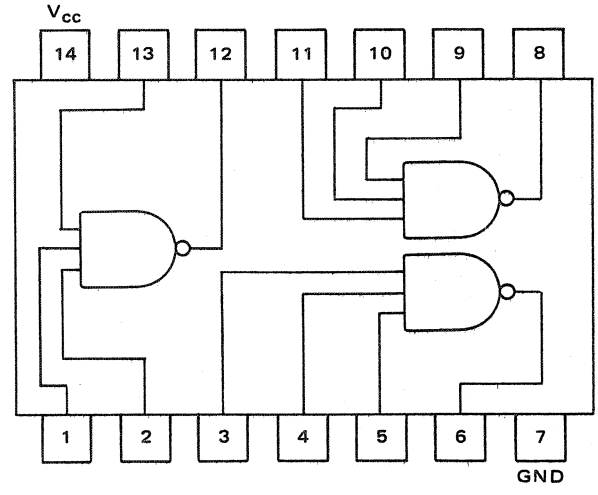
A	B
1	0
0	1

7402
QUADRUPLE 2-INPUT POSITIVE NOR GATE



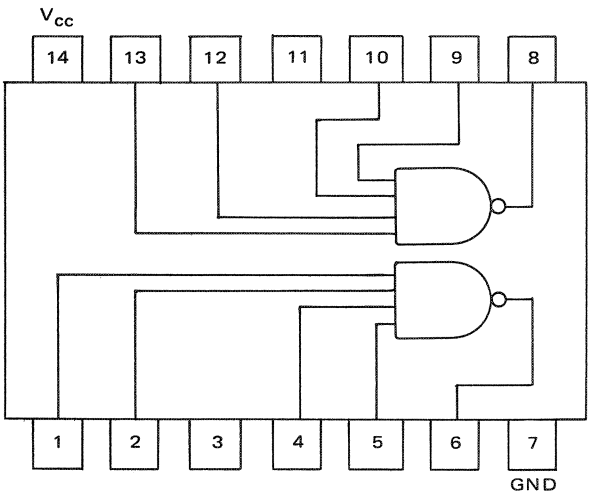
A	B	C
0	0	1
1	1	0
1	0	0
0	1	0

7410
TRIPLE 3-INPUT POSITIVE NAND GATE



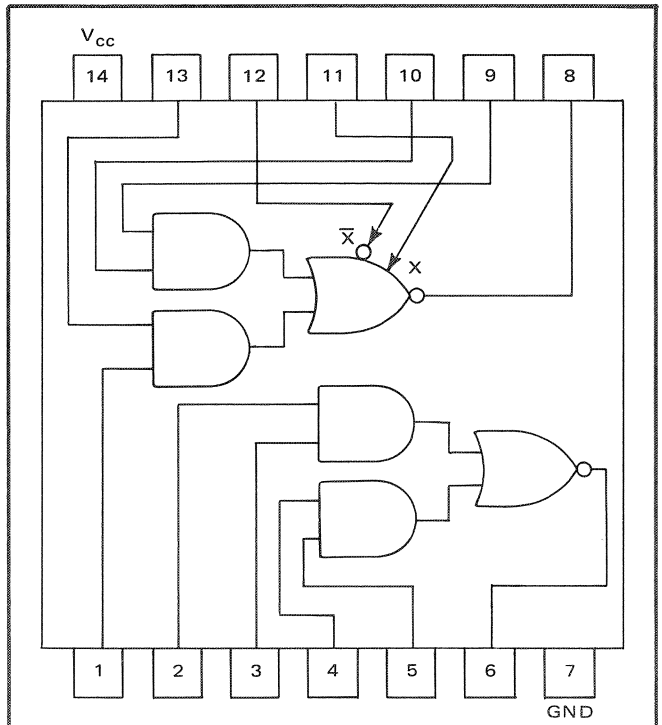
A	B	C	D
1	1	1	0
1	1	0	1
1	0	0	1
0	0	0	1

7420
DUAL 4-INPUT POSITIVE NAND GATE

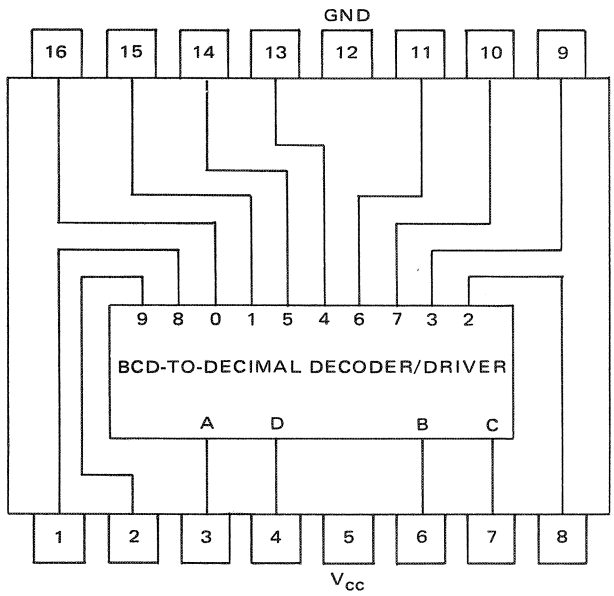


A	B	C	D	E
1	1	1	1	0
1	1	1	0	1
1	1	0	0	1
1	0	0	0	1
0	0	0	0	1

7451
EXPANDABLE DUAL 2-WIDE 2-INPUT AND-OR-INVERT GATES



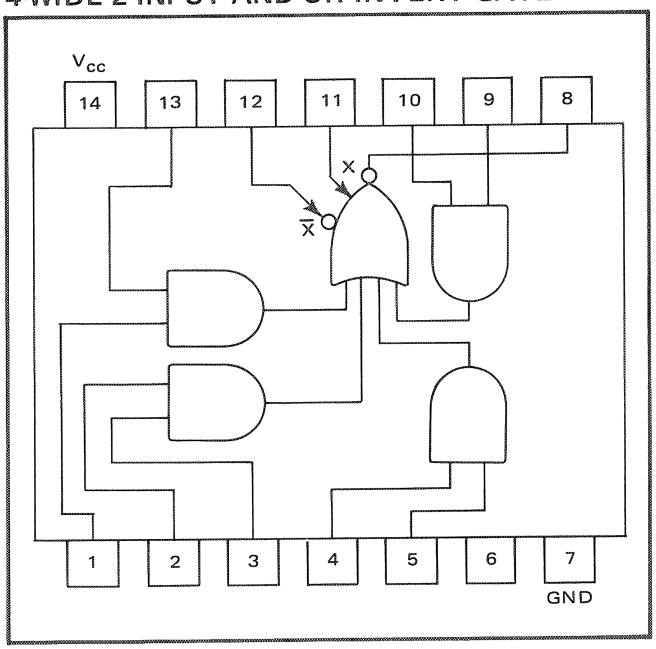
7441
BCD-TO-DECIMAL DECODER/DRIVER



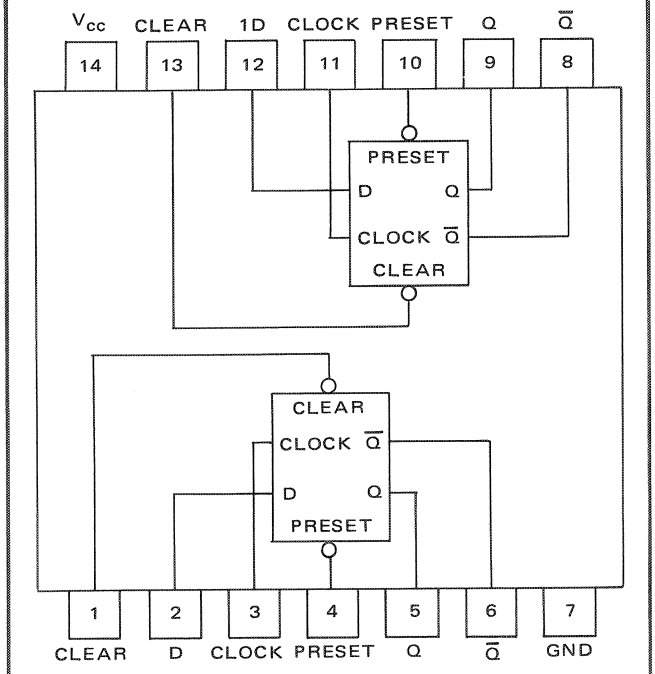
D	C	B	A	
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9

Figure 5.24 - Integrated Circuits

7454
4-WIDE 2-INPUT AND-OR-INVERT GATE



74H74
DUAL D-TYPE EDGE TRIGGERED FLIP-FLOP



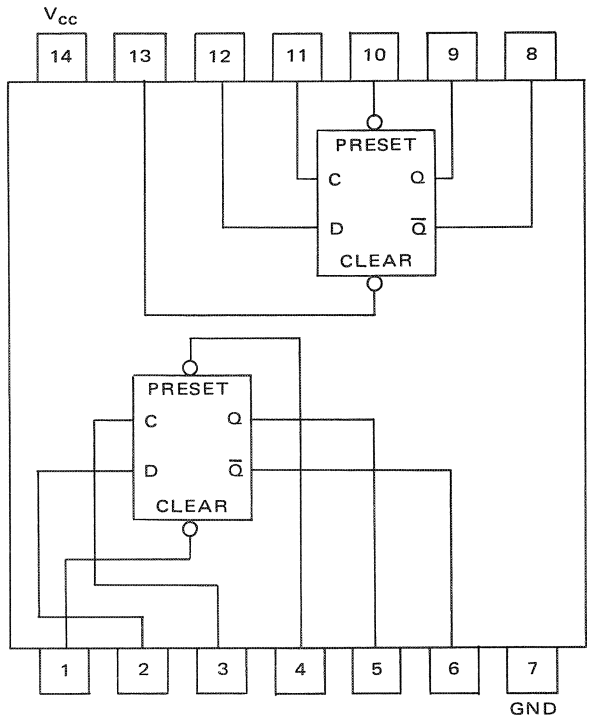
(Each Flip-Flop)		
t_n	t_{n+1}	
Input	Output	Output
D	Q	Q
L	L	H
H	H	L

H = High Level, L = Low Level

NOTES:

1. t_n = bit time before clock pulse
2. t_{n+1} = bit time after clock pulse

7474
DUAL D-TYPE EDGE-TRIGGERED FLIP-FLOP



D_n	Q_{n+1}	$\overline{Q}_{n+1}$
1	1	0
0	0	1

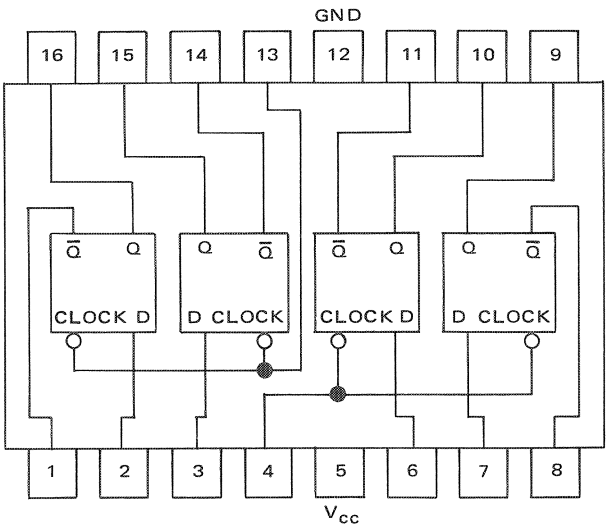
Preset	Clear	Q
1	1	Q
1	0	0
0	1	1
0	0	†

† Both outputs in 1 state

n is time prior to clock

n + 1 is time following clock

7475
QUADRUPLE BISTABLE LATCH

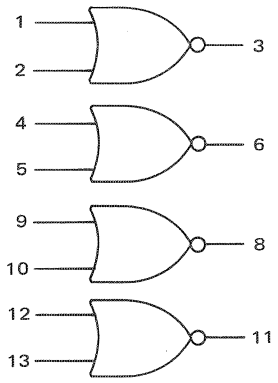


(Each Latch)		
t_n	t_{n+1}	
D	Q	$\bar{Q}$
1	1	0
0	0	1

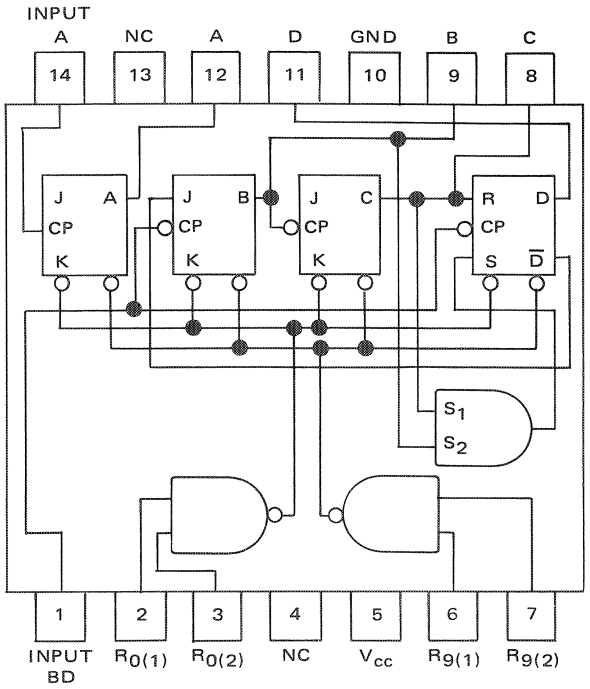
NOTES:

1. t_n = bit time before clock pulse.
2. t_{n+1} = bit time after clock pulse.
3. These voltages are with respect to network ground terminal.

MC1010
QUAD 2-INPUT GATES



7490
DECADE COUNTER



BCD COUNT SEQUENCE (See Note 1)

	OUTPUT			
COUNT	D	C	B	A
0	0	0	0	0
1	0	0	0	0
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1

RESET/COUNT (See Note 2)

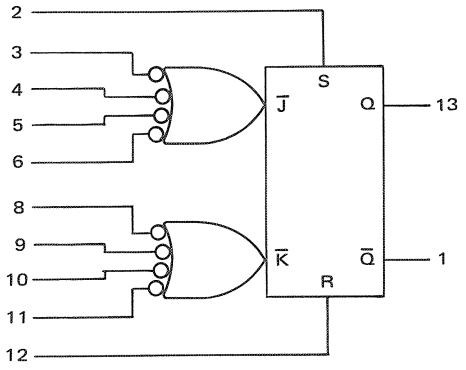
RESET INPUTS				OUTPUT			
$R_{0(2)}$	$R_{0(2)}$	$R_{9(1)}$	$R_{9(2)}$	D	C	B	A
1	1	0	X	0	0	0	0
1	1	X	0	0	0	0	0
X	X	1	1	1	0	0	1
X	0	X	0	COUNT			
0	X	0	X	COUNT			
0	X	X	0	COUNT			
X	0	0	X	COUNT			

NOTES:

1. Output A connected to input BD for BCD count.
2. X indicates that either a logical 1 of a logical 0 may be present.
3. Fanout from output A to input BD and to 10 additional Series 54/74 loads is permitted.

Figure 5.24 - Integrated Circuits continued

MC1013 / MC1027
AC-COUPLED J-K FLIP-FLOP



MC1013
DC Input Loading Factor = 1
DC Output Loading Factor = 25
tpd = 6.0 ns typ
Power Dissipation = 125 mW typ

MC1027
DC Input Loading Factor = 2
DC Output Loading Factor = 25
tpd = 4.0 ns typ
Power Dissipation = 250 mW typ

R-S TRUTH TABLE

Pin No.	R	S	Q^{n+1}
	12	2	13
	0	0	Q^n
	0	1	1
	1	0	0
	1	1	N.D.

All $\overline{J}$-$\overline{K}$ inputs are static.
N.D. = Not defined.

$\overline{J}_D$ - $\overline{K}_D$ TRUTH TABLE

Pin No.	$\overline{J}_D$	$\overline{K}_D$	Q^{n+1}
	*	*	13
	0	0	Q^n
	0	1	0
	1	0	1
	1	1	$\overline{Q}^n$

All other $\overline{J}$-$\overline{K}$ inputs and the R-S inputs are at a "0" level.

CLOCKED $\overline{J}$-$\overline{K}$ TRUTH TABLE

Pin No.	$\overline{J}$	$\overline{K}$	$\overline{C}_D$	Q^n
	*	*	**	13
	Ø	Ø	0	Q^n
	0	0	1	$\overline{Q}^n$
	0	1	1	1
	1	0	1	0
	1	1	1	Q^n

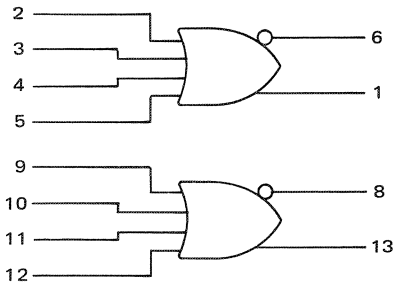
All other $\overline{J}$-$\overline{K}$ inputs and the R-S inputs are at a "0" level.
Ø = Either state will result in the desired output.

* Any $\overline{J}$ or $\overline{K}$ input, not used for $\overline{C}_D$.

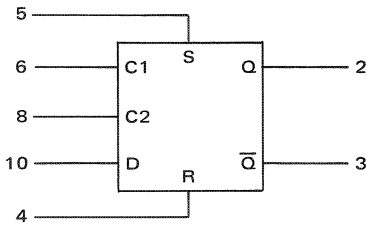
** $\overline{C}_D$ obtained by connecting one $\overline{J}$ and one $\overline{K}$ input together.

The $\overline{J}$ and $\overline{K}$ inputs refer to logic levels while the $\overline{C}_D$ input refers to dynamic logic swings. The $\overline{J}$ and $\overline{K}$ inputs should be changed to a logical "1" only while the $\overline{C}_D$ input is in a logic "1" state. ($\overline{C}_D$ maximum "1" level = V_{CC} – 0.6V). Clock $\overline{C}_D$ is obtained by tying one $\overline{J}$ and one $\overline{K}$ input together.

MC1023
DUAL 4-INPUT CLOCK DRIVER



MC1034
TYPE D FLIP-FLOP



DC Input Loading Factor:
C = 1, D = 2, R and S = 6
DC Output Loading Factor = 25
Power Dissipation = 185 mW typical using external 600-ohm pull-down resistors
240 mW typical using internal pull-down resistors

R-S TRUTH TABLE

Pin No.	R	S	Q^{n+1}	$\overline{Q}^{n+1}$
	4	5	2	3
	0	0	Q^n	$\overline{Q}^n$
	0	1	1	0
	1	0	0	1
	1	1	N.D.	N.D.

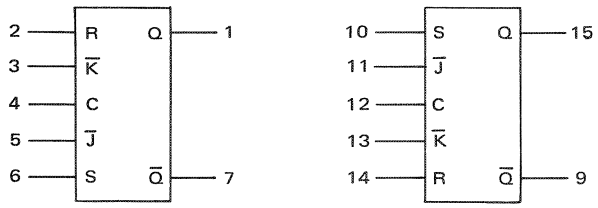
N.D. = Not Defined

CLOCKED TRUTH TABLE

Pin No.	D	C	Q^{n+1}	$\overline{Q}^{n+1}$
	10	6 or 8	2	3
	0	0	Q^n	$\overline{Q}^n$
	1	0	Q^n	$\overline{Q}^n$
	0	1*	0	1
	1	1*	1	0

*A "1" or Clock input is defined for this flip-flop as a change in level from a low state to a high state of the clock.

MC1032
100-MHz AC-COUPLED DUAL J-K FLIP-FLOP



V_{CC} = Pin 16
V_{EE} = Pin 8

DC Input Loading Factor:
Clock = 2
$\overline{J}$, $\overline{K}$, S, R = 1
DC Output Loading Factor = 25
tpd = 4.5 ns typ
Power Dissipation = 180 mW typ

R-S TRUTH TABLE

	R	S	Q^{n+1}
Pin No.	2 & 14	6 & 10	1 & 15
	0	0	Q^n
	0	1	1
	1	0	0
	1	1	N.D.

All $\overline{J}$-$\overline{K}$ inputs and Clock inputs are static
N.D. = Not defined

$\overline{J}_D$-$\overline{K}_D$ TRUTH TABLE

	$\overline{J}$	$\overline{K}$	Q^{n+1}
Pin No.	*	*	1 & 15
	0	0	Q^n
	0	1	0
	1	0	1
	1	1	$\overline{Q}^n$

All Clock inputs and the R-S inputs are at a "0" level.

CLOCKED $\overline{J}$-$\overline{K}$ TRUTH TABLE

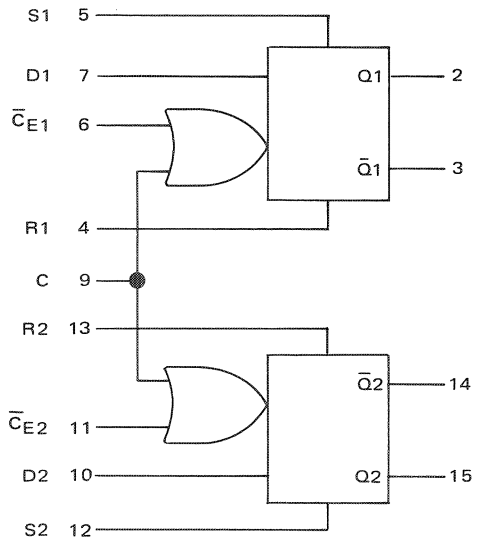
	$\overline{J}$	$\overline{K}$	Clock	Q^n
Pin No.	*	*	4 & 12	1 & 15
	Ø	Ø	0	Q^n
	0	0	1	$\overline{Q}^n$
	0	1	1	1
	1	0	1	0
	1	1	1	Q^n

All other $\overline{J}$-$\overline{K}$ inputs and the R-S inputs are at a "0" level.
Ø = Either state will result in the desired output.

* Any $\overline{J}$ or $\overline{K}$ input

The $\overline{J}$ and $\overline{K}$ inputs refer to logic levels while the clock input refers to dynamic logic swings. The $\overline{J}$ and $\overline{K}$ inputs should be changed to a logic "1" only while the clock input is in a logic "1" state. (Clock maximum "1" level = V_{CC} – 0.7V.)

MC10131
DUAL TYPE D MASTER-SLAVE FLIP-FLOP



V_{CC1} = Pin 1
V_{CC2} = Pin 16
V_{EE} = Pin 8

R-S TRUTH TABLE

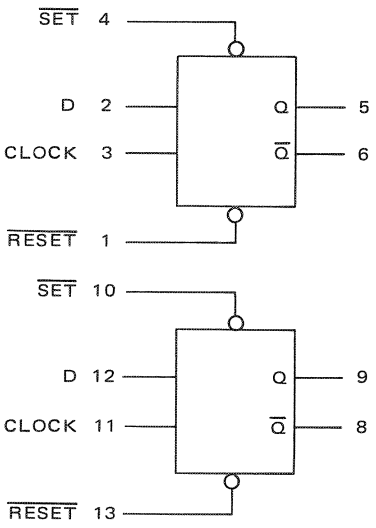
R	S	Q^{n+1}	$\overline{Q}^{n+1}$
L	L	Q^n	$\overline{Q}^n$
L	H	H	L
H	L	L	H
H	H	N.D.	N.D.

N.D. = Not Defined

SEQUENTIAL TRUTH TABLE

D	C	$\overline{C}_E$	Q_{n+1}
L	L	L	Q_n
L	L	H	L
L	H	L	Q_n
L	H	H	Q_n
H	L	L	Q_n
H	L	H	H
H	H	L	Q_n
H	H	H	Q_n

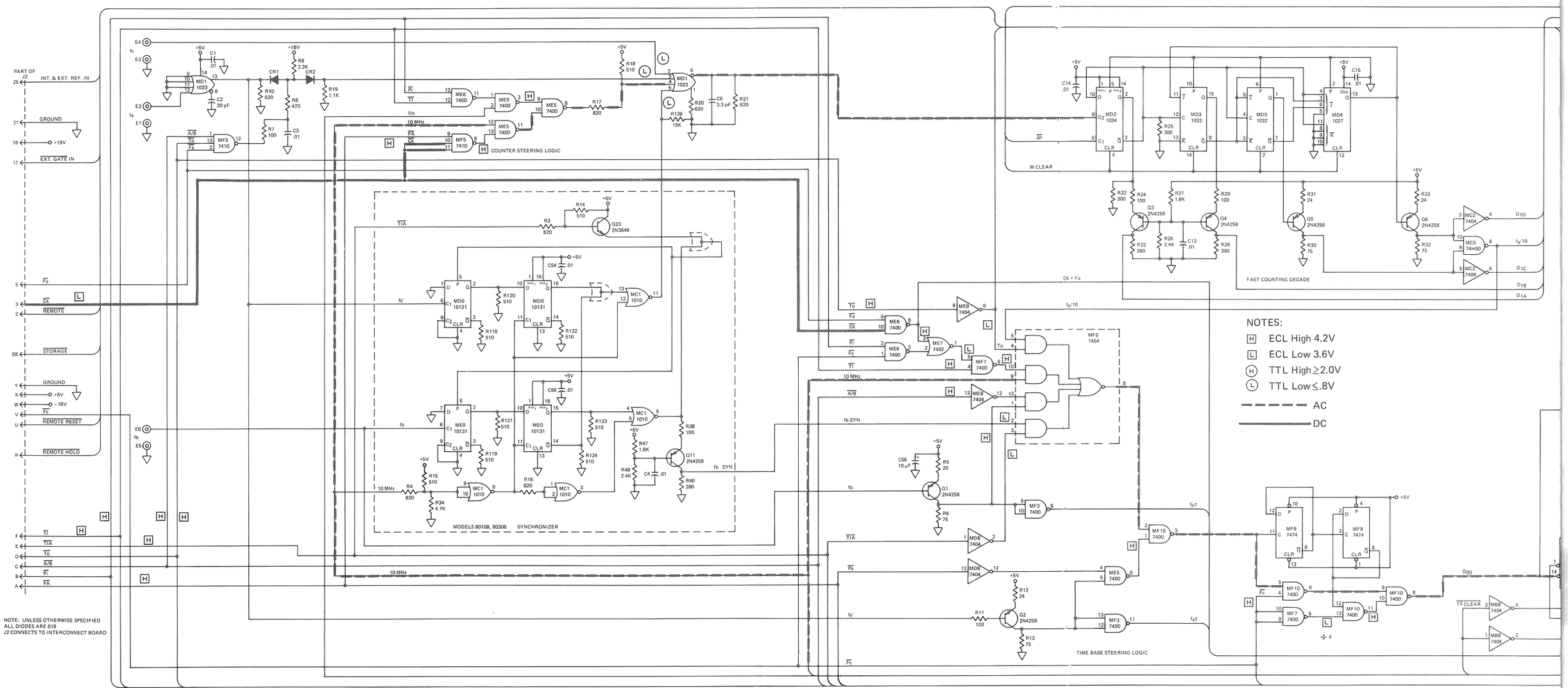
DUAL TYPE D FLIP-FLOP MC3060F

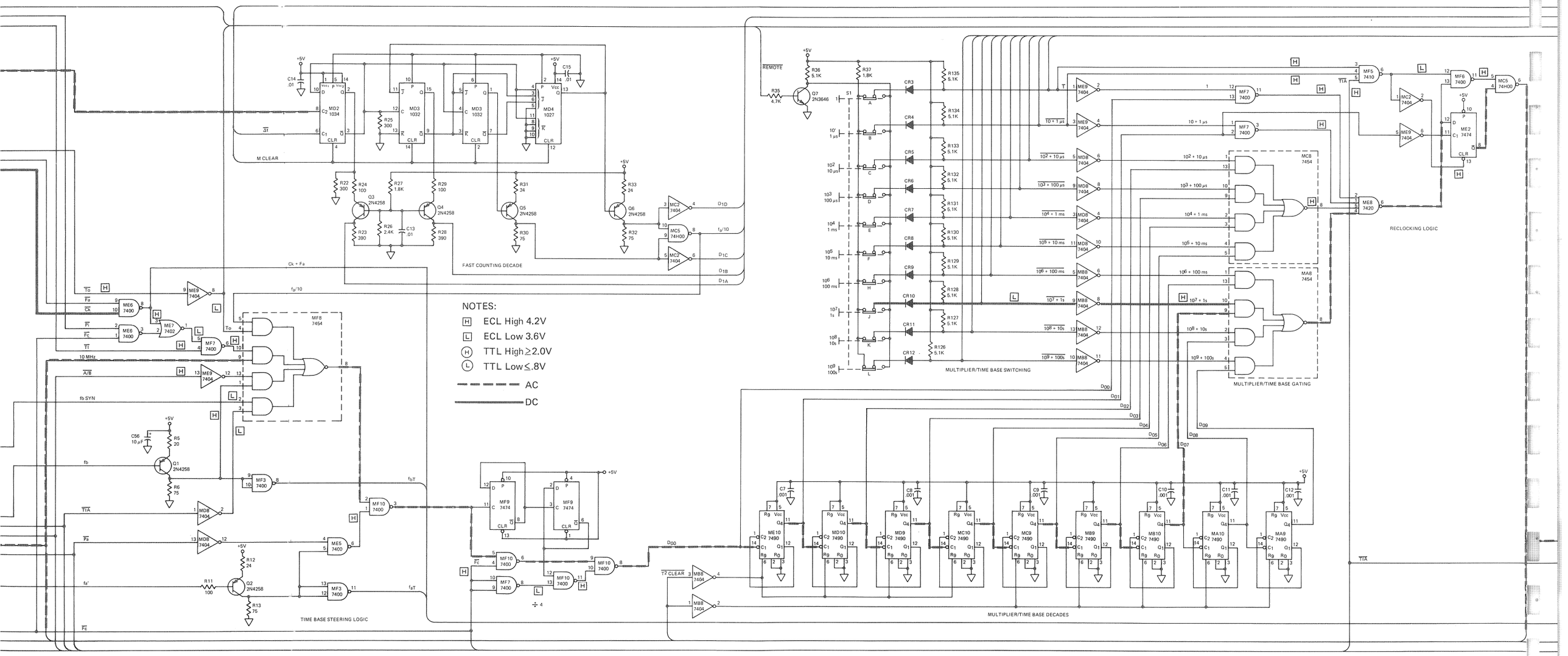


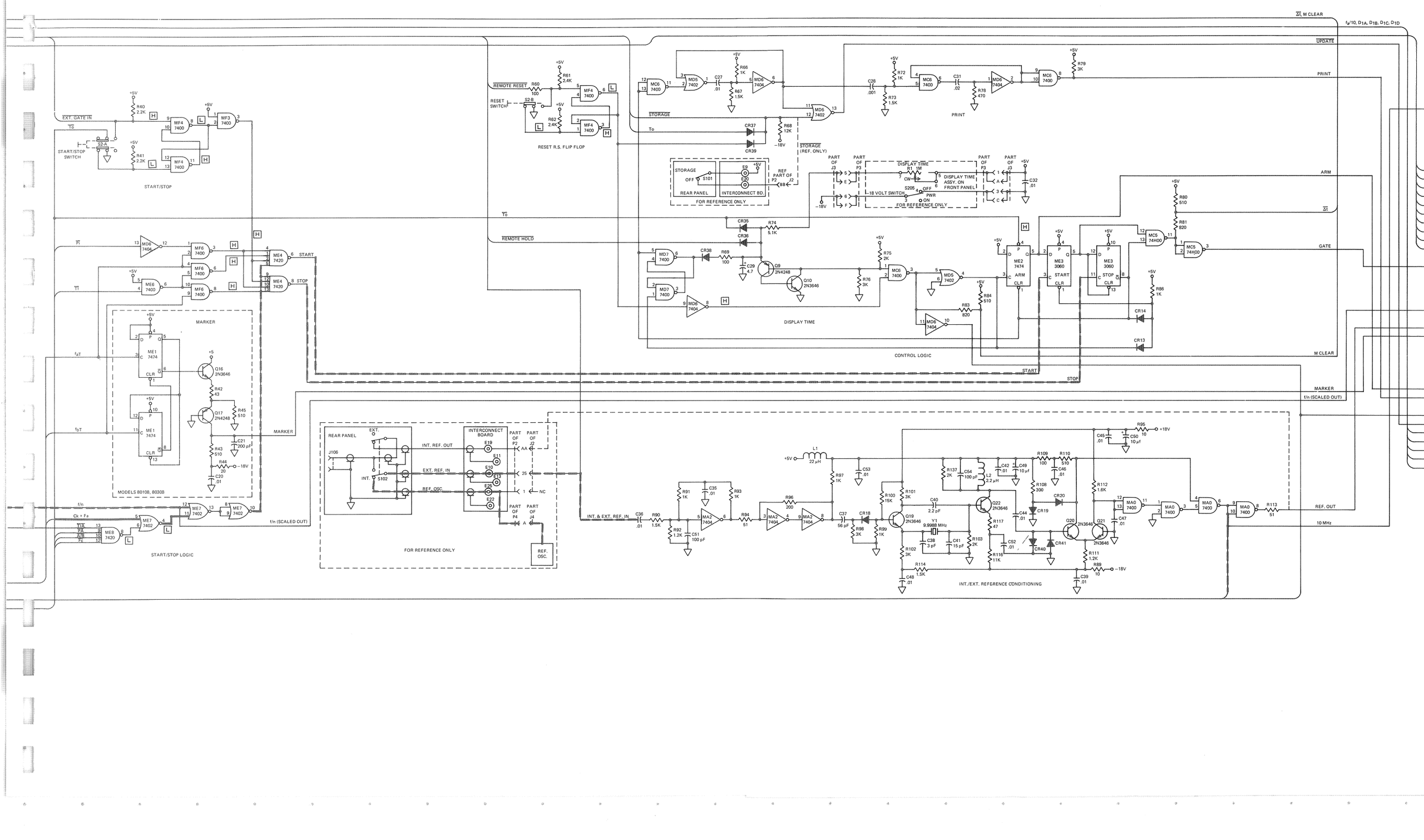
TRUTH TABLE

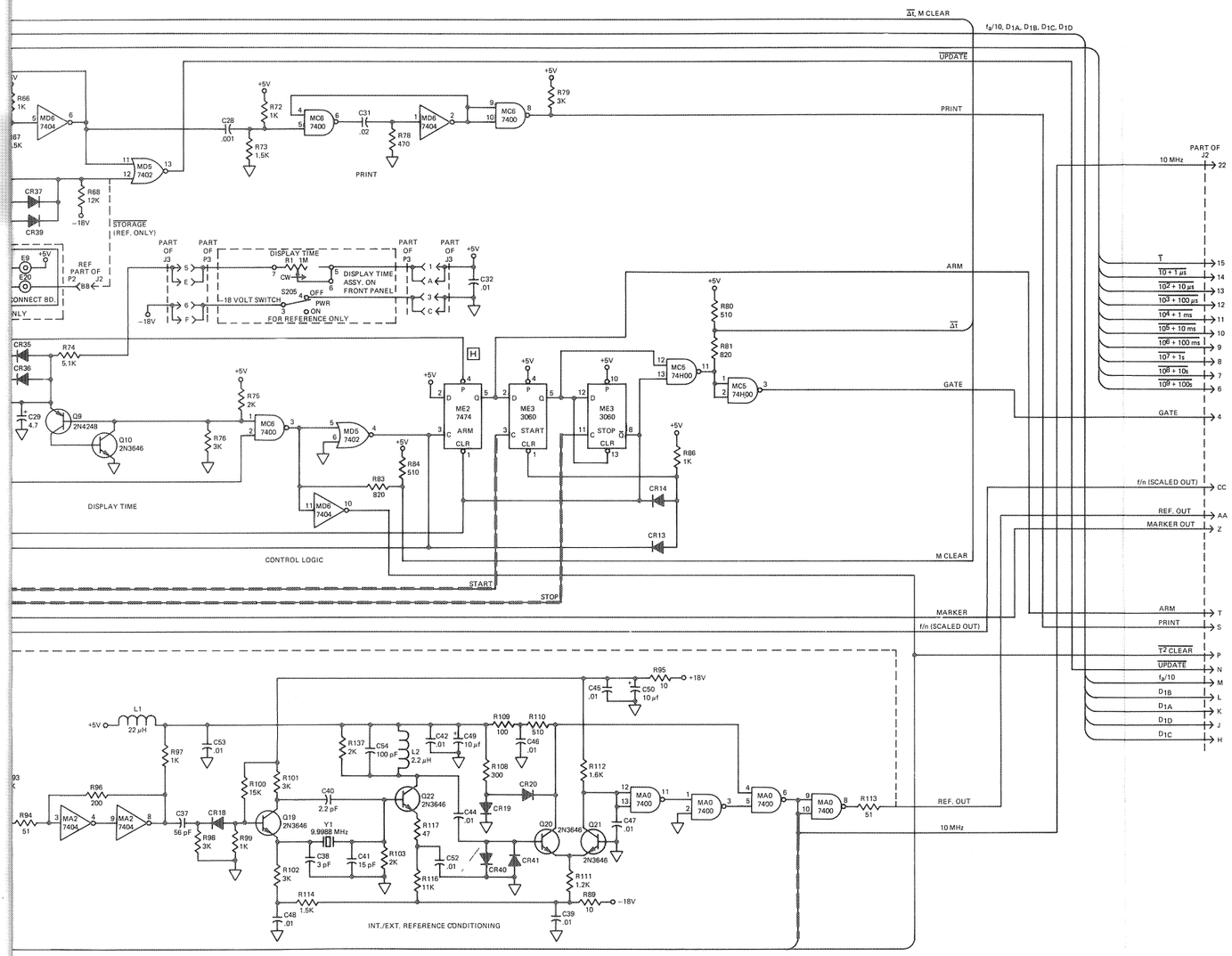
D	Q^n	Q^{n+1}
0	0	0
0	1	0
1	0	1
1	1	1

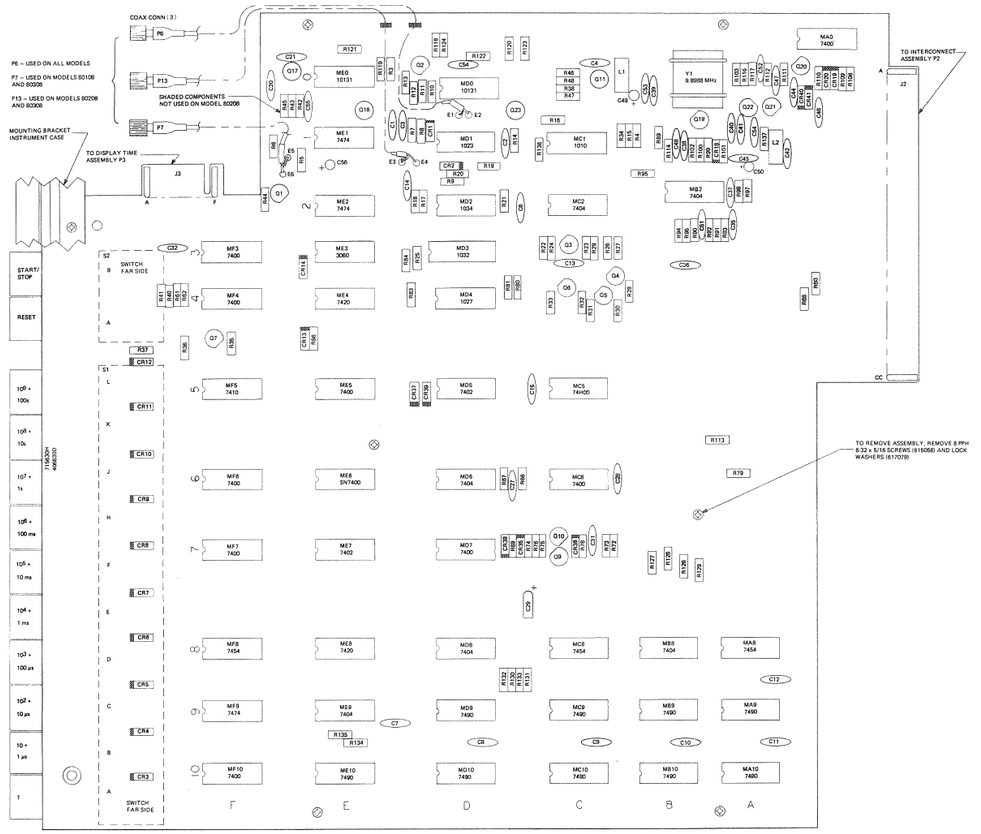
$Q^{n+1} = D^n$

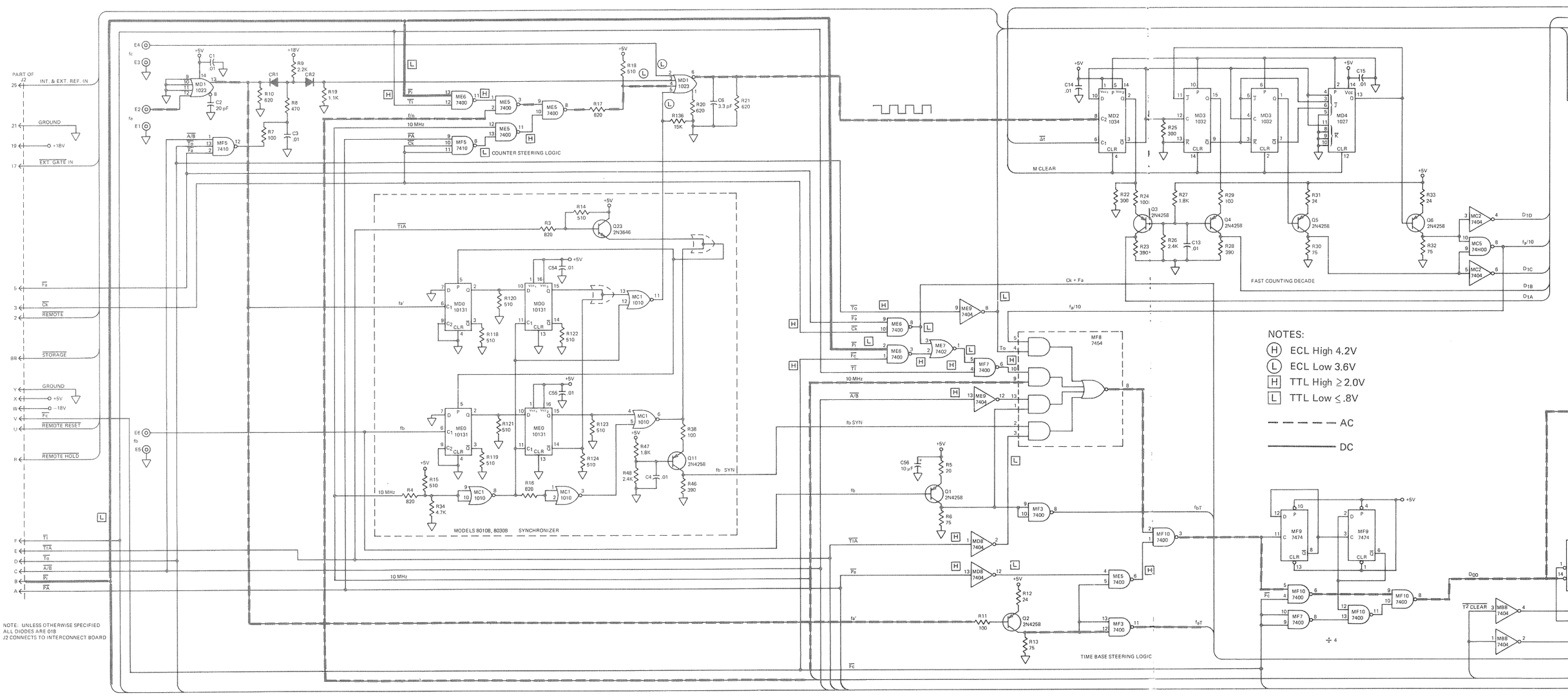

PART OF J2
INT. & EXT. REF. IN
GROUND
+18V
EXT. GATE IN
GROUND
+5V
−18V
REMOTE RESET
REMOTE HOLD
STORAGE
REMOTE
COUNTER STEERING LOGIC
MODELS 80108, 80308 SYNCHRONIZER
TIME BASE STEERING LOGIC
FAST COUNTING DECADE
M CLEAR
10 MHz
NOTES:
H ECL High 4.2V
L ECL Low 3.6V
H TTL High ≥ 2.0V
L TTL Low ≤ .8V
AC
DC
NOTE: UNLESS OTHERWISE SPECIFIED
ALL DIODES ARE 018
J2 CONNECTS TO INTERCONNECT BOARD

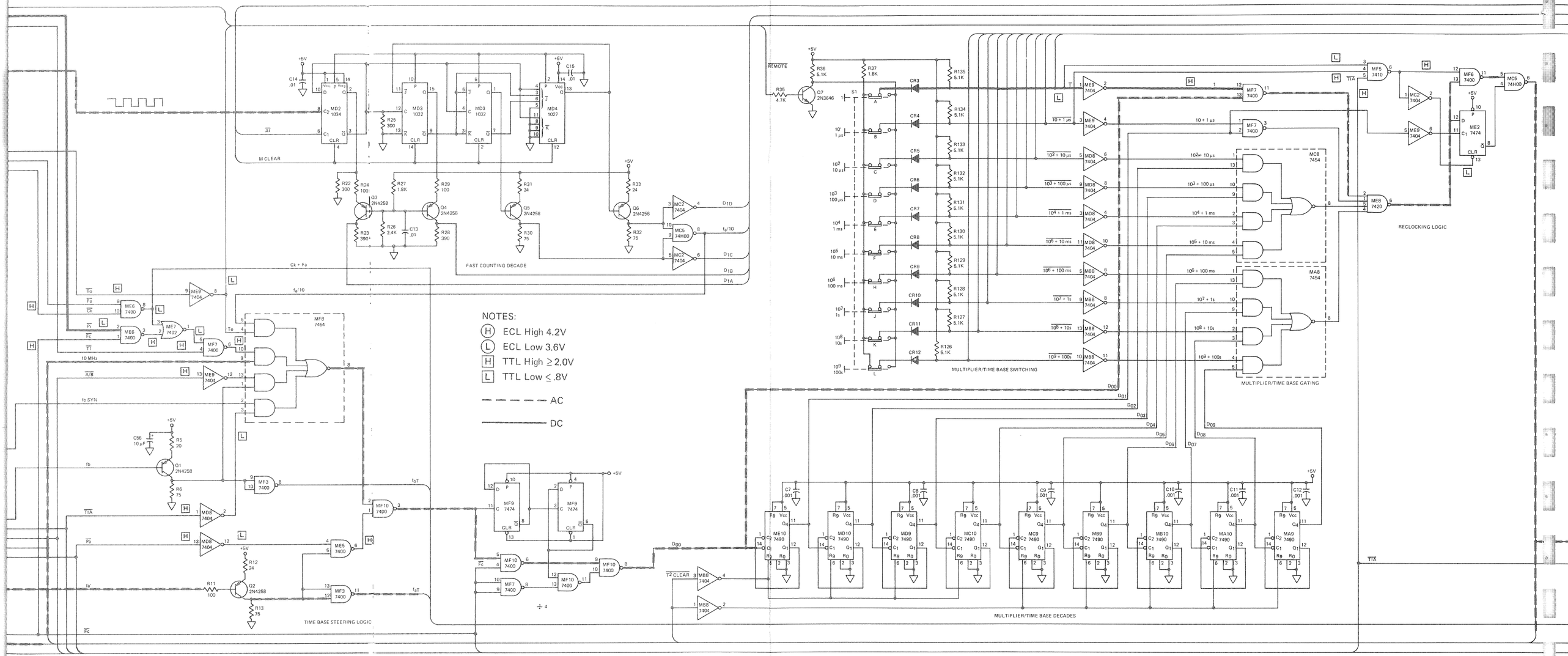

NOTES:
H ECL High 4.2V
L ECL Low 3.6V
(H) TTL High ≥ 2.0V
(L) TTL Low ≤ .8V
AC
DC
REMOTE
M CLEAR
FAST COUNTING DECADE
TIME BASE STEERING LOGIC
MULTIPLIER/TIME BASE SWITCHING
MULTIPLIER/TIME BASE GATING
MULTIPLIER/TIME BASE DECADES
RECLOCKING LOGIC
÷ 4

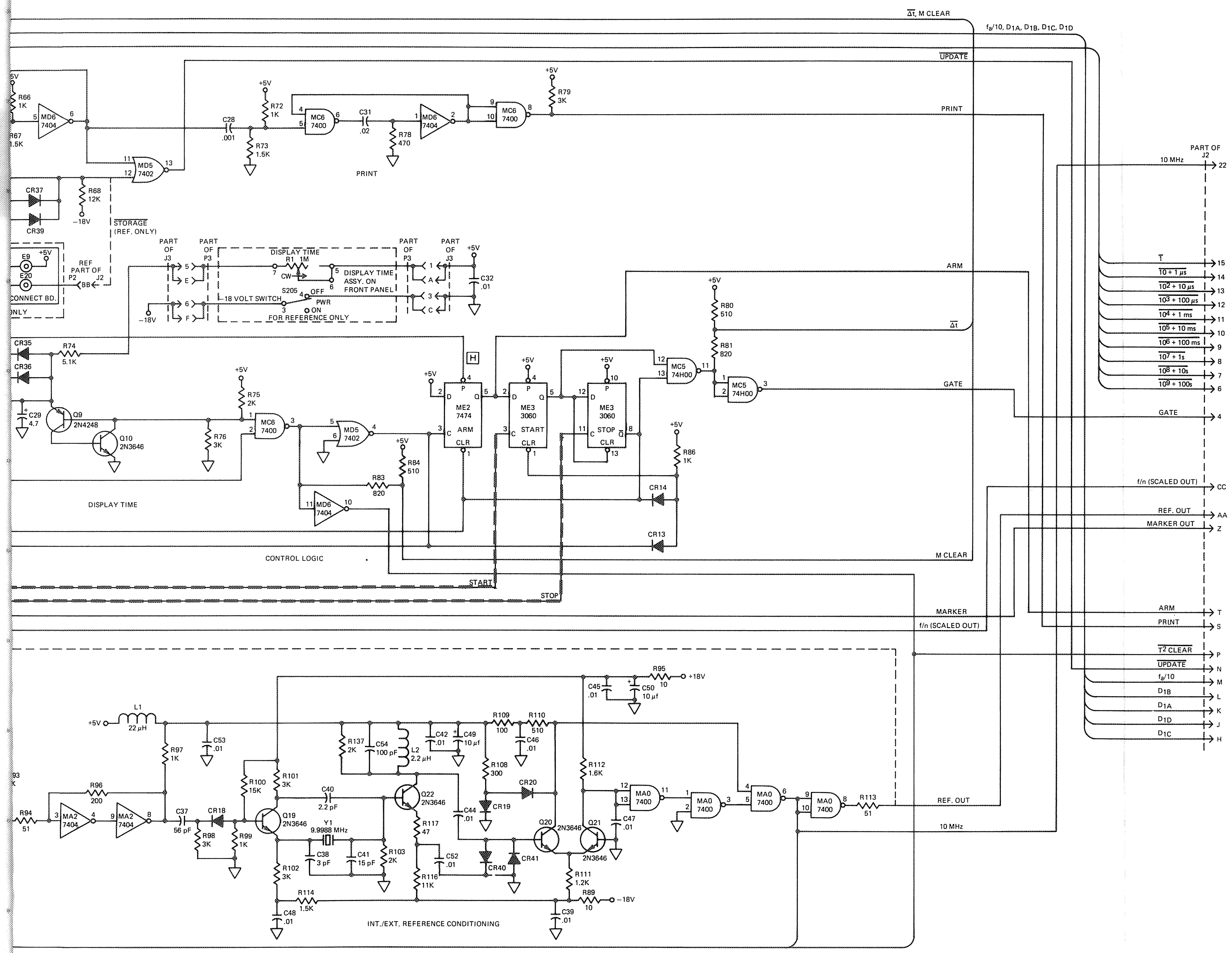

EXT. GATE IN
START/STOP SWITCH
START/STOP
REMOTE RESET
RESET SWITCH
RESET R.S. FLIP FLOP
STORAGE
REAR PANEL
INTERCONNECT BD.
FOR REFERENCE ONLY
REMOTE HOLD
DISPLAY TIME
DISPLAY TIME ASSY. ON FRONT PANEL
18 VOLT SWITCH
CONTROL LOGIC
PRINT
MARKER
MODELS 8010B, 8030B
START/STOP LOGIC
INT. REF. OUT
EXT. REF. IN
REF. OSC.
INTERCONNECT BOARD
FOR REFERENCE ONLY
INT. & EXT. REF. IN
INT./EXT. REFERENCE CONDITIONING
10 MHz
UPDATE
ARM
GATE
M CLEAR
START
STOP
REF. OUT

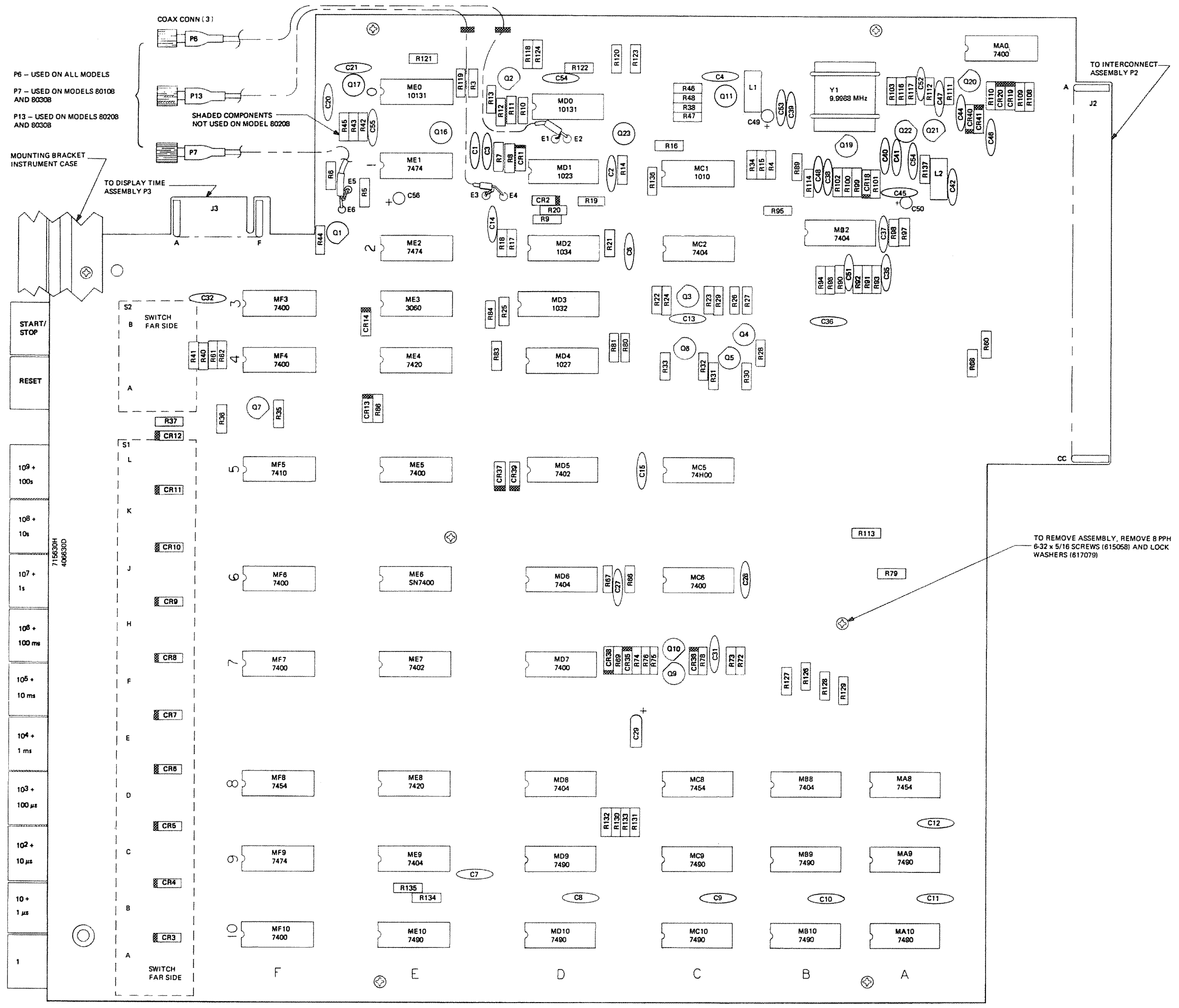

ΔT, M CLEAR
f0/10, D1A, D1B, D1C, D1D
UPDATE
PRINT
ARM
ΔT
GATE
f/n (SCALED OUT)
REF. OUT
MARKER OUT
M CLEAR
START
STOP
MARKER
f/n (SCALED OUT)
ARM
PRINT
T2 CLEAR
UPDATE
f0/10
D1B
D1A
D1D
D1C
10 MHz
REF. OUT
10 MHz
PART OF J2
DISPLAY TIME
CONTROL LOGIC
INT./EXT. REFERENCE CONDITIONING
STORAGE (REF. ONLY)
18 VOLT SWITCH
DISPLAY TIME ASSY. ON FRONT PANEL
FOR REFERENCE ONLY
MD6 7404
MC6 7400
MD5 7402
MC5 74H00
ME2 7474 ARM CLR
ME3 3060 START CLR
ME3 3060 STOP CLR
MA0 7400
MA2 7404
Q9 2N4248
Q10 2N3646
Q19 2N3646
Q20 2N3646
Q21 2N3646
Q22 2N3646
Y1 9.9988 MHz

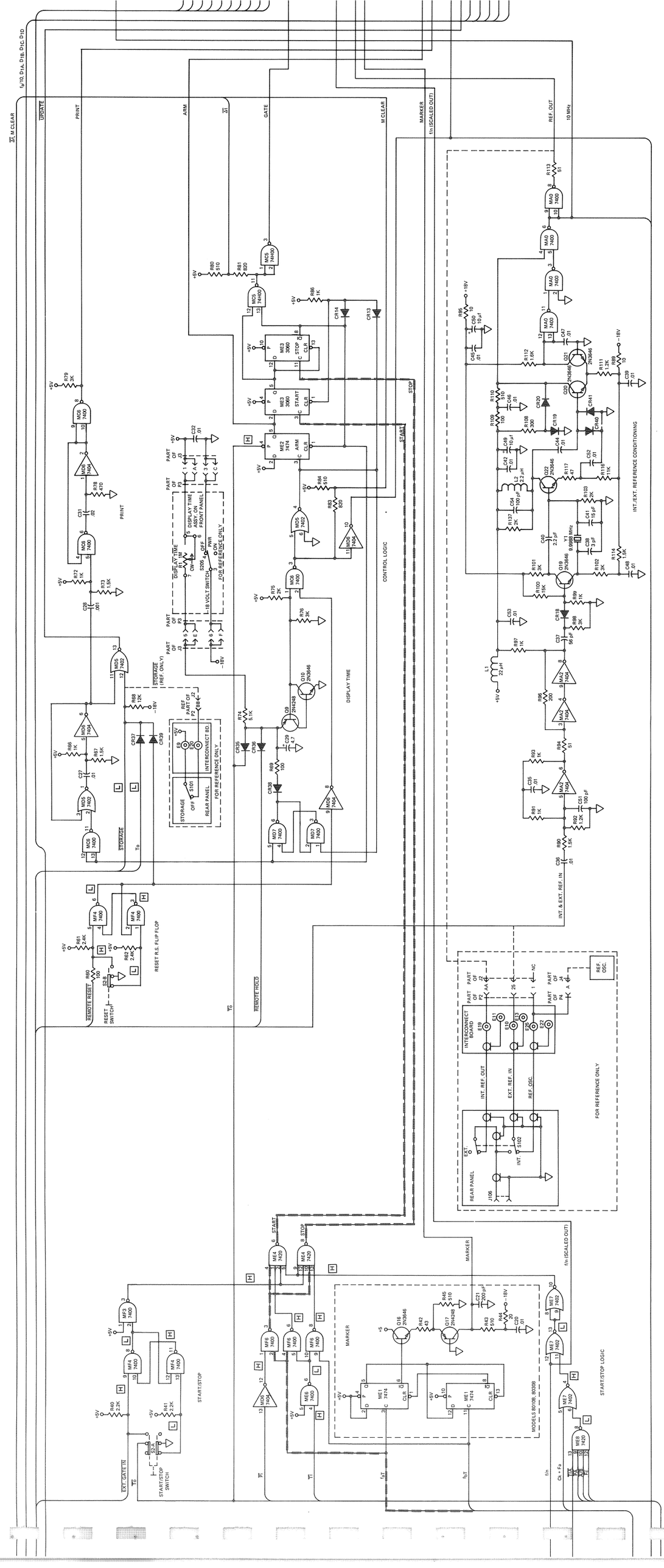

COAX CONN (3)
P6 – USED ON ALL MODELS
P7 – USED ON MODELS 60108 AND 60208
P13 – USED ON MODELS 60208 AND 60308
SHADED COMPONENTS NOT USED ON MODEL 60208
MOUNTING BRACKET INSTRUMENT CASE
TO DISPLAY TIME ASSEMBLY P3
TO INTERCONNECT ASSEMBLY P2
TO REMOVE ASSEMBLY, REMOVE 8 PPH 6-32 x 5/16 SCREWS (6150568) AND LOCK WASHERS (6170759)
START/ STOP
RESET
SWITCH FAR SIDE
Y1 9.9988 MHz
MA0 7400
MD0 10131
ME0 10131
ME1 7474
MC1 1010
MD1 1023
MB2 7404
MC2 7404
MD2 1034
ME2 7474
ME3 3060
MD3 1032
MF3 7400
MF4 7400
ME4 7420
MD4 1027
MF5 7410
ME5 7400
MD5 7402
MC5 74H05
MF6 7400
ME6 SN7400
MD6 7404
MC6 7400
MF7 7400
ME7 7402
MD7 7400
MF8 7454
ME8 7420
MD8 7404
MC8 7454
MB8 7404
MA8 7454
MF9 7474
ME9 7404
MD9 7490
MC9 7490
MB9 7490
MA9 7490
MF10 7400
ME10 7490
MD10 7490
MC10 7490
MB10 7490
MA10 7480
SWITCH FAR SIDE

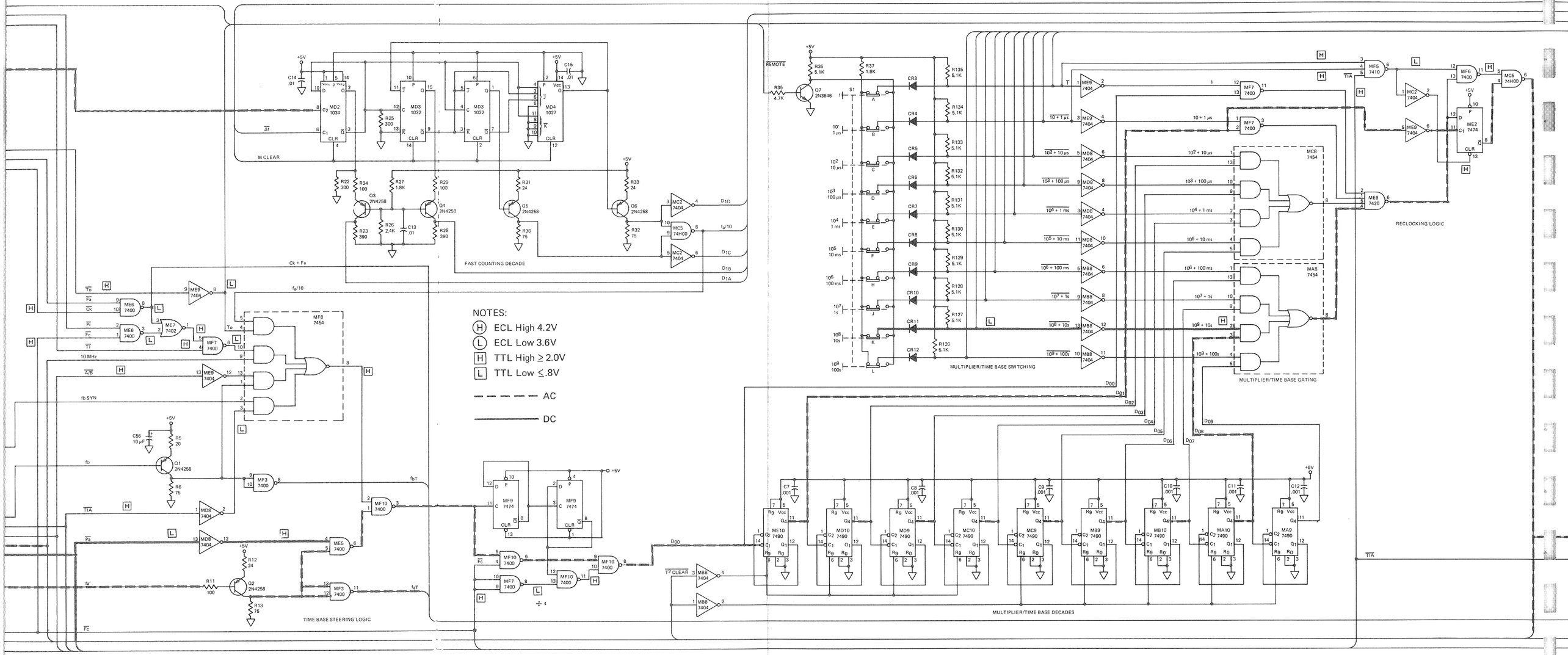

PART OF J2
INT. & EXT. REF. IN
GROUND
+18V
EXT. GATE IN
GROUND
STORAGE
GROUND
+5V
−18V
REMOTE RESET
REMOTE HOLD
NOTE: UNLESS OTHERWISE SPECIFIED ALL DIODES ARE 018 J2 CONNECTS TO INTERCONNECT BOARD
COUNTER STEERING LOGIC
MODELS 8010B, 8030B SYNCHRONIZER
TIME BASE STEERING LOGIC
FAST COUNTING DECADE
M CLEAR
T2 CLEAR
÷ 4
NOTES:
H ECL High 4.2V
L ECL Low 3.6V
H TTL High ≥ 2.0V
L TTL Low ≤ .8V
AC
DC


NOTES:
H ECL High 4.2V
L ECL Low 3,6V
H TTL High ≥ 2.0V
L TTL Low ≤ .8V
AC
DC
FAST COUNTING DECADE
RECLOCKING LOGIC
MULTIPLIER/TIME BASE SWITCHING
MULTIPLIER/TIME BASE GATING
MULTIPLIER/TIME BASE DECADES
TIME BASE STEERING LOGIC
REMOTE
M CLEAR
Ck + Fa
10 MHz
fb SYN
÷ 4


Δt, M CLEAR
fₒ/10, D1A, D1B, D1C, D1D
UPDATE
PRINT
PART OF J2
10 MHz
STORAGE (REF. ONLY)
DISPLAY TIME
DISPLAY TIME ASSY. ON FRONT PANEL
18 VOLT SWITCH
FOR REFERENCE ONLY
ARM
Δt
GATE
START
STOP
f/n (SCALED OUT)
REF. OUT
MARKER OUT
CONTROL LOGIC
M CLEAR
MARKER
T2 CLEAR
INT./EXT. REFERENCE CONDITIONING


COAX CONN (3)
P6 – USED ON ALL MODELS
P7 – USED ON MODELS 8010B AND 8020B
P13 – USED ON MODELS 8020B AND 8030B
SHADED COMPONENTS NOT USED ON MODEL 8020B
MOUNTING BRACKET INSTRUMENT CASE
TO DISPLAY TIME ASSEMBLY P3
TO INTERCONNECT ASSEMBLY P2
START/STOP
RESET
SWITCH FAR SIDE
TO REMOVE ASSEMBLY, REMOVE 8 PPH 6-32 x 5/16 SCREWS (615058) AND LOCK WASHERS (617079)


ΔT, M CLEAR
UPDATE
PRINT
ARM
ΔT
GATE
M CLEAR
MARKER
f/n (SCALED OUT)
REF. OUT
10 MHz
f0/10, D1A, D1B, D1C, D1D
CONTROL LOGIC
DISPLAY TIME
START
STOP
INT./EXT. REFERENCE CONDITIONING
FOR REFERENCE ONLY
INTERCONNECT BOARD
REAR PANEL
INT. REF. OUT
EXT. REF. IN
REF. OSC.
INT. & EXT. REF. IN
STORAGE (REF. ONLY)
DISPLAY TIME ASSY. ON FRONT PANEL
18 VOLT SWITCH
PWR ON
OFF
STORAGE
REAR PANEL
INTERCONNECT BD.
RESET R.S. FLIP FLOP
REMOTE RESET
RESET SWITCH
REMOTE HOLD
START/STOP
START/STOP SWITCH
EXT. GATE IN
START/STOP LOGIC
MODELS 80108, 80309
MARKER
REF. OSC.


NOTES:
H ECL High 4.2V
L ECL Low 3.6V
H TTL High ≥ 2.0V
L TTL Low ≤.8V
AC
DC
M CLEAR
FAST COUNTING DECADE
RECLOCKING LOGIC
MULTIPLIER/TIME BASE SWITCHING
MULTIPLIER/TIME BASE GATING
MULTIPLIER/TIME BASE DECADES
TIME BASE STEERING LOGIC
REMOTE
÷ 4

PART OF J2

25 INT. & EXT. REF. IN
21 GROUND
19 +18V
17 EXT. GATE IN
5 $\overline{Fa}$
3 $\overline{Ck}$
2 REMOTE
BB STORAGE
Y GROUND
X +5V
W −18V
V $\overline{Fc}$
U REMOTE RESET
R REMOTE HOLD
F $\overline{TI}$
E $\overline{TIA}$
D $\overline{To}$
C $\overline{A/B}$
B $\overline{PI}$
A $\overline{PA}$

E4 fc
E3
E2 fa
E1
E6 fb
E5

+5V C1 .01
MD1 1023
C2 20 pF
+18V R9 2.2K
CR1 CR2
R10 620
R8 470
R19 1.1K
R7 100
C3 .01
$\overline{A/B}$ $\overline{To}$ $\overline{Fa}$ MF5 7410

$\overline{PI}$ $\overline{TI}$ ME6 7400
ME5 7400 ME5 7400 ME5 7400
f/n 10 MHz $\overline{PA}$ $\overline{Ck}$ MF5 7410
COUNTER STEERING LOGIC
+5V R18 510
MD1 1023
R136 15K
R20 620
C6 3.3 pF
R21 620
R17 820

MODELS 80108, 80308 SYNCHRONIZER
R14 510 +5V
R3 820 $\overline{TIA}$
Q23 2N3646
+5V C54 .01
MD0 10131 R120 510
MC1 1010
R118 510
MD0 10131 R122 510
fa'
+5V C55 .01
MD0 10131 R121 510
MC1 1010
R123 510
MD0 10131 R119 510
fb
+5V R47 1.8K
R38 100
Q11 2N4258
fb SYN
R48 2.4K
C4 .01
R46 390
+5V R15 510
10 MHz R4 820
MC1 1010
R16 820
MC1 1010
R34 4.7K

+5V C14 .01
MD2 1034
$\overline{\Delta T}$
M CLEAR
MD3 1032
MD3 1032
MD4 1027
+5V C15 .01
R25 300
R22 300
R24 100
Q3 2N4258
R27 1.8K
R29 100
Q4 2N4258
R23 390
R26 2.4K
C13 .01
R28 390
R31 24
Q5 2N4258
R30 75
+5V R33 24
Q6 2N4258
R32 75
FAST COUNTING DECADE
MC2 7404
MC5 74H00
MC2 7404
D_{1D}
$f_a/10$
D_{1C}
D_{1B}
D_{1A}
Ck + Fa

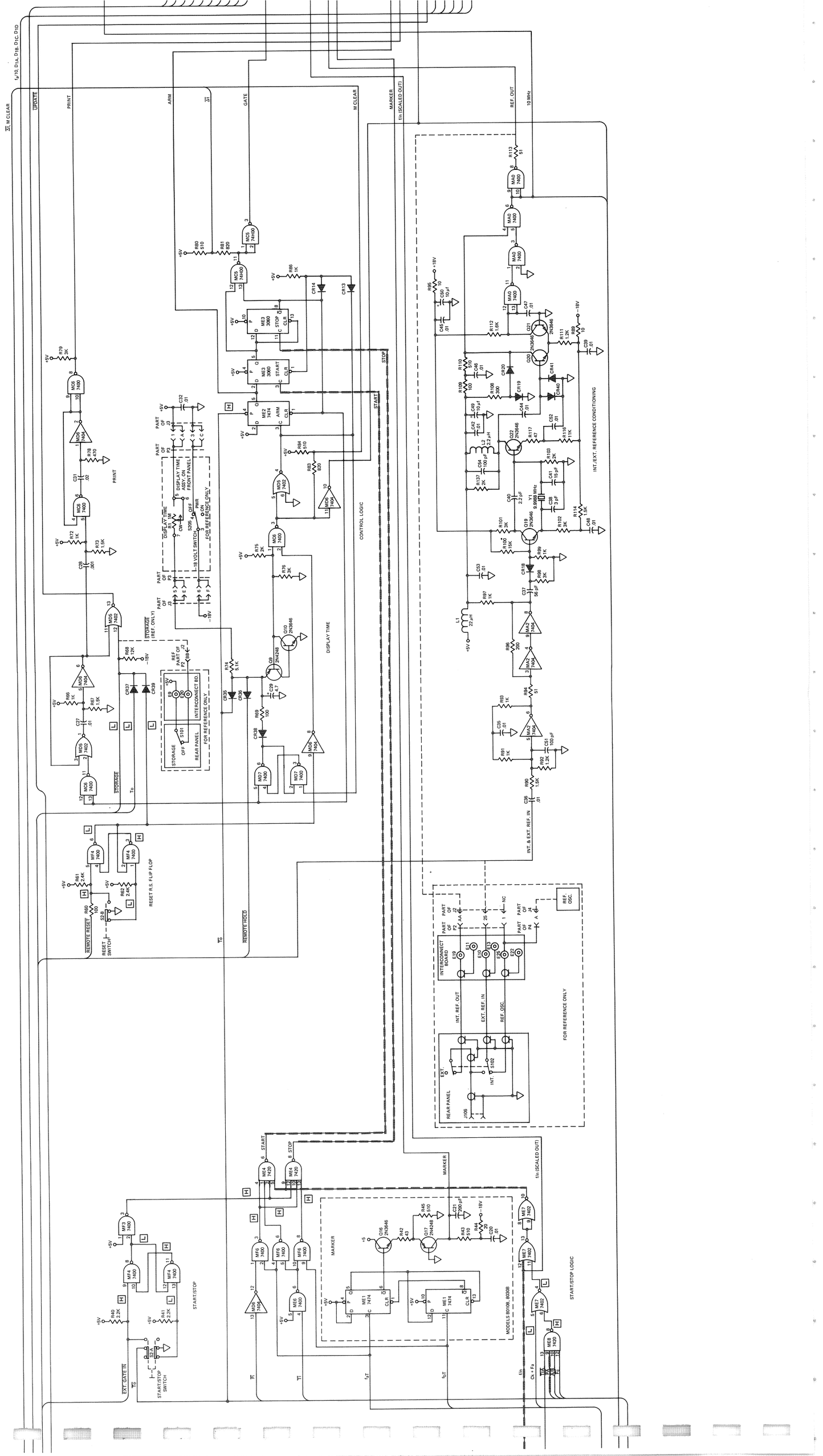
$\overline{To}$ ME8 7400
$\overline{Fa}$ $\overline{Ck}$
$\overline{PI}$ ME6 7400
$\overline{Fc}$ $\overline{TI}$
ME7 7402
MF7 7400
10 MHz
$\overline{A/B}$ ME9 7404
fb SYN
+5V C56 10 µF
R5 20
Q1 2N4258
fb
R6 75
MF3 7400
$\overline{TIA}$ MD8 7404
$\overline{Pa}$ MD8 7404
+5V R12 24
R11 100
Q2 2N4258
fa'
R13 75
$\overline{Fc}$
ME5 7400
MF3 7400
f_aT
MF10 7400
f_bT
MF8 7454
$f_a/10$
TIME BASE STEERING LOGIC

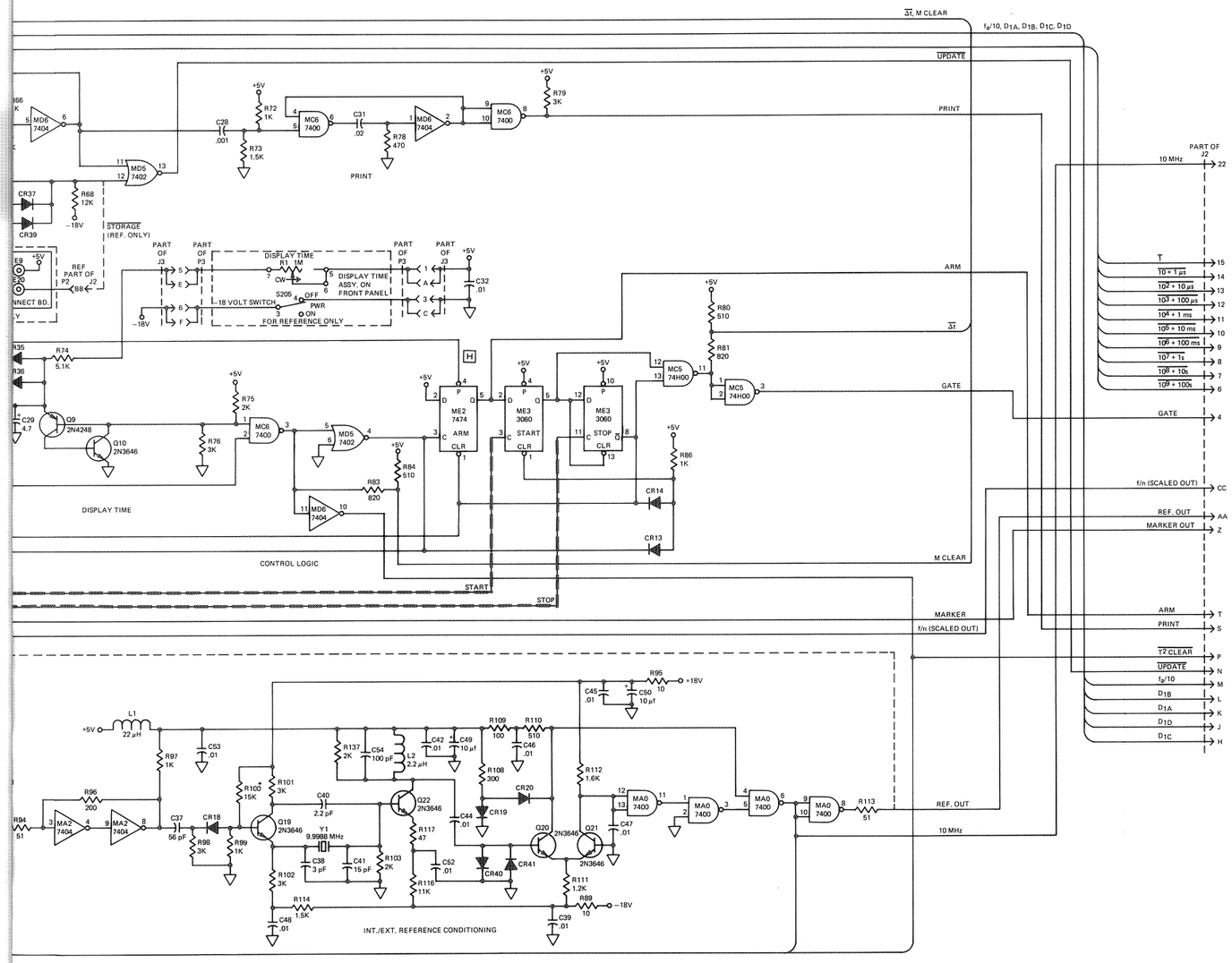
MF9 7474
MF9 7474
MF10 7400
MF10 7400
MF7 7400
MF10 7400
MF10 7400
÷ 4
D_{00}
$\overline{T2}$ CLEAR
MB8 7404
MB8 7404
C7 .001
ME10 7490
Q_0 Q_1 Q_2 Q_4
R_0 R_9 Vcc

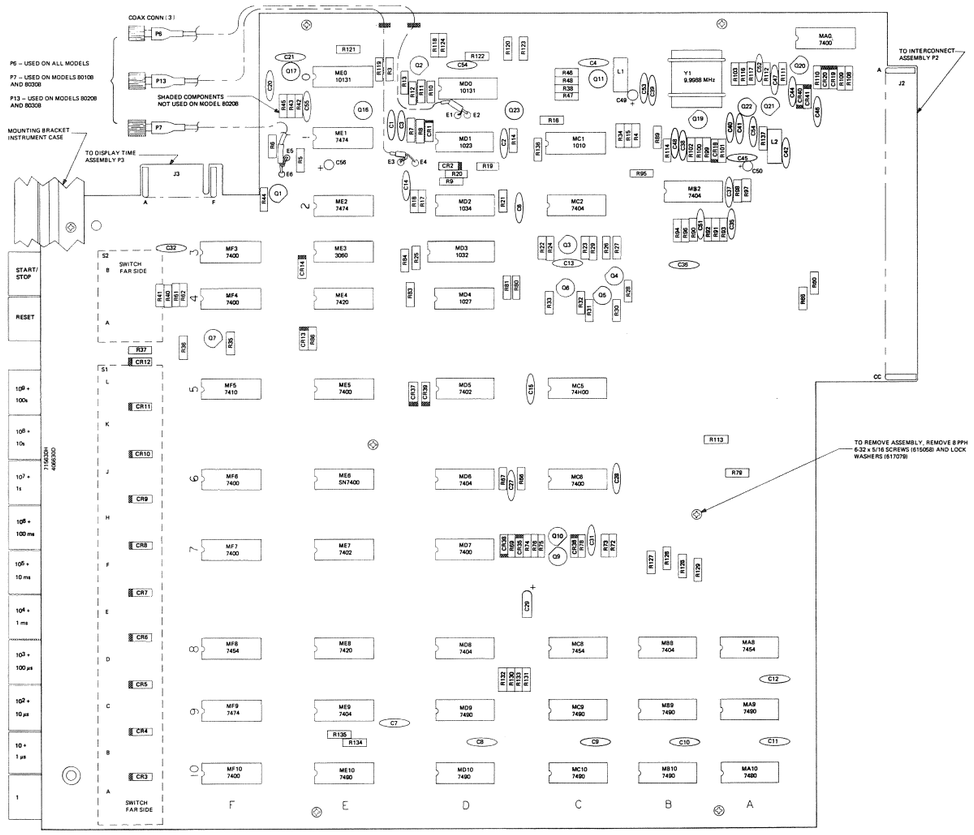
REMOTE
R35 4.7K

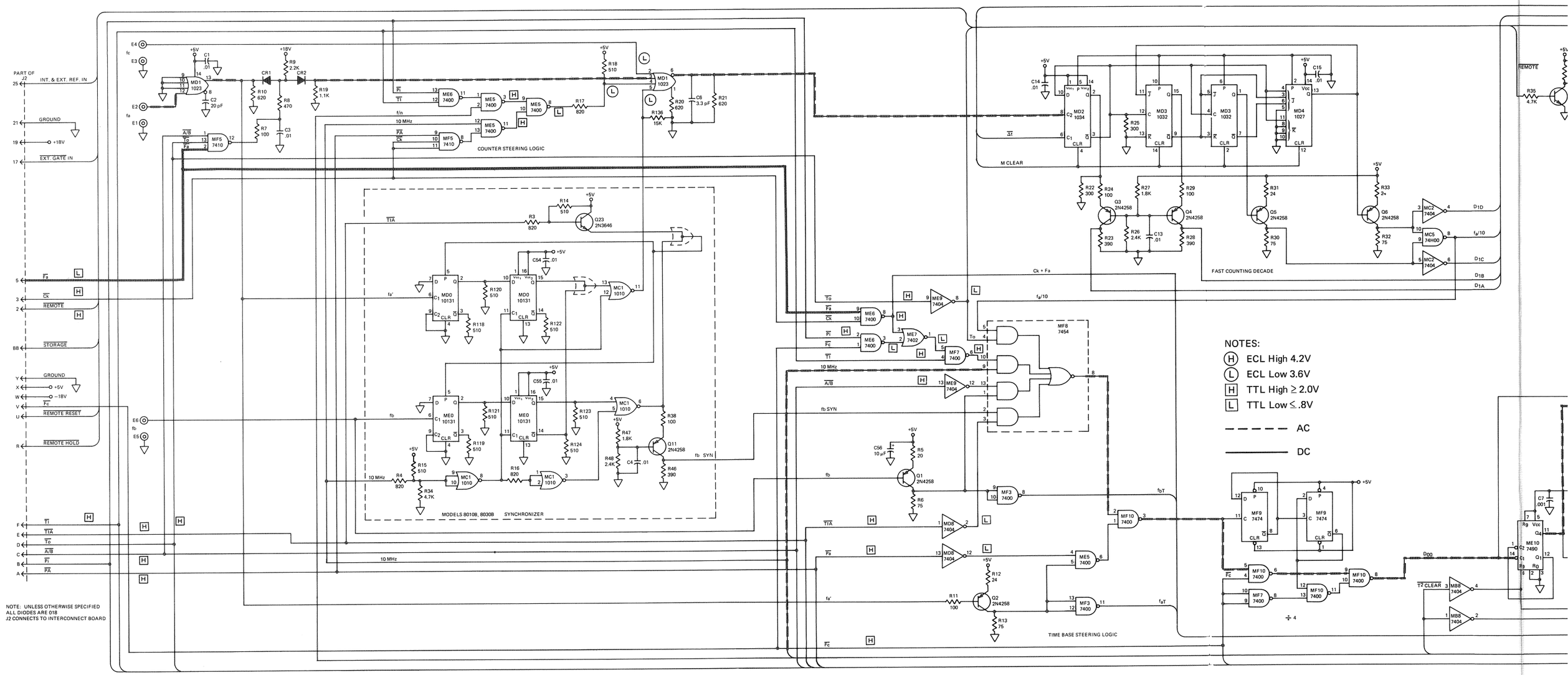
NOTES:
- (H) ECL High 4.2V
- (L) ECL Low 3.6V
- [H] TTL High ≥ 2.0V
- [L] TTL Low ≤.8V
- — — — — AC
- ——————— DC

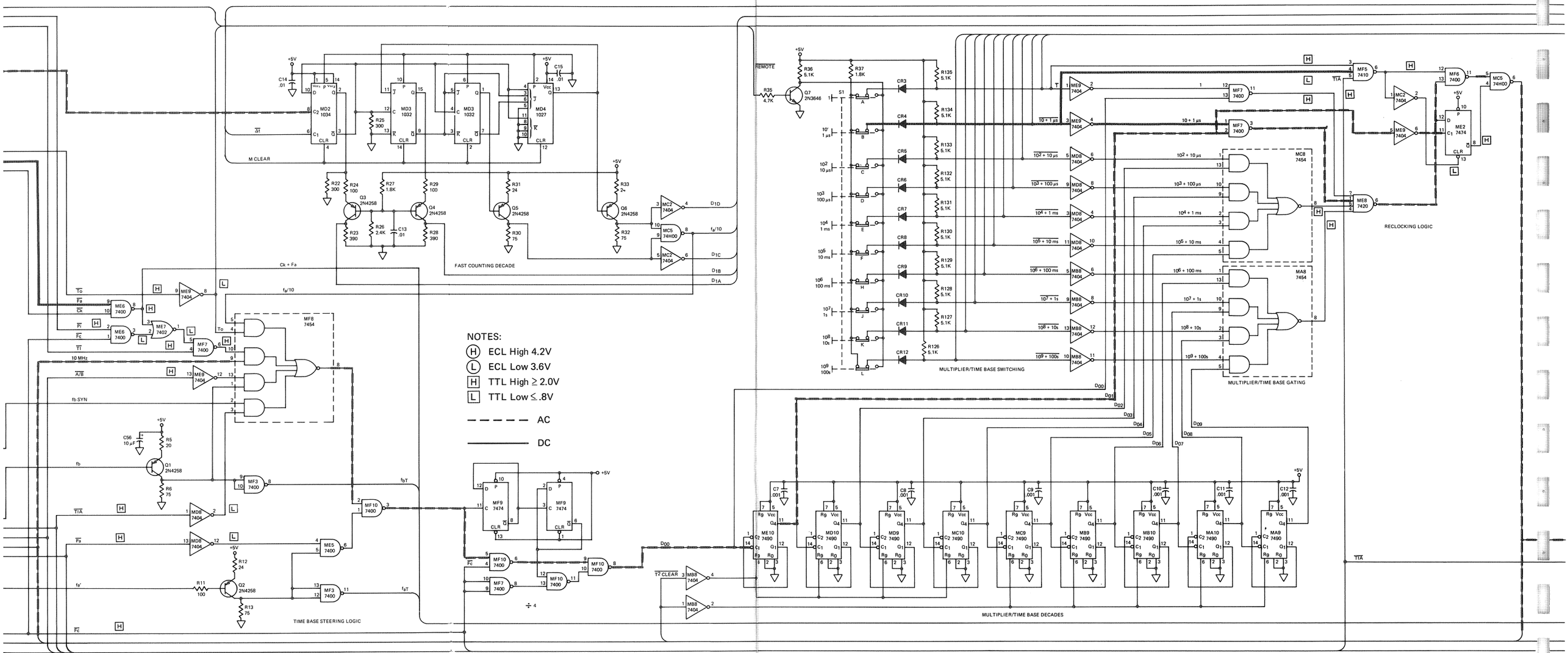
NOTE: UNLESS OTHERWISE SPECIFIED
ALL DIODES ARE 018
J2 CONNECTS TO INTERCONNECT BOARD

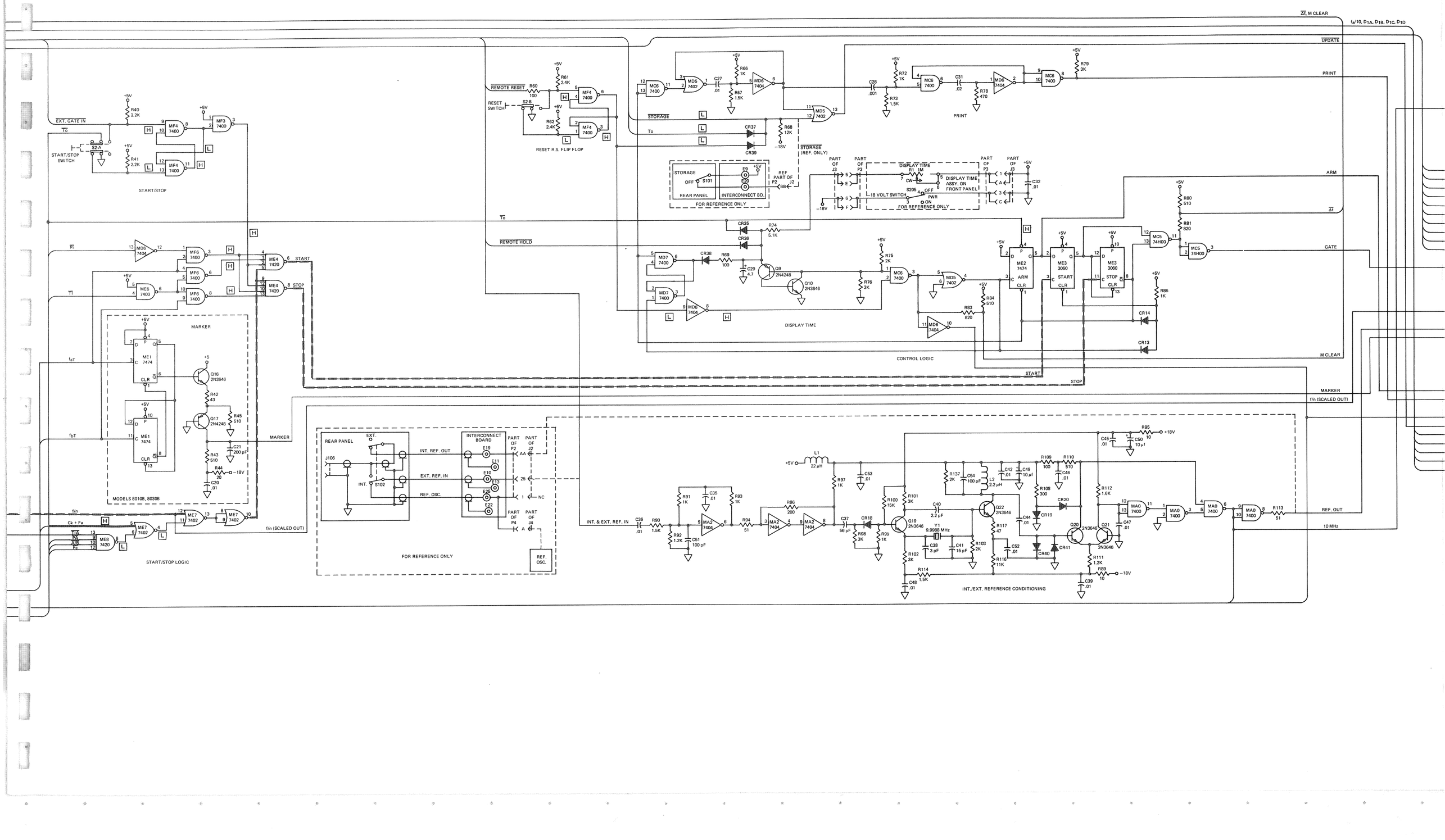

$\overline{\Sigma T}$, M CLEAR
UPDATE
PRINT
ARM
$\overline{\Sigma T}$
GATE
M CLEAR
MARKER
f/n (SCALED OUT)
REF. OUT
10 MHz
CONTROL LOGIC
DISPLAY TIME
STORAGE (REF. ONLY)
INT./EXT. REFERENCE CONDITIONING
FOR REFERENCE ONLY
START/STOP LOGIC
RESET R.S. FLIP FLOP
REMOTE RESET
REMOTE HOLD
START/STOP SWITCH
EXT. GATE IN
INT. REF. OUT
EXT. REF. IN
REF. OSC.
INT. & EXT. REF. IN
MODELS 80108, 80309
REAR PANEL
INTERCONNECT BOARD
REF. OSC.

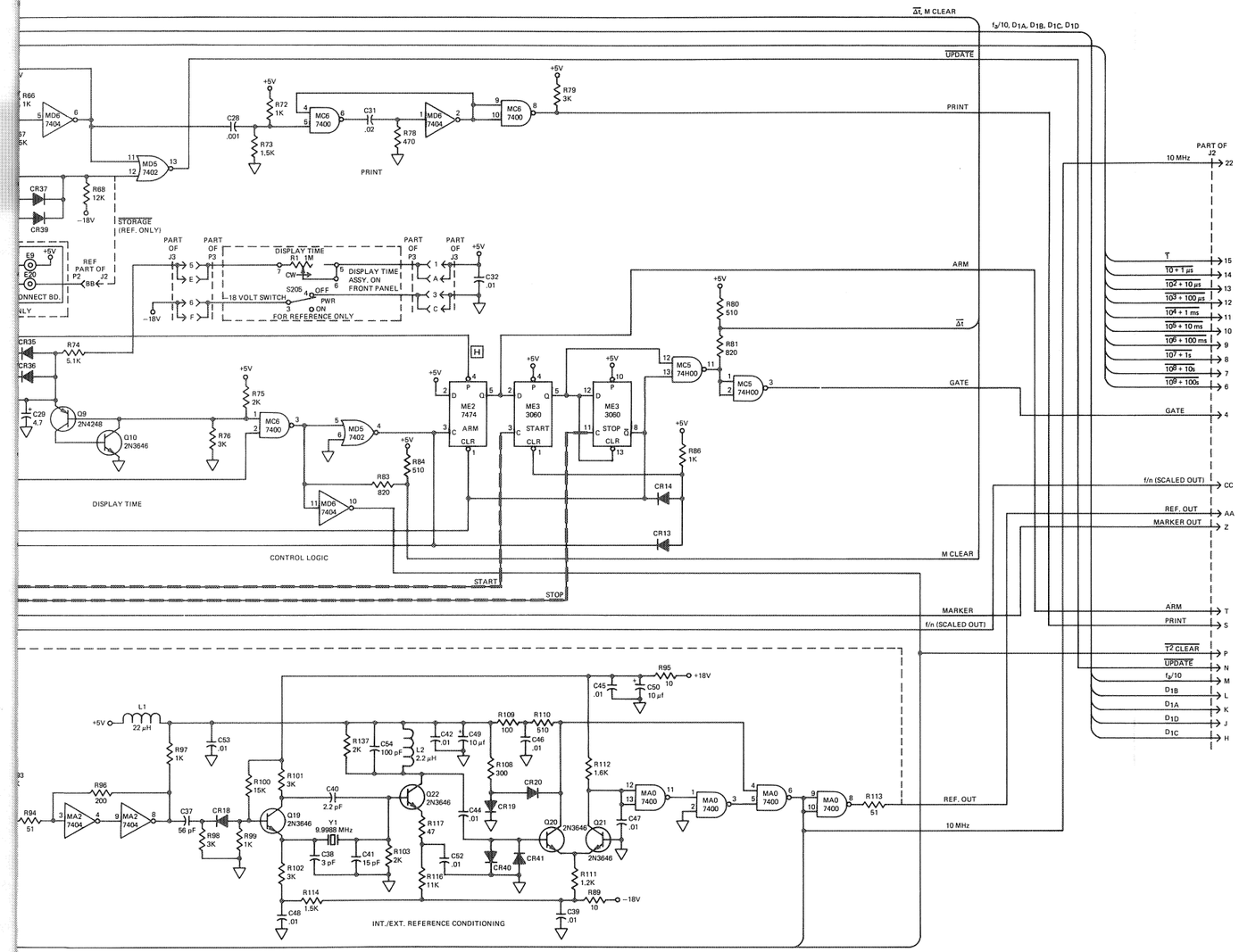

Δt, M CLEAR
f_B/10, D1A, D1B, D1C, D1D
UPDATE
PRINT
ARM
Δt
GATE
f/n (SCALED OUT)
REF. OUT
MARKER OUT
M CLEAR
START
STOP
MARKER
f/n (SCALED OUT)
ARM
PRINT
T2 CLEAR
UPDATE
f_B/10
D1B
D1A
D1D
D1C
10 MHz
REF. OUT
10 MHz
PART OF J2
DISPLAY TIME
CONTROL LOGIC
INT./EXT. REFERENCE CONDITIONING
STORAGE (REF. ONLY)
DISPLAY TIME ASSY. ON FRONT PANEL
18 VOLT SWITCH
FOR REFERENCE ONLY
REF PART OF P2
MD5 7402
MC6 7400
MD6 7404
MC5 74H00
ME2 7474
ME3 3060
Q9 2N4248
Q10 2N3646
Q19 2N3646
Q20 2N3646
Q21 2N3646
Q22 2N3646
Y1 9.9988 MHz
MA0 7400
MA2 7404

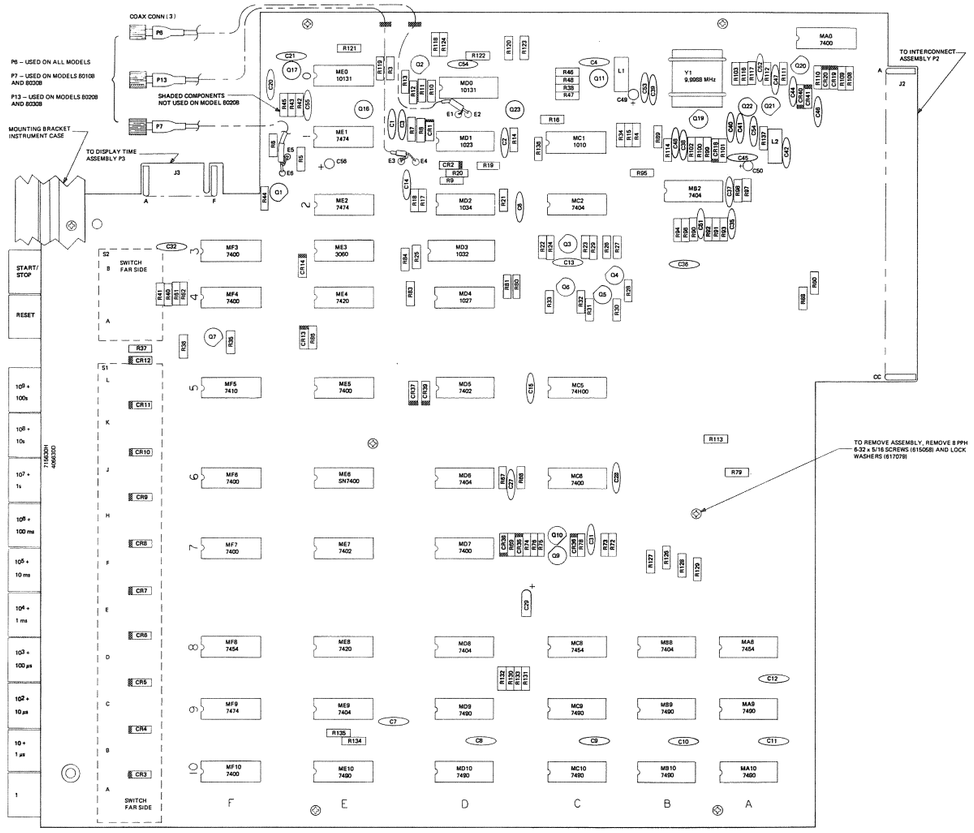

COAX CONN (3)
P6 – USED ON ALL MODELS
P7 – USED ON MODELS 8010B AND 8020B
P13 – USED ON MODELS 8020B AND 8030B
SHADED COMPONENTS NOT USED ON MODEL 8020B
MOUNTING BRACKET INSTRUMENT CASE
TO DISPLAY TIME ASSEMBLY P3
TO INTERCONNECT ASSEMBLY P2
Y1 9.9988 MHz
START/ STOP
RESET
SWITCH FAR SIDE
TO REMOVE ASSEMBLY, REMOVE 8 PPH 6-32 x 5/16 SCREWS (6110568) AND LOCK WASHERS (6110709)

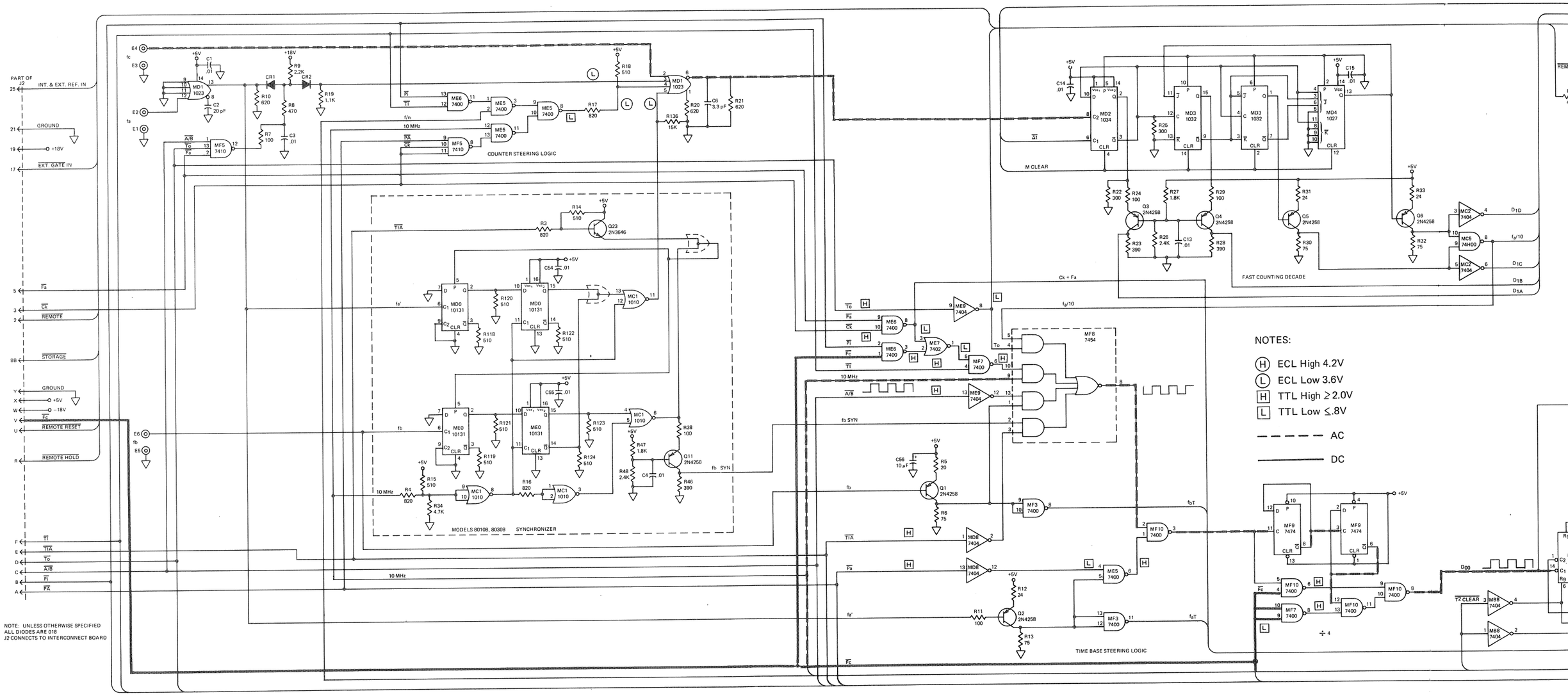

PART OF J2
INT. & EXT. REF. IN
GROUND
+18V
EXT. GATE IN
GROUND
+5V
−18V
REMOTE RESET
REMOTE HOLD
STORAGE
REMOTE
COUNTER STEERING LOGIC
MODELS 8010B, 8030B SYNCHRONIZER
TIME BASE STEERING LOGIC
M CLEAR
FAST COUNTING DECADE
Ck + Fa
10 MHz
fb SYN
÷ 4
÷ 2 CLEAR
NOTES:
(H) ECL High 4.2V
(L) ECL Low 3.6V
[H] TTL High ≥ 2.0V
[L] TTL Low ≤ .8V
AC
DC
NOTE: UNLESS OTHERWISE SPECIFIED
ALL DIODES ARE 018
J2 CONNECTS TO INTERCONNECT BOARD


NOTES:
H ECL High 4.2V
L ECL Low 3.6V
H TTL High ≥ 2.0V
L TTL Low ≤ .8V
AC
DC
M CLEAR
FAST COUNTING DECADE
TIME BASE STEERING LOGIC
MULTIPLIER/TIME BASE SWITCHING
MULTIPLIER/TIME BASE GATING
MULTIPLIER/TIME BASE DECADES
RECLOCKING LOGIC
REMOTE
÷ 4


EXT. GATE IN
To
START/STOP SWITCH
S2-A
START/STOP
RESET R.S. FLIP FLOP
REMOTE RESET
RESET SWITCH
S2-B
STORAGE
To
REMOTE HOLD
STORAGE (REF. ONLY)
STORAGE
OFF
S101
REAR PANEL
INTERCONNECT BD.
FOR REFERENCE ONLY
DISPLAY TIME R1 1M
DISPLAY TIME ASSY. ON FRONT PANEL
18 VOLT SWITCH
S205
PWR ON
OFF
FOR REFERENCE ONLY
PRINT
DISPLAY TIME
CONTROL LOGIC
MARKER
MODELS 8010B, 8030B
START/STOP LOGIC
REAR PANEL
EXT.
INT.
S102
J106
INT. REF. OUT
EXT. REF. IN
REF. OSC.
INTERCONNECT BOARD
FOR REFERENCE ONLY
REF. OSC.
INT. & EXT. REF. IN
INT./EXT. REFERENCE CONDITIONING
Δt, M CLEAR
f0/10, D1A, D1B, D1C, D1D
UPDATE
PRINT
ARM
Δt
GATE
M CLEAR
START
STOP
MARKER
f/n (SCALED OUT)
REF. OUT
10 MHz


ΔT, M CLEAR
f0/10, D1A, D1B, D1C, D1D
UPDATE
PRINT
ARM
ΔT
GATE
M CLEAR
START
STOP
MARKER
f/n (SCALED OUT)
REF. OUT
10 MHz
T2 CLEAR
PART OF J2
10 MHz
T
10⁰ + 1 µs
10² + 10 µs
10³ + 100 µs
10⁴ + 1 ms
10⁵ + 10 ms
10⁶ + 100 ms
10⁷ + 1s
10⁸ + 10s
10⁹ + 100s
f/n (SCALED OUT)
REF. OUT
MARKER OUT
ARM
PRINT
T2 CLEAR
UPDATE
f0/10
D1B
D1A
D1D
D1C
DISPLAY TIME
CONTROL LOGIC
INT./EXT. REFERENCE CONDITIONING
STORAGE (REF. ONLY)
18 VOLT SWITCH
DISPLAY TIME ASSY. ON FRONT PANEL
FOR REFERENCE ONLY


COAX CONN (3)
P6 – USED ON ALL MODELS
P7 – USED ON MODELS 6010B AND 6030B
P13 – USED ON MODELS 6020B AND 6030B
SHADED COMPONENTS NOT USED ON MODEL 6020B
MOUNTING BRACKET INSTRUMENT CASE
TO DISPLAY TIME ASSEMBLY P3
TO INTERCONNECT ASSEMBLY P2
TO REMOVE ASSEMBLY, REMOVE 8 PPH 6-32 x 5/16 SCREWS (61505B) AND LOCK WASHERS (6170?B)
SWITCH FAR SIDE
START/ STOP
RESET


PART OF J2
INT. & EXT. REF. IN
GROUND
+18V
EXT. GATE IN
GROUND
+5V
−18V
REMOTE RESET
REMOTE HOLD
STORAGE
GROUND
REMOTE
COUNTER STEERING LOGIC
MODELS 8010B, 8030B SYNCHRONIZER
M CLEAR
FAST COUNTING DECADE
TIME BASE STEERING LOGIC
10 MHz
fb SYN
Ck + Fa
fB/10
÷ 4
NOTES:
H ECL High 4.2V
L ECL Low 3.6V
H TTL High ≥ 2.0V
L TTL Low ≤.8V
AC
DC
NOTE: UNLESS OTHERWISE SPECIFIED
ALL DIODES ARE 018
J2 CONNECTS TO INTERCONNECT BOARD

NOTES:

- (H) ECL High 4.2V
- (L) ECL Low 3.6V
- [H] TTL High ≥ 2.0V
- [L] TTL Low ≤.8V
- AC
- DC

FAST COUNTING DECADE

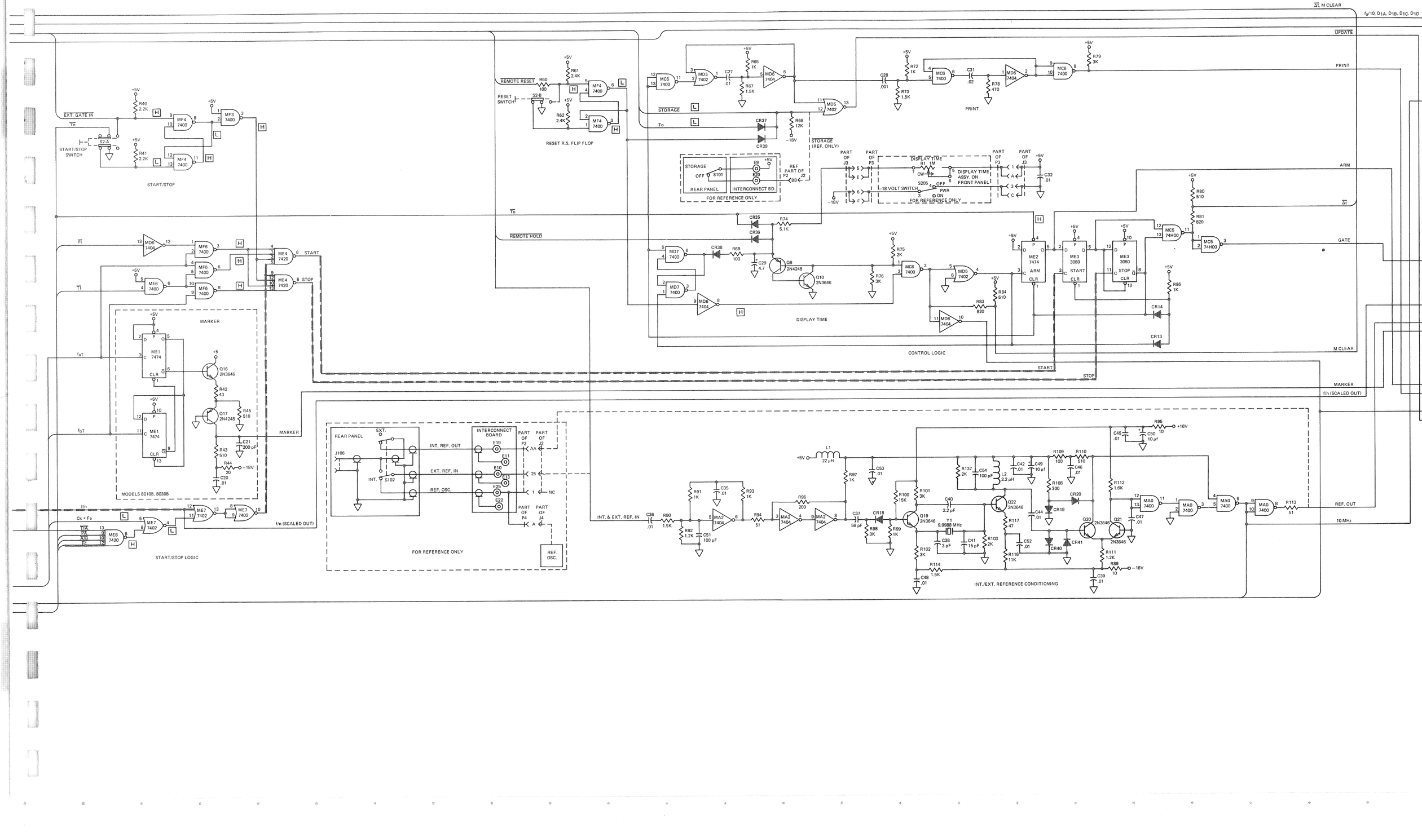
MULTIPLIER/TIME BASE SWITCHING

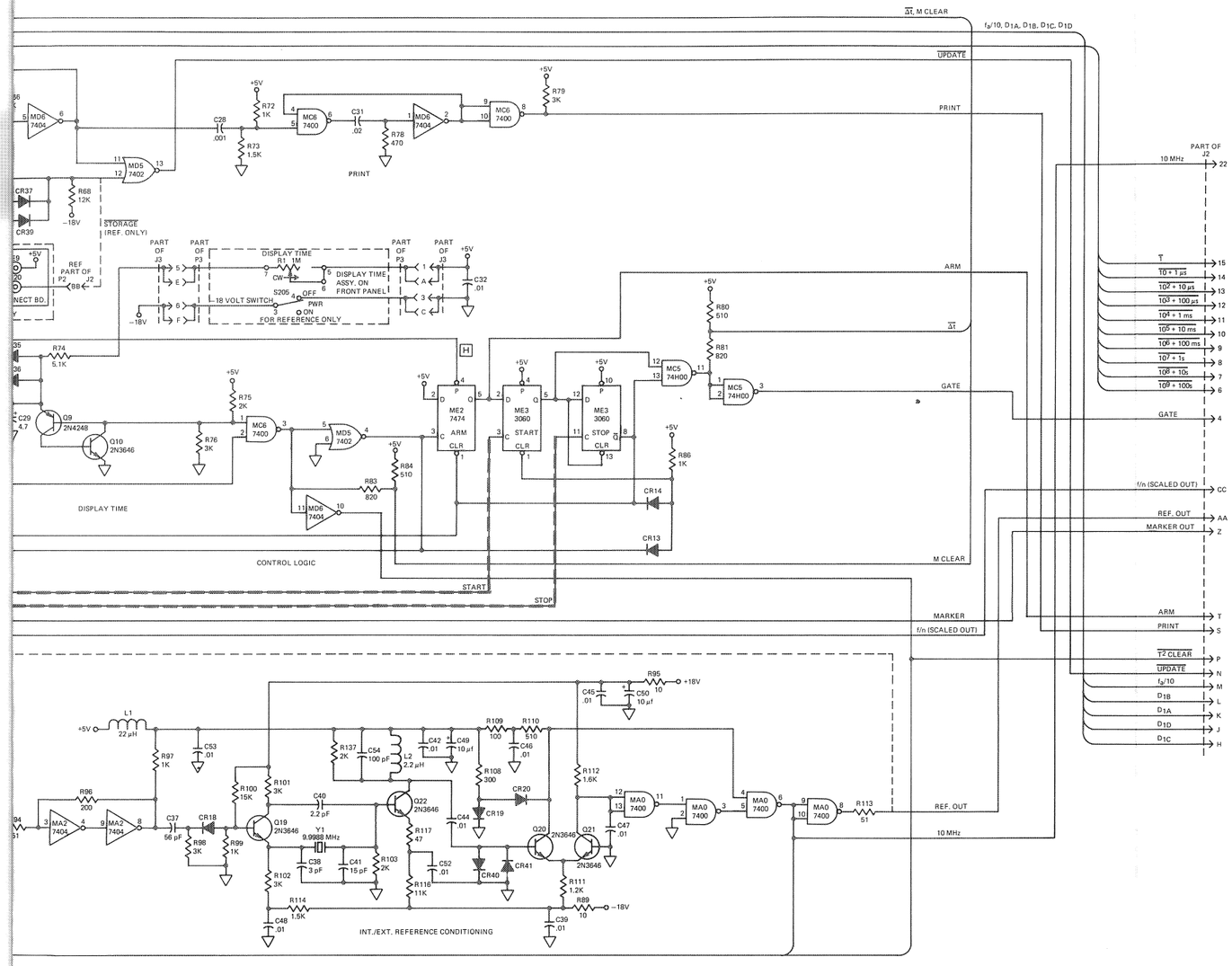
MULTIPLIER/TIME BASE GATING

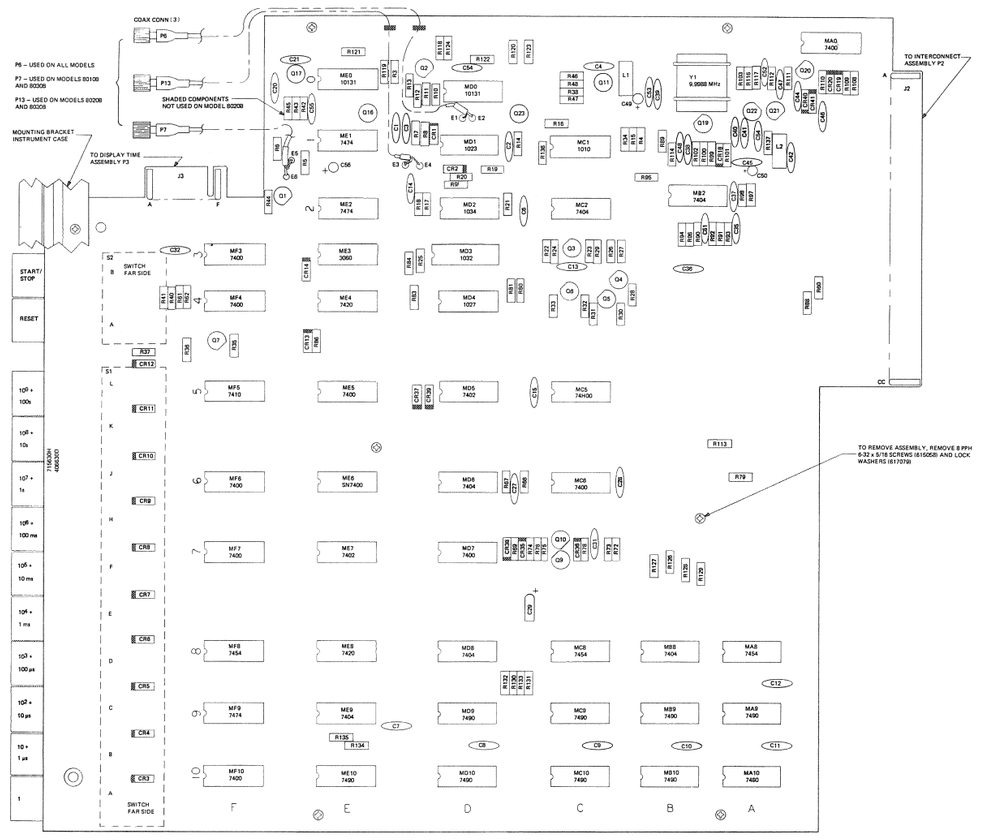
RECLOCKING LOGIC

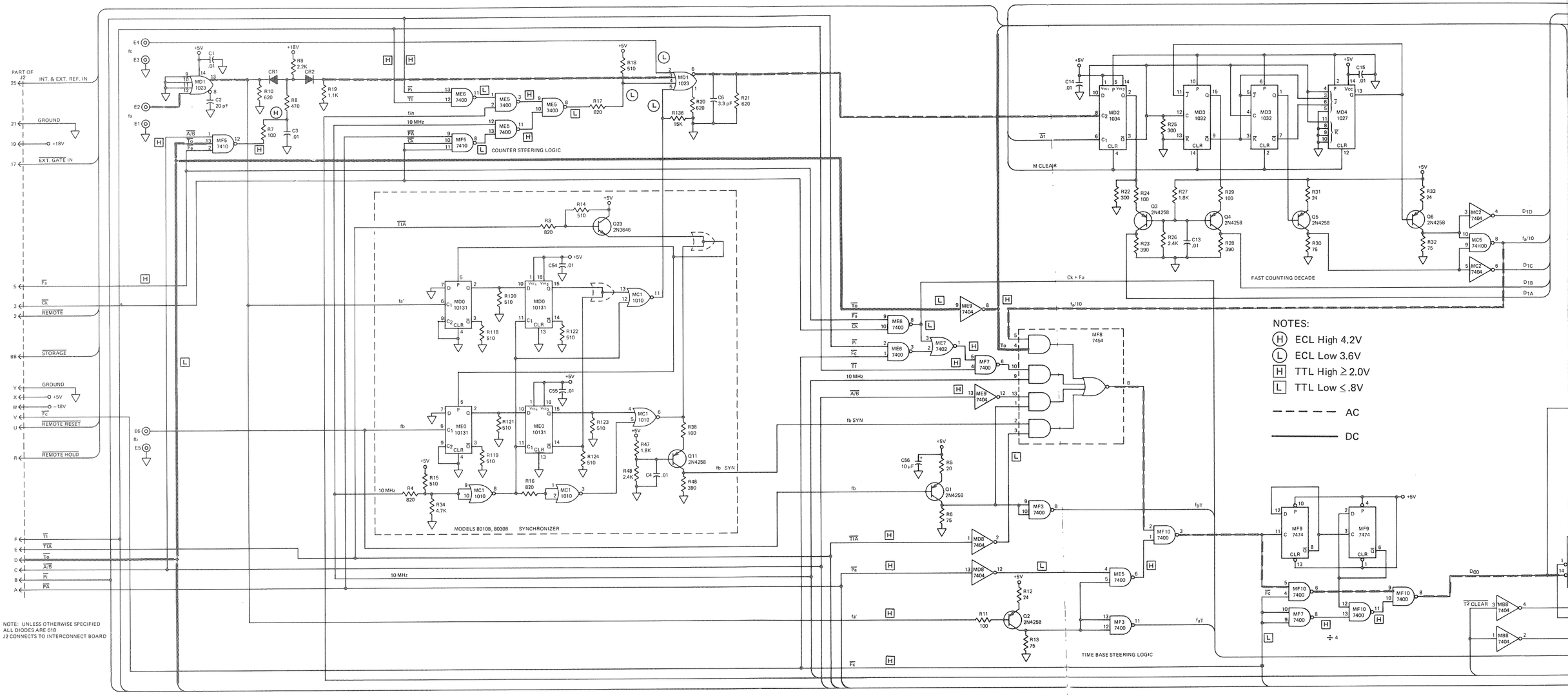
MULTIPLIER/TIME BASE DECADES

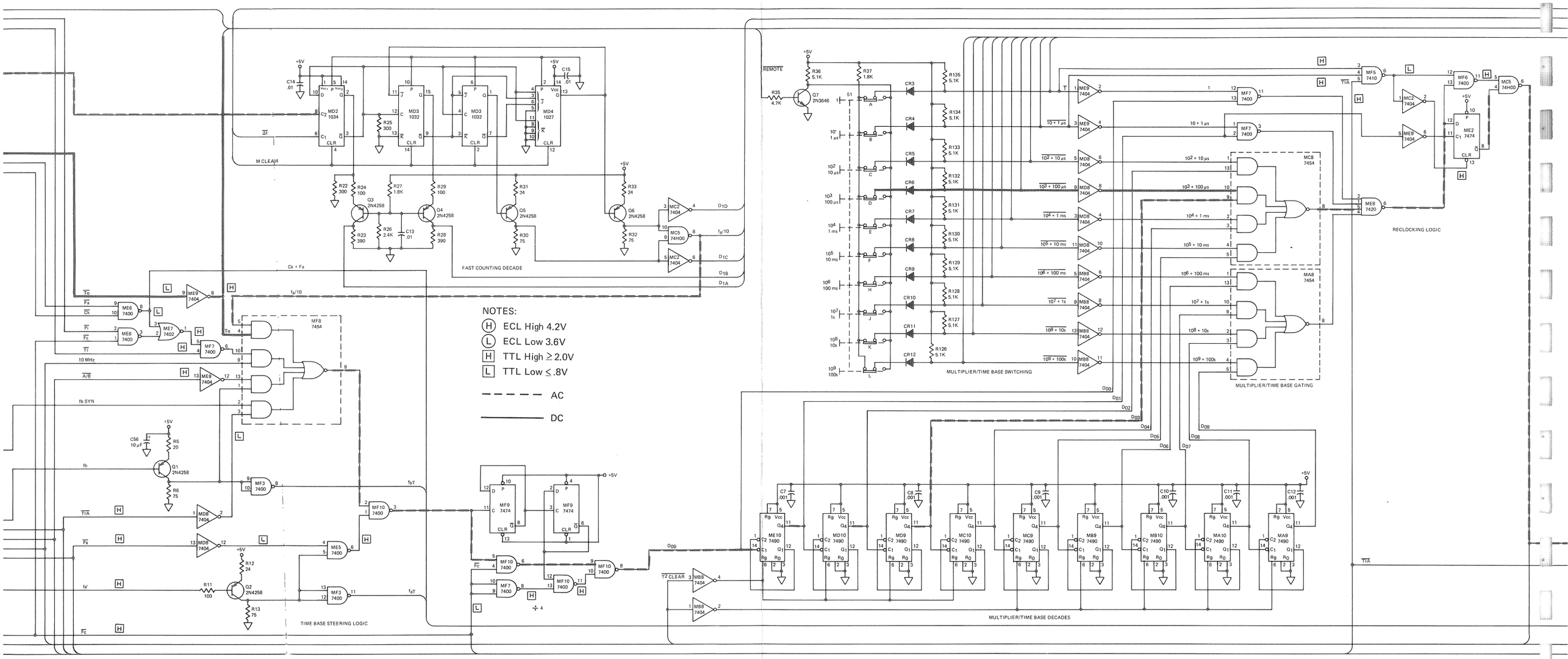
TIME BASE STEERING LOGIC


EXT. GATE IN
START/STOP SWITCH
START/STOP
REMOTE RESET
RESET SWITCH
RESET R.S. FLIP FLOP
STORAGE
STORAGE (REF. ONLY)
REAR PANEL
INTERCONNECT BD.
FOR REFERENCE ONLY
DISPLAY TIME
DISPLAY TIME ASSY. ON FRONT PANEL
18 VOLT SWITCH
PRINT
REMOTE HOLD
CONTROL LOGIC
MARKER
MODELS 80108, 80308
START/STOP LOGIC
INT. REF. OUT
EXT. REF. IN
REF. OSC.
INT. & EXT. REF. IN
INT./EXT. REFERENCE CONDITIONING
Y1 9.9988 MHz
UPDATE
ARM
GATE
M CLEAR
REF. OUT
10 MHz


ΔT, M CLEAR
f0/10, D1A, D1B, D1C, D1D
UPDATE
PRINT
ARM
ΔT
GATE
M CLEAR
START
STOP
MARKER
f/n (SCALED OUT)
T2 CLEAR
UPDATE
f0/10
D1B
D1A
D1D
D1C
PART OF J2
10 MHz
T
10 + 1 µs
10² + 10 µs
10³ + 100 µs
10⁴ + 1 ms
10⁵ + 10 ms
10⁶ + 100 ms
10⁷ + 1s
10⁸ + 10s
10⁹ + 100s
f/n (SCALED OUT)
REF. OUT
MARKER OUT
ARM
PRINT
T2 CLEAR
UPDATE
f0/10
D1B
D1A
D1D
D1C
REF. OUT
10 MHz
DISPLAY TIME
CONTROL LOGIC
INT./EXT. REFERENCE CONDITIONING
STORAGE (REF. ONLY)
18 VOLT SWITCH
PWR ON OFF
FOR REFERENCE ONLY
DISPLAY TIME ASSY. ON FRONT PANEL
PART OF P3
PART OF J3
PART OF P2
NECT BD.
MD5 7402
MC6 7400
MD6 7404
MC5 74H00
MC6 74H00
ME2 7474 ARM
ME3 3060 START
ME3 3060 STOP
MA2 7404
MA0 7400
Q9 2N4248
Q10 2N3646
Q19 2N3646
Q20 2N3646
Q21 2N3646
Q22 2N3646
Y1 9.9988 MHz
CR37
CR39
CR14
CR13
CR20
CR19
CR41
CR40
L1 22 µH
L2 2.2 µH
+5V
−18V
+18V


COAX CONN (3)
P6 – USED ON ALL MODELS
P7 – USED ON MODELS 8010B AND 8030B
P13 – USED ON MODELS 8020B AND 8030B
SHADED COMPONENTS NOT USED ON MODEL 8020B
MOUNTING BRACKET INSTRUMENT CASE
TO DISPLAY TIME ASSEMBLY P3
TO INTERCONNECT ASSEMBLY P2
START/ STOP
RESET
SWITCH FAR SIDE
Y1 9.9988 MHz
TO REMOVE ASSEMBLY, REMOVE 8 PPH 6-32 x 5/16 SCREWS (6150SB) AND LOCK WASHERS (6170TB)
MF3 7400
MF4 7400
MF5 7410
MF6 7400
MF7 7400
MF8 7454
MF9 7474
MF10 7400
ME3 3060
ME4 7420
ME5 7400
ME6 SN7400
ME7 7402
ME8 7420
ME9 7404
ME10 7490
MD2 1022
MD4 1027
MD5 7402
MD6 7404
MD7 7400
MD8 7404
MD9 7490
MD10 7490
MC2 7404
MC5 74H00
MC6 7400
MC7 7400
MC8 7454
MC9 7490
MC10 7490
MB2 7404
MB7 7404
MB8 7404
MB9 7490
MB10 7490
MA8 7454
MA9 7490
MA10 7490
SWITCH FAR SIDE


PART OF J2
INT. & EXT. REF. IN
GROUND
+18V
EXT. GATE IN
GROUND
+5V
−18V
REMOTE RESET
REMOTE HOLD
STORAGE
REMOTE
COUNTER STEERING LOGIC
10 MHz
MODELS 8010B, 8030B SYNCHRONIZER
M CLEAR
FAST COUNTING DECADE
TIME BASE STEERING LOGIC
÷ 4
T2 CLEAR
NOTES:
H ECL High 4.2V
L ECL Low 3.6V
H TTL High ≥ 2.0V
L TTL Low ≤ .8V
AC
DC
NOTE: UNLESS OTHERWISE SPECIFIED
ALL DIODES ARE 018
J2 CONNECTS TO INTERCONNECT BOARD


NOTES:
(H) ECL High 4.2V
(L) ECL Low 3.6V
[H] TTL High ≥ 2.0V
[L] TTL Low ≤ .8V
AC
DC
FAST COUNTING DECADE
TIME BASE STEERING LOGIC
MULTIPLIER/TIME BASE SWITCHING
MULTIPLIER/TIME BASE GATING
MULTIPLIER/TIME BASE DECADES
RECLOCKING LOGIC
M CLEAR
REMOTE
fb SYN
10 MHz
÷ 4

PART OF J2

INT. & EXT. REF. IN

GROUND

+18V

EXT. GATE IN

$\overline{Fa}$

$\overline{Ck}$

REMOTE

STORAGE

GROUND

+5V

−18V

$\overline{Fc}$

REMOTE RESET

REMOTE HOLD

$\overline{Ti}$

$\overline{TiA}$

$\overline{To}$

A/B

$\overline{Pi}$

$\overline{PA}$

NOTE: UNLESS OTHERWISE SPECIFIED
ALL DIODES ARE 018
J2 CONNECTS TO INTERCONNECT BOARD

COUNTER STEERING LOGIC

MODELS 80108, 80308 SYNCHRONIZER

TIME BASE STEERING LOGIC

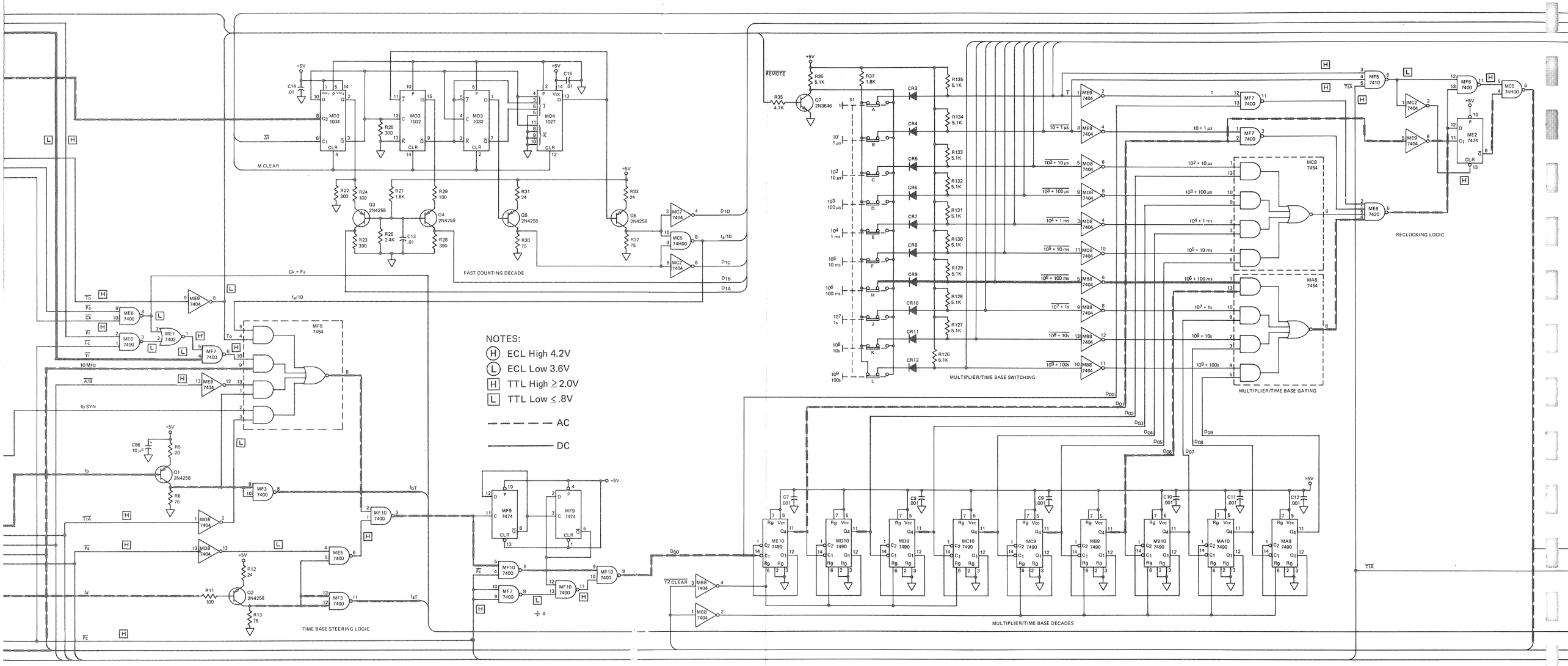
FAST COUNTING DECADE

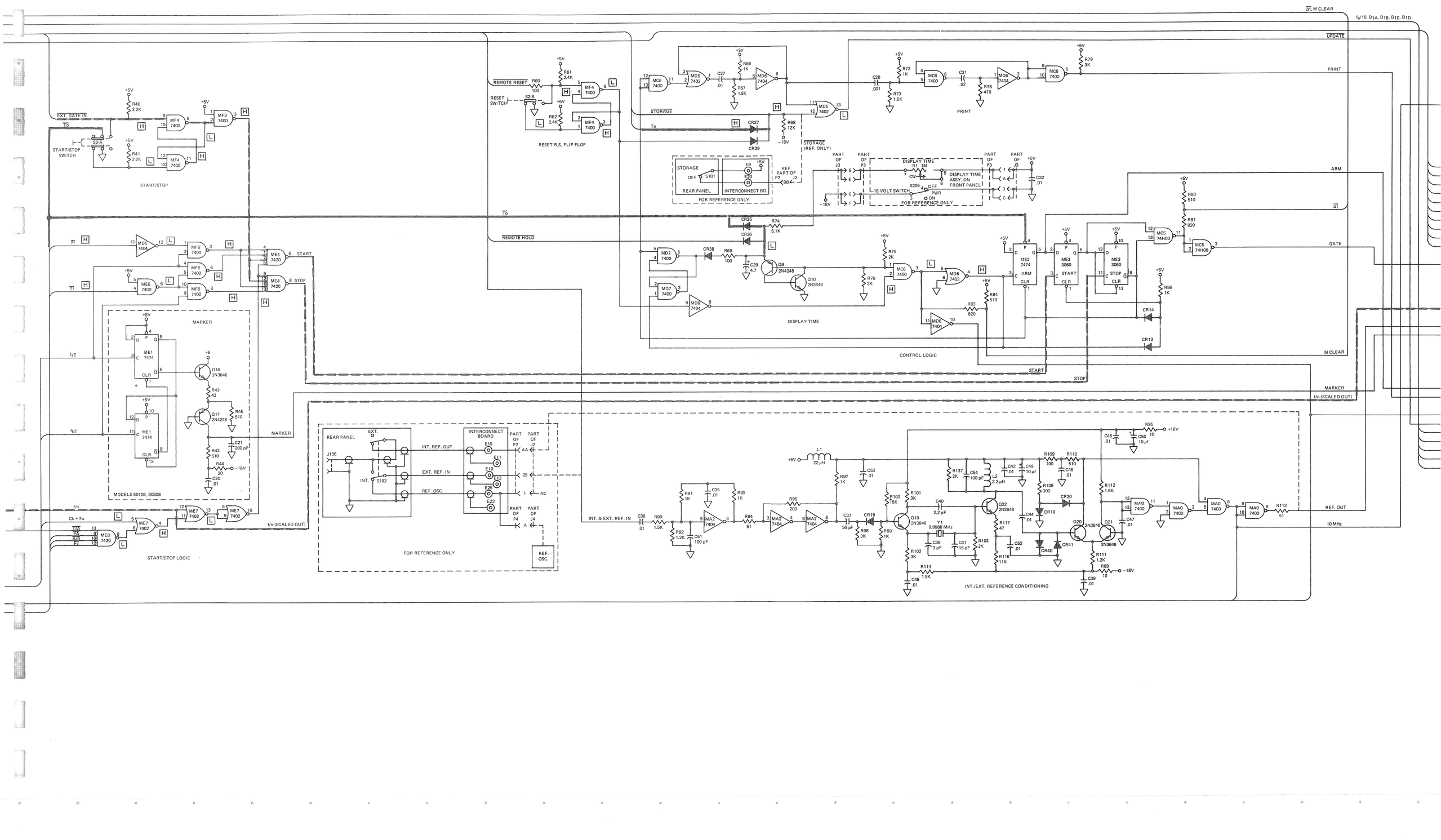
M CLEAR

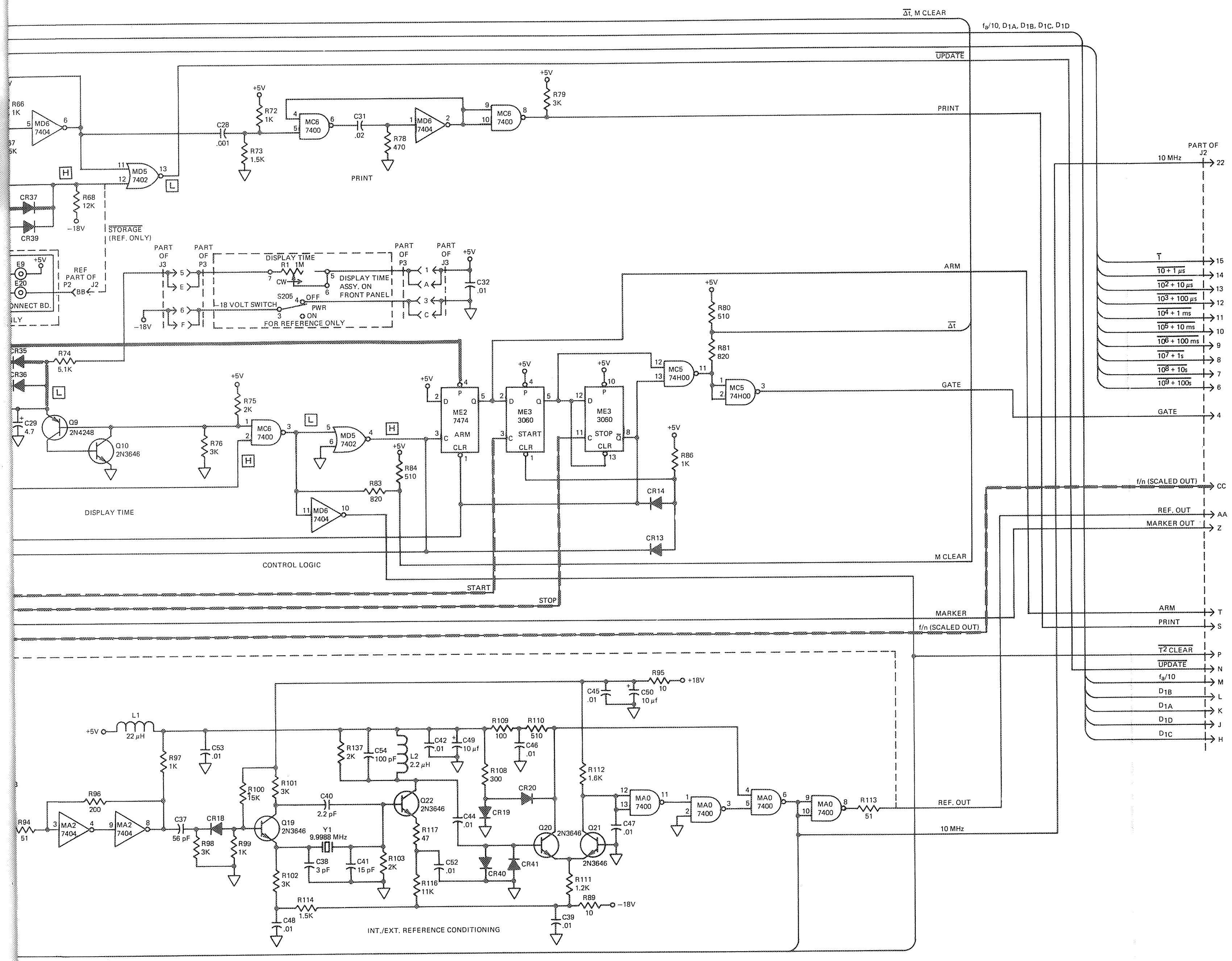
REMOTE

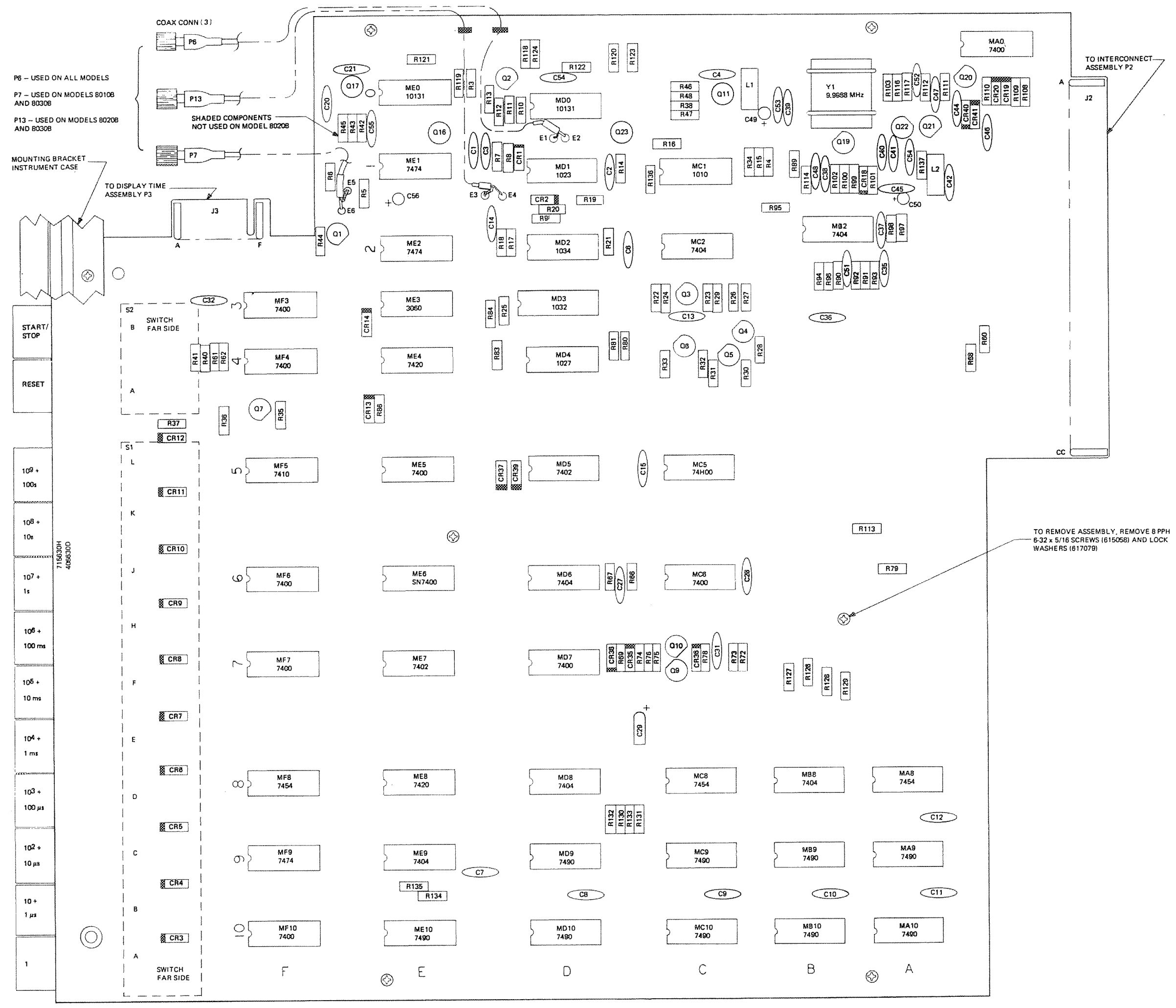
NOTES:

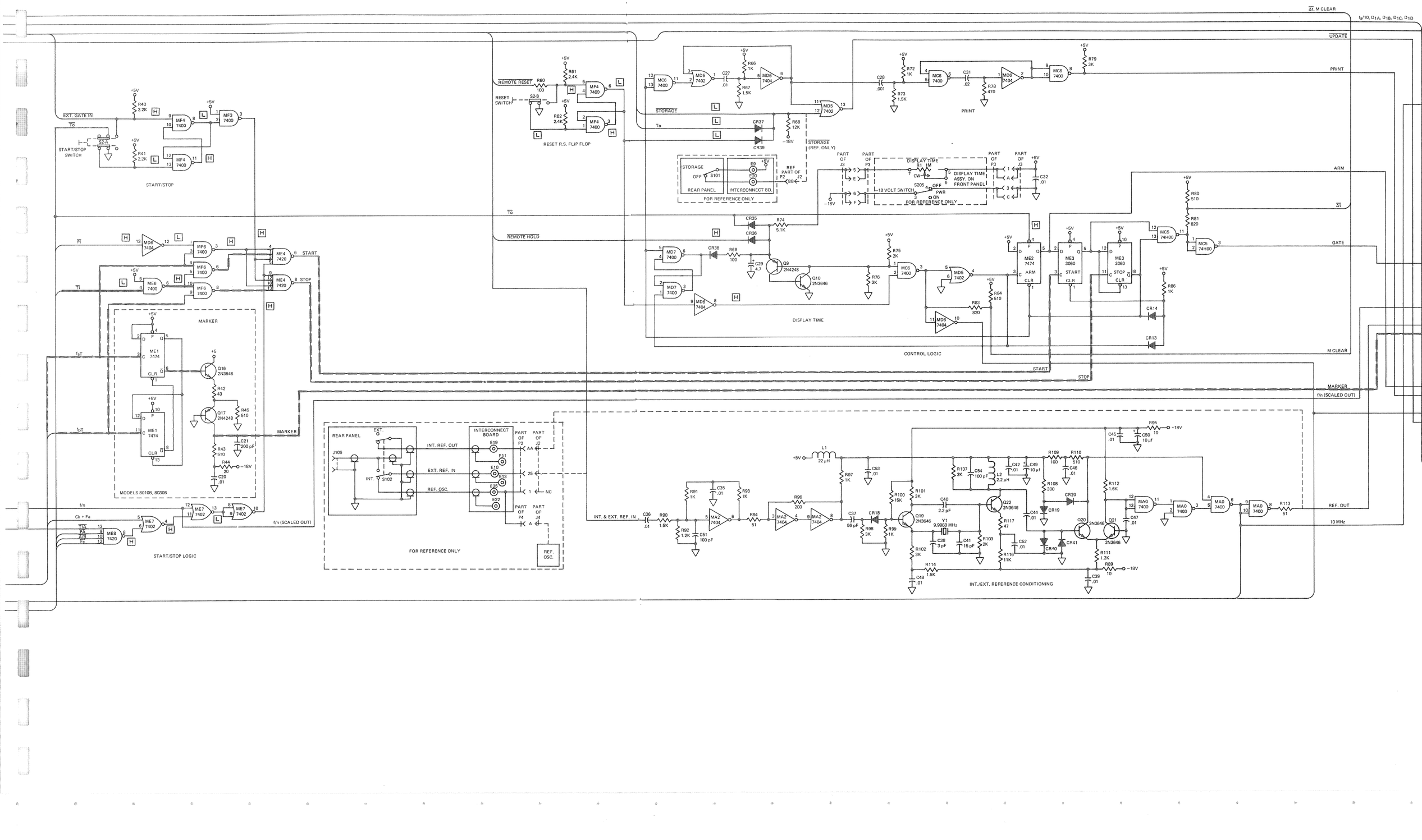
- (H) ECL High 4.2V
- (L) ECL Low 3.6V
- [H] TTL High ≥ 2.0V
- [L] TTL Low ≤ .8V
- AC
- DC

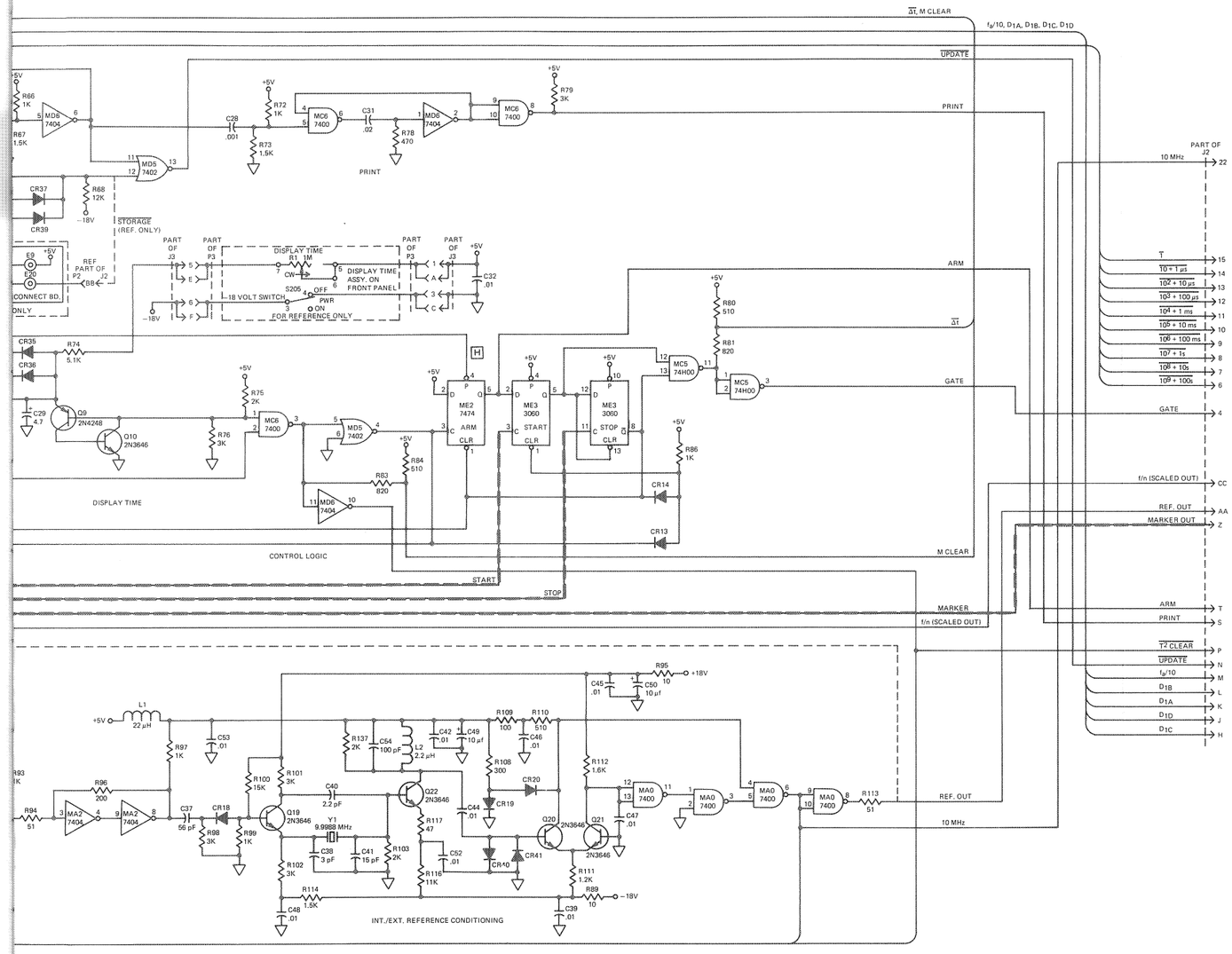

NOTES:
H ECL High 4.2V
L ECL Low 3.6V
H TTL High ≥ 2.0V
L TTL Low ≤ .8V
AC
DC
FAST COUNTING DECADE
TIME BASE STEERING LOGIC
÷ 4
MULTIPLIER/TIME BASE SWITCHING
MULTIPLIER/TIME BASE GATING
MULTIPLIER/TIME BASE DECADES
RECLOCKING LOGIC
REMOTE
M CLEAR
Ck + Fa
10 MHz
fb SYN
T2 CLEAR

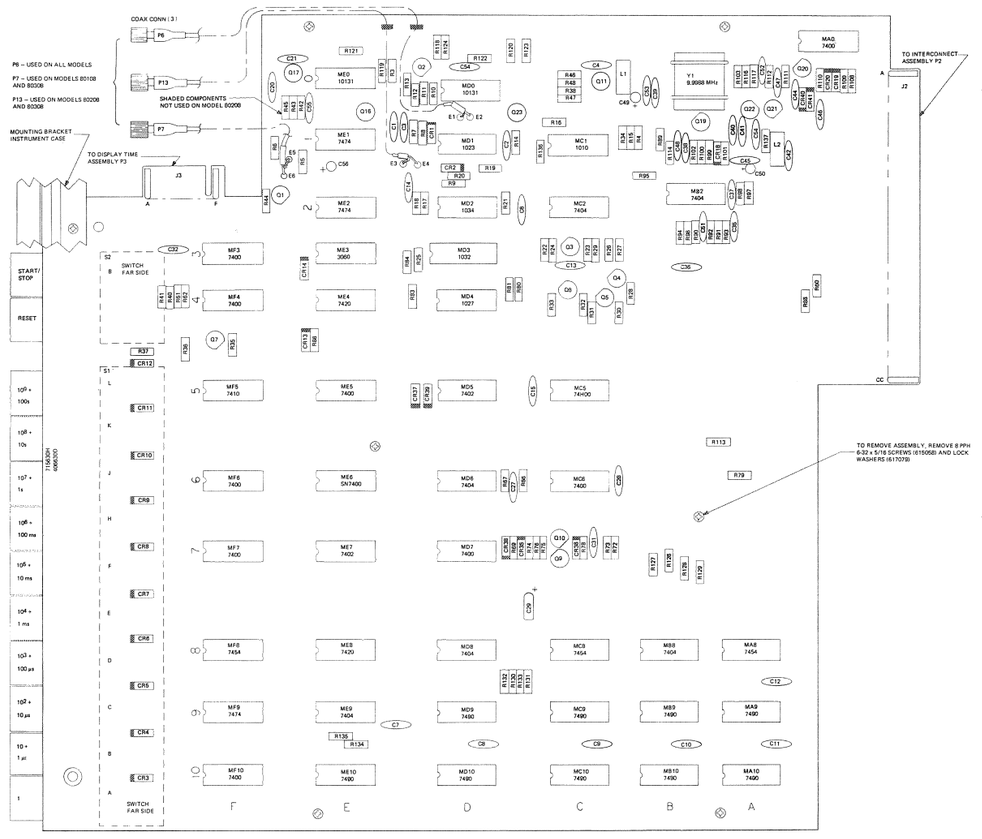

EXT. GATE IN
START/STOP SWITCH
START/STOP
REMOTE RESET
RESET SWITCH
RESET R.S. FLIP FLOP
STORAGE
STORAGE (REF. ONLY)
REAR PANEL
INTERCONNECT BD.
FOR REFERENCE ONLY
DISPLAY TIME
DISPLAY TIME ASSY. ON FRONT PANEL
18 VOLT SWITCH
PRINT
REMOTE HOLD
MARKER
CONTROL LOGIC
START
STOP
ARM
GATE
M CLEAR
UPDATE
REF. OUT
10 MHz
MARKER
f/n (SCALED OUT)
MODELS 8010B, 8030B
START/STOP LOGIC
INT. REF. OUT
EXT. REF. IN
REF. OSC.
INT. & EXT. REF. IN
INT./EXT. REFERENCE CONDITIONING


Δt, M CLEAR
f₀/10, D1A, D1B, D1C, D1D
UPDATE
PRINT
PART OF J2
10 MHz
STORAGE (REF. ONLY)
DISPLAY TIME ASSY. ON FRONT PANEL
18 VOLT SWITCH
FOR REFERENCE ONLY
ARM
Δt
GATE
f/n (SCALED OUT)
REF. OUT
MARKER OUT
M CLEAR
START
STOP
MARKER
f/n (SCALED OUT)
T2 CLEAR
DISPLAY TIME
CONTROL LOGIC
INT./EXT. REFERENCE CONDITIONING
REF. OUT
10 MHz


COAX CONN (3)
P6 – USED ON ALL MODELS
P7 – USED ON MODELS 80106 AND 80208
P13 – USED ON MODELS 80208 AND 80308
SHADED COMPONENTS NOT USED ON MODEL 80206
MOUNTING BRACKET INSTRUMENT CASE
TO DISPLAY TIME ASSEMBLY P3
TO INTERCONNECT ASSEMBLY P2
START/STOP
RESET
SWITCH FAR SIDE
TO REMOVE ASSEMBLY, REMOVE 8 PPH 6-32 x 5/16 SCREWS (615056) AND LOCK WASHERS (617079)
F
E
D
C
B
A


EXT. GATE IN
START/STOP SWITCH
START/STOP
REMOTE RESET
RESET SWITCH
RESET R.S. FLIP FLOP
STORAGE
REAR PANEL
INTERCONNECT BD.
FOR REFERENCE ONLY
STORAGE (REF. ONLY)
DISPLAY TIME
1Δ VOLT SWITCH
DISPLAY TIME ASSY. ON FRONT PANEL
PRINT
REMOTE HOLD
MARKER
MODELS 80108, 80308
DISPLAY TIME
CONTROL LOGIC
START/STOP LOGIC
INT. REF. OUT
EXT. REF. IN
REF. OSC.
INT. & EXT. REF. IN
INT./EXT. REFERENCE CONDITIONING
ΔT, M CLEAR
UPDATE
PRINT
ARM
ΔT
GATE
M CLEAR
START
STOP
MARKER
f/n (SCALED OUT)
REF. OUT
10 MHz


ΔT, M CLEAR
f0/10, D1A, D1B, D1C, D1D
UPDATE
PRINT
ARM
ΔT
GATE
T
10 + 1 μs
10² + 10 μs
10³ + 100 μs
10⁴ + 1 ms
10⁵ + 10 ms
10⁶ + 100 ms
10⁷ + 1s
10⁸ + 10s
10⁹ + 100s
f/n (SCALED OUT)
REF. OUT
MARKER OUT
M CLEAR
START
STOP
MARKER
f/n (SCALED OUT)
ARM
PRINT
T2 CLEAR
UPDATE
f0/10
D1B
D1A
D1D
D1C
PART OF J2
10 MHz
REF. OUT
10 MHz
DISPLAY TIME
CONTROL LOGIC
INT./EXT. REFERENCE CONDITIONING
STORAGE (REF. ONLY)
DISPLAY TIME ASSY. ON FRONT PANEL
18 VOLT SWITCH
FOR REFERENCE ONLY
CONNECT BD. ONLY


P6 – USED ON ALL MODELS
P7 – USED ON MODELS 80108 AND 80308
P13 – USED ON MODELS 80208 AND 80308
SHADED COMPONENTS NOT USED ON MODEL 80208
MOUNTING BRACKET INSTRUMENT CASE
TO DISPLAY TIME ASSEMBLY P3
TO INTERCONNECT ASSEMBLY P2
START/ STOP
RESET
SWITCH FAR SIDE
TO REMOVE ASSEMBLY, REMOVE 8 PPH 6-32 x 5/16 SCREWS (6150S8) AND LOCK WASHERS (6110709)

PART OF J2
25 INT. & EXT. REF. IN
21 GROUND
19 +18V
17 EXT. GATE IN
5 $\overline{Fa}$
3 $\overline{Ck}$
2 REMOTE
BB STORAGE
Y GROUND
X +5V
W −18V
V $\overline{Fc}$ REMOTE RESET
U
R REMOTE HOLD
F $\overline{TI}$
E $\overline{TIA}$
D $\overline{To}$
C $\overline{A/B}$
B $\overline{Pi}$
A $\overline{PA}$

NOTE: UNLESS OTHERWISE SPECIFIED
ALL DIODES ARE 018
J2 CONNECTS TO INTERCONNECT BOARD

E4 fc
E3
E2
fa
E1
+5V C1 .01
MD1 1023
C2 20 pF
+18V R9 2.2K CR2
CR1 R10 620
R8 470
R7 100
C3 .01
R19 1.1K
MF5 7410
$\overline{A/B}$ $\overline{Fa}$ $\overline{Fc}$
ME6 7400 ME5 7400 ME5 7400 ME5 7400
$\overline{Pi}$ $\overline{TI}$ f/n 10 MHz
$\overline{PA}$ $\overline{Ck}$ MF5 7410
COUNTER STEERING LOGIC
+5V R18 510
R17 820
MD1 1023
R136 15K
R20 620
C6 3.3 pF
R21 620

$\overline{TIA}$ R14 510 +5V R3 820 Q23 2N3646
fa' MD0 10131 C54 .01 R120 510 R118 510 MC1 1010
MD0 10131 R122 510
fb MD0 10131 C55 .01 R121 510 R119 510
MD0 10131 R123 510 R124 510
MC1 1010 R38 100 Q11 2N4258 fb SYN
+5V R47 1.8K R48 2.4K C4 .01 R46 390
10 MHz R4 820 R15 510 R34 4.7K MC1 1010
R16 820 MC1 1010
MODELS 8010B, 8030B SYNCHRONIZER

$\overline{To}$ $\overline{Fa}$ $\overline{Ck}$ ME6 7400
$\overline{Pi}$ $\overline{Fc}$ ME6 7400 ME7 7402 MF7 7400
$\overline{TI}$ 10 MHz $\overline{A/B}$ fb SYN
+5V C56 10 µF R5 20 Q1 2N4258 R6 75
fb MF3 7400 f_bT
$\overline{TIA}$ MD8 7404 ME9 7404 $f_a/10$
$\overline{Pa}$ MD8 7404 +5V R12 24 Q2 2N4258 R13 75
fa' R11 100 ME5 7400 MF3 7400 f_aT
$\overline{Fc}$
TIME BASE STEERING LOGIC
MF8 7454
MF10 7400

+5V C14 .01 MD2 1034 MD3 1032 MD3 1032 +5V C15 .01 MD4 1027
$\overline{\Delta t}$ M CLEAR
R22 300 R24 100 R27 1.8K R29 100 R31 24 R33 24
Q3 2N4258 Q4 2N4258 Q5 2N4258 Q6 2N4258
R23 390 R26 2.4K C13 .01 R28 390 R30 75 R32 75
MC2 7404 MC5 74H00 MC2 7404
D_{1D} $f_a/10$ D_{1C} D_{1B} D_{1A}
Ck + Fa FAST COUNTING DECADE

REMOTE R35 4.7K

MF9 7474 MF9 7474 MF10 7400 MF10 7400 MF10 7400 MF7 7400 MF10 7400
$\overline{Fc}$ $\div 4$
D_{00} ME10 7490 Q_A Q_D
$\overline{T2}$ CLEAR MB8 7404 MB8 7404
C7 .001

NOTES:
- (H) ECL High 4.2V
- (L) ECL Low 3.6V
- [H] TTL High ≥ 2.0V
- [L] TTL Low ≤ .8V
- AC
- DC

NOTES:

(H) ECL High 4.2V

(L) ECL Low 3.6V

[H] TTL High ≥ 2.0V

[L] TTL Low ≤ .8V

– – – – – AC

——————— DC

FAST COUNTING DECADE

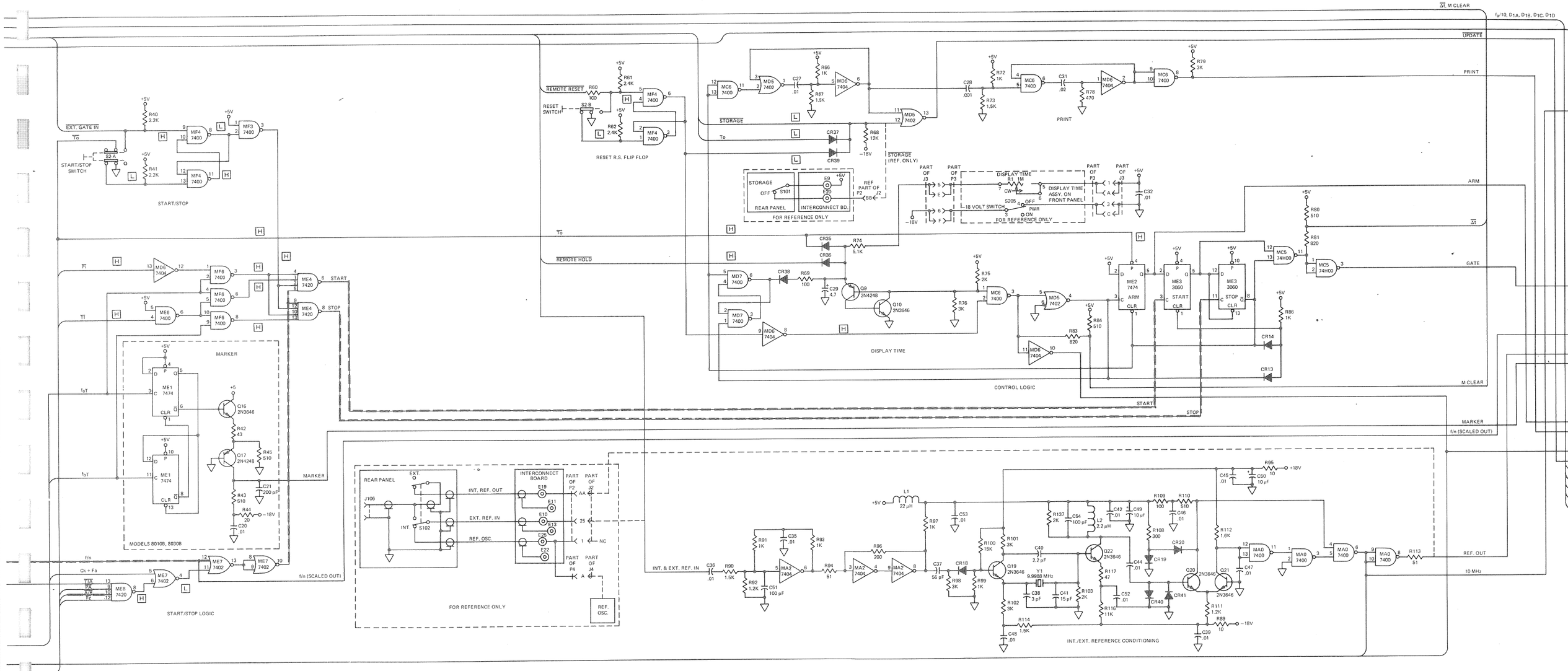
TIME BASE STEERING LOGIC

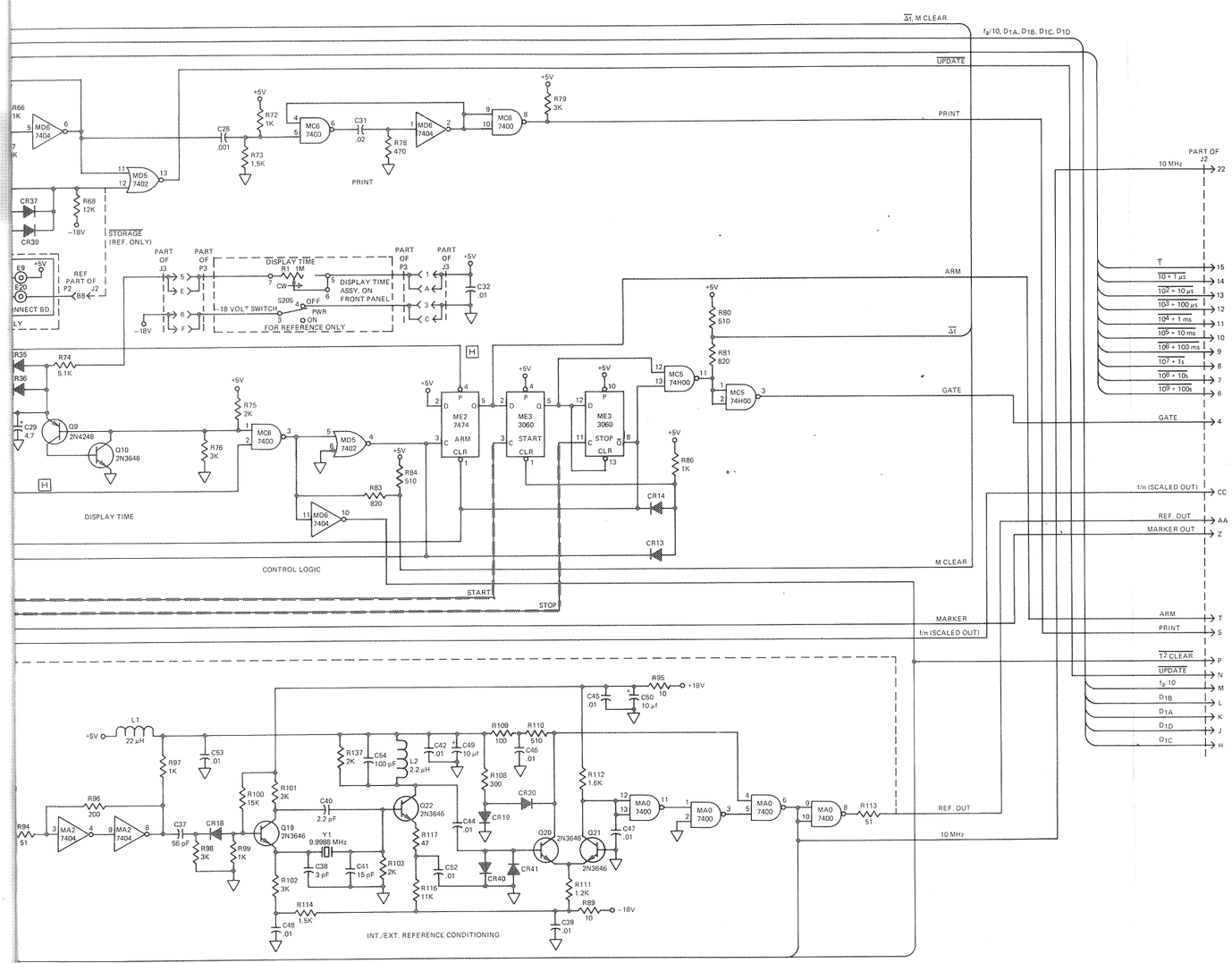
MULTIPLIER/TIME BASE SWITCHING

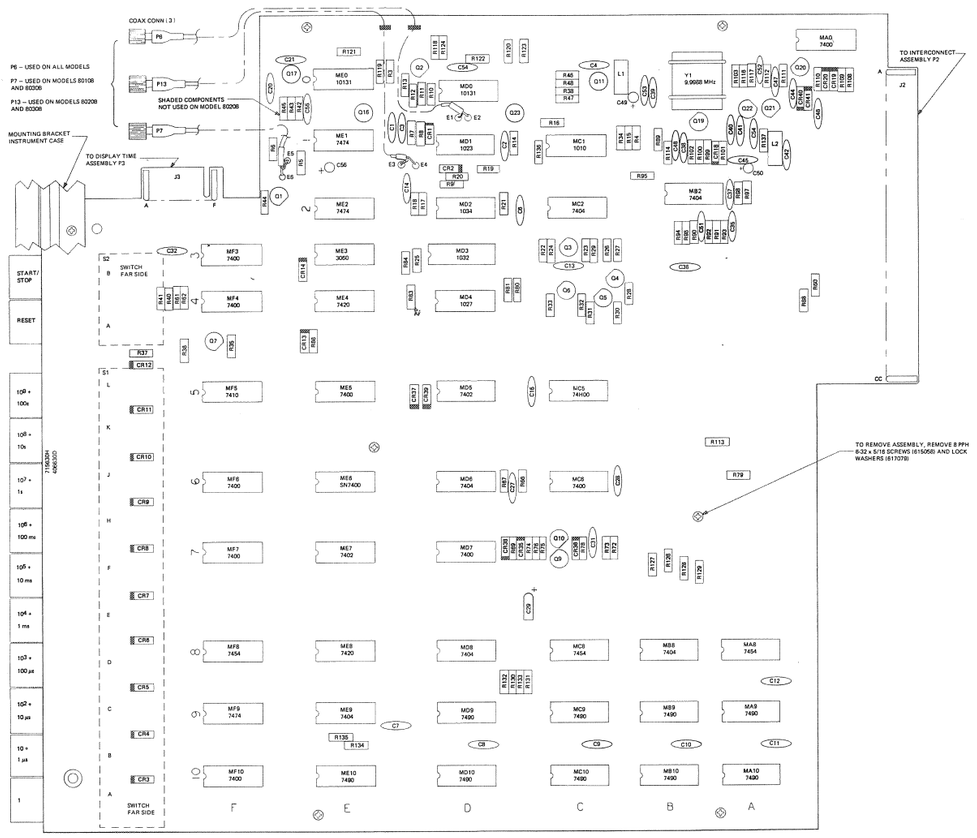
MULTIPLIER/TIME BASE GATING

RECLOCKING LOGIC

MULTIPLIER/TIME BASE DECADES


EXT. GATE IN
TG
START/STOP SWITCH
S2-A
START/STOP
REMOTE RESET
RESET SWITCH
S2-B
RESET R.S. FLIP FLOP
STORAGE
To
REMOTE HOLD
STORAGE (REF. ONLY)
REAR PANEL
INTERCONNECT BD.
FOR REFERENCE ONLY
DISPLAY TIME
DISPLAY TIME ASSY. ON FRONT PANEL
18 VOLT SWITCH
PWR
PRINT
CONTROL LOGIC
DISPLAY TIME
ARM
GATE
START
STOP
M CLEAR
UPDATE
MARKER
f/n (SCALED OUT)
MARKER
MODELS 8010B, 8030B
START/STOP LOGIC
f/n (SCALED OUT)
REAR PANEL
INTERCONNECT BOARD
INT. REF. OUT
EXT. REF. IN
REF. OSC.
FOR REFERENCE ONLY
REF. OSC.
INT. & EXT. REF. IN
INT./EXT. REFERENCE CONDITIONING
REF. OUT
10 MHz


Δt, M CLEAR
f0/10, D1A, D1B, D1C, D1D
UPDATE
PRINT
ARM
Δt
GATE
GATE
f/n (SCALED OUT)
REF. OUT
MARKER OUT
M CLEAR
START
STOP
MARKER
f/n (SCALED OUT)
ARM
PRINT
T2 CLEAR
UPDATE
f0/10
D1B
D1A
D1D
D1C
PART OF J2
10 MHz
T
10 + 1 µs
10² + 10 µs
10³ + 100 µs
10⁴ + 1 ms
10⁵ + 10 ms
10⁶ + 100 ms
10⁷ + 1s
10⁸ + 10s
10⁹ + 100s
CC
AA
Z
T
S
P
N
M
L
K
J
H
DISPLAY TIME
CONTROL LOGIC
INT./EXT. REFERENCE CONDITIONING
STORAGE (REF. ONLY)
18 VOLT SWITCH
DISPLAY TIME ASSY. ON FRONT PANEL
FOR REFERENCE ONLY
ON PWR
OFF
CW
10 MHz
REF. OUT


COAX CONN (3)
P6 – USED ON ALL MODELS
P7 – USED ON MODELS 80108 AND 80208
P13 – USED ON MODELS 80208 AND 80308
SHADED COMPONENTS NOT USED ON MODEL 80208
MOUNTING BRACKET INSTRUMENT CASE
TO DISPLAY TIME ASSEMBLY P3
TO INTERCONNECT ASSEMBLY P2
TO REMOVE ASSEMBLY, REMOVE 8 PPH 8-32 x 5/16 SCREWS (615058) AND LOCK WASHERS (617078)
SWITCH FAR SIDE
Y1 9.9888 MHz
START/STOP
RESET

PART OF J2

25 INT. & EXT. REF. IN
21 GROUND
19 +18V
17 EXT. GATE IN
5 $\overline{Fa}$
3 $\overline{Ck}$
2 REMOTE
BB STORAGE
Y GROUND
X +5V
W −18V
V $\overline{Fc}$
U REMOTE RESET
R REMOTE HOLD
F $\overline{TI}$
E $\overline{TIA}$
D $\overline{To}$
C A/B
B $\overline{Pi}$
A $\overline{PA}$

E4 fc
E3
E2
fa
E1
E6 fb
E5

+5V C1 .01
MD1 1023
C2 20 pF
+18V R9 2.2K
CR1 CR2
R10 620
R8 470
R19 1.1K
R7 100
C3 .01
A/B To Fa MF5 7410
PA Ck MF5 7410
$\overline{Pi}$ $\overline{TI}$ ME6 7400
ME5 7400
ME5 7400
ME5 7400
+5V R18 510
MD1 1023
R20 620
C6 3.3 pF
R21 620
R136 15K
f/n
10 MHz
COUNTER STEERING LOGIC

MODELS 8010B, 8030B SYNCHRONIZER

$\overline{TIA}$
R14 510
+5V
R3 820
Q23 2N3646
fa'
MD0 10131
C54 .01
R120 510
MD0 10131
MC1 1010
R118 510
R122 510
fb
ME0 10131
C55 .01
R121 610
ME0 10131
R123 510
MC1 1010
R38 100
R47 1.8K
R48 2.4K
C4 .01
Q11 2N4258
R46 390
fb SYN
R15 510
R4 620
MC1 1010
R16 820
MC1 1010
R34 4.7K
10 MHz

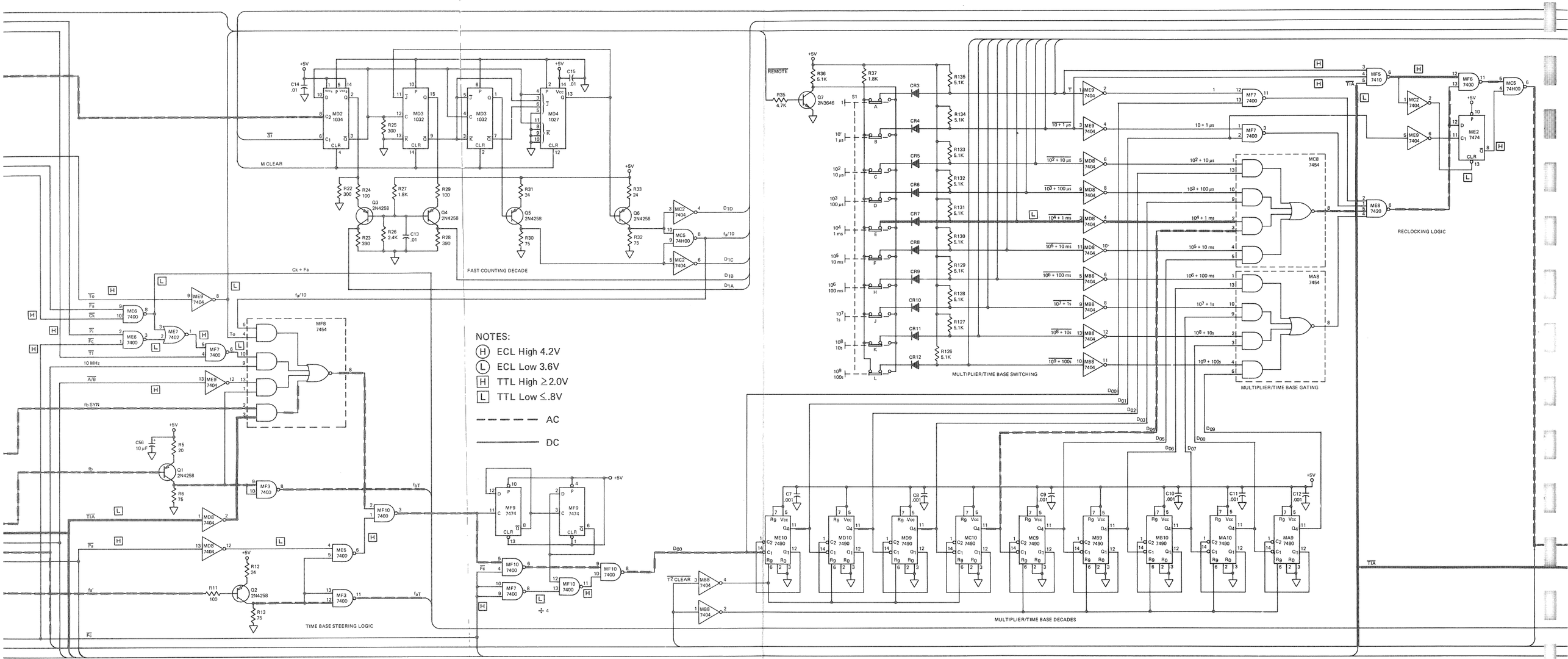
NOTE: UNLESS OTHERWISE SPECIFIED
ALL DIODES ARE 018
J2 CONNECTS TO INTERCONNECT BOARD

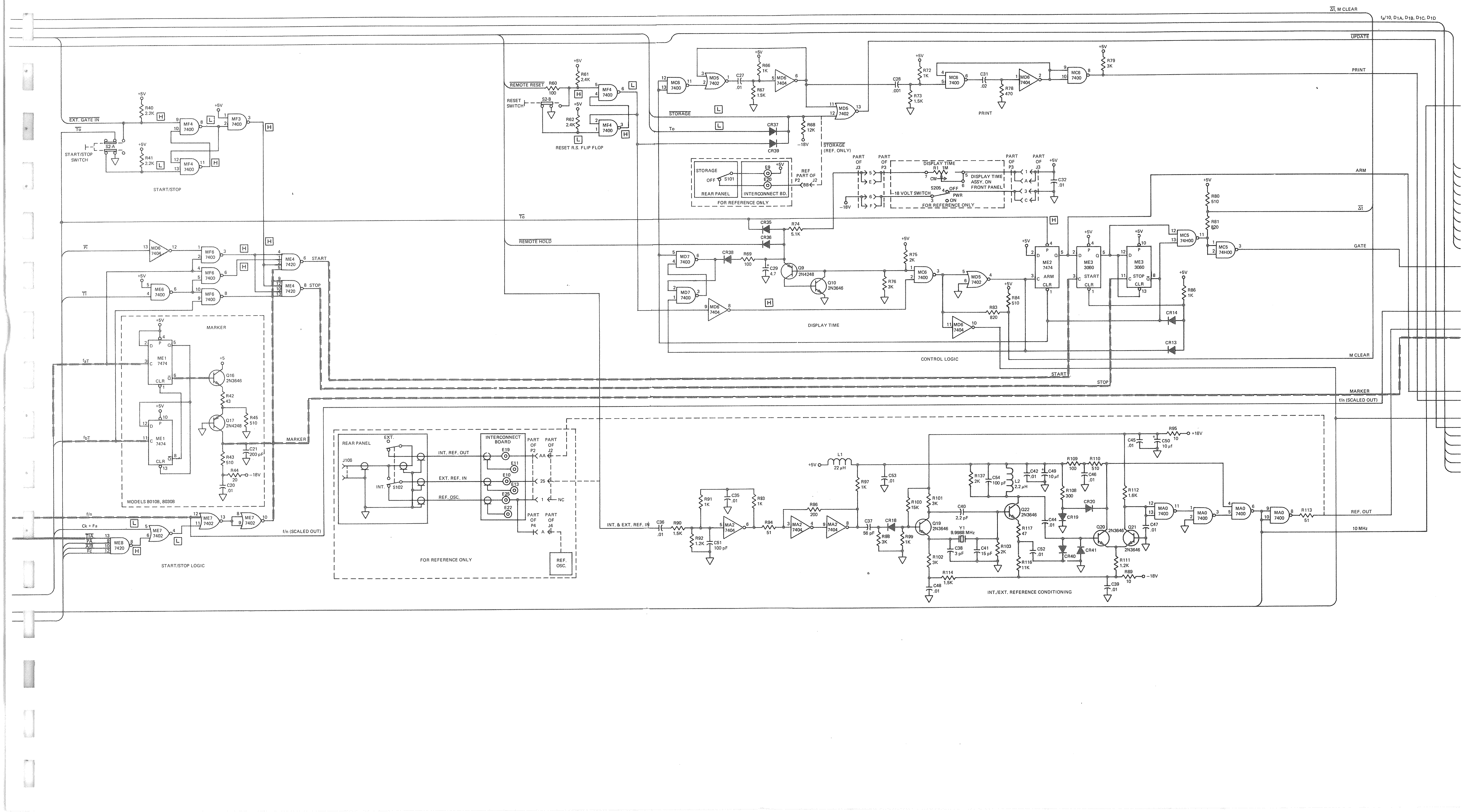
+5V C14 .01
MD2 1034
MD3 1032
MD3 1032
+5V C15 .01
MD4 1027
$\overline{\Delta T}$
M CLEAR
R22 300
R24 100
R27 1.8K
R29 100
Q3 2N4258
Q4 2N4258
R26 2.4K
C13 .01
R23 390
R28 390
R25 300
R31 24
Q5 2N4258
R30 75
+5V R33 24
Q6 2N4258
R32 75
MC2 7404
MC5 74H00
MC2 7404
D_{1D}
$f_a/10$
D_{1C}
D_{1B}
D_{1A}
FAST COUNTING DECADE
Ck + Fa
REMOTE
R35 4.7K

$\overline{To}$ $\overline{Fa}$ ME6 7400
$\overline{Ck}$ ME6 7400
$\overline{Pi}$ $\overline{Fc}$ ME6 7400
ME7 7402
MF7 7400
$\overline{TI}$
10 MHz
$\overline{A/B}$
fb SYN
ME9 7404
ME9 7404
+5V C56 10 µF
R5 20
Q1 2N4258
R6 75
fb
$\overline{TIA}$
$\overline{Pa}$
MD8 7404
MD8 7404
+5V R12 24
fa'
R11 100
Q2 2N4258
R13 75
MF8 7454
MF3 7400
MF10 7400
MF3 7400
MF5 7400
MF3 7400
f_{bT}
f_{aT}
$f_a/10$
TIME BASE STEERING LOGIC
$\overline{Fc}$

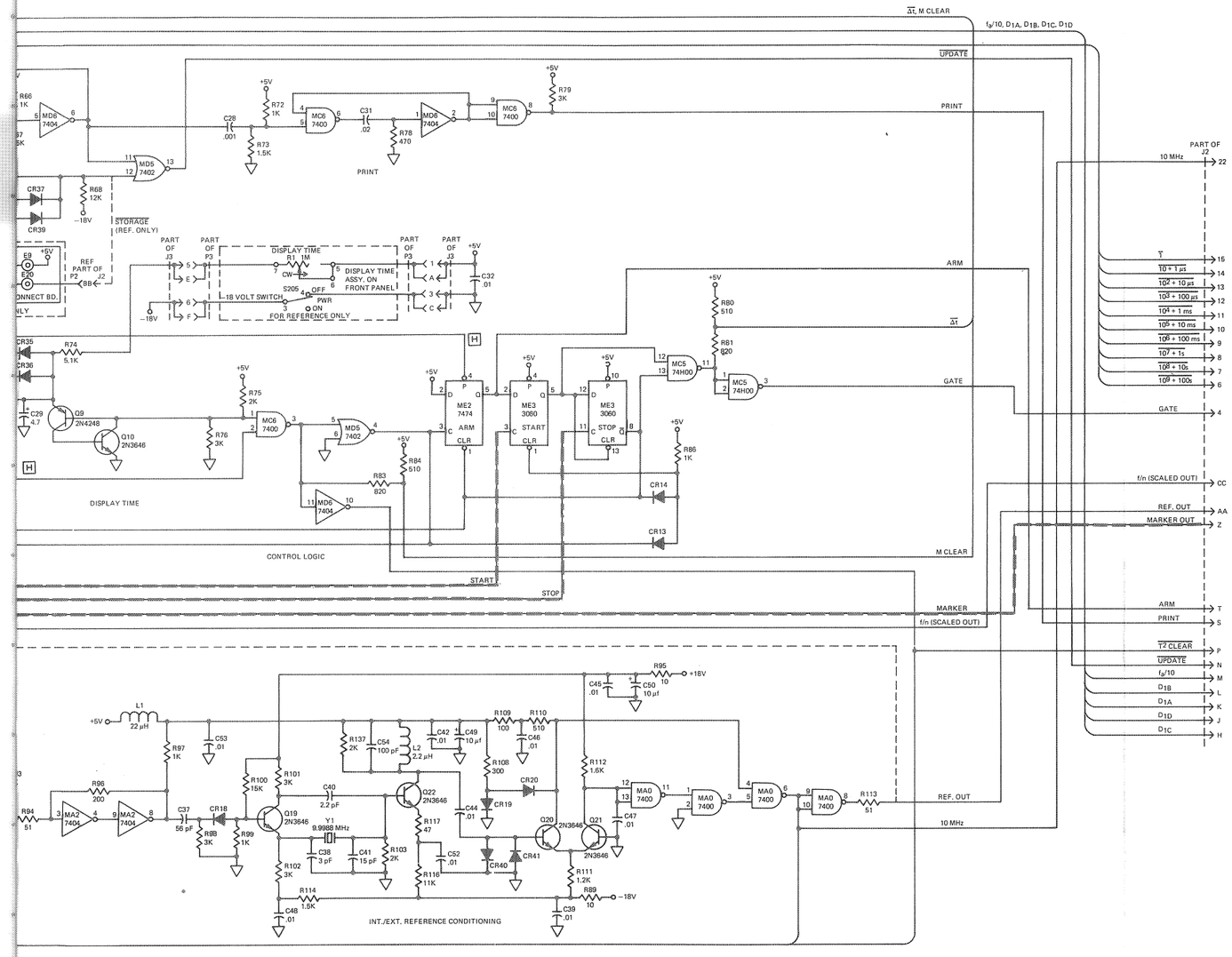
MF9 7474
MF9 7474
CLR
MF10 7400
MF10 7400
MF7 7400
÷ 4
D_{DO}
$\overline{T2}$ CLEAR
MB8 7404
MB8 7404
MF10 7490
C_7 .001
R_9 Vcc Q_4
C_2 C_1 Q_1
R_9 R_0

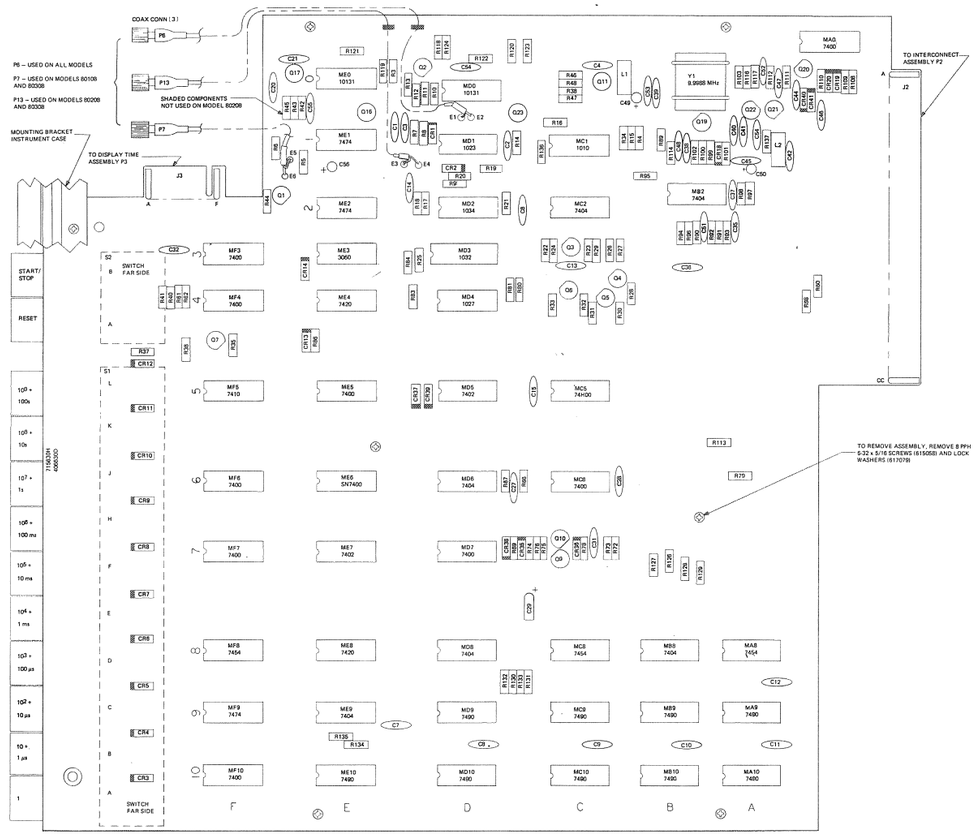
NOTES:
- (H) ECL High 4.2V
- (L) ECL Low 3.6V
- [H] TTL High ≥ 2.0V
- [L] TTL Low ≤ .8V
- AC
- DC


NOTES:
H ECL High 4.2V
L ECL Low 3.6V
H TTL High ≥2.0V
L TTL Low ≤.8V
AC
DC
M CLEAR
FAST COUNTING DECADE
MULTIPLIER/TIME BASE SWITCHING
MULTIPLIER/TIME BASE GATING
RECLOCKING LOGIC
MULTIPLIER/TIME BASE DECADES
TIME BASE STEERING LOGIC
REMOTE
10 MHz
fb SYN
Ck + Fa
÷ 4



Δt, M CLEAR
UPDATE
PRINT
ARM
Δt
GATE
M CLEAR
MARKER
f/n (SCALED OUT)
REF. OUT
10 MHz
EXT. GATE IN
START/STOP SWITCH
START/STOP
REMOTE RESET
RESET SWITCH
RESET R.S. FLIP FLOP
STORAGE
STORAGE (REF. ONLY)
REAR PANEL
INTERCONNECT BD.
FOR REFERENCE ONLY
DISPLAY TIME ASSY. ON FRONT PANEL
18 VOLT SWITCH
REMOTE HOLD
DISPLAY TIME
CONTROL LOGIC
START
STOP
MARKER
MODELS 8010B, 8030B
START/STOP LOGIC
INT. REF. OUT
EXT. REF. IN
REF. OSC.
INTERCONNECT BOARD
INT. & EXT. REF. IN
INT./EXT. REFERENCE CONDITIONING


ΔT, M CLEAR
f0/10, D1A, D1B, D1C, D1D
UPDATE
PRINT
ARM
ΔT
GATE
M CLEAR
START
STOP
MARKER
f/n (SCALED OUT)
T2 CLEAR
UPDATE
f0/10
D1B
D1A
D1D
D1C
REF. OUT
10 MHz
PART OF J2
DISPLAY TIME
CONTROL LOGIC
INT./EXT. REFERENCE CONDITIONING
STORAGE (REF. ONLY)
18 VOLT SWITCH
DISPLAY TIME ASSY. ON FRONT PANEL
FOR REFERENCE ONLY
10 MHz
10 + 1 µs
10² + 10 µs
10³ + 100 µs
10⁴ + 1 ms
10⁵ + 10 ms
10⁶ + 100 ms
10⁷ + 1s
10⁸ + 10s
10⁹ + 100s
f/n (SCALED OUT)
REF. OUT
MARKER OUT
ARM
PRINT
T2 CLEAR
UPDATE
f0/10
D1B
D1A
D1D
D1C


COAX CONN (3)
P6 – USED ON ALL MODELS
P7 – USED ON MODELS 8010B AND 8020B
P13 – USED ON MODELS 8020B AND 8030B
SHADED COMPONENTS NOT USED ON MODEL 8020B
MOUNTING BRACKET INSTRUMENT CASE
TO DISPLAY TIME ASSEMBLY P3
TO INTERCONNECT ASSEMBLY P2
TO REMOVE ASSEMBLY, REMOVE 8 PPH 6-32 x 5/16 SCREWS (6150S8) AND LOCK WASHERS (6170T8)
SWITCH FAR SIDE
START/ STOP
RESET
Y1 9.9988 MHz

SECTION 6 SCHEMATICS

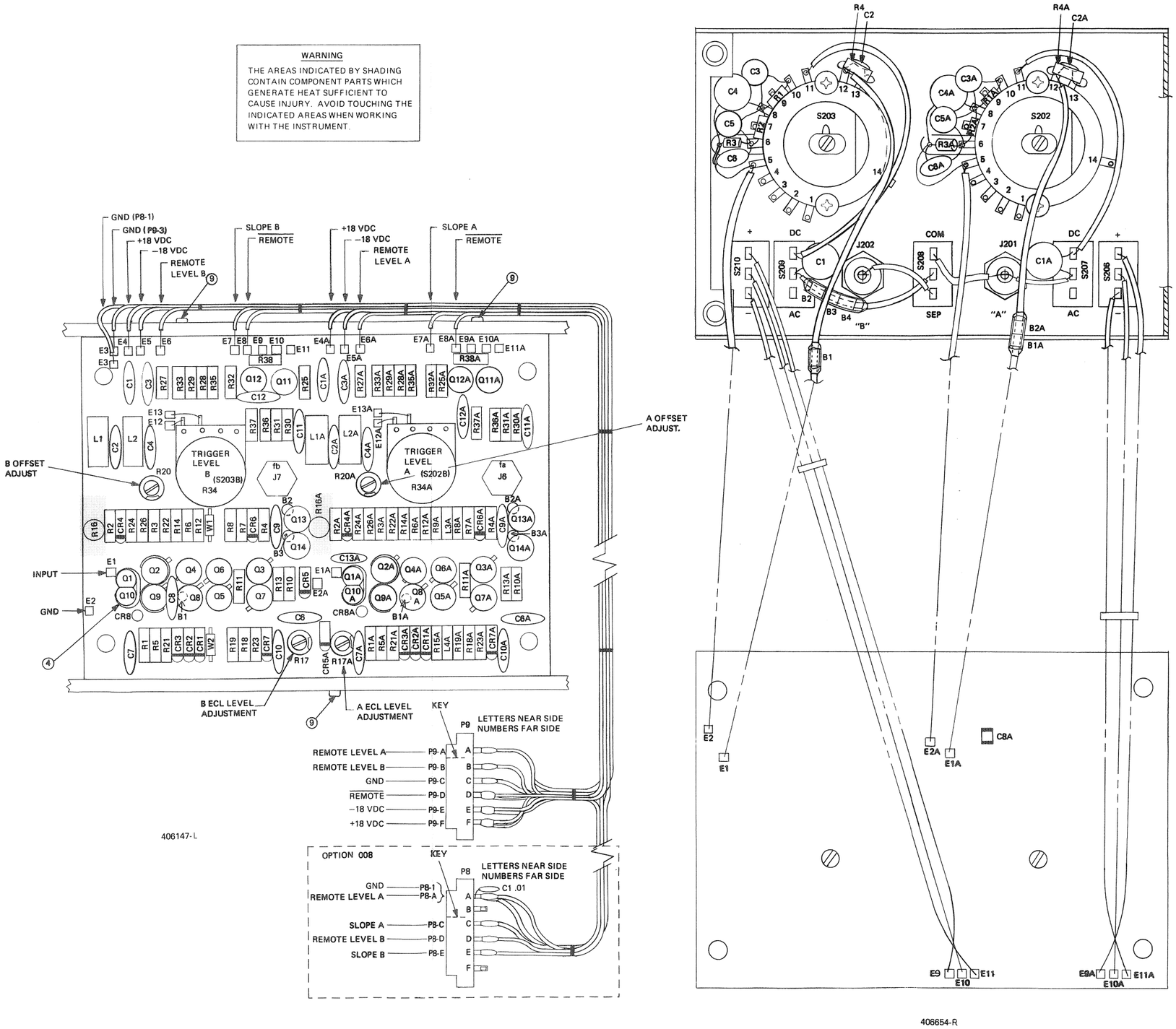


Figure 6.1 - Layout, Signal Conditioning – Dual

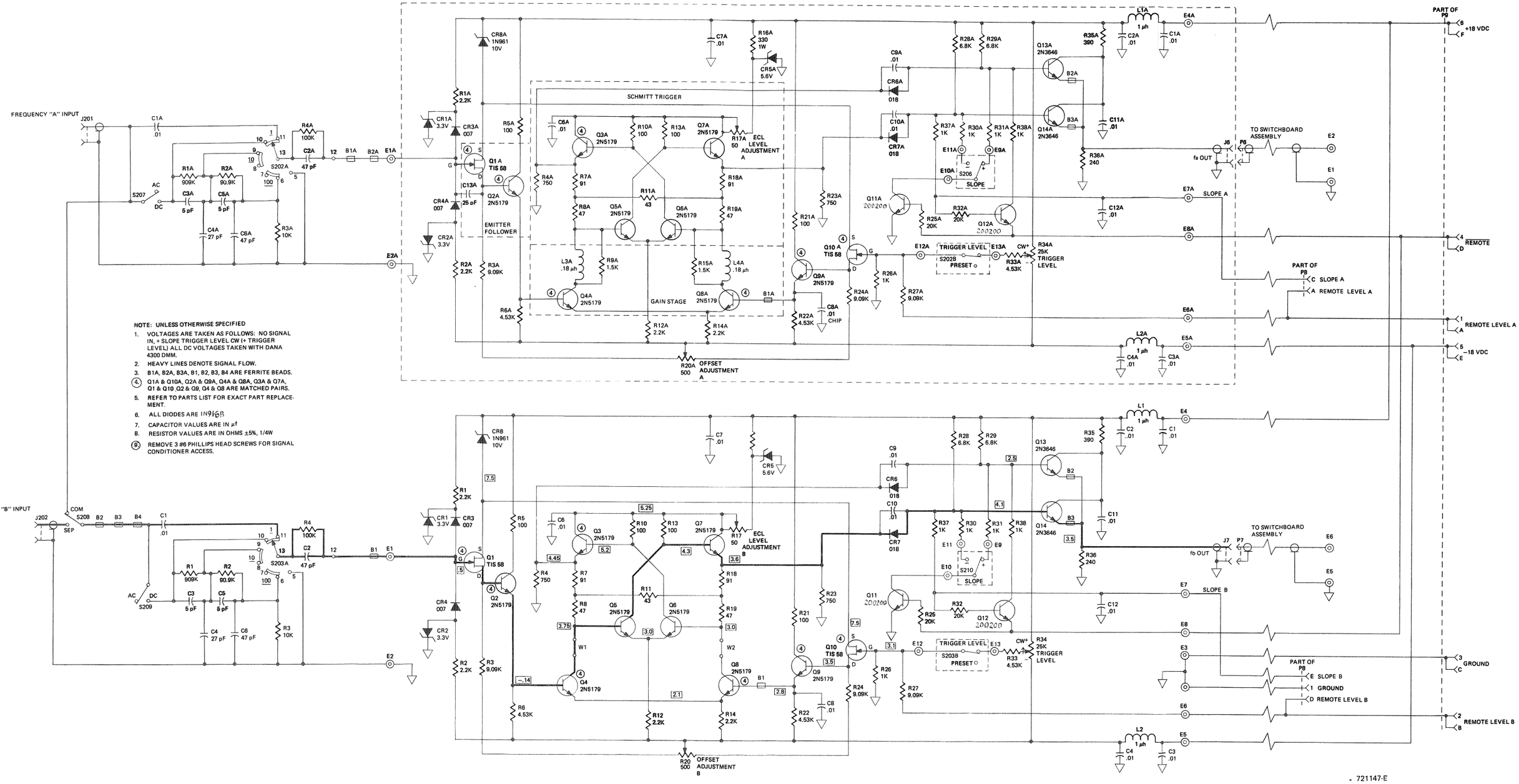


Figure 6.2 - Schematic, Signal Conditioning – Dual

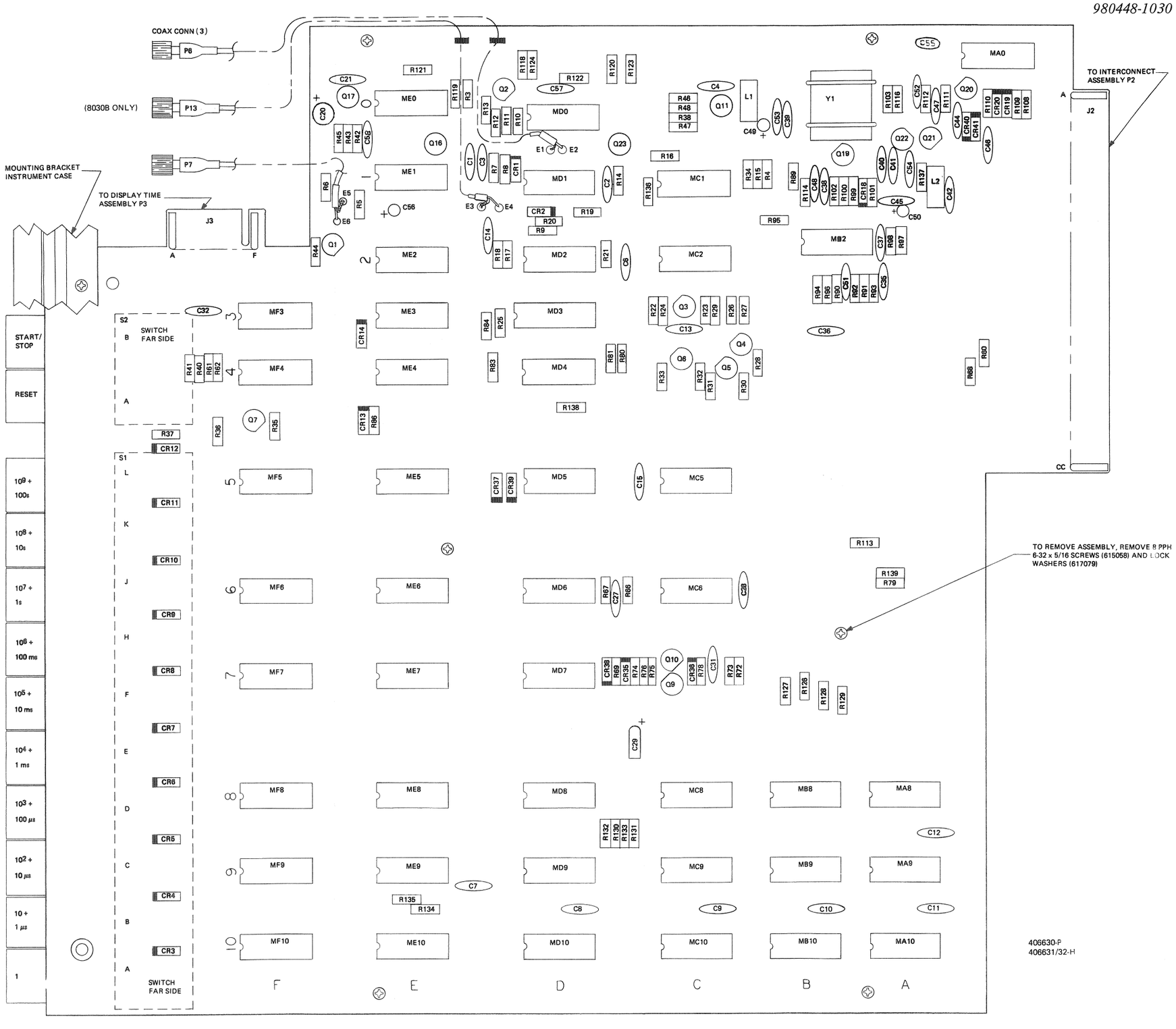


Figure 6.3 - Layout, Switch Board TIA

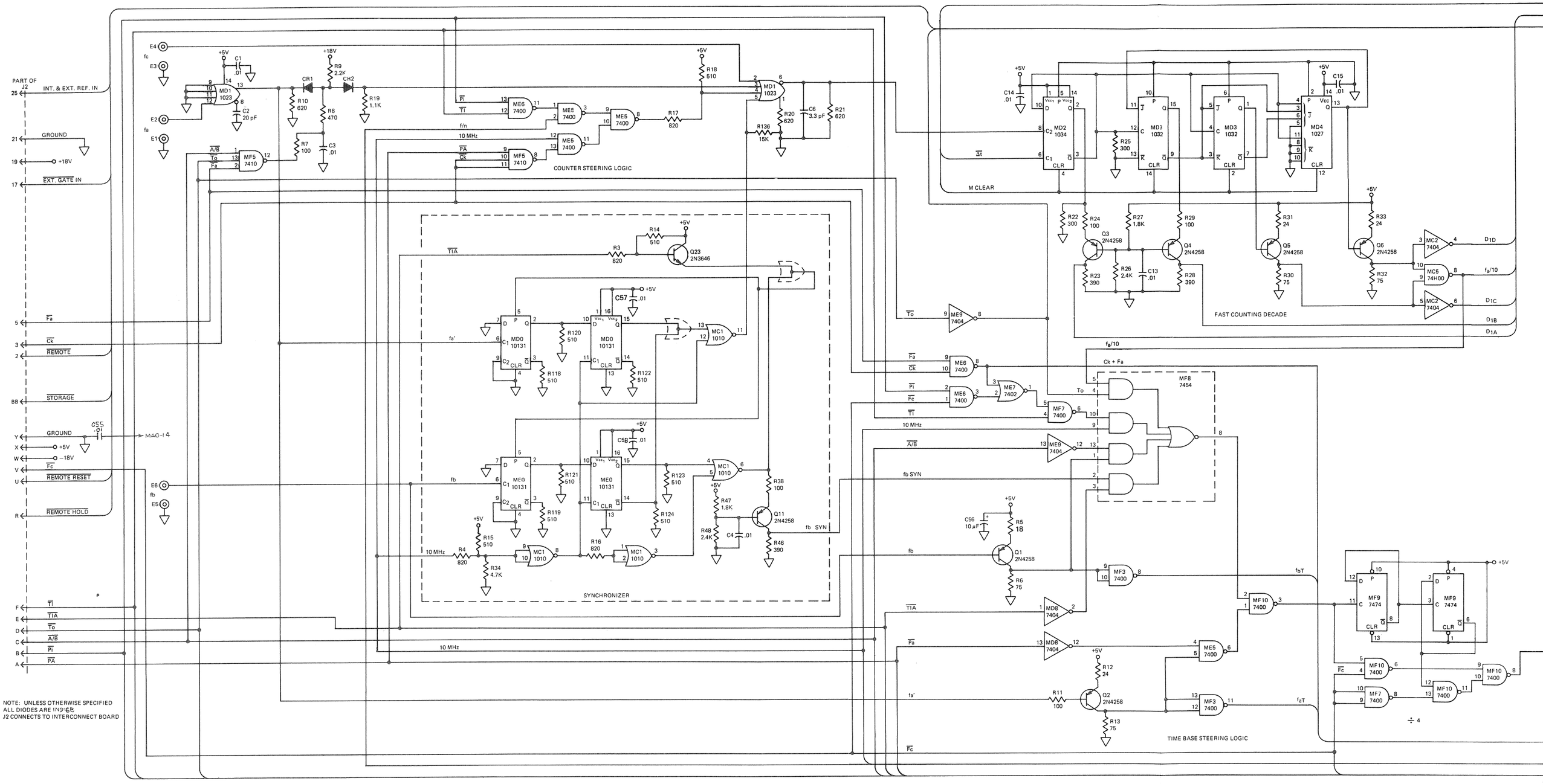


Figure 6.4 - Schematic, Switch Board TIA

MULTIPLIER/TIME BASE SWITCHING

MULTIPLIER/TIME BASE GATING

RECLOCKING LOGIC

START/STOP

MULTIPLIER/TIME BASE DECADES

START/STOP LOGIC

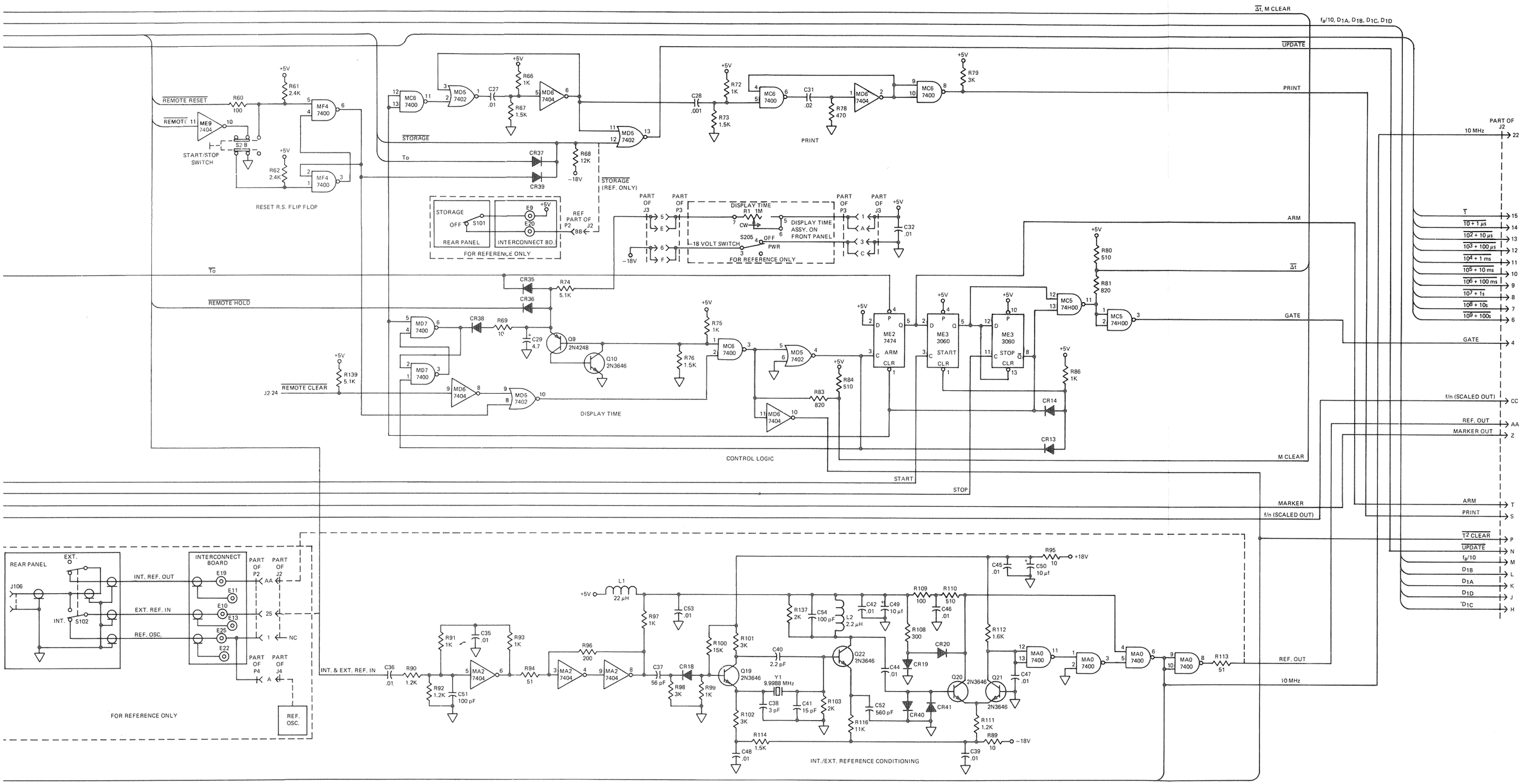


Figure 6.4 - Schematic, Switch Board TIA continued

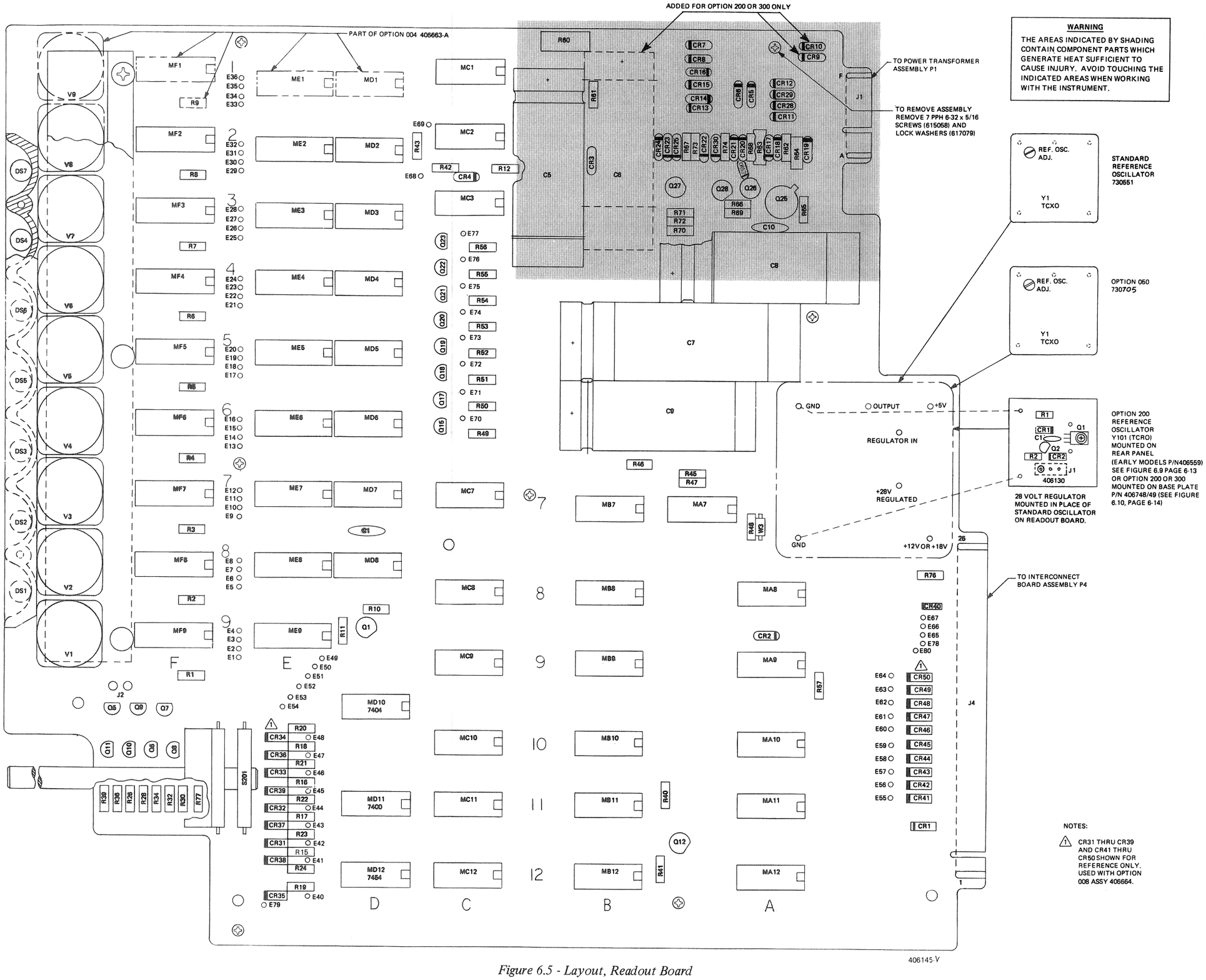
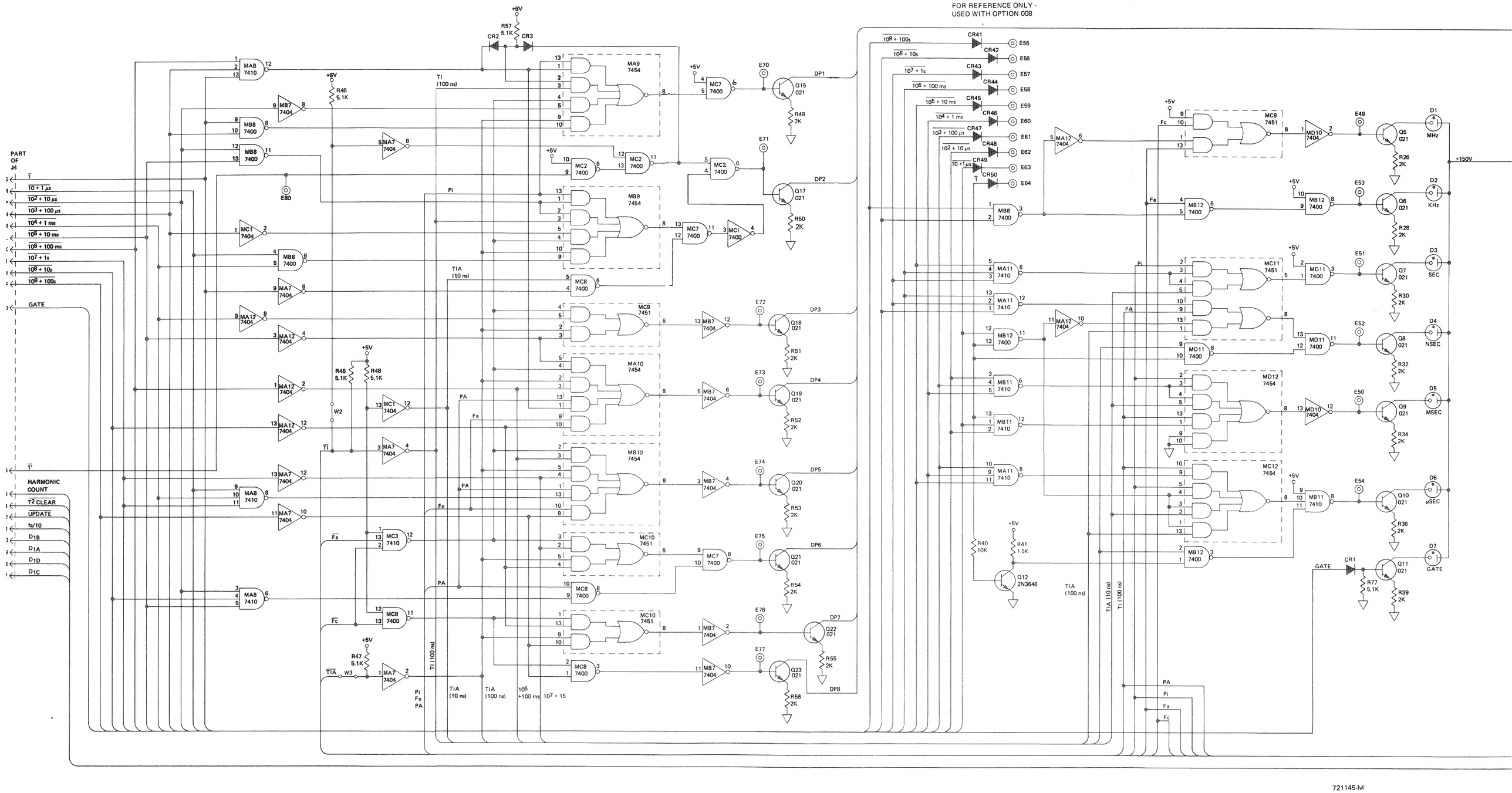
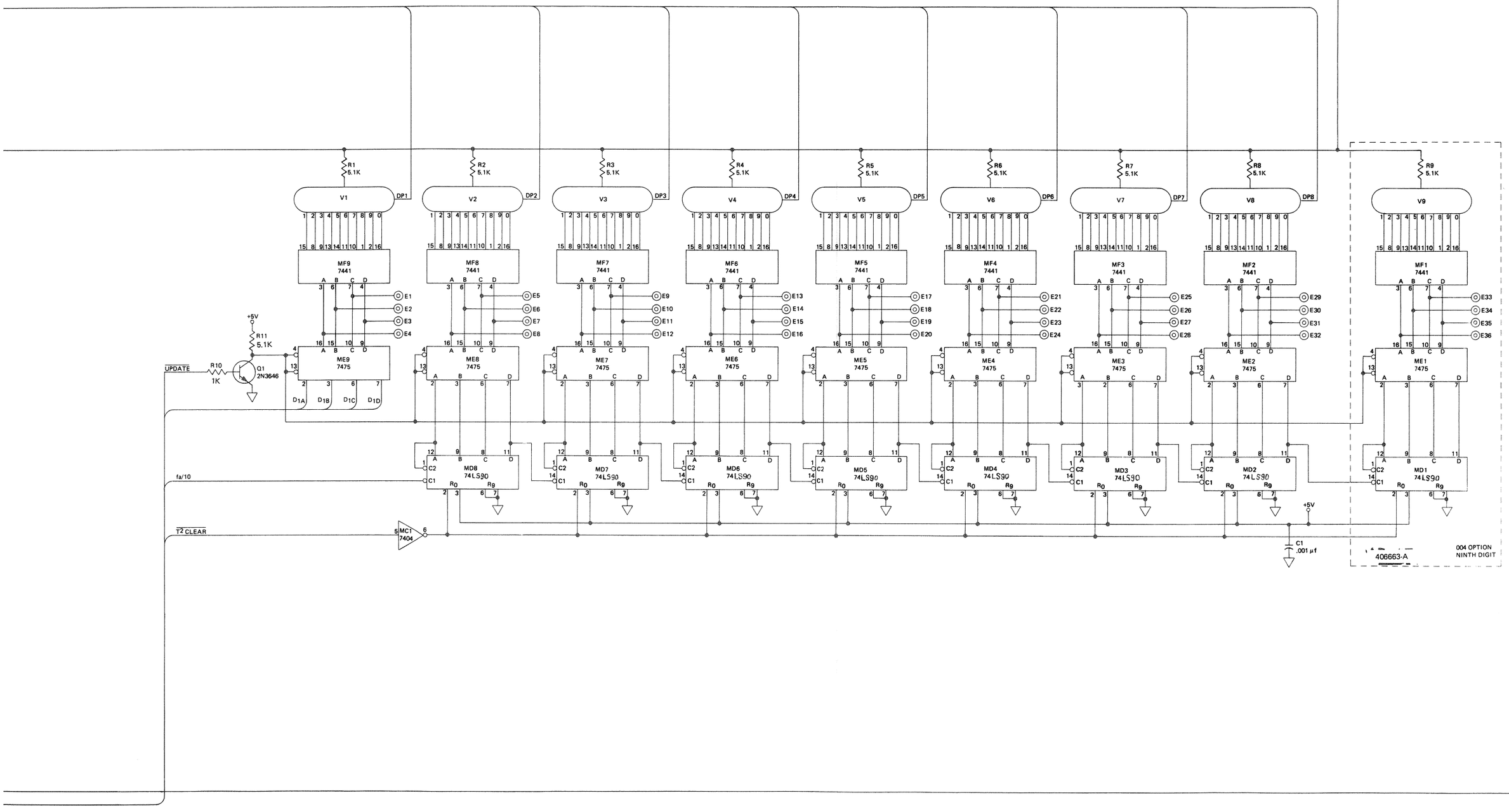


Figure 6.5 - Layout, Readout Board



721145-M

Figure 6.6 - Schematic, Readout Board


R1 5.1K
R2 5.1K
R3 5.1K
R4 5.1K
R5 5.1K
R6 5.1K
R7 5.1K
R8 5.1K
R9 5.1K
V1
V2
V3
V4
V5
V6
V7
V8
V9
DP1
DP2
DP3
DP4
DP5
DP6
DP7
DP8
MF9 7441
MF8 7441
MF7 7441
MF6 7441
MF5 7441
MF4 7441
MF3 7441
MF2 7441
MF1 7441
E1
E2
E3
E4
E5
E6
E7
E8
E9
E10
E11
E12
E13
E14
E15
E16
E17
E18
E19
E20
E21
E22
E23
E24
E25
E26
E27
E28
E29
E30
E31
E32
E33
E34
E35
E36
+5V
R11 5.1K
R10 1K
Q1 2N3646
UPDATE
ME9 7475
ME8 7475
ME7 7475
ME6 7475
ME5 7475
ME4 7475
ME3 7475
ME2 7475
ME1 7475
D1A
D1B
D1C
D1D
fa/10
MD8 74LS90
MD7 74LS90
MD6 74LS90
MD5 74LS90
MD4 74LS90
MD3 74LS90
MD2 74LS90
MD1 74LS90
T2 CLEAR
MC1 7404
C1 .001 µf
406663-A
004 OPTION NINTH DIGIT

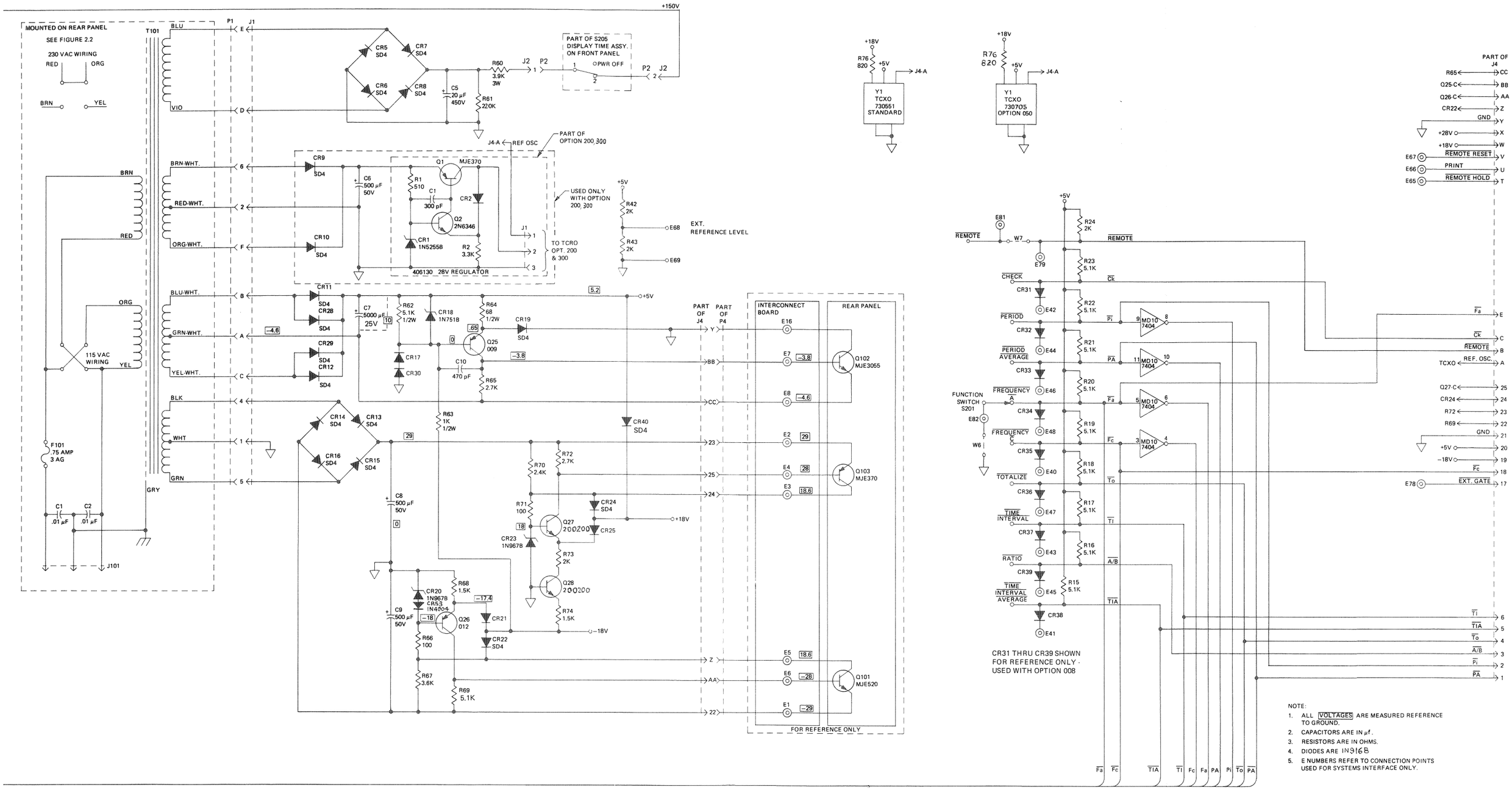


Figure 6.6 - Schematic, Readout Board continued

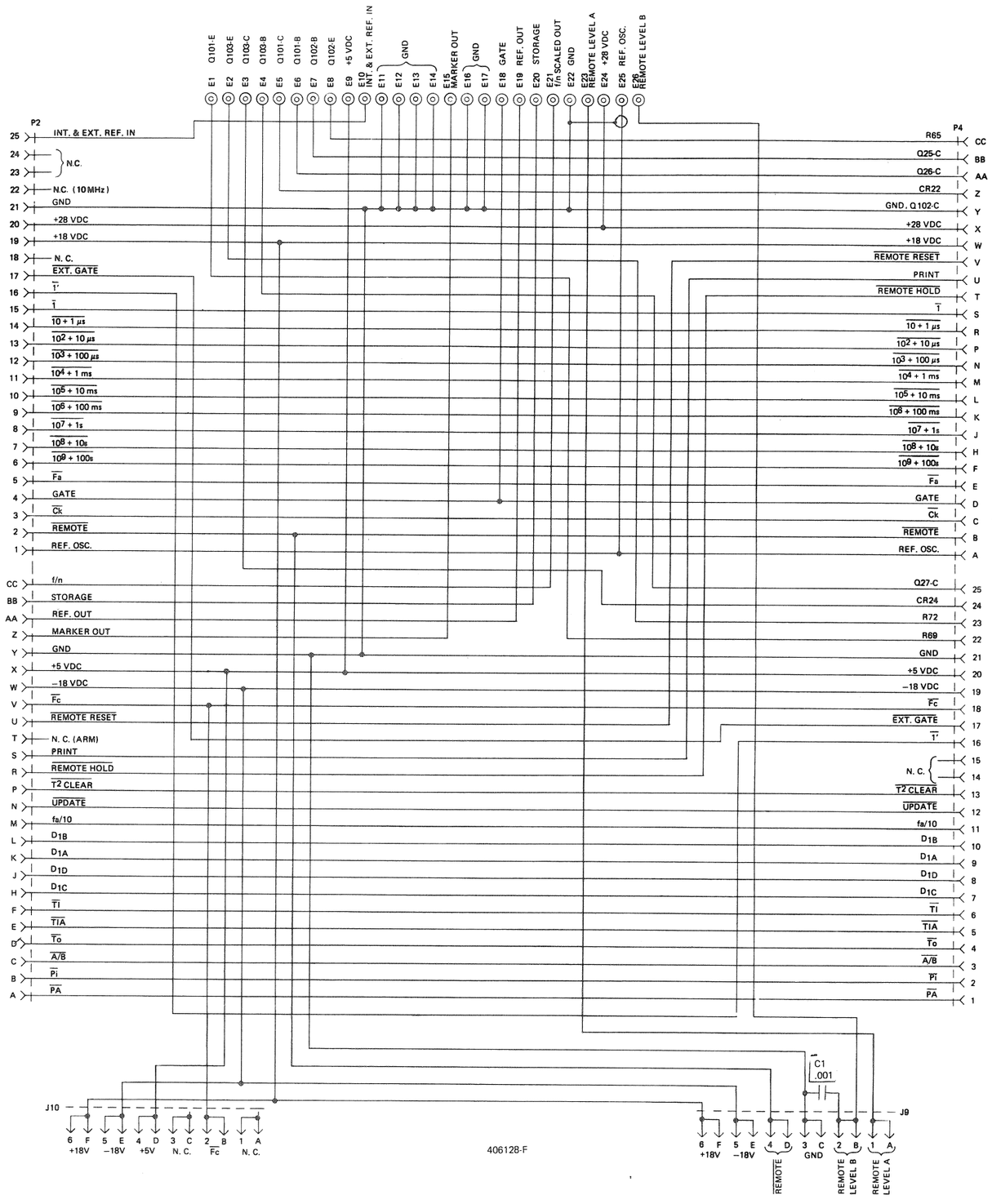


Figure 6.7 - Schematic, Interconnect Board

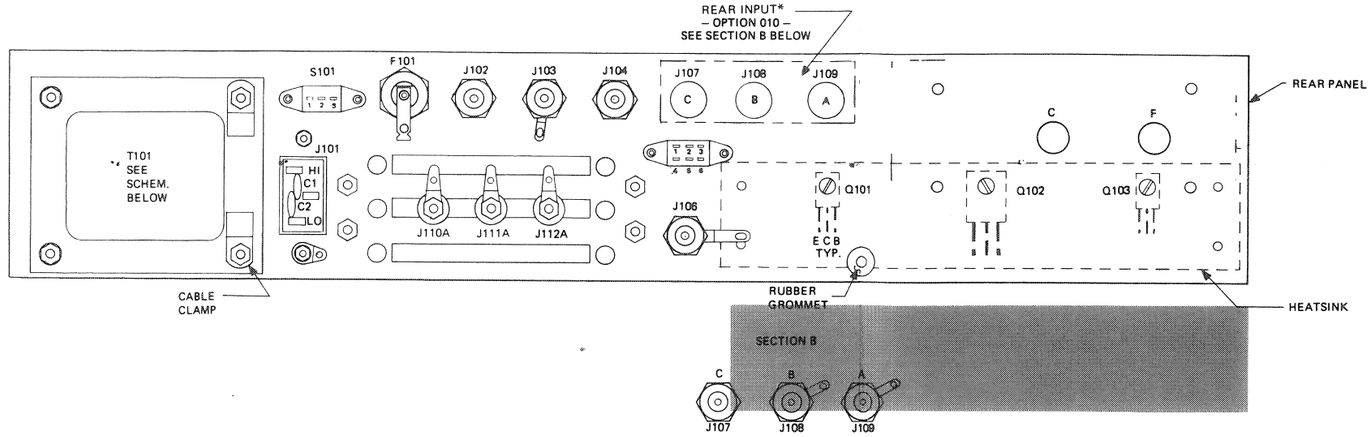
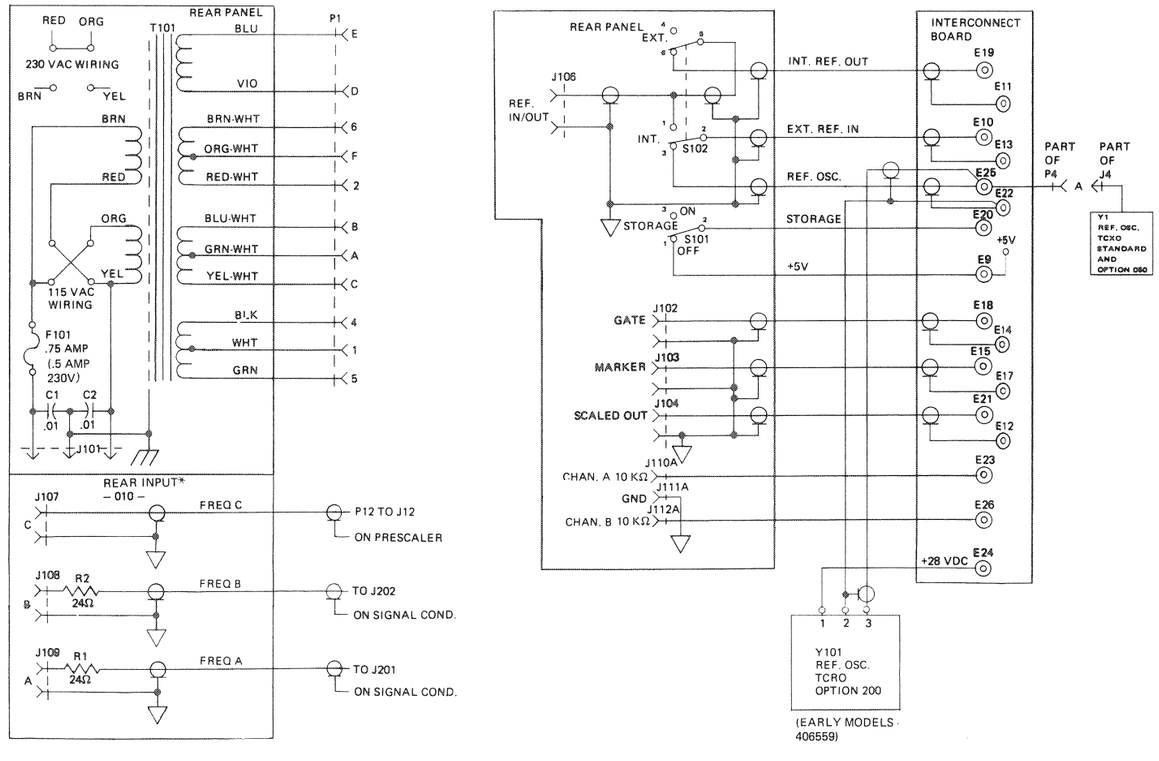
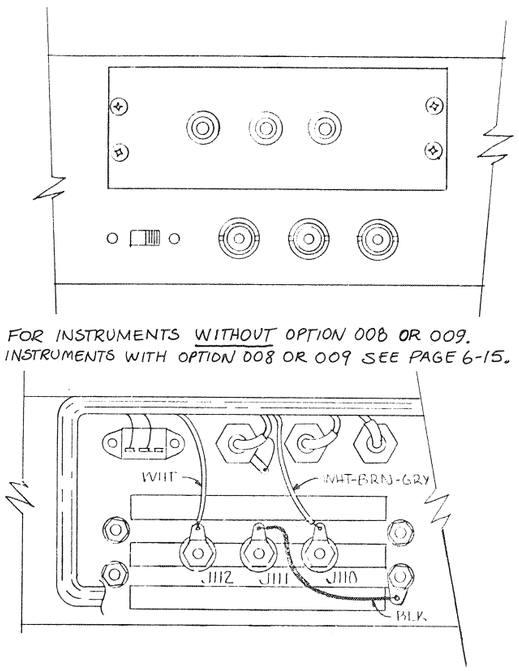


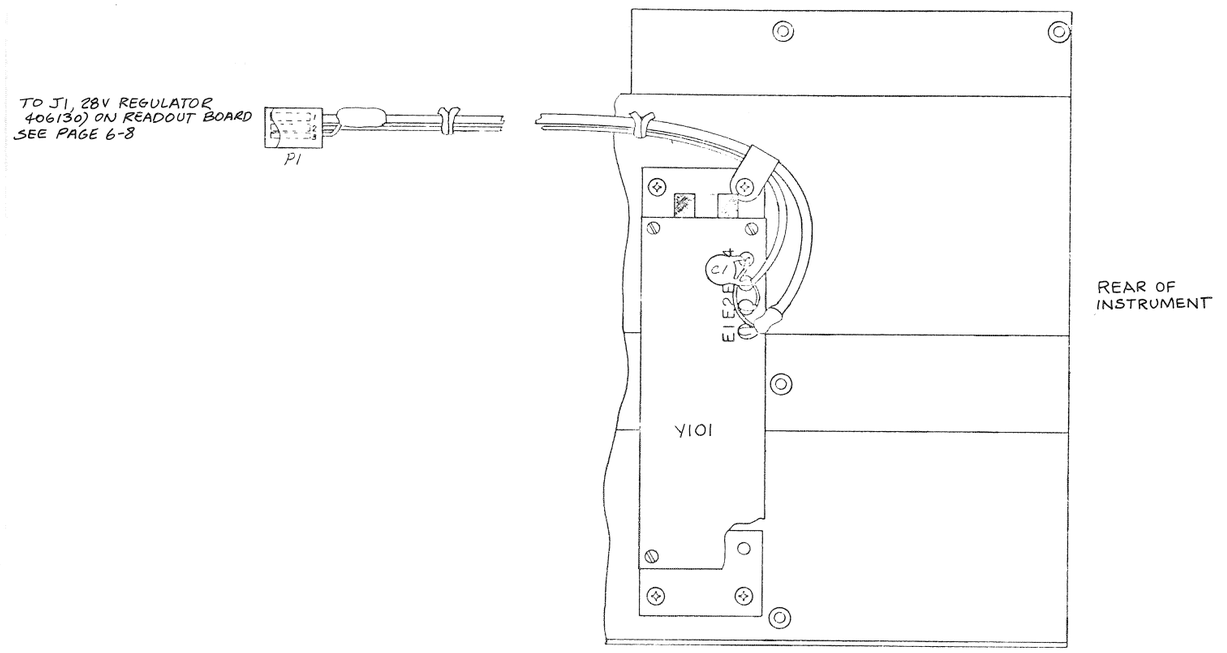
Figure 6.8 - Layout, Rear Panel



*INSTRUMENTS EQUIPPED WITH OPTION 200 OR 300 REFER TO PAGE 6-15 TO SHOW LAYOUT OF OPTION 010 REAR INPUT

Figure 6.9 - Schematic, Rear Panel

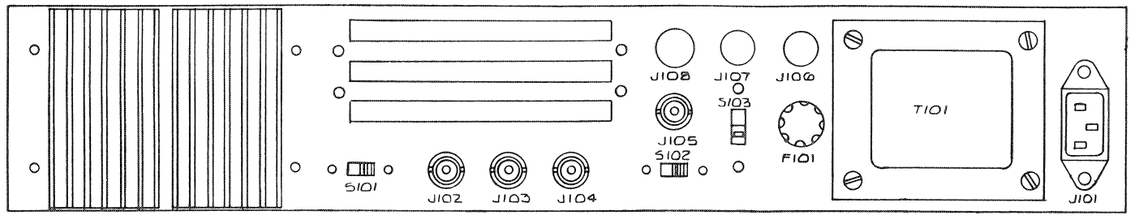


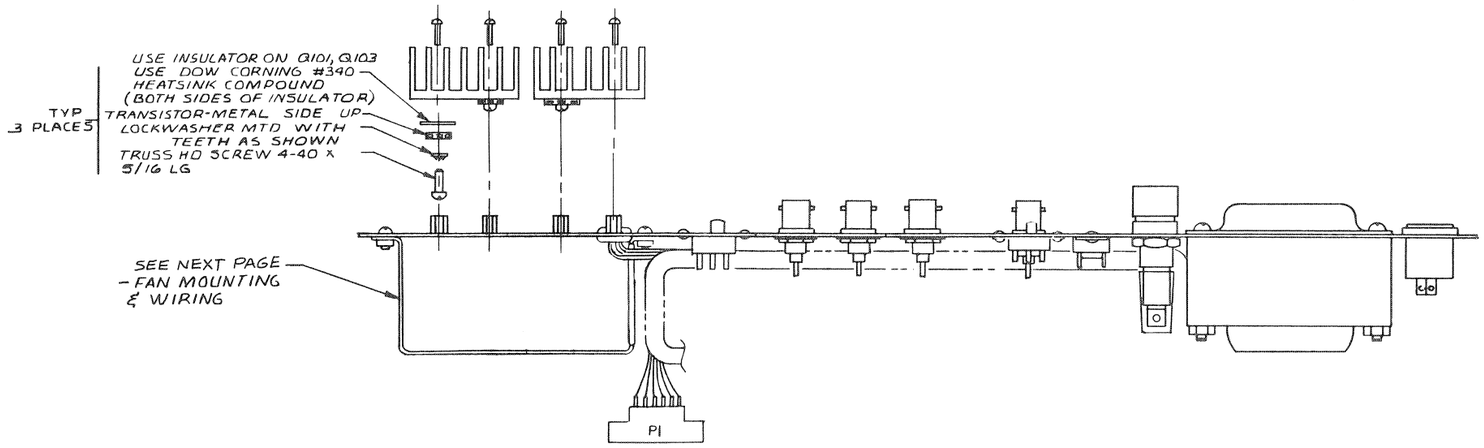


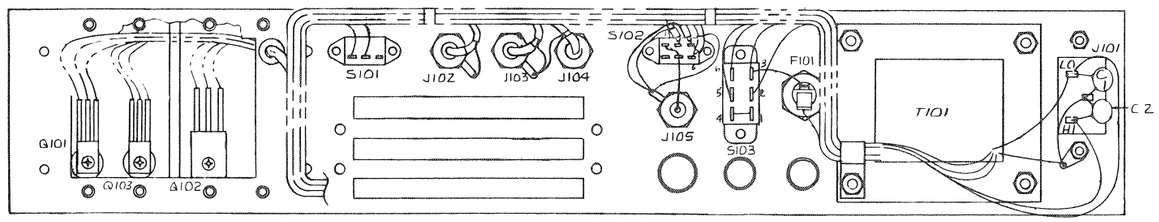
IF 406654 OR 406655 SIGNAL CONDITIONER MODULES ARE USED REMOVE 600245 JUMPER ON 406732 REAR PANEL ASSY.

406748/749-F

Figure 6.10 - Assembly, Oscillator (Option 200 or 300)







406732-E

WIRING

J101 LOW	YEL 500048		T101
J101 GND	GRN 500047		CHASSIS GND LUG
J101 HI	8 1/2"	BLK 500058	F101 END LUG
T101	3 1/8"	GRN 500047	CHASSIS GND LUG

T101	BLU		P1-E
	VIO		P1-D
	WHT-BLU		P1-B
	WHT-GRN		P1-A
	WHT-YEL		P1-C
	BLK		P1-4
	WHT		P1-1
	GRAY		P1-5
	WHT-BRN		P1-6
	WHT-ORN		P1-F
T101	WHT-RED		P1-2

CABLE 15.0 L6

GND	BLK 1 1/4"		
EXT GATE J102	16 1/2"		E18
		1 1/4"	E14-BLK
MARKER J103	7 1/4"		E15
GND	BLK 1 1/4"	1 1/4"	
SCALED OUT J104	8"		E21
GND	BLK 1 1/4"	1 1/4"	E17-BLK
		1 1/4"	E12-BLK

S107-1	3/8"	BUSS	5XXXX4	S103-4
2		ORN		T101
3		BRN		T101
4	3-3/4"	BLK	500058	F101 TOP LUG
5		RED		T101
S107-6	12"	YEL	500048	J101 LO
S101		GRN	500047 9 3/4"	+5V E9
S101		WHT	500096 4 3/8"	STORAGE E20

406128 PCB-ASSY INTER-CONNECT

S102 5XXX43 1"LG REF J105 WHT

40	INT REF OUT - 10"		E19
10	EXT. REF IN - 9 1/4"	1 1/4"	E11-BLK 500058
30	REF OSC. - 10 1/8"	1 1/4"	E10
		1 1/4"	E13-BLK "
1 3/4" BLK 500058 GND LUG J105		1 1/4"	E22-BLK "

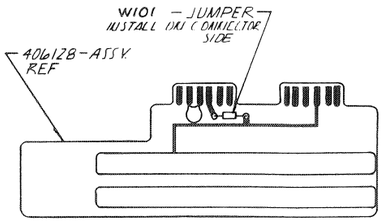
GROMMET

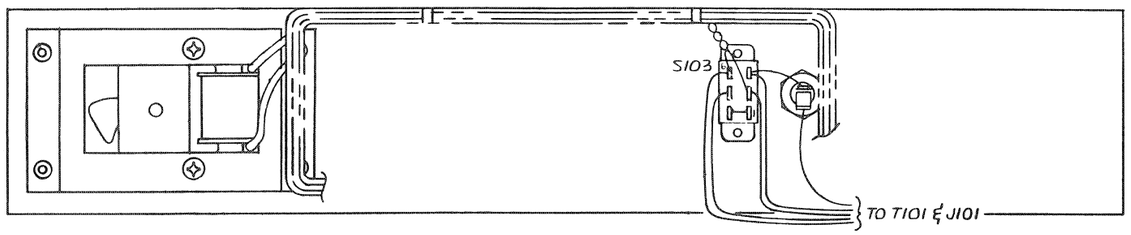
Q101 C	BLK	500058	9 1/2"	E5
Q101 B	BRN	500087	9 1/2"	E6
Q101 E	RED	500088	9 1/2"	E1
Q102 C	ORN	500089	8 3/4"	E16
Q102 B	YEL	500098	8 3/4"	E7
Q102 E	GRN	500097	8 3/4"	E8
Q103 C	BLU	500046	7 1/2"	E3
Q103 B	VIO	500090	7 1/2"	E4
Q103 E	GRY	500091	7 1/2"	E2

(Part of P/N 406748/49 Option 200 & 300)

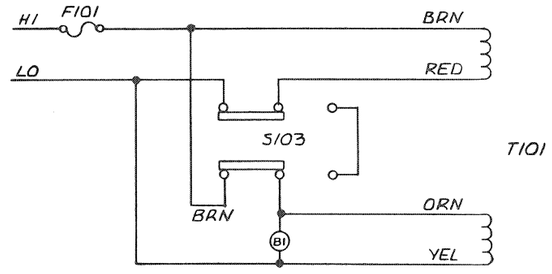
FOR INSTRUMENTS WITH OPTION 008 OR 009.
INSTRUMENTS WITHOUT OPTION 008 OR 009 SEE PAGE 6-14.

Figure 6.11 - Layout, Rear Panel (Part of Option 200 & 300)

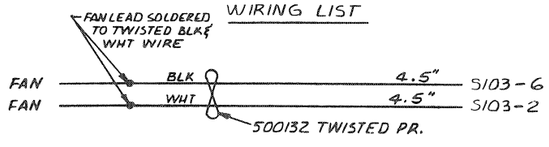




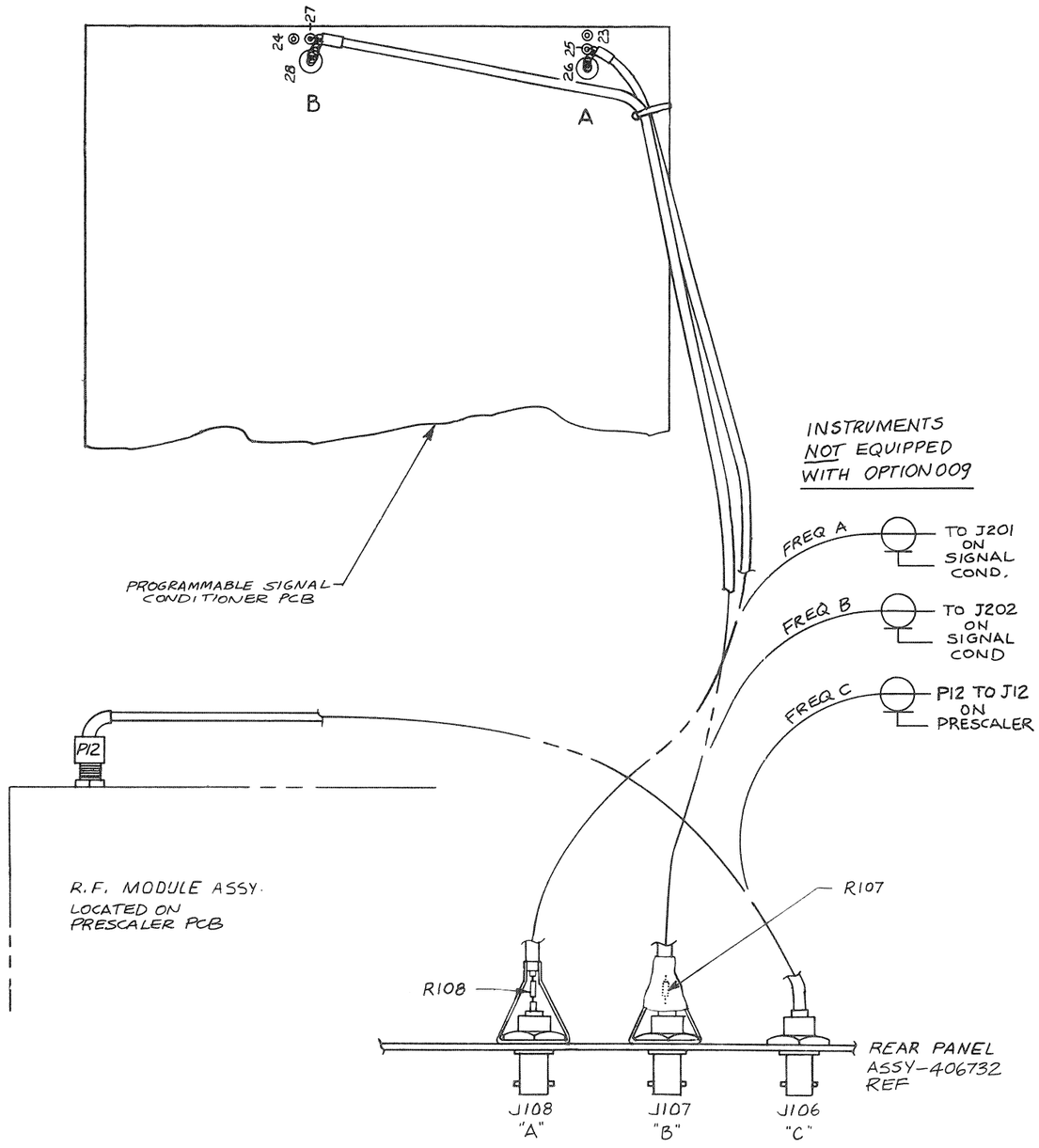
FAN MOUNTING



WIRING DIAGRAM FOR FAN & P5



INSTRUMENTS EQUIPPED WITH OPTION 009



OPTION 010

(Part of P/N 406748/49 Option 200 & 300)

Figure 6.11 - Layout, Rear Panel
(Part of Option 200 & 300) continued

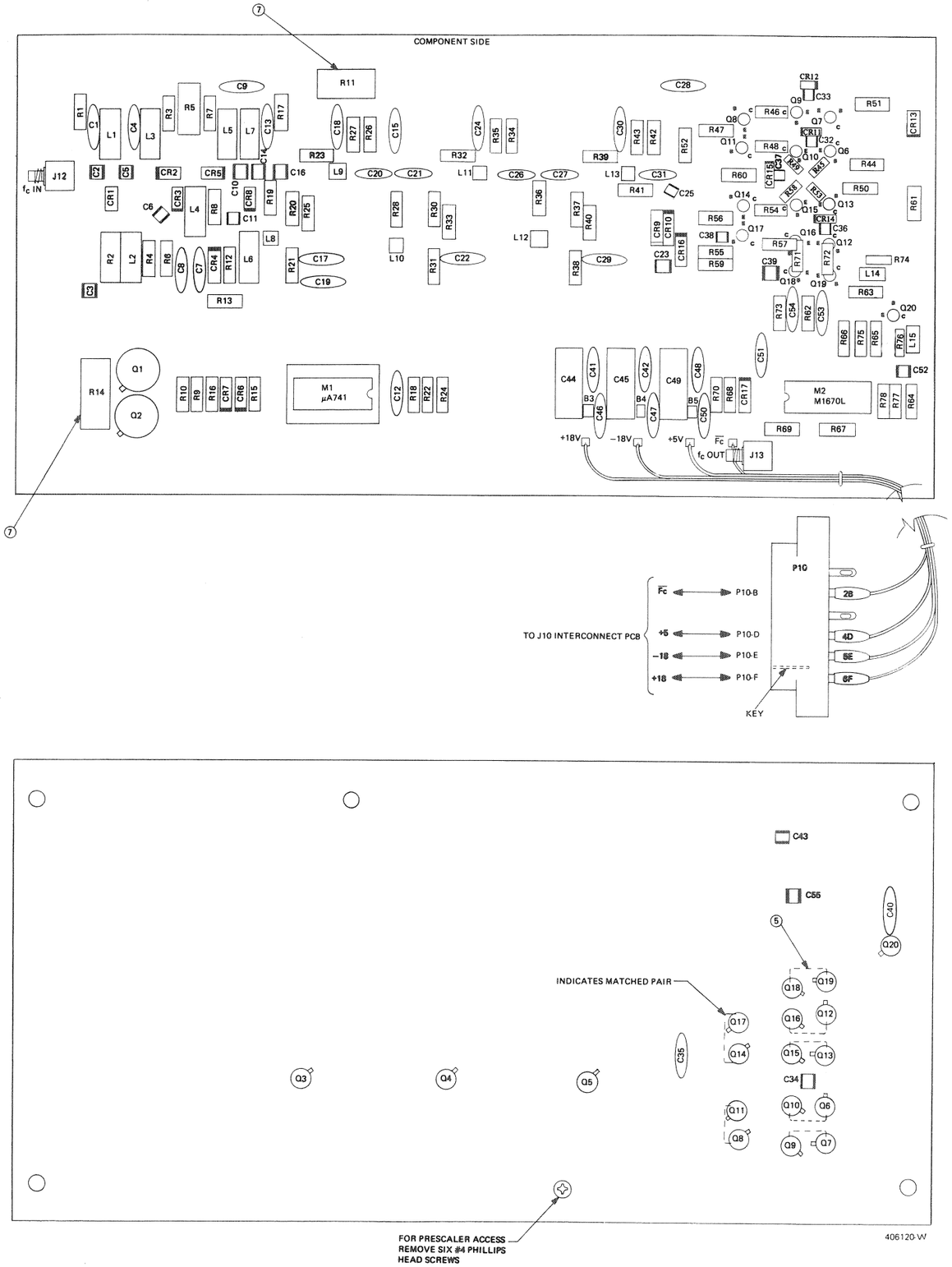
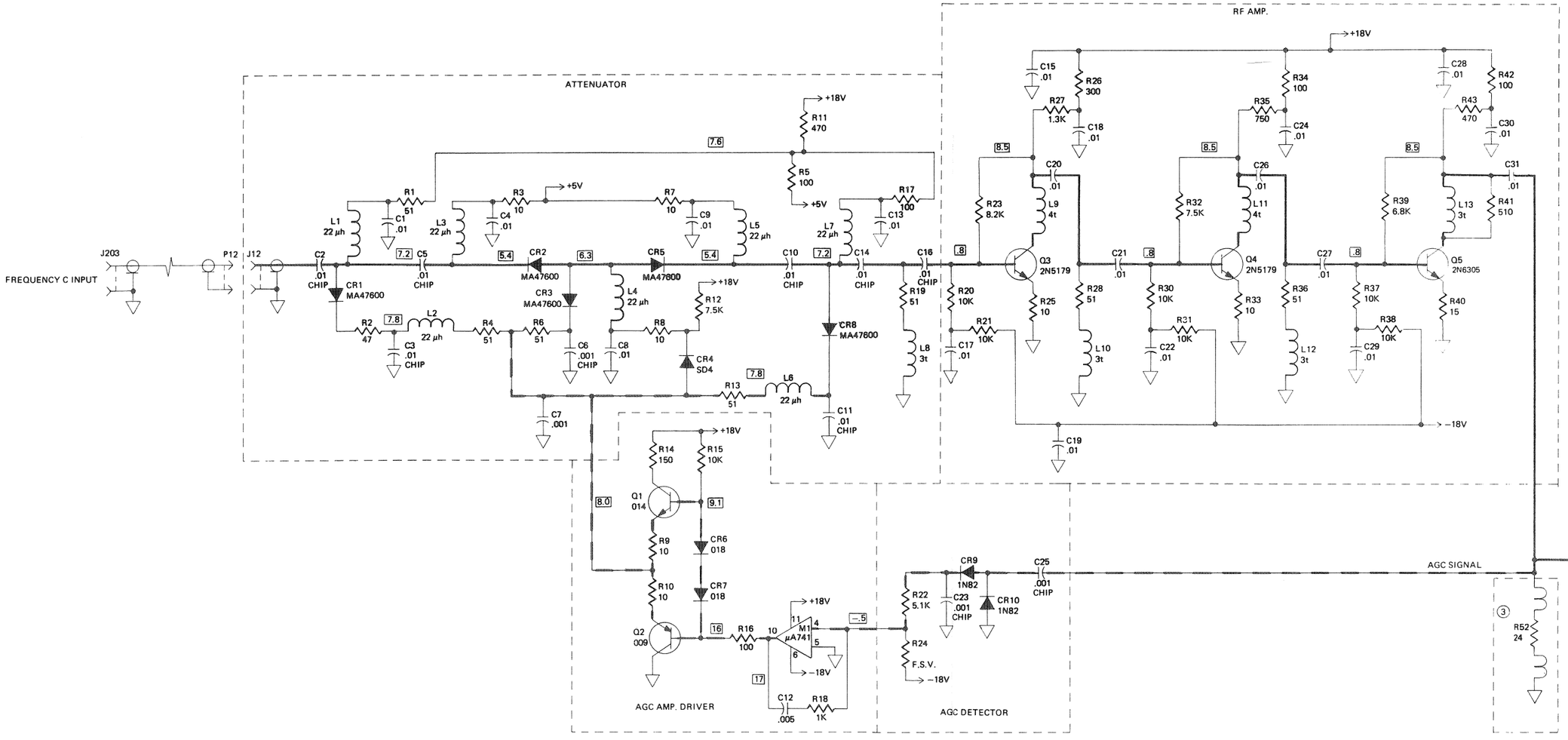
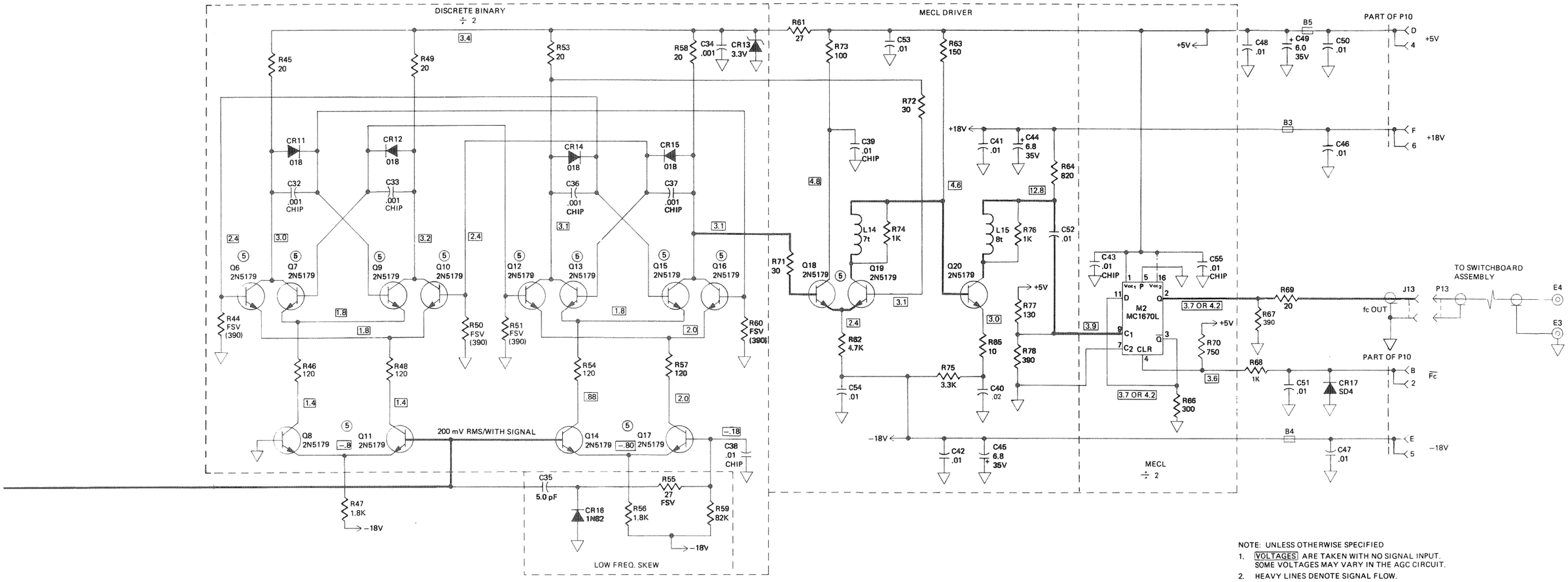


Figure 6.12 - Layout, Prescaler 550 MHz (50 mV)


ATTENUATOR
RF AMP.
FREQUENCY C INPUT
J203
P12
J12
+18V
+5V
R11 470
R5 100
R1 51
C1 .01
L1 22 µh
L3 22 µh
R3 10
C4 .01
R7 10
C9 .01
L5 22 µh
L7 22 µh
R17 100
C13 .01
C2 .01 CHIP
C5 .01 CHIP
CR1 MA47600
CR2 MA47600
CR3 MA47600
CR5 MA47600
CR8 MA47600
C10 .01 CHIP
C14 .01 CHIP
C16 .01 CHIP
R2 47
C3 .01 CHIP
L2 22 µh
R4 51
R6 51
C6 .001 CHIP
C8 .01
L4 22 µh
R8 10
R12 7.5K
CR4 SD4
R13 51
L6 22 µh
C7 .001
C11 .01 CHIP
R19 51
L8 3t
R20 10K
C17 .01
R21 10K
C15 .01
R26 300
R27 1.3K
C18 .01
C19 .01
R23 8.2K
C20 .01
L9 4t
Q3 2N5179
R25 10
C21 .01
R28 51
L10 3t
R32 7.5K
C26 .01
L11 4t
Q4 2N5179
R33 10
R30 10K
R31 10K
C22 .01
R34 100
R35 750
C24 .01
C27 .01
R36 51
L12 3t
R39 6.8K
C28 .01
L13 3t
Q5 2N6305
R40 15
R37 10K
R38 10K
C29 .01
R42 100
R43 470
C30 .01
C31 .01
R41 510
-18V
R14 150
R15 10K
Q1 014
R9 10
CR6 018
R10 10
CR7 018
Q2 009
R16 100
M1 µA741
C12 .005
R18 1K
AGC AMP. DRIVER
CR9 1N82
C25 .001 CHIP
R22 5.1K
C23 .001 CHIP
CR10 1N82
R24
F.S.V.
AGC DETECTOR
AGC SIGNAL
R52 24



NOTE: UNLESS OTHERWISE SPECIFIED

1. [VOLTAGES] ARE TAKEN WITH NO SIGNAL INPUT. SOME VOLTAGES MAY VARY IN THE AGC CIRCUIT.
2. HEAVY LINES DENOTE SIGNAL FLOW.
3. RESISTOR R52 FORMS A TUNED CIRCUIT UTILIZING THE LEADS AS INDUCTORS AND IS MOUNTED .25 ABOVE PCB.
4. B3, B4 & B5 ARE FERRITE BEADS.
5. Q6 & Q10, Q7 & Q9, Q8 & Q11, Q12 & Q16, Q13 & Q15, Q14 & Q17, Q18 & Q19 ARE MATCHED PAIRS.
6. REFER TO PARTS LIST FOR EXACT PART REPLACEMENT.
7. R11, R14, ARE MOUNTED ABOVE PCB FOR HEAT DISSIPATION.
8. CAPACITOR VALUES ARE IN μf.
9. RESISTOR VALUES ARE IN OHMS ±5%, 1/4W.
10. ALL DIODES ARE IN916B

721120-P

Figure 6.13 - Schematic, Prescaler 550 MHz (50 mV)

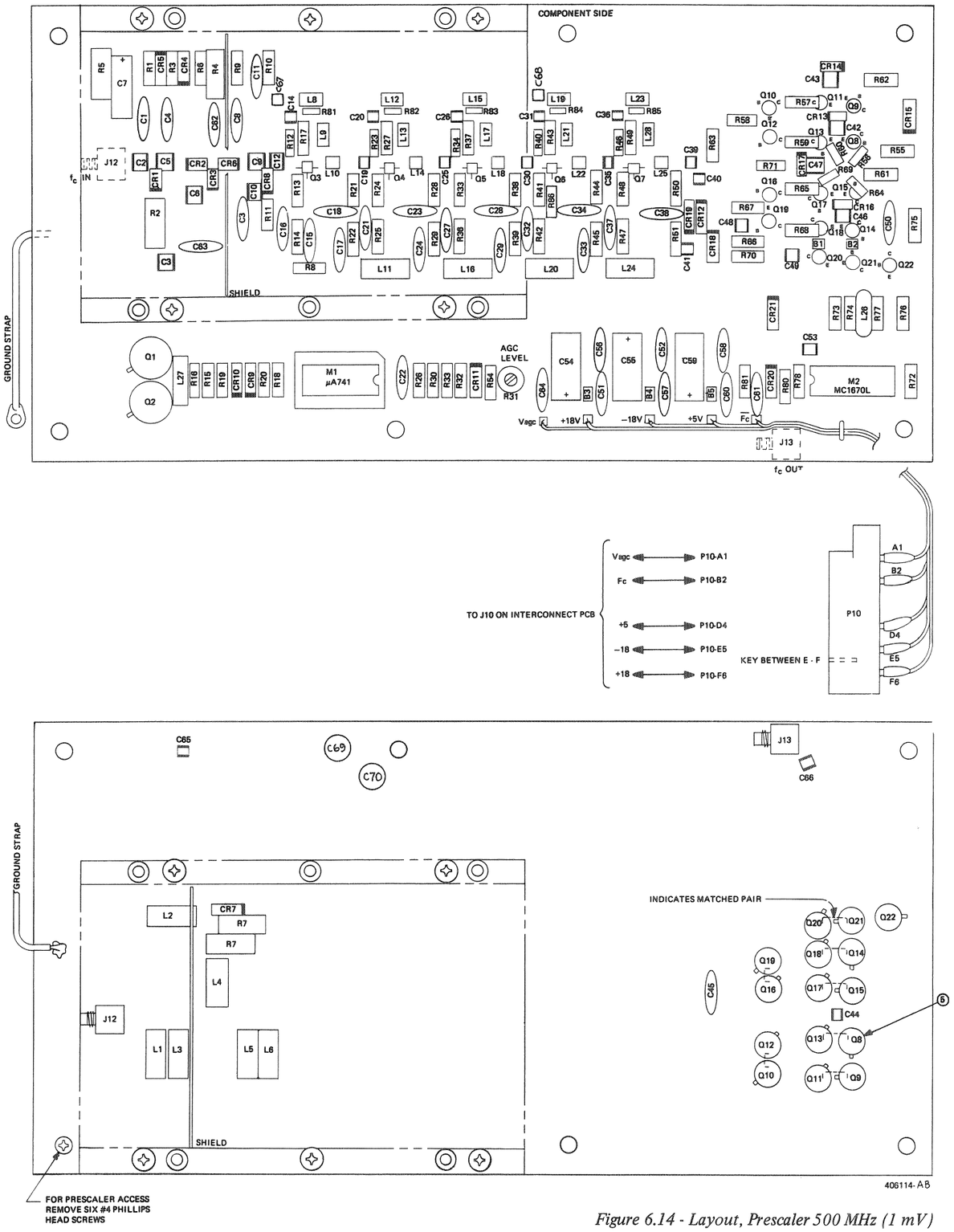
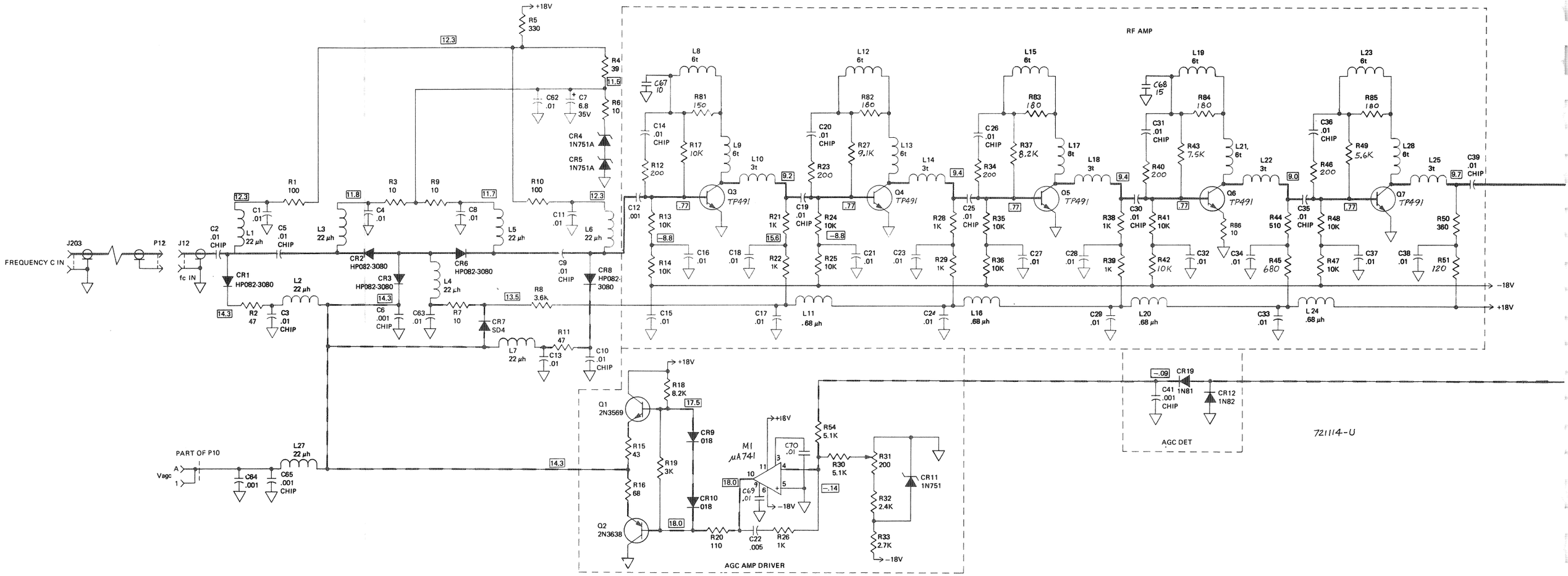
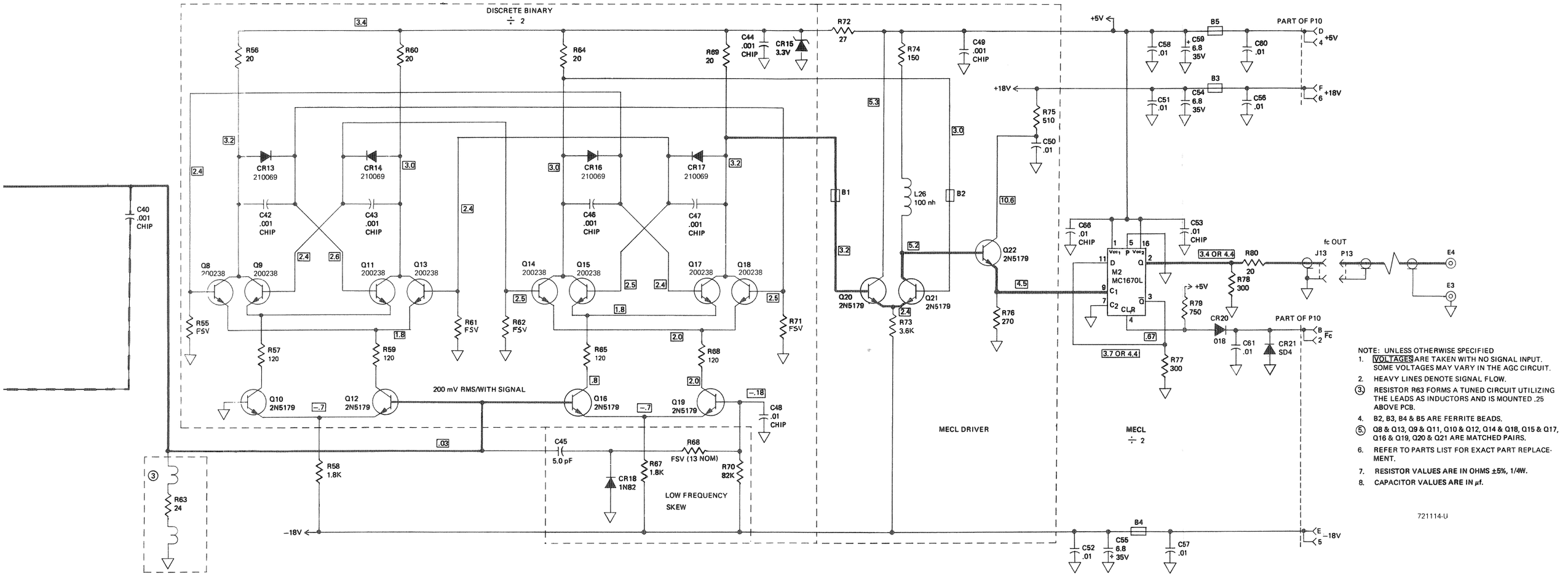


Figure 6.14 - Layout, Prescaler 500 MHz (1 mV)


RF AMP
FREQUENCY C IN
J203
P12
J12
fc IN
+18V
R5 330
R4 39
R6 10
C62 .01
C7 6.8 35V
CR4 1N751A
CR5 1N751A
C1 .01
C2 .01 CHIP
C5 .01 CHIP
L1 22 µh
L3 22 µh
L5 22 µh
L6 22 µh
R1 100
R3 10
R9 10
R10 100
C4 .01
C8 .01
C11 .01
CR1 HP082-3080
CR2 HP082-3080
CR3 HP082-3080
CR6 HP082-3080
CR8 HP082-3080
C9 .01 CHIP
L2 22 µh
L4 22 µh
R8 3.6K
R2 47
C3 .01 CHIP
C6 .001 CHIP
C63 .01
R7 10
CR7 SD4
L7 22 µh
R11 47
C13 .01
C10 .01 CHIP
L8 6t
L12 6t
L15 6t
L19 6t
L23 6t
C67 10
C68 15
R81 150
R82 180
R83 180
R84 180
R85 180
C14 .01 CHIP
C20 .01 CHIP
C26 .01 CHIP
C31 .01 CHIP
C36 .01 CHIP
R17 10K
R27 9.1K
R37 8.2K
R43 7.5K
R49 5.6K
L9 6t
L13 6t
L17 8t
L21, 6t
L28 6t
L10 3t
L14 3t
L18 3t
L22 3t
L25 3t
C39 .01 CHIP
R12 200
R23 200
R34 200
R40 200
R46 200
Q3 TP491
Q4 TP491
Q5 TP491
Q6 TP491
Q7 TP491
C12 .001
R13 10K
R21 1K
C19 .01 CHIP
R24 10K
C25 .01 CHIP
R35 10K
C30 .01 CHIP
R41 10K
C35 .01 CHIP
R48 10K
R50 380
R14 10K
C16 .01
C18 .01
R22 1K
R25 10K
C21 .01
C23 .01
R28 1K
R29 1K
R36 10K
C27 .01
C28 .01
R38 1K
R39 1K
R42 10K
C32 .01
C34 .01
R45 680
C37 .01
C38 .01
R51 120
C15 .01
C17 .01
L11 .68 µh
C24 .01
L16 .68 µh
C29 .01
L20 .68 µh
C33 .01
L 24 .68 µh
R86 10
R44 510
-18V
+18V
-.09
CR19
C41 .001 CHIP
1N81
CR12 1N82
AGC DET
721114-U
+18V
R18 8.2K
Q1 2N3569
R15 43
R19 3K
R16 68
Q2 2N3638
CR9 018
CR10 018
M1 µA741
C70 .01
C69 .01
R54 5.1K
R30 5.1K
R31 200
R32 2.4K
R33 2.7K
CR11 1N751
-18V
R20 110
C22 .005
R26 1K
AGC AMP DRIVER
PART OF P10
Vagc
L27 22 µh
C64 .001
C65 .001 CHIP
12.3
11.8
11.7
11.5
9.2
9.4
9.0
9.7
15.6
-8.8
14.3
13.5
17.5
18.0
-.14



NOTE: UNLESS OTHERWISE SPECIFIED

1. VOLTAGES ARE TAKEN WITH NO SIGNAL INPUT. SOME VOLTAGES MAY VARY IN THE AGC CIRCUIT.
2. HEAVY LINES DENOTE SIGNAL FLOW.
3. RESISTOR R63 FORMS A TUNED CIRCUIT UTILIZING THE LEADS AS INDUCTORS AND IS MOUNTED .25 ABOVE PCB.
4. B2, B3, B4 & B5 ARE FERRITE BEADS.
5. Q8 & Q13, Q9 & Q11, Q10 & Q12, Q14 & Q18, Q15 & Q17, Q16 & Q19, Q20 & Q21 ARE MATCHED PAIRS.
6. REFER TO PARTS LIST FOR EXACT PART REPLACEMENT.
7. RESISTOR VALUES ARE IN OHMS ±5%, 1/4W.
8. CAPACITOR VALUES ARE IN μf.

721114-U

Figure 6.15 - Schematic, Prescaler 500 MHz (1 mV)

SECTION 7 PARTS LIST

7.1 This section contains lists of replaceable parts arranged in the order of the following subassemblies:

7.2 Manufacturers are identified by FSC numbers listed in table 7.2, "List of Suppliers". The code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1, H4-2, and their supplements.

7.3 Certain parts having 21793 (Dana) listed in the "FSC" column are specially-selected semiconductors. For some of these, standard commercial parts will serve as satisfactory replacements. These Dana parts are identified in table 7.1 along with the commercial equivalent.

Table 7.1

Semiconductor Type:		Equivalent:
007	Diode	Fairchild FD300
009	Transistor	Motorola 2N2905
014	Transistor	Motorola 2N3501
021	Transistor	MPS A42 :ruments

Table 7.2 - List of Suppliers

FSC	NAME	FSC	NAME
01121	ALLEN BRADLEY CO. MILWAUKEE, WISCONSIN	02660	AMPHENOL CORP. BROADVIEW, ILLINOIS
01295	TEXAS INSTRUMENTS, INC. (Components Group) DALLAS, TEXAS	04222	AEROVOX CORP. (Hi-Q Division) MYRTLE BEACH, SOUTH CAROLINA
02114	FERROXCUBE CORP. SAUGERTIES, NEW YORK	04713	MOTOROLA, INC. (Semiconductor Products Division) PHOENIX, ARIZONA

Table 7.2 - List of Suppliers continued

FSC	NAME
05397	UNION CARBIDE CORP. (Materials Systems Division) CLEVELAND, OHIO
05624	BARBER & COLMAN CO. ROCKFORD, ILLINOIS
07263	FAIRCHILD SEMICONDUCTOR MOUNTAIN VIEW, CALIFORNIA
07716	TRW ELECTRONIC COMPONENTS
08806	GENERAL ELECTRIC (Miniature Light Division) CLEVELAND, OHIO
11237	CTS KEENE, INC. PASO ROBLES, CALIFORNIA
21551	C-F ELECTRONICS, INC. VAN NUYS, CALIFORNIA
21793	DANA LABORATORIES, INC. IRVINE, CALIFORNIA
23095	AZTEC ELECTRONICS, INC. ANAHEIM, CALIFORNIA
27264	MOLEX PRODUCTS CO. DOWNERS GROVE, ILLINOIS
28520	HEYCO (Division of Heyman Mfg. Co.) KENILWORTH, NEW JERSEY
32767	GRIFFITH PLASTIC PRODUCT CO. (Nobex Division) BURLINGAME, CALIFORNIA
44655	OHMITE MFG. CO. SKOKIE, ILLINOIS
50434	HEWLETT-PACKARD CO. PALO ALTO, CALIFORNIA
56289	SPRAGUE ELECTRIC CO. (Pacific Division) LOS ANGELES, CALIFORNIA
71471	AEROVOX CORP. (Cinema Plant) MONCKS CORNER, SOUTH CAROLINA
71590	CENTRALAB ELECTRONICS (Division of Globe-Union, Inc.) MILWAUKEE, WISCONSIN
71785	TRW ELECTRONIC COMPONENTS (Cinch Division) ELK GROVE VILLAGE, ILLINOIS
72982	ERIE TECHNOLOGICAL PRODUCTS, INC. ERIE, PENNSYLVANIA
73138	BECKMAN INSTRUMENTS, INC. (Helipot Division) FULLERTON, CALIFORNIA
73445	AMPEREX ELECTRONIC CORP. HICKSVILLE, LONG ISLAND, NEW YORK
74276	SIGNALITE, INC. NEPTUNE, NEW JERSEY
75915	LITTELFUSE, INC. DES PLAINES, ILLINOIS
76493	J. W. MILLER CO. COMPTON, CALIFORNIA
79727	C-W INDUSTRIES WARMINSTER, PENNSYLVANIA
80031	MEPCO-ELECTRA MORRISTOWN, NEW JERSEY
80131	ELECTRONIC INDUSTRIES ASSOC. WASHINGTON, D.C.
81349	MILITARY SPECIFICATION
82389	SWITCHCRAFT, INC. CHICAGO, ILLINOIS
96341	MICROWAVE ASSOCIATES, INC. BURLINGTON, MASSACHUSETTS
98291	SEALECTRO CORP. MAMARONECK, NEW YORK
99800	AMERICAN PRECISION INDUSTRIES, INC. (Delevan Division) EAST AURORA, NEW YORK

406654 – Assy., ATTENUATOR, SIGNAL COND (DUAL CHANNEL)

REF DES	DANA P/N	DESCRIPTION					FSC	MANU P/N
B1	920563	BEADS, SHIELDING			56-59065/4B		02114	56-59065/4B
B1A	920563	BEADS, SHIELDING			56-59065/4B		02114	56-59065/4B
B2	920563	BEADS, SHIELDING			56-59065/4B		02114	56-59065/4B
B2A	920563	BEADS, SHIELDING			56-59065/4B		02114	56-59065/4B
B3	920563	BEADS, SHIELDING			56-59065/4B		02114	56-59065/4B
B4	920563	BEADS, SHIELDING			56-59065/4B		02114	56-59065/4B
C1	100063	CAP	CERAM	.01 MFD	500 V	20%	56289	C023B501E103M
C1A	100063	CAP	CERAM	.01 MFD	500 V	20%	56289	C023B501E103M
C2	101182	CAP	CERAM	47 PFD	500 V	10%	71471	TCD-DI-2(N750)
C2A	101182	CAP	CERAM	47 PFD	500 V	10%	71471	TCD-DI-2(N750)
C3	100009	CAP	CERAM	5 PFD	500 V	10%	71471	TCDI-1(N750)
C3A	100009	CAP	CERAM	5 PFD	500 V	10%	71471	TCDI-1(N750)
C4	100016	CAP	CERAM	27 PFD	1000 V	10%	71590	DD270
C4A	100016	CAP	CERAM	27 PFD	1000 V	10%	71590	DD270
C5	100009	CAP	CERAM	5 PFD	500 V	10%	71471	TCDI-1(N750)
C5A	100009	CAP	CERAM	5 PFD	500 V	10%	71471	TCDI-1(N750)
C6	101182	CAP	CERAM	47 PFD	500 V	10%	71471	TCD-DI-2(N750)
C6A	101182	CAP	CERAM	47 PFD	500 V	10%	71471	TCD-DI-2(N750)
J201	600567	CONN	RECPTLE		31-236		02660	31-236
J202	600567	CONN	RECPTLE		31-236		02660	31-236
R1	010609	RES	METAL	909 K		1% 1/8W	81349	RN60D9093F
R1A	010609	RES	METAL	909 K		1% 1/8W	81349	RN60D9093F
R2	010680	RES	METAL	90.9 K		1%	81349	RN55C9092F
R2A	010680	RES	METAL	90.9 K		1% 1/10W	81349	RN55C9092F
R3	010529	RES	METAL	10 K		1% 1/10W	81349	RN55C1002F
R3A	010529	RES	METAL	10 K		1% 1/10W	81349	RN55C1002F
R4	000104	RES	CARBON	100 K		5% 1/4W	81349	RC07GF104J
R4A	000104	RES	CARBON	100 K		5% 1/4W	81349	RC07GF104J
S202	600603	SWITCH	ATTENUATOR				11237	
S203	600603	SWITCH	ATTENUATOR				11237	
S206	600613	SWITCH	SLIDE, SPDT				79727	GF-124
S207	600613	SWITCH	SLIDE, SPDT				79727	GF-124
S208	600613	SWITCH	SLIDE, SPDT				79727	GF-124
S209	600613	SWITCH	SLIDE, SPDT				79727	GF-124
S210	600613	SWITCH	SLIDE, SPDT				79727	GF-124

406147 – Assy., PCB, SIGNAL COND (DUAL CHANNEL)

REF DES	DANA P/N	DESCRIPTION					FSC	MANU P/N
B1	920563	BEADS, SHIELDING			56-59065/4B		02114	56-59065/4B
B1A	920563	BEADS, SHIELDING			56-59065/4B		02114	56-59065/4B
B2	920563	BEADS, SHIELDING			56-59065/4B		02114	56-59065/4B
B2A	920563	BEADS, SHIELDING			56-59065/4B		02114	56-59065/4B
B3	920563	BEADS, SHIELDING			56-59065/4B		02114	56-59065/4B
B3A	920563	BEADS, SHIELDING			56-59065/4B		02114	56-59065/4B
C1	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C1A	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C2	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C2A	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C3	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C3A	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C4	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C4A	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C6	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C6A	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C7	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C7A	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C8	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C8A	130103	CAP	CERAM	.01 MFD	25 V	20%	72982	9ACF-W5R103M
C9	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C9A	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C10	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C10A	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C11	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C11A	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C12	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C12A	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C13A	100041	CAP	CERAM	25 PFD	1000 V	5%	56289	C030B102F250J
CR1	220031	DIODE	SILICO	ZENER	1/4M3.3AZ5		04713	1/4M3.3AZ5
CR1A	220031	DIODE	SILICO	ZENER	1/4M3.3AZ5		04713	1/4M3.3AZ5
CR2	220031	DIODE	SILICO	ZENER	1/4M3.3AZ5		04713	1/4M3.3AZ5
CR2A	220031	DIODE	SILICO	ZENER	1/4M3.3AZ5		04713	1/4M3.3AZ5
CR3	211236	DIODE	SILICO		007		21793	211236
CR3A	211236	DIODE	SILICO		007		21793	211236
CR4	211236	DIODE	SILICO		007		21793	211236
CR4A	211236	DIODE	SILICO		007		21793	211236
CR5	220019	DIODE	SILICO	ZENER	1N752A		81349	1N752A
CR5A	220019	DIODE	SILICO	ZENER	1N752A		81349	1N752A
CR6	211083	DIODE	SILICO		1N916B		81349	1N916B
CR6A	211083	DIODE	SILICO		1N916B		81349	1N916B
CR7	211083	DIODE	SILICO		1N916B		81349	1N916B

406147 – Assy., PCB, SIGNAL COND (DUAL CHANNEL) *continued*

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
CR7A	211083	DIODE SILICO 1N916B	81349	1N916B
CR8	220004	DIODE SILICO ZENER 1N961B	81349	1N961B
CR8A	220004	DIODE SILICO ZENER 1N961B	81349	1N961B
J6	600573	CONN RF 50-051-0000	98291	50-051-0000
J7	600573	CONN RF 50-051-0000	98291	50-051-0000
L1	310068	CHOKE, RF 1 UH 10%	99800	1537-12
L1A	310068	CHOKE, RF 1 UH 10%	99800	1537-12
L2	310068	CHOKE, RF 1 UH 10%	99800	1537-12
L2A	310068	CHOKE, RF 1 UH 10%	99800	1537-12
L3A	310108	CHOKE, RF .18 μH 10%	99800	1025-02
L4A	310108	CHOKE, RF .18 μH 10%	99800	1025-02
Q1	200189	TRANS MATCHED PAIR WITH Q10 TIS58	21793	200189
Q1A	200189	TRANS MATCHED PAIR WITH Q10A TIS58	21793	200189
Q2	200186	TRANS MATCHED PAIR WITH Q9	21793	200186
Q2A	200186	TRANS MATCHED PAIR WITH Q9A	21793	200186
Q3	200195	TRANS SILICO NPN SELECTED 2N5179	21793	200195
Q3A	200186	TRANS MATCHED PAIR WITH Q7A	21793	200186
Q4	200186	TRANS MATCHED PAIR WITH Q8	21793	200186
Q4A	200186	TRANS MATCHED PAIR WITH Q8A	21793	200186
Q5	200195	TRANS SILICO NPN SELECTED 2N5179	21793	200195
Q5A	200151	TRANS SILICO NPN SELECTED 2N5179	21793	200151
Q6	200195	TRANS SILICO NPN SELECTED 2N5179	21793	200195
Q6A	200151	TRANS SILICO NPN SELECTED 2N5179	21793	200151
Q7	200195	TRANS SILICO NPN SELECTED 2N5179	21793	200195
Q7A	200186	TRANS MATCHED PAIR WITH Q3A	21793	200186
Q8	200186	TRANS MATCHED PAIR WITH Q4	21793	200186
Q8A	200186	TRANS MATCHED PAIR WITH Q4A	21793	200186
Q9	200186	TRANS MATCHED PAIR WITH Q2	21793	200186
Q9A	200186	TRANS MATCHED PAIR WITH Q2A	21793	200186
Q10	200189	TRANS MATCHED PAIR WITH Q1 TIS58	21793	200189
Q10A	200189	TRANS MATCHED PAIR WITH Q1A TIS58	21793	200189
Q11	200200	TRANS NPN	21793	200200
Q11A	200200	TRANS NPN	21793	200200
Q12	200200	TRANS NPN	21793	200200
Q12A	200200	TRANS NPN	21793	200200
Q13	200037	TRANS SILICO NPN 2N3646	80131	2N3646
Q13A	200037	TRANS SILICO NPN 2N3646	80131	2N3646
Q14	200037	TRANS SILICO NPN 2N3646	80131	2N3646
Q14A	200037	TRANS SILICO NPN 2N3646	80131	2N3646
P9	600593	CONN 6 PIN 250-06-30-170	71785	250-06-30-170

406147 – Assy., PCB, SIGNAL COND (DUAL CHANNEL) *continued*

REF DES	DANA P/N	DESCRIPTION				FSC	MANU P/N
R1	000222	RES	CARBON	2.2 K	5% 1/4W	81349	RC07GF222J
R1A	000222	RES	CARBON	2.2 K	5% 1/4W	81349	RC07GF222J
R2	000222	RES	CARBON	2.2 K	5% 1/4W	81349	RC07GF222J
R2A	000222	RES	CARBON	2.2 K	5% 1/4W	81349	RC07GF222J
R3	010720	RES	METAL	9.09 K	.25% 1/10W	81349	RN55C9091C
R3A	010720	RES	METAL	9.09 K	.25% 1/10W	81349	RN55C9091C
R4	000751	RES	CARBON	750 OHM	5% 1/4W	81349	RC07GF751J
R4A	000751	RES	CARBON	750 OHM	5% 1/4W	81349	RC07GF751J
R5	000101	RES	CARBON	100 OHM	5% 1/4W	81349	RC07GF101J
R5A	000101	RES	CARBON	100 OHM	5% 1/4W	81349	RC07GF101J
R6	010705	RES	METAL	4.53 K	1% 1/10W	81349	RN55C4531F
R6A	010705	RES	METAL	4.53 K	1% 1/10W	81349	RN55C4531F
R7	000910	RES	CARBON	91 OHM	5% 1/4W	81349	RC07GF910J
R7A	000910	RES	CARBON	91 OHM	5% 1/4W	81349	RC07GF910J
R8	000470	RES	CARBON	47 OHM	5% 1/4W	81349	RC07GF470J
R8A	000470	RES	CARBON	47 OHM	5% 1/4W	81349	RC07GF470J
R9A	000152	RES	CARBON	1.5 K	5% 1/4W	81349	RC07GF152J
R10	000101	RES	CARBON	100 OHM	5% 1/4W	81349	RC07GF101J
R10A	000101	RES	CARBON	100 OHM	5% 1/4W	81349	RC07GF101J
R11	000430	RES	CARBON	43 OHM	5% 1/4W	81349	RC07GF430J
R11A	000430	RES	CARBON	43 OHM	5% 1/4W	81349	RC07GF430J
R12	000222	RES	CARBON	2.2 K	5% 1/4W	81349	RC07GF222J
R12A	000222	RES	CARBON	2.2 K	5% 1/4W	81349	RC07GF222J
R13	000101	RES	CARBON	100 OHM	5% 1/4W	81349	RC07GF101J
R13A	000101	RES	CARBON	100 OHM	5% 1/4W	81349	RC07GF101J
R14	000222	RES	CARBON	2.2 K	5% 1/4W	81349	RC07GF222J
R14A	000222	RES	CARBON	2.2 K	5% 1/4W	81349	RC07GF222J
R15A	000152	RES	CARBON	1.5 K	5% 1/4W	81349	RC07GF152J
R16	001758	RES	CARBON	330 OHM	5% 1W	81349	RC32GF331J
R16A	001758	RES	CARBON	330 OHM	5% 1W	81349	RC32GF331J
R17	040114	POT	CERMET	50 OHM	10%	73138	62PR50
R17A	040114	POT	CERMET	50 OHM	10%	73138	62PR50
R18	000910	RES	CARBON	91 OHM	5% 1/4W	81349	RC07GF910J
R18A	000910	RES	CARBON	91 OHM	5% 1/4W	81349	RC07GF910J
R19	000470	RES	CARBON	47 OHM	5% 1/4W	81349	RC07GF470J
R19A	000470	RES	CARBON	47 OHM	5% 1/4W	81349	RC07GF470J
R20	040115	POT	CERMET	500 OHM	10%	73138	62PR500
R20A	040115	POT	CERMET	500 OHM	10%	73138	62PR500
R21	000101	RES	CARBON	100 OHM	5% 1/4W	81349	RC07GF101J
R21A	000101	RES	CARBON	100 OHM	5% 1/4W	81349	RC07GF101J
R22	010705	RES	METAL	4.53 K	1% 1/10W	81349	RN55C4531F
R22A	010705	RES	METAL	4.53 K	1% 1/10W	81349	RN55C4531F
R23	000751	RES	CARBON	750 OHM	5% 1/4W	81349	RC07GF751J
R23A	000751	RES	CARBON	750 OHM	5% 1/4W	81349	RC07GF751J
R24	010720	RES	METAL	9.09 K	.25% 1/10W	81349	RN55C9091C

406147 – Assy., PCB, SIGNAL COND (DUAL CHANNEL) *continued*

REF DES	DANA P/N	DESCRIPTION					FSC	MANU P/N
R24A	010720	RES	METAL	9.09 K		.25% 1/10W	81349	RN55C9091C
R25	000203	RES	CARBON	20 K		5% 1/4W	81349	RC07GF203J
R25A	000203	RES	CARBON	20 K		5% 1/4W	81349	RC07GF203J
R26	010704	RES	METAL	1 K		1% 1/10W	81349	RN55D1001F
R26A	010704	RES	METAL	1 K		1% 1/10W	81349	RN55D1001F
R27	010630	RES	METAL	9.09 K		1% 1/10W	81349	RN55C9091F
R27A	010630	RES	METAL	9.09 K		1% 1/10W	81349	RN55C9091F
R28	000682	RES	CARBON	6.8 K		5% 1/4W	81349	RC07GF682J
R28A	000682	RES	CARBON	6.8 K		5% 1/4W	81349	RC07GF682J
R29	000682	RES	CARBON	6.8 K		5% 1/4W	81349	RC07GF682J
R29A	000682	RES	CARBON	6.8 K		5% 1/4W	81349	RC07GF682J
R30	000102	RES	CARBON	1 K		5% 1/4W	81349	RC07GF102J
R30A	000102	RES	CARBON	1 K		5% 1/4W	81349	RC07GF102J
R31	000102	RES	CARBON	1 K		5% 1/4W	81349	RC07GF102J
R31A	000102	RES	CARBON	1 K		5% 1/4W	81349	RC07GF102J
R32	000203	RES	CARBON	20 K		5% 1/4W	81349	RC07GF203J
R32A	000203	RES	CARBON	20 K		5% 1/4W	81349	RC07GF203J
R33	010705	RES	METAL	4.53 K		1% 1/10W	81349	RN55C4531F
R33A	010705	RES	METAL	4.53 K		1% 1/10W	81349	RN55C4531F
R34	040212	POT		25 K	UPE200-25K		11237	UPE200-25K
R34A	040212	POT		25 K	UPE200-25K		11237	UPE200-25K
R35	000391	RES	CARBON	390 OHM		5% 1/4W	81349	RC07GF391J
R35A	000391	RES	CARBON	390 OHM		5% 1/4W	81349	RC07GF391J
R36	000241	RES	CARBON	240 OHM		5% 1/4W	81349	RC07GF241J
R36A	000241	RES	CARBON	240 OHM		5% 1/4W	81349	RC07GF241J
R37	000102	RES	CARBON	1 K		5% 1/4W	81349	RC07GF102J
R37A	000102	RES	CARBON	1 K		5% 1/4W	81349	RC07GF102J
R38	000102	RES	CARBON	1 K		5% 1/4W	81349	RC07GF102J
R38A	000102	RES	CARBON	1 K		5% 1/4W	81349	RC07GF102J
S202B		SWITCH	(PART OF R34 & R34A)					
S203B		SWITCH	(PART OF R34 & R34A)					
W1	600245	JUMPER, INSULATED			L-2007-1LP			L-2007-1LP
W2	600245	JUMPER, INSULATED			L-2007-1LP			L-2007-1LP

406630 & 406631/32 – Assy., PCB, SWITCH BOARD

REF DES	DANA P/N	DESCRIPTION					FSC	MANU P/N
C1	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C2	100069	CAP	CERAM	20 PFD	1000 V	20%	56289	C023B102E200M
C3	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C4	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C6	100003	CAP	CERAM	3.3 PFD	1000 V		71590	DD3R3
C7	101174	CAP	CERAM	.001 MFD	500 V	10%	04222	SCD-DI-2X5F-1000
C8	101174	CAP	CERAM	.001 MFD	500 V	10%	04222	SCD-DI-2X5F-1000
C9	101174	CAP	CERAM	.001 MFD	500 V	10%	04222	SCD-DI-2X5F-1000
C10	101174	CAP	CERAM	.001 MFD	500 V	10%	04222	SCD-DI-2X5F-1000
C11	101174	CAP	CERAM	.001 MFD	500 V	10%	04222	SCD-DI-2X5F-1000
C12	101174	CAP	CERAM	.001 MFD	500 V	10%	04222	SCD-DI-2X5F-1000
C13	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C14	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C15	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C20	110158	CAP	TANTA	10 MFD	50 V	10%	05397	T362C106K050A
C21	100040	CAP	CERAM	200 PFD	1000 V	20%	56289	C023B102E201M
C27	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C28	101174	CAP	CERAM	.001 MFD	500 V	10%	04222	SCD-DI-2X5F-1000
C29	110104	CAP	TANTA	4.7 MFD	10 V	10%	05397	T310A475K010AS
C31	100068	CAP	CERAM	.02 MFD	100 V	20%	56289	C023B101H203M
C32	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C35	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C36	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C37	100053	CAP	CERAM	56 PFD	1000 V	5%	56289	C030A102J560J
C38	100051	CAP	CERAM	3 PFD	500 V		71471	TCD-B1-0
C39	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C40	100050	CAP	CERAM	2.2 PFD	1000 V	5%	56289	C030B102S2R2D
C41	100060	CAP	CERAM	15 PFD	1000 V	5%	56289	C030B102E150J
C42	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C44	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C45	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C46	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C47	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C48	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C49	110151	CAP	TANTA	10 MFD	35 V	20%	05397	T362C106M035A
C50	110151	CAP	TANTA	10 MFD	35 V	20%	05397	T362C106M035A
C51	101145	CAP	CERAM	100 PFD	500 V	10%	04222	TCD-DI-1N5600-100
C52	100038	CAP	CERAM	560 PFD	500 V	10%	71590	DD561
C53	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C54	101145	CAP	CERAM	100 PFD	500 V	10%	04222	TCD-DI-1N5600-100
C55	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C56	110151	CAP	TANTA	10 MFD	35 V	20%	05397	T362C106M035A
C57	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C58	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M

406630 & 406631/32 – Assy., PCB, SWITCH BOARD *continued*

REF DES	DANA P/N	DESCRIPTION				FSC	MANU P/N
CR1	211083	DIODE	SILICO		1N916B	81349	1N916B
CR2	211083	DIODE	SILICO		1N916B	81349	1N916B
CR3	211083	DIODE	SILICO		1N916B	81349	1N916B
CR4	211083	DIODE	SILICO		1N916B	81349	1N916B
CR5	211083	DIODE	SILICO		1N916B	81349	1N916B
CR6	211083	DIODE	SILICO		1N916B	81349	1N916B
CR7	211083	DIODE	SILICO		1N916B	81349	1N916B
CR8	211083	DIODE	SILICO		1N916B	81349	1N916B
CR9	211083	DIODE	SILICO		1N916B	81349	1N916B
CR10	211083	DIODE	SILICO		1N916B	81349	1N916B
CR11	211083	DIODE	SILICO		1N916B	81349	1N916B
CR12	211083	DIODE	SILICO		1N916B	81349	1N916B
CR13	211083	DIODE	SILICO		1N916B	81349	1N916B
CR14	211083	DIODE	SILICO		1N916B	81349	1N916B
CR18	211083	DIODE	SILICO		1N916B	81349	1N916B
CR19	211083	DIODE	SILICO		1N916B	81349	1N916B
CR20	211083	DIODE	SILICO		1N916B	81349	1N916B
CR35	211083	DIODE	SILICO		1N916B	81349	1N916B
CR36	211083	DIODE	SILICO		1N916B	81349	1N916B
CR37	211083	DIODE	SILICO		1N916B	81349	1N916B
CR38	211083	DIODE	SILICO		1N916B	81349	1N916B
CR39	211083	DIODE	SILICO		1N916B	81349	1N916B
CR40	211083	DIODE	SILICO		1N916B	81349	1N916B
CR41	211083	DIODE	SILICO		1N916B	81349	1N916B
L1	310062	CHOKE	RF	22 UH	1537-44	99800	1537-44
L2	310072	CHOKE, RF		2.2 UH	10%	99800	1537-20
MA0	230028	INTEGRATED CIRCUIT			7400	01295	7400
MA2	230064	INTEGRATED CIRCUIT			7404	01295	7404
MA8	230099	INTEGRATED CIRCUIT			7454	01295	7454
MA9	230317	INTEGRATED CIRCUIT			SN74LS90	01295	SN74LS90
MA10	230317	INTEGRATED CIRCUIT			SN74LS90	01295	SN74LS90
MB8	230064	INTEGRATED CIRCUIT			7404	01295	7404
MB9	230317	INTEGRATED CIRCUIT			SN74LS90	01295	SN74LS90
MB10	230317	INTEGRATED CIRCUIT			SN74LS90	01295	SN74LS90
MC1	230043	INTEGRATED CIRCUIT			MC1010P	04713	MC1010P
MC2	230064	INTEGRATED CIRCUIT			7404	01295	7404
MC5	230079	INTEGRATED CIRCUIT			74H00	07263	74H00
MC6	230028	INTEGRATED CIRCUIT			7400	07263	7400
MC8	230099	INTEGRATED CIRCUIT			7454	01295	7454
MC9	230317	INTEGRATED CIRCUIT			SN74LS90	01295	SN74LS90
MC10	230317	INTEGRATED CIRCUIT			SN74LS90	01295	SN74LS90
MD0	230112	INTEGRATED CIRCUIT			MC10131	04713	MC10131
MD1	230039	INTEGRATED CIRCUIT			MC1023P	04713	MC1023P

406630 & 406631/32 – Assy., PCB, SWITCH BOARD *continued*

REF DES	DANA P/N	DESCRIPTION				FSC	MANU P/N
MD2	230097	INTEGRATED CIRCUIT			MC1034P	04713	MC1034P
MD3	230096	INTEGRATED CIRCUIT			MC1032P	04713	MC1032P
MD4	230048	INTEGRATED CIRCUIT			MC1027P	04713	MC1027P
MD5	230030	INTEGRATED CIRCUIT			7402	01295	7402
MD6	230064	INTEGRATED CIRCUIT			7404	01295	7404
MD7	230028	INTEGRATED CIRCUIT			7400	01295	7400
MD8	230064	INTEGRATED CIRCUIT			7404	01295	7404
MD9	230317	INTEGRATED CIRCUIT			SN74LS90	01295	SN74LS90
MD10	230317	INTEGRATED CIRCUIT			SN74LS90	01295	SN74LS90
ME0	230112	INTEGRATED CIRCUIT			MC10131P	04713	MC10131P
ME1	230072	INTEGRATED CIRCUIT			7474	01295	7474
ME2	230072	INTEGRATED CIRCUIT			7474	01295	7474
ME3	230081	INTEGRATED CIRCUIT			MC3060P	04713	MC3060P
ME4	230032	INTEGRATED CIRCUIT			7420	01295	7420
ME5	230028	INTEGRATED CIRCUIT			7400	01295	7400
ME6	230028	INTEGRATED CIRCUIT			7400	01295	7400
ME7	230030	INTEGRATED CIRCUIT			7402	01295	7402
ME8	230032	INTEGRATED CIRCUIT			7420	01295	7420
ME9	230064	INTEGRATED CIRCUIT			7404	01295	7404
ME10	230317	INTEGRATED CIRCUIT			SN74LS90	01295	SN74LS90
MF3	230028	INTEGRATED CIRCUIT			7400	01295	7400
MF4	230028	INTEGRATED CIRCUIT			7400	01295	7400
MF5	230031	INTEGRATED CIRCUIT			7410	01295	7410
MF6	230028	INTEGRATED CIRCUIT			7400	01295	7400
MF7	230028	INTEGRATED CIRCUIT			7400	01295	7400
MF8	230099	INTEGRATED CIRCUIT			7454	01295	7454
MF9	230072	INTEGRATED CIRCUIT			7474	01295	7474
MF10	230028	INTEGRATED CIRCUIT			7400	01295	7400
P6	600483	CONN	COAX	PLUG	27-7	02660	27-7
P7	600483	CONN	COAX	PLUG	27-7	02660	27-7
P13*	600483	CONN	COAX	PLUG	27-7	02660	27-7
Q1	200099	TRANS	SILICO	PNP	2N4258	81349	2N4258
Q2	200099	TRANS	SILICO	PNP	2N4258	81349	2N4258
Q3	200099	TRANS	SILICO	PNP	2N4258	81349	2N4258
Q4	200099	TRANS	SILICO	PNP	2N4258	81349	2N4258
Q5	200099	TRANS	SILICO	PNP	2N4258	81349	2N4258
Q6	200099	TRANS	SILICO	PNP	2N4258	81349	2N4258
Q7	200037	TRANS	SILICO	NPN	2N3646	80131	2N3646
Q9	200088	TRANS	SILICO	PNP	2N4248	80131	2N4248
Q10	200037	TRANS	SILICO	NPN	2N3646	80131	2N3646
Q11	200099	TRANS	SILICO	PNP	2N4258	81349	2N4258
Q16	200037	TRANS	SILICO	NPN	2N3646	80131	2N3646
Q17	200088	TRANS	SILICO	PNP	2N4248	80131	2N4248

*Used only on 8030B Assy. 406632

406630 & 406631/32 – Assy., PCB, SWITCH BOARD *continued*

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
Q19	200037	TRANS SILICO NPN 2N3646	80131	2N3646
Q20	200037	TRANS SILICO NPN 2N3646	80131	2N3646
Q21	200037	TRANS SILICO NPN 2N3646	80131	2N3646
Q22	200037	TRANS SILICO NPN 2N3646	80131	2N3646
Q23	200037	TRANS SILICO NPN 2N3646	80131	2N3646
R3	000821	RES CARBON 820 OHM 5% 1/4W	81349	RC07GF821J
R4	000821	RES CARBON 820 OHM 5% 1/4W	81349	RC07GF821J
R5	000180	RES CARBON 18 OHM 5% 1/4W	81349	RC07GF180J
R6	000750	RES CARBON 75 OHM 5% 1/4W	81349	RC07GF750J
R7	000101	RES CARBON 100 OHM 5% 1/4W	81349	RC07GF101J
R8	000471	RES CARBON 470 OHM 5% 1/4W	81349	RC07GF471J
R9	000222	RES CARBON 2.2 K 5% 1/4W	81349	RC07GF222J
R10	000621	RES CARBON 620 OHM 5% 1/4W	81349	RC07GF621J
R11	000101	RES CARBON 100 OHM 5% 1/4W	81349	RC07GF101J
R12	000240	RES CARBON 24 OHM 5% 1/4W	81349	RC07GF240J
R13	000750	RES CARBON 75 OHM 5% 1/4W	81349	RC07GF750J
R14	000511	RES CARBON 510 OHM 5% 1/4W	81349	RC07GF511J
R15	000511	RES CARBON 510 OHM 5% 1/4W	81349	RC07GF511J
R16	000821	RES CARBON 820 OHM 5% 1/4W	81349	RC07GF821J
R17	000821	RES CARBON 820 OHM 5% 1/4W	81349	RC07GF821J
R18	000511	RES CARBON 510 OHM 5% 1/4W	81349	RC07GF511J
R19	000112	RES CARBON 1.1 K 5% 1/4W	81349	RC07GF112J
R20	000621	RES CARBON 620 OHM 5% 1/4W	81349	RC07GF621J
R21	000621	RES CARBON 620 OHM 5% 1/4W	81349	RC07GF621J
R22	000301	RES CARBON 300 OHM 5% 1/4W	81349	RC07GF301J
R23	000391	RES CARBON 390 OHM 5% 1/4W	81349	RC07GF391J
R24	000101	RES CARBON 100 OHM 5% 1/4W	81349	RC07GF101J
R25	000301	RES CARBON 300 OHM 5% 1/4W	81349	RC07GF301J
R26	000242	RES CARBON 2.4 K 5% 1/4W	81349	RC07GF242J
R27	000182	RES CARBON 1.8 K 5% 1/4W	81349	RC07GF182J
R28	000391	RES CARBON 390 OHM 5% 1/4W	81349	RC07GF391J
R29	000101	RES CARBON 100 OHM 5% 1/4W	81349	RC07GF101J
R30	000750	RES CARBON 75 OHM 5% 1/4W	81349	RC07GF750J
R31	000240	RES CARBON 24 OHM 5% 1/4W	81349	RC07GF240J
R32	000750	RES CARBON 75 OHM 5% 1/4W	81349	RC07GF750J
R33	000240	RES CARBON 24 OHM 5% 1/4W	81349	RC07GF240J
R34	000472	RES CARBON 4.7 K 5% 1/4W	81349	RC07GF472J
R35	000472	RES CARBON 4.7 K 5% 1/4W	81349	RC07GF472J
R36	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R37	000182	RES CARBON 1.8 K 5% 1/4W	81349	RC07GF182J
R38	000101	RES CARBON 100 OHM 5% 1/4W	81349	RC07GF101J
R40	000222	RES CARBON 2.2 K 5% 1/4W	81349	RC07GF222J
R41	000222	RES CARBON 2.2 K 5% 1/4W	81349	RC07GF222J
R42	000430	RES CARBON 43 OHM 5% 1/4W	81349	RC07GF430J

406630 & 406631/32 – Assy., PCB, SWITCH BOARD *continued*

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
R43	000511	RES CARBON 510 OHM 5% 1/4W	81349	RC07GF511J
R44	000200	RES CARBON 20 OHM 5% 1/4W	81349	RC07GF200J
R45	000511	RES CARBON 510 OHM 5% 1/4W	81349	RC07GF511J
R46	000391	RES CARBON 390 OHM 5% 1/4W	81349	RC07GF391J
R47	000182	RES CARBON 1.8 K 5% 1/4W	81349	RC07GF182J
R48	000242	RES CARBON 2.4 K 5% 1/4W	81349	RC07GF242J
R60	000101	RES CARBON 100 OHM 5% 1/4W	81349	RC07GF101J
R61	000242	RES CARBON 2.4 K 5% 1/4W	81349	RC07GF242J
R62	000242	RES CARBON 2.4 K 5% 1/4W	81349	RC07GF242J
R66	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R67	000152	RES CARBON 1.5 K 5% 1/4W	81349	RC07GF152J
R68	000123	RES CARBON 12 K 5% 1/4W	81349	RC07GF123J
R69	000100	RES CARBON 10 OHM 5% 1/4W	81349	RC07GF100J
R72	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R73	000152	RES CARBON 1.5 K 5% 1/4W	81349	RC07GF152J
R74	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R75	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R76	000152	RES CARBON 1.5 K 5% 1/4W	81349	RC07GF152J
R78	000471	RES CARBON 470 OHM 5% 1/4W	81349	RC07GF471J
R79	000302	RES CARBON 3 K 5% 1/4W	81349	RC07GF302J
R80	000511	RES CARBON 510 OHM 5% 1/4W	81349	RC07GF511J
R81	000821	RES CARBON 820 OHM 5% 1/4W	81349	RC07GF821J
R83	000821	RES CARBON 820 OHM 5% 1/4W	81349	RC07GF821J
R84	000511	RES CARBON 510 OHM 5% 1/4W	81349	RC07GF511J
R86	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R89	000100	RES CARBON 10 OHM 5% 1/4W	81349	RC07GF100J
R90	000122	RES CARBON 1.2 K 5% 1/4W	81349	RC07GF122J
R91	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R92	000122	RES CARBON 1.2 K 5% 1/4W	81349	RC07GF122J
R93	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R94	000510	RES CARBON 51 OHM 5% 1/4W	81349	RC07GF510J
R95	000100	RES CARBON 10 OHM 5% 1/4W	81349	RC07GF100J
R96	000201	RES CARBON 200 OHM 5% 1/4W	81349	RC07GF201J
R97	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R98	000302	RES CARBON 3 K 5% 1/4W	81349	RC07GF302J
R99	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R100	000153	RES CARBON 15 K 5% 1/4W	81349	RC07GF153J
R101	000302	RES CARBON 3 K 5% 1/4W	81349	RC07GF302J
R102	000302	RES CARBON 3 K 5% 1/4W	81349	RC07GF302J
R103	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R108	000301	RES CARBON 300 OHM 5% 1/4W	81349	RC07GF301J
R109	000101	RES CARBON 100 OHM 5% 1/4W	81349	RC07GF101J
R110	000511	RES CARBON 510 OHM 5% 1/4W	81349	RC07GF511J
R111	000122	RES CARBON 1.2 K 5% 1/4W	81349	RC07GF122J
R112	000162	RES CARBON 1.6 K 5% 1/4W	81349	RC07GF162J

406630 & 406631/32 – Assy., PCB, SWITCH BOARD *continued*

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
R113	000510	RES CARBON 51 OHM 5% 1/4W	81349	RC07GF510J
R114	000152	RES CARBON 1.5 K 5% 1/4W	81349	RC07GF152J
R116	000113	RES CARBON 11 K 5% 1/4W	81349	RC07GF113J
R118	000511	RES CARBON 510 OHM 5% 1/4W	81349	RC07GF511J
R119	000511	RES CARBON 510 OHM 5% 1/4W	81349	RC07GF511J
R120	000511	RES CARBON 510 OHM 5% 1/4W	81349	RC07GF511J
R121	000511	RES CARBON 510 OHM 5% 1/4W	81349	RC07GF511J
R122	000511	RES CARBON 510 OHM 5% 1/4W	81349	RC07GF511J
R123	000511	RES CARBON 510 OHM 5% 1/4W	81349	RC07GF511J
R124	000511	RES CARBON 510 OHM 5% 1/4W	81349	RC07GF511J
R126	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R127	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R128	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R129	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R130	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R131	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R132	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R133	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R134	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R135	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R136	000153	RES CARBON 15 K 5% 1/4W	81349	RC07GF153J
R137	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R138	000101	RES CARBON 100 OHM 5% 1/4W	81349	RC07GF101J
R139	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
S1	600605	SWITCH PUSHBUTTON	71590	Series PB15
S2	600604	SWITCH PUSHBUTTON 2P2P	71590	Series PB15
Y1	920583	CRYSTAL 9.9988 MHz	21793	920583

406145 – Assy., PCB, READOUT BOARD

REF DES	DANA P/N	DESCRIPTION					FSC	MANU P/N
C1	101174	CAP	CERAM	.001 MFD	500 V	10%	04222	SCD-DI-2X5F-1000
C5	110131	CAP	ELECT	20 MFD	450 V		56289	39D206F450GL4
C7	110177	CAP	ELECT	5000 MFD	25 V		80031	3050HPS02
C8	110062	CAP	ELECT	500 MFD	50 V		56289	39D507G050GL4
C9	110062	CAP	ELECT	500 MFD	50 V		56289	39D507G050GL4
C10	101641	CAP	CERAM	470 PFD	500 V	10%	71471	SCD1X5F
CR1	211083	DIODE	SILICO		1N916B		81349	1N916B
CR2	211083	DIODE	SILICO		1N916B		81349	1N916B
CR3	211083	DIODE	SILICO		1N916B		81349	1N916B
CR5	210004	DIODE	SILICO		1N4004		81349	1N4004
CR6	210004	DIODE	SILICO		1N4004		81349	1N4004
CR7	210004	DIODE	SILICO		1N4004		81349	1N4004
CR8	210004	DIODE	SILICO		1N4004		81349	1N4004
CR11	210004	DIODE	SILICO		1N4004		81349	1N4004
CR12	210004	DIODE	SILICO		1N4004		81349	1N4004
CR13	210004	DIODE	SILICO		1N4004		81349	1N4004
CR14	210004	DIODE	SILICO		1N4004		81349	1N4004
CR15	210004	DIODE	SILICO		1N4004		81349	1N4004
CR16	210004	DIODE	SILICO		1N4004		81349	1N4004
CR17	211083	DIODE	SILICO		1N916B		81349	1N916B
CR18	220067	DIODE		ZENER	5.1 V	2%	04713	1/4M5.1AZ2
CR19	210004	DIODE	SILICO		1N4004		81349	1N4004
CR20	220015	DIODE	SILICO	ZENER	1N967B		81349	1N967B
CR21	211083	DIODE	SILICO		1N916B		81349	1N916B
CR22	210004	DIODE	SILICO		1N4004		81349	1N4004
CR23	220015	DIODE	SILICO	ZENER	1N967B		81349	1N967B
CR24	210004	DIODE	SILICO		1N4004		81349	1N4004
CR25	211083	DIODE	SILICO		1N916B		81349	1N916B
CR28	210004	DIODE	SILICO		1N4004		81349	1N4004
CR29	210004	DIODE	SILICO		1N4004		81349	1N4004
CR30	211083	DIODE	SILICO		1N916B		81349	1N916B
CR40	210004	DIODE	SILICO		1N4004		81349	1N4004
CR53	210004	DIODE	SILICO		1N4004		81349	1N4004
D1	920602	BULB	NEON		A1C-A		74276	A1C-A
D2	920116	LAMP	NEON		NE-2H		08806	C2A
D3	920116	LAMP	NEON		NE-2H		08806	C2A
D4	920116	LAMP	NEON		NE-2H		08806	C2A
D5	920116	LAMP	NEON		NE-2H		08806	C2A
D6	920116	LAMP	NEON		NE-2H		08806	C2A

406145 – Assy., PCB, READOUT BOARD *continued*

REF DES	DANA P/N	DESCRIPTION		FSC	MANU P/N
D7	920116	LAMP NEON	NE-2H	08806	C2A
J2	600665	TERMINAL, MALE	R62-3	27264	R62-3
MA7	230064	INTEGRATED CIRCUIT	7404	01295	7404
MA8	230031	INTEGRATED CIRCUIT	7410	01295	7410
MA9	230099	INTEGRATED CIRCUIT	7454	01295	7454
MA10	230099	INTEGRATED CIRCUIT	7454	01295	7454
MA11	230031	INTEGRATED CIRCUIT	7410	01295	7410
MA12	230064	INTEGRATED CIRCUIT	7404	01295	7404
MB7	230064	INTEGRATED CIRCUIT	7404	01295	7404
MB8	230028	INTEGRATED CIRCUIT	7400	01295	7400
MB9	230099	INTEGRATED CIRCUIT	7454	01295	7454
MB10	230099	INTEGRATED CIRCUIT	7454	01295	7454
MB11	230031	INTEGRATED CIRCUIT	7410	01295	7410
MB12	230028	INTEGRATED CIRCUIT	7400	01295	7400
MC1	230064	INTEGRATED CIRCUIT	7404	01295	7404
MC2	230028	INTEGRATED CIRCUIT	7400	01295	7400
MC3	230031	INTEGRATED CIRCUIT	7410	01295	7410
MC7	230028	INTEGRATED CIRCUIT	7400	01295	7400
MC8	230028	INTEGRATED CIRCUIT	7400	01295	7400
MC9	230098	INTEGRATED CIRCUIT	7451	01295	7451
MC10	230098	INTEGRATED CIRCUIT	7451	01295	7451
MC11	230098	INTEGRATED CIRCUIT	7451	01295	7451
MC12	230099	INTEGRATED CIRCUIT	7454	01295	7454
MD2	230317	INTEGRATED CIRCUIT	SN74LS90	C1295	SN74LS90
MD3	230317	INTEGRATED CIRCUIT	SN74LS90	01295	SN74LS90
MD4	230317	INTEGRATED CIRCUIT	SN74LS90	01295	SN74LS90
MD5	230317	INTEGRATED CIRCUIT	SN74LS90	01295	SN74LS90
MD6	230317	INTEGRATED CIRCUIT	SN74LS90	01295	SN74LS90
MD7	230317	INTEGRATED CIRCUIT	SN74LS90	01295	SN74LS90
MD8	230317	INTEGRATED CIRCUIT	SN74LS90	01295	SN74LS90
MD10	230064	INTEGRATED CIRCUIT	7404	01295	7404
MD11	230028	INTEGRATED CIRCUIT	7400	01295	7400
MD12	230099	INTEGRATED CIRCUIT	7454	01295	7454
ME2	230065	INTEGRATED CIRCUIT	7475	01295	7475
ME3	230065	INTEGRATED CIRCUIT	7475	01295	7475
ME4	230065	INTEGRATED CIRCUIT	7475	01295	7475
ME5	230065	INTEGRATED CIRCUIT	7475	01295	7475
ME6	230065	INTEGRATED CIRCUIT	7475	01295	7475
ME7	230065	INTEGRATED CIRCUIT	7475	01295	7475
ME8	230065	INTEGRATED CIRCUIT	7475	01295	7475
ME9	230065	INTEGRATED CIRCUIT	7475	01295	7475
MF2	230034	INTEGRATED CIRCUIT	74141	07263	74141
MF3	230034	INTEGRATED CIRCUIT	74141	07263	74141

406145 – Assy., PCB, READOUT BOARD *continued*

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
MF4	230034	INTEGRATED CIRCUIT 74141	07263	74141
MF5	230034	INTEGRATED CIRCUIT 74141	07263	74141
MF6	230034	INTEGRATED CIRCUIT 74141	07263	74141
MF7	230034	INTEGRATED CIRCUIT 74141	07263	74141
MF8	230034	INTEGRATED CIRCUIT 74141	07263	74141
MF9	230034	INTEGRATED CIRCUIT 74141	07263	74141
Q1	200037	TRANS SILICO NPN 2N3646	80131	2N3646
Q5	200087	TRANS SILICO 021	21793	200087
Q6	200087	TRANS SILICO 021	21793	200087
Q7	200087	TRANS SILICO 021	21793	200087
Q8	200087	TRANS SILICO 021	21793	200087
Q9	200087	TRANS SILICO 021	21793	200087
Q10	200087	TRANS SILICO 021	21793	200087
Q11	200087	TRANS SILICO 021	21793	200087
Q12	200037	TRANS SILICO NPN 2N3646	80131	2N3646
Q15	200087	TRANS SILICO 021	21793	200087
Q17	200087	TRANS SILICO 021	21793	200087
Q18	200087	TRANS SILICO 021	21793	200087
Q19	200087	TRANS SILICO 021	21793	200087
Q20	200087	TRANS SILICO 021	21793	200087
Q21	200087	TRANS SILICO 021	21793	200087
Q22	200087	TRANS SILICO 021	21793	200087
Q23	200087	TRANS SILICO 021	21793	200087
Q25	200052	TRANS SILICO PNP 009	21793	200052
Q26	200088	TRANS SILICO PNP 2N4248	80131	2N4248
Q27	200200	TRANS NPN	21793	200200
Q28	200200	TRANS NPN	21793	200200
R1	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R2	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R3	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R4	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R5	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R6	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R7	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R8	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R10	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R11	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R15	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R16	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R17	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R18	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R19	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J

406145 – Assy., PCB, READOUT BOARD *continued*

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
R20	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R21	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R22	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R23	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R24	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R26	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R28	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R30	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R32	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R34	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R36	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R39	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R40	000103	RES CARBON 10 K 5% 1/4W	81349	RC07GF103J
R41	000152	RES CARBON 1.5 K 5% 1/4W	81349	RC07GF152J
R42	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R43	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R45	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R46	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R47	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R48	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R49	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R50	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R51	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R52	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R53	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R54	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R55	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R56	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R57	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R60	020620	RES WW 3.9 K 5% 3 W	21551	M-200
R61	001766	RES CARBON 220 K 5% 1/2W	81349	RC20GF224J
R62	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R63	001793	RES CARBON 1 K 5% 1/2W	01121	See Descrpt.
R64	001765	RES CARBON 68 OHM 5% 1/2W	81349	RC20GF680J
R65	000272	RES CARBON 2.7 K 5% 1/4W	81349	RC07GF272J
R66	000101	RES CARBON 100 OHM 5% 1/4W	81349	RC07GF101J
R67	000362	RES CARBON 3.6 K 5% 1/4W	81349	RC07GF362J
R68	000152	RES CARBON 1.5 K 5% 1/4W	81349	RC07GF152J
R69	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R70	000242	RES CARBON 2.4 K 5% 1/4W	81349	RC07GF242J
R71	000101	RES CARBON 100 OHM 5% 1/4W	81349	RC07GF101J
R72	000272	RES CARBON 2.7 K 5% 1/4W	81349	RC07GF272J
R73	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R74	000152	RES CARBON 1.5 K 5% 1/4W	81349	RC07GF152J

406145 – Assy., PCB, READOUT BOARD *continued*

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
R76	000821	RES CARBON 820 OHM 5% 1/4W	81349	RC07GF821J
R77	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
S201	600601	SWITCH ROTARY	21793	600601
V1	920506	TUBE NEON DISPLAY ZM1000	73445	ZM1000
V2	920506	TUBE NEON DISPLAY ZM1000	73445	ZM1000
V3	920506	TUBE NEON DISPLAY ZM1000	73445	ZM1000
V4	920506	TUBE NEON DISPLAY ZM1000	73445	ZM1000
V5	920506	TUBE NEON DISPLAY ZM1000	73445	ZM1000
V6	920506	TUBE NEON DISPLAY ZM1000	73445	ZM1000
V7	920506	TUBE NEON DISPLAY ZM1000	73445	ZM1000
V8	920506	TUBE NEON DISPLAY ZM1000	73445	ZM1000
W3	600245	JUMPER, INSULATED L-2007-1LP		L-2007-1LP
W6	600245	JUMPER, INSULATED L-2007-1LP		L-2007-1LP
W7	600245	JUMPER, INSULATED L-2007-1LP		L-2007-1LP

406580 – Assy., PCB, REAR PANEL

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
C1	100063	CAP CERAM .01 MFD 500 V 20%	56289	C023B501E103M
C2	100063	CAP CERAM .01 MFD 500 V 20%	56289	C023B501E103M
F101	920205	FUSE GLASS .75 A 250 V (115V Operation)	75915	3AG3/4ASB
	920204	FUSE SLO .50 A 250 V (230V Operation)	75915	3AG1/2ASB
H1	730423	HEATSINK 730423	21793	730423
J101	600619	CONN RECPTLE	82389	EAC-301
J102	600567	CONN RECPTLE 31-236	02660	31-236
J103	600567	CONN RECPTLE 31-236	02660	31-236
J104	600567	CONN RECPTLE 31-236	02660	31-236
J106	600567	CONN RECPTLE 31-236	02660	31-236
J107	920574	PLUG, PLASTIC, BLK P-562	28520	P-562
J108	920573	COVER HOLE P-437	28520	P-437
J109	920573	COVER HOLE P-437	28520	P-437
J110	600589	POST BINDING RED 820-65	32767	820-65
J111	600587	POST BINDING BLK 820-45	32767	820-45
J112	600586	POST BINDING WHITE 820-25	32767	820-25
P1	600566	CONN 6 PIN 251-0630160	71785	251-0630160
Q101	200223	TRANS NPN MJE521	04713	MJE521
Q102	200130	TRANS SILICO NPN MJE3055	04713	MJE3055
Q103	200183	TRANS SILICO PNP MJE371	04713	MJE371
S101	600680	SWITCH SLIDE, SPDT GF-124	79727	GF-124
S102	600617	SWITCH SLIDE, DPDT G126	79727	G126
T101	300065	TRANSFORMER 115 V 11824	23095	11824

406732 – Assy., REAR PANEL, PART OF P/N 406749, OPTION 200 & 300

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
B1	600759	FAN MOTOR TYPE AYAA 115 V	05624	Type AYAA
C1	100063	CAP CERAM .01 MFD 500 V 20%	56289	C023B501E103M
C2	100063	CAP CERAM .01 MFD 500 V 20%	56289	C023B501E103M
F101	920205	FUSE GLASS .75 A 250 V (115V Operation)	75915	3AG3/4ASB
	920204	FUSE SLOW .50 A 250 V (220V Operation)	75915	3AG1/2ASB
J101	600619	CONN RECPTLE EAC-301	82389	EAC-301
J102	600567	CONN RECPTLE 31-236	02660	31-236
J103	600567	CONN RECPTLE 31-236	02660	31-236
J104	600567	CONN RECPTLE 31-236	02660	31-236
J105	600567	CONN RECPTLE 31-236	02660	31-236
J106	920573	COVER HOLE P-437	28520	P-437
J107	920573	COVER HOLE P-437	28520	P-437
J108	920574	PLUG, PLASTIC, BLK P-562	28520	P-562
P1	600566	CONN 6 PIN 251-0630160	71785	251-0630160
Q101	200223	TRANS NPN MJE521	04713	MJE521
Q102	200130	TRANS SILICO NPN MJE3055	04713	MJE3055
Q103	200183	TRANS SILICO PNP MJE371	04713	MJE371
S101	600680	SWITCH SLIDE SPDT GF124	79727	GF124
S102	600617	SWITCH SLIDE DPDT G126	79727	G126
S103	600521	SWITCH DPDT 46256LFE	82389	46256LFE
T101	300065	TRANSFORMER POWER 115 V	23095	11824
W101	600245	JUMPER, INSULATED L-2007-1LP		L-2007-1LP

406561 – Assy., PCB, DISPLAY TIME CONTROL

REF DES	DANA P/N	DESCRIPTION			FSC	MANU P/N
P3	730739	CONN 6 PIN MODIFIED			21793	730739
	600250	KEY, POLARIZING, TYPE 2			71785	50PK-2
P5	600545	PLUG 3 PIN		1625-3P-1	27264	1625-3P-1
	600381	TERM, PIN FEMALE		1561	27264	1561
R1		POT	1 MEG	(PART OF 600600)		
S205	600600	SWITCH	SPST	CTS45	11237	CTS45

406128 – Assy., PCB, INTERCONNECT BOARD

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
C1	101174	CAP CERAM .001 MFD 500 V 10%	04222	SCD-DI-2X5F-1000
P2	600575	CONN 25 PIN 252-25-30-160	71785	252-25-30-160
P4	600575	CONN 25 PIN 252-25-30-160	71785	252-25-30-160

406663 – Assy., PCB, 9 DIGIT READOUT, OPTION 004

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
MD1	230317	INTEGRATED CIRCUIT SN74LS90	01295	SN74LS90
ME1	230065	INTEGRATED CIRCUIT 7475	01295	7475
MF1	230034	INTEGRATED CIRCUIT 74141	07263	74141
R9	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
V9	920506	TUBE NEON DISPLAY ZM1000	73445	ZM1000

For location of parts:

Refer to Layout and Schematic Readout Board, Pages 6-8 and 6-10

406660-662 – Assy., REAR INPUT, OPTION 010 (Rear Panel 406580, Page 6-13)

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
J107	406564	BNC CABLE ASSY 406564	21793	406564
J108	600567	CONN RECPTLE 31-236	02660	31-236
J109	600567	CONN RECPTLE 31-236	02660	31-236
R108	001803	RES CARBON 24 OHM 5% 1/8W	81349	RC05GF240J
R109	001803	RES CARBON 24 OHM 5% 1/8W	81349	RC05GF240J

406735 – Assy., REAR INPUT, OPTION 010 (Rear Panel 406732, Page 6-15)

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
J106	406564	BNC CABLE ASSY 406564	21793	406564
J107	600567	CONN RECPTLE 31-236	02660	31-236
J108	600567	CONN RECPTLE 31-236	02660	31-236
R107	001803	RES CARBON 24 OHM 5% 1/8W	81349	RC05GF240J
R108	001803	RES CARBON 24 OHM 5% 1/8W	81349	RC05GF240J

406659 – Assy., PCB, TCXO OSCILLATOR, OPTION 050

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
Y1	730705	TCXO 10 MHz	21793	730705

For location of parts:

Refer to Layout and Schematic Readout Board, Pages 6-8 and 6-11

406749 – Assy., OSCILLATOR, OPTION 200

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
A1*	406130	PCB ASSY 28V REGULATOR 406130	21793	406130
A2**	406732	REAR PANEL ASSY 406732	21793	406732
C1	100063	CAP CERAM .01 MFD 500 V 20%	56289	C023B501E103M
C6*	110180	CAP ELECT 1300 MFD 50 V 10%	80031	ME3050GL132U050
CR9*	210004	DIODE SILICO 1N4004	81349	1N4004
CR10*	210004	DIODE SILICO 1N4004	81349	1N4004
J1	600379	RECEPT 3P	27264	1625-3R
P1-1	600381	TERMINAL PIN FEMALE	27264	1561
P1-2	600381	TERMINAL PIN FEMALE	27264	1561
P1-3	600380	TERMINAL PIN MALE	27264	1854
Y101	730647	OSCILLATOR 730647	21793	730647

406748 – Assy., OSCILLATOR, OPTION 300

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
A1*	406130	PCB ASSY 28V REGULATOR 406130	21793	406130
A2**	406732	REAR PANEL ASSY 406732	21793	406732
C1	100063	CAP CERAM .01 MFD 500 V 20%	56289	C023B501E103M
C6*	110180	CAP ELECT 1300 MFD 50 V 10%	80031	ME3050GL132U050
CR9*	210004	DIODE SILICO 1N4004	81349	1N4004
CR10*	210004	DIODE SILICO 1N4004	81349	1N4004
J1	600379	RECEPT 3P	27264	1625-3R
P1-1	600381	TERMINAL PIN FEMALE	27264	1561
P1-2	600381	TERMINAL PIN FEMALE	27264	1561
P1-3	600380	TERMINAL PIN MALE	27264	1854
Y101	730648	OSCILLATOR 730648	21793	730648

*Located on Readout Board

**Schematic and Assy. Rear Panel, Pages 6-14, 6-15
Parts List, Page 7-20

406559 – Assy., OSCILLATOR, OPTION 200 (USED ON EARLY MODELS)

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
A1*	406130	PCB ASSY, 28V REGULATOR	21793	406130
C6*	110062	CAP ELECT 500 MFD 50 V	56289	39D507G050GL4
CR9*	210004	DIODE SILICO 1N4004	81349	1N4004
CR10*	210004	DIODE SILICO 1N4004	81349	1N4004
Y101**	730349	OSCILLATOR	21793	730349

*Located on Readout Board

**Option 100 P/N730353
Option 300 P/N730228

406130 – Assy., PCB, 28V REGULATOR, PART OF OPTION 200 & 300

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
J1	600664	TERMINAL FEMALE	27264	M93-102
	600665	TERMINAL MALE (2)	27264	R62-3
C1	101098	CAP CERAM 330 PFD 500 V 10%	56289	10TS-T33
CR1	220061	DIODE ZENER 28 V 5% 1/2W	81349	1N5255B
CR2	211083	DIODE SILICO 1N916B	81349	1N916B
Q1	200154	TRANS SILICO PNP MJE370	04713	MJE370
Q2	200037	TRANS SILICO NPN 2N3646	80131	2N3646
R1	000511	RES CARBON 510 OHM 5% 1/4W	81349	RC07GF511J
R2	000332	RES CARBON 3.3 K 5% 1/4W	81349	RC07GF332J

406120 – Assy., PCB, 550 MHz PRESCALER (50 mV) (8030B Only)

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
B3	406466	CHOKE ASSY FERRITE BEADS 406466	21793	406466
B4	406466	CHOKE ASSY FERRITE BEADS 406466	21793	406466
B5	406466	CHOKE ASSY FERRITE BEADS 406466	21793	406466
C1	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C2	130103	CAP CERAM .01 MFD 25 V 20%	72982	9ACF-W5R103M
C3	130103	CAP CERAM .01 MFD 25 V 20%	72982	9ACF-W5R103M
C4	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C5	130103	CAP CERAM .01 MFD 25 V 20%	72982	9ACF-W5R103M
C6	130104	CAP CERAM .001 MFD 100 V 20%	72982	9ACF-W5R102M
C7	101174	CAP CERAM .001 MFD 500 V 10%	04222	SCD-DI-2X5F-1000
C8	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C9	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C10	130103	CAP CERAM .01 MFD 25 V 20%	72982	9ACF-W5R103M
C11	130103	CAP CERAM .01 MFD 25 V 20%	72982	9ACF-W5R103M
C12	100025	CAP CERAM .005 MFD 100 V 20%	72982	835-000-X5V0502Z
C13	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C14	130103	CAP CERAM .01 MFD 25 V 20%	72982	9ACF-W5R103M
C15	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C16	130103	CAP CERAM .01 MFD 25 V 20%	72982	9ACF-W5R103M
C17	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C18	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C19	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C20	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C21	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C22	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C23	130104	CAP CERAM .001 MFD 100 V 20%	72982	9ACF-W5R102M
C24	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C25	130104	CAP CERAM .001 MFD 100 V 20%	72982	9ACF-W5R102M
C26	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C27	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C28	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C29	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C30	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C31	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C32	130104	CAP CERAM .001 MFD 100 V 20%	72982	9ACF-W5R102M
C33	130104	CAP CERAM .001 MFD 100 V 20%	72982	9ACF-W5R102M
C34	130104	CAP CERAM .001 MFD 100 V 20%	72982	9ACF-W5R102M
C35	100009	CAP CERAM 5 PFD 500 V 10%	71471	TCDI-1 (N750)
C36	130104	CAP CERAM .001 MFD 100 V 20%	72982	9ACF-W5R102M
C37	130104	CAP CERAM .001 MFD 100 V 20%	72982	9ACF-W5R102M
C38	130103	CAP CERAM .01 MFD 25 V 20%	72982	9ACF-W5R103M
C39	130103	CAP CERAM .01 MFD 25 V 20%	72982	9ACF-W5R103M
C40	100068	CAP CERAM .02 MFD 100 V 20%	56289	C023B101H203M
C41	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C42	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C43	130103	CAP CERAM .01 MFD 25 V 20%	72982	9ACF-W5R103M

406120 – Assy., PCB, 550 MHz PRESCALER (50 mV) *continued*

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
C44	110001	CAP TANTA 6.8 MFD 35 V 10%	05397	T310B685K035AS
C45	110001	CAP TANTA 6.8 MFD 35 V 10%	05397	T310B685K035AS
C46	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C47	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C48	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C49	110001	CAP TANTA 6.8 MFD 35 V 10%	05397	T310B685K035AS
C50	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C51	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C52	130103	CAP CERAM .01 MFD 25 V 20%	72982	9ACF-W5R103M
C53	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C54	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C55	130103	CAP CERAM .01 MFD 25 V 20%	72982	9ACF-W5R103M
CR1	210040	DIODE MA47600	96341	MA47600
CR2	210040	DIODE MA47600	96341	MA47600
CR3	210040	DIODE MA47600	96341	MA47600
CR4	210004	DIODE SILICO 1N4004	81349	1N4004
CR5	210040	DIODE MA47600	96341	MA47600
CR6	211083	DIODE SILICO 1N916B	81349	1N916B
CR7	211083	DIODE SILICO 1N916B	81349	1N916B
CR8	210040	DIODE MA47600	96341	MA47600
CR9	210026	DIODE RF DETECTOR 1N82AG	81349	1N82AG
CR10	210026	DIODE RF DETECTOR 1N82AG	81349	1N82AG
CR11	210069	DIODE SILICO Matched Set of 4	21793	210069
CR12	210069	DIODE SILICO Matched Set of 4	21793	210069
CR13	220031	DIODE SILICO ZENER 1/4M3.3AZ5	04713	1/4M3.3AZ5
CR14	210069	DIODE SILICO Matched Set of 4	21793	210069
CR15	210069	DIODE SILICO Matched Set of 4	21793	210069
CR16	210026	DIODE RF DETECTOR 1N82AG	81349	1N82AG
CR17	210004	DIODE SILICO 1N4004	81349	1N4004
J12	600610	CONN RECPTLE 50-053-0000	98291	50-053-0000
J13	600610	CONN RECPTLE 50-053-0000	98291	50-053-0000
L1	310062	CHOKE RF 22 UH 1537-44	99800	1537-44
L2	310062	CHOKE RF 22 UH 1537-44	99800	1537-44
L3	310062	CHOKE RF 22 UH 1537-44	99800	1537-44
L4	310062	CHOKE RF 22 UH 1537-44	99800	1537-44
L5	310062	CHOKE RF 22 UH 1537-44	99800	1537-44
L6	310062	CHOKE RF 22 UH 1537-44	99800	1537-44
L7	310062	CHOKE RF 22 UH 1537-44	99800	1537-44
L8	310081	CHOKE INDUCTOR	21793	310081
L9	310099	CHOKE 310099	21793	310099
L10	310081	CHOKE INDUCTOR	21793	310081
L11	310099	CHOKE 310099	21793	310099

406120 – Assy., PCB, 550 MHz PRESCALER (50 mV) *continued*

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
L12	310081	CHOKE INDUCTOR	21793	310081
L13	310081	CHOKE INDUCTOR	21793	310081
L14	310104	CHOKE 7 TURN	21793	310104
L15	310103	CHOKE 8 TURN	21793	310103
M1	230045	INTEGRATED CIRCUIT UA741C	07263	U6E7741393
M2	230095	INTEGRATED CIRCUIT MC1670L	04713	MC1670L
P10	600593	CONN 6 PIN 250-06-30-170	71785	250-06-30-170
Q1	200035	TRANS SILICO NPN 014	21793	200035
Q2	200011	TRANS SILICO PNP 009	21793	200011
Q3	200151	TRANS SILICO SELECTED 2N5179	21793	200151
Q4	200151	TRANS SILICO SELECTED 2N5179	21793	200151
Q5	200212	TRANS NPN 2N6305	81349	2N6305
Q6	200238	TRANS MATCHED SET	21793	200238
Q7	200238	TRANS MATCHED SET	21793	200238
Q8	200186	TRANS MATCHED PAIR WITH Q11	21793	200186
Q9	200238	TRANS MATCHED SET	21793	200238
Q10	200238	TRANS MATCHED SET	21793	200238
Q11	200186	TRANS MATCHED PAIR WITH Q8	21793	200186
Q12	200238	TRANS MATCHED SET	21793	200238
Q13	200238	TRANS MATCHED SET	21793	200238
Q14	200186	TRANS MATCHED PAIR WITH Q17	21793	200186
Q15	200238	TRANS MATCHED SET	21793	200238
Q16	200238	TRANS MATCHED SET	21793	200238
Q17	200186	TRANS MATCHED PAIR WITH Q14	21793	200186
Q18	200186	TRANS MATCHED PAIR WITH Q19	21793	200186
Q19	200186	TRANS MATCHED PAIR WITH Q18	21793	200186
Q20	200151	TRANS SILICO SELECTED 2N5179	21793	200151
R1	000510	RES CARBON 51 OHM 5% 1/4W	81349	RC07GF510J
R2	001683	RES CARBON 47 OHM 5% 1/2W	81349	RC20GF470J
R3	000100	RES CARBON 10 OHM 5% 1/4W	81349	RC07GF100J
R4	000510	RES CARBON 51 OHM 5% 1/4W	81349	RC07GF510J
R5	001675	RES CARBON 100 OHM 5% 1/2W	81349	RC20GF101J
R6	000510	RES CARBON 51 OHM 5% 1/4W	81349	RC07GF510J
R7	000100	RES CARBON 10 OHM 5% 1/4W	81349	RC07GF100J
R8	000100	RES CARBON 10 OHM 5% 1/4W	81349	RC07GF100J
R9	000100	RES CARBON 10 OHM 5% 1/4W	81349	RC07GF100J
R10	000100	RES CARBON 10 OHM 5% 1/4W	81349	RC07GF100J
R11	001788	RES CARBON 470 OHM 5% 1 W		See Description
R12	000752	RES CARBON 7.5 K 5% 1/4W	81349	RC07GF752J
R13	000510	RES CARBON 51 OHM 5% 1/4W	81349	RC07GF510J
R14	030007	RES WW 150 OHM 5% 3 W	44655	4396

406120 – Assy., PCB, 550 MHz PRESCALER (50 mV) *continued*

REF DES	DANA P/N	DESCRIPTION					FSC	MANU P/N
R15	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R16	000101	RES	CARBON	100 OHM		5% 1/4W	81349	RC07GF101J
R17	000101	RES	CARBON	100 OHM		5% 1/4W	81349	RC07GF101J
R18	000102	RES	CARBON	1 K		5% 1/4W	81349	RC07GF102J
R19	000510	RES	CARBON	51 OHM		5% 1/4W	81349	RC07GF510J
R20	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R21	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R22	000512	RES	CARBON	5.1 K		5% 1/4W	81349	RC07GF512J
R23	000822	RES	CARBON	8.2 K		5% 1/4W	81349	RC07GF822J
R24	001737	RES	CARBON		FSV	5% 1/4W	21793	001737
R25	000100	RES	CARBON	10 OHM		5% 1/4W	81349	RC07GF100J
R26	000301	RES	CARBON	300 OHM		5% 1/4W	81349	RC07GF301J
R27	000132	RES	CARBON	1.3 K		5% 1/4W	81349	RC07GF132J
R28	000510	RES	CARBON	51 OHM		5% 1/4W	81349	RC07GF510J
R30	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R31	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R32	000752	RES	CARBON	7.5 K		5% 1/4W	81349	RC07GF752J
R33	000100	RES	CARBON	10 OHM		5% 1/4W	81349	RC07GF100J
R34	000101	RES	CARBON	100 OHM		5% 1/4W	81349	RC07GF101J
R35	000751	RES	CARBON	750 OHM		5% 1/4W	81349	RC07GF751J
R36	000510	RES	CARBON	51 OHM		5% 1/4W	81349	RC07GF510J
R37	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R38	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R39	000682	RES	CARBON	6.8 K		5% 1/4W	81349	RC07GF682J
R40	000150	RES	CARBON	15 OHM		5% 1/4W	81349	RC07GF150J
R41	000511	RES	CARBON	510 OHM		5% 1/4W	81349	RC07GF511J
R42	000101	RES	CARBON	100 OHM		5% 1/4W	81349	RC07GF101J
R43	000471	RES	CARBON	470 OHM		5% 1/4W	81349	RC07GF471J
R44	000391	RES	CARBON	390 OHM		5% 1/4W	81349	RC07GF391J
R45	001787	RES	CARBON	20 OHM		5% 1/8W	01121	See Descrpt.
R46	000121	RES	CARBON	120 OHM		5% 1/4W	81349	RC07GF121J
R47	000182	RES	CARBON	1.8 K		5% 1/4W	81349	RC07GF182J
R48	000121	RES	CARBON	120 OHM		5% 1/4W	81349	RC07GF121J
R49	001787	RES	CARBON	20 OHM		5% 1/8W	01121	See Descrpt.
R50	000391	RES	CARBON	390 OHM		5% 1/4W	81349	RC07GF391J
R51	000391	RES	CARBON	390 OHM		5% 1/4W	81349	RC07GF391J
R52	000240	RES	CARBON	24 OHM		5% 1/4W	81349	RC07GF240J
R53	001787	RES	CARBON	20 OHM		5% 1/8W	01121	See Descrpt.
R54	000121	RES	CARBON	120 OHM		5% 1/4W	81349	RC07GF121J
R55	000270	RES	CARBON	27 OHM		5% 1/4W	81349	RC07GF270J
R56	000182	RES	CARBON	1.8 K		5% 1/4W	81349	RC07GF182J
R57	000121	RES	CARBON	120 OHM		5% 1/4W	81349	RC07GF121J
R58	001787	RES	CARBON	20 OHM		5% 1/8W	01121	See Descrpt.
R59	000823	RES	CARBON	82 K		5% 1/4W	81349	RC07GF823J
R60	000391	RES	CARBON	390 OHM		5% 1/4W	81349	RC07GF391J
R61	000270	RES	CARBON	27 OHM		5% 1/4W	81349	RC07GF270J
R62	000472	RES	CARBON	4.7 K		5% 1/4W	81349	RC07GF472J
R63	000151	RES	CARBON	150 OHM		5% 1/4W	81349	RC07GF151J

406120 – Assy., PCB, 550 MHz PRESCALER (50 mV) *continued*

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
R64	000821	RES CARBON 820 OHM 5% 1/4W	81349	RC07GF821J
R65	000100	RES CARBON 10 OHM 5% 1/4W	81349	RC07GF100J
R66	000301	RES CARBON 300 OHM 5% 1/4W	81349	RC07GF301J
R67	000391	RES CARBON 390 OHM 5% 1/4W	81349	RC07GF391J
R68	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R69	000200	RES CARBON 20 OHM 5% 1/4W	81349	RC07GF200J
R70	000751	RES CARBON 750 OHM 5% 1/4W	81349	RC07GF751J
R71	000300	RES CARBON 30 OHM 5% 1/4W	81349	RC07GF300J
R72	000300	RES CARBON 30 OHM 5% 1/4W	81349	RC07GF300J
R73	000101	RES CARBON 100 OHM 5% 1/4W	81349	RC07GF101J
R74	001794	RES CARBON 1 K 5% 1/8W	01121	See Descrpt.
R75	000332	RES CARBON 3.3 K 5% 1/4W	81349	RC07GF332J
R76	001794	RES CARBON 1 K 5% 1/8W	01121	See Descrpt.
R77	000131	RES CARBON 130 OHM 5% 1/4W	81349	RC07GF131J
R78	000391	RES CARBON 390 OHM 5% 1/4W	81349	RC07GF391J

406114 – Assy., PCB, 500 MHz PRESCALER (1 mV) OPTION 030 (8030B Only)

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
B1	920563	BEADS, SHIELDING 56-59065/4B	02114	56-59065/4B
B2	920563	BEADS, SHIELDING 56-59065/4B	02114	56-59065/4B
B3	406466	CHOKE ASSY FERRITE BEADS 406466	21793	406466
B4	406466	CHOKE ASSY FERRITE BEADS 406466	21793	406466
B5	406466	CHOKE ASSY FERRITE BEADS 406466	21793	406466
C1	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C2	130103	CAP CERAM .01 MFD 25 V 20%	72982	9ACF-W5R103M
C3	130103	CAP CERAM .01 MFD 25 V 20%	72982	9ACF-W5R103M
C4	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C5	130103	CAP CERAM .01 MFD 25 V 20%	72982	9ACF-W5R103M
C6	130104	CAP CERAM .001 MFD 100 V 20%	72982	9ACF-W5R102M
C7	110001	CAP TANTA 6.8 MFD 35 V 20%	05397	T310B685K035AS
C8	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C9	130103	CAP CERAM .01 MFD 25 V 20%	72982	9ACF-W5R103M
C10	130103	CAP CERAM .01 MFD 25 V 20%	72982	9ACF-W5R103M
C11	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C12	130104	CAP CERAM .001 MFD 100 V 20%	72982	9ACF-W5R102M
C13	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C14	130103	CAP CERAM .01 MFD 25 V 20%	72982	9ACF-W5R103M
C15	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C16	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C17	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C18	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C19	130103	CAP CERAM .01 MFD 25 V 20%	72982	9ACF-W5R103M
C20	130103	CAP CERAM .01 MFD 25 V 20%	72982	9ACF-W5R103M
C21	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C22	100025	CAP CERAM .005 MFD 100 V 20%	72982	835-000-X5V0502Z
C23	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C24	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C25	130103	CAP CERAM .01 MFD 25 V 20%	72982	9ACF-W5R103M
C26	130103	CAP CERAM .01 MFD 25 V 20%	72982	9ACF-W5R103M
C27	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C28	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C29	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C30	130103	CAP CERAM .01 MFD 25 V 20%	72982	9ACF-W5R103M
C31	130103	CAP CERAM .01 MFD 25 V 20%	72982	9ACF-W5R103M
C32	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C33	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C34	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C35	130103	CAP CERAM .01 MFD 25 V 20%	72982	9ACF-W5R103M
C36	130103	CAP CERAM .01 MFD 25 V 20%	72982	9ACF-W5R103M
C37	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C38	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C39	130103	CAP CERAM .01 MFD 25 V 20%	72982	9ACF-W5R103M

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
C40	130104	CAP CERAM .001 MFD 100 V 20%	72982	9ACF-W5R102M
C41	130104	CAP CERAM .001 MFD 100 V 20%	72982	9ACF-W5R102M
C42	130104	CAP CERAM .001 MFD 100 V 20%	72982	9ACF-W5R102M
C43	130104	CAP CERAM .001 MFD 100 V 20%	72982	9ACF-W5R102M
C44	130104	CAP CERAM .001 MFD 100 V 20%	72982	9ACF-W5R102M
C45	100009	CAP CERAM 5 PFD 500 V 10%	71471	TCDI-1(N750)
C46	130104	CAP CERAM .001 MFD 100 V 20%	72982	9ACF-W5R102M
C47	130104	CAP CERAM .001 MFD 100 V 20%	72982	9ACF-W5R102M
C48	130103	CAP CERAM .01 MFD 25 V 20%	72982	9ACF-W5R103M
C49	130104	CAP CERAM .001 MFD 100 V 20%	72982	9ACF-W5R102M
C50	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C51	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C52	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C53	130103	CAP CERAM .01 MFD 25 V 20%	72982	9ACF-W5R103M
C54	110001	CAP TANTA 6.8 MFD 35 V 20%	05397	T310B685K035AS
C55	110001	CAP TANTA 6.8 MFD 35 V 20%	05397	T310B685K035AS
C56	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C57	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C58	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C59	110001	CAP TANTA 6.8 MFD 35 V 20%	05397	T310B685K035AS
C60	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C61	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C62	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C63	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C64	101174	CAP CERAM .001 MFD 500 V 10%	04222	SCD-DI-2X5F-1000
C65	130104	CAP CERAM .001 MFD 100 V 20%	72982	9ACF-W5R102M
C66	130103	CAP CERAM .01 MFD 25 V 20%	72982	9ACF-W5R103M
C67	100130	CAP CERAM 10 PFD 100 V 10%	71590	CN15A100K
C68	100060	CAP CERAM 15 PFD 1000 V 5%	56289	C030B102E150J
C69	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C70	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
CR1	210022	DIODE HP5082-3080	50434	HP5082-3080
CR2	210022	DIODE HP5082-3080	50434	HP5082-3080
CR3	210022	DIODE HP5082-3080	50434	HP5082-3080
CR4	220007	DIODE SILICO ZENER 1N751A	81349	1N751A
CR5	220007	DIODE SILICO ZENER 1N751A	81349	1N751A
CR6	210022	DIODE HP5082-3080	50434	HP5082-3080
CR7	210004	DIODE SILICO 1N4004	81349	1N4004
CR8	210022	DIODE HP5082-3080	50434	HP5082-3080
CR9	211083	DIODE SILICO 1N916B	81349	1N916B
CR10	211083	DIODE SILICO 1N916B	81349	1N916B
CR11	220007	DIODE SILICO ZENER 1N751A	81349	1N751A
CR12	210026	DIODE RF DETECTOR 1N82AG	81349	1N82AG
CR13	210069	DIODE SILICO Matched Set of 4	21793	210069
CR14	210069	DIODE SILICO Matched Set of 4	21793	210069
CR15	220031	DIODE SILICO ZENER 1/4M3.3AZ5	04713	1/4M3.3AZ5
CR16	210069	DIODE SILICO Matched Set of 4	21793	210069
CR17	210069	DIODE SILICO Matched Set of 4	21793	210069
CR18	210026	DIODE RF DETECTOR 1N82AG	81349	1N82AG
CR19	210026	DIODE RF DETECTOR 1N82AG	81349	1N82AG
CR20	211083	DIODE SILICO 1N916B	81349	1N916B

406114 – Assy., PCB, 500 MHz PRESCALER (1 mV) OPTION 030 *continued*

REF DES	DANA P/N	DESCRIPTION				FSC	MANU P/N
CR21	210004	DIODE	SILICO		1N4004	81349	1N4004
J12	600610	CONN	RECEPTACLE			98291	50-053-0000
J13	600610	CONN	RECEPTACLE			98291	50-053-0000
L1	310062	CHOKE	RF	22 UH	1537-44	99800	1537-44
L2	310062	CHOKE	RF	22 UH	1537-44	99800	1537-44
L3	310062	CHOKE	RF	22 UH	1537-44	99800	1537-44
L4	310062	CHOKE	RF	22 UH	1537-44	99800	1537-44
L5	310062	CHOKE	RF	22 UH	1537-44	99800	1537-44
L6	310062	CHOKE	RF	22 UH	1537-44	99800	1537-44
L7	310062	CHOKE	RF	22 UH	1537-44	99800	1537-44
L8	310087	CHOKE				21793	310087
L9	310087	CHOKE				21793	310087
L10	310081	CHOKE	INDUCTOR			21793	310081
L11	310066	CHOKE	RF	.68 UH	1025-16	99800	1025-16
L12	310087	CHOKE				21793	310087
L13	310087	CHOKE				21793	310087
L14	310081	CHOKE	INDUCTOR			21793	310081
L15	310087	CHOKE				21793	310087
L16	310066	CHOKE	RF	.68 UH	1025-16	99800	1025-16
L17	310087	CHOKE				21793	310087
L18	310081	CHOKE	INDUCTOR			21793	310081
L19	310087	CHOKE				21793	310087
L20	310066	CHOKE	RF	.68 UH	1025-16	99800	1025-16
L21	310087	CHOKE				21793	310087
L22	310081	CHOKE	INDUCTOR			21793	310081
L23	310087	CHOKE				21793	310087
L24	310066	CHOKE	RF	.68 UH	1025-16	99800	1025-16
L25	310081	CHOKE	INDUCTOR			21793	310081
L26	310092	CHOKE	RF	.1 UH	9230-94	76493	9230-94
L27	310062	CHOKE	RF	22 UH	1537-44	99800	1537-44
L28	310087	CHOKE				21793	310087
M1	230045	INTEGRATED CIRCUIT			UA741C	07263	U6E7741393
M2	230095	INTEGRATED CIRCUIT			MC1670L	04713	MC1670L
P10	730421	CONN	6 PIN	MODIFIED	730421	21793	730421
Q1	200149	TRANS	SILICO	NPN	2N3569	81349	2N3569
Q2	200148	TRANS	SILICO	PNP	2N3638	81349	2N3638
Q3	200255	TRANS	SILICO	NPN	TP491	07716	TP491
Q4	200255	TRANS	SILICO	NPN	TP491	07716	TP491
Q5	200255	TRANS	SILICO	NPN	TP491	07716	TP491
Q6	200255	TRANS	SILICO	NPN	TP491	07716	TP491
Q7	200255	TRANS	SILICO	NPN	TP491	07716	TP491
Q8	200238	TRANS	MATCHED SET			21793	200238
Q9	200238	TRANS	MATCHED SET			21793	200238

406114 – Assy., PCB, 500 MHz PRESCALER (1 mV) OPTION 030 *continued*

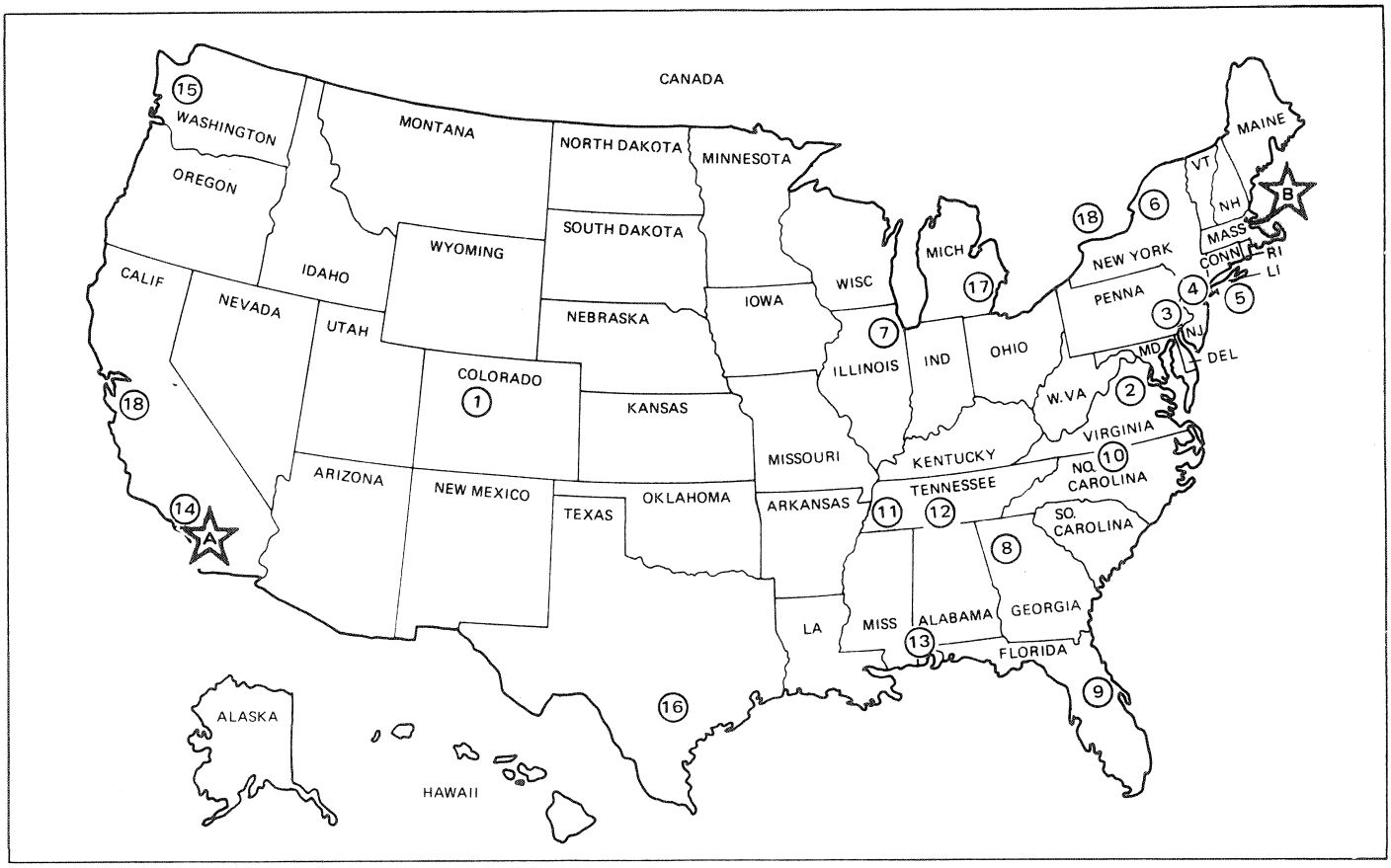
REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
Q10	200186	TRANS MATCHED PAIR WITH Q12	21793	200186
Q11	200238	TRANS MATCHED SET	21793	200238
Q12	200186	TRANS MATCHED PAIR WITH Q10	21793	200186
Q13	200238	TRANS MATCHED SET	21793	200238
Q14	200238	TRANS MATCHED SET	21793	200238
Q15	200238	TRANS MATCHED SET	21793	200238
Q16	200186	TRANS MATCHED PAIR WITH Q19	21793	200186
Q17	200238	TRANS MATCHED SET	21793	200238
Q18	200238	TRANS MATCHED SET	21793	200238
Q19	200186	TRANS MATCHED PAIR WITH Q16	21793	200186
Q20	200186	TRANS MATCHED PAIR WITH Q21	21793	200186
Q21	200186	TRANS MATCHED PAIR WITH Q20	21793	200186
Q22	200151	TRANS SILICO NPN SELECTED 2N5179	21793	200151
R1	000101	RES CARBON 100 OHM 5% 1/4W	81349	RC07GF101J
R2	001683	RES CARBON 47 OHM 5% 1/2W	81349	RC20GF470J
R3	000100	RES CARBON 10 OHM 5% 1/4W	81349	RC07GF100J
R4	001684	RES CARBON 39 OHM 5% 1/2W	81349	RC20GF390J
R5	001159	RES CARBON 330 OHM 5% 1/2W	81349	RC20GF331J
R6	000100	RES CARBON 10 OHM 5% 1/4W	81349	RC07GF100J
R7	001472	RES CARBON 10 OHM 5% 1/2W	81349	RC20GF100J
R8	000362	RES CARBON 3.6 K 5% 1/4W	81349	RC07GF362J
R9	000100	RES CARBON 10 OHM 5% 1/4W	81349	RC07GF100J
R10	000101	RES CARBON 100 OHM 5% 1/4W	81349	RC07GF101J
R11	000470	RES CARBON 47 OHM 5% 1/4W	81349	RC07GF470J
R12	001773	RES CARBON 200 OHM 5% 1/8W	81349	RC05GF201J
R13	000103	RES CARBON 10 K 5% 1/4W	81349	RC07GF103J
R14	000103	RES CARBON 10 K 5% 1/4W	81349	RC07GF103J
R15	000430	RES CARBON 43 OHM 5% 1/4W	81349	RC07GF430J
R16	000680	RES CARBON 68 OHM 5% 1/4W	81349	RC07GF680J
R17	000103	RES CARBON 10 K 5% 1/4W	81349	RC07GF103J
R18	000822	RES CARBON 8.2 K 5% 1/4W	81349	RC07GF822J
R19	000302	RES CARBON 3 K 5% 1/4W	81349	RC07GF302J
R20	000111	RES CARBON 110 OHM 5% 1/4W	81349	RC07GF111J
R21	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R22	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R23	001773	RES CARBON 200 OHM 5% 1/8W	81349	RC05GF201J
R24	000103	RES CARBON 10 K 5% 1/4W	81349	RC07GF103J
R25	000103	RES CARBON 10 K 5% 1/4W	81349	RC07GF103J
R26	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R27	000912	RES CARBON 9.1 K 5% 1/4W	81349	RC07GF912J
R28	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R29	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R30	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R31	040122	POT 200 OHM 62PR200	73138	62PR200

406114 – Assy., PCB, 500 MHz PRESCALER (1 mV) OPTION 030 *continued*

REF DES	DANA P/N	DESCRIPTION				FSC	MANU P/N
R32	000242	RES	CARBON	2.4 K	5% 1/4W	81349	RC07GF242J
R33	000272	RES	CARBON	2.7 K	5% 1/4W	81349	RC07GF272J
R34	001773	RES	CARBON	200 OHM	5% 1/8W	81349	RC05GF201J
R35	000103	RES	CARBON	10 K	5% 1/4W	81349	RC07GF103J
R36	000103	RES	CARBON	10 K	5% 1/4W	81349	RC07GF103J
R37	000822	RES	CARBON	8.2 K	5% 1/4W	81349	RC07GF822J
R38	000102	RES	CARBON	1 K	5% 1/4W	81349	RC07GF102J
R39	000102	RES	CARBON	1 K	5% 1/4W	81349	RC07GF102J
R40	001773	RES	CARBON	200 OHM	5% 1/8W	81349	RC05GF201J
R41	000103	RES	CARBON	10 K	5% 1/4W	81349	RC07GF103J
R42	000103	RES	CARBON	10 K	5% 1/4W	81349	RC07GF103J
R43	000752	RES	CARBON	7.5 K	5% 1/4W	81349	RC07GF752J
R44	000102	RES	CARBON	1 K	5% 1/4W	81349	RC07GF102J
R45	000681	RES	CARBON	680 OHM	5% 1/4W	81349	RC07GF681J
R46	001773	RES	CARBON	200 OHM	5% 1/8W	81349	RC05GF201J
R47	000103	RES	CARBON	10 K	5% 1/4W	81349	RC07GF103J
R48	000103	RES	CARBON	10 K	5% 1/4W	81349	RC07GF103J
R49	000562	RES	CARBON	5.6 K	5% 1/4W	81349	RC07GF562J
R50	000361	RES	CARBON	360 OHM	5% 1/4W	81349	RC07GF361J
R51	000121	RES	CARBON	120 OHM	5% 1/4W	81349	RC07GF121J
R54	000512	RES	CARBON	5.1 K	5% 1/4W	81349	RC07GF512J
R55	001737	RES	CARBON	FSV	5% 1/4W	21793	001737
R56	001787	RES	CARBON	20 OHM	5% 1/8W	01121	See Descrpt.
R57	000121	RES	CARBON	120 OHM	5% 1/4W	81349	RC07GF121J
R58	000182	RES	CARBON	1.8 K	5% 1/4W	81349	RC07GF182J
R59	000121	RES	CARBON	120 OHM	5% 1/4W	81349	RC07GF121J
R60	001787	RES	CARBON	20 OHM	5% 1/8W	01121	See Descrpt.
R61	001737	RES	CARBON	FSV	5% 1/4W	21793	001737
R62	001737	RES	CARBON	FSV	5% 1/4W	21793	001737
R63	000240	RES	CARBON	24 OHM	5% 1/4W	81349	RC07GF240J
R64	001787	RES	CARBON	20 OHM	5% 1/8W	01121	See Descrpt.
R65	000121	RES	CARBON	120 OHM	5% 1/4W	81349	RC07GF121J
R66	000130	RES	CARBON	13 OHM	5% 1/4W	81349	RC07GF130J
R67	000182	RES	CARBON	1.8 K	5% 1/4W	81349	RC07GF182J
R68	000121	RES	CARBON	120 OHM	5% 1/4W	81349	RC07GF121J
R69	001787	RES	CARBON	20 OHM	5% 1/8W	01121	See Descrpt.
R70	000823	RES	CARBON	82 K	5% 1/4W	81349	RC07GF823J
R71	001737	RES	CARBON	FSV	5% 1/4W	21793	001737
R72	000270	RES	CARBON	27 OHM	5% 1/4W	81349	RC07GF270J
R73	000362	RES	CARBON	3.6 K	5% 1/4W	81349	RC07GF362J
R74	000151	RES	CARBON	150 OHM	5% 1/4W	81349	RC07GF151J
R75	000511	RES	CARBON	510 OHM	5% 1/4W	81349	RC07GF511J
R76	000271	RES	CARBON	270 OHM	5% 1/4W	81349	RC07GF271J
R77	000301	RES	CARBON	300 OHM	5% 1/4W	81349	RC07GF301J
R78	000301	RES	CARBON	300 OHM	5% 1/4W	81349	RC07GF301J

406114 – Assy., PCB, 500 MHz PRESCALER (1 mV) OPTION 030 *continued*

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
R79	000751	RES CARBON 750 OHM 5% 1/4W	81349	RC07GF751J
R80	000200	RES CARBON 20 OHM 5% 1/4W	81349	RC07GF200J
R81	001792	RES CARBON 150 OHM 5% 1/8W	81349	RC05GF151J
R82	001782	RES CARBON 180 OHM 5% 1/8W	81349	RC05GF181J
R83	001782	RES CARBON 180 OHM 5% 1/8W	81349	RC05GF181J
R84	001782	RES CARBON 180 OHM 5% 1/8W	81349	RC05GF181J
R85	001782	RES CARBON 180 OHM 5% 1/8W	81349	RC05GF181J
R86	000100	RES CARBON 10 OHM 5% 1/4W	81349	RC07GF100J



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Boulder Industrial Park
Boulder, Colorado 80302
Telephone: (303) 441-4786

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Falls Church, Virginia 22042
Telephone: (703) 573-8240

(3) P.O. Box 507
Lansdale, Pennsylvania 19446
Telephone: (215) 822-2929

AMPOWER ELECTRONIC INSTRUMENT CO., INC.

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Totowa, New Jersey 07512
Telephone: (201) 790-6750
TWX: 710-988-5949

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Farmingdale, New York 11735
Telephone: (516) 752-1078

(6) 1161 Brighton-Henrietta
Town Line Road
Rochester, New York 14623
Telephone: (716) 473-0140

(7) PIVAN SERVICE
3535 Peterson Avenue
Chicago, Illinois 60659
Telephone: (312) 539-4838
TWX: 910-221-0177

BROWNELL-ELECTRO

(8) 3020 Commerce Way
Atlanta, Georgia 30354
Telephone: (404) 762-5181

(9) 307 27th Street
Orlando, Florida 32806
Telephone: (305) 843-6775

(10) 5141 Belhaven Blvd.
Charlotte, North Carolina 28216
Telephone: (704) 394-4341

(11) 3053 Tranquility Drive
Memphis, Tennessee 38116
Telephone: (901) 332-9258

(12) 1050 Acorn Drive
Nashville, Tennessee 37210
Telephone: (615) 889-8230

(13) 3450 Armour Drive
Mobile, Alabama 76607
Telephone: (205) 479-8581

(14) STAUS ENGINEERING
1900 Tyler Avenue, Unit 26
South El Monte, California 91733
Telephone: (213) 442-3634

(15) XTEK
2689 151st Place NE
Redmond, Washington 98052
Telephone: (206) 885-6969

(16) RHODES-GROOS LABORATORIES
3409 Andtree Blvd.
Austin, Texas 78724
Telephone: (512) 928-0813

(17) SSCO STANDARDS LABORATORY
8720 Northend Avenue
Oak Park, Michigan 48237
Telephone: (313) 358-2500

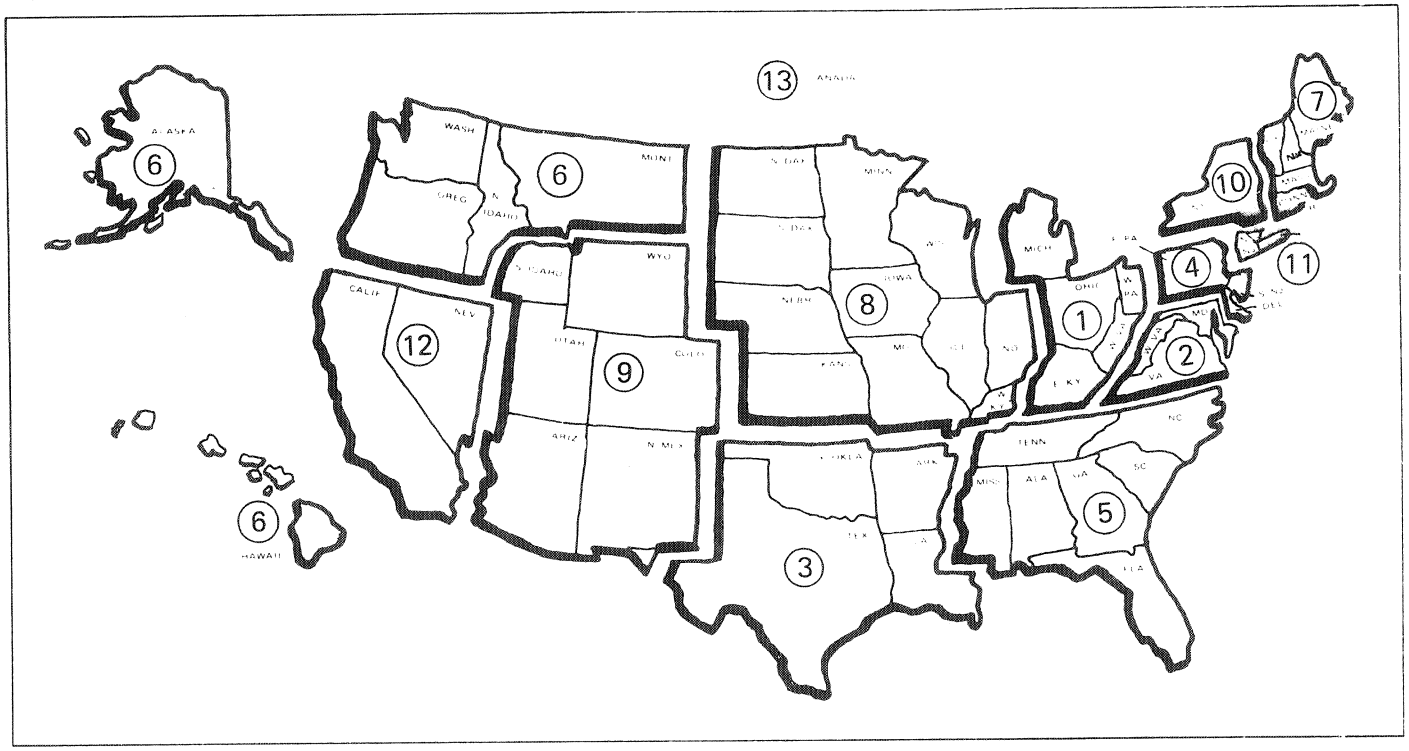
(18) J.D. ASSOCIATES
1012 Morse, Suite No. 6
Sunnyvale, California 94086
Telephone: (408) 734-5529

FACTORY SERVICE LOCATIONS

(A) RACAL-DANA INSTRUMENTS INC.
18912 Von Karman Avenue
Irvine, California 92715
Telephone: (714) 833-1234

(B) PAT JENKS ASSOCIATES
591 North Ave., Door 3
Wakefield, Massachusetts 01880
Telephone: (617) 246-1590

PRODUCT SERVICE TWX 910-595-1539



1 CARTER, McCORMIC & PEIRCE, INC.

23995 Freeway Park Drive
Farmington, Michigan 48024
Telephone: (313) 477-7700
TWX: 810-242-2986

22650 Lorain Road
Fairview Park, Ohio 44126
Telephone: (216) 779-5100
TWX: 810-427-9253

4977 Northcutt Place
Behnken Building, Suite 316
Dayton, Ohio 45414
Telephone: (513) 222-7700
TWX: 810-459-1613

409 Beatty Rd.
Monroeville, Pennsylvania 15146
Telephone: (412) 372-4415
TWX: 710-797-3671

2 CREATIVE MARKETING ASSOC.

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McLean, Virginia 22101
Telephone: (703) 893-6612
TWX: 710-833-0310

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Houston, Texas 77057
Telephone: (713) 780-2511
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14235 Proton Road
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Telephone: (214) 661-0300
TWX: 910-860-5483

8622 Crownhill, Suite 105
San Antonio, Texas 78209
Telephone: (512) 828-0937
TWX: 910-871-1033

2401 N.W. 39 Expressway,
Suite 103
Oklahoma City, Oklahoma 73112
Telephone: (405) 528-6071
TWX: None

300 Huntland Avenue, Suite 233
Austin, Texas 78752
Telephone: (512) 451-5174
TWX: None

4 EASTERN INSTRUMENTATION OF PHILADELPHIA

613 West Cheltenham Avenue
Philadelphia, Pennsylvania 19126
Telephone: (215) 927-7777
TWX: 710-670-0949

5 GENTRY ASSOCIATES, INC.

550 N. Bumby Avenue
Orlando, Florida 32803
Telephone: (305) 894-4401
TWX: 810-850-0136

2109 W. Clinton Avenue, Rm 130
Huntsville, Alabama 35805
Telephone: (205) 534-9771
TWX: 810-726-2220

428 Alamance Road
Burlington, North Carolina 27215
Telephone: (919) 227-3639
TWX: 510-921-5751

16 Perimeter Park Dr., Suite 106B
Atlanta, Georgia 30341
Telephone: (404) 455-1206
TWX: None

6 PACIFIC NORTHWEST ELECTRONICS

14264 S.E. Eastgate Way
Bellevue, Washington 98007
Telephone: (206) 641-6444
TWX: None

2035 S.W. 58th Street
Portland, Oregon 97221
Telephone: (503) 292-3505
TWX: None

7 PAT JENKS ASSOCIATES

2315 Whitney Avenue
Hamden, Connecticut 06518
Telephone: (203) 281-0810
TWX: 710-465-2096

591 North Avenue, Door 3
Wakefield, Massachusetts 01880
Telephone: (617) 246-1590
TWX: 710-348-6559

8 PIVAN ENGINEERING CO.

3535 Peterson Avenue
Chicago, Illinois 60659
Telephone: (312) 539-4838
TWX: 910-221-0177

5920 Nall, Suite 102
Shawnee Mission, Kansas 66202
Telephone: (913) 722-1030
TWX: 910-743-4172

11734 Lackland Industrial Drive
St. Louis, Missouri 63141
Telephone: (314) 567-3636
TWX: None

1259 West 86th Street
Indianapolis, Indiana 46260
Telephone: (317) 253-1681
TWX: 810-341-3308

5100 Edina Industrial Blvd.
Minneapolis, Minnesota 55435
Telephone: (612) 835-3060
TWX: 910-576-2982

3055 North Brookfield Road
Brookfield, Wisconsin 53005
Telephone: (414) 786-1940
TWX: None

204 Collins Rd., N.E.
Cedar Rapids, Iowa 52405
Telephone: (319) 377-9434
TWX: None

9 PLS ASSOCIATES, INC.

7418 E. Princeton Avenue
Denver, Colorado 80237
Telephone: (303) 773-1218
TWX: None

4300 H Silver Avenue, S.E.
Albuquerque, New Mexico 87108
Telephone: (505) 255-2330
TWX: None

7120 E. 4th St., Suite 4
Scottsdale, Arizona 85251
Telephone: (602) 994-5461
TWX: None

2332 E. Woodthrush Drive
Sandy, Utah 84070
Telephone: (801) 942-2081
TWX: None

10 SDM REPRESENTATIVES, INC.

23 North Fairview Ave.
Paramus, New Jersey 07652
Telephone: (201) 368-0123
TWX: 710-990-5168

673 Panorama Trail West
Rochester, New York 14625
Telephone: (716) 381-9962
TWX: None

37 Necterine Lane
Liverpool, New York 13088
Telephone: (315) 652-8335
TWX: None

11 TECHNICAL MARKETING ASSOC.

2460 Lemoine Avenue
Fort Lee, New Jersey 07024
Telephone: (201) 224-6911
TWX: 710-991-9710

12 WARD/DAVIS ASSOCIATES

16722 South Hawthorne Blvd.
Lawndale, California 90260
Telephone: (213) 542-7740
TWX: None

757 E. Evelyn Avenue
Sunnyvale, California 94086
Telephone: (408) 245-3700
TWX: None

8934 Caminito Verano
La Jolla, California 92037
Telephone: (714) 459-3351
TWX: None

13 TELE-RADIO SYSTEMS LTD.

301 Supertest Road
Downsview Post Office
Toronto, Ontario
CANADA M3J 2M4
(416) 661-3221
TWX: 610-492-2384