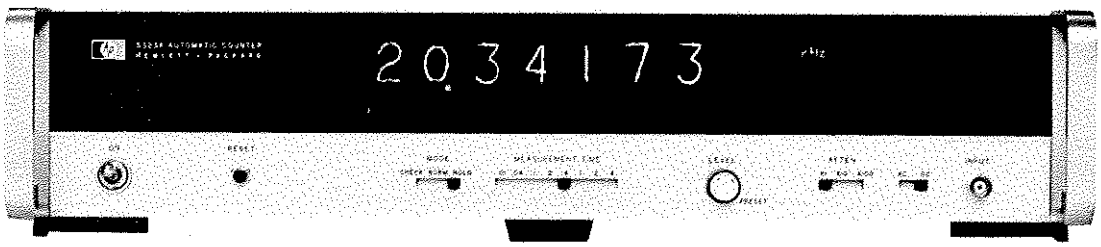
OPERATING AND SERVICE MANUAL

AUTOMATIC COUNTER

5323A



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CERTIFICATION

The Hewlett-Packard Company certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory. The Hewlett-Packard Company further certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards to the extent allowed by the Bureau's calibration facility.

WARRANTY AND ASSISTANCE

All Hewlett-Packard products are warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery, or, in the case of certain major components listed in the operating manual, for the specified period. We will repair or replace products which prove to be defective during the warranty period yrovitled they are returned to Hewlett-Pacltard. No other warranty is expressed or implied. We are not liable for consequential damages.

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For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

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AUTOMATIC COUNTER
5323A

SERIAL PREFIX: 936-

This manual applies directly Lo Hewlett-Packard Model 5323A Automatic Counters having serial prefix 936.

SERIAL *PREFIXES* NOT *LISTED*

For newer instruments with serial prefix above 936, a "Manual Changes" sheet is included with *this manual.* For older. instruments with serial prefix' below 936, changes required to backdate the manual can be found in Section VII.

02841-1 **Printed: NOV 1969**

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MANUAL CONTENT

This manual provides operating and service information for Hewlett-Packard 5323A Automatic Counter. Information is arranged in eight sections as follows:

Section I, GENERAL INFORMATION. contains an overall instrument description. specifications. equipment supplied, available accessories, options. and instrument applications.

Section II, INSTALLATION, covers unpacking, inspection, rack installation. power and cooling requirements. connections tor remote programming, and printer operation.

Section III, OPERATION, explains how to operate the 5323A, including display interpretation for all modes of operation.

Section IV, THEORY OF OPERATION, describes the overall theory of operation. Integrated circuit operation and special circuit operation arc included in this section.

Section V, MAINTENANCE, provides maintenance procedures, assembly designations. recommended test equipment, in-cabinet performance checks (incoming inspection). adjustments (calibration procedures), overall troubleshooting (locating defective assembly), and removal and replacement instructions.

Section VI, KEPLACEMENT PARTS. lists replacement parts by reference designator. including options. lists total quantity of each part used. and manufacturer's code and part number.

Section VII, OPTIONS, SPECIALS, AND MANUAL CIIANGES. covers options available, information for special instruments where applicable, and provides information to make this manual applicable for older instruments.

Section VIII, CIRCUIT DIAGRAMS AND SERVICE INFORMATION. contains schematic diagrams and component locators for all assemblies, operation of each assembly including waveforms and voltages. Adjustment and troubleshooting information are included in this section.

ADDITIONAL MANUALS

To order additional operating and service manuals, contact your nearest Hewlett-Packard Sales and Service Office. Give complete model. name, and 8-digit serial number. The serial number place is on the rear panel (see Section I for serial number system). This manual's HP part number is the last item listed in Table 6-1. Comments on this mallual arc welcome at any Sales and Service Office.

TABLE OF CONTENTS

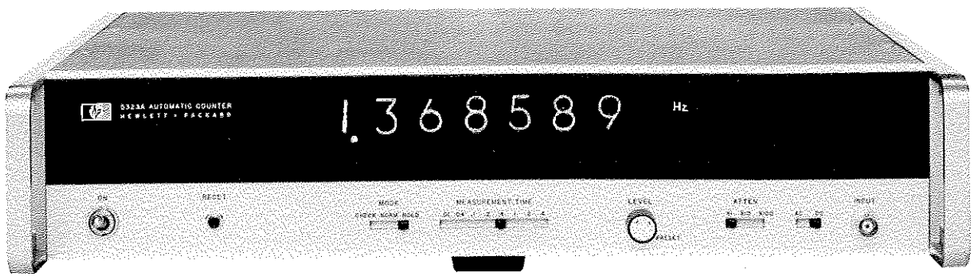
TABLE OF CONTENTS (CONT'D)

LIST OF TABLES

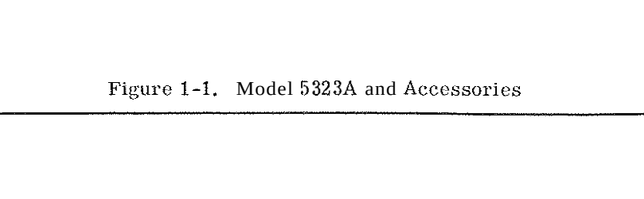
LIST OF FIGURES

Figure 1-1. Model 5323A and Accessories

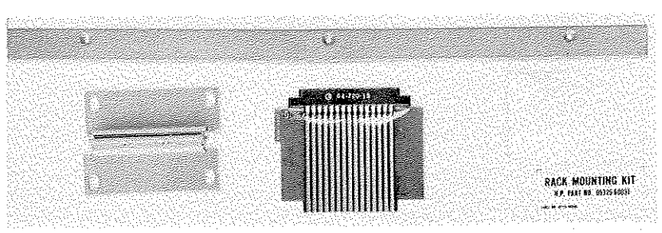
MODEL 5323A



BNC-BNC CABLE and POWER CORD



RACK MOUNTING KIT



SECTION I

GENERAL INFORMATION

1-1. DESCRIPTION

1-2. The 5323A Automatic Counter measures frequency with automatic range selection and constant resolution at all frequencies from 0.125 Hz to 20 MHz.

1-3. Frequency is measured by counting an arbitrary number of input periods (X) and accurately measuring the number of clock periods (Y) during the same interval. Input frequency is then computed by dividing X by Y and multiplying the result by the clock frequency. Frequency is displayed with seven digit resolution, automatically positioned decimal point, and correct measurement units.

1-4. Display features included are: 10 percent range-switching hysteresis, and automatic blanking of non-significant digits.

1-5. Selected measurement times of: .01, .04, .1, .2, .4, 1, 2, and 4 seconds, are front-panel selectable or controlled through the REMOTE PROGRAM connector. Measurement times can be controlled by using an external gate signal, to obtain times other than those described above, any value from 0 to 4 seconds.

1-6. The Counter will measure RPM by converting input pulses per second through a X60 multiplier to events-per-minute.

1-7. IDENTIFICATION

1-8. Hewlett-Packard uses a two-section, eight digit serial number (on instrument rear panel) to identify instruments (000-00000). The first three digits are a serial prefix number, and the last five digits refer to a specific instrument. If the serial prefix on your instrument does not appear on the title page of this manual, there may be differences between the manual and your instrument. If there are differences, they will be described in a change sheet included with the manual.

1-9. All instruments with the same prefix are the same. The group of instruments to which this manual applies directly is identified on the title page. For older instruments (lower serial numbers), make manual changes listed in Section VII. For newer instruments, having serial numbers higher than those listed on the title page, manual change sheets are included, describing the required changes. The manual for an instrument having special electrical modifications will include an insert sheet describing those modifications. If a change sheet or special information sheet is missing, the information sheet can be supplied by any Hewlett-Packard Sales and Service Office listed at the back of this manual.

1-10. SPECIFICATIONS

1-11. A complete list of specifications is found in Table 1-1.

Table 1-1. Specifications

RANGE: dc coupled: 0.125 Hz to 20 MHz.
ac coupled: 10 Hz to 20 MHz.

MEASUREMENT TIME: Selectable; 0.01, 0.04, 0.1, 0.2, 0.4, 1.0, 2.0, 4.0 s, or any time up to 4 s determined by the duration of an external gate signal.

GATE TIME: Automatically selected between measurement time and twice the measurement time.

SAMPLE RATE: Sum of gate time and computing time of approximately 1 ms.

ACCURACY: ±1 count ± time base error ± noise

RANGE SELECTION: Automatic.

HYSTERESIS: Range switching will automatically position the most significant digit in the first display position, except when the frequency is decreasing from 10... to 09.... In this case range switching is delayed until the input drops below 09... . This 10% hysteresis prevents unnecessary range changes due to input frequency jitter. Hysteresis may be inhibited by a rear panel switch.

SIGNAL INPUT:
Sensitivity (min.): 0.1 Vrms sine wave.
0.3 V p-p pulse, 25 ns minimum pulse width.
Sensitivity can be decreased by 10 or 100 times using the ATTENUATOR switch.

Impedance: 1 MΩ shunted by 35 pF.

Maximum Input:

Volts	ATTENUATOR Setting
120 Vrms (<1 kHz)	X1
250 Vrms	X10
500 Vrms	X100

Overload Level: 1.5 Vrms X ATTENUATOR settings

Table 1-1. Specifications (Cont'd)

SIGNAL INPUT Cont'd:
Trigger Level: PRESET to center triggering about OV, or adjustable:

Range	ATTENUATOK Setting
±1V	X1
±10V	X10
±100V	X100

Trigger Threshold Band: < 1.0 mV, referred to input at 20 MHz.

Time Base

CRYSTAL FREQUENCY: 10 MHz

CRYSTAL OVEN: Self-regulating solid-state type.

STABILITY:
Aging Rate: Less than 3 parts in 10^7/mo.

Temperature: ≤ ±7 parts in 10^8/°C.

Line Voltage: ≤ ±1 part in 10^7 for ±10% line voltage variation.

OSCILLATOR OUTPUT: 10 MHz, 1.0 V p-p, 5062 (approx.) source impedance at rear panel BNC.

EXTERNAL INPUT: 1.0 Vrms at a frequency of 1, 2.5, 5, or 10 MHz.

General

DISPLAY: 7-digit in-line Nixie® digital read-out plus positioned decimal point, units annunciator, and RPM annunciator.

BLANKING: All non-significant digits will be automatically blanked if the measurement time selected on the front panel is too short to guarantee lull accuracy. Rear panel switch allows all digits to be displayed without blanking if desired.

DISPLAY STORAGE: Holds reading and digital output constant between samples.

RPM DISPLAY: Rear panel switch connects an internal XKO multiplier that converts measurement from pulses per second to revolutions per minute.

"ARMED" LAMP. Is illuminated between time of reset and when input signal first reaches trigger level thereafter.

®Burroughs Corporation

GATE OUTPUT: 0V while gate open, +4V while gate closed. Available at rear panel BNC.

RESET: Front panel pushbutton switch resets the counter and causes display to be 0 Hz.

AUTOMATIC RESET: The counter will automatically reset to zero if the input is removed during any measurement, or if the period of the input signal is longer than twice the selected measurement time.

HOLD: Retains displayed information indefinitely while new measurement is made. New information is displayed immediately when "hold" is removed. A single measurement may be made by resetting from the "hold" position.

SELF-CHECK: Measures internal 10 MHz signal.

REMOTE PROGRAMMING: All front panel function controls are programmable.

Control Signal: Single line control lor each function. Operated by DTL or TTL integrated circuits or contact closure to ground. Amplifier trigger level can be set by the level of an external ±1V input (which is multiplied by the ATTENUATOR settings: X1, X10, X100).

DIGITAL OUTPUT:
Code: All numerals, decimal point, and unit information arc available as 4-lint! 8-4-2-1 coded signals. Logic "0" slate approximately 0.4V at 10 mA sink; logic "1" state approximately 5V open circuit, 2.5 kΩ impedance.

Print Command: +5V to OV step, dc coupled; occurs at end of measuring and computing cycle.

Storage: Buffer storage is provided so BCD output is held constant while next measurement is being made.

Hold-Off: Inhibits transfer of data to buffer storage when instrument's cycle time is less than time required for external equipment to interrogate BCD outputs. Positive inhibit +5V min., +20V max.

Chassis Connector: Special HP manufactured connector assembly.

CONNECTORS: All are BNC's except for Remote Programming (Cinch or Amphenol 57-40500-375, which mates with Amphenol 57-30500, HP 1251-0086) and Digital Output.

OPERATING TEMPERATURE: 0° to 50°C

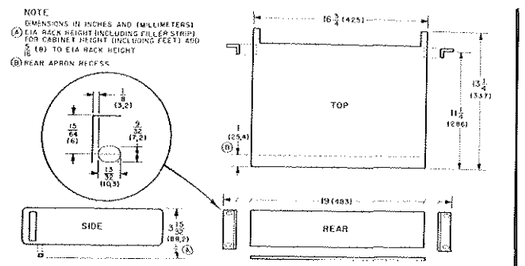
POWER REQUIREMENTS: 115 or 230 volts ±10%, 50 to 400 Hz, 45 watts maximum. Fast circuit breaker action with internal power reset switch protects supply. Also resets when main power is turned off. No cooling fan required.

Table 1-1. Specifications (Cont'd)

WEIGHT: Net, 14 lb (6, 4 kg).
Shipping, 19 lb (8, 6 kg)

ACCESSORIES FURNISHED: Power cord, 7-1/2 it. HP 10503A, 50Ω BNC to BNC cable, 4 ft (122 cm). Rack mount kit with P.C. extender board.

DIMENSIONS: 3-15/16 in. high, 16-3/4 in. wide, 11-1/4 in. deep (88, 2 x 425 x 286 mm).



1-12. INSTALLATION AND OPERATION

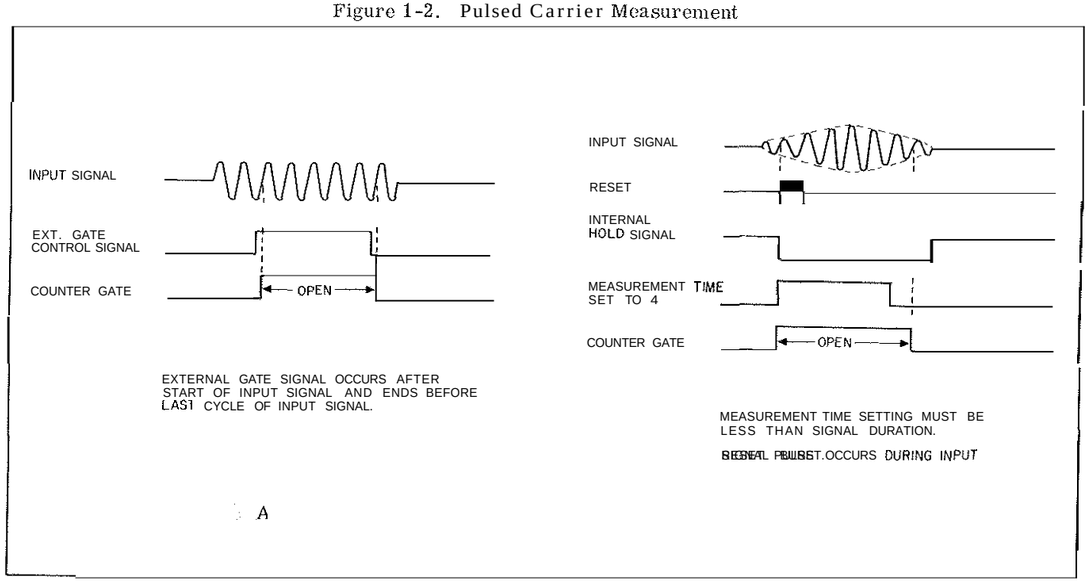
1-13. Installation and operation procedures arc described in Sections II and III of this manual. Remote programming and use of the HP 5050B Digital Recorder are included in Section II.

1-14. APPLICATIONS

1-15. The Automatic Counter measures frequency directly from 0. 125 Hz to 20 MHz. For tachometry applications, an internal X60 multiplier converts data from pulses per second to events per minute.

1-16. The Counter can be used to measure the carrier frequency of a pulsed signal (tone burst) without the use of a transfer oscillator by one of two methods. First is to apply an external gate signal and, as long as the gate signal is removed before the burst ends, the counter will measure the carrier frequency. Second is to set MEASUREMENT TIME switch to a time known to be shorter than the burst and the MODE switch to IIOLD. Then apply a reset pulse to the Counter sometime between bursts. The 5323A will start counting when a burst starts, and will stop before the burst ends. The two modes of operation are shown in Figures 1-2A and 1-2B.

Figure 1-2. Pulsed Carrier Measurement



1-17. EQUIPMENT SUPPLIED AND AVAILABLE

1-18. Equipment supplied is listed in Table 1-2. Table 1-3 lists some of the equipment available for use with the 5323A Counter.

Table 1-2. Equipment Supplied

DESCRIPTION	HP PART NO.
Cable: 4 ft. (122 cm) 50 ohm, male BNC connectors	10503A
Rack Mount Kit	05325-60031
Printed Circuit Extender Board	05245-6022
Detachable Power Cord: 7-1/2 ft. (231 cm) NEMA Plug	8120-0078
Fuse: Slo-Blow, 0.4A, 125V (For 230 Vac operation)	2110-0019

Table 1-3. Equipment Available

DESCRIPTION	HP PART NO.
Recorder Interconnecting Cable	10524A
Digital Recorder	5050B

SECTION II

INSTALLATION

2-1. INTRODUCTION

2-2. This section contains information on unpacking, inspection, repacking, storage, installation, remote programming, and use with the HP 5050B Digital Recorder.

2-3. UNPACKING AND INSPECTION

2-4. If the shipping carton is damaged, ask that the carrier's agent be present when instrument is unpacked. Inspect the instrument for damage (scratches, dents, broken knobs, etc.). If instrument is damaged or fails lo meet specifications, notify the carrier and the nearest Hewlett-Packard Sales and Service Office immediately (Sales and Service Offices are listed at the back of this manual). Retain tile shipping carton and the padding material for the carrier's inspection. The Sales and Service Office will arrange for repair or replacement of your instrument without waiting for the claim against the carrier to be settled.

2-5. STORAGE AND SHIPMENT

2-6. PACKAGING. To protect valuable electronic equipment during storage or shipment, always use the best packaging methods available. Your Hewlett-Packard Sales and Service Office can provide packing material such as that used for original factory packaging. Contract packaging companies in many cities can provide dependable custom packaging on short notice. Here are two recommended packaging methods:

a. Rubberized Hair. Cover painted surfaces of instrument with protective wrapping paper. Pack instrument securely in strong corrugated container (350 lb/sq. in. bursting test) with 2-inch rubberized hair pads placed along all surfaces of the instrument. Insert fillers between pads and container to insure a snug fit.

b. Excelsior. Cover painted surfaces of instrument with protective wrapping paper. Pack instrument in strong corrugated container (350 lb/sq. in. bursting test) with a layer of excelsior about six inches thick packed firmly against all surfaces of the instrument.

2-7. ENVIRONMENT. Temperature limitations during storage and shipment should be limited as follows:

a. Maximum temperature: +75°C (167°F).

b. Minimum temperature: -40°C (-40°F)

2-8. RACK INSTALLATION

2-9. The instrument is ready for bench operation as shipped from the factory. Additional parts necessary for rack mounting are packaged with the instrument. To convert lor rack installation, refer to Figure 2-1 and proceed as follows:

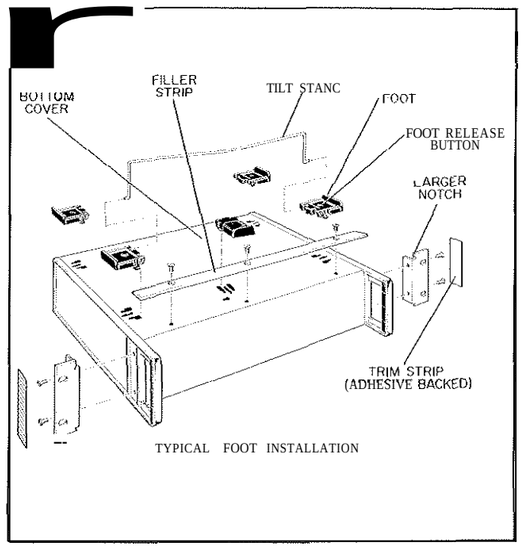
a. Remove feet (press the foot-release button, slide foot toward center of instrument, and lift off).

b. Remove adhesive-backed trim strips at front end of sides.

c. Attach filler strip along bottom edge of front panel.

d. Attach flanges to front end of sides (larger corner notch toward bottom of instrument). Instrument is now ready to mount in standard rack.

Figure 2-1. Conversion for Rack Mounting



2-10. POWER CONNECTION

2-11. LINE VOLTAGE. The Counter may be operated from either 115 or 230 volt (±10%) power lines. A slide switch on the rear panel permits quick conversion for operation from either voltage. The Counter is supplied with a 115 volt fuse; be sure to replace the fuse for 230 volt operation; see Table 2-1.

CAUTION

Before plugging the instrument into the AC power line, be sure the slide switch is properly positioned.

Table 2-1. 115/230 Volt Conversion

CONVERSION	115 VOLT	230 VOLT
Slide Switch	Left (115)	Right (230)
AC Line Fuse	0.8 Ampere Slow-Blow (HP 2110-0020)	0.4 Ampere Slow-Blow (HP 2110-0019)

2-12. POWER CABLE. The Counter is supplied with a detachable three-wire power cable. To install:

a. Connect flat plug (three conductor female connector) to rear panel AC line connection.

b. Determine AC line voltage in use. Use a narrow blade screwdriver and set rear panel 115/230V switch to same as line voltage in use.

c. Connect plug (two-blade with round grounding pin) to three-wire (grounded) power outlet. Exposed portions of instrument arc grounded through plug. When only a two-blade outlet is available, use HP adapter 1251-0048 and connect short wire from side of adapter to ground.

2-13. COOLING

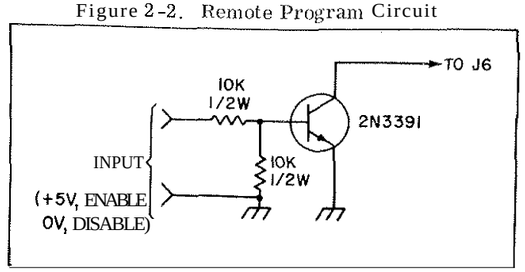
2-14. The Automatic Counter does not require a cooling fan. Adequate ventillation should be provided to maintain the temperature below +50°C.

2-15. REMOTE PROGRAMMING

2-16. All controls except the input attenuator, trigger level, and AC/DC coupling selector can be remotely programmed by contact closure to ground, by saturated NPN transistor, or by DTL or TTL integrated circuits.

To ensure proper operation in automatic systems, remote controls override the manual switches. Remotely programmable operations are: reset, self-check, measurement time step, measurement time interval from 0 to 4 seconds (duration equal to remote external gate command), HOLD, blanking inhibit, and hysteresis inhibit. A typical NPN transistor circuit is shown in Figure 2-2.

Figure 2-2. Remote Program Circuit



2-17. LEVEL control can be remotely set by applying a dc voltage equal to the desired triggering level (divided by input attenuator setting). LEVEL input voltage is ±1 volt multiplied by the input attenuator setting (X1, X10, X100).

2-18. Table 2-2 lists the pin assignments for J6, the remote program connector, mounted on the instrument rear panel. Wire colors, interconnection data, and levels are also indicated.

2-19. DIGITAL RECORDER

2-20. BCD output to drive the HP 5050B Digital Recorder are provided at A11J1 (DIGITAL RECORDER, rear panel of instrument). Pin assignments and BCD weighting for the connector signals are shown in Table 2-3.

2-21. A hold-off voltage from +5 to +20V will prevent the counter from resetting and taking a new measurement. When the Digital Recorder completes its cycle, this hold off is removed and the counter makes a new measurement.

Table 2-2. Connections To Remote Program Connector, J6

FUNCTION	PIN NO.	WIRE COLOR	CONNECTS TO*	REMARKS
15V	1	Wht-Blk	A16(13, 14)	----------
LEVEL	2	Wht-Brn	A2(3, C)	±1V (X1, X10, X100)
GROUND	3	Wilt-Red	Ground	----------
RESET	4	Wht-Orn	A3(10), J4, S1	Ground will enable.
CHECK	5	Wht-Yel	A3(E)	Ground will enable.
HOLD	6	Wht-Grn	A3(P), A11J4(11)	Ground will enable.
01	7	Wht-Blu	A6(P), A8(13)	Ground will enable.
04	8	Wht-Vio	A6(N), A8(11)	Ground will enable.
.1	9	Wht-Gra	A6(9), A8(10)	Ground will cnable.
2	14	Wht-Elk-Grn	A6(K), A8(9)	Ground will enable.
.4	11	Wht-Blk-Red	A6(J)	Ground will enable.
1	13	Wht-Blk-Yel	A6(H)	Ground will enable.
2	10	Wht-Blk-Brn	A6(8)	Ground will enable.
4	12	Wht-Blk-Orn	A6(7)	Ground will enable
EXT PROG	15	Wht-Blk-Blu	A11(Blu)	Ground will disable A10 **
GROUND	19	Blk	Ground	----------
EXT GATE	20	Brn	J2, A3(L)	Ground will enable A3 Board.
GATE OUT	21	Orn	53, A8(R)	0V (Gate Open). 14V (Gate Closed)
PRINT	22	Yel	A8(14), A11J4 (10)	+5V (Hold-Off). 0V (Print Command)
BLANK	23	Gra	S4, A8(F)	Ground will disable
HYSTERESIS	24	Wht	S5, A11(Wht)	Ground will disable.
No Connections are Made to Pins 16 Through 18 and 25 Through 36.				

* All interconnections between J6 and components are made via the A9 Connector Board Assembly (refer to Section VIII for schematic).

**The EXT PROG signal should be grounded, so that the MODE and MEASUREMENT TIME switches will be disabled. Otherwise, the switches will still control the counter operation and may not he overriden by remote programming.

Table 2-3. Digital Recorder (A11J1) Pin Functions

OUTPUT	BCD WEIGHT			
	8	4	2	1
	A11J1 PINS			
UNITS	2(U)	2(W)	2(X)	2(V)
10^1	2(S)	1(U)	1(V)	2(T)
10^2	1(P)	2(P)	2(R)	1(R)
10^3	2(M)	1(M)	1(N)	2(N)
10^4	1(J)	2(K)	2(L)	1(K)
10^5	2(J)	1(F)	1(H)	1(E)
10^6	2(D)	2(F)	2(H)	2(E)
EXPONENT	2(Y)	2(b)	2(c)	2(Z)
+5 VOLTS	1 (C, D, L, S, T, W, X, Y, Z, a, b, c) 2(C)			
GROUND	1 (A, B) 2 (A, B)			
	PRINT COMMAND		PIN 1(d)	
	PRINTER HOLD-OFF		PIN 2(a)	

1 Indicates component (top) side of A11, 2 Indicates copper (bottom) side of A11
Mating Connector for A11J1 is (1) HP Part No. 1251-2339, (2) Cinch Jones Part No. 600-121-26.

SECTION III

OPERATION

3-1. INTRODUCTION

3-2. The Counter measures frequency or RPM. The MODE switch selects NORM, CHECK, or HOLD. The MEASUREMENT TIME switch selects .01, .04, .1, .2, .4, 1, 2, or 4 seconds. The LEVEL control determines at what voltage level of the input signal together with the ATTEN switch, the input amplifier will trigger. Figures 3-2 and 3-3 describe the front and rear panel operating controls. Figures 3-4 and 3-5 provide step-by-step operating procedures for self-check and frequency measurements. Section II explains Remote Operation.

3-3. INTERPRETING DISPLAY

3-4. Direct readout is provided lor all measurements. The Counter automatically places the most significant digit to the left. Decimal point is positioned and measurement unit is displayed automatically. When the Hz/RPM switch is set to RPM, RPM will be displayed, otherwise MHz, kHz, or Hz will be displayed.

3-5. The BLANKING switch causes the non-significant digit(s) Lo be blanked when MEASUREMENT TIME selected is too short to obtain an accurate seven-digit readout. Table 3-1 lists the number of digits displaycil at various time settings.

Table 3-1. Digits Display Versus Measurement

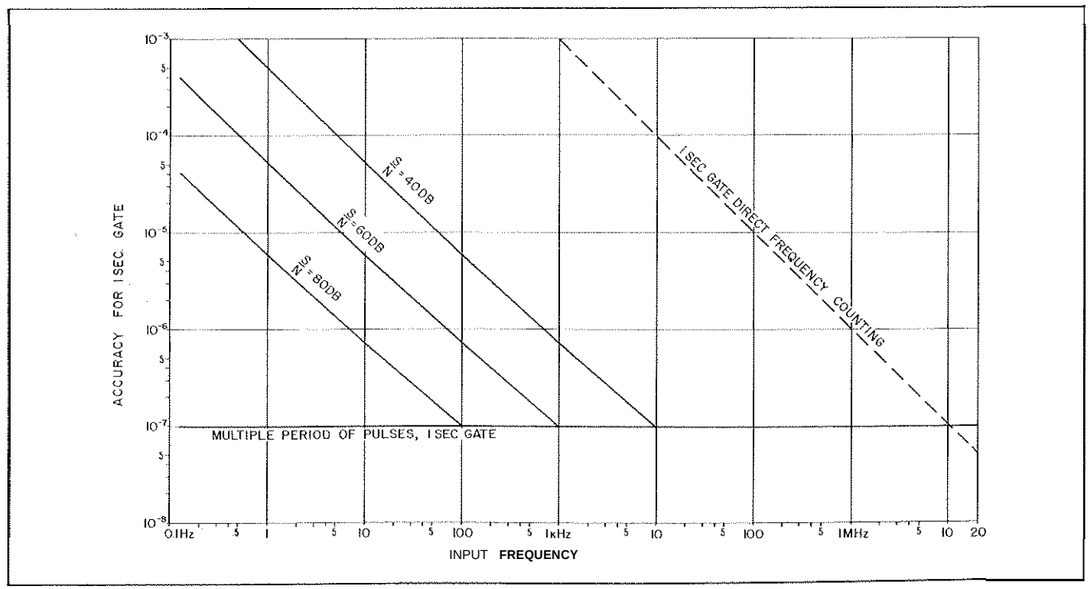
Measurement Time Setting	Most Significant Digit (MSD) of Input Frequency	
	MSD = 1 or Blank	MSD = 2 through 9
	Digits Displayed	Digits Displayed
.O1	G	5
.04	G	5
. 1	7	6
. 2	7	6
. 4	7	7
1	7	7
2	7	7
4	7	7

3-6. When a full input cycle does not occur during two times the selected measurement time, the Counter displays all zeros.

3-7. ACCURACY

3-8. Accuracy of the 5323A is shown in Figure 3-1; accuracy lor a conventional counter is shown for comparison. The accuracy shown in Figure 3-1 docs not

Figure 3-1. Accuracy Versus Frequency



include time base errors (as an external time base could be used), but consists of a ±100 nsec clockpulse ambiguity and a ± trigger error for 100 mV sine Wave input. With the LEVEL control set to PRESET, the error curves have a 99% confidence level.

3-9. Measurement resolution is limited only by ±1 count of the 10 MHz time base, or ±100 nsec time interval error. When MEASUREMENT TIME is decreased, resolution will degrade. For example:

Using a 1 second measurement lime, the resolution is 1 sec/100 nsec, or 1 part in 10^7, and all seven displayed digits are significant. Using a 0.1 second measurement time the resolution is 0.1 sec/100 nsec, or 1 part in 10^6, and the last digit of 1000000 is significant; however, a readout of 9999999 would only be accurate to 110, and the last digil is blanked.

3-10. HYSTERESIS

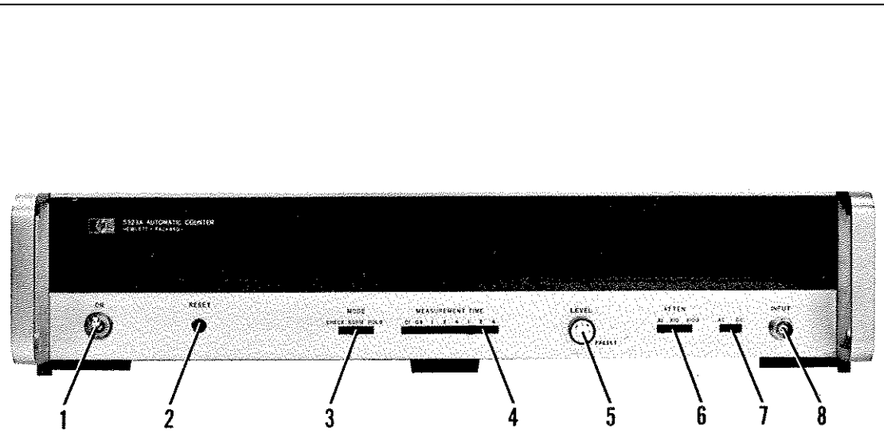
3-11. The range selection circuits have a hysteresis control designed to reduce confusion when the measured signal frequency is decreasing or changing about a decade value. For example:

With the Hysteresis switch on, if an input frequency of 999.9999 Hz increases 1 count to 1.000000 kHz, the range and decimal point change. However, if frequency decreases from 1.000000 kHz, the range and decimal point will remain unchanged until the frequency is < 0.900000 kHz, then changes to 899.9999 *Hz*. This 10% hysteresis prevents unnecessary and confusing range changes.

3-12. RPM MEASUREMENTS

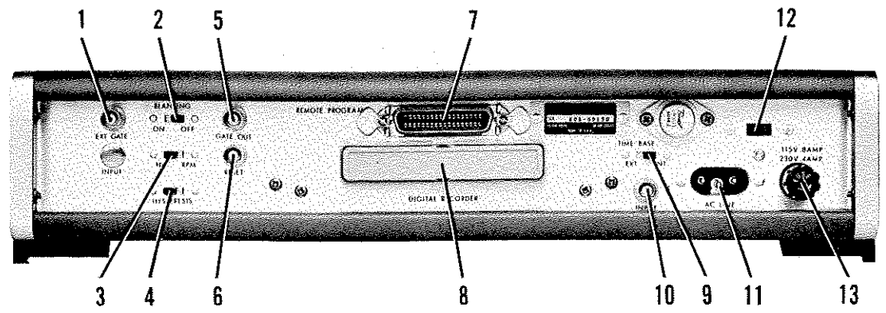
3-13. The Counter will measure RPM directly when the Hz/RPM switch is set to RPM. In this position, the internal 10 MHz clock is divided by 6, and the display decimal point is shifted one place, giving the effect of multiplying the input by 60. This will also increase the MEASUREMENT TIME by 6.

Figure 3-2. Front Operating Controls



1. POWER switch controls power to all circuits except part of Oscillator/Multiplier Assembly, (controlled by rear panel TIME BASE switch).
2. RESET pushbutton returns displayed and internal count to zero.
3. MODE:
   a. Applies 10 MHz internal clock to Gate Board in CHECK position. Display will be 10.00000 MHz or 100.0000 RPM.
   b. Permits frequency measurements of signals applied to INPUT connector in NORM position.
   c. Prevents display from automatically resetting in HOLD position.
4. MEASUREMENT TIME switch permits measurement time selections of .01, .04, .1, .2, .4, 1, 2, or 4 seconds.
5. LEVEL control selects input trigger level (multiplied by ATTEN setting). Trigger mill occur at OV when set Lo PRESET.
6. ATTEN switcli attenuates input signal amplitude by factors of 1, 10, or 100 (maximum overload; 120 Vrms in position 1, 250 Vrms in position 10, 500 Vrms in position 100).
7. AC-DC switch provides coupling to input amplifier through .033 μF (AC), or directly (DC).
8. INPUT, 0.125 Hz to 20 MHz

Figure 3-3. Rear Operating Controls

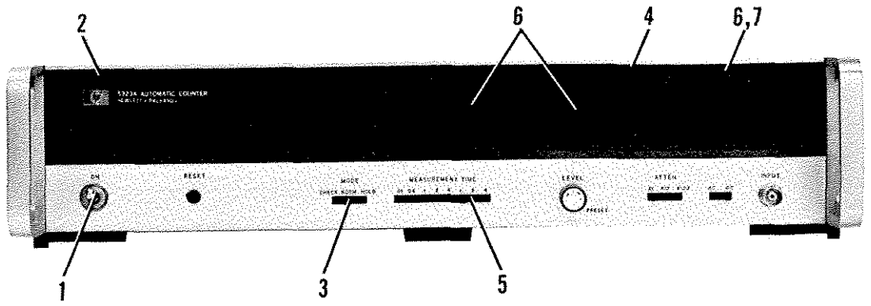


1. EXT GATE: permits use of an external gate signal lor measurement Limos other than those on front panel (between 0 and 4 seconds).
2. BLANKING switch disables automatic blanking feature.
3. Hz-RPM switch converts display from frequency (Hz) to events-per-minute (RPM).
4. HYSTERESIS switch disables automatic hysteresis feature.
5. GATE OUT: provides OV when Counter is counting (gate cycle) and +5V when not counting.
6. RESET: permits use of an external reset. Reset will occur when input is less than +0.8V.
7. REMOTE PROGRAM connector permits remote programming of:
   a. RESET
   b. SELF-CHECK
   c. HOLD
   d. BLANKING
   c. HYSTERESIS
   f. MEASUREMENT TIME
   g. LEVEL
   h. PRINTER HOLDOFF VOLTAGE
8. DIGITAL RECORDER connector supplies BCD information to recorder, digital-to-analog converter, or other data processing equipment.
9. TIME BASE switch selects either internal clock or permits use of an external time bast!. In INT position the internal clock is available as an output at connector J1, (10 MHz, 1.0V peak-to-peak).
10. J1 connector for applying external time base of 1. 2.5, 5, or 10 MHz, 1.0 Vrms (with TIME BASE in EXT) or counter's internal time hase output (with TIME BASE in INT).
11 AC LINE connector connects with flat plug of power cable.
12. Line Voltage switch permits selection of 115V or 230V AC line; insert narrow-blade screwdriver and slide to left for 115V operation, slide to right for 230V operation.
13. Fuse provides overload protection; should be 0.8 ampere, slow-blow for 115V operation or 0.4 ampere, slow-blow for 230V operation.

CAUTION

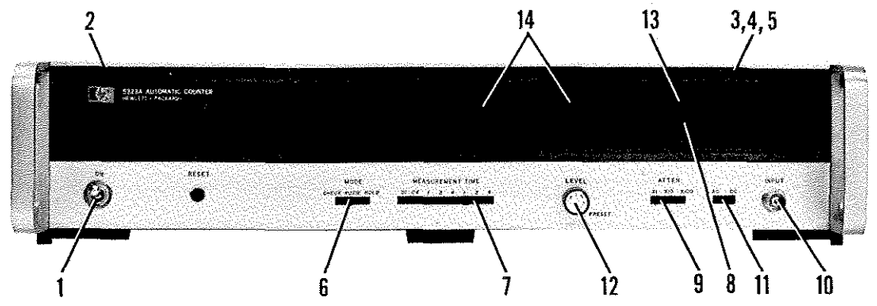
Before plugging instrument to AC power line be sure slide switch is properly positioned and correct fuse is installed.

Figure 3-4. Self-Check



1. Set POWER switch to ON.
2. Set TIME BASE switch (rear panel) to INT.
3. Set MODE switch tu CHECK.
4. Set BLANKING switch (rear panel) OFF.
5. Set MEASUREMENT TIME switch to any position
6. Set Hz/RPM switch (rear panel) to Hz. Display should be 10.00000 MHz.
7. Set Hz/RPM switch to RPM. Display should be 100.0000 RPM.

Figure 3-5. Frequency Measurement



1. Set POWER switch to ON.
2. Set TIME BASE switch (rear panel) to INT.
3. Set BLANKING switch (rear panel) to ON.
4. Set Hz/RPM switch (rear panel) to Hz.
5. Set HYSTERESIS switch (rear panel) Lo ON.
6. Set MODE switch to CHECK to verily proper Counter operation (see Figure 3-4). Return MODE switch to NORM.
7. Set the MEASUREMENT TIME switch to the desired measurement time.
8. With no input signal, the ARM lamp should be illuminated.
9. Set ATTEN switch to X100.
10. Connect unknown signal to INPUT jack.
11. Set AC-DC switch to AC (10 Hz to 20 MHz) or DC (0.125 Hz to 20 MHz).
12. Adjust LEVEL control for a steady display. If there is nu count, or if count is uncertain, switch ATTEN Lo a lower factor and readjust LEVEL control. Normally, the PRESET position will provide a steady display, with no DC offset voltage on the input signal.
13. The COUNTING lamp will illuminate, and the ARM lamp will go off when the measurement is being made.
14. Read frequency from display. Decimal point is correctly positioned, and correct measurement unit (MHz, kHz, or Hz) is displayed.

SECTION IV

THEORY OF OPERATION

4-1. INTRODUCTION

4-2. This sectiondiscusses the operation of individual circuits. Assemblies that make up the instrument are covered in detail in Section VIII, opposite each schematic diagram. Compute and Display Cycle timing, arithmetic operation, and overall Block Diagram are also described in this section.

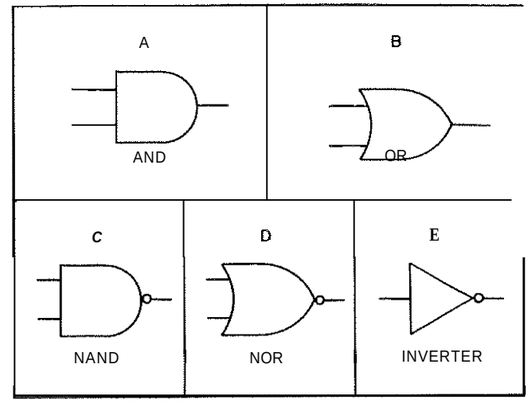
4-3. Logic Symbols

4-4. Two states exist in the binary system, 1 and 0. HIGH (N) and LOW (L) are used to represent the levels of 1 and 0. HIGH always represents the more positive level, whether it be positive or negative logic. Figure 4-1 shows four pairs of logic symbols that have the same truth tables and can be used interchangeably. The same function isnerformed bv what appears to bc two different logic symbols.

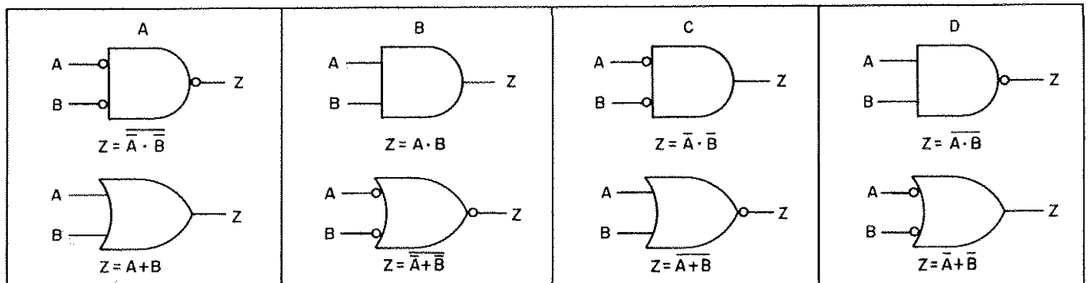
4-5. GATES. Figure 4-2(A) represents a basic AND gate. The AND gate output is HIGH if all inputs are HIGH. An AND gate may have two or more inputs. Figure 4-2(B) represents a basic OH gate. The OR pate output is HIGH if one or more of its inputs is HIGH. An OR gate may have two or more inputs.

4-6. INVERSION. AND and OR gates are shown in Figure 4-2 (A, B). A circle on the output of a logic symbol indicates a LOW when activated as shown in Figure 4-2 (C and D). Thus, a circle indicates inversion. An AND gate with an inverted output is called a NAND gate; an OR gate with an inverted output is called a NOR pate. A unity-gain amplifier with an inverted output is called an inverter, Figure 4-2 (E).

Figure 4-2. Gate Symbols



F i g 4-1. Logic Function Comparison



A	B	Z	A	B	Z	A	B	Z	A	B	Z
L	L	L	L	L	L	L	L	H	L	L	H
L	H	H	L	H	L	L	H	L	L	H	H
H	L	H	H	L	L	H	L	L	H	L	H
H	H	H	H	H	H	H	H	L	H	H	L

4-7. INTEGRATED CIRCUIT OPERATION

4-8. AND/OR Invert Gate

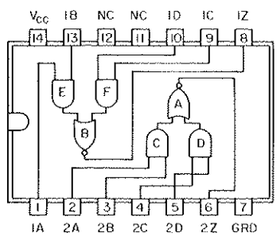
4-9. The DUAL AND/OR Invert Gate package is shown in Figure 4-3. The output (Z) will he LOW under three conditions:

a. Inputs A and B are both HIGH, oı

h. Inputs C and D are both HIGH, oı

c. Inputs A, B, C, and D are all HIGII. At all other times, Z will be HIGH.

Figure 4-3. AND-OR Invert Gate (1820-0063)



4-10. Dual D Triggered Flip/Flop

4-11. The Dual D Triggered Flip/Flop package is shown in Figure 4-4. The Q output will assume the same stale as the D input at the positive transition of the clock (CLK) pulse. The $\bar{Q}$ output is always opposite of the Q output, If the R input is LOW, the Q output will go LOW regardless of tlic D and CLK inputs. If the S input is LOW, the Q output will go HIGH regardless of the D and CLK inputs.

4-12. BCD to Decimal Decoder/Driver

4-13. The BCD to Decimal Decoder/Driver package is shown in Figure 4-5. The negative logic 4-bit BCD input controls the slate of one of 10 high-voltage output transistors (part of IC package), used to drive display tubes. Each of the 6 unused states (10 through 15) will turn off all output transistors to produce a blank display.

Figure 4-4. Dual D Triggered Flip/Flop (1820-0077)

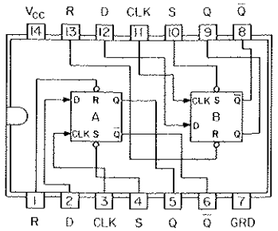
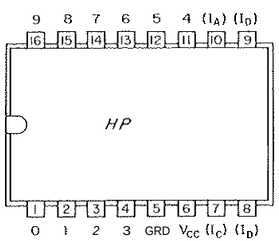


Figure 4-5. BCD lo Decimal Decoder/Driver (1820-0092)

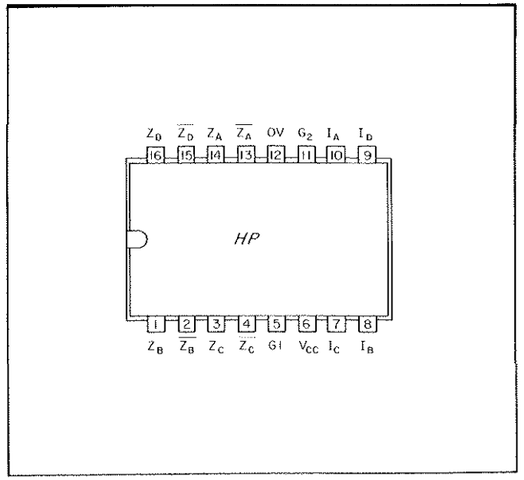


I_A(1)	I_B(2)	I_C(4)	I_D(8)	"ON" OUTPUT
H	H	H	H	0
L	H	H	H	1
H	L	H	H	2
L	L	H	H	3
H	H	L	H	4
L	H	L	H	5
H	L	L	H	6
L	L	L	H	7
H	H	H	L	8
L	H	H	L	9
BCD 10–15				NONE

4-14. Four-Bit Buffer Storage

4-15. The 4-hit Buffer Storage package is shown in Figure 4-6. The 4-hit BCD input will he gated into the buffer when tlic G1 input is cnahied by a LOW or open. The non-inverted output (Za, Zb, Zc, Zd) is in-phase with tlic input when G1 is LOW or open. The inverted output ($\bar{Z}$a, $\bar{Z}$b, $\bar{Z}$c, $\bar{Z}$d) is enabled when G2 is HIGH. When G2 is LOW, the inverted output is HHHH.

Figure 4-6. 4 Bit Buffer Storage (1820-0116)



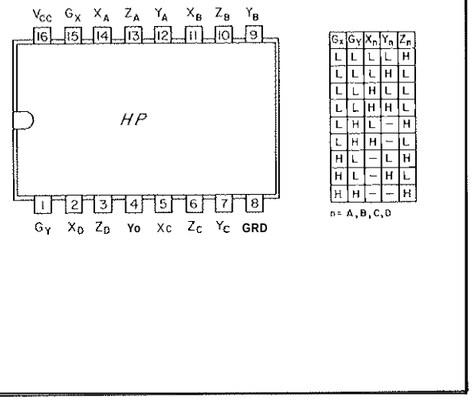
4-16. Blanking Decade Countet

4-11. The Blanking Decade Counter package is shown in Figure 4-7. The counter has two reset states determined by the reset control input. If the reset control is LOW, a HIGH resel pulse will set the counter lo LLLL (Blank). If the reset control is HIGII, a HIGH reset pulse will set the counter to HHHH (zero). The negative logic outputs are shown on the timing diagram.

4-18. Four-Pole Switch

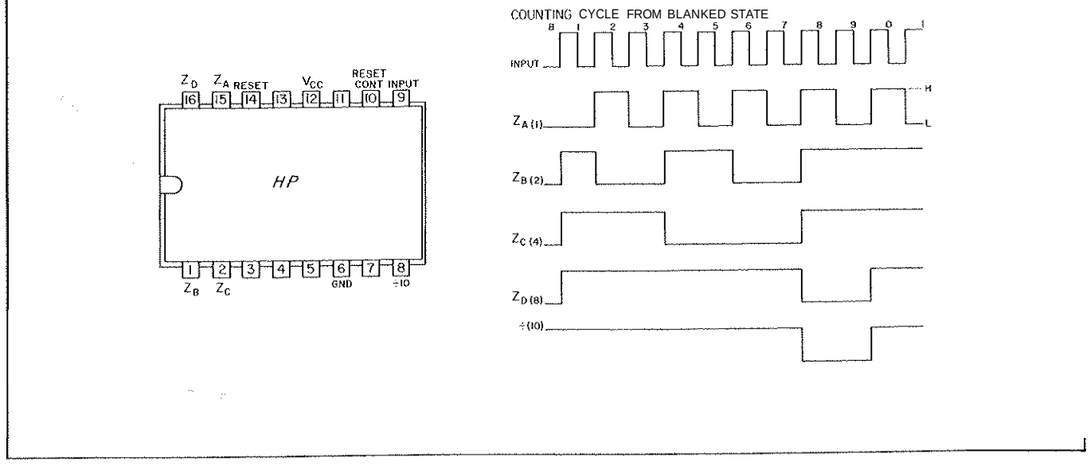
4-19. The 4-Pole Switch package is shown in Figure 4-8. The dashes in tlic input columns indicate that the state may be either HIGH or LOW without affecting the output (Z). Gx enables X inputs, Gy enables Y inputs.

Figure 4-8. 4 Pole Switch (1820-0135)



G_X	G_Y	X_n	Y_n	Z_n
L	L	L	L	H
L	L	L	H	L
L	L	H	L	L
L	L	H	H	L
L	H	L	–	H
L	H	H	–	L
H	L	–	L	H
H	L	–	H	L
H	H	–	–	H

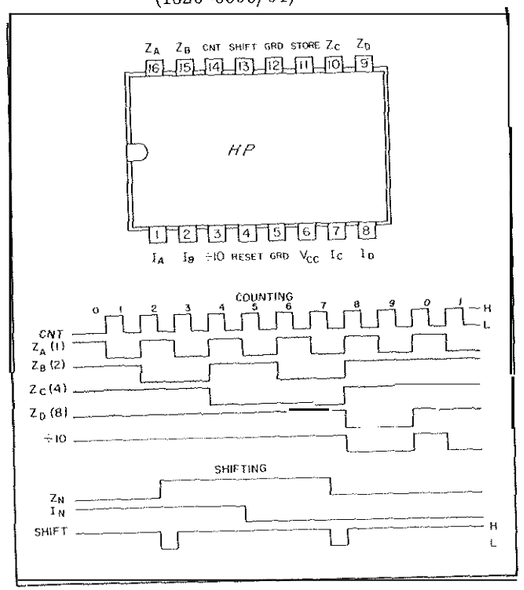
Figure 4-7. Blanking Decade Counter (1820-0119)



4-20. Decade Counter and Shift Register

4-21. The Decade Counter and Shift Register package is shown in Figure 4-9. The device operates either as a counter or as a shift register as shown in the timing diagram. A HIGH reset input will set all outputs HIGH. Both input and output use negative logic. The shift input should be HIGH when counting or resetting. The maximum counting frequency of the 1820-0190 is 10 MHz and the 1820-0191 is 2 MHz.

Figure 4-9. Decade Counter and Shift Register (1820-0090/91)



4-22. Up/Down Presettable Decade Counter

4-23. The Up/Down Presettable Decade Counter package is shown in Figure 4-10. A number between 0 to 9 may be preset and then the decade will count either up or down from this value. The preset count will be set according to the truth table when the preset input goes HIGH. The up and down count inputs should be inhibited by a HIGH when enabling preset. The decade can he reset to zero by applying a HIGH to the reset input while the up and down count inputs are HIGH (inhibited). A LOW input to a count input will change the state of the decade (up or down); the unused count input must be inhibited by a MIGH.

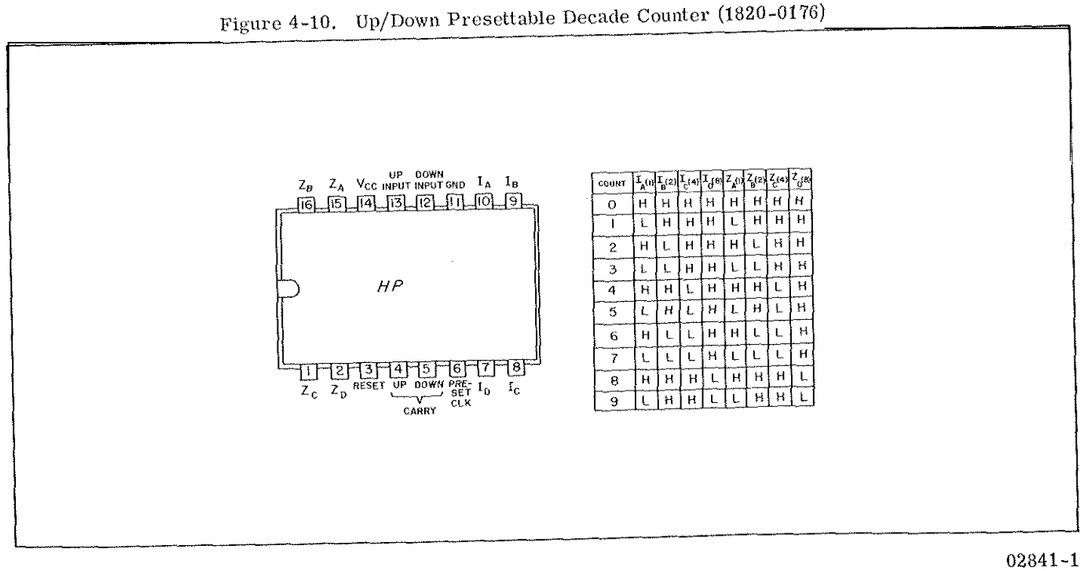
4-24. J-K Flip/Flop

4-25. The dual J-K Master-Slave Flip/Flop package is shown in Figure 4-11. When both inputs are LOW, the clock has no effect. When the J input is HIGH, the positive clock transition will set Q HIGH. When the K input is HIGH, the positive clock transition will cause $\overline{Q}$ to go HIGH. When both inputs are HIGH, the flip/flop will change state (toggle) with each positive transition of the clock input. A LOW R input will override other inputs and reset the Q output LOW. The Q and $\overline{Q}$ outputs are always opposite in level.

4-26. Divide by 16 Counter

4-27. The Divide by 16 Counter package is shown in Figure 4-12, and is a 4-bit binary ripple counter. The negative logic 4-bit BCD outputs and the ÷16 output are shown in the timing diagram. A reset signal (HIGH) sets the outputs HIGH. The counter will advance on the leading edge of the input pulse.

Figure 4-10. Up/Down Presettable Decade Counter (1820-0176)



COUNT	I_A(1)	I_B(2)	I_C(4)	I_D(8)	Z_A(1)	Z_B(2)	Z_C(4)	Z_D(8)
0	H	H	H	H	H	H	H	H
1	L	H	H	H	L	H	H	H
2	H	L	H	H	H	L	H	H
3	L	L	H	H	L	L	H	H
4	H	H	L	H	H	H	L	H
5	L	H	L	H	L	H	L	H
6	H	L	L	H	H	L	L	H
7	L	L	L	H	L	L	L	H
8	H	H	H	L	H	H	H	L
9	L	H	H	L	L	H	H	L

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Figure 4-11. Dual J-K Flip/Flop (1820-0208)

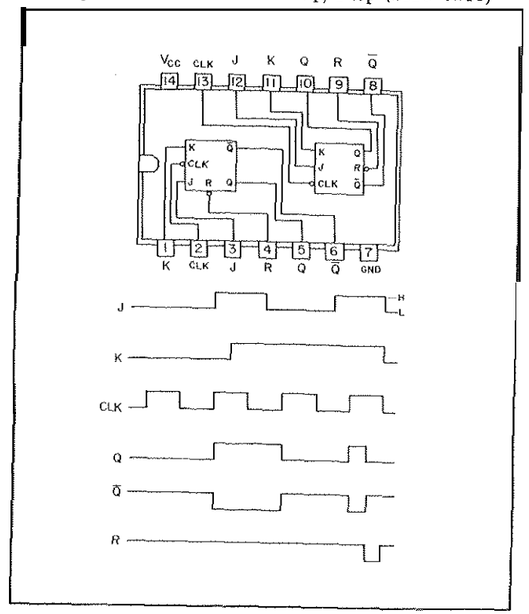
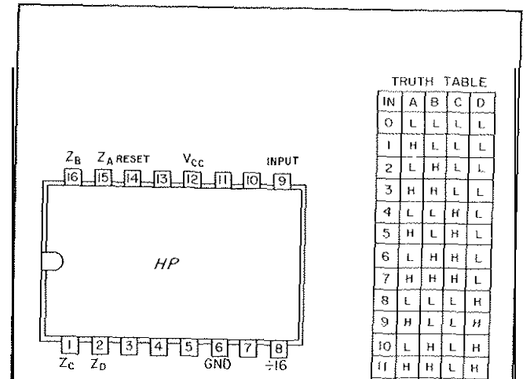


Figure 4-12. Divide by 16 Counter (1820-0209)

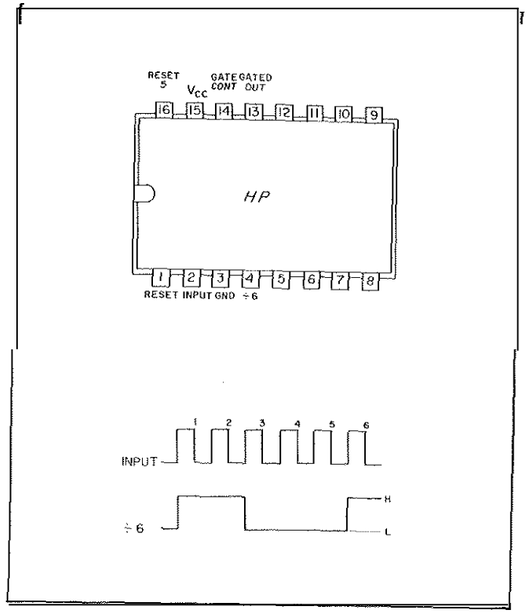


IN	A	B	C	D
0	L	L	L	L
1	H	L	L	L
2	L	H	L	L
3	H	H	L	L
4	L	L	H	L
5	H	L	H	L
6	L	H	H	L
7	H	H	H	L
8	L	L	L	H
9	H	L	L	H
10	L	H	L	H
11	H	H	L	H
12	L	L	H	H
13	H	L	H	H
14	L	H	H	H
15	H	H	H	H

4-28. Divide by 6 Counter

4-29. The Divide by 6 Counter package is shown in Figure 4-13, The Gate Control input must be LOW to enable the gated output. The reset "0" or resct "5" inputs most be HIGH to enable the reset. The counter will advance on the leading edge of the input pulse.

Figure 4-13. Divide by 6 Counter (1820-0210)



4-30. Four-Bit Binary Full Adder

4-31. The 4-Bit Binary Full Adder package is shown in Figure 4-14, with its truth table. Tile adder adds two 4-bit binary numbers (A1, A2, A3, A4, and B1, 132, B3, B4) and a carry-in (C_{in}) to produce their sum (21, 22, Σ3, Σ4) and a carry-out (C4). The inputs A1, A2, 131, B2, and C_{in} determine Σ1, Σ2, and the internal carry (C2). The inputs A3, A4, B3, B4, and internal carry C2 dctcrmine z3, x4, and C4.

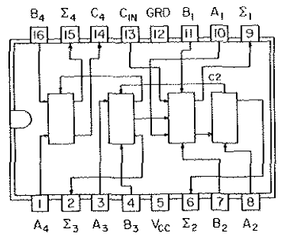
4-32. THEORY OF OPERATION

4-33. The operation of the HP 5323A is divided into three cycles: Gate, Compute, and Display. A flow diagram included in Section VIII (Figure 8-2) depicts the three cycles and the MEASUIIEMENT TIME process. A block diagram included in Scction VIII (Figure 8-3) shows the functional relationship of the major assemblies and critical signals used by the assemblies. These figures should be folded out for reference during tile following discussion.

4-34. Gate Cycle

4-35. Input frequency (Fx) connects to A2 (Amplifier/Trigger) via A1 (Attenuator). The input signal triggers A2 and the narrow pulse produced, goes to A3. This pulse appears at the input of the $\frac{Fx}{2}$ flip/flop, when MODE is set to NOIIM. When MODE is set to CHECK, internal clock pulses (Fy or $\frac{Fy}{G}$) will appear at the $\frac{Fx}{2}$ flip/flop instead of Fx.

Figure 4-14. Four-Bit Binary Full Adder (1820-0305)



TRUTH TABLE (SEE NOTE 1)

INPUT				OUTPUT							
				WHEN C_{IN}=L			WHEN C_{IN}=H				
				WHEN C2=L			WHEN C2=H				
A_1 / A_3	B_1 / B_3	A_2 / A_4	B_2 / B_4	Σ_1 / Σ_3	Σ_2 / Σ_4	C_2 / C_4	Σ_1 / Σ_3	Σ_2 / Σ_4	C_2 / C_4
L	L	L	L	L	L	L	H	L	L
H	L	L	L	H	L	L	L	H	L
L	H	L	L	H	L	L	L	H	L
H	H	L	L	L	H	L	H	H	L
L	L	H	L	L	H	L	H	H	L
H	L	H	L	H	H	L	L	L	H
L	H	H	L	H	H	L	L	L	H
H	H	H	L	L	L	H	H	L	H
L	L	L	H	L	H	L	H	H	L
H	L	L	H	H	H	L	L	L	H
L	H	L	H	H	H	L	L	L	H
H	H	L	H	L	L	H	H	L	H
L	L	H	H	L	L	H	H	L	H
H	L	H	H	H	L	H	L	H	H
L	H	H	H	H	L	H	L	H	H
H	H	H	H	L	H	H	H	H	H

4-36 The first Fx pulse will set the $\frac{Fx}{2}$ flip/flop to Q HIGH, enabling the Single Cycle Register and the ~~X Gate~~ Enable flip/flop, producing the GATE signal. GA E resets the 11-Register to D= 15 signaling start of the Gate cycle. The COUNTING lamp will be on. The EXT GATE signal must be high to initiate the $\overline{GATE}$ signal.

4-37. The clock pulse from A14 (Oscillator/Multiplier) enables tlie Gale Control flip/flop enabling the Y-Gate. Y-Gate output is a series of COUNT Y pulses, which are accumulated in the Y-Register. The clock frequency is 10 MHz. COUNTY pulses will be 10 MHz when the Hz/RPM switch is in Hz, or 10/6 MHz when in RPM.

4-38. The next Fx pulse enables the X-Gate, and a COUNT X pulse will occur. COUNT X pulses continue at tlie $\frac{Fx}{2}$ frequency and are accumulated in the X-Register. When the Y-Register contents equals the selected measurement time, a TIME signal occurs enabling the Single Cycle Register and X-Gate Enable flip/flop. The X and Y-Gates will be disabled by the next input pulse, terminating COUNT X and COUNT Y pulses and the $\overline{GATE}$ signal will return to its initial state.

4-39. When the input frequency period is longer than the selected measurement time, *the Gate Control* uses the Single Cycle Register to terminate the Gate Cycle on the second positive slope zero-crossing of the input. A PRESCALE signal is sensed by A7 (Control Board), which alters the Compute Cycle to correct for single-cycle operation.

4-40. Notice that clock and input frequencies arc synchronized by the $\frac{Ex}{2}$ flip/flop so that maximum error during the Gate cycle is equal to one clock period (100 nscc for Hz or 600 nscc for RPM). The selected measurement time is (T). At the end of the Gate Cycle Y-Register contains Fy x T (or $\frac{Fy}{6}$ x T for RPM) and X-Register contains Fx x T. *The X and* Y-Registers contain information needed to calculate frequency F. When no input signal occurs alter the TIME signal, a low-frequency reset signal occurs at 2 × Measurement Time.

4-41. Compute Cycle

4-42. Frequency (F) is calculated by dividing X-Register contents by Y-Register contents and multiplying the result by the clock frequency (Fo), ($F = \frac{X}{Y} \times Fo$). F is calculated one digit at a time. As each digit is calculated, it is transferred to the Display; decimal point position and measurement units for the Display are determined by the magnitude of X and Y. F calculation is performed by A5 (Adder Board) and A7, refer to Figures 4-15 and 4-17.

4-43. To divide X by Y, a process of repeatedly subtracting Y from X is used. To subtract Y from X, a technique known as nines complementing is used. The nines complement of X is the difference between each digit of X and the number 9. Sequentially, the nines complement of X (called Xc) is added to Y; Y is then added to X until a left-digit carry occurs; the last sum (without the carry) is then complemented and added to Y to restore the remainder. The last step is required because Y must be added Io X until a carry occurs, which is one step too far in the division process. Tlie restored remainder is then multiplied by 10, and the process repeated to determine the next digit of F. The number of times that Y was added Io X before a carry occurs is tlie value of the first digit of F (called Z). Figure 4-16 is an example of the arithmetic operations performed by A5; the first digit of F is 3.

Figure 4-15. Timing and Control Diagram

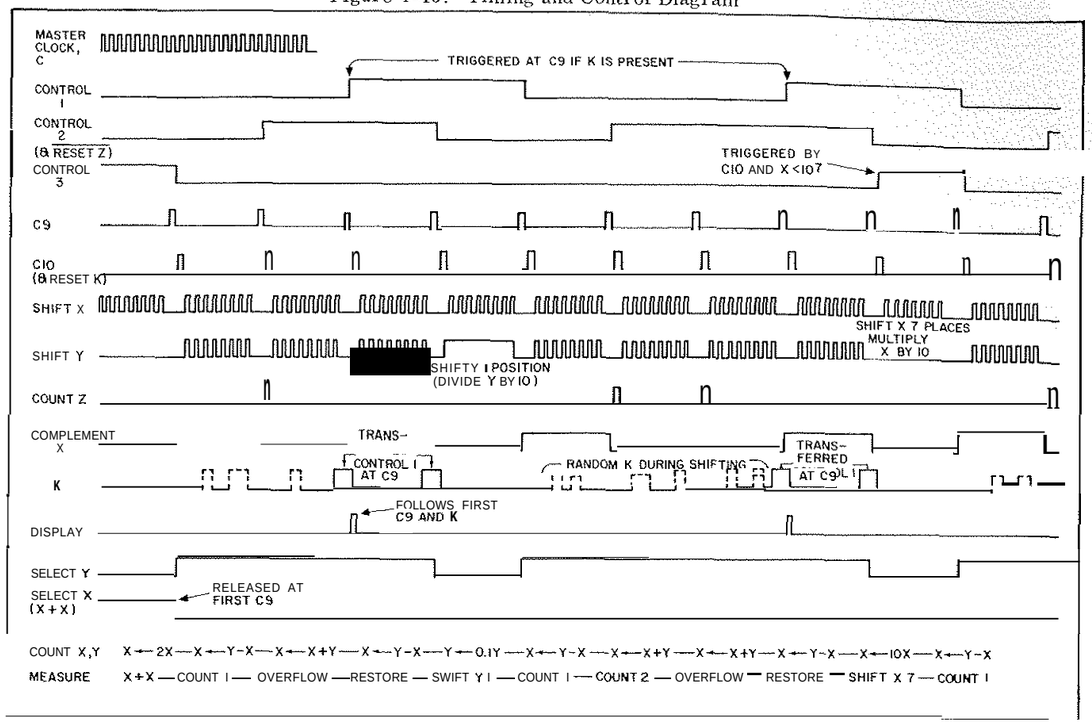
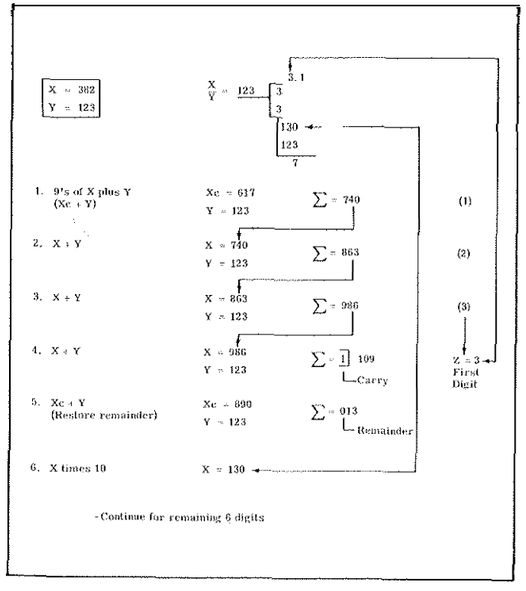


Figure 4-16. Arithmetic Operation



4-44. The first step in the calculation is to double the X-Register contents to correct for the division of the $\frac{Fx}{2}$ flip/flop. A7 enables the 4-pole switches in A5, so that X+X occurs. When a single-cycle measurement occurs, X + X is inhibited because F was not divided by two (refer to Figure 4-15).

4-45. The next operation initiated is complementing X-Register contents and adding the results to the Y-Register contents (Xc + Y). A7 then sets the 4-pole switches to perform an X + Y operation. The operation is repeated until a carry from the Adder occurs (equivalent to a negative remainder). The correct remainder is restored by using the Xc + Y operation, because we have made one extra subtraction. The remainder is now multiplied by 10, and the second digit of F will be calculated. This process is repeated until all 7 digits of F have been determined. Note the Y-Register contents are recirculated during the compute cycle (Y remains unchanged)

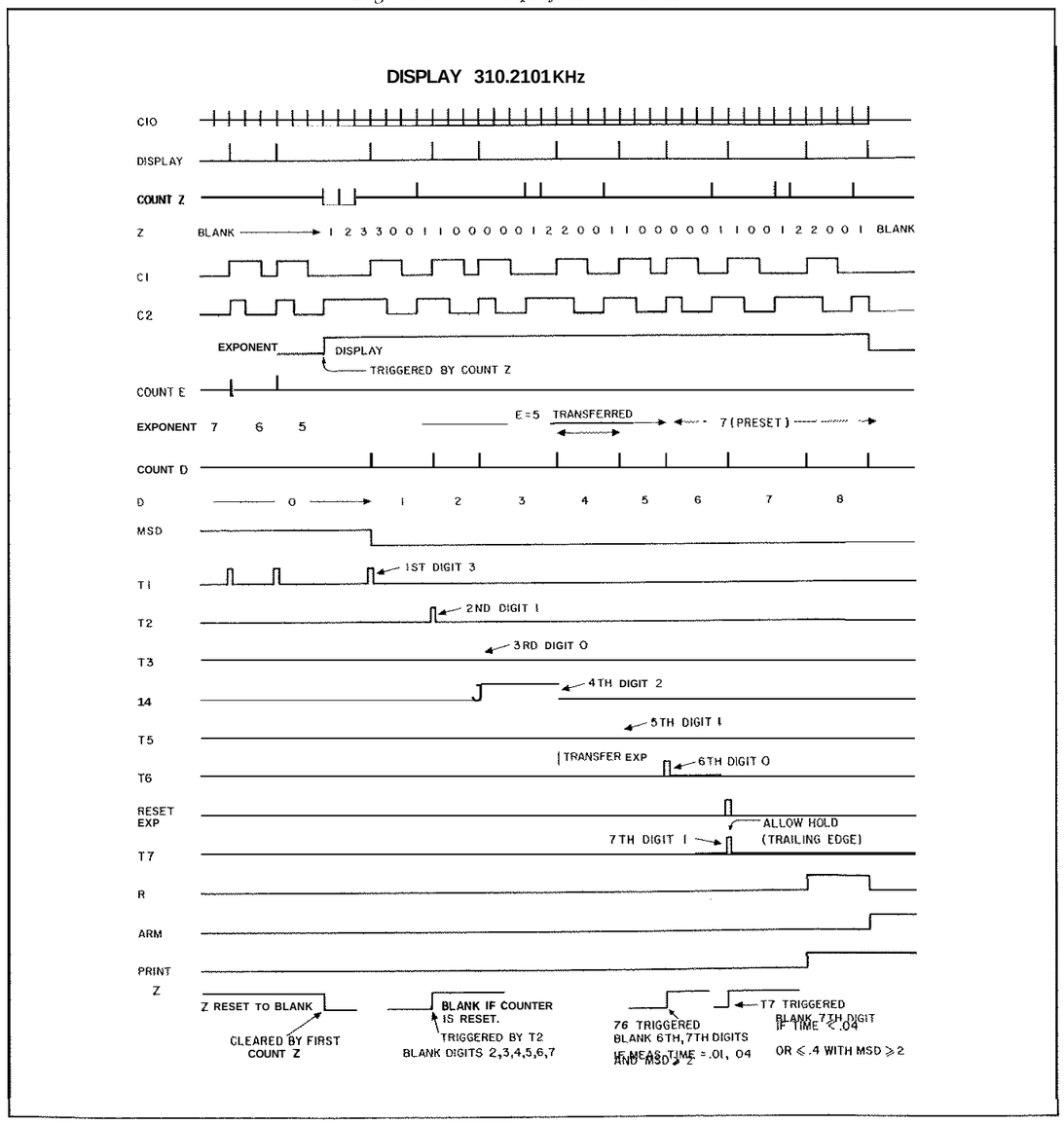
4-46. Shift pulses for X and Y-Registers and control pulses for the 4-pole switches in A5 are generated by A7, using clock pulses. The carry pulses are used by the Control Board to generate COUNT Z and DISPLAY signals.

4-47. Display Cycle

4-48. The Compute and Display Cycles occur at the same time. As each digit of F is calculated it must be transferred to buffer storage and the Display. At the start of the Compute and Display Cycles, the $\overline{GATE}$ signal ending the Gate Cycle resets the D-Register to D = 0.

4-49. During the Compute Cycle, when the first division is attempted (first digit calculation) a carry may occur. Each time such a carry occurs, a DISPLAY pulse is generated by A7 (refer to Figure 4-17). These DISPLAY pulses increment either the E or D-Registers, depending on the state of the Range Detector. In case of an immediate carry during first digit calculation, the DISPLAY pulse would decrease the

Figure 4-17. Display 310.2101 kHz



E-Register count, and no COUNT D pulse would occur. DISPLAY pulses will continue to decrease the E-Register count until a successful subtraction occurs (no carry), and a COUNT Z pulse is produced by the Control Board. The initial COUNT Z pulse causes the Range Detector to disable the E-Register input and enable the D-Register input. The COUNT Z pulses are accumulated in the Z-Register and represent one digit of F.

4-50. When a carry occurs after successful subtraction, DISPLAY and COUNT D pulses are generated. The most significant digit (MSD) is now transferred from the Z-Register to the buffer storage and Display, and the D-Register advanced to D = 1. Each new DISPLAY pulse will produce a COUNT D pulse to advance the D-Register, until all 7 digits have been calculated and displayed. The last digit will be transferred at D = 6.

4-51. At D = 4, the contents of the Exponent Register are transferred to the decimal and measurement unit decode logic. The location of the decimal point and the measurement unit (MHz, kHz, or Hz) art? determined and transferred to the Display and Annunciator. When the Hz/RPM switch is set to RPM, the clock frequency is divided by 6, and the E-Register is changed by one count (X10) resulting in multiplication by 60.

4-52. After the last digit has been calculated, DISPLAY pulses will continue to be generated by A7 and continue to advance the D-Register, unless a HOLD is present. If the MODE switch is set to HOLD at this time, the Clock Gate in A3 will be disabled, inhibiting the DISPLAY and COUNT D signals to preserve the display. If no HOLD is present, or when it is removed, the D-Register will advance to D = 7. D = 7 is a blank state, but D = 8 causes the PRINT Command and $\overline{R}$ signal to be generated, The $\overline{R}$ signal is an automatic reset which clears the X, Y, and Z-Registers.

4-53. At D = 9, the ARM signal is generated, turning the ARM lamp on, resetting the Range Detector, inhibiting the clock in A7 and enabling the Gate Control in A3 for the next Gate Cycle.

4-54. When the RLANKING switch is ON, the Blanking Control logic will automatically blank the sixth and/or seventh display digit, if tlic selected measurement time is so short that false resolution would occur.

4-55. When the HYSTERESIS switch is OFF, and the firstdigit changes from 1 to 9 in successive measurements, the decimal point and display will shift, and the measurement unit may change. To prevent this condition, tlic hysteresis feature may be used. With the HYSTERESIS switch ON, the Hysteresis Control logic senses the state of the MSD < 2 Memory and Z-Register contents. When the first digit changes from 1 to 9, the first Display digit will be blanked, the E-Register will be advanced, and an extra COUNT D pulse will advance the D-Register to D = 1. The first digit (Z = 9) will be transferred to the second display position, and the remaining digits are calculated and displayed. Hysteresis is effective only for descending range changes.

SECTION V

MAINTENANCE

5-1. INTRODUCTION

5-2. This section gives maintenance and service information. Included is a table of recommended test equipment, disassembly and repair procedures, in-cabinet performance check which may be used to verify proper Counter operation, overall troubleshooting procedures, and adjustments. Theory of operation and specific troubleshooting information for each assembly are located in Section VIII, opposite each schematic diagram.

5-3. ASSEMBLY DESIGNATIONS

5-4. Table 5-1 lists the designations, name, and Hewlett-Packard part number of assemblies used in this instrument.

5-5. TEST EQUIPMENT

5-6. Test equipment recommended for maintaining and checking performance is listed in Table 5-2. Test equipment having equivalent characteristics may he substituted for the equipment listed.

5-7. ASSEMBLY CONNECTION IDENTIFICATION

5-8. Throughout the manual, connections to printed circuit assemblies are referred to in abbreviated form. For example, connection to A3, pin10 is A3(10).

Table 5-1. Assembly Identification

Assy	Name	HP Part No.
A1	Attenuator Board	05323-60006
A2	Input Amplifier Board	05325-60035
A3	Gate and Reset Board	05323-60011
A4	X-Register Board	05323-60005
A5	Adder Board	05323-60002
A6	Y-Register Board	05323-60003
A7	Control Board	05323-60004
A8	Display Control Board	05323-60009
A9	Connector Board	05323-60014
A10	Function Switch	05323-60007
A11	Main Board	05323-60001
A12	Display Board	05323-60008
A13	Annunciator Board	05323-60017
A14	Oscillator/Multiplier Board	05325-60008
A15	Crystal/Oven 10 MHz	05325-60012
A16	+5.1V and +175V Supply	05325-60022
A17	±12V Supply	05325-60005

02841-1

5-9. IN-CABINET PERFORMANCE CHECK

5-10. GENERAL. The performance check, Table 5-3, and test card can be used to verify proper operation of all circuits in the Counter and may also be used:

a. As part of an incoming inspection check of instrument specifications.

b. Periodically, for instruments used in systems where maximum reliability is important.

c. As part of a procedure to locate defective circuits.

d. After any repairs or adjustments, and before returning instrument to regular service.

e. As a permanent record of instrument maintenance performed, because the test record pages are perforated and may be removed.

5-11. VARIABLE LINE VOLTAGE. During the test (Table 5-3), Counter should be connected to a variable voltage source so the line voltage may be varied ±10% from nominal (115 or 230 Vac).

5-12. INSTRUMENT COVER REMOVAL

5-13. To remove top or bottom cover, remove the four screws which secure cover to instrument. Slide cover toward rear of instrument and lift off. To replace cover, reverse procedure.

WARNING

115/230 VAC AND +175 VDC SUPPLY WIRES ARE EXPOSED WHEN EITHER TOP OR BOTTOM COVER IS IZEMOVED. USE EXTREME CAUTION DURING TROUBLESHOOTING, ADJUSTMENT, OR REPAIR. AVOID DAMAGE TO INSTRUMENT BY REMOVING POWER BEFORE REMOVING OR REPLACING COVERS, ASSEMBLIES, OR COMPONENTS.

5-14. ASSEMBLY LOCATION

5-15 Top internal, tront and rear panel views of the Counter are shown in Figure 5-1. This figure shows the location of the assemblies, connectors, and chassis parts.

Figure 5-1. Top Internal, Front and Rear Panels

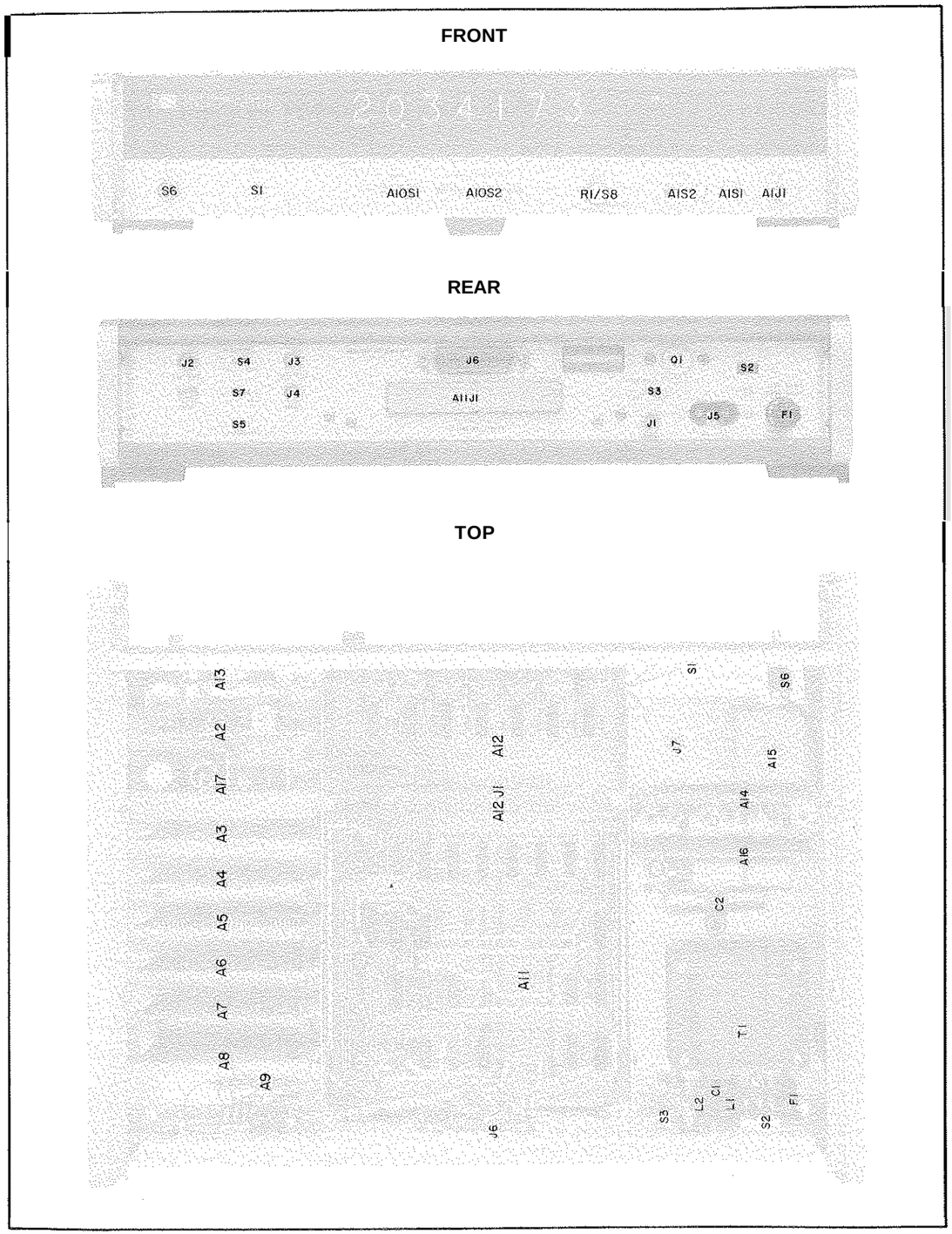


Table 5-2. Recommended Test Equipment

Instrument Type	Required Characteristics	Recommended Type
Oscilloscope	50 MHz Bandwidth, plug-in capabilities	HP 180A
Vertical Plug-in Time Base Plug-in	50 mV/cm sensitivity, 50 MHz Bandwidth 50 nsec/cm sensitivity	HP 1801A HP 1820A
Frequency Synthesizer	50 Hz to 20 MHz, 100 mVrms	HP 5100B
Synthesizer Driver	1 MHz output, 1.0 Vrms	HP 5110B
Digital Recorder	Compatible with BCD weighting used	HP 5050B
50Ω Feed-Thru Termination		HP 10100A
Cable Assembly	Compatible with Digital Recorder/Counter	HP 10524A
Low-Frequency Function Generator	0.1 Hz to 1100 Hz, 1V peak-to-peak, ±2%	HP 202A
Variable Attenuator	12 dB in 1 dB steps	HP 355C
Variable Attenuator	120 dB in 10 dB steps	HP 355D
Pulse Generator	30 nsec, ±0.3V, 10 MHz	HP 222A
RF Voltmeter	10 mV to 10V, 20 MHz, ±3% FS	HP 411A
DC Volt-Ohm-Ammeter	0 to +10V, ±1%, R x 1 capability	HP 412A
BNC "T" Connector		HP Part No. 1250-0781
Variable Line Voltage Source	Variable from 103 to 127 Vac (207 to 253 Vac)	
VIIF Oscillator	20 MHz, 300 mVrms	HP 32000
Frequency Standard	1 MHz, stability < 2 parts in 10^{11} per month	HP5065A or HP5061A
Resistive Probe	10:1, 10 pF, DC to 20 MHz	HP 10003A
Electronic Counter	20 MHz, 8-digit readout	HP 5245M
Current Probe	10 mA to 50 mA, 1 mV/mA sensitivity	HP 1110A
DC Probe Amplifier	Compatible with probe used	HP 1111A
Logic Probe	Compatible with DTL and TTL voltage levels	IIP 10525A
Resistive Probe	50:1, DC to 10 MHz	HP 10002A

5-16. REMOVAL OF PRINTED CIRCUIT BOARDS

5-11. MAIN BOARD (A11). To remove this board:

a. Remove top cover (see paragraph 5-12).

b. Remove the 10 wires which are connected to the top of the board by push-on connectors. Each terminal on the board is color-coded to the mating wire color.

c. Remove the 7 screws that secure the board to the chassis and connector J4.

d. Slide board toward rear of Counter until A11J2 is disengaged from the Display Board (A12).

e. Raise the front of the board to clear the Display Board (A12) and slide the board forward until A11J1 is out of the rear panel slot. Remove the board from the unit.

f. When reinstalling the board, do not connect any wire to tlie terminal between IC15 and IC19 (see Section VIII). This is a special test point.

5-18. DISPLAY BOARD (A12)

a. Remove the Main board (A11) (see paragraph 5-17).

b. Remove printed circuit board A2, A17, A3, A4, A5, and A6.

c. Reniove Annunciator Board (A13) by removing two nuts and washers that secure the assembly to the front panel.

d. Rcmove the WHT-RED wire which is connected to the Display Board by a push-on connector.

e. Remove the 4 screws that secure the board to the chassis. Reniove board from unit.

5-19. CONNECTOR BOARD (A9)

a. Remove top and bottom covers (see paragraph 5-12).

b. From top of Counter, remove 3 large screws attaching the Main Board (All) to connector A9J4.

c. From bottom of board, remove connectors attached to A9J2 and A9J3.

CAUTION

Take care not to put a strain on connecting wires or bend them too many times. This will cause the wires to break or become weakened.

d. Unsolder the 7 wires and 2 coaxial cables connected to the front of the hoard

e. From top of Counter, remove the 8 wires connected to the board by push-on connectors. These connectors arc accessible through a cutout in the chassis, located behind the Display Control Board (A8). The A7 and A8 boards may be removed to provide niore access to tlre connectors.

I. From the bottom of the Counter, remove tlic 6 screws and spacers that secure tlre board to the chassis. Do not remove the 3 screws securing connector A9J4 to the board. Remove the board from the bottom of the Counter.

5-20. REPAIR

5-21. Printed Circuit Component Replacement

5-22. Component lead holes in the circuit boards have plated-through walls to ensure good electrical contact between conductors on opposite sides of the board. To prevent damage to the plating and the replacement component, apply heat sparingly, and work carefully.

5-23. Replacing Integrated Circuits

5-24. Following arc two recommended methods of replacing integrated circuits:

a. SOLDER GOBBLER. This is the best method. Solder is removed from board by a soldering iron with a hollow tip connected to a vacuum source.

b. CLIP-OUT. This method should be used as a last resort only. Clip the leads as close to the case as possible. Wilh a soldering iron and long nose pliers, carefully remove the wires from each hole. Then clean the holes.

5-25. ADJUSTMENTS

5-26. The adjustments in Table 5-4 are in the order they should be performed, but should not be done unless:

a. A trouble has been repaired which would affect these valucs.

h. The instrument does not meet all specifications while performing the check in Table 5-3 (In-Cabinet Performance Checks).

Table 5-3. In-Cabinet Performance Check

FREQUENCY/RPM MEASUREMENTS

1. SELF-CHECK

   a. Set Counter controls as follows:

MODE	CHECK
MEASUREMENT TIME	.4
TIME BASE	INT
Hz/RPM	Hz

   b. Display should be 10.00000 MHz, and COUNTING lamp ON. Record on test card.

2. DECIMAL POINT/MEASUREMENT UNITS

   a. Set Counter controls as follows:

MODE	NORM
MEASUREMENT TIME	.4
LEVEL	PRESET
ATTEN	X1
AC-DC	DC
BLANKING	ON
Hz/RPM	Hz
HYSTERESIS	ON
TIME BASE	EXT

Table 5-3. In-Cabinet Performance Check (Cont'd)

FREQUENCY/RPM MEASUREMENTS (Cont'd)

b. Connect Frequency Synthesizer output to Counter INPUT through a 50-ohm feedthrough termination.

c. Connect Synthesizer Driver 1 MHz output to Counter external time base INPUT (rear panel).

d. Connect Digital Recorder to Counter DIGITAL RECORDER connector.

Note

Refer to Operating and Service Manual for Digital Recorder Installation and Operation Information.

e. Set synthesizer frequency to the values in Table 5-3A. Decimal point location, measurement unit, and printed exponent are shown in Table 5-3A. Displayed and printed digit values (N) are disregarded during this test. Record display and printed exponent on test card.

Table 5-3A. Decimal Point/Measurement Unit

Synthesizer Frequency	Display	Printed Exponent
10 MHz	NN. NNNNN MHz	7
1 MHz	N. NNNNNN MHz	6
100 kHz	NNN. NNNN kHz	5
10 kHz	NN. NNNNN kHz	4
1 kHz	N. NNNNNN kHz	3
100 Hz	NNN. NNNN Hz	2
50 Hz	NN. NNNNN Hz	1
0 Hz	0. Hz	0

3. ACCURACY

   a. Set synthesizer frequency to tlic values in Table 5-3B. Display should be within ±1 count of the selected frequency. Record display value and printed value on test card; printed and displayed values should be identical. Disconnect Digital Recorder.

Table 5-3B. Accuracy

1.111111 MIlz
2.222222 MHz
3.333333 MIlz
4.444444 MHz
5.555555 MHz
6.666666 MHz
7.777777 MHz
8.888888 MHz
9.999999 MHz

4. HYSTERESIS

   a. Set Counter controls as shown in step 2a.

   b. Set synthesizer frequency to 1.0000000 MHz, then decrease to ,98888888 MHz. Display should be ,988888 MIlz. Record on lest card.

   c. Set HYSTERESIS to OFF. Display should be 988.8888 kHz. Record on test card.

Table 5-3. In-Cabinet Performance Check (Cont'd)

FREQUENCY/RPM MEASUREMENTS (Cont'd)

5. BLANKING
   a. Set Counter controls as shown in step 2a.
   b. Set synthesizer to 2 MHz.
   c. Set MEASUREMENT TIME as shown in Table 5-3C. The number of digits displayed is shown in Table 5-3C. Record on test card.
   d. Set synthesizer to 1 MHz and repeat step 4c.
   e. Set synthesizer to 9.888888 MHz and repeat step 4c.

Note

Change frequency from 10.00000 MHz lo 9.888888 MHz to enable hysteresis circuits.

   f. Set synthesizer to 1 MHz. Set Counter BLANKING switch OFF and MEASUREMENT TIME switch to .01. Seven digits should be displayed. Record on tcst card.

Tablc 5-3C. Blanking Check

MEASUREMENT TIME	DISPLAYED DIGITS 2 MHz	1 MHz	0.888888 MHz
4	7	7	6
2	7	7	6
1	7	7	6
.4	7	7	6
.2	6	7	6
.1	6	7	6
.04	5	6	5
.01	5	6	5

6. RPM
   a. Set Counter controls as shown in step 2a, except set Hz/RPM to RPM and MEASUREMENT TIME to .1. Adjust synthesizer frequency to values in Tablc 5-3D. Record display value on test card.
   b. Disconnect synthesizer and synthesizer driver from Counter. Set Counter TIME BASE to INT.
   c. Connect Low Frequency Function Generator to Counter INPUT with BNC "T" connector. Connect oscilloscope vertical input to tlie "T" connector.
   d. Set function generator output for a 1V P-P, 10 Hz sine wave measured on oscilloscope.
   e. Display should be 600.000 RPM ±2%. Record on tcst card.
   f. Set Function Generator Frequency to 1 Hz (1V P-P sine wave). Display should be 60.0000 RPM ±2%. Record on test card.
   g. Set Function Generator Frequency to 0.1 Hz (1V P-P sine wave). Display should be 6.00000 RPM ±2%. Record on test card.

Tablc 5-3D. RPM Display

FREQUENCY	DISPLAY
10 MHz	600. 000 RPM
1 MHz	60. 000 RPM
100 kHz	6. 0000 RPM
10 kHz	60000N. RPM
1 kHz	60000. N RPM
100 Hz	6000. NN RPM
0 Hz	0. RPM

Table 5-3. In-Cabinet Performance Check (Cont'd)

RESET AND HOLD

1. RESET
   a. Connect equipment as described in step 6c of Frequency/RPM Tests. Set function generator output for 1 kHz sine wave at 1V P-P.
   b. Set Counter controls as shown in step 2a of Frequency/RPM Tests, except set MEASUREMENT TIME to 1 and TIME BASE to INT.
   c. Depress and release the RESET pushbutton.
   d. Display should be zero for 1 second, then display 1 kHz ±2%. Record on test card.
   e. Remove signal at Countcr INPUT.
   f. Display should reset to zero after 1 to 2 seconds and ARMED lamp should illuminate. Record on tesl card.
   g. Re-connect signal to INPUT.
   h. COUNTING lamp should illuminate and display should be 1 kHz ±2% after 1 second. Record on tcst card.

2. HOLD
   a. Set function generator frequency to 1.1 kHz sine wave at 1V P-P. Set MODE to HOLD and AC-DC to AC.
   b. The Display should be 1.1 kHz ±2%. Record on test card.
   c. Depress and release RESET.
   d. Display should reset to zero lor 1 second, then display 1.1 kHz ±2%. Record on test card.

3. LOW-FREQUENCY RESET
   a. Set MOUE lo NORM and AC-llC to DC.
   b. Set MEASUREMENT TIME as shown in Table 5-3E.
   c. Decrease function generator frcquency until Counter reads zero. Tho lowest displayed frequency for a particular measurement time should be within ±5% of tlie value shown in Tablc 5-3E. Record on tcst card.

Table 5-3E.

MEASUREMENT TIME	LOWEST DISPLAYED FREQUENCY ±5%
.01	50 Hz
.04	12.5 Hz
.1	5 Hz
.2	2.5 Hz
.4	1.25 Hz
1	0.5 Hz
2	0.25 Hz
4	0.125 Hz

SENSITIVITY

1. SENSITIVITY MEASUREMENT
   a. Connect Frequency Synthesizer lo INPUT using a 50-ohm feedthrough termination. Insert HP 355C and D Variable Attenuators between synthesizer and termination. Connect an RF Voltmeter to tlie INPUT using a BNC "T" connector.
   b. Set Counter controls as shown in step 2a of frequency tests. Connect the Synthesizer Driver 1 MHz output to Counter time base INPUT connector.
   c. Set synthesizer output frequency to 20 MHz.

Tablc 5-3. In-Cabinet Performance Check (Cont'd)

SENSITIVITY (Cont'd)

d. Set attenuators to 0 dB.

e. Display should be 20.00000 MHz ±1 count. Slowly increase attenuation in 1 dB steps until count becomes unstable. Record the RF voltmeter reading on the test card (should be ≤ 100 mVrms).

I. Disconnect synthesizer from INPUT.

2. PULSE OPERATION

a. Connect a Pulse Generator to INPUT using a 50-ohm feedthrough termination. Connect oscilloscope in parallel with the input using a BNC "T" connector.

b. Set Pulse Generator controls for a +300 mV peak-to-peak pulse, 30 nscc wide, at a repetition ratc of 10 MHz, measured with oscilloscope.

c. Set Counter controls as shown in step 2a of frequency tests, except set TIME BASE to INT.

d. Adjust Counter LEVEL control for a stable displayed count. Display should be 10, MHz. Record value on tcst card. Repeat 2b through 2d for an amplitude of -300 mV P-P.

3. GATE OUT ANDEXTERNALGATE

a. Connect Pulse Generator to Counter EXT GATE using 50-ohm feedthrough termination. Connect oscilloscope in parallel with EXT GATE using a BNC "T" connector.

b. Adjust Pulse Generator for a repetition rate of 10 Hz at maximum pulse width. Adjust the amplitude to +3V P-P.

c. Remove oscilloscope and "T" connector from EXT GATE.

d. Connect the oscilloscope to Counter GATE OUT.

e. Set MODE to CIIECK and MEASUREMENT TIME to 4.

f. Display should be 10 MHz with ARMED and COUNTING lamps alternately flashing (COUNTING lamp may he very dim). Record on test card.

g. The GATE OUT signal viewed on the oscilloscope should be a 4V P-P (minimum) pulse train at 10 Hz. Record on tcst card.

4. INTERNAL OSCILLATOR OUTPUT

a. Connect oscilloscope to tlie time base INI'UT connector.

b. Verify that the Counter TIME BASE is set to INT.

c. The internal time base output should be a minimum of 1.0V P-P. Record on test card.

REMOTE PROGRAMMING

1. ENABLE/DISABLE FUNCTIONS

a. Using a DC Volt-Ohm-Ammeter, with the Counter POWER switch OFF, verify continuity between J6(20) and EXT GATE jack, J6(21) and GATE OUT jack, J6(3) and chassis ground, and J6(19) and chassis ground. Record on tcst card. Refer to Figure 5-2 for J6(REMOTE PROGRAM) connector pin locations.

b. Set the Counter POWER to ON and measure the dc voltage between J6(1) and chassis ground. The voltage should be +5V ±0.5V. Record on tcst card.

c. Connect J6(15) to chassis ground using a clip lead or test box (see Figure 5-2).

d. By connecting appropriate pins to ground, verify operation of CHECK and HOLD modes, measurement times, RESET, and HYSTERESIS and BLANKING disable. Record on tcst card.

e. Remove all external grounds to J6 from stcps 1c and 1d and connect oscilloscope between J6(22) and chassis ground. Set MODE to CHECK and MEASUREMENT TIME to .01. PRINT output should be a pulse train with a repetition ratc of 100 Hz, pulse width of 15 μsec, and amplitude of < +0.5V with respect Lo +5V baseline. Record on tcst card.

Tablc 5-3. In-Cabinet Performance Check (Cont'd)

POWER SUPPLY REGULATION

1. 115/230 LINE VOLTAGE CHECK

a. **Mark the nominal line voltage used in testing the instrument by making an X in the appropriate box on the test card.**

b. Connect tlie Counter power cord to a variable ac voltage source. Set ac voltage to LOW LINE (see Table 5-3F). Set Counter POWER to ON.

c. Connect the DC-Volt-Ohm-Ammeter to J6(1) (+5V). The measured voltage should be +5 ± 0.5 Vdc. Record on tcst card. Set the Counter POWER to OFF.

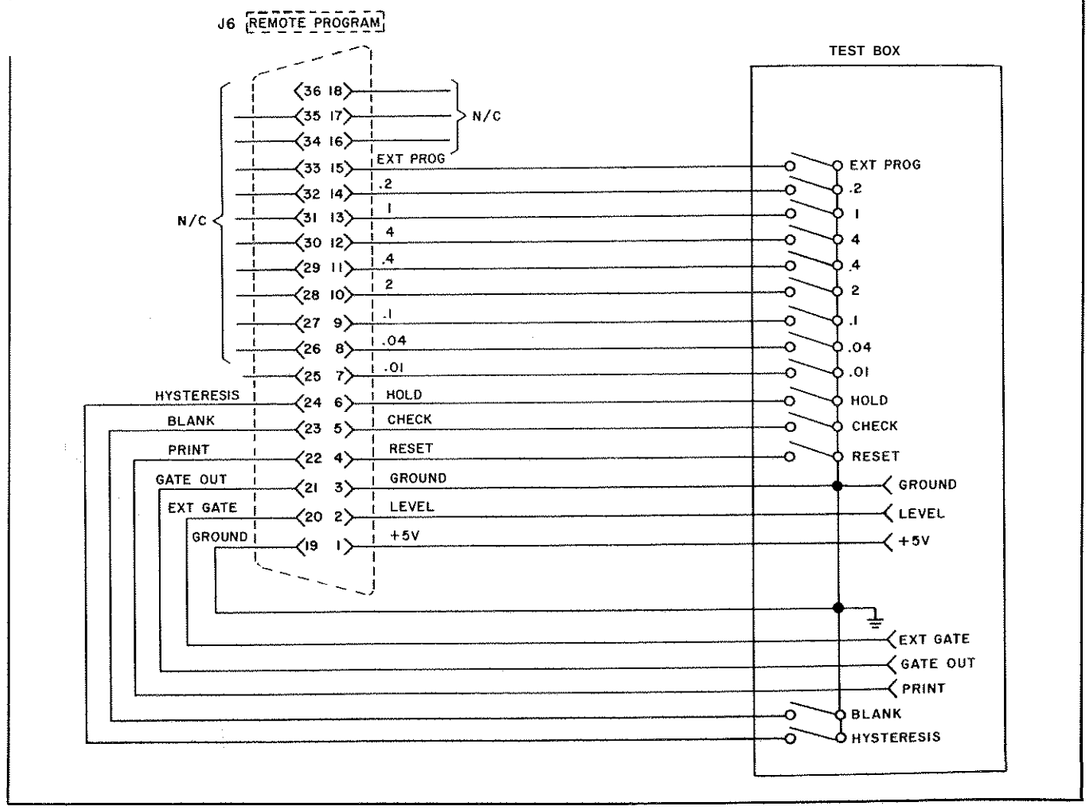
Table 5-3F. Line Voltage

Description	115 Volts	230 Volts
LOW LINE	102.0	204.0
NORMAL LINE	115.0	230.0
HIGH LINE	128.0	256.0

d. Repeat stcps 1b and 1c for NORMAL LINE voltage.

c. Repeat stcps 1b arid 1c fur HIGH LINE voltagc.

Figure 5-2. Remote Program 'Test Box



PERFORMANCE CHECK TEST CARD

Hewlett-Packard Model 5323A
Automatic Counter

Serial No. _____

Tests Performed by _____

Date _____

Description		Check
FREQUENCY/RPM MEASUREMENTS		
1. SELF-CHECK	_____	10.00000 MHz
2. DECIMAL POINT/MEASUREMENT UNITS		
Display	_____	NN. NNNNN MHz
(N = any digit, but not blanked)	_____	N. NNNNNN MHz
(X = blank digit)	_____	NNN. NNNN kHz
	_____	NN. NNNNN kHz
	_____	N. NNNNNN kHz
	_____	NNN. NNNN Hz
	_____	NN. NNNNN Hz
	_____	0. XXXXXX Hz
Printed Exponent	_____	7
	_____	6
	_____	5
	_____	4
	_____	3
	_____	2
	_____	1
	_____	0
3. ACCURACY		
Display/Printed Value	_____	1.111111 MHz ±1 Count
	_____	2.222222 MHz ±1 Count
	_____	3.333333 MIIz ±1 Count
	_____	4.444444 MHz ±1 Count
	_____	5.555555 MHz ±1 Count
	_____	6.666666 MHz ±1 Count
	_____	7.777777 MHz ±1 Count
	_____	8.888888 MHz ±1 Count
	_____	9.999999 MHz ±1 Count
4. HYSTERESIS		
Enabled	_____	,988888 MHz
Disabled	_____	988.8888 kHz

PERFORMANCE CHECK TEST CARD

Description			Check
FREQUENCY/RPM MEASUREMENTS			
5. BLANKING		2 MHz	
Enabled	4	_____	7 digits
	2	_____	7 digits
	1	_____	7 digits
	.4	_____	7 digits
	.2	_____	6 digits
	.1	_____	6 digits
	.04	_____	5 digits
	.01	_____	5 digits
Enabled		1 MHz	
	4	_____	7 digits
	2	_____	7 digits
	1	_____	7 digits
	.4	_____	7 digits
	.2	_____	7 digits
	.1	_____	7 digits
	.04	_____	6 digits
	.01	_____	6 digits
Enabled (with Hysteresis)		9.888888 MHz	
	4	_____	6 digits
	2	_____	6 digits
	1	_____	6 digits
	.4	_____	6 digits
	.2	_____	6 digits
	.1	_____	6 digits
	.04	_____	5 digits
	.01	_____	5 digits
Disabled	.01	_____	7 digits
6. RPM			
Display		_____	600.00N RPM
(N = any digit, but not blanked)		_____	60.000N RPM
		_____	6.0000N RPM
		_____	60000N. RPM
		_____	60000.N RPM
		_____	6000.NN RPM
		_____	0. RPM

Model 5323A

PERFORMANCE CHECK TEST CARD

Description			Check
FREQUENCY/RPM MEASUREMENTS (Cont'd)			
6. RPM (Cont'd)			
Low Frequency		10 Hz	_____ 600.000 RPM ±2%
		1 Hz	_____ 60.0000 RPM ±2%
		0.1 Hz	_____ 6.00000 RPM ±2%
RESET AND HOLD			
1. RESET			_____ Reset to zero
			_____ 1 kHz ±2%
			_____ Reset to zero
			_____ ARMED lamp ON
			_____ COUNTING lamp ON
			_____ 1 kHz ±2%
2. HOLD			_____ 1.1 kHz ±2%
			_____ Reset to zero
			_____ 1.1 kHz ±2%
3. LOW-FREQUENCY RESET		.01	_____ 50 Hz ±5%
		.04	_____ 12.5 Hz ±5%
		.1	_____ 5 Hz ±5%
		.2	_____ 2.5 Hz ±5%
		.4	_____ 1.25 Hz ±5%
		1	_____ 0.5 Hz ±5%
		2	_____ 0.25 Hz 15%
		4	_____ 0.125 Hz ±5%
SENSITIVITY			
1. SENSITIVITY MEASUREMENT			_____ 20.00000 MHz ±1 Count
			_____ 100 mVrms, maximum
2. PULSE OPERATION			
		+ Pulse	_____ 10 MHz
		- Pulse	_____ 10 MHz
3. GATE OUT AND EXTERNAL GATE			_____ 10.00000 MHz
			_____ 4V P-P, minimum
4. INTERNAL OSCILLATOR OUTPUT			_____ 1.0V P-P, minimum

PERFORMANCE CHECK TEST CARD

Description		Check	
REMOTE PROGRAMMING			
1. ENABLE/DISABLE FUNCTIONS	J6(20)	_____	continuity to EXT GATE
	J6(21)	_____	continuity to GATE OUT
	J6(3)	_____	continuity to chassis
	J6(19)	_____	continuity to chassis
	J6(1)	_____	+5 ±0.5 Vdc
	Check	_____	verified
	Hold	_____	verified
	.O1	_____	verified
	.04	_____	verified
	.1	_____	verified
	.2	_____	verified
	.4	_____	verified
	1	_____	verified
	2	_____	verified
	4	_____	verified
	Reset	_____	verified
	Hysteresis	_____	veriliecl
	Blanking	_____	verified
	Print	_____	100 Hz
		_____	15 μsec
		_____	+O.5 Vdc, maximum

POWER SUPPLY REGULATION

115/230 LINE VOLTAGE CHECK AT J6(1) 115V ☐ 230V ☐

LOW	_____	_____	+5 ± 0.5 Vdc
NORM	_____	_____	+5 ± 0.5 Vdc
HIGH	_____	_____	+5 ± 0.5 Vdc

Table 5-4. Adjustments

NOTE: All voltage measurements with respect to chassis

1. **INPUT AMPLIFIER A2**

The following procedure sets the sensitivity of the input amplifier and checks the frequency response.

a. Set Counter controls as follows:

MODE	NORM
MEASUREMENT TIME	.4
LEVEL	PRESET
ATTEN.	X1
AC-DC	DC
Hz/RPM	Hz
BLANKING	ON
HYSTERESIS	ON
TIME BASE	INT

b. Connect HP 3200B to HP 355C and 355D attenuators connected in series. Set attenuators to zero dB and connect through 50-ohm feedthrough termination to Counter INPUT.

c. Set HP 32000 controls for 20 MHz output as indicated by Counter Display.

d. Increase attenuator settings until Counter Display becomes erratic or reads zero.

e. Adjust A2R10 for a stable 20 MHz display.

f. Repeat steps d and e until A2 Amplifier is peaked.

g. Measure Counter input using HI' 411A RE' voltmeter. Minimum input level for stable display should be 100 mV.

2. OSCILLATOR/MULTIPLIER ASSEMBLY A14

a. Set Counter TIME BASE switch to EXT.

b. Connect a 1 MHz standard frequency to time base INPUT connector.

c. Connect oscilloscope through a 10:1 probe Lo A14(1).

Note

Do not use extender board during adjustments

d. Acljust oscilloscope controls for a stable display.

e. Adjust L2, L3, L4, and L5 for maximum output on oscilloscope (should be greater than 2V P-P). Disconnect all test equipment.

f. Set Counter TIME BASE switch to INT.

g. Connect an HP 5245M Electronic Counter to time base INPUT connector.

h. Adjust A14C5 for 10 MHz ± 11 Hz.

Note

If crystal or heater (A15 Assy) has been changed, it may be necessary to select C4 to permit tuning to 10 MHz.

i. Clip current probe over the orange wire from A14(12). Connect the probe through probe amplifier to oscilloscope input. Set oscilloscope to .05V/cm and probe amplifier to 5mA/cm.

j. Adjust A14R6 for 20 mA P-P on oscilloscope.

k. Readjust A14C5 for 10 MHz ± 1 count on electronic counter.

3. POWER SUPPLY ADJUSTMENTS

No power supply adjustments are necessary. If power supplies fail, remove ac power and press A17S1 RESET switch. Return Counter ac power on. If supplies are still off or low, determine cause by troubleshooting.

5-27. TROUBLESHOOTING

5-28. Troubleshooting Aids

5-29. THEORY OF OPERATION. Section IV provides information with a flow chart on Counter operation in all modes.

5-30. SCHEMATIC DIAGRAMS. Schematic diagrams, waveforms, and operation and troubleshooting of individual assemblies are provided in Section VIII.

5-31. COMPONENT LOCATION. Photographs of printed circuit assemblies with component callouts are included in Section VIII with the schematics.

5-32. TROUBLESHOOTING PROCEDURE

5-33. The following paragraphs, steps, and charts aid in locating problems. Use this section to isolate trouble to an assembly; then go to that assembly schematic and operation in Section VIII to locate the defective components. The Flow Diagram and Block Diagram should be referred to during the following discussion; these may be folded out from Section VIII.

5-34. TROUBLE AT TURN ON. If Counter fails to turn on (no display, decimal point, measurement unit, or COUNTING/ARM display) make the following checks:

a. Line voltage switch set for correct voltage (115V or 230V).

b. Power cord plugged into counter and power source.

c. Line fuse good.

d. AC power available at source.

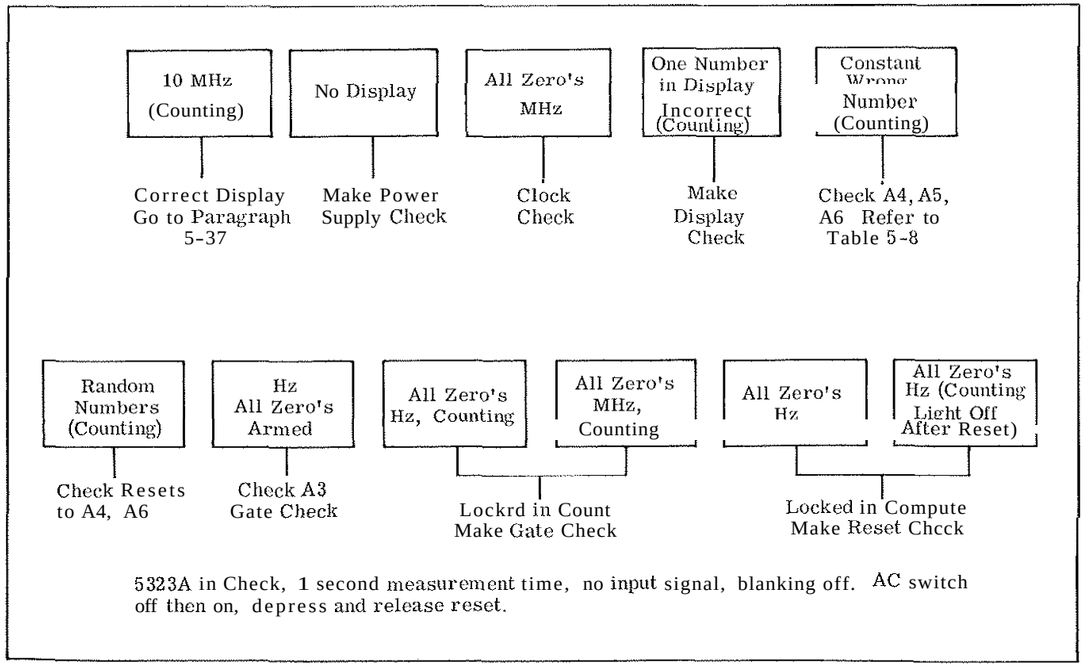
e. Check A16, A17, T1, L1, and L2

Note

The +5.1V output from A16 is available at J7. The +12V output from A17 is available at a test point located between J7 and A15.

5-35. TROUBLE DURING SELF CHECK. Refer to Table 5-5, the diagnostic tree for the Counter. Five troubleshooting routines are indicated: power supply, clock, reset, gate and display check. The power supply check has been discussed in paragraph 5-34. When using an oscilloscope to troubleshoot, a fast MEASUREMENT TIME setting is useful. The .01 setting may be used, or a HNC cable may be connected from GATE OUT to EXT GATE on the rear panel of the Counter (use a BNC Tee to provide external trigger for the oscilloscope).

Table 5-5. 5323A Diagnostic Tree



5323A in Check, 1 second measurement time, no input signal, blanking off. AC switch off then on, depress and release reset.

5-36. CLOCK CHECK

a. Check the 10 MHz internal time base signal at time base INPUT with TIME BASE set to INT. The signal should be 10 MHz, 1.0V P-P (minimum) into a 50-ohm load. If signal frequency or amplitude are incorrect, go to A14, A15.

b. Check for clock input (Fy) at pin C of A3. Go to A9 and interconnecting coaxial cable if signal is absent.

c. Check fur CLOCK output at pin N of A3. If no signal, make sure that MODE is not in HOLD. IS frequency is not Fy, but Fy/6, check Hz/RPM switch, then go to A3.

d. Check for CLOCK input at pin C of A7. Go to A9 if signal is absent.

5-37. RESET CHECK

a. Hold RESET depressed or connect a clip-lead from the BRN wire of the RESET switch to chassis ground.

Note

The ARMED light will go dim in this state. Use a Logic Probe to verify the following conditions.

b. Check A3: should be HIGH on pins 12 and 13, LOW on pin K.

c. Check A4: Xa, Xb, Xc, Xd should be LOW.

d. Check AS: Σa, Cb, Zc, Σd should be HIGH.

c. Check A6: Ya, Yb, Yc, Yd should he LOW.

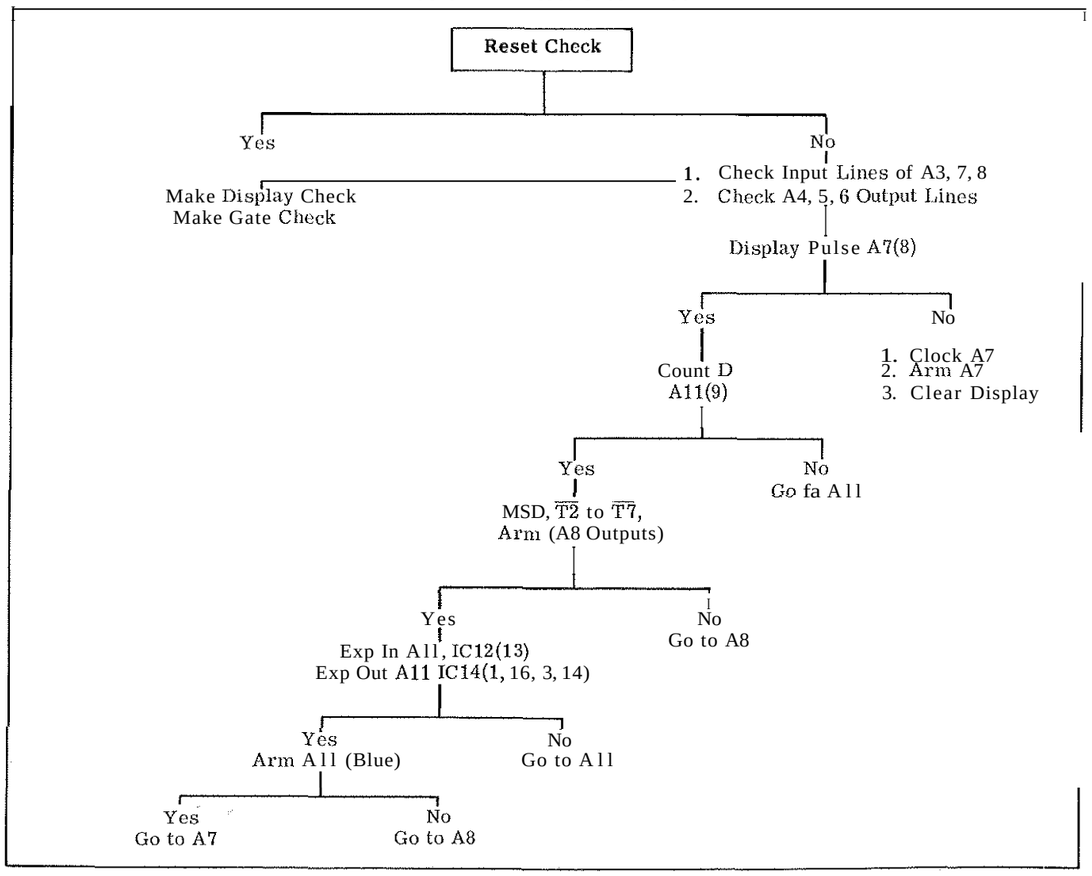
f. Chcck A7: should be HIGH on pins 10 and 14.

g. Check A8: should be HIGH on pin 5.

h. If the above tests with the Logic Probe indicate a malfunction, refer to Table 5-6 for a more detailed procedure.

i. Remove the clip-lead from the RESET switch after troubleshooting.

Table 5-6. Rcsct Check Tree



5-38. *GATE CHECK*

a. Set MODE to CHECK, MEASUREMENT TIME to 1, Hz/RPM to Hz, and TIME BASE to INT.

b. Check A3: should be HIGH on pins 3, 10, L, and P, LOW on pin E.

c. Refer to Table 5-7 for more detailed trouble-shooting procedure.

5-39. DISPLAY CHECK

a. With MODE set to CHECK and MEASUREMENT TIME set to 1, connect a clip-lead from A11IC8(4) (test point isprovided between IC15 and IC19) to chassis ground. Display should step from all ones to all twos, etc., to all nines. Last digit (LSD) of the all nines display will be a zero which is normal. The all zero display will be skipped which is also normal. If all numbers appear and the display steps from ones to nines, the display is *normal*. Remove the clip-lead.

b. If the display steps correctly, but a wrong number appears such as a three when all eights are displayed, set MODE to HOLD to freeze the incorrect display. Tlrc BCD lines from the A11 and A12 boards can now be checked with the Logic Probe.

c. A digit that will not change may be caused by a missing transfer pulse (MSD, $\overline{T2}$ through $\overline{T7}$). Go to A8.

d. If the display does not step, make Reset Check (paragraph 5-34). If reset is correct, go to A7.

e. A blanked display tube can be caused by a defective display tube or blank input. Go to A12.

f. If a constant wrong number is displayed with the Counter MODE set lo CHECK (A11 test point not grounded), the problem should be in A4, A5, or A6. Check the X, Y, I and Σ lines, because aline is probably held HIGH or LOW. Refer to Table 5-8 which lists typical defective displays and their causes.

5-40. ADDITIONAL TESTS

a. If the Counter correctly displays 10.00000 MHz, check to verify that it resets.

b. Make a display check to see if all numbers appear.

c. Check all MEASUREMENT TIME settings. Reset at each setting. If trouble occurs, go to A10.

d. With MODE set to NORM, verify that ARM light is ON with no input signal. If trouble occurs, go to A13.

e. Connect a signal to INPUT and verify operation to 20 MHz and to 100 mV sensitivity. This will check the A1 and A2 assemblies.

f. Check opcration of the Hz/RPM switch in RPM. Fy should be divided by 6 in A3 and appear at pin N. All measurement times are now multiplied by 6.

g. Check blanking, hysteresis, and external gate operation.

Table 5-7. Gate Check Tree

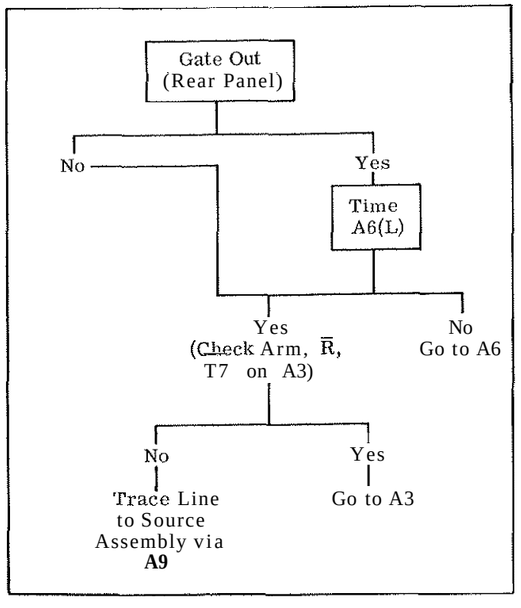


Table 5-8. Defective Displays

Display (COUNTING and MHz ON)	Check Line for Signal:
10.11111	**Ib, Id**
11.11111	**Xd, C2**
11.22222	Σd
12.11118	Ia
12.22222	Xc
15.55555	Σa
2.111111	Ic
21.11111	Ic
24.44444	Σb
25.55555	Xa
42.22222	Xc, Ic, Σc
44.44444	Xb
99.99999	$\overline{C2}$

SECTION VI

REPLACEABLE PARTS

6-1. INTRODUCTION

6-2. This section contains information for ordering replacement parts. Table 6-1 lists parts in alpha-numerical order of their reference designators and indicates the description and HP part number of each part, together with any applicable notes. Table 6-2 lists parts in alpha-numerical order of their HP part number and provides the *following information* on each part:

a. Description of part (see abbreviations below).

b. Typical manufacturer of the part in a five-digit code; see list of manufacturers in Table 6-3.

c. Manufacturer's part number.

d. Totalquantity used inthe instrument (TQ column).

6-3. Miscellaneous parts are listed at the end of Table 6-1.

6-4. ORDERING INFORMATION

6-5. To obtain replacement parts, address order or inquiry to your local Hewlett-Packard Sales and Service office (seelists at rear of this manual for addresses). Identify parts by their *Hewlett-Packard* part numbers.

6-6. To obtain a part that is not listed, include:

a. Instrument model number.

b. Instrument serial number.

c. Description of the part.

d. Function and location of the part.

REFERENCE DESIGNATORS

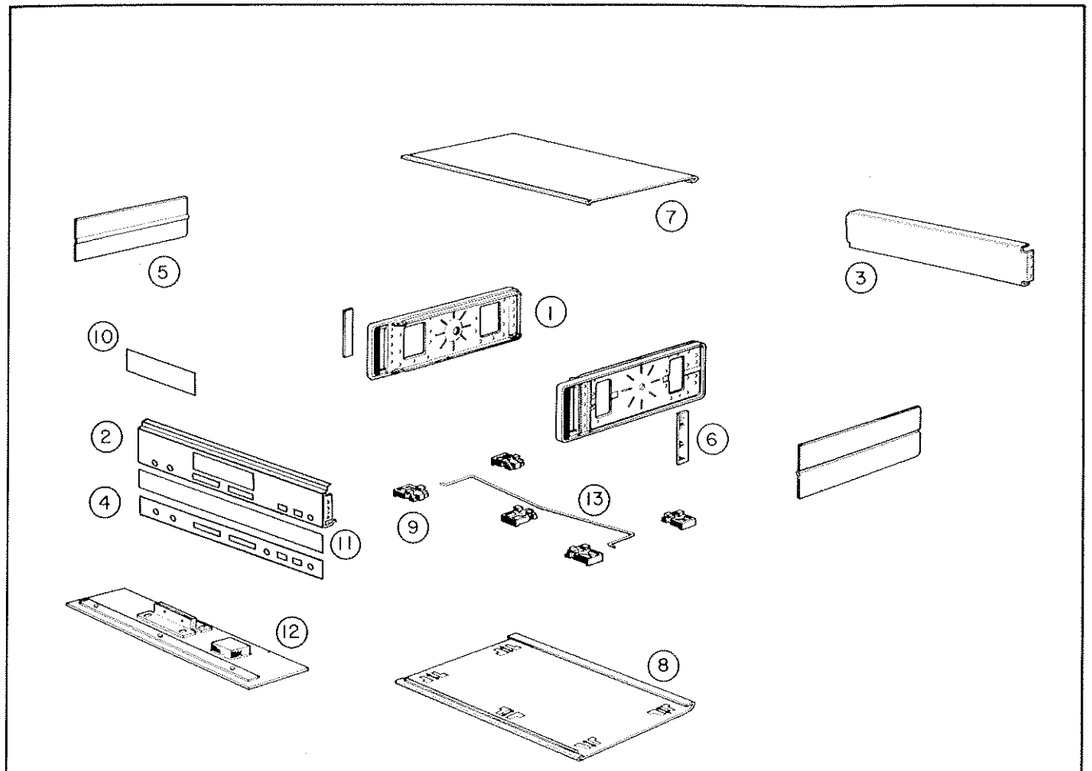
A	=	assembly	F	=	fuse	MP	=	mechanical part	U	=	integrated circuit
B	=	motor	FL	=	filter	P	=	plug	V	=	vacuum, tube, neon bulb, photocell, etc.
BT	=	battery	IC	=	integrated circuit	Q	=	transistor			
C	=	capacitor	J	=	jack	R	=	resistor	VR	=	voltage regulator
CP	=	coupler	K	=	relay	RT	=	thermistor	W	=	cable
CR	=	diode	L	=	inductor	S	=	switch	X	=	socket
DL	=	delay line	LS	=	loud speaker	T	=	transformer	Y	=	crystal
DS	=	device signaling (lamp)	M	=	meter	TB	=	terminal board	Z	=	tuned cavity, network
E	=	misc electronic part	MK	=	microphone	TP	=	test point			

ABBREVIATIONS

A	=	amperes	H	=	henries	N/O	=	normally open	RMO		rack mount only
AFC	=	automatic frequency control	HDW	=	hardware	NOM	=	nominal	RMS		root-mean square
AMPL	=	amplifier	HEX	=	hexagonal	NPO	=	negative positive zero (zero temperature coefficient)	RWV		reverse working voltage
			HG	=	mercury						
BFO	=	beat frequency oscillator	HR	=	hour(s)				S-B	=	slow-blow
BE CU	=	beryllium copper	HZ	=	hertz	NPN	=	negative-positive-negative	SCR	=	screw
BH	=	binder head							SE	=	selenium
BP	=	bandpass	IF	=	intermediate freq	NRFR	=	not recommended for field replacement	SECT	=	section(s)
BRS	=	brass	IMPG	=	impregnated				SEMICON	=	semiconductor
BWO	=	backward wave oscillator	INCD	=	incandescent	NSR	=	not separately replaceable	SI	=	silicon
			INCL	=	include(s)				SIL	=	silver
CCW	=	counter-clockwise	INS	=	insulation(ed)				SL	=	slide
CER	=	ceramic	INT	=	internal	OBD	=	order by description	SPG	=	spring
CMO	=	cabinet mount only				OH	=	oval head	SPL	=	special
COEF	=	coefficient	K	=	kilo = 1000	OX	=	oxide	SST	=	stainless steel
COM	=	common	LH	=	left hand	P	=	peak	SR	=	split ring
COMP	=	composition	LIN	=	*linear taper*	PC	=	*printed circuit*	STL	=	steel
COMPL	=	complete	LK WASH	=	lock washer	PF	=	picofarads = 10^{-12} farads	TA	=	tantalum
CONN	=	connector	LOG	=	logarithmic taper				TD	=	time delay
CP	=	cadmium plate	LPF	=	low pass filter	PH BRZ	=	phosphor bronze	TGL	=	toggle
CRT	=	cathode-ray tube				PHL	=	Phillips	THD	=	thread
CW	=	clockwise	M	=	milli = 10^{-3}	PIV	=	peak inverse voltage	TI	=	titanium
			MEG	=	meg = 10^{6}	PNP	=	positive-negative-positive	TOL	=	tolerance
DEPC	=	deposited carbon	MET FLM	=	metal film				TRIM	=	trimmer
DR	=	drive	MET OX	=	metallic oxide	P/O	=	part of	TWT	=	traveling wave tube
			MFR	=	manufacturer	POLY	=	polystyrene			
ELECT	=	electrolytic	MHZ	=	mega hertz	PORC	=	porcelain	U	=	micro = 10^{-6}
ENCAP	=	encapsulated	MINAT	=	miniature	POS	=	position(s)			
EXT	=	external	MOM	=	momentary	POT	=	potentiometer	VAR	=	variable
			MOS	=	metal ozide substrate	PP	=	peak-to-peak	VDCW	=	dc working volts
F	=	farads	MTG	=	mounting	PT	=	point			
FH	=	flat head	MY	=	"mylar"	PWV	=	peak working voltage	W	=	with
FIL H	=	fillister head							W	=	watts
FXD	=	fixed	N	=	nano (10^{-9})	RECT	=	rectifier	WIV	=	working inverse voltage
G	=	giga (10^{9})	N/C	=	normally closed	RF	=	radio frequency			
GE	=	germanium	NE	=	neon	RH	=	round head or right hand	WW	=	wirewound
GL	=	glass	NI PL	=	nickel plate				W/O	=	without
GRD	=	ground(ed)									

01194-14

Figure 6-1. Modular Cabinet Parts



Item No.	Description	HP Part Number
1	Side Frame Assembly	5060-0729
2	Front Panel	05323-00001
3	Rear Panel	05323-00004
4	Bottom Extrusion Panel	05323-00003
5	Side Frame Cover	5000-0729
6	Side Trim	5000-0050
7	Top Cover	05325-00008
8	Bottom Cover Assembly	05325-60032
9	Foot Assembly	5060-40001
10	Light Mask	05323-40002
11	Light Bezel Mask	05323-80001
12	Rack Mount Kit	05325-60031
13	Tilt Stand	1490-0030

Table 6-1. Reference Designation Index

Reference Designation	Part No.	Description #	Note
A2CR2	1901-0376	DIODE:SILICON 35V	
A2CR3	1901-0376	DIODE:SILICON 35V	
A2CR4	1901-0040	DIODE:SILICON 30MA 30WV	
A2CR5	1901-0040	DIODE:SILICON 30MA 30WV	
A2CR6	1901-0040	DIODE:SILICON 30MA 30WV	
A2CR7	1910-0022	DIODE:GERMANIUM 5 WIV	
A2CR8	1910-0022	DIODE:GERMANIUM 5 WIV	
A2CR9	1910-0022	DIODE:GERMANIUM 5 WIV	
A2CR10	1901-0460	DIODE:SILICON JUNCTION STABISTOR	
A2CR11	1901-0040	DIODE:SILICON 30MA 30WV	
A2CR12	1901-0040	DIODE:SILICON 30MA 30WV	
A2Q1	1855-0320	TRANSISTOR:DUAL FET SILICON	
A2Q2	1853-0015	TRANSISTOR:SILICON PNP 2N3640	
A2Q3	1854-0071	TRANSISTOR:SILICON NPN	
A2Q4	1853-0015	TRANSISTOR:SILICON PNP 2N3640	
A2Q5	1854-0019	TRANSISTOR:SILICON NPN	
A2Q6	1854-0071	TRANSISTOR:SILICON NPN	
A2Q7	1854-0019	TRANSISTOR:SILICON NPN	
A2Q8	1854-0009	TRANSISTOR:SILICON NPN 2N709	
A2Q9	1854-0009	TRANSISTOR:SILICON NPN 2N709	
A2Q10	1854-0009	TRANSISTOR:SILICON PNP	
A2Q11	1854-0009	TRANSISTOR:SILICON NPN 2N709	
A2R1	0683-5125	R:FXD COMP 5100 OHM 5% 1/4W	
A2R2	0683-5125	R:FXD COMP 5100 OHM 5% 1/4W	
A2R3	0683-1045	R:FXD COMP 1M OHM 5% 1/4W	
A2R4	0683-1065	R:FXD COMP 10M OHM 5% 1/4W	
A2R5	0683-6815	R:FXD COMP 680 OHM 5% 1/4W	
A2R6	0683-4725	R:FXD COMP 4700 OHM 5% 1/4W	
A2R7	0683-1325	R:FXD COMP 1300 OHM 5% 1/4W	
A2R8	0683-4315	R:FXD COMP 430 OHM 5% 1/4W	
A2R9	0683-9105	R:FXD COMP 91 OHM 5% 1/4W	
A2R10	2100-1757	R:VAR WW 500 OHM 10% LIN 1/2W	
A2R11	0683-2015	R:FXD COMP 200 OHM 5% 1/4W	
A2R12	0683-9105	R:FXD COMP 91 OHM 5% 1/4W	
A2R13	0683-4315	R:FXD COMP 430 OHM 5% 1/4W	
A2R14	0683-1035	R:FXD COMP 1 MEGOHM 5% 1/4W	
A2R15	0683-5105	R:FXD COMP 51 OHM 5% 1/4W	
A2R16	0683-6815	R:FXD COMP 680 OHM 5% 1/4W	
A2R17	0683-3315	R:FXD COMP 330 OHM 5% 1/4W	
A2R18	0683-3315	R:FXD COMP 330 OHM 5% 1/4W	
A2R19		NOT ASSIGNED	
A2R20		NOT ASSIGNED	
A2R21	0683-2715	R:FXD COMP 270 OHM 5% 1/4W	
A2R22	0683-1025	R:FXD COMP 1000 OHM 5% 1/4W	
A2R23	0683-2725	R:FXD COMP 2700 OHM 5% 1/4W	
A2R24	0683-1535	R:FXD COMP 15K OHM 5% 1/4W	
A2R25	0683-1235	R:FXD COMP 12K OHM 5% 1/4W	

See introduction to this section for ordering information

Reference Designation	Part No.	Description #	Note
A1	05323-6006	BOARD ASSY:ATTENUATOR	
	05323-6006	BOARD:BLANK PC	
A1C1	0160-0180	C:FXD MY 0.033 UF 5%	
A1C2	0140-0239	C:FXD MICA 5.0 PF 1%	
A1C3	0140-0231	C:FXD MICA 51 PF 5%	
A1C4	0140-0234	C:FXD MICA 500 PF 1%	
A1J1	1250-1163	CONNECTOR:BNC INPUT	
A1R1	0698-4045	R:FXD COMP 100K OHMS 5% 1/4W	
A1R2	0698-1335	R:FXD COMP 1 MEGOHM 5% 1/4W	
A1R3	0698-1035	R:FXD COMP 10K OHM 5% 1/4W	
A1	5040-0385	SWITCH:LEVER	
	5002-3340	SPRING:DETENT	
	5040-0211	SLIDE:4-POLE	
	5020-3442	SPRING:CONTACT	
	5020-2015	GUIDE:SWITCH	
A2	05324-60035	BOARD ASSY:AMPLIFIER	
	05325-00035	BOARD:BLANK PC	
A2C1	0180-0210	C:FXD ELECT 3.3 UF 20% 15VDCW	
A2C2 THRU A2C3	0180-0110	C:FXD ELECT 3.3 UF 20% 15VDCW NOT ASSIGNED	
A2C5 THRU A2C6	0180-1734	NOT ASSIGNED C:FXD ELECT 0.1 UF 10% 35VDCW	
A2C7	0140-0392	C:FXD MICA 68 PF 5%	
A2C8	0140-0392	C:FXD MICA 68 PF 5%	
A2C9	0160-2255	C:FXD CER 8.2-0.25 PF 500VDCW	
A2C10	0180-0210	C:FXD ELECT 3.3 UF 20% 15VDCW	
A2C11	0180-0055	C:FXD ELECT 3.3 UF 20% 15VDCW	
A2C12	0180-0220	C:FXD ELECT 3.3 UF 20% 15VDCW	
A2C13	0160-0176	C:FXD MICA 240PF 5% 300VDCW	
A2C14	0160-0176	C:FXD MICA 240PF 5% 300VDCW	
A2C15	0180-0210	C:FXD ELECT 3.3 UF 20% 15VDCW	
A2C16	0160-2268	C:FXD CER 4.3-0.25 PF 500VDCW	
A2C17	0150-0093	C:FXD CER 0.01 UF +80-20% 100VDCW	
A2C18	0140-0233	C:FXD MICA 15 PF 0.5 PF	
A2C19	0160-2211	C:FXD CER 2.2-0.25 PF 500VDCW	
A2C20	0150-0050	C:FXD CER 0.01 UF 600VDCW	
A2C21	0140-2119	C:FXD MICA 390 PF 5%	
A2CR1	1901-0040	DIODE:SILICON 30MA 30WV	

See introduction to this section for ordering information

Reference Designation	Part No.	Description #	Note
A2R26	0683-1235	R:FXD COMP 12K OHM 5% 1/4W	
A2R27	0683-1535	R:FXD COMP 15K OHM 5% 1/4W	
A2R28	0683-2725	R:FXD COMP 2700 OHM 5% 1/4W	
A2R29	0683-2715	R:FXD COMP 270 OHM 5% 1/4W	
A2R30	0683-3615	R:FXD COMP 360 OHM 5% 1/4W	
A2R31	0683-3015	R:FXD COMP 300 OHM 5% 1/4W	
A2R32	0683-3015	R:FXD COMP 300 OHM 5% 1/4W	
A2R33	0683-6825	R:FXD COMP 6800 OHM 5% 1/4W	
A2R34	0683-2425	R:FXD COMP 2400 OHM 5% 1/4W	
A2R35	0683-2035	R:FXD COMP 20K OHM 5% 1/4W	
A2R36	0683-8235	R:FXD COMP 82K OHM 5% 1/4W	
A2R37	0683-7525	R:FXD COMP 7500 OHM 5% 1/4W	
A2R38	0683-2015	R:FXD COMP 200 OHM 5% 1/4W	
A2R39	0683-1525	R:FXD COMP 1500 OHM 5% 1/4W	
A2R40	0683-2035	R:FXD COMP 20K OHM 5% 1/4W	
A2R41	0683-1615	R:FXD COMP 160 OHM 5% 1/4W	
A2R42		NOT ASSIGNED	
A2R43	0683-2035	R:FXD COMP 20K OHM 5% 1/4W	
A2R44	0683-5105	R:FXD COMP 51 OHM 5% 1/4W	
A3	05323-60011	BOARD ASSY:GATE	
	05323-20011	BOARD:BLANK PC	
A3IC1	1820-0054	INTEGRATED CIRCUIT:QUAD NAND GATE	
A3IC2	1820-0068	INTEGRATED CIRCUIT:TTL	
A3IC3	1820-0328	INTEGRATED CIRCUIT:TTL	
A3IC4	1820-0328	INTEGRATED CIRCUIT:TTL	
A3IC5	1820-0077	INTEGRATED CIRCUIT:TTL	
A3IC6	1820-0077	INTEGRATED CIRCUIT:TTL	
A3IC7	1820-0208	INTEGRATED CIRCUIT	
A3IC8	1820-0094	INTEGRATED CIRCUIT:QUAD NAND GATE	
A3IC9	1820-0210	INTEGRATED CIRCUIT	
A3R1	0683-1035	R:FXD COMP 10K OHM 5% 1/4W	
A3R2	0683-1035	R:FXD COMP 10K OHM 5% 1/4W	
A3R3	0683-1035	R:FXD COMP 10K OHM 5% 1/4W	
A3R4	0683-1035	R:FXD COMP 10K OHM 5% 1/4W	
A4	05323-60005	BOARD ASSY:REGISTER X	
	05323-20005	BOARD:BLANK PC	
A4IC1	1820-0191	INTEGRATED CIRCUIT:SHIFT DECADE,2MHZ	
A4IC2	1820-0191	INTEGRATED CIRCUIT:SHIFT DECADE,2MHZ	
A4IC3	1820-0191	INTEGRATED CIRCUIT:SHIFT DECADE,2MHZ	
A4IC4	1820-0191	INTEGRATED CIRCUIT:SHIFT DECADE,2MHZ	
A4IC5	1820-0191	INTEGRATED CIRCUIT:SHIFT DECADE,2MHZ	

See introduction to this section for ordering information

Reference Designation	Part No.	Description #	Note
A4IC6	[illegible]0191	INTEGRATED CIRCUIT:SHIFT DECADE,2MHZ	
A4IC7	[illegible]0190	INTEGRATED CIRCUIT:SHIFT DECADE,10MHZ	
A4IC8	[illegible]0191	INTEGRATED CIRCUIT:SHIFT DECADE,2MHZ	
A4IC9	[illegible]0069	INTEGRATED CIRCUIT:TTL	
A4IC10	[illegible]0328	INTEGRATED CIRCUIT:TTL	
A5	5[illegible]3-60004	BOARD ASSY:ADDER	
	5[illegible]3-20002	BOARD:BLANK PC	
A5IC1	[illegible]	INTEGRATED CIRCUIT:TTL	
A5IC2	[illegible]005	INTEGRATED CIRCUIT:QUAD NAND GATE	
A5IC3	[illegible]034	INTEGRATED CIRCUIT:TTL	
A5IC4	[illegible]006	INTEGRATED CIRCUIT:TTL	
A5IC5	[illegible]030	INTEGRATED CIRCUIT:TTL	
A5IC6	[illegible]013	INTEGRATED CIRCUIT:4-POLE SWITCH	
A5IC7	[illegible]030	INTEGRATED CIRCUIT:TTL	
A5IC8	[illegible]013	INTEGRATED CIRCUIT:4-POLE SWITCH	
A5IC9	[illegible]077	INTEGRATED CIRCUIT:TTL	
A6	05323-[illegible]0003	BOARD ASSY:REGISTER Y	
	053[illegible]-20003	BOARD:BLANK PC	
A6IC1	1820-0191	INTEGRATED CIRCUIT:SHIFT DECADE,2MHZ	
A6IC2	1820-0191	INTEGRATED CIRCUIT:SHIFT DECADE,2MHZ	
A6IC3	1820-0191	INTEGRATED CIRCUIT:SHIFT DECADE,2MHZ	
A6IC4	1820-0191	INTEGRATED CIRCUIT:SHIFT DECADE,2MHZ	
A6IC5	1820-0191	INTEGRATED CIRCUIT:SHIFT DECADE,2MHZ	
A6IC6	1820-0191	INTEGRATED CIRCUIT:SHIFT DECADE,2MHZ	
A6IC7	1820-0191	INTEGRATED CIRCUIT:SHIFT DECADE,2MHZ	
A6IC8	1820-0190	INTEGRATED CIRCUIT:SHIFT DECADE,10MHZ	
A6IC9	1820-0327	INTEGRATED CIRCUIT:TTL	
A6IC10	1820-0307	INTEGRATED CIRCUIT	
A6IC11	1820-0327	INTEGRATED CIRCUIT:TTL	
A6IC12	[illegible]0307	INTEGRATED CIRCUIT	
A6R1	0683-[illegible]35	R:FXD COMP 10K OHM 5% 1/4W	
A6R2	0683-1035	R:FXD COMP 10K OHM 5% 1/4W	
A6R3	0683-1035	R:FXD COMP 10K OHM 5% 1/4W	
A6R4	0683-1035	R:FXD COMP 10K OHM 5% 1/4W	
A6R5	0683-1035	R:FXD COMP 10K OHM 5% 1/4W	
A6R6	0683-1035	R:FXD COMP 10K OHM 5% 1/4W	
A6R7	0683-10[illegible]	R:FXD COMP 10K OHM 5% 1/4W	
A6R8	0683-10	R:FXD COMP 10K OHM 5% 1/4W	
A7	05323-[illegible]0004	BOARD ASSY:CONTROL	
	[illegible]323-20004	BOARD:BLANK PC	
A7IC1	1820-0209	INTEGRATED CIRCUIT	

See introduction to this section for ordering information

Reference Designation	Part No.	Description #	Note
A7IC2	1820-0119	INTEGRATED CIRCUIT	
A7IC3	1820-0328	INTEGRATED CIRCUIT:TTL	
A7IC4	1820-0077	INTEGRATED CIRCUIT:TTL	
A7IC5	1820-0077	INTEGRATED CIRCUIT:TTL	
A7IC6	1820-0054	INTEGRATED CIRCUIT:QUAD NAND GATE	
A7IC7	1820-0054	INTEGRATED CIRCUIT:QUAD NAND GATE	
A7IC8	1820-0328	INTEGRATED CIRCUIT:TTL	
A7IC9	1820-0068	INTEGRATED CIRCUIT:TTL	
A7IC10	1820-0068	INTEGRATED CIRCUIT:TTL	
A8	05323-60009	BOARD ASSY:DISPLAY CONTROL	
	05323-20009	BOARD:BLANK PC	
A8IC1	1820-0119	INTEGRATED CIRCUIT	
A8IC2	1820-0068	INTEGRATED CIRCUIT:TTL	
A8IC3	1820-0054	INTEGRATED CIRCUIT:QUAD NAND GATE	
A8IC4	1820-0328	INTEGRATED CIRCUIT:TTL	
A8IC5	1820-0054	INTEGRATED CIRCUIT:QUAD NAND GATE	
A8IC6	1820-0054	INTEGRATED CIRCUIT:QUAD NAND GATE	
A8IC7	1820-0328	INTEGRATED CIRCUIT:TTL	
A8IC8	1820-0094	INTEGRATED CIRCUIT	
A8IC9	1820-0094	INTEGRATED CIRCUIT	
A8IC10	1820-0307	INTEGRATED CIRCUIT	
A8Q1	1854-0071	TRANSISTOR:SILICON NPN	
A8R1	0683-2025	R:FXD COMP 2000 OHM 5% 1/4W	
A9	05323-60014	BOARD ASSY:CONNECTOR	
	05323-20014	BOARD:BLANK PC	
A9C1	0160-0161	C:FXD MY 0.01 UF 10% 200VDCW	
A9CR1	1910-0030	DIODE:GERMANIUM 100 MA 0.65V	
A9L1	9140-0114	COIL:FXD RF 10 UH	
A9L2	9140-0114	COIL:FXD RF 10 UH	
A9L3	9140-0114	COIL:FXD RF 10 UH	
A9L4	9140-0114	COIL:FXD RF 10 UH	
A9L5	9140-0114	COIL:FXD RF 10 UH	
A9L6	9140-0114	COIL:FXD RF 10 UH	
A9L7	9140-0114	COIL:FXD RF 10 UH	
A9L8	9140-0114	COIL:FXD RF 10 UH	
A9R1	0683-1035	R:FXD COMP 10K OHM 5% 1/4W	
A9XA1		NOT ASSIGNED	
A9XA2-A9XA6	1251-1886	CONNECTOR:PC 30 CONTACTS	
A9XA7	1251-1886	CONNECTOR:PC 30 CONTACTS	
A9XA8	1251-1886	CONNECTOR:PC 30 CONTACTS	
A9XA9-A9XA16		NOT ASSIGNED NOT ASSIGNED	
A9XA17	1251-1886	CONNECTOR:PC 30 CONTACTS	

See introduction to this section for ordering information

Reference Designation	Part No.	Description #	Note
A10	5323-[illegible]007	BOARD ASSY:SWITCH-FUNCTION	
	05323-2[illegible]007	BOARD:BLANK PC	
	5040-0238	SWITCH:LEVER	
	5040-0238	SLIDE:4-POLE	
	5020-34[illegible]1	SPRING:CONTACT	
	[illegible]020-3 48	SPRING:DETENT	
	05323-2 016	GUIDE:SWITCH	
A11	5323-6 [illegible]1	BOARD ASSY:MAIN	
	05323-20[illegible]1	BOARD:BLANK PC	
A11 [illegible]1	820-00	INTEGRATED CIRCUIT:QUAD NAND GATE	
A11 [illegible]2	1820 0054	INTEGRATED CIRCUIT:QUAD NAND GATE	
A11 [illegible]3	1820 0116	INTEGRATED CIRCUIT	
A11 [illegible]4	1820 0116	INTEGRATED CIRCUIT	
A11 [illegible]5	1820 0116	INTEGRATED CIRCUIT	
A11 [illegible]6	1820 0116	INTEGRATED CIRCUIT	
A11 [illegible]7	1820-0116	INTEGRATED CIRCUIT	
A11 [illegible]8	1820 0116	INTEGRATED CIRCUIT	
A11 [illegible]9	1820 0116	INTEGRATED CIRCUIT	
A11 [illegible]0	1820 0094	INTEGRATED CIRCUIT	
A11 [illegible]1	1820 0054	INTEGRATED CIRCUIT:QUAD NAND GATE	
A11 [illegible]1	1820-0176	INTEGRATED CIRCUIT:NEGATIVE LOGIC	
A11 [illegible]1	1820-0054	INTEGRATED CIRCUIT:QUAD NAND GATE	
A11 [illegible]1	1820-0116	INTEGRATED CIRCUIT	
A11 [illegible]1	1820-0069	INTEGRATED CIRCUIT:TTL	
A11 [illegible]1	1820-0054	INTEGRATED CIRCUIT:QUAD NAND GATE	
A11 [illegible]1	1820 0094	INTEGRATED CIRCUIT	
A11 [illegible]1	1820 0119	INTEGRATED CIRCUIT	
A11 [illegible]1	1820 0094	INTEGRATED CIRCUIT	
A11 [illegible]2	1820 0077	INTEGRATED CIRCUIT:TTL	
A11 [illegible]2	1820 0069	INTEGRATED CIRCUIT:TTL	
A11IC2	1820-0328	INTEGRATED CIRCUIT:TTL	
A11IC2	1820-0068	INTEGRATED CIRCUIT:TTL	
A11Q1	1854-0071	TRANSISTOR:SILICON NPN	
A11Q2Q	1853-0020	TRANSISTOR:SILICON PNP	
A11R1	0683-1035	R:FXD COMP 10K OHM 5% 1/4W	
A1 R[illegible]	0683-1035	R:FXD COMP 10K OHM 5% 1/4W	
A1 R[illegible]	0683-1035	R:FXD COMP 10K OHM 5% 1/4W	
A1 R[illegible]	0683-1035	R:FXD COMP 10K OHM 5% 1/4W	
A1 R[illegible]	0683-1035	R:FXD COMP 10K OHM 5% 1/4W	
A1 R[illegible]	0683-1035	R:FXD COMP 10K OHM 5% 1/4W	
A1	05323-60006	BOARD ASSY:DISPLAY	
	05323-20008	BOARD:BLANK PC	
A1 D 1	1970-0035	TUBE:ELECTRON 10-DIGIT INDICATOR	

See introduction to this section for ordering information

Reference Designation	Part No.	Description	Note
A12DS2	1970-0035	TUBE:ELECTRON 10-DIGIT INDICATOR	
A12DS3	1970-0035	TUBE:ELECTRON 10-DIGIT INDICATOR	
A12DS4	1970-0035	TUBE:ELECTRON 10-DIGIT INDICATOR	
A12DS5	1970-0035	TUBE:ELECTRON 10-DIGIT INDICATOR	
A12DS6	1970-0035	TUBE:ELECTRON 10-DIGIT INDICATOR	
A12DS7	1970-0035	TUBE:ELECTRON 10-DIGIT INDICATOR	
A12IC1	1820-0092	INTEGRATED CIRCUIT:NIXIE DRIVER	
A12IC2	1820-0092	INTEGRATED CIRCUIT:NIXIE DRIVER	
A12IC3	1820-0092	INTEGRATED CIRCUIT:NIXIE DRIVER	
A12IC4	1820-0092	INTEGRATED CIRCUIT:NIXIE DRIVER	
A12IC5	1820-0092	INTEGRATED CIRCUIT:NIXIE DRIVER	
A12IC6	1820-0092	INTEGRATED CIRCUIT:NIXIE DRIVER	
A12IC7	1820-0092	INTEGRATED CIRCUIT:NIXIE DRIVER	
A12IC8	1820-0092	INTEGRATED CIRCUIT:NIXIE DRIVER	
A12R1	0683-1235	R:FXD COMP 12K OHM 5% 1/4W	
A12R2	0683-1235	R:FXD COMP 12K OHM 5% 1/4W	
A12R3	0683-1235	R:FXD COMP 12K OHM 5% 1/4W	
A12R4	0683-1235	R:FXD COMP 12K OHM 5% 1/4W	
A12R5	0683-1235	R:FXD COMP 12K OHM 5% 1/4W	
A12R6	0683-1235	R:FXD COMP 12K OHM 5% 1/4W	
A12R7	0683-1235	R:FXD COMP 12K OHM 5% 1/4W	
A12XA1-A12XA11		NOT ASSIGNED	
A12XA12	1251-2225	CONNECTOR:PC CONTACTS	
A12	05323-00002	BRACKET:CONNECTOR	
	1200-0766	SOCKET:TUBE 14 CONTACT	
A13	05323-60017	BOARD ASSY:ANNUNCIATOR	
	05323-20017	BOARD:BLANK PC	
A13DS1	2140-0311	LAMP:INCANDESCENT 5.0V 0.06A	
A13DS2	2140-0311	LAMP:INCANDESCENT 5.0V 0.06A	
A13DS3	2140-0311	LAMP:INCANDESCENT 5.0V 0.06A	
A13DS4	2140-0311	LAMP:INCANDESCENT 5.0V 0.06A	
A13DS5	2140-0311	LAMP:INCANDESCENT 5.0V 0.06A	
A13DS6	2140-0311	LAMP:INCANDESCENT 5.0V 0.06A	
A13	02116-0001	CONTACT:LIGHT BULB	
	0361-0140	RIVET:SEMITUBULAR 8 R&S	
A14	05325-60008	ASSY:OSCILLATOR MULTIBOARD	
	05325-20008	BOARD:BLANK PC	
A14C1	0170-0065	C:FXD MI 0.1UF 20% 50DCW	

See introduction to this section for ordering information

Reference Designation	Part No.	Description	Note
A14C2	0180-0210	C:FXDEL ECT 3.3 F 20% 15VDC	
A14C3	0150-0050	C:FXDCE R 1000 P 600VDCW	
A14C4	0160-0368	C:FXDMI CA 16 PF 5% 500VDCW	
A14C5	0121-0059	C:VARCE R 2-8 PF 300VDCW	
A14C6	0140-0177	C:FXDMI CA 400 PW 1%	
A14C7	0140-0208	C:FXDMI CA 680 PF 5 %	
A14C8	0160-2055	C:FXDCE R 0.01 UF + 80-20% 100VDCW	
A14C9	0160-2055	C:FXDCE R 0.01 UF + 80-20% 100VDCW	
A14C10	0160-2055	C:FXDCE R 0.01 UF + 80-20% 100VDCW	
A14C11	0160-2218	C:FXDMI CA 1000 PF 5%	
A14C12	0160-2055	C:FXDCE R 0.01 UF + 80-20% 100VDCW	
A14C13	0140-0192	C:FXDMI CA 68 PF 5%	
A14C14	0160-0194	C:FXDMY 0.015UF 10%	
A14C15	0140-0195	C:FXDMI CA 130 PF 5% 300 VDCW	
A14C16	0140-0182	C:FXDMI CA 5000 PF 2%	
A14C17	0140-0199	C:FXDMI CA 240 PF 5 %	
A14C18	0160-2055	C:FXDCE R 0.01 UF + 80-20% 100VDCW	
A14C19	0140-0209	C:FXDMI CA 5.0 PF 1 0%	
A14C20	0160-0298	C:FXDMY 0.0015 UF 10% 500VDCW	
A14C21	0140-0199	C:FXDMI CA 240 PF 5 %	
A14C22	0140-0200	C:FXDMI CA 390 PF 5 %	
A14C23	0180-0210	C:FXDEL ECT 3.3 UF 20% 15VDCW	
A14C24	0160-2199	C:FXDMI CA 30 PF 5%	
A14CR1	1910-0022	DIODE:SE RANIUM 5 W 1V	
A14L1	9140-0158	COIL:FD PF 1 UH 10 %	
A14L2	9140-0126	COIL:VAR 1.76-4.02 UH	
A14L3	9140-0126	COIL:VAR 1.76-4.02 UH	
A14L4	9140-0125	COIL:VAR 0.9-1.9 UH	
A14L5	9140-0125	COIL:VAR 0.9-1.9 UH	
A14L6	9140-0158	COIL:FXD PF 1 UH 10%	
A14Q1	1854-0019	TRANSISTOR:SILICON NPN	
A14Q2	1854-0071	TRANSISTOR:SILICON NPN	
A14Q3	1854-0071	TRANSISTOR:SILICON NPN	
A14Q4	1854-0071	TRANSISTOR:SILICON NPN	
A14Q5	1853-0036	TRANSISTOR:SILICON PNP	
A14Q6	1853-0036	TRANSISTOR:SILICON PNP	
A14Q7	1854-0005	TRANSISTOR:SILICON NPN 2N708	
A14Q8	1854-0009	TRANSISTOR:SILICON NPN 2N709	
A14Q9	1854-0009	TRANSISTOR:SILICON NPN 2N709	
A14R1	0698-5565	R:FXDCAR BON 2.2K OHM 5% 1/8W	
A14R2	0698-6001	R: XDCOM P 0K OHM 5% 1/8W	
A14R3	0698-3376	R: XDCOM P -3 OHM 5% /8W	
A14R4	0698-5180	R: XDCOM P K OHM 5% /8W	
A14R5	0698-6000	R: XDCOM P .7K OHM 5 1/8W	

See introduction to this section for ordering information

Reference Designation	Part No.	Description #	Note
A14R6	2100-1760	R:VAR WW 5K OHM 10% LIN 1/2W	
A14R7	0698-3381	R:FXD COMP 150 OHM 5% 1/8W	
A14R8	0698-5567	R:FXD CARBON 27K OHM 5% 1/8W	
A14R9	0698-5185	R:FXD COMP 15K OHM 5% 1/8W	
A14R10	0698-5180	R:FXD COMP 2K OHM 5% 1/8W	
A14R11	0698-6001	R:FXD COMP 10K OHM 5% 1/8W	
A14R12	0698-6000	R:FXD COMP 2.7K OHM 5% 1/8W	
A14R13	0698-6123	R:FXD COMP 20K OHM 5% 1/8W	
A14R14	0698-6123	R:FXD COMP 20K OHM 5% 1/8W	
A14R15	0698-5180	R:FXD COMP 2K OHM 5% 1/8W	
A14R16	0698-5997	R:FXD COMP 12K OHM 5% 1/8W	
A14R17	0698-5565	R:FXD CARBON 2.2K OHM 5% 1/8W	
A14R18	0698-5565	R:FXD CARBON 2.2K OHM 5% 1/8W	
A14R19	0698-3113	R:FXD CARBON 100 OHM 5% 1/8W	
A14R20	0698-6001	R:FXD COMP 10K OHM 5% 1/8W	
A14R21	0698-5565	R:FXD CARBON 2.2K OHM 5% 1/8W	
A14R22	0698-3114	R:FXD COMP 300 OHM 5% 1/8W	
A14R23	0698-5103	R:FXD COMP 430 OHM 5% 1/8W	
A14R24	0698-3278	R:FXD CARBON 51 OHM 5% 1/8W	
A14R25	0698-3114	R:FXD COMP 300 OHM 5% 1/8W	
A14R26	0698-5996	R:FXD COMP 560 OHM 5% 1/8W	
A14R27	0698-5183	R:FXD COMP 4.3K OHM 5% 1/8W	
A14R28	0698-5566	R:FXD COMP 2.4K OHM 5% 1/8W	
A14R29	0698-5174	R:FXD COMP 200 OHM 5% 1/8W	
A14R30	0698-5172	R:FXD COMP 13 OHM 5% 1/8W	
A14R31	0698-5174	R:FXD COMP 200 OHM 5% 1/8W	
A14R32	0698-3881	R:FXD COMP 150 OHM 5% 1/8W	
A15	05325-60012	ASSY:CRYSTAL/OVEN 10MHZ	
	05325-20015	BOARD:BLANK PC	
	7100-0071	CAN:SQUARE 1-1/2" X 2-7/16"	
	7100-0893	COVER:SQUARE 1-15/32 X 3/16"	
A15RT1	0410-0161	COMPONENT:OVEN	
A15Y1	0410-0175	CRYSTAL:QUARTZ 10 MHZ	
A16	05323-60022	POWER SUPPLY:+5.1V,+175V	
	05323-20022	BOARD:BLANK PC	
A16C1	0180-1962	C:FXD ELECT 15 UF 250VDCW	
A16C2	0180-0154	C:FXD ELECT 1900 UF +75-10% 15VDCW	
A16C3	0180-0210	C:FXD ELECT 3.3 UF 20% 15VDCW	
A16C4	0160-2226	C:FXD MICA 2200 PF 5% 300VDCW	
A16CR1	1901-0028	DIODE:SILICON 0.75A 400PIV	
A16CR2	1901-0028	DIODE:SILICON 0.75A 400PIV	
A16CR3	1901-0028	DIODE:SILICON 0.75A 400PIV	
A16CR4	1901-0028	DIODE:SILICON 0.75A 400PIV	
A16CR5	1901-0200	DIODE:SILICON 100 PIV 3A	

See introduction to this section for ordering information

Reference Designation	Part No.	Description #	Note
A16CR6	1901-0200	DIODE:SILICON 100 PIV 3A	
A16CR7	1901-0200	DIODE:SILICON 100 PIV 3A	
A16CR8	1901-0200	DIODE:SILICON 100 PIV 3A	
A16CR9	1901-0040	DIODE:SILICON 30MA 30WV	
A16CR10	1902-3094	DIODE BREAKDOWN:5.11V 2%	
A16CR11	1902-3429	DIODE BREAKDOWN:100V 2%	
A16CR12	1902-3394	DIODE BREAKDOWN:75V 2%	
A16Q1	1853-0020	TRANSISTOR:SILICON PNP	
A16Q2	1854-0232	TRANSISTOR:SILICON NPN	
A16Q3	1854-0071	TRANSISTOR:SILICON NPN	
A16R1	0683-1045	R:FXD COMP 100K OHMS 5% 1/4W	
A16R2	0683-7515	R:FXD COMP 750 OHM 5% 1/4W	
A16R3	0683-2035	R:FXD COMP 20K OHM 5% 1/4W	
A16R4	0683-1505	R:FXD COMP 15 OHM 5% 1/4W	
A16	1205-0050	HEAT DISSIPATOR	
A17	05325-60005	POWER SUPPLY:+12V	
	05325-20005	BOARD:BLANK PC	
A17C1	0180-2102	C:FXD ELECT 700 UF +75-10% 25VDCW	
A17C2	0180-2102	C:FXD ELECT 700 UF +75-10% 25VDCW	
A17C3	0180-0210	C:FXD ELECT 3.3 UF 20% 15VDCW	
A17C4	0180-0160	C:FXD ELECT 22 UF 20% 35VDCW	
A17C5	0180-0210	C:FXD ELECT 3.3 UF 20% 15VDCW	
A17CR1	1901-0049	DIODE:SILICON 50PIV	
A17CR2	1901-0049	DIODE:SILICON 50PIV	
A17CR3	1901-0049	DIODE:SILICON 50PIV	
A17CR4	1901-0049	DIODE:SILICON 50PIV	
A17CR5	1901-0049	DIODE:SILICON 50PIV	
A17CR6	1901-0049	DIODE:SILICON 50PIV	
A17CR7	1901-0049	DIODE:SILICON 50PIV	
A17CR8	1901-0049	DIODE:SILICON 50PIV	
A17CR9	1902-3114	DIODE BREAKDOWN:6.19V 2%	
A17CR10	1902-3114	DIODE BREAKDOWN:6.19V 2%	
A17Q1	1853-0020	TRANSISTOR:SILICON PNP	
A17Q2	1854-0300	TRANSISTOR:SILICON NPN	
	05050-0034	HEAT SINK	
A17Q3	1854-0071	TRANSISTOR:SILICON NPN	
A17Q4	1853-0020	TRANSISTOR:SILICON PNP	
A17Q5	1854-0300	TRANSISTOR:SILICON NPN	
	05050-0034	HEAT SINK	
A17Q6	1854-0071	TRANSISTOR:SILICON NPN	
A17R1	0683-1325	R:FXD COMP 1300 OHM 5% 1/4W	

See introduction to this section for ordering information

Reference Designation	Part No.	Description #	Note
A17R2	0683-2225	R:FXD COMP 2.2KOHM 5% 1/4W	
A17R3	0683-5125	R:FXD COMP 5100OHM 5% 1/4W	
A17R4	0683-5125	R:FXD COMP 5100OHM 5% 1/4W	
A17R5	0683-2225	R:FXD COMP 2.2KOHM 5% 1/4W	
A17R6	0683-3935	R:FXD COMP 39KOHM 5% 1/4W	
A17R7	0683-6235	R:FXD COMP 62KOHM 5% 1/4W	
A17R8	0683-4335	R:FXD COMP 43KOHM 5% 1/4W	
A17R9	0683-4335	R:FXD COMP 43KOHM 5% 1/4W	
A17R10	0683-5635	R:FXD COMP 56KOHM 5% 1/4W	
A17S1	3101-1312	SWITCH:SLIDE SDT .05A 12.5V & 1VDC	
C1	0150-0119	C:FXD CER 0.X 0.UF 20% 2 KVAC	
C2	0180-2154	C:FXD ELECT 190 UF +75-10% 15 VDCW	
F1	2110-0020	FUSE:SLO-BLO 0.8 125VAC 5 VCD	
	2110-0019	FUSE:SLO BLO 0.4A 125VAC 0 VCD	
J1	1250-0083	CONNECTOR:BNC	
J2	1250-0083	CONNECTOR:BNC	
J3	1250-0083	CONNECTOR:BNC	
J4	1250-0083	CONNECTOR:BNC	
J5	1251-0148	CONNECTOR:PWR 3 IN MAL	
J6	1251-0085	CONNECTOR:FEM 6-PIN MIN TR	
J7	1250-0083	CONNECTOR:BNC	
L1	9140-0179	COIL/CHOKE 22. OJH 10%	
L2	9140-0179	COIL/CHOKE 22. OJH 10%	
Q1	1854-0063	TRANSISTOR:NPN SIL ICON 2N3055W	
R1	2100-2643	R: VAR COMP 50K CTR 20% LIN 1W	
S1	3101-1216	SWITCH:PUSHBUTTON PST	
S2	3101-0033	SWITCH:SLIDE DBT 0.5A 125V AC DC	
S3	3101-0199	SWITCH:SLIDE DBT 0.5A 125V AC DC	
S4	3101-0199	SWITCH:SLIDE DBT 0.5A 125V AC DC	
S5	3101-0199	SWITCH:SLIDE DBT 0.5A 125V AC DC	
S6	3101-0036	SWITCH:TOG SPST 3 AMP 250V	
S7	3101-0199	SWITCH:SLIDE DPT 0.5A 125V AC DC	
T1	9100-2842	TRANSFORMR:POWER	
W1	05323-60012	CABLE ASSY:CLOCK	
W2	05323-60013	CABLE ASSY:MEASR	
	1251-0160	CONNECTOR:15 PIN	
	5040-0051	HOOD:CONNECTOR	
W3	05323-60015	CABLE ASSY:INPUT	
W4	05323-60016	CABLE ASSY:OSCILLATOR	
W5	8120-0078	CABLE ASSY:POWER CORD	
W6	05323-60018	CABLE ASSY:ANNUNCIATOR	
W7	05325-60018	CABLE ASSY:AC POWER	

See introduction to this section for ordering information

Reference Designation	Part No.	Description #	Note
W8	05323-60010	CABLE ASSY:REMOTE PROGRAM	
	1251-0085	CONNECTOR:FEMALE 36-PIN MIN TR	
	1251-0160	CONNECTOR:15 PIN	
	5040-0051	HOOD:CONNECTOR	
XA1-XA13		NOT ASSIGNED	
XA14	1251-0135	CONNECT :BODY 15 PIN	
XA15		NOT ASSIGNED	
XA16	1251-0135	CONNECT :BODY 15 PIN	
XF1	1400-0084	FUSEHOLDER:EXTRACTOR POST TYP	
	1490-0030	STANDOFFS:HEX MISCELLANEOUS	
	5000-0050	TRIM:SIDES	
	5000-0729	COVER:SIDE FM	
	5060-0729	FRAME ASSY:3 X 11(SIDE)	
	5060-0767	PIVOT ASSY:FM	
	01821-67401	KNOB ASSY	
	05216-4007	SOCKET:CONNECTOR	
	05216-4008	GROUND:CONNECTOR	
	05323-00001	PANEL:FRONT	
	05323-00003	PANEL:EXTRUDED, BOTTOM	
	05323-00004	PANEL:REAR	
	05323-00005	CHASSIS:AMPLIFIER	
	05323-00006	CHASSIS:POWER SUPPLY	
	05323-20010	BAR:CHASSIS	
	05323-20018	SPACER:TRANSFORMER	
	05323-40001	PANEL TRIM: OP	
	05323-40002	MASK:LIGHT	
	05325-00008	COVER:TOP	
	05325-60031	KIT:RACK MOUNT	
	05325-60032	COVER ASSY: BOTTOM	
	05323-60019	CONNECTOR:SPACER ASSY	
	0340-0037	TERMINAL:TURRET	
	0340-0038	POST:TERMINAL	
	0340-0039	BUSHING:INSULATOR	
	05325-00008	INSULATOR:BOTTOM COVER	
	05323-60001	MASK:LIGHT SHIELD	
	05323-90005	Model 323A Operating and Service Manual	

See introduction to this section for ordering information

Part No.	Description #	Mfr.	Mfr. Part No.	TQ
0121-0059	C:VAR CER 2-8 PF 300VDCW	28480	0121-0059	1
0140-0177	C:FXD MICA 400 PF 1%	28480	0140-0177	1
0140-0182	C:FXD MICA 5000 PF 2%	28480	0140-0182	1
0140-0192	C:FXD MICA 68 PF 5%	28480	0140-0192	3
0140-0195	C:FXD MICA 130 PF 5% 300 VDCW	04062	DM15F131J 300V	1
0140-0199	C:FXD MICA 240 PF 5%	28480	0140-0199	2
0140-0200	C:FXD MICA 390 PF 5%	28480	0140-0200	1
0140-0208	C:FXD MICA 680 PF 5%	28480	0140-0208	1
0140-0209	C:FXD MICA 5.0 PF 10%	28480	0140-0209	2
0140-0234	C:FXD MICA 500 PF 1%	28480	0140-0234	1
0150-0050	C:FXD CER 1000 PF 600VDCW	77630	OBD	2
0150-0093	C:FXD CER 0.01 UF +80-20% 100VDCW	91418	TA	1
0150-0119	C:FXD CER 2 X 0.01 UF 20% 250WVAC	56289	36C219A	1
0160-0161	C:FXD MY 0.01 UF 10% 200VDCW	28480	0160-0161	1
0160-0180	C:FXD MY 0.033 UF 5%	28480	0160-0180	1
0160-0194	C:FXD MY 0.015UF 10%	28480	0160-0194	1
0160-0196	C:FXD MICA 24PF 5% 300VDCW	04062	RDM15C240J3S	2
0160-0298	C:FXD MY 0.0015 UF 10% 200VDCW	56289	192P15292-PTS	1
0160-0333	C:FXD MICA 15 PF 0.5 PF	28480	0160-0333	1
0160-0368	C:FXD MICA 16 PF 5% 500VDCW	28480	0160-0368	1
0160-2055	C:FXD CER 0.01 UF +80-20% 100VDCW	91418	TA	5
0160-2199	C:FXD MICA 30 PF 5%	28480	0160-2199	2
0160-2201	C:FXD MICA 51 PF 5%	28480	0160-2201	1
0160-2218	C:FXD MICA 1000 PF 5%	28480	0160-2218	1
0160-2226	C:FXD MICA 2200 PF 5% 300VDCW	28480	0160-2226	1
0160-2241	C:FXD CER 2.2-0.25 PF 500VDCW	72982	301-000-COJO-229C	1
0160-2248	C:FXD CER 4.3 0.25 PF 500VDCW	28480	0160-2248	5
0160-2255	C:FXD CER 8.2 0.25 PF 500VDCW	28480	0160-2255	2
0170-0085	C:FXD MY 0.1UF 20% 50VDCW	84411	601PE STYLE 3	1
0180-0160	C:FXD ELECT 22 UF 20% 35VDCW	28480	0180-0160	1
0180-0210	C:FXD ELECT 3.3 UF 20% 15VDCW	82376	TES 3.3M-15	10
0180-1743	C:FXD ELECT 0.1 UF 10% 35VDCW	28480	0180-1743	1
0180-1952	C:FXD ELECT 15 UF 250VDCW	28480	0180-1952	1
0180-2102	C:FXD ELECT 700 UF +75-10% 25VDCW	28480	0180-2102	2
0180-2154	C:FXD ELECT 1900 UF +75-10% 15VDCW	28480	0180-2154	2
0340-0037	TERMINAL:TURRET	28480	0340-0037	2
0340-0038	POST:TERMINAL	28480	0340-0038	1
0340-0039	BUSHING:INSULATOR	28480	0340-0039	3
0361-0140	RIVET:SEMITUBULAR BRASS	00000	OBD	6
0410-0161	COMPONENT:OVEN	82647	4STI-2	1
0410-0175	CRYSTAL:QUARTZ 10 MHZ	28480	0410-0175	1
0683-1025	R:FXD COMP 1000 OHM 5% 1/4W	01121	CB 1025	1
0683-1035	R:FXD COMP 10K OHM 5% 1/4W	01121	CB 1035	20
0683-1045	R:FXD COMP 100K OHMS 5% 1/4W	01121	CB 1045	3
0683-1055	R:FXD COMP 1 MEGOHM 5% 1/4W	01121	CB 1055	2
0683-1065	R:FXD COMP 10M OHM 5% 1/4W	01121	CB 1065	1
0683-1235	R:FXD COMP 12K OHM 5% 1/4W	01121	CB 1235	9
0683-1325	R:FXD COMP 1300 OHM 5% 1/4W	01121	CB 1325	2
0683-1505	R:FXD COMP 15 OHM 5% 1/4W	01121	CB 1505	1
0683-1525	R:FXD COMP 1500 OHM 5% 1/4W	01121	CB 1525	1
0683-1535	R:FXD COMP 15K OHM 5% 1/4W	01121	CB 1535	2
0683-1615	R:FXD COMP 160 OHM 5% 1/4W	01121	CB 1615	1
0683-2015	R:FXD COMP 200 OHM 5% 1/4W	01121	CB 2015	2
0683-2025	R:FXD COMP 2000 OHM 5% 1/4W	01121	CB 2025	1

See introduction to this section for ordering information

Part No.	Description #	Mfr.	Mfr. Part No.	TQ
0683-2035	R:FXD COMP 20K OHM 5% 1/4W	01121	CB 2035	4
0683-2225	R:FXD COMP 2.2K OHM 5% 1/4W	01121	CB 2225	2
0683-2425	R:FXD COMP 2400 OHM 5% 1/4W	01121	CB 2425	1
0683-2715	R:FXD COMP 270 OHM 5% 1/4W	01121	CB 2715	2
0683-2725	R:FXD COMP 2700 OHM 5% 1/4W	01121	CB 2725	2
0683-3015	R:FXD COMP 300 OHM 5% 1/4W	01121	CB 3015	2
0683-3315	R:FXD COMP 330 OHM 5% 1/4W	01121	CB 3315	2
0683-3615	R:FXD COMP 360 OHM 5% 1/4W	01121	CB 3615	1
0683-3935	R:FXD COMP 39K OHM 5% 1/4W	01121	CB 3935	1
0683-4315	R:FXD COMP 430 OHM 5% 1/4W	01121	C 4315	2
0683-4335	R:FXD COMP 43K OHM 5% 1/4W	01121	C 4335	2
0683-4725	R:FXD COMP 4700 OHM 5% 1/4W	01121	C 4725	1
0683-5105	R:FXD COMP 51 0 HM 5% 1/4W	01121	C 5105	2
0683-5125	R:FXD COMP 5100 OHM 5% 1/4W	01121	C 5125	4
0683-5635	R:FXD COMP 6K OHMS 5% 1/4W	01121	CB 5635	1
0683-6235	R:FXD COMP 2K OHM 5% 1/4W	01121	CB 6235	1
0683-6815	R:FXD COMP 80 OHM 5% 1/4W	01121	CB 6815	2
0683-6825	R:FXD COMP 80 0 OHM 5% 1/4W	01121	CB 6825	1
0683-7515	R:FXD COMP 50 OHM 5% 1/4W	01121	CB 7515	1
0683-7525	R:FXD COMP 500 OHM 5% 1/4W	01121	CB 7525	1
0683-8235	R:FXD COMP 2K OHM 5% 1/4W	01121	EB 8235	1
0683-9105	R:FXD COMP 1 0 HM 5% 1/4W	01121	CB 9105	2
0698-3113	R:FXD CARB 0 10 0 OHM 5%21/8W	28480	0698-3113	1
0698-3114	R:FXD COMP 03 OH 5% 1/W	28480	0698-3114	2
0698-3376	R:FXD COMP 340 HM 5% 1/8	28480	0698-3376	1
0698-3378	R:FXD CARB 0N1 0 5% 18W	28480	0698-3378	1
0698-3381	R:FXD COMP 51 OH 5% 1/W	28480	0698-3381	2
0698-5103	R:FXD COMP 34 OH 5% 1/W	28480	0698-5103	1
0698-5172	R:FXD COMP 310HM 5% 1/8	28480	0698-5172	1
0698-5174	R:FXD COMP 02 0OHM 5% 18W	28480	0698-5174	2
0698-5180	R:FXD COMP K20HM 5% 1/8	28480	0698-5180	3
0698-5183	R:FXD COMP .4K OHM 5% 28 W	28480	0698-5183	1
0698-5185	R:FXD COMP 51 0 OHM 5% 18W	28480	0698-5185	1
0698-5565	R:FXD CARB0 N 2.2K 0 HM 5%1 /8W	28480	0698-5565	4
0698-5566	R:FXD COMP 24K OHM 5% 28 W	480	0698-5566	1
0698-5567	R:FXD CARB0 N 27K OHM 5%1/ 8W	480	0698-5567	1
0698-5996	R:FXD COMP 5K0 OHM 5% 18W	480	0698-5996	1
0698-5997	R:FXD COMP 1K OHM 5% 18W	480	0698-5997	1
0698-6000	R:FXD COMP .2K OHM 5% 28 W	28487	0698-6000	2
0698-6001	R:FXD COMP 0K OHM 5% 18W	28480	0698-6001	3
0698-6123	R:FXD COMP 0R OHM 5% 18W	28480	0698-6123	2
1200-0766	SOCKET:DIP 14 CONTACT	83594	SK 196	7
1205-0050	HEAT SINK:PWR	28480	1205-0050	1
1250-0083	CONNECTOR:BNC	28480	1250-0083	5
1250-1163	CONNECTOR:BNC:INPUT	28480	1250-1163	1
1251-0085	CONNECTOR:FEMALE 36-PIN MINIATR	28480	1251-0085	1
1251-0135	CONNECTOR:BOD 15 PIN	28480	1251-0135	2
1251-0148	CONNECTOR:PWR 3 PINMALE	87930	1065-1	1
1251-0160	CONNECTOR:15 PIN	28480	1251-016	2
1251-1886	CONNECTOR:PCB CONTACTS	28480	1251-188	8
1251-2225	CONNECTOR:PCB CONTACTS	02660	225-2222 -105	1
1400-0084	FUSEHOLDER:EXTR CTORPOST TYPE	79515	342014	1
1490-0030	STANDOFF:HEX	28480	1490-003.	1
1820-0054	INTEGRATED CKT:MICROCIRCUIT NAND GATE	01295	SN4342	13
1820-0063	INTEGRATED CKT:MICROCIRCUIT DUAL EXCLOR	01295	SN7451N	2

See introduction to this section for ordering information

Part No.	Description #	Mfr.	Mfr. Part No.	TQ
1820-0068	INTEGRATED CIRCUIT:TTL 3-INPUT NAND	01295	SN7410N	4
1820-0069	INTEGRATED CIRCUIT:TTL DUAL 4-INPUT NAND	01295	SN7420N	3
1820-0077	INTEGRATED CIRCUIT:TTL DUAL D F-F	01295	SN7474N	6
1820-0092	INTEGRATED CIRCUIT:NIXIE DRIVER	28480	1820-0092	8
1820-0094	INTEGRATED CIRCUIT:QUAD 2-INPUT NAND	04713	MC846N	5
1820-0116	INTEGRATED CIRCUIT:4-BIT BINARY STORAGE	28480	1820-0116	8
1820-0119	INTEGRATED CIRCUIT	28480	1820-0119	3
1820-0135	INTEGRATED CIRCUIT:4-POLE SWITCH	28480	1820-0135	2
1820-0176	INTEGRATED CIRCUIT:NEGATIVE LOGIC	28480	1820-0176	1
1820-0190	INTEGRATED CIRCUIT:SHIFT DECADE,10MHZ	28480	1820-0190	2
1820-0191	INTEGRATED CIRCUIT:SHIFT DECADE,2MHZ	28480	1820-0191	14
1820-0208	INTEGRATED CIRCUIT	18324	N8826A	1
1820-0209	INTEGRATED CIRCUIT	28480	1820-0209	1
1820-0210	INTEGRATED CIRCUIT	28480	1820-0210	1
1820-0305	INTEGRATED CIRCUIT:TTL 4-BIT BINARY	01295	SN7493N	2
1820-0307	INTEGRATED CIRCUIT	28480	1820-0307	3
1820-0327	INTEGRATED CIRCUIT:TTL QUAD 2-INPUT NAND	01295	SN7401N	2
1820-0328	INTEGRATED CIRCUIT:TTL QUAD 2-INPUT NOR	01295	SN7402N	10
1853-0015	TRANSISTOR:SILICON PNP 2N3640	28480	1853-0015	2
1853-0020	TRANSISTOR:SILICON PNP	28480	1853-0020	7
1853-0036	TRANSISTOR:SILICON PNP	28480	1853-0036	3
1854-0005	TRANSISTOR:SILICON NPN 2N708	02735	2N708	1
1854-0009	TRANSISTOR:SILICON NPN 2N709	07263	2N709	5
1854-0019	TRANSISTOR:SILICON NPN	28480	1854-0019	3
1854-0063	TRANSISTOR:NPN SILICON 2N3055	02735	2N3055	1
1854-0071	TRANSISTOR:SILICON NPN	28480	1854-0071	10
1854-0232	TRANSISTOR:SILICON NPN	28480	1854-0232	1
1854-0300	TRANSISTOR:SILICON NPN	28480	1854-0300	2
1855-0320	TRANSISTOR:DUAL FET SILICON	28480	1855-0320	1
1901-0028	DIODE:SILICON 0.75A 400PIV	28480	1901-0028	4
1901-0040	DIODE:SILICON 30MA 30WV	28480	1901-0040	7
1901-0049	DIODE:SILICON 50PIV	28480	1901-0049	8
1901-0200	DIODE:SILICON 100 PIV 3A	02735	1N4998	4
1901-0376	DIODE:SILICON 35V	28480	1901-0376	2
1901-0460	DIODE:SILICON 3 JUNCTION STABISTOR	28480	1901-0460	1
1902-3094	DIODE BREAKDOWN:5.11V 2%	28480	1902-3094	1
1902-3114	DIODE BREAKDOWN:6.19V 2%	28480	1902-3114	2
		28480	1902-3139	1
1902-3394	DIODE BREAKDOWN:75V 2%	28480	1902-3394	1
1902-3429	DIODE BREAKDOWN:100V 2%	28480	1902-3429	1
1910-0022	DIODE:GERMANIUM 5 WIV	28480	1910-0022	4
1910-0030	DIODE:GERMANIUM 100 MA 0.65V	28480	1910-0030	1
1970-0035	TUBE:ELECTRON 10-DIGIT INDICATOR	83594	B-5441-A	7
2100-1757	R:VAR WW 500 OHM 10% LIN 1/2W	28480	2100-1757	1
2100-1760	R:VAR WW 5K OHM 10% LIN 1/2W	28480	2100-1760	1
2100-2645	R:VAR COMP 50K OHM 20% LIN 1/2W	28480	2100-2645	1
2110-0019	FUSE:SLO BLO 0.4A 125V	28480	2110-0019	1
2110-0020	FUSE:SLO-BLO 0.8A 125V	28480	2110-0020	1
2140-0311	LAMP:INCANDESCENT 5.0V 0.06A	71744	CM8783	6
3101-0033	SWITCH:SLIDE DPDT 0.5A 125V AC/DC	79727	G326-0001	1
3101-0036	SWITCH:TOG SPST 3 AMP 250 V	88140	8280K16	1
3101-0199	SWITCH:SLIDE DPDT 0.5A 125V AC/DC	79727	G126-0012	4
3101-1218	SWITCH:PUSHBUTTON SPST	28480	3101-1218	1
3101-1312	SWITCH:SLIDE SPDT 0.5A 125V AC/DC	79727	G132-0003	1
5000-0050	TRIM:SIDES	28480	5000-0050	2

See introduction to this section for ordering information

Part No.	Description #	Mfr.	Mfr. Part No.	TQ
5000-0729	COVER:SIDE FM	28480	5000-0729	2
5020-3412	SPRING:CONTACT	28480	5020-3412	8
5020-3440	SPRING:DETENT	28480	5020-3440	4
5040-0051	HOOD:CONNECTOR	28480	5040-0051	2
5040-0281	SLIDE:4-POLE	28480	5040-0281	4
5040-0285	SWITCH:LEVER	28480	5040-0285	4
5060-0729	FRAME ASSY:3 X 11(SIDE)	28480	5060-0729	2
5060-0767	FOOT ASSY:FM	28480	5060-0767	5
7100-0393	CAN:SQUARE 1-1/2" X 2-7/16"	02875	HU4500-2-7/16AL	1
7100-1683	COVER:SQUARE 1-15/32 X 3/16"	28480	7100-0393	1
8120-0078	CABLE ASSY:POWER CORD	28480	8120-0078	1
9100-2842	TRANSFORMER:POWER	28480	9100-2842	1
9140-0114	COIL:FXD RF 10 UH	28480	9140-0114	8
9140-0125	COIL:VAR 0.9-1.9 UH	28480	9140-0125	2
9140-0126	COIL:VAR 1.76-4.02 UH	28480	9140-0126	2
9140-1258	COIL:FXD RF 1 UH 10%	99800	1025-20	2
9140-0179	COIL/CHOKE 22.0 UH 10%	28480	9140-0179	2
0182 1-6740 1	KNOB ASSY	28480	01821-67401	1
0211 6-0001	CONTACT:LIGHT BULB	28480	02116-0001	6
0505 0-0034	HEAT SINK	28480	05050-0034	2
0521 6-4007	SOCKET:CONNECTOR	28480	05216-4007	1
0521 6-4008	GROUND:CONNECTOR	28480	05216-4008	1
05323-00001	PANEL:FRONT	28480	05323-00001	1
05323-00002	BRACKET:CONNECTOR	28480	05323-00002	2
05323-00003	PANEL:EXTRUSION,BOTTOM	28480	05323-00003	1
05323-00004	PANEL:REAR	28480	05323-00004	1
05323-00005	CHASSIS:AMPLIFIER	28480	05323-00005	1
05323-00006	CHASSIS:POWER SUPPLY	28480	05323-00006	1
05323-20001	BOARD:BLANK PC	28480	05323-20001	1
05323-20002	BOARD:BLANK PC	28480	05323-20002	1
05323-20003	BOARD:BLANK PC	28480	05323-20003	1
05323-20004	BOARD:BLANK PC	28480	05323-20004	1
05323-20005	BOARD:BLANK PC	28480	05323-20005	1
05323-20006	BOARD:BLANK PC	28480	05323-20006	1
05323-20007	BOARD:BLANK PC	28480	05323-20007	1
05323-20008	BOARD:BLANK PC	28480	05323-20008	1
05323-20009	BOARD:BLANK PC	28480	05323-20009	1
05323-20010	BAR:CHASSIS	28480	05323-20010	2
05323-20011	BOARD:BLANK PC	28480	05323-20011	1
05323-20014	BOARD:BLANK PC	28480	05323-20014	1
05323-20015	GUIDE:SWITCH	28480	05323-20015	2
05323-20016	GUIDE:SWITCH	28480	05323-20016	2
05323-20017	BOARD:BLANK PC	28480	05323-20017	1
05323-20018	SPACER:TRANSFORMER	28480	05323-20018	2
05323-20022	BOARD:BLANK PC	28480	05323-20022	1
05323-40001	PANEL TRIM:TOP	28480	05323-40001	1
05323-40002	MASK:LIGHT	28480	05323-40002	1
05323-60001	BOARD ASSY:MAIN	28480	05323-60001	1
05323-60002	BOARD ASSY:ADDER	28480	05323-60002	1
05323-60003	BOARD ASSY:REGISTER Y	28480	05323-60003	1
05323-60004	BOARD ASSY:CONTROL	28480	05323-60004	1
05323-60005	BOARD ASSY:REGISTER X	28480	05323-60005	1
05323-60006	BOARD ASSY:ATTENUATOR	28480	05323-60006	1
05323-60007	BOARD ASSY:SWITCH-FUNCTION	28480	05323-60007	1
05323-60008	BOARD ASSY:DISPLAY	28480	05323-60008	1
05323-60009	BOARD ASSY:DISPLAY CONTROL	28480	05323-60009	1

See introduction to this section for ordering information

Part No.	Description #	Mfr.	Mfr. Part No.	TQ
05323-60010	CABLE ASSY:REMOTE PROGRAM	28480	05323-60010	1
05323-60011	BOARD ASSY:GATE	28480	05323-60011	1
05323-60012	CABLE ASSY:CLOCK	28480	05323-60012	1
05323-60013	CABLE ASSY:MEASURE	28480	05323-60013	1
05323-60014	BOARD ASSY:CONNECTOR	28480	05323-60014	1
05323-60015	CABLE ASSY:INPUT	28480	05323-60015	1
05323-60016	CABLE ASSY:OSCILLATOR	28480	05323-60016	1
05323-60017	BOARD ASSY:ANNUNCIATOR	28480	05323-60017	1
05323-60018	CABLE ASSY:ANNUNCIATOR	28480	05323-60018	1
05323-60019	CONNECTOR:SPACER ASSY, PRESSURE	28480	05323-60019	1
05323-60022	POWER SUPPLY:+5.1V,+175V	28480	05323-60022	1
05323-60001	MASK:LIGHT BEZEL	28480	05323-60001	1
05325-00008	COVER:TOP	28480	05325-00008	1
05325-20005	BOARD:BLANK PC	28480	05325-20005	1
05325-20008	BOARD:BLANK PC	28480	05325-20008	1
05325-20015	BOARD:BLANK PC	28480	05325-20015	1
05325-20035	BOARD:BLANK PC	28480	05325-20035	1
05325-60005	POWER SUPPLY:±12V	28480	05325-60005	1
05325-60008	ASSY:OSCILLATOR MULTI BOARD	28480	05325-60008	1
05325-60012	ASSY:CRYSTAL/OVEN 10MHZ	28480	05325-60012	1
05325-60018	CABLE ASSY:AC POWER	28480	05325-60018	1
05325-60031	KIT:RACK MOUNT	28480	05325-60031	1
05325-60032	COVER ASSY:BOTTOM	28480	05325-60032	1
05325-60035	BOARD ASSY:AMPLIFIER	28480	05325-60035	1
05326-00008	INSULATOR:BOTTOM COVER	28480	05326-00008	1
05323-90005	Model 5323A Operating and Service Manual			

See introduction to this section for ordering information

Table 6-3. Code List of Manufacturers

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 Handbooks.

Code No.	Manufacturer	Address
00000	U. S. A. Common	Any supplier.
00136	McCoy Electronics	Mount Holly Springs, Pa.
00213	Sage Electronics Corp	Rochester, N.Y.
00287	Cemco Inc	Danielson, Conn.
00334	Humidial	Colton, Calif
00348	Microtron Co., Inc.	Valley Stream, N.Y.
00373	Gartock Inc.	Cherry Hill, N. J.
00656	Aerovox Corp.	Bedford, Mass
00779	Amp Inc	Harrisburg, Pa.
00781	Aircraft Radio Corp	Boonton, N. J.
00809	Croven Ltd.	Whitby, Ontario Canada
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.
00853	Sangamo Electric Co..	Pickens Div. Pickens, S. C.
00866	Goe Engineering Co	City of Industry, Cal
00891	Carl E. Holmes Corp.	Los Angeles, Calif.
00929	Microlab Inc.	Livingston, N. J.
01002	General Electric Co., Capacitor Dept	
01009	Alden Products Co.	Brockton, Mass.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Calif.
01281	TRW Semiconductors, Inc	Lawndale, Calif.
01295	Texas Instruments, Inc. Transistor Products Div	Dallas, Texas
01349	The Alliance Mfg Co.	Alliance, Ohio
01538	Small Parts Inc	Los Angeles, Calif
01589	Pacific Relays, Inc	Van Nuys, Calif.
01670	Gudebrod Bros. Silk Co.	New York, N.Y.
01930	Amerock Corp	Rockford, Ill.
01961	Pulse Engineering Co, Ferroxcube America	Santa Clara, Saugerties, N. Y.
02114	Ferroxcube Corp	Long Branch, N. J.
02116	Wheelock Signals, Inc.	Sunnyvale, Calif
02286	Cole Rubber and Plastics Inc	Broadview, Ill.
02660	Amphenol-Borg Electronics Corp	Somerville, N. J.
02735	Radio Corp of America, Semiconductor Inm Materials Div	
02771	Vocaline Co of America, Inc	Old Saybrook, Conn.
02777	Hopkins Engineering Co	San Fernando, Calif.
03508	G E Semiconductor Prod. Dept	Syracuse, N.Y.
03705	Apex Machine & Tool Co	Dayton, Ohio
03797	Eldema Corp	Compton, Calif
03818	Parker Seal Co.	Los Angeles, Calif.
03877	Transitron Electric Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co., Inc	Cedar Knolls, N.J.
03954	Singer Co., Diehl Div Finderne Plant	Somerville, N. J
04009	Arrow, Hart and Hegeman Elect Co.	Hartford, Conn.
04013	Taurus Corp	N. J.
04062	Arco Electronic Inc.	Great Neck, N.Y.
04212	Essex Wire Hi-Q Division of Aerovox	Los Angeles, Calif Myrtle Beach, S.C.
04354	Precision Paper Tube Co	Wheeling, Ill
04404	Dymec Division of Hewlett-Packard Co	Calif
04651	Sylvania Electric Products, Microwave Device Div	Mountain View, Calif.
04673	Dakota Engr Inc	Culver City, Calif.
04713	Motorola, Inc., Semiconductor Prod. Div.	Phoenix, Arizona
04732	Filtron Co., Inc. Western Div	Culver City, Calif
04773	Automatic Electric Co	Northlake, Ill.
04796	Sequoia Wire Co.	Redwood City, Calif.
04811	Precision Coil Spring Co	El Monte, Calif.
04870	P M Motor Company	Westchester, Ill.
04919	Component Mfg Service Co.	W. Bridgewater, Mass.
05006	Twentieth Century Plastics, Inc	Los Angeles, Calif.
05245	Components Corp	Chicago, Ill
05277	Westinghouse Electric Corp. Semi-Conductor Dept	Youngwood, Pa.
05347	Ultronix, Inc	San Mateo, Calif
05397	Union Carbide Corp., Elect. Div	New York, N.Y.
05574	Viking Ind. Inc.	Canoga Park, Calif
05593	Icore Electro-Plastics Inc.	Sunnyvale, Calif.
05616	Cosmo Plastic (c a Electrical Spec Co.)	Cleveland, Ohio
05624	Barber Colman Co	Rockford, Ill.
05728	Tiffen Optical Co	Roslyn Heights, Long Island, N Y
05729	Metro Tel Corp	Westbury, N.Y
05783	Stewart Engineering Co	Santa Cruz, Calif.
05820	Wakefield Engineering Inc	Wakefield, Mass
06004	Bassick Co., Div. of Stewart Warner Corp	Bridgeport, Conn
06090	Raychem Corp	Redwood City, Calif.
06175	Bausch and Lomb Optical Co	Rochester, N Y
06402	E T A Products Co of America	Chicago, Ill.
06540	Amatom Electronic Hardware Co., Inc	New Rochelle, N Y.
06555	Beede Electrical Instrument Co., Inc	Penacook, N.H
06666	General Devices Co., Inc.	Indianapolis, Ind
06751	Components Inc., Ariz. Div.	Phoenix, Ariz.
06812	Torrington Mfg Co., West Div	Van Nuys, Calif
06980	Varian Assoc Eimac Div	San Carlos, Calif.
07088	Kelvin Electric Co	Van Nuys, Calif
07126	Digitran Co	Pasadena, Calif.
07137	Transistor Electronics Corp	Minneapolis, Minn
07138	Westinghouse Electric Corp Electronic Tube Div	Elmira, N Y
07149	Filmohm Corp	New York, N.Y.
07233	Cinch Graphik Co	City of Industry, Calif
07256	Silicon Transistor Corp	Carle Place, N.Y.
07261	Avnet Corp	Culver City, Calif
07263	Fairchild Camera & Inst Corp Semiconductor Div	Mountain View, Calif
07322	Minnesota Rubber Co	Minneapolis, Minn
07387	Bircher Corp., The	Monterey Park, Calif.
07397	Sylvania Elect Prod Inc., Mt View Operations	Mountain View, Calif
07700	Technic Electric Products Inc	Crawford, N J
07828	Bodine Co	Chicago, Ill
07910	Continental Device Corp	Hawthorne, Calif
07933	Raytheon Mfg Co Semiconductor Div	Mountain View, Calif
07980	Hewlett Packard Co., Boonton Radio Div	Rockaway, N J
08145	U S Engineering Co	Los Angeles, Calif
08289	Blinn, Delbert Co	Pomona, Calif
08358	Burgess Battery Co	Niagara Falls, Ontario, Canada
08524	Deutsch Fastener Corp	Los Angeles, Calif
08664	Bristol Co The	Waterbury, Conn
08717	Sloan Company	Sun Valley, Calif.
08718	ITT Cannon Electric Inc., Phoenix Div	Phoenix, Arizona
08727	National Radio Lab. Inc	Paramus, N J
08792	CBS Electronics Semiconductor Operations, Div of C. B. S. Inc	Lowell, Mass
08806	General Electric Co. Miniat Lamp Dept.	Cleveland, Ohio
08984	Met-Ram	Indianapolis, Ind
09026	Babcock Relays Div	Costa Mesa, Calif
09134	Texas Capacitor Co	Houston, Texas
09145	Tech. Ind. Inc. Alohm Elect.	Burbank, Calif.
09250	Electro Assemblies, Inc.	Chicago, Ill.
09353	C & K Components Inc.	Newton, Mass.
09569	Mallory Battery Co of Canada, Ltd	Toronto, Ontario, Canada
09922	Burndy Corp.	Norwalk, Conn.
10214	General Transistor Western Corp.	Los Angeles, Calif.
10411	Ti Tal, Inc.	Berkeley, Calif.
10646	Carborundum Co	Niagara Falls, N Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Telephone of California, Inc	So Pasadena, Calif.
11242	Bay State Electronics Corp.	Waltham, Mass.
11312	Teledyne Inc., Microwave Div	Palo Alto, Calif.
11314	National Seat	Downey, Calif.
11453	Precision Connector Corp	Jamaica, N.Y.
11534	Duncan Electronics Inc	Costa Mesa, Calif.
11711	General Instrument Corp., Semiconductor Div., Products Group	Newark, N. J.
11717	Imperial Electronic, Inc	Buena Park, Calif
11870	Mefabs, Inc	Palo Alto, Calif.
12040	National Semiconductor	Danbury, Conn
12136	Philadelphia Handle Co	Camden, N.J.
12361	Grove Mfg Co., Inc.	Shady Grove, Pa
12574	Gulton Ind Inc Data System Div	Albuquerque, N M.
12697	Clarostat Mfg Co.	Dover, N. H.
12728	Elmar Filter Corp	W Haven, Conn.
12859	Nippon Electric Co., Ltd	Tokyo, Japan
12881	Metex Electronics Corp.	Clark, N. J.
12930	Delta Semiconductor Inc.	Newport Beach, Calif
12954	Dickson Electronics Corp	Scottsdale, Arizona
13019	Amco Supply Co.	Wichita, Kansas
13103	Thermotloy	Dallas, Texas
13396	Telefunken (Gmbh)	Hanover, Germany
13835	Midland Wright Div of Pacific Industries, Inc	Kansas City, Kansas
14099	Sem Tech	Newbury Park, Calif
14193	Calif Resistor Corp	Santa Monica, Calif.
14298	American Components, Inc	Conshohocken, Pa
14433	ITT Semiconductor, A Div of Int Telephone & Telegraph Corp.	West Palm Beach, Fla
14493	Hewlett Packard Company	Loveland, Colo
14655	Cornell Dubilier Electric Corp	Newark, N J.
14674	Corning Glass Works	Corning, N Y.
14752	Electro Cube Inc	San Gabriel, Calif
14960	Williams Mfg. Co	San Jose, Calif
15106	The Sohere Co., Inc	Little Falls, N J
15203	Webster Electronics Co	New York, N Y
15287	Sconics Corp	Northridge, Calif.
15291	Adjustable Bushing Co	N Hollywood, Calif
15558	Micron Electronics	Garden City, Long Island, N Y
15566	Amprobe Inst Corp	Lynbrook, N.Y
15631	Cabletronics	Costa Mesa, Calif
15772	Twentieth Century Coil Spring Co	Santa Clara, Calif
15801	Fenwal Elect Inc	Framingham, Mass.
15818	Amelco Inc	Mt View, Calif
16037	Spruce Pine Mica Co	Spruce Pine, N.C.
16179	Omni Spectra Inc	Farmington, Mich
16352	Computer Diode Corp.	Lodi, N. J.
16585	Bonis Aircraft Rut Corp.	Pasadena, Calif.
16688	Ideal Prec. Meter Co., Inc De Jur Meter Div	Brooklyn, N Y
16758	Delco Radio Div. of G M. Corp	Kokomo, Ind.
17109	Thermonetics Inc	Canoga Park, Calif.
17474	Trianex Company	Mountain View, Calif.
17554	Components Inc	Biddeford, Ma
17675	Hamlin Metal Products Corp	Akron, Ohio
17745	Angstrohm Prec. Inc.	No. Hollywood, Calif
17856	Siliconix Inc	Sunnyvale, Calif.

Table 6-3. Code List of Manufacturers (Cont'd)

Code No.	Manufacturer	Address
17870	McGraw-Edison Co.	Manchester, N.H.
18042	Power Design Pacific Inc.	Palo Alto, Calif.
18083	Clevite Corp., Semiconductor Div.	Palo Alto, Calif.
18324	Signetics Corp.	Sunnyvale, Calif.
18476	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
18486	TRW Elect. Comp. Div.	Des Plaines, Ill.
18583	Curtis Instrument, Inc.	Mt. Kisco, N.Y.
18612	Vishay Instruments Inc.	Malvern, Pa.
18873	E.I. DuPont and Co., Inc.	Wilmington, Del.
18911	Durant Mfg. Co.	Milwaukee, Wis.
19315	The Bendix Corp., Navigation & Control Div.	Teterboro, N.J.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison Co.	West Orange, N.J.
19589	Concoa	Baldwin Park, Calif.
19644	LRC Electronics	Horseheads, N.Y.
19701	Electra Mfg. Co.	Independence, Kansas
20183	General Atronics Corp.	Philadelphia, Pa.
21226	Executone, Inc.	Long Island City, N.Y.
21335	Fafnir Bearing Co., The	New Britain, Conn.
21520	Fansteel Metallurgical Corp.	N. Chicago, Ill.
23042	Texscan Corp.	Indianapolis, Ind.
23783	British Radio Electronics Ltd.	Washington, D.C.
24455	G.E. Lamp Division	Nela Park, Cleveland, Ohio
24655	General Radio Co.	West Concord, Mass.
24681	Mencor Inc., Comp. Div.	Huntington, Ind.
24796	Paretco Inc.	San Juan Capistrano, Calif.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.
26462	Grobet File Co. of America, Inc.	Carlstadt, N.J.
26851	Compac/Hollister Co.	Hollister, Calif.
26992	Hamilton Watch Co.	Lancaster, Pa.
27251	Specialties Mfg. Co., Inc.	Stratford, Conn.
28480	Hewlett-Packard Co.	Palo Alto, Calif.
28520	Heyman Mfg. Co.	Kenilworth, N.J.
30817	Instrument Specialties Co., Inc.	Little Falls, N.J.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm Inc.	Chicago, Ill.
36196	Stanwyck Coil Products Ltd.	Hawkesbury, Ontario, Canada
36287	Cunningham, W.H. & Hill, Ltd.	Toronto Ontario, Canada
37942	P.R. Mallory & Co. Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod. Co.	Akron, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N.H.
42190	Muter Co.	Chicago, Ill.
43930	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Ill.
46384	Penn Eng. & Mfg. Corp.	Doylestown, Pa.
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer & Inst. Co.	Southampton, Pa.
49956	Microwave & Power Tube Div.	Waltham, Mass.
52090	Rowan Controller Co.	Westminster, Md.
52983	Sanborn Company	Waltham, Mass.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Ill.
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Raytheon Co. Commercial Apparatus & Systems Div.	So. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	North Adams, Mass.
59446	Telex Corp.	Tulsa, Okla.
59730	Thomas & Betts Co.	Elizabeth, N.J.
60741	Tiplett Electrical Inst. Co	Bluffton, Ohio
61775	Union Switch and Signal, Div. of Westinghouse Air Brake Co	Pittsburgh, Pa.
62119	Universal Electric Co.	Owosso, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	Weston Inst. Inc. Weston-Newark	Newark, N.J.
65295	Wittek Mfg. Co.	Chicago, Ill.
66346	Minnesota Mining & Mfg. Co. Revere Mincom Div.	St. Paul, Minn.
70276	Allen Mfg. Co.	Hartford, Conn.
70309	Allied Control	New York, N.Y.
70318	Allmetal Screw Product Co., Inc.	Garden City, N.Y.
70417	Amptex, Div. of Chrysler Corp.	Detroit, Mich.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
70563	Amperite Co., Inc.	Union City, N.J.
70674	ADC Products Inc.	Minneapolis, Minn.
70903	Belden Mfg. Co.	Chicago, Ill.
70998	Bird Electronic Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71034	Bliley Electric Co., Inc.	Erie, Pa.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.
71218	Bud Radio, Inc.	Willoughby, Ohio
71279	Cambridge Thermionics Corp.	Cambridge, Mass.
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Cardwell Condenser Corp.	Lindenhurst L.I., N.Y.
71400	Bussmann Mfg. Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Ill.
71447	Calif. Spring Co., Inc.	Pico-Rivera, Calif.
71450	CTS Corp.	Elkhart, Ind.
71468	ITT Cannon Electric Inc.	Los Angeles, Calif.
71471	Cinema, Div. Aerovox Corp.	Burbank, Calif.
71482	C.P. Clare & Co.	Chicago, Ill.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
71615	Commercial Plastics Co.	Chicago, Ill.
71700	Cornish Wire Co., The	New York, N.Y.
71707	Colo Coil Co., Inc.	Providence, R.I.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71785	Cinch Mfg. Co., Howard B. Jones Div.	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
72619	Dialight Corp.	Brooklyn, N.Y.
72656	Indiana General Corp., Electronics Div.	Keasby, N.J.
72699	General Instrument Corp., Cap. Div.	Newark, N.J.
72765	Drake Mfg. Co.	Harwood Heights, Ill.
72825	Hugh H. Eby Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Ill.
72962	Elastic Stop Nut Corp.	Union, N.J.
72964	Robert M. Hadley Co.	Los Angeles, Calif.
72982	Erie Technological Products, Inc.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73076	H.M. Harper Co.	Chicago, Ill.
73138	Helipot Div. of Beckman Inst., Inc.	Fullerton, Calif.
73293	Hughes Products Division of Hughes Aircraft Co	Newport Beach, Calif
73445	Amperex Elect Co	Hicksville, L.I., N.Y
73568	Dalley Electronics Corp	New Haven, Conn
73586	Circle F Mfg Co	Hartford, Conn
73682	George K Garrett Co., Div MSL Industries Inc	Trenton, N. J.
73734	Federal Screw Products Inc	Philadelphia, Pa.
73743	Fischer Special Mfg Co	Chicago, Ill
13191	General Industries Co., The	Cincinnati, Ohio
73846	Goshen Stamping & Tool Co.	Elyria, Ohio
73899	JFD Electronics Corp	Goshen, Ind.
73905	Jennings Radio Mfg Corp.	Brooklyn, N Y
73957	Groov-Pin Corp	San Jose, Calif.
74276	Signalite Inc	Ridgefield, N.J.
74455	J H Winns, and Sons	Neptune, N J
74861	Industrial Condenser Corp.	Winchester, Mass
74868	R.F Products Division of Amphenol-Borg Electronics Corp	Chicago, Ill.
74970	E f Johnson Co	Danbury, Conn
75042	International Resistance Co	Waseca, Minn
75263	Keystone Carbon Co., Inc	Philadelphia, Pa.
75378	CTS Knights Inc.	St Marys, Pa.
75382	Kulka Electric Corporation	Sandwich, Ill
75818	Lenz Electric Mfg Co	Mt Vernon, N Y.
75915	Littlefuse, Inc	Chicago, Ill.
76005	Lord Mfg Co	Des Plaines, Ill
76210	C W Marwedel	Erie, Pa
76433	General Instrument Corp., Micamold Division	San Francisco, Calif
76487	James Millen Mfg Co., Inc	Newark, N J.
76493	J.W Miller Co	Malden, Mass
76530	Cinch Monadnock, Div. of United Carr Fastener Corp	Los Angeles, Calif.
76545	Mueller Electric Co	San Leandro, Calif.
76703	National Union	Cleveland, Ohio
76854	Oak Manufacturing Co	Newark, N J.
77068	The Bendix Corp., Electrodynamics Div.	Crystal Lake, Ill
77075	Pacific Metals Co.	N Hollywood, Calif.
77221	Phanostran Instrument and Electronic Co	San Francisco, Calif.
77252	Philadelphia Steel and Wire Corp	South Pasadena, Calif
77342	American Machine & Foundry Co Potter & Brumfield Div	Philadelphia, Pa
77630	TRW Electronic Components Div Ireo	Princeton, Ind
77764	Resistance Products Co.	Camden, N J
77969	Rubbercraft Corp. of Calif.	Harrisburg, Pa.
78189	Shakeproof Division of Illinois Tool Works	Torrance, Calif.
78277	Sigma	Elgin, Ill.
78283	Signal Indicator Corp	So Braintree, Mass.
78290	Struthers-Dunn Inc.	New York, N.Y.
78424	Specialty Leather Prod Co	Pittman, N. J
78452	Thompson-Bremer & Co	Newark, N. J
78471	Tilley Mfg Co	Chicago, Ill.
78488	Stackpole Carbon Co.	San Francisco, Calif
78493	Standard Thomson Corp	St Marys, Pa
78553	Tinnerman Products, Inc	Waltham, Mass.
78790	Transformer Engineers	Cleveland, Ohio
78947	Ucinite Co	San Gabriel, Calif.
79136	Veeder Kobiqdncinc	Newtonville, Mass
79142		Long Island City, Qeens
79251	Wenco Mfg Co.	Chicago, Ill
79727	Continental Wirt Electronics Corp.	Philadelphia, Pa
79963	Zierick Mfg Corp	New Rochelle, N Y
80031	Mepco Division of Sessions Clock Co.	Morristown, N.J.
80033	Prestole Corp.	Toledo, Ohio
80120	Schnitzer Alloy Products Co.	Elizabeth, N.J.
80131	Electronic Industries Association. Any brand Tube meeting EIA Standards-Washington, DC.	
80207	Unimax Switch, Div. Maxon Electronics Corp.	Wallingford, Conn.
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Ill.
80294	Bourns Inc.	Riverside, Calif.
80411	Acro Div. of Robertshaw Controls Co.	Columbus, Ohio

Table 6-3. Code List of Manufacturers (Cont'd)

Code No.	Manufacturer	Address
80486	All Star Products Inc.	Defiance, Ohio
80509	Avery Label Co.	Monrovia, Calif.
80583	Hammarlund Co., Inc.	Mars Hill, N.C.
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
80813	Dimco Gray Co.	Dayton, Ohio
81030	International Instruments Inc.	Orange, Conn.
81073	Grayhill Co.	LaGrange, Ill.
81095	Triad Transformer Corp.	Venice, Calif.
81312	Winchester Elec. Div. Litton Ind., Inc.	Oakville, Conn.
81349	Military Specification	
81483	International Rectifier Corp.	El Segundo, Calif.
81541	Airpax Electronics, Inc.	Cambridge, Maryland
81860	Barry Controls, Div. Barry Wright Corp.	Watertown, Mass.
82042	Carter Precision Electric Co.	Skokie, Ill.
82047	Sperti Faraday Inc., Copper Hewitt Electric Div.	Hoboken, N.J.
82116	Electric Regulator Corp.	Norwalk, Conn.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
82170	Fairchild Camera & Inst. Corp. Space & Defense System Div.	Paramus, N.J.
82209	Maguire Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod. Inc. Electronic Tube Division	Emporium, Pa.
82376	Astron Corp.	East Newark, Harrison, N.J.
82389	Switchcraft, Inc.	Chicago, Ill.
82647	Metals & Controls Inc. Spencer Products	Attleboro, Mass.
82768	Phillips-Advance Control Co.	Joliet, Ill.
82866	Research Products Corp.	Madison, Wis.
82877	Rotron Mfg. Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Calif.
83014	Hartwell Corp.	Los Angeles, Calif.
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.
83125	General Instrument Corp., Capacitor Div.	Darlington, S.C.
83148	ITT Wire and Cable Div.	Los Angeles, Calif.
83186	Victory Eng. Corp.	Springfield, N.J.
83298	Bendix Corp., Red Bank Div.	Red Bank, N.J.
83315	Hubbell Corp.	Mondelein, Ill.
83324	Rosan Inc.	Newport Beach, Calif.
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83332	Tech Labs	Palisade's Park, N.J.
83385	Central Screw Co.	Chicago, Ill.
83501	Gavitt Wire and Cable Co. Div. of Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp. Electronic Tube Div.	Plainfield, N.J.
83740	Union Carbide Corp. Consumer Prod. Div.	New York, N.Y.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
83942	Aeronautical Inst. & Radio Co.	Lodi, N.J.
84171	Arco Electronics Inc.	Great Neck, N.Y.
84396	A.J. Glesener Co., Inc.	San Francisco, Calif.
84411	TRW Capacitor Div.	Ogallala, Neb.
84970	Sarkes Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Company	Boonton, N.J.
85471	A.B. Boyd Co.	San Francisco, Calif.
85474	R.M. Bracamonte & Co.	San Francisco, Calif.
85660	Kerled Kords, Inc.	Hamden, Conn.
85911	Seamless Rubber Co.	Chicago, Ill.
86174	Fafnir Bearing Co.	Los Angeles, Calif.
86197	Clifton Precision Products Co., Inc.	Clifton Heights, Pa.
86579	Precision Rubber Products Corp.	Dayton, Ohio
86684	Radio Corp. of America, Electronic Comp. & Devices Div.	Harrison, N.J.
86928	Seastrom Mfg. Co.	Glendale, Calif.
87034	Marco Industries	Anaheim, Calif.
87216	Philco Corporation (Lansdale Division)	Lansdale, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco, Calif.
87664	Van Waters & Rogers Inc.	San Francisco, Calif.
87930	Tower Mfg. Corp.	Providence, R.I.
88140	Cutler-Hammer, Inc.	Lincoln, Ill.
88220	Gould-National Batteries, Inc.	St. Paul, Minn.
88698	General Mills, Inc.	Buffalo, N.Y.
89231	Graybar Electric Co.	Oakland, Calif.
89473	G.E. Distributing Corp.	Schenectady, N.Y.
89665	United Transformer Co.	Chicago, Ill.
90030	United Shoe Machinery Corp.	Beverly, Mass.
90179	US Rubber Co., Consumer Ind. & Plastics Prod. Div.	Passaic, N.J.
90763	United Carr Fastener Corp.	Chicago, Ill.
90970	Beaming Engineering Co.	San Francisco, Calif.
91146	ITT Cannon Elect, Inc., Salem Div.	Salem, Mass.
91260	Connor Spring Mfg. Co.	San Francisco, Calif.
91345	Miller Dial & Nameplate Co.	El Monte, Calif.
91418	Radio Materials Co.	Chicago, Ill.
91506	Augat Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Nebr.
91662	Elco Corp.	Willow Grove, Pa.
91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.
91827	K F Development Co.	Redwood City, Calif.
91886	Maico Mfg. Co., Inc.	Chicago, Ill.
91929	Honeywell Inc., Micro Switch Div.	Freeport, Ill.
91961	Nahm-Bros. Spring Co.	Oakland, Calif.
92180	Tru-Connector Corp.	Peabody, Mass.
92367	Elgeet Optical Co. Inc.	Rochester, N.Y.
92607	Tensolite Insulated Wire Co., Inc.	Tarrytown, N.Y.
92702	IMC Magnetics Corp.	Wesbury Long Island, N.Y.
92966	Hudson Lamp Co.	Kearney, N.J.
93332	Sylvania Electric Prod. Inc. Semiconductor Div.	Woburn, Mass.
93369	Robbins & Myers Inc.	Palisades Park, N.J.
93410	Slemco Controls, Div. of Essex Wire Corp.	Mansfield, Ohio
93632	Waters Mfg. Co.	Culver City, Calif.
93929	G.V. Controls	Livingston, N.J.
94137	General Cable Corp.	Bayonne, N.J.
94142	Phelps Dodge	Yonkers, N.Y.
94144	Raytheon Co., Comp. Div., Ind. Comp. Operations	Quincy, Mass.
94148	Scientific Electronics Products, Inc.	Loveland, Colo.
94154	Wagner Elect. Corp., Tung-Sol Div.	Newark, N.J.
94197	Curtiss-Wright Corp. Electronics Div.	East Paterson, N.J.
94222	South Chester Corp.	Chester, Pa.
94330	Wire Cloth Products, Inc.	Bellwood, Ill.
94375	Automatic Metal Products Co.	Brooklyn, N.Y.
94682	Worcester Pressed Aluminum Corp.	Worcester, Mass.
94696	Magnecraft Electric Co.	Chicago, Ill.
95023	George A. Philbrick Researchers, Inc.	Boston, Mass.
95236	Allies Products Corp.,	Dania, Fla.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., Inc.	Long Island, N.Y.
95265	National Coil Co.	Sheridan, Wyo.
95275	Vitramon, Inc.	Bridgeport, Conn.
95348	Gordos Corp.	Bloomfield, N.J.
95354	Methode Mfg. Co.	Rolling Meadows, Ill.
95566	Arnold Engineering Co.	Marengo, Ill.
95712	Dage Electric Co., Inc.	Franklin, Ind.
95984	Siemon Mfg. Co.	Wayne, Ill.
95987	Weckesser Co.	Chicago, Ill.
96067	Microwave Assoc., West Inc.	Sunnyvale, Calif.
96095	Hi-Q Div. of Aerovox Corp.	Olean, N.Y.
96256	Thordarson-Meissner Inc.	Mt. Carmel, Ill.
96296	Solar Manufacturing Co.	Los Angeles, Calif.
96306	Microswitch, Div. of Minn.-Honeywell	Freeport, Ill.
96330	Carlton Screw Co.	Chicago, Ill.
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Calif.
96508	Xcelite Inc.	Orchard Park, N.Y.
96733	San Fernando Elect. Mfg. Co.	San Fernando, Calif.
96881	Thomson Ind. Inc.	Long Is., N.Y.
97464	Industrial Retaining Ring Co.	Irvington, N.J.
97539	Automatic & Precision Mfg.	Englewood, N.J.
97979	Resn Resistor Corp.	Yonkers, N.Y.
97983	Litton System Inc., Adler-Westrex Commun. Div.	New Rochelle, N.Y.
98141	R-Tronetis, Inc.	Jamaica, N.Y.
98159	Rubber Teck, Inc.	Gardena, Calif.
98220	Hewlett-Packard Co., Moseley Div.	Pasadena, Calif.
98278	Microdot, Inc.	So. Pasadena, Calif.
98291	Sealectro Corp.	Mamaroneck, N.Y.
98376	Zero Mfg. Co.	Burbank, Calif.
98410	Etc Inc.	Cleveland, Ohio
98731	General Mills Inc., Electronics Div.	Minneapolis, Minn.
98734	Paeco Div. of Hewlett-Packard Co.	Palo Alto, Calif.
98821	North Hills Electronics, Inc.	Glen Cove, N.Y.
98978	International Electronic Research Corp.	Burbank, Calif.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Calif.
99378	Atlee Corp.	Winchester, Mass.
99515	Marshall Ind., Capacitor Div.	Monrovia, Calif.
99707	Control Switch Division, Controls Co. of America	El Segundo, Calif.
99800	Delevan Electronics Corp.	East Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99928	Branson Corp.	Whippany, N.J.
99934	Renbrandt, Inc.	Boston, Mass.
99942	Hoffman Electronics Corp. Semiconductor Div.	El Monte, Calif.
99957	Technology Instrumeal Corp. of Calif.	Newbury Park, Calif.

THE FOLLOWING HP VENDORS HAVE NO NUMBER ASSIGNED IN THE LATEST SUPPLEMENT TO THE FEDERAL SUPPLY CODE FOR MANUFACTURERS HANDBOOK.

0000F	Malco Tool and Die	Los Angeles, Calif.
0000Z	Willow Leather Products Corp.	Newark, N.J.
000AB	ETA	England
000B8	Precision Instrument Components Co.	Van Nuys, Calif.
000CS	Hewlett-Packard Co., Colorado Springs	Colorado Springs, Colorado
000MM	Rubber Eng. & Development	Hayward, Calif.
000NN	A "N" D Mfg. Co.	San Jose, Calif.
000QQ	Cooltron	Oakland, Calif.
000WW	California Eastern Lab.	Burlington, Calif.
000YY	S.K. Smith Co.	Los Angeles, Calif.

00015-48
Revised October, 1969

From: FSC. Handbook Supplements

SECTION VII

OPTIONS, SPECIALS, AND MANUAL CHANGES

7-1. OPTIONS

7-2. No options are available at this time.

7-3. SPECIAL

7-4. A rear-mounted BNC connector may be added below the EXT GATE jack (J8). A chassis plug is normally installed in the J8 mounting hole as shipped from the factory.

7-5. Operation and parts for remote programming are shown in Section II. Schematic information for remote programming is shown in Section VIII.

7-6. MANUAL CHANGES

7-7. This manual applies directly to standard Model 5323A having serial prefix number 936 (refer to paragraph 1-7).

7-8. NEWER INSTRUMENTS

7-9. As changes are made, new instruments may have serial number prefixes not listed in this manual. The manuals for these instruments will be supplied with an added "Manual Change" sheet with the required information. If this sheet is missing contact your nearest Hewlett-Packard Sales and Service office, listed at the back of this manual.

7-10. OLDER INSTRUMENTS

7-11. To adapt this manual to 5323A with serial prefix number 924, make the following changes.

Tables 6-1 and 6-2,
Change A16C1 to 1820-1962, C:FXD ELECT 9μF +50-10% 200 VDCW.

Figure 8-15,
Change A16C1 from 15 μF to 9 μF.

7-12. To adapt this manual to 5323A with serial prefix number 908, make the following changes.

Tables 6-1 and 6-2,
Change A16 to 05325-60039, POWER SUPPLY: +5.1V, +175V; 05325-20039, BOARD: BLANK P.C.

Add A16CR13: 1902-3139, DIODE BREAKDOWN: SILICON 8.25V, 5%.

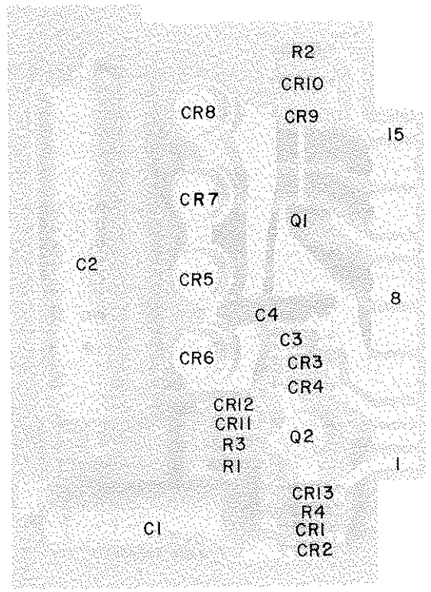
Change A16R3 to 0683-5135, R:FXD COMP, 51K OHM, 5%, 1/4W.

Change A16R4 to 0683-2015, R:FXD COMP, 200 OHM, 5%, 1/4W.

Delete A16Q3.

Figure 8-15,
Replace with Figures 7-1 and 7-2.

Figure 7-1. Component Locators A16/A17



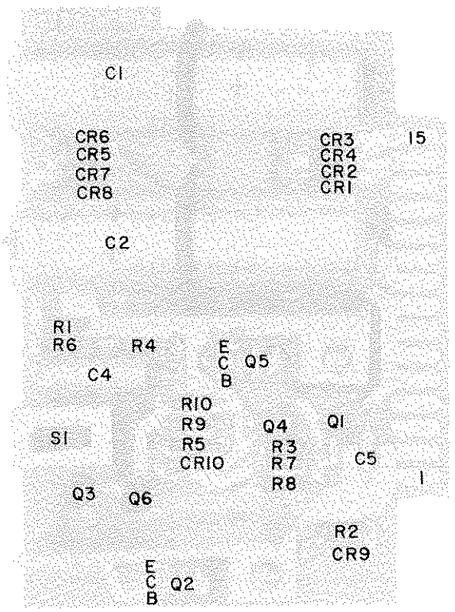
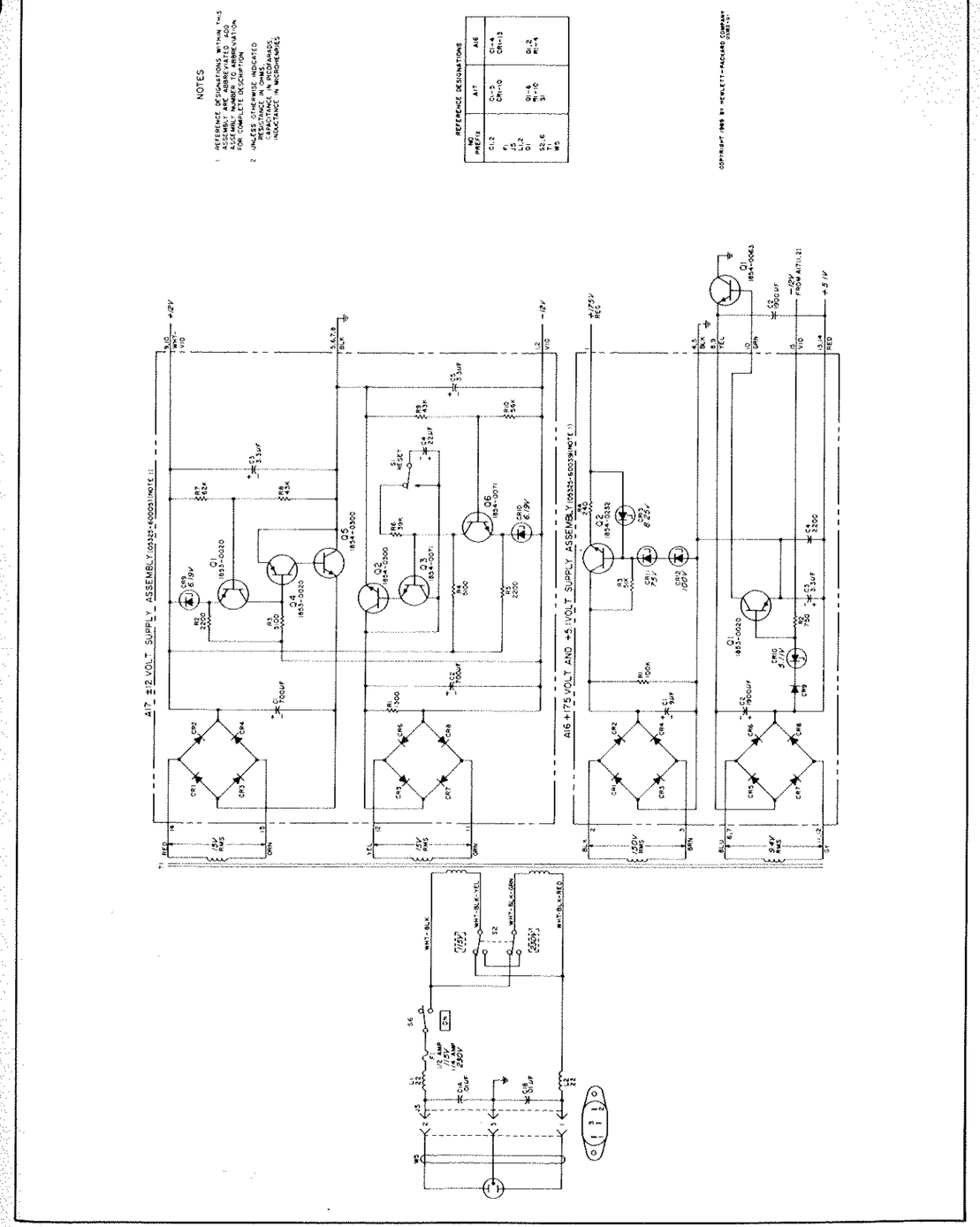


Figure 7-2. A16 +5.1V, +175V Power Supply; A17 ±12V Power Supply



SECTION VIII

CIRCUIT DIAGRAMS

8-1. This section contains the following:

a. General note for schematic diagrams in Figure 8-1.

b. Flow diagram, Figure 8-2

c. Block diagram, Figure 8-3

d. Schematic diagrams and component locators for assemblies including theory of operation and trouble-shooting procedures in Figures 8-4 through 8-15.

8-2. The diagrams, when unfolded, can he used with other parts of the manual or when tire manual is closed.

Figure 8-1. Schematic Diagram Notes

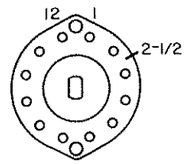
SYMBOLS

- FRONT PANEL
- REAR PANEL
- KNOB CONTROL
- SCREWDRIVER ADJUST
- MAIN SIGNAL PATH
- FEEDBACK PATH
- CONDUCTING ELEMENT
- WIPER MOVES TOWARD "CW" WHEN CONTROL IS ROTATED CLOCKWISE
- POWER LINE GROUND
- CIRCUIT COMMON GROUND
- TEST POINT
- "AND" GATE
- INHIBIT GATE
- "OR" GATE

WAVEFORMS SHOWN ARE TYPICAL

SWITCH DESIGNATIONS

A3S1BR(2-1/2)

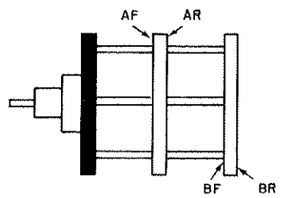


A3S1 SWITCH S1 WITHIN ASSEMBLY A3

B 2ND WAFER FROM FRONT (A=1ST, ETC)

R REAR OF WAFER (F=FRONT)

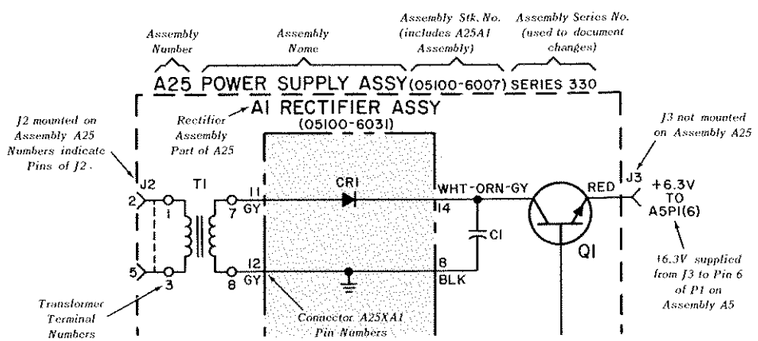
(2-1/2) TERMINAL LOCATION ($2\frac{1}{2}$) (VIEWED FROM FRONT)

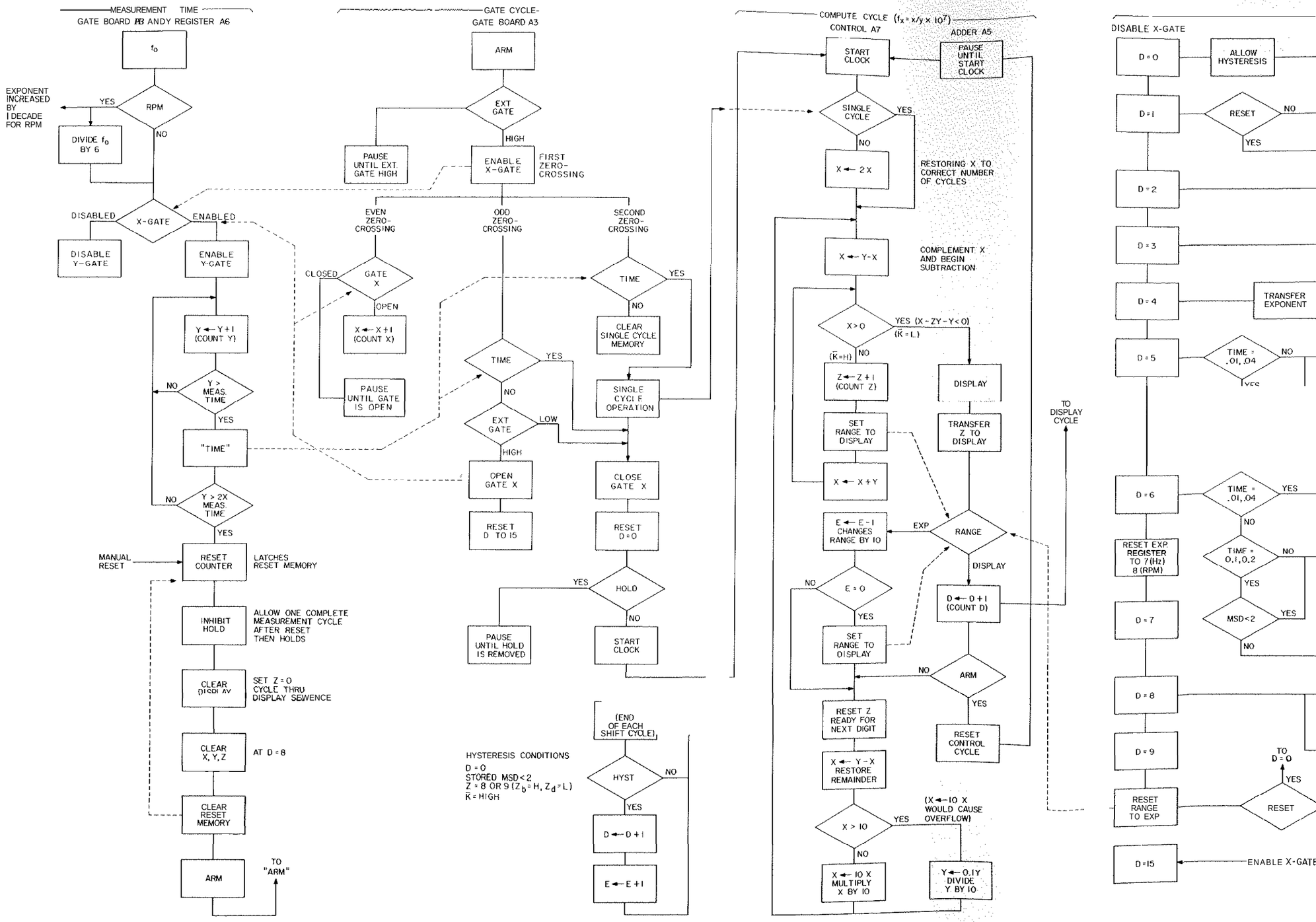


REFERENCE DESIGNATIONS

REFERENCE DESIGNATIONS WITHIN ASSEMBLIES ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.

ASSEMBLY	ABBREVIATION	COMPLETE DESCRIPTION
A25	C1	A25C1
A25A1	CR1	A25A1CR1
NO PREFIX	J3	J3




MEASUREMENT TIME
GATE BOARD #3 AND Y REGISTER A6
f_o
EXPONENT INCREASED BY 1 DECADE FOR RPM
YES
RPM
NO
DIVIDE f_o BY 6
DISABLED
X-GATE
ENABLED
DISABLE Y-GATE
ENABLE Y-GATE
Y ← Y+1 (COUNT Y)
NO
Y > MEAS. TIME
YES
"TIME"
NO
Y > 2X MEAS. TIME
YES
MANUAL RESET
RESET COUNTER
LATCHES RESET MEMORY
INHIBIT HOLD
ALLOW ONE COMPLETE MEASUREMENT CYCLE AFTER RESET THEN HOLDS
CLEAR DISPLAY
SET Z=0 CYCLE THRU DISPLAY SEWENCE
CLEAR X, Y, Z
AT D=8
CLEAR RESET MEMORY
ARM
TO "ARM"
GATE CYCLE-
GATE BOARD A3
ARM
EXT GATE
HIGH
PAUSE UNTIL EXT GATE HIGH
ENABLE X-GATE
FIRST ZERO-CROSSING
EVEN ZERO-CROSSING
ODD ZERO-CROSSING
SECOND ZERO-CROSSING
CLOSED
GATE X
OPEN
X ← X+1 (COUNT X)
PAUSE UNTIL GATE IS OPEN
TIME
YES
NO
CLEAR SINGLE CYCLE MEMORY
TIME
YES
NO
EXT GATE
LOW
HIGH
SINGLE CYCLE OPERATION
OPEN GATE X
CLOSE GATE X
RESET D TO 15
RESET D=0
YES
HOLD
NO
PAUSE UNTIL HOLD IS REMOVED
START CLOCK
(END OF EACH SHIFT CYCLE),
HYSTERESIS CONDITIONS
D=0
STORED MSD<2
Z=8 OR 9 (Z_b=H, Z_d=L)
$\overline{K}$=HIGH
HYST
NO
YES
D ← D+1
E ← E+1
COMPUTE CYCLE ($f_x = x/y \times 10^7$)
CONTROL A7
ADDER A5
START CLOCK
PAUSE UNTIL START CLOCK
SINGLE CYCLE
YES
NO
X ← 2X
RESTORING X TO CORRECT NUMBER OF CYCLES
X ← Y-X
COMPLEMENT X AND BEGIN SUBTRACTION
X>0
YES (X-ZY-Y<0)
($\overline{K}$=L)
($\overline{K}$=H)
NO
Z ← Z+1 (COUNT Z)
SET RANGE TO DISPLAY
X ← X+Y
E ← E-1 CHANGES RANGE BY 10
EXP
RANGE
DISPLAY
DISPLAY
TRANSFER Z TO DISPLAY
NO
E=0
YES
SET RANGE TO DISPLAY
D ← D+1 (COUNT D)
NO
ARM
YES
RESET Z READY FOR NEXT DIGIT
RESET CONTROL CYCLE
X ← Y-X RESTORE REMAINDER
X > 10
YES
(X ← 10 X WOULD CAUSE OVERFLOW)
NO
X ← 10 X MULTIPLY X BY 10
Y ← 0.1Y DIVIDE Y BY 10
TO DISPLAY CYCLE
DISABLE X-GATE
D=0
ALLOW HYSTERESIS
D=1
RESET
NO
YES
D=2
D=3
D=4
TRANSFER EXPONENT
D=5
TIME = .01, .04
NO
YES
D=6
TIME = .01, .04
YES
NO
RESET EXP. REGISTER TO 7(Hz) 8(RPM)
TIME = 0.1, 0.2
NO
YES
D=7
MSD<2
YES
NO
D=8
D=9
TO D=0
YES
RESET RANGE TO EXP
RESET
D=15
ENABLE X-GATE

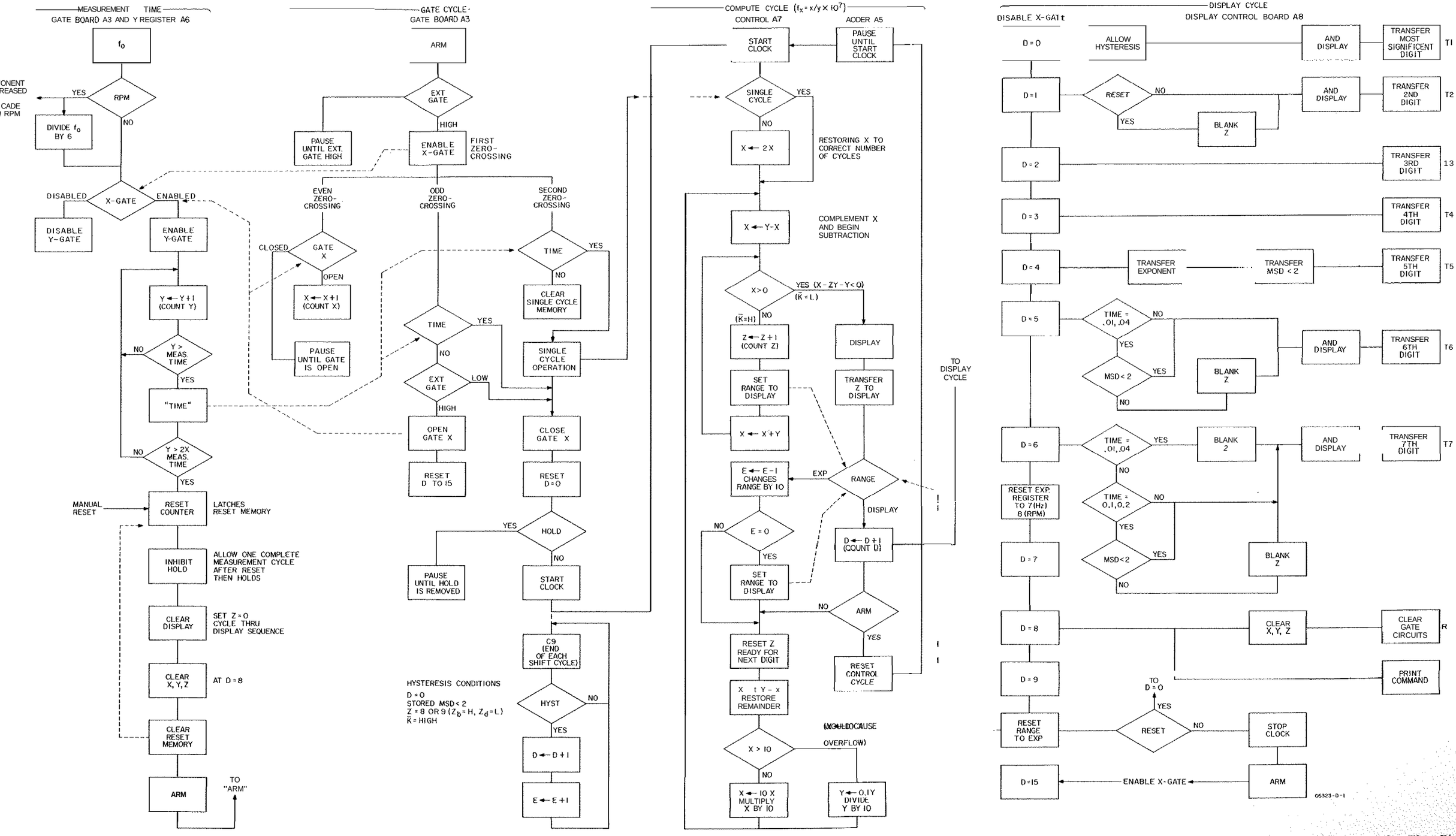


Figure 8-2. Flow Diagram

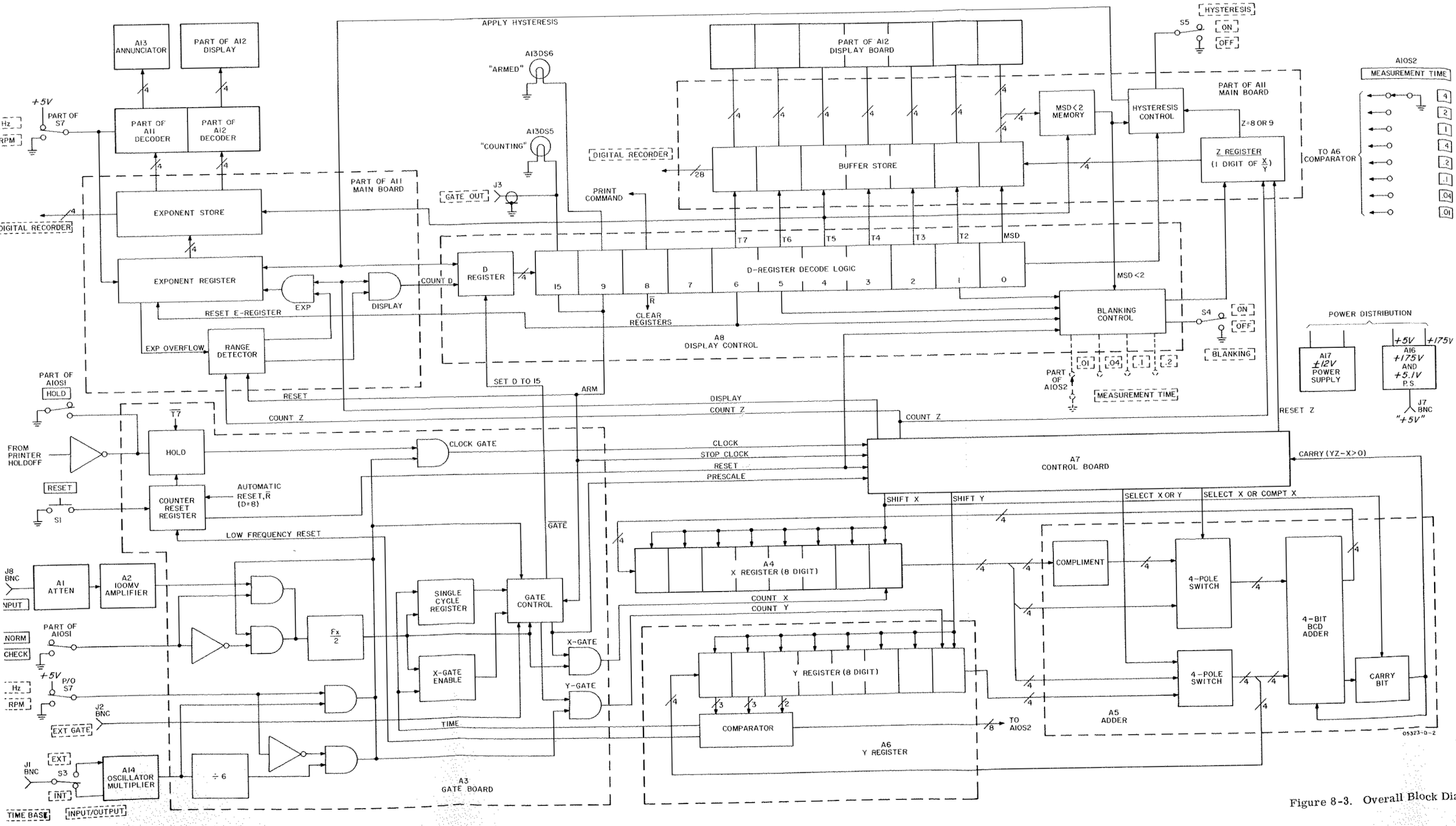


Figure 8-3. Overall Block Diagram

A1 OPERATION

The Counter input from J1 will be either AC- or DC-coupled to the attenuator depending on the position of S1. S2 selects the desired attenuation factor of 1, 10, or 100. Capacitors C2, C3, and C4 compensate for changes in frequency response as S2 is varied. The output of S2 is connected to the input of A2 via A9.

A1 TROUBLESHOOTING

If assembly is not working, check other positions of ATTEN and AC-DC switches. When it has been determined what positions are not operating, the trouble may be traced to the specific resistor, capacitor, or switch.

A2 OPERATION

The input signal from A1 appears at the gate of FET A . Q1A and Q1B control the gain of a differential amplifier composed of Q2, Q3, and Q4. The outputs from the differential amplifier are determined by the input signal level and the LEVEL control, R1-S7. The outputs appear as inputs to be differential Schmitt trigger, composed of Q5, Q6, and Q7. As the input signal level varies with time, the output of the differential amplifier will vary, which causes triggering of the differential Schmitt trigger. This output triggers a one-shot, composed of Q8-Q11. The output of A2 will be a pulse train from the one-shot that accurately follows the input signal, if the LEVEL control is set to allow triggering to occur. The output is connected to the input of A3.

A2 TROUBLESHOOTLNG

The first thing to do is check all the dc voltages coming into the board (-12V at pins 6 and 13, +12V at pins 7 and 8, and +5. 1V at pin 15). Now check input signal at pin 1 (should be at least 100 mVrms, . 28V peak-to-peak). Make waveform checks to determine which stage is not operating. When trouble has been isolated to a stage, make voltage and resistance measurements.

A2 ADJUSTMENT

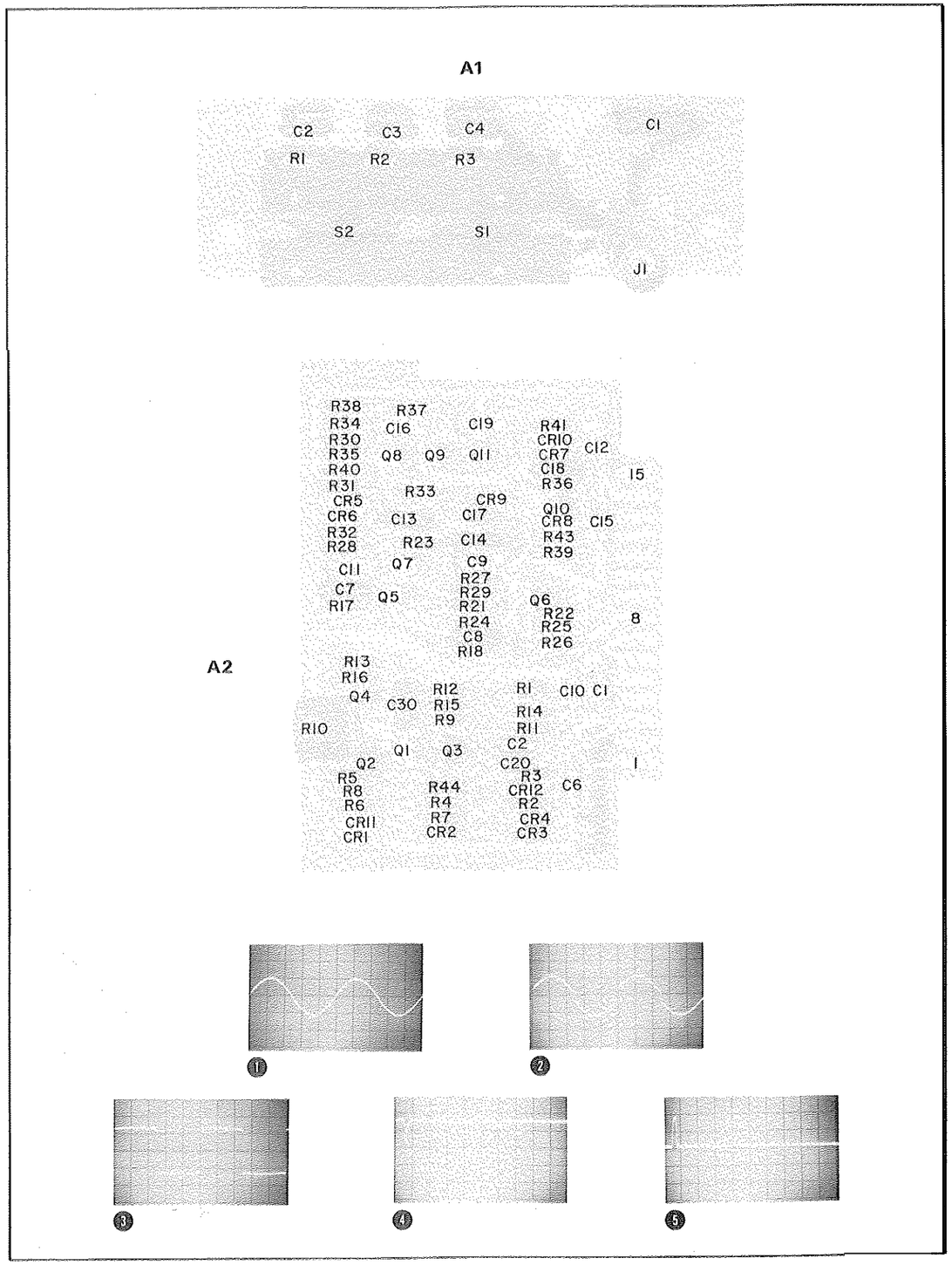
Follow procedure described in Table 5-4, ADJUSTMENTS (steps 1a through 1g), except use HP 651B Test Oscillator to supply 1 kHz input signal and HP 3400A RMS Voltnreter to monitor the input signal. Display should be approximately 1 kHz.

Set Controls:

POWER	ON
MODE	NORMAL
MEASUREMENT TIME	.4
LEVEL	PRESET
ATTEN	X1
AC-DC	DC
TIME BASE	INT
Hz/RPM	Hz

All waveforms taken with HP 180A Oscilloscope, HP 1801A Vertical Plug-in, NP 1821A Time Base Plug-in, and HP 10004A 10:1 Probe.

WAVEFORM NO.	Oscilloscope Settings				
	SENS V/CM	AC	DC	SLOPE +	SLOPE -	SWEEP /CM
1	.05V	x		x		.2 msec
2	.05V	x		x		.2 msec
3	.1V	x		x		.2 msec
4	.05V		x		x	.2 μsec
5	.2V		x	x		.2 μsec



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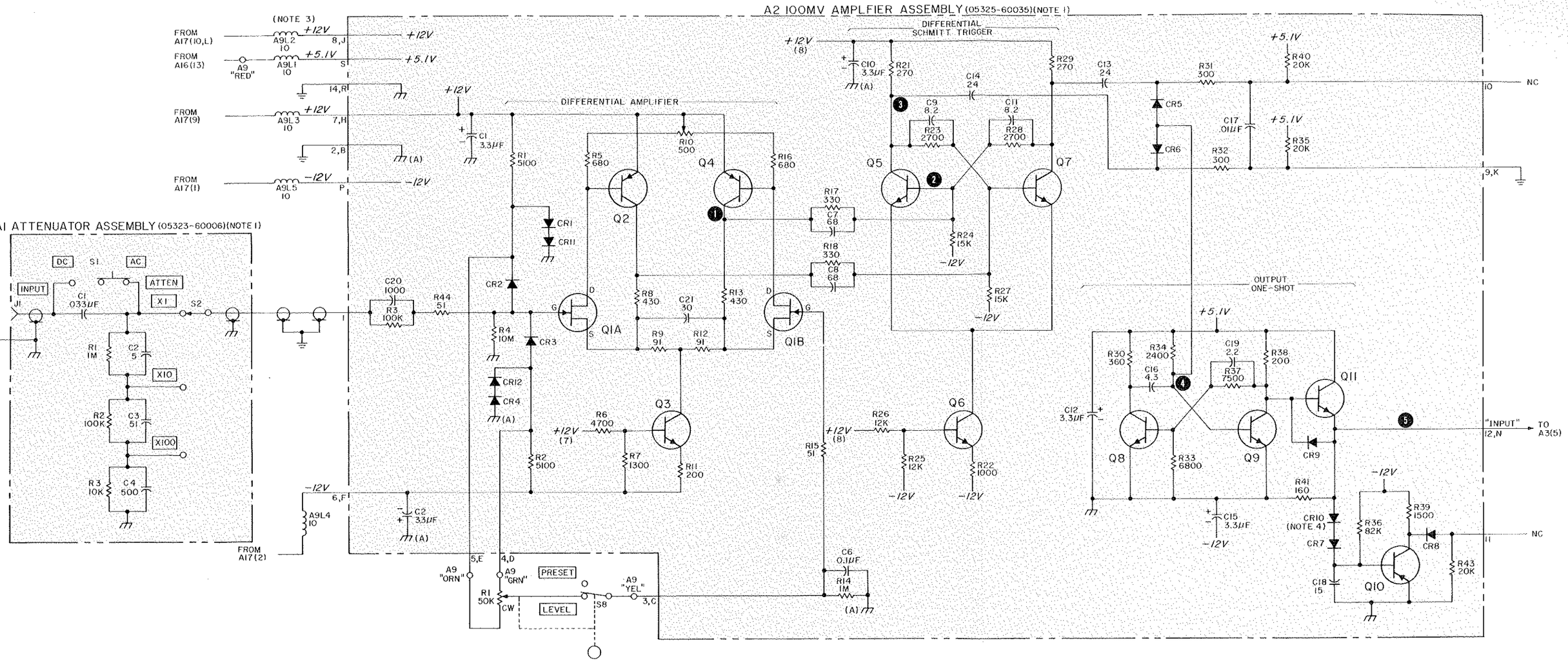
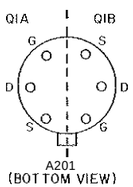


NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.
2. UNLESS OTHERWISE INDICATED
   RESISTANCE IN OHMS.
   CAPACITANCE IN PICOFARADS.
   INDUCTANCE IN MICROHENRIES
3. ALL CONNECTIONS TO XA2 ARE THRU A9, CONNECTOR HOARD ASSY
4. CRIO IS A 3 JUNCTION DIODE

REFERENCE DESIGNATIONS

NO PREFIX	A1	A2	A9
	C1-4	C1,2,6-21	
		CR1-12	
	J1		L1-5
		Q1-11	
R1	R1-3	R1-18,21-41,	
S8	S1,2	43,44	



TABLE

REFERENCE DESIGNATIONS	HP PART NUMBERS
CR1, 4-6, 11, 12	1901-0040
2, 3	1901-0376
7-9	1910-0022
10	1901-0460
Q1	1855-0320
2, 4	1853-0015
	2N3640
3, 6	1854-0071
5, 7	1854-0019
8, 9, 11	1854-0009
	2N709
10	1853-0036
	2N3906

05323-8-4

Figure 8-4 A1 Attenuator Board Assy
A2 Input Amplifier Assy

A3 OPERATION

IC1, IC9 and signal $\overline{RPM}$ control the selection of either Hz or RPM as the basic Counter unit of measurement. Fy pulses are used for frequency measurement at the 10 MHz clock frequency; Fy pulses are divided by 6 in IC9 for RPM measurement.

IC2 (A, B, C), IC4B, and signal $\overline{CHECK}$ control the selection of either NORM or CHECK mode. When $\overline{CHECK}$ is HIGH, IC2B will be enabled, and IC2A will be disabled via IC4B. This condition allows Fx pulses to appear at the output of ICZC; tlie resultant pulses represent $\overline{Fx}$ because of inversion in IC2C.

The Counter may be reset either manually or automatically. If the RESET pushbutton is momentarily depressed, tlie R input to the Reset flip/flop will become LOW, then HIGH, as the pushbutton is operated. This causes the CLEAR DISPLAY and RESET REGISTERS signals to go HIGH, $\overline{RESET\ Z}$ to go LOW, and the Clock Gate to be enabled; IC5A, GB, 7A, and 7B will be reset. The $\overline{R}$ signal produced by A7 will then cause the CLEAR DISPLAY and RESET REGISTERS signals to go LOW and the $\overline{RESET\ Z}$ signal to go IIIGII. If the input to A3 disappears during a Gate cycle, the Reset flip/flop will produce a CLEAR DISPLAY signal which gives an all-zero Display. The gate flip/flops arc resct by the $\overline{R}$ signal which is generated near the end of the Display cycle (at D = 8).

If the $\overline{HOLD}$ signal is LOW, a complete measurement cycle will occur until D = 6 when the trailing edge of the $\overline{T7}$ signal will set tlic Hold Gate Control flip/flop, enable the Hold gatc, and disable the Clock gatc, preventing automatic reset.

After reset has been completed, an ARM signal from A8 will be generated causing IC8A1 to become HIGH. With no EXT GATE signal present, both inputs to IC8A will he HIGH resulting in IC8B4 going LOW. IC8B output must now become IIIGII, which makes the J input of the Fx/2 flip/flop HIGH. The Fx/2 flip/flop is now armed, because the K input is always HIGH. The Fx/2 flip/flop will toggle on falling clock pulses as soon as Fx starts (rising Fx pulse produces falling clock input). Notice that if the EXT GATE input is LOW the J input of the Fx/2 flip/flop will also be LOW which prevents toggling. The states of critical gates and flip/flops after arming are shown in Table 8-1.

The firstinput pulse from A2 will cause the Fx/2 flip/flop to toggle. The X-Gate Enable flip/flop will change slate to Q = L, $\overline{Q}$ = H, and the PRESCALE and $\overline{GATE}$ signals will go LOW. The next Fy pulse will enable the Y-Gate Control flip/flop and Y-Gate allowing COUNT Y pulses to occur. Each even input pulse will cause a COUNT X pulse to occur and the SC Register will change state.

When the TIME signal occurs, the Gate cycle will be terminated by the X-Gate Control flip/flop on the next odd input pulse. The X-Gale will be disabled (COUNT X = LOW), and the PRESCALE and $\overline{GATE}$ signals will go HIGH. The next Fy pulse will disable tlie Y-Gate Control flip/flop and Y-Gate, which makes the COUNT Y = LOW. A special case arises when the TIME signal occurs before the second input pulse (Single-Cycle operation). The SC Control gate output IC4D13 will go LOW which prevents the SC Register from changing state on the 2nd input pulse, so a COUNT X = HIGH pulse will be generated, and $\overline{GATE}$ will go IIIGII, but PRESCALE will remain LOW.

After arming, IC8A1 will be HIGH. If the EXT GATE signal is held LOW, IC8A3 will be IIIGH, which results in the output of the Fx/2 Control gate (IC8B6) going LOW. The J input of the Fx/2 flip/flop will be held LOW, and toggling will be inhibited (COUNT X and COUNT Y will remain LOW). When the EXT GATE signal goes HIGH, the J input of the Fx/2 flip/flop will go HIGH. The Gate cycle is now enabled.

If the EXT GATE signal becomes LOW during a Gate Cycle, the Fx/2 flip/flop (IC7B) will be inhibited from toggling. The EXT GATE Control gate output (IC8D11) will become HIGH along with the D input to the X-Gate Control flip/flop. The Gate cycle will then terminate on tlie next odd input pulse.

A3 TROUBLESHOOTING

Check the input +5 Vdc at pin 15, S. Check for presence of Fx and Fy signals at pins 5 and C. If a problem exists with the mode or Hz/RPM functions, use the HP 10525A Logic Probe to check the NORM/CHECK and Hz/RPM decode logic. If the MOLD mode is inoperative, use the Logic Probe Io check signal HOLD, the Hold Gate Enable flip/flop, Hold gatc, and Clock gate.

Depress and hold the RESET pushbutton. Verify that the $\overline{R}$ and $\overline{T7}$ waveforms are correct. Release the RESET pushbutton and set the MODE switch to CHECK and MEASUREMENT TIME switch to .01. Verify that the $\overline{RESET\ Z}$ and RESET REGISTERS waveforins arc correct. If manual reset does not occur, check tlie Reset flip/flop and CLEAR DISPLAY waveform. If reset and arming occur correctly, the states of critical gates and flip/flops should be the same as shown in Table 8-1.

Next, check the CLOCK, COUNT Y and COUNT X output waveforms (the CLOCK and COUNT Y waveforms are nearly the same). Verify that the PRESCALE and $\overline{GATE}$ signals go LOW on the first Fx pulse. $\overline{GATE}$ should go HIGH at the end of the Gate cycle. Check the external gatc function by using the Logic Probe on signals ARM, EXT GATE, and IC8A, IC8B, and IC8D. This procedure should isolate the trouble to an individual gate element, flip/flop, or counter.

Figure 8-

A1 ATTENUATOR BOARD ASS
A2 INPUT AMPLIFIER ASS

(See Page 8-

COUNTER SETTINGS

A, RESET, ... depress and hold
MODE . . . . . CHECK
MEASUREMENTTIME O1
TIME BASE . . . . . INT

B. MODE. . . . . CHECK
MEASUREMENT TIME O1
TIME BASE . . . . . INT
Hz/RPM . . . . . Hz
BLANKING.. . . . . ON

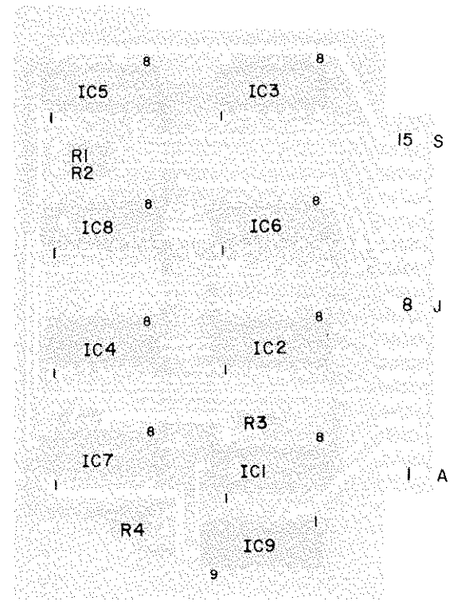
C. RESET . . . . . depress and release
MODE . . . . . NORM
MEASUREMENT TIME 4

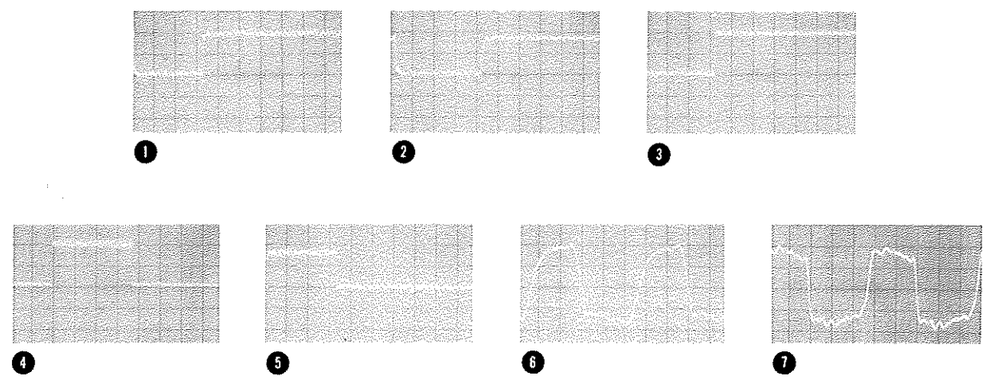
All waveforms taken with IIP 180A Oscilloscope, HP 1801A Vertical Plug-in, HI' 1821A Time Base Plug-in, IIP 10004A 10:1 Divider Probe. Center line of graticule is zero volts.

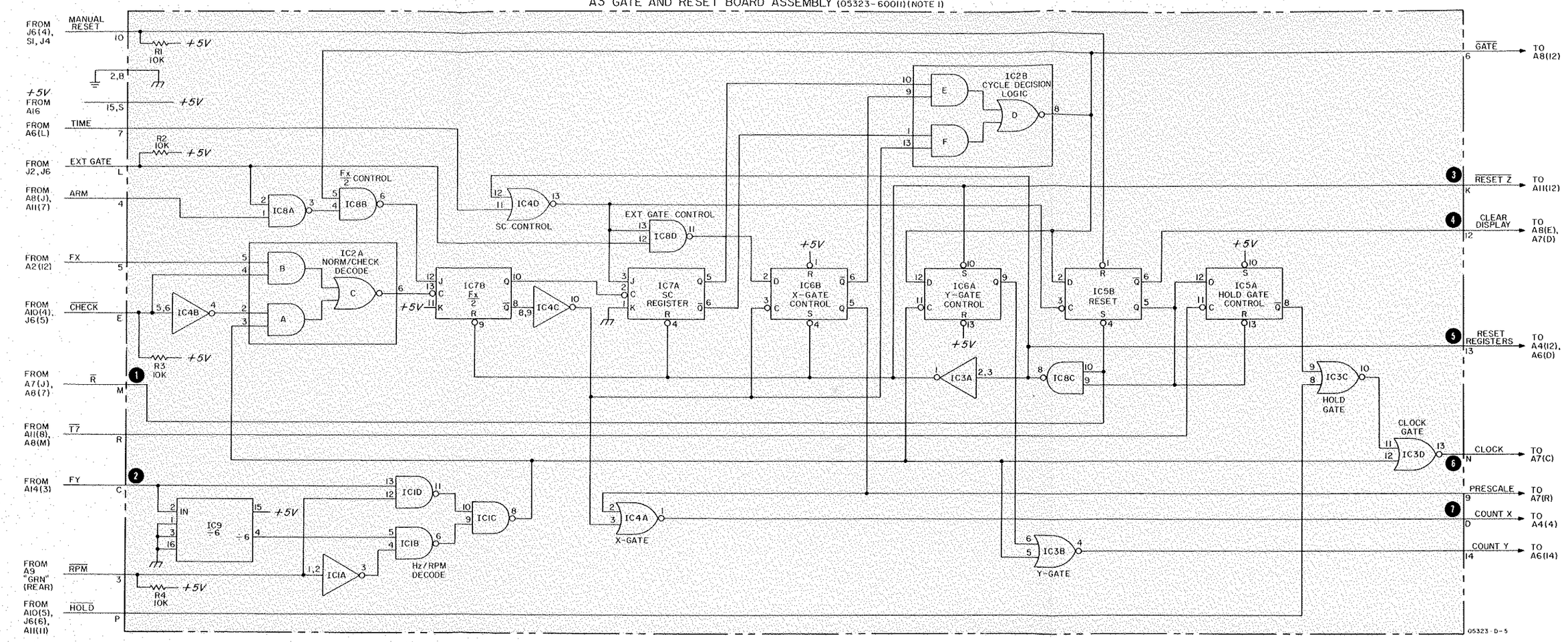
WAVEFORM NO.	COUNTER SETTINGS	Oscilloscope Scltlnes V/CM		DC	SLOPE +	SLOPE -	SWEEP /CM	SWEEP MODE
1	A	.2		x		x	.5 μs	NORM
2	A	.2		x		x	.2 μs	NORM
3	B	.2		x		x	5 μs	NORM
4	C	.2		x	x		.2 μs	SINGLE
5	B	.2		x	x		5 μs	NORM
6	B	.1	x			x	20 ns	NORM
7	B	.1	x		x		40 ns	NORM

Table 8-1. A3 Stales (Counter Armed)

ELEMENT	DESIGNATION	STATES OR GATE OUTPUT
Fx/2 F/F	IC7B	J = H, Q = L, $\overline{Q}$ = H
SC Register	IC7A	J = H, Q = L, $\overline{Q}$ = H
X-Gale Control F / F	ICRR	D = L, Q = H, $\overline{Q}$ = L
Y-Gate Control F / F	IC6A	D = H, Q = H
Reset F/F	IC5B	D = H, Q = H, $\overline{Q}$ = L
Hold Gate Control F/F	IC5A	D = H, $\overline{Q}$ = H
Fx/2 Control Gate	IC8B	LOW
SC Control Gate	IC4D	HIGII
Ext. Gate Control	IC8D	LOW
Cycle Decision Logic	IC2 (D, E, F)	HIGH
X-Gate	IC4A	LOW
Y-Gate	IC3B	LOW
Hold Gate	IC3C	LOW
Clock Gate	IC3D	Enabled (Fy or Fy/6)







NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.
2. UNLESS OTHERWISE INDICATED: RESISTANCE IN OHMS;

TABLE

REFERENCE DESIGNATIONS	HP PART NUMBERS
IC1,8	1820-0054
2	1820-0063
3,4	1820-0328
5,6	1820-0077
7	1820-0208
9	1820-0210

REFERENCE DESIGNATIONS

A3
IC1-9
R1-4

Figure 8-5. **A3** Gate **and** Reset Board Assy

A4 OPERATION

During reset, a RESET REGISTERS pulse is generated by A3. This pulse will reset all eight Decade Counter/Shift Registers (IC1-IC8). When COUNT X pulses appear at IC7(14) the first Decade Counter (IC7) will begin accumulating pulses. Overflow of the first Decade Counter produces a ÷ 10 output at IC7(3), which is counted by IC6. This process is repeated for successive counters, resulting in a capability of storing up to 10^8 COUNT X pulses.

During the Compute cycle, information from A5 must be periodically loaded into the X-Register. The data are loaded using summation lines Σa, Σb, Cc, and Σd which connect to Ia, Ib, Ic, and Id of IC8 (pins 1, 2, 7, and 8, respectively). The Z outputs of IC8 connect to the I inputs of IC1; the Z outputs of IC1 connect to the I inputs of IC2, etc. The 4-bit BCD words on the summation lines are shifted by $\overline{\text{SHIFT X}}$ pulses into successive registers until, on the 8th $\overline{\text{SHIFT X}}$ pulse, the first 4-bit BCD word is stored in IC7. The old data in the X-Register has been shifted, one digil at *a* lime, into A5.

Buffer gates IC10A, B, C, and D develop signals Xa, Xb, Xc, and Xd corresponding to the 4-bit wordstored in IC7. When $\overline{\text{SHIFT X}}$ goes LOW, the Z outputs are enabled. Therefore, at the end of each $\overline{\text{SHIFT X}}$ pulse (HIGH), a new 4-bit BCD word is available for use by A5. In order to maintain $X > 10^7$ = LOW, all 4 inputs to IC9A must be HIGH. Thereforc, the Za, Zb, Zc, and Zd outputs from IC8 (pins 16, 15, 10, and 9, respectively) must bc HIGH. The Decade counters use negative-logic, 1-2-4-8 coded outputs, so the Z outputs will be HIGH until IC1 overflows. When IC1 overflows, IC8(16) will become LOW, and $X > 10^7$ will go HIGH.

A4 TROUBLESHOOTING

Check the i-5 Vdc at pin 15, S. To check the count operation, set the MODE switch to CHECK and MEASUREMENT TIME to 4. Verify that COUNT X pulses are available at pin K. Then use the oscilloscope to trace the COUNT X overflow signal from pin3 of each Dccadc Counter up to IC8. Verily that reset of the Decadc Counters occurs with a Logic Probe and check the RESET REGISTERS waveform.

If the count operation is satisfactory, check the waveform of the $\overline{\text{SHIFT X}}$ signal with MODE set to CHECK. The Z outputs of each Shift Register can then be checked with the oscilloscope to isolate a defective unit. Finally, check IC9A and the $X > 10^7$ signal waveform.

Figure 8-5
A3 GATE AND RESET BOARD ASSY

(See Page 8-9)

COUNTER SETTINGS

A.	MODE	CHECK
	MEASUREMENT TIME	.01
	TIME BASE	INT
	Hz/RPM	Hz
B.	MODE	CHECK
	MEASUREMENT TIME	4
	TIME BASE	INT
	Hz/RPM	Hz

A12 OPERATION

IC1-IC7 are BCD to Decimal Decoders and Display Tube Drivers which receive the 4-bit BCD words from the Buffer Storage Registcrs in A11 and drive the display tubes. Refer to Section IV for the BCD to Decimal Decoder/Driver operating states (including blanked display). A LOW applied to pin 11 of display tubes DS2-DS7 will causethe decimal point to illuminate for the selected tube. Selection is controlled by IC8, which receives inputs from the Exponent/Measurement Unit Decode Logic in A11. Table 8-6 in the discussion of the A11 Main Board Assembly shows the inputs to IC8. Using the Truth Table for the BCD to Decimal Decoder/Driver, together with the Decode Logic table, the operation of IC8 can be understood.

A12 TROUBLESHOOTING

Check the +175 Vdc at the WHT-RED push-on connector and the +5 Vdc at pin 21, Y. Grouncl the test point on the A11 Main Board with a clip lead and use the Logic Probe Io check the inputsto the BCDto Decimal Decoder/Drivers (set MEASUREMENT TIME to 1 or 4). Use a DC Voltmeter to check the outputs of the Decoder/Drivers; enabled digit voltage should be approximately +2 Vdc and disabled digit voltage should be approximately +90 Vdc. The display tubes can be checked by substitution or interchanging.

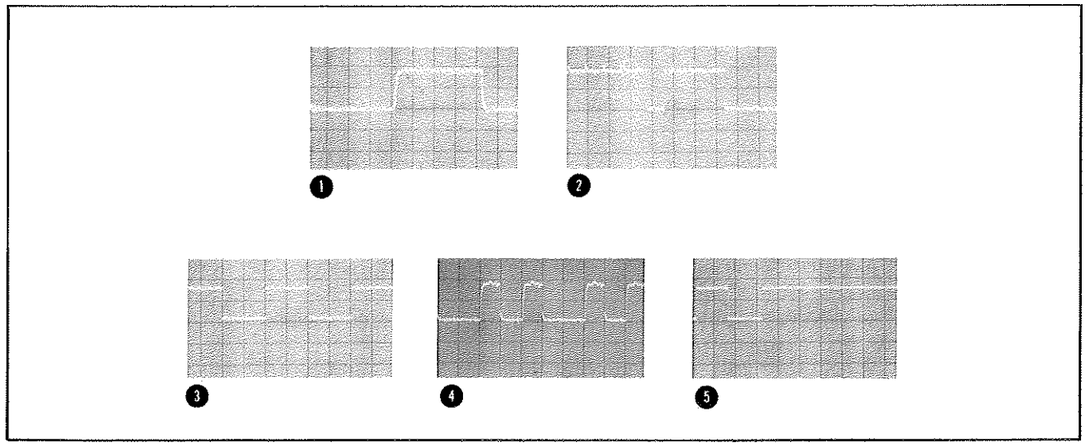
WARNING

USE EXTREME CAUTION WHEN TROUBLESHOOTING THIS ASSEMBLY AS +175 VOLTS IS PRESENT AT MANY POINTS ON BOARD.

All waveforms taken with HP 180A Oscilloscope, IIP 1801A Vertical Plug-in, HP 1821A Time Base Plug-in, HP 10004A 10:1 Divider Probe. Center line of graticule is zero volts.

WAVEFORM NO.	COUNTER SETTINGS	Oscilloscope Settings					
		SENS V/CM	AC	DC	SLOPE +	SLOPE −	SWEEP /CM	MAIN TRIGGER
1	A	.2		x		x	.2 μs	INT
2	A	.2		x	x		2 μs	EXT(1)
3	B	.2		x	x		.1 ms	INT
4	B	.2		x		x	.4 μs	EXT(2)
5	A	.2		x		x	10 μs	INT

(1) Connect external trigger input to $\overline{\text{SHIFT X}}$, IC8(13).
(2) Connect external trigger input to Xa, IC10B4.



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2. UNLESS OTHEI
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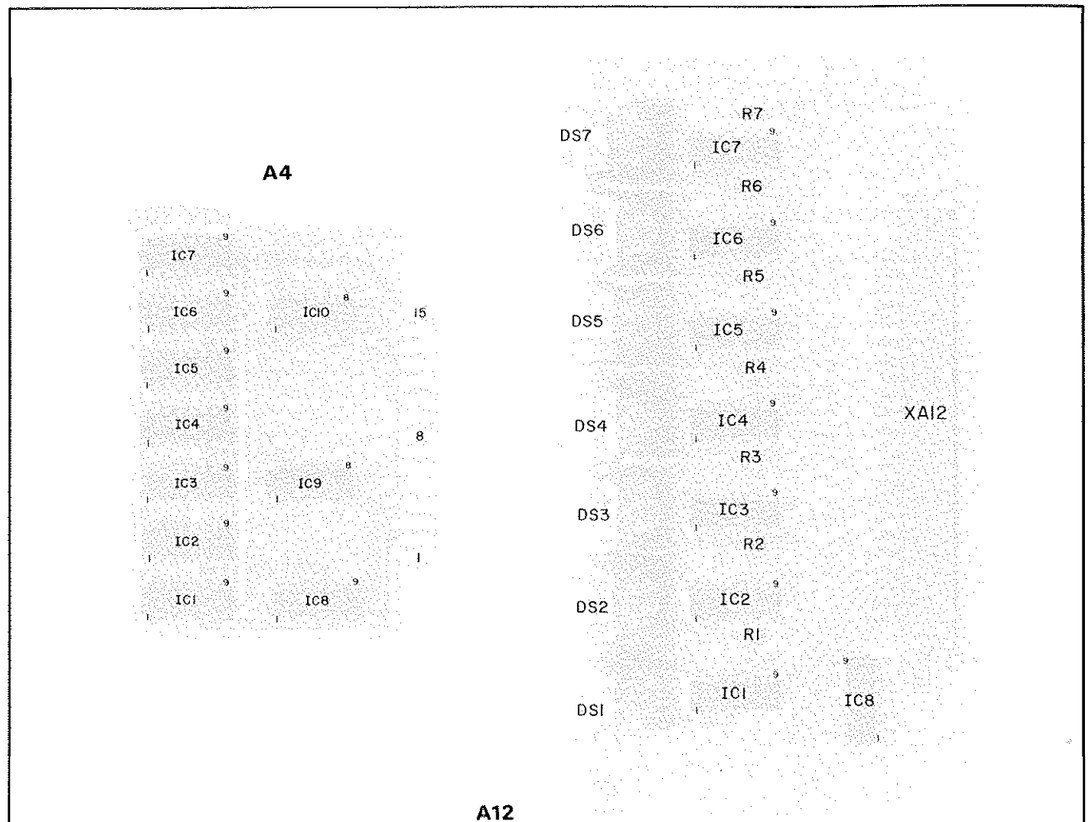

NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.
2. UNLESS OTHERWISE INDICATED: RESISTANCE IN OHMS,

RFFERENCE DESIGNATIONS

A4	A12
IC1 10	DS1-7 IC1-8 R1-7

TABLE

REFEWENCE DESIGNATIONS	HP PART NUMBERS
A4	
IC1-6,8	1820-0191
7	1820-0190
9	1820-0069
10	1820-0328
A12	
IC1-8	1820-0092

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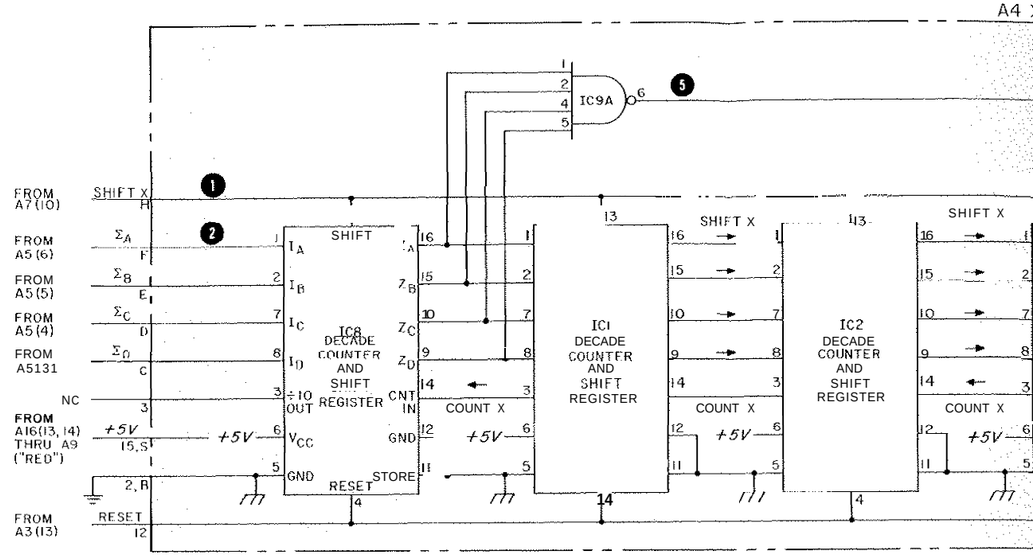

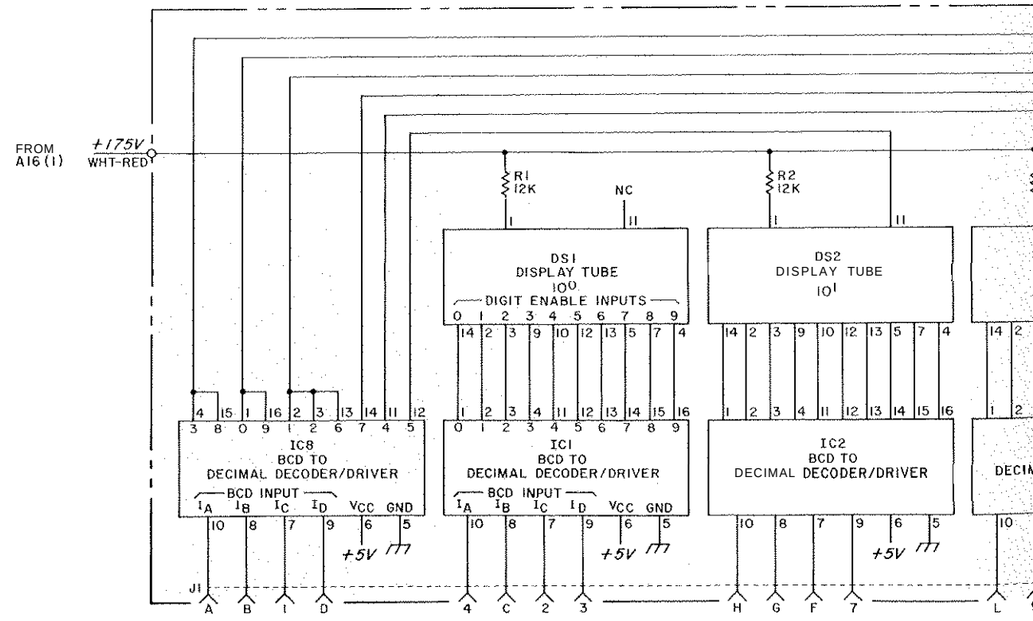

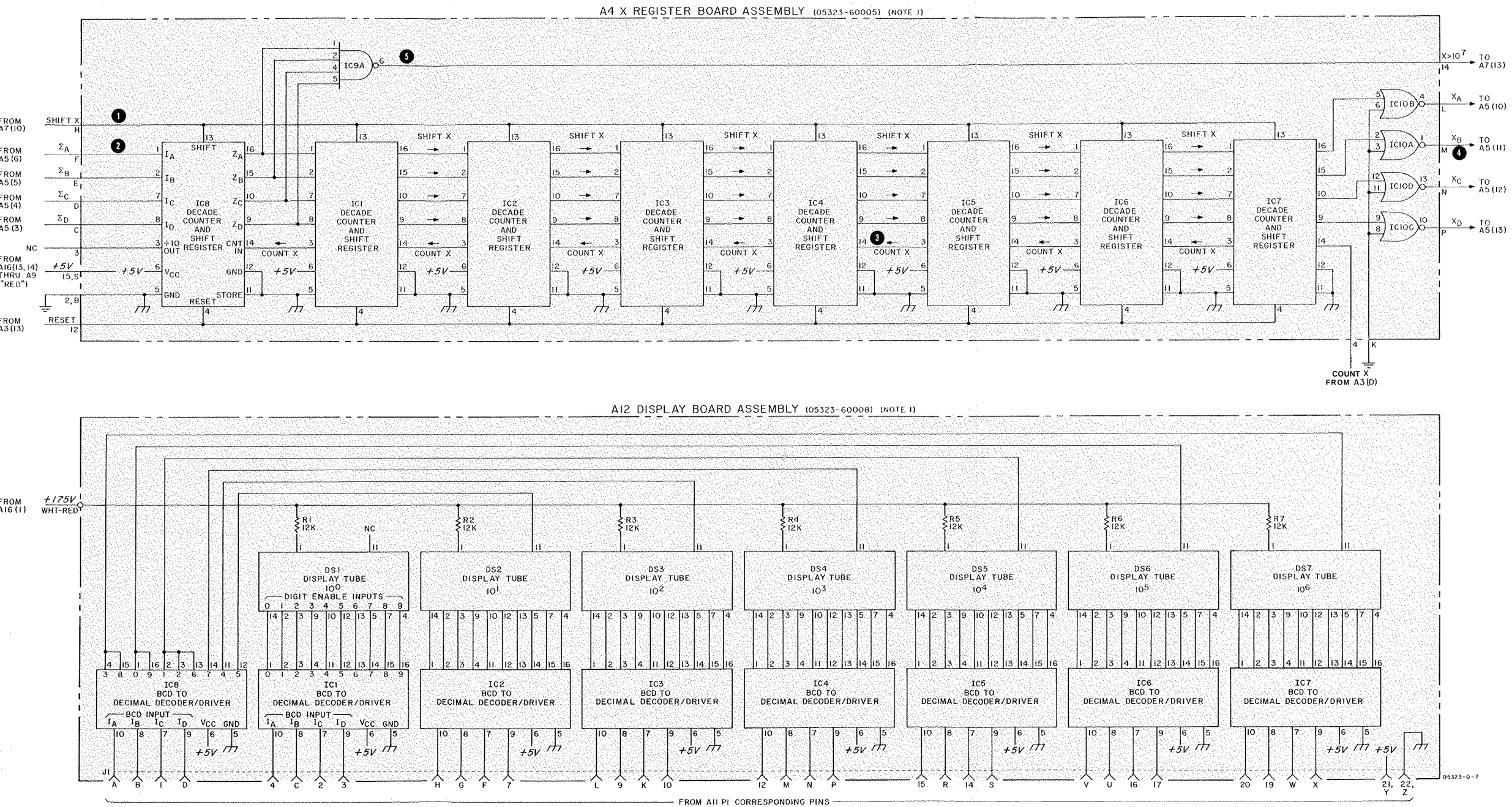

Figure 8-6. A4 X-Register Board Assy
A12 Display Board Assy

A5 OPERATION

At the start of the Compute cycle, the $\overline{X+X}$ signal will be LOW, and both C1 and C2 are LOW ($\overline{C2}$ = HIGH). IC2C8 and IC2B6 outputs will be HIGH, and IC3C10 and IC3B4 outputs will be LOW. The first 4-bit BCD word stored in the X-Register will be gated via four-pole switches IC8 and IC6 to the A and B inputs of the 1st binary adder (IC5). The 1st binary adder (IC5) produces the sum and a C4 carry signal. If the sum is greater than 9, decode logic IC4(A, B, C), IC1D, and IC1A will cause IC1A1 to go LOW, which makes the B input word to the 2nd binary adder (IC7) equal to 6 in BCD form. The BCD 6 must be added to the A input (Σ output of 1st binary adder) when the sum is greater than 9, so that the Σ output of IC7 is in decimal form. A carry pulse will also be generated by the IC1A1 LOW output which appears at the D input of IC9A.

When the first $\overline{SHIFT\ X}$ pulse occurs, the new least significant digit on the Σa, Σb, Σc, Σd lines will be loaded into the X-Register. On the trailing edge of the $\overline{SHIFT\ X}$ pulse, the carry from IC1A1 will be clocked into IC9A. As a result of the C pulse, the $\overline{Q}$ output state of IC9A will be clocked into IC9B. The $\overline{Q}$ output of IC9B represents the carry-in to the 1st binary adder. A $\overline{K}$ signal (carry pulse) will also be generated by IC9A ($\overline{K}$ = LOW represents a carry pulse). The next 4-bit BCD word from the X-Register will now be summed and a carry-in will be added, if generated by the first summation.

At the end of a complete shift cycle, IC9 is reset ($\overline{K}$ = HIGH) by a $\overline{C10}$ pulse. During the X + X operation, $\overline{SHIFT\ Y}$ pulses are inhibited so that the Y-Register contents remain undisturbed.

The Xc + Y operation is the 2nd addition that occurs during a Compute cycle and represents the start of a division process. The $\overline{X+X}$ and $\overline{C2}$ signals are HIGH, and the C1 signal is LOW. IC2C8 and IC3B4 outputs will be HIGH, and IC3C10 and IC2B6 outputs will be LOW.

The first 4-bit BCD word stored in the Y-Register will be gated via four-pole switch IC8 to the A input of the 1st binary adder. The B input to the 1st binary adder should consist of the 9-complement of X, routed via four-pole switch IC6. To obtain the 9-complement of X, IC1B, IC1C, IC2A, IC3D, and IC4(D, E, F) are used. Table 8-2 shows the Boolian expressions and their simplified forms produced by the 9-complement logic. Adder operation is the same as that previously described for the X + X operation. The new Xc + Y word is shifted into the X-Register as X + X is shifted out.

Figure 8-6
A4 X-REGISTER BOARD ASSY
A12 DISPLAY BOARD ASSY
(See Page 8-11)

The third step in the Compute cycle is to add Y to the contents of the X-Register. This will be repeated until a $\overline{K}$ signal is generated. At the start of this addition, $\overline{C2}$ is LOW, so the IC3C10 output will be HIGH, and the IC3B4 output will be LOW.

The first 4-bit BCD word from the Y-Register will be routed by the IC8 four-pole switch to the A input of the 1st binary adder. The first word from the X-Register will be routed by the IC6 four-pole switch to the B input of the 1st binary adder. A sum and carry will be generated as previously described. The new sum (X + Y) will be stored in the X-Register.

When a carry signal ($\overline{K}$ = LOW) is generated, the A7 Control Board Assembly will cause C1 = LOW and $\overline{C2}$ = HIGH, which initiates a new Xc + Y operation to restore the remainder of the last division, prior to multiplying by 10. After X has been multiplied by 10, a new division is started with Xc + Y being the first operation in A5.

A5 TROUBLESHOOTING

Check the +5 Vdc at pin 15, S. Check the Xa, Xb, Xc, Xd, and Ya, Yb, Yc, Yd input waveforms with the oscilloscope. Check the $\overline{X+X}$, C1, $\overline{C2}$, C, $\overline{C10}$, and $\overline{SHIFT\ X}$ signal waveforms. Check the Ia, Ib, Ic, Id waveforms to verify proper operation of IC8 (recirculation of Y for X + Y and Xc + Y operations). Compare the Xa, Xb, Xc, Xd waveforms to the A input to the 1st binary adder; they should be the same for the X + X operations.

Using the Logic Probe, check the operation of the Complement logic, using the data in Table 8-2; then check the B input to the 1st binary adder. Using the Logic Probe, check the operation of the +6 logic and the B input to the 2nd adder. To check the complement and +6 logic with the Logic Probe, the Counter should be in HOLD or ARMED (no signal input). Using a clip lead, various gate inputs can be made LOW by grounding them while the gate outputs are observed with the Logic Probe. Check the Σa, Σb, Σc, Σd output waveforms. Check the $\overline{K}$ waveform with the oscilloscope and verify operation of the $\overline{K}$ Memory flip/flops. The C signal (pin 14) can be used to sync the oscilloscope on non-repetitive waveforms.

COUNTER SETTINGS

MODE	CHECK
MEASUREMENT TIME	.01
TIME BASE	INT
BLANKING	ON
Hz/RPM	Hz

All waveforms taken with HP 180A Oscilloscope, HP 1801A Vertical Plug-in, HP 1821A Time Base Plug-in, HP 10004A 10:1 Divider Probe. Center line of graticule is zero volts.

WAVEFORM NO.	Oscilloscope Settings					
	SENS V/CM	AC	DC	SLOPE + -	SWEEP /CM	MAIN TRIGGER
1	.2		x	x	5 μs	INT
2	.2		x	x	20 μs	INT
3	.2		x	x	10 μs	INT
4	.2		x	x	.5 μs	INT
5	.2		x	x	2 μs	INT
6	.2		x	x	10 μs	EXT(1)

(1) Connect external trigger input to C signal, IC9B11.

Table 8-2. 9-Complement Logic Operation

INPUT	INPUT LOCATION	OUTPUT (B-INPUT TO 1ST BINARY ADDER)		OUTPUT LOCATION
		ORIGINAL EXPRESSION	SIMPLIFIED FORM	
Xa	A5(10)	$\overline{X1}$	$\overline{X1}$	IC6(13) IC5(11)
Xb	A5(11)	X2	X2	IC6(10) IC5(7)
Xc	A5(12)	$\overline{(X2 \cdot X4) + (\overline{X2} + \overline{X4})}$	$X2 \cdot \overline{X4} + \overline{X2} \cdot X4$	IC6(6) IC5(4)
Xd	A5(13)	$\overline{X8 + (\overline{X4} + \overline{X8})}$	$\overline{X4} + \overline{X8}$	IC6(3) IC5(16)

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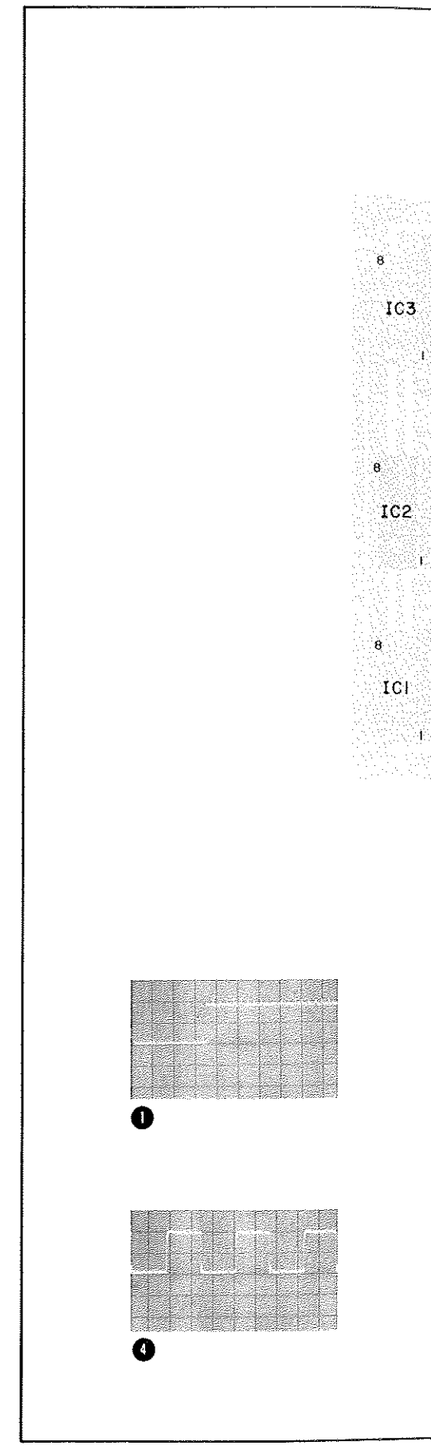
Model 5323A



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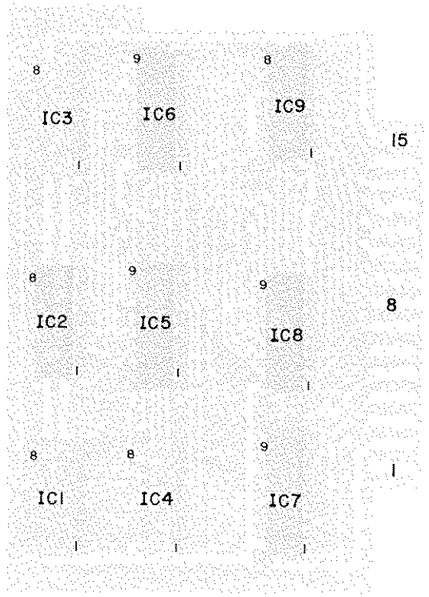
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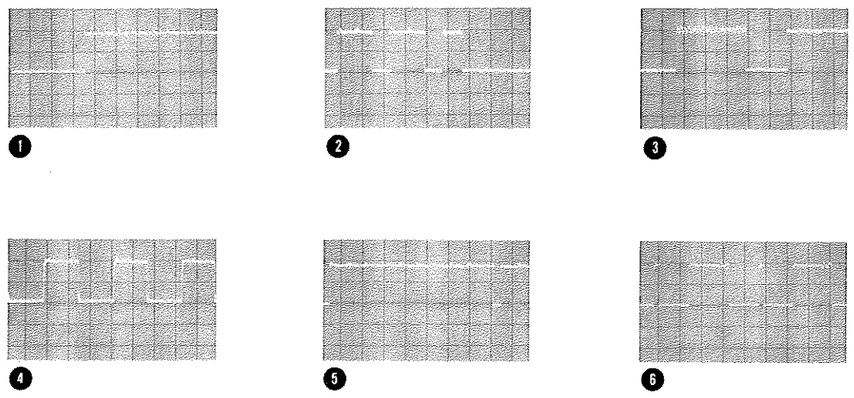
IC6
IC9
IC2
IC5
IC8
IC1
IC4
IC7
15
8
1


1
2
3
4
5
6

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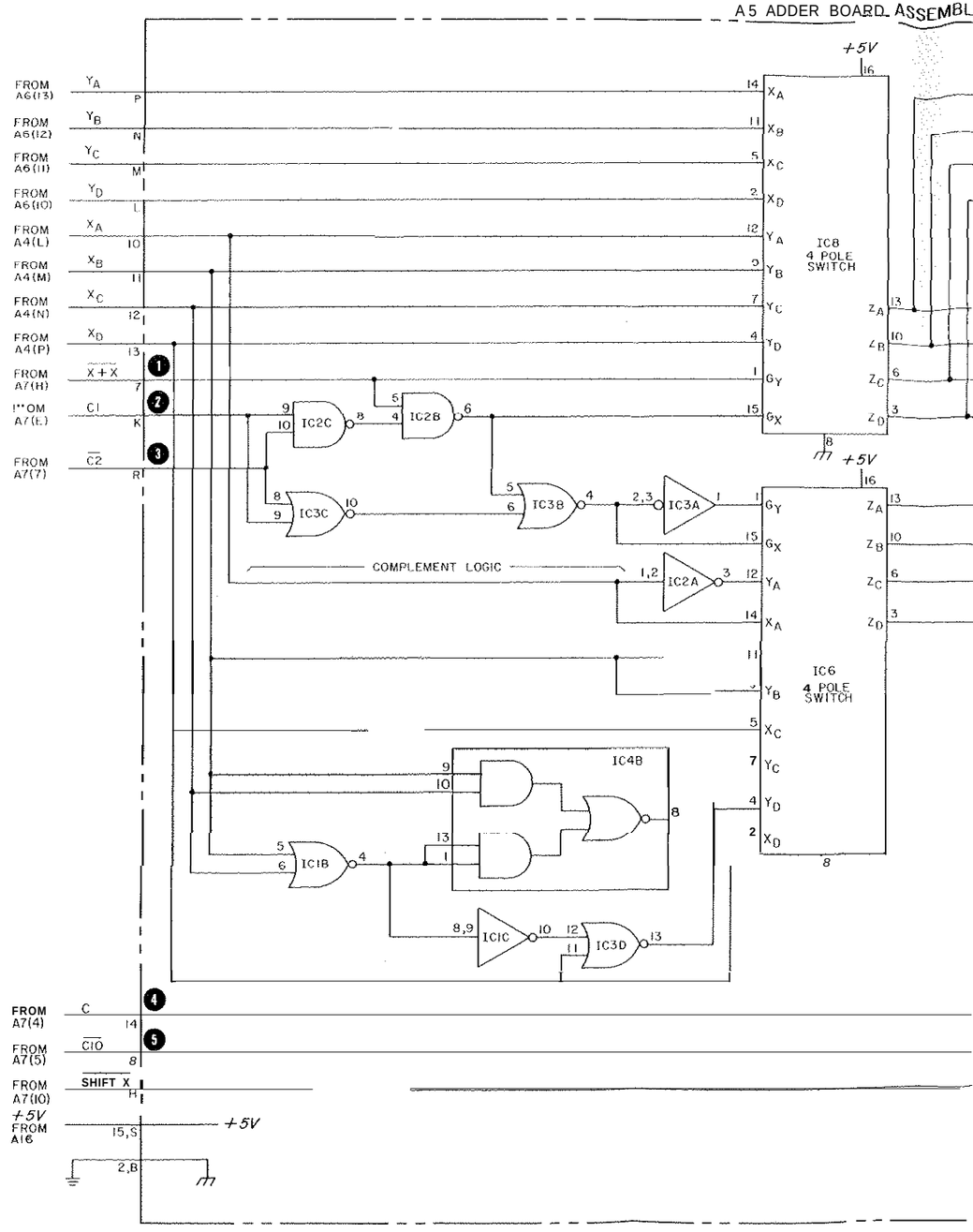
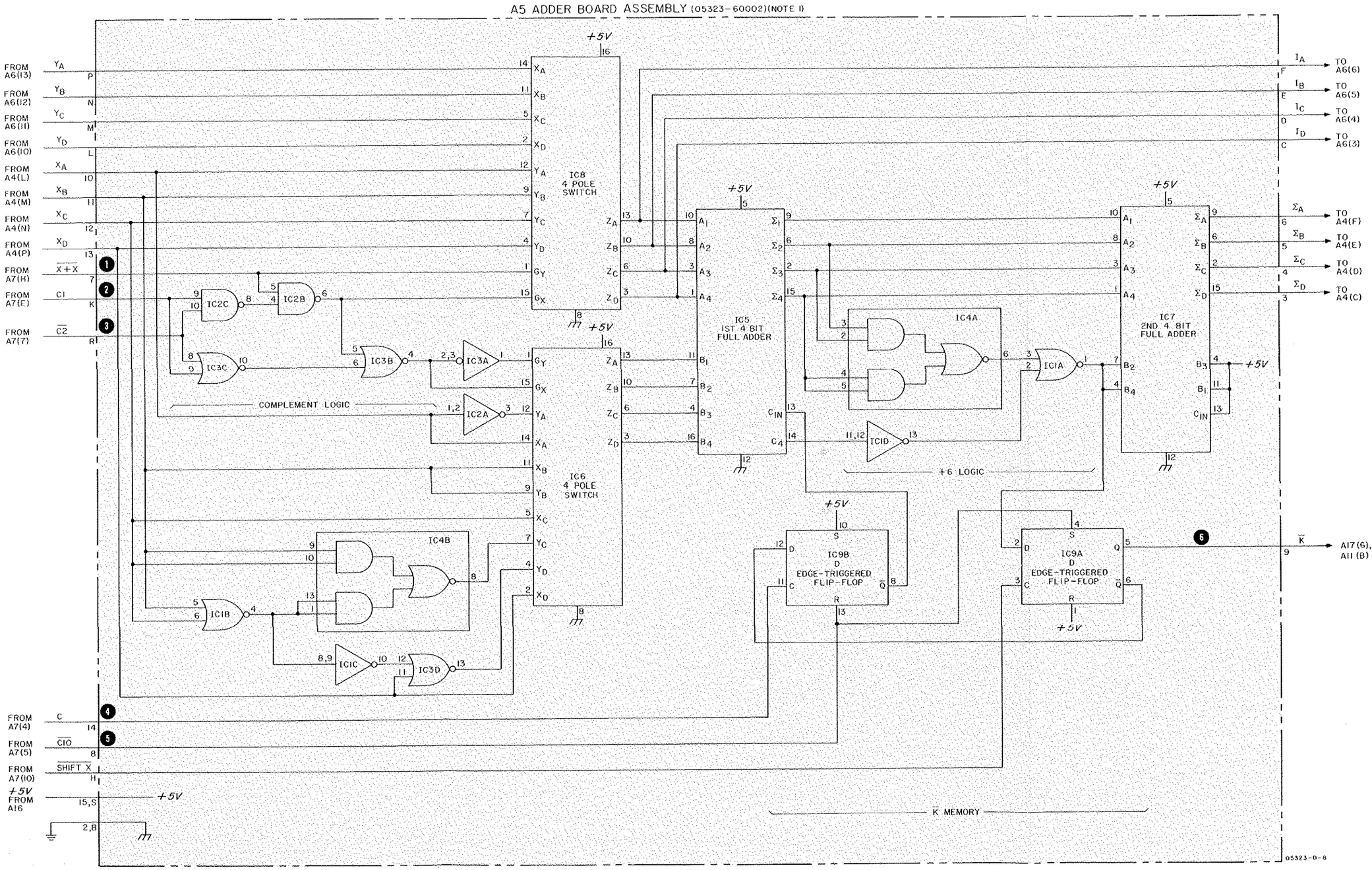

A5 ADDER BOARD ASSEMBL
+5V
FROM A6(13)
FROM A6(12)
FROM A6(11)
FROM A6(10)
FROM A4(L)
FROM A4(M)
FROM A4(N)
FROM A4(P)
FROM A7(H)
FROM A7(L)
FROM A7(7)
IC8 4 POLE SWITCH
IC6 4 POLE SWITCH
IC2C
IC2B
IC3C
IC3B
IC3A
IC2A
IC4B
IC1B
IC1C
IC3D
COMPLEMENT LOGIC
FROM A7(4)
FROM A7(5)
FROM A7(10)
FROM A16
SHIFT X
+5V
1
2
3
4
5



NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.

TABLE

REFERENCE DESIGNATIONS	HP PART NUMBERS
IC1, 3	1820-0328
2	1820-0054
4	1820-0063
5,7	1820-0305
6,8	1820-0135
9	1820-0077

REFERENCE DESIGNATIONS

A5
IC1-9

Figure 8-7. A5 Adder Board Assy

A6 OPERATION

Operation of the Y-Register is similar to the X-Register operation, previously described, except for an additional comparator circuit. COUNT Y pulses (Fy or Fy/6) appear at IC7(14) and are accumulated in the Decade Counters (IC1-IC6). This register also has a capability of storing 10^8 COUNT Y pulses. During the Compute cycle, $\overline{\text{SHIFT Y}}$ pulses shift the eight 4-bit BCD words into A5 via inverters IC12 (C, D, E, F) on lines Ya, Yb, Yc, and Yd. These words are recirculated through A5 and loaded on lines Ia, Ib, Ic, and Id back into the Y-Register, preserving the contents of the register.

The MEASUREMENT TIME switch selects one of eight measurement times for gating Fx and Fy pulses: .01, .04, .1, .2, .4, 1, 2, or 4 seconds. The selected measurement time determines the states of one input of the 2-innut NAND gates (IC9 and IC11). The other inputs of tire NAND gates are controlled by the contents of the Y-Register (Z outputs of Decade Counters). The NAND gates compare the register contents to the selected measurement time, and the TIME signal will go HIGH when coincidence occurs (measurement time = number of COUNT Y pulses stored).

AG TROUBLESHOOTING

Check the +5 Vdc at pins 15, S. To check the count operation, verify that COUNT Y pulses are present at pin 14. Trace the COUNT Y signal through the counters bv observing the waveform at the CNT IN (pin 14) terminals. To check the shift operation, verify that $\overline{\text{SHIFT Y}}$. RESET REGISTERS. and Ia, Ib, Ic, Id signals arc present. Trace the shifted data at the Z outputs of each shift register up to the output buffers. Check the Ya, Yb, Yc, Yd output waveforms.

If count and shift operation arc correct, check the comparator logic with the Logic Probe; then, check the TIME Signal waveform. This procedure should isolate the trouble to the defective counter/register or gate element.

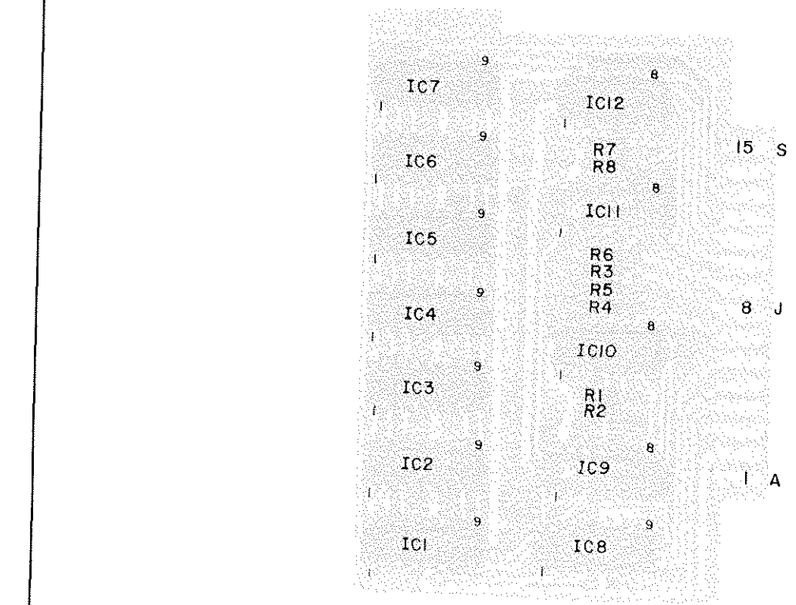
COUNTER SETTINGS

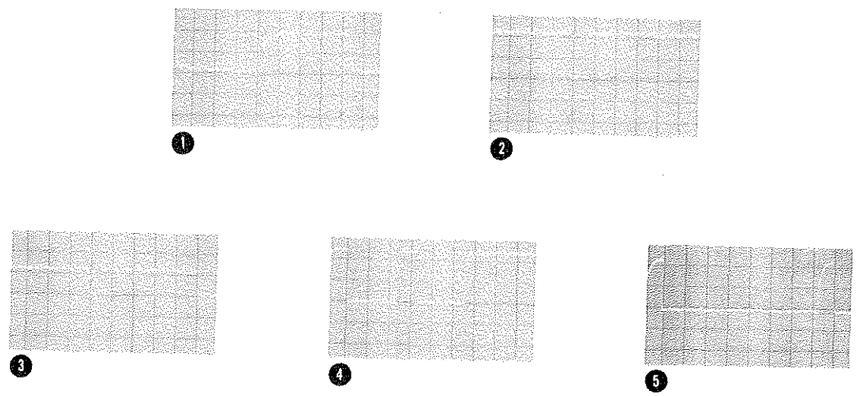
MODE	CHECK
MEASUREMENT TIME	.01
TIME BASE	INT
Hz/RPM	Hz
BLANKING	ON

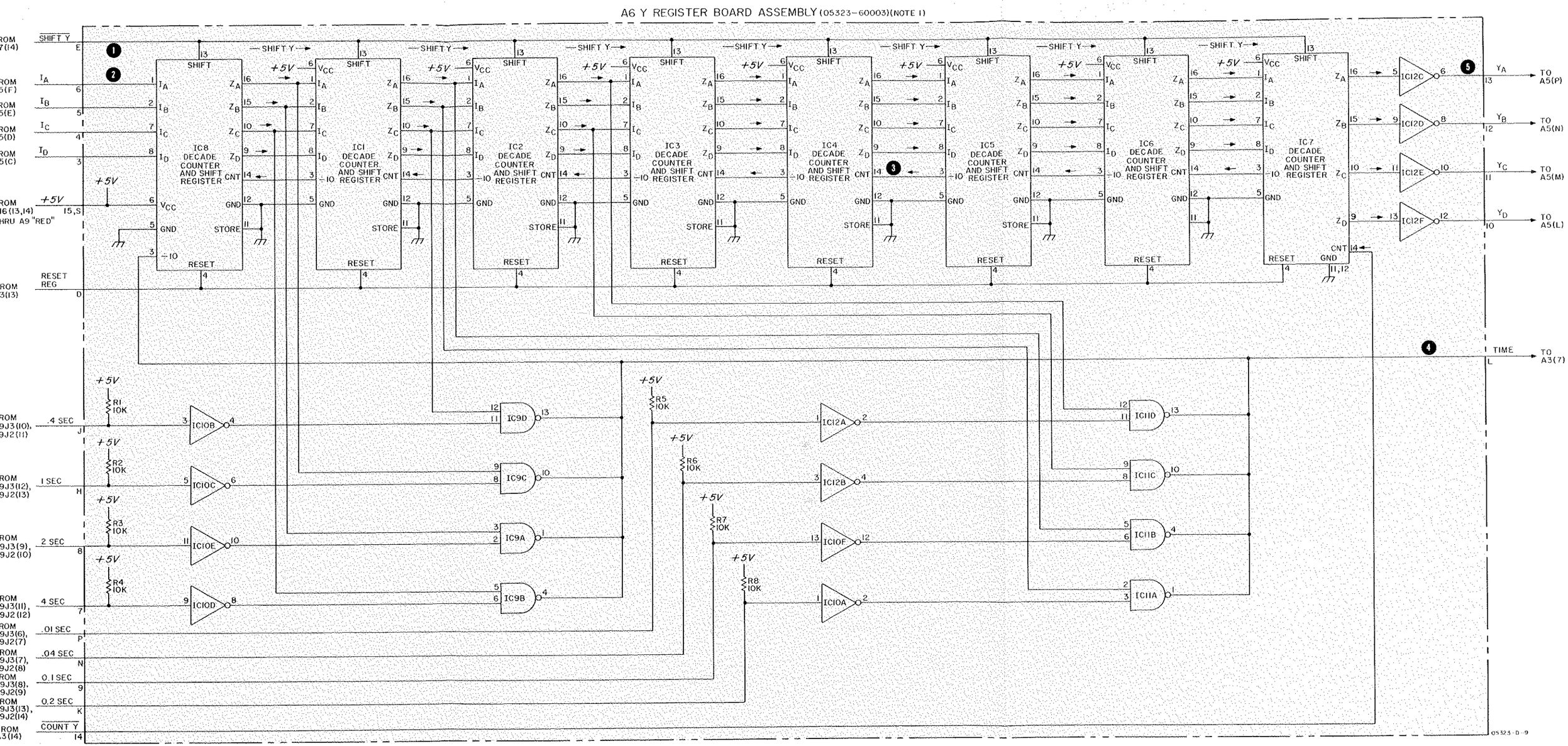
All waveforms taken with HP 180A Oscilloscope, HP 1801A Vertical Plug-in, HP 1821A Time Base Plug-in, HP 10004A 10:1 Divider Probe. Center line of graticule is zero volts.

WAVEFORM NO.	Oscilloscope Settings					
	SENS V/CM	AC	DC	SLOPE +	SLOPE -	SWEEP /CM	MAIN TRIGGER
1	.2		x		x	2 μs	INT
2	.2		x		x	2 μs	EXT(1)
3	.2		x		x	20 μs	INT
4	.2		x	x			INT
5	.2		x	x			INT

(1) Connect external trigger input to $\overline{\text{SHIFT Y}}$, IC8(13).







NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION
2. UNLESS OTHERWISE INDICATED: RESISTANCE IN OHMS:

TABLE

REFERENCE DESIGNATIONS	HP PART NUMBERS
IC1-7	1820-0191
8	1820-0190
9,11	1820-0327
10,12	1820-0307

REFERENCE DESIGNATIONS

A6
IC1-12
R1-8

Figure 8-8 AG Y-Register Assy

Model 5323A

A7 OPERATION

The $\overline{R}$ signal generated during the Reset cycle will reset the C1 Register and set the C2 Register. When the Counter is armed, $\overline{ARM}$ will go LOW which causes output IC3A1 to become HIGH, resetting IC1 and IC2 to all outputs HIGII. Additionally, the LOW $\overline{ARM}$ signal will set the C1 Register and reset the $X > 10^7$ and Restore X Registers. Gate inputs IC9B9, IC10B9, IC10A3, 5 and signal C1 will become LOW, and gate inputs IC9A5 and IC10B11 will become HIGH.

The PRESCALE signal will he *HIGH until* the second rising Fx transition, so gate input IC7D13 will be HIGII, and output IC7D11 will he LOW. Signal $\overline{X + X}$, IC7A1, and IC4A1 will all become LOW. The LOW reset input to the C2 register will cause IC9B10, IC9A4, and signal C2 to become LOW, and IC10B10, IC10A4, and signal $\overline{C2}$ to become HIGH.

The Fy (or Fy/6) clock pulses are divided by 16 in IC1 to produce a 625 kHz (or 625/6 kHz) internal computer clock. Ten pulses make up the subcyclc for arithmetic operations: 8 shift pulses, C9, and C10. The 1st through 8th 625 kHz clock pulses produce 8 $\overline{SHIFT\ X}$ pulses (HIGH to LOW) at IC9C12, which shift the contents of A4 into A5. Input IC10C1 is LOW during this process, so no $\overline{SHIFT\ Y}$ pulses will occur. Alter the 8th $\overline{SHIFTX}$ pulse has occurred, the Za output of the 10-state Counter IC2(15) will go LOW. The LOW input at IC3B6 will disable IC9C, terminating $\overline{SHIFT\ X}$ pulses. The LOW input IC6D12, 13 produces a HIGH at IC6D11, which sets the C2 Register to Q =H, $\overline{Q}$ = L; C2 will go NIGEI, and $\overline{C2}$ will go LOW. At the 9th 625 kHz clock pulse, a C9 = HIGH pulse will occur, If a carry was produced by the *first* Xc + Y operation ($\overline{K}$ = LOW), the C1 Register would change statc to Q = L, $\overline{Q}$ = H, and C1 would go HIGH. When the tenth 625 kHz clock pulse occurs, the Za output of IC2 (pin 15) will become LOW and $\overline{C10}$ = LOW and DISPLAY = HIGH pulses will occur. If the $X > 10^7$ signal is HIGH, the $X > 10^7$ Register will change states lo Q = L, $\overline{Q}$ = H. If a carry pulse was not present at the C9 time, no DISPLAY pulse will occur, but a $\overline{COUNT\ Z}$ = LOW pulse will occur instead, The $\overline{C10}$ trailing edge (LOW to HIGH) will cause the Restore X Register to change statc ($\overline{Q}$ = L), which enables IC10C, allowing $\overline{SHIFT\ Y}$ pulses to occur during the next subcyclc.

Figure 8-8
A6 Y-REGISTER ASSY
(See Page 8-15)

In normal operation, the sequence of arithmetic operations is X + X, Xc + Y, X + Y. The X + Y operation is repeated until a carry signal ($\overline{K}$ = LOW occurs. Each time the X + Y operation is completed without a carry signal a $\overline{COUNT\ Z}$ = LOW pulse will be generated by IC9A coincident with the C9 pulse, When $\overline{K}$ = LOW, a DISPLAY pulse will he generated instead of $\overline{COUNT\ Z}$. The $\overline{K}$ = LOW signal also changes C1 to HIGH which causes the next operation to be Xc + Y (restore remainder). *After* the remainder bas been restored the contents of the X-Register will be multiplied by 10 and the next display digit will be determined. The restored remainder can be multiplied by 10 either by eliminating the 8th $\overline{SHIFT\ X}$ pulse or sopplying only one long $\overline{SHIFT\ Y}$ pulse. The method used will depend on the statc of the $X > 10^7$ signal, If the contents of the X-Register are $> 10^7$, the 8th $\overline{SHIFTX}$ pulse cannot be eliminated or the MSD would be lost.

Therefore, $X > 10^7$ = HIGH will set the $X > 10^7$ Register to Q = H, $\overline{Q}$ = L, and the previous carry pulse will reset the C1 Register to Q = L, $\overline{Q}$ = H. The 1st 625 kHz clock pulse will cause $\overline{SHIFT\ Y}$ to go LOW. $\overline{SHIFT\ Y}$ will remain low until the 8th clock pulse when IC2(16) will go LOW, disabling IC10C. If the contents of the X-Register are $< 10^7$, the $X > 10^7$ signal will remain LOW, and tile $X > 10^7$ Register will remain at Q = L, $\overline{Q}$ = H. The previous carry pulse will reset the C1 Register to Q = L, $\overline{Q}$ = H and the C2 Register to Q = L, $\overline{Q}$ = H. When the D output of IC2(16) goes LOW at the end of the 7th $\overline{SHIFT\ X}$ pulse, gate input IC9C1 will go LOW, and $\overline{SHIFT\ X}$ will remain HIGH (no 8th $\overline{SHIFT\ X}$ pulse generated). Only 7 $\overline{SHIFT\ X}$ pulses will be generated.

When a single-cycle of Fx is measured (one $\overline{COUNT}$ Xpulse), the PRESCALE signalwill be LOW, so $\overline{X + X}$ will be HIGH during the 1st 8 $\overline{SHIFT\ X}$ pulses. Recause X + X and $\overline{C2}$ are HIGH, and C1 is LOW, the Xc + Y operation is the first one utilized by A5. In other words, Fx was not divided by two in A3; *therefore*, Fx was not multiplied by two during the Compute cycle. Instead, the division process is immediately initiated.

When the CLEAR DISPLAY signal goes HIGH, IC1 and IC2 will be enabled along with ICGA. DISPLAY pulses will be produced to clear the Display.

A7 TROUBLESHOOTING

Check the +5 Vdc at pin 15, S. Check the $\overline{R}$, $\overline{ARM}$ and CLEAR DISPLAY waveforms; using the Logic Probe, verify that the output signal states ere as shown in Table 8-3 after reset and arming. Check the DISPLAY and $\overline{COUNT\ Z}$ waveforms with the MODE switch set to CHECK and MEASUREMENT TIME to .01. Check the other output waveforms. If reset and arming occur properly, but one or more output signals arc incorrect, check the $\overline{K}$, $X > 10^7$, and PRESCALE signals. If no output signals occur, check the CLOCK input and ÷ 16 and Zd *outputs from IC1; then, check* the Za, Zb, Zc, Zd outputs from the 10-state Counter. This procedure should isolate the trouble to the defective gate element, register, or counter.

COUNTER SETTINGS

MODE	CHECK
MEASUREMENT TIME	.01
TIME BASE	INT
Hz/RPM	Hz
BLANKING	ON

All waveforms taken with HP *180A* Oscilloscope, *HP* 1801A Vertical Plug-in, HP 1821A Time Base Plug-in, HP 10004A 10:1 Divider Probe. Center line of graticule is zero volts.

WAVEFORM NO.	Oscilloscope Settings				
	SENS V/CM	AC	DC	SLOPE + −	SWEEP /CM
1	.2		x	x	.1 ms
2	.2		x	x	.5 μs
3	.2		x	x	2 μs
4-Upper	.2(1)		x	x	50 μs
4-Lower	.2(1)		x	x	.2 μs
5	.2		x	x	.2 μs

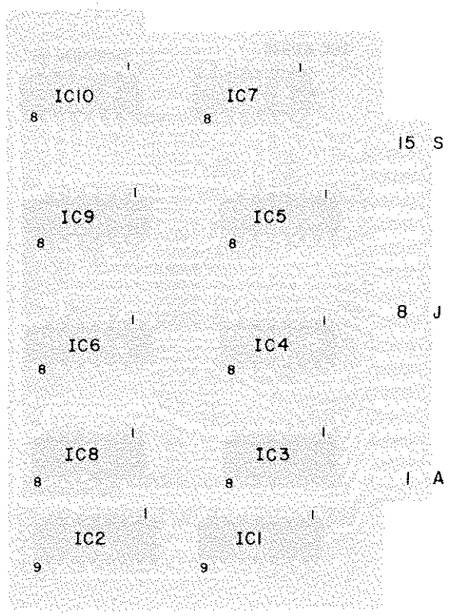
(1) Baseline of each trace corresponds to zero volts dc.

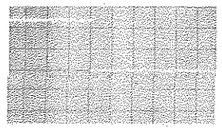
Table 8-3. A7 Output Signal States at End of Reset and Arming

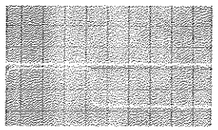
SIGNAL	A7 PIN	STATE (POSITIVE LOGIC)
$\overline{X + X}$	H	LOW
$\overline{C10}$	5	HIGH
C9	3	
DISPLAY	8	
$\overline{COUNT\ Z}$	12	HIGH
C2	9	
C1	E	
$\overline{SHIFT\ X}$	10	HIGH
$\overline{SHIFT\ Y}$	14	HIGII
C	4	LOW
$\overline{C2}$	7	HIGH

02841-1

02841-1







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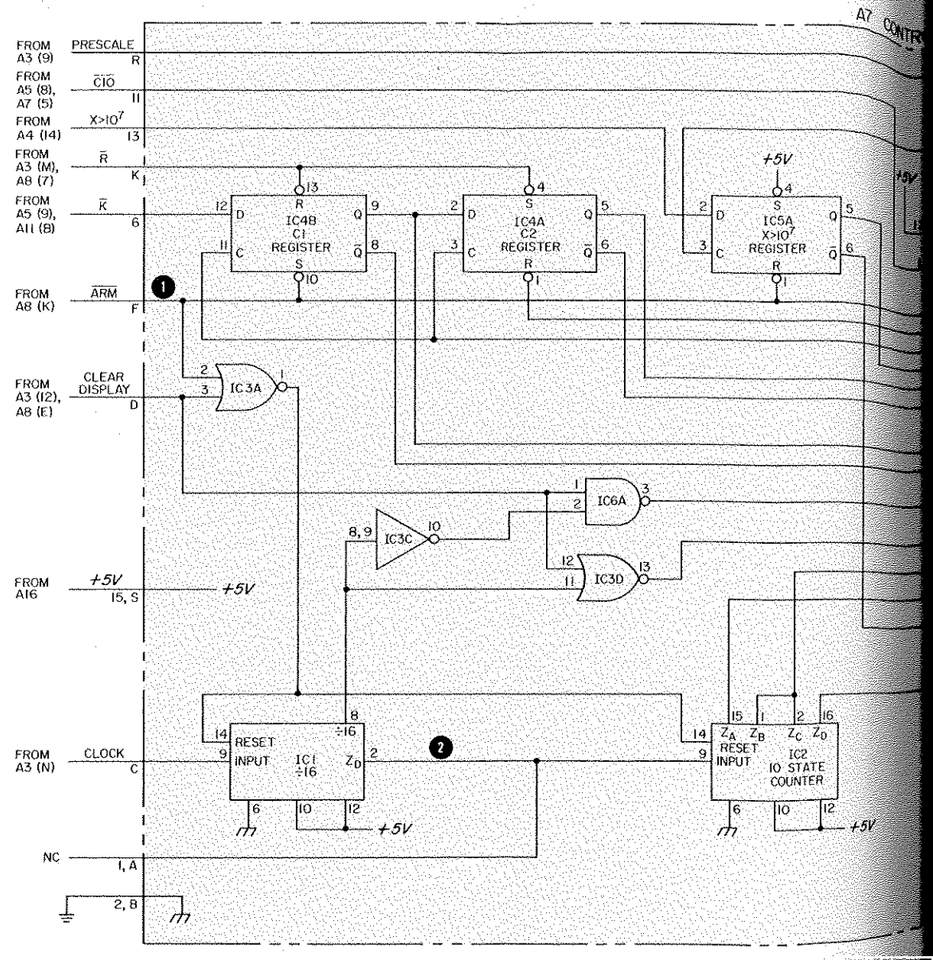
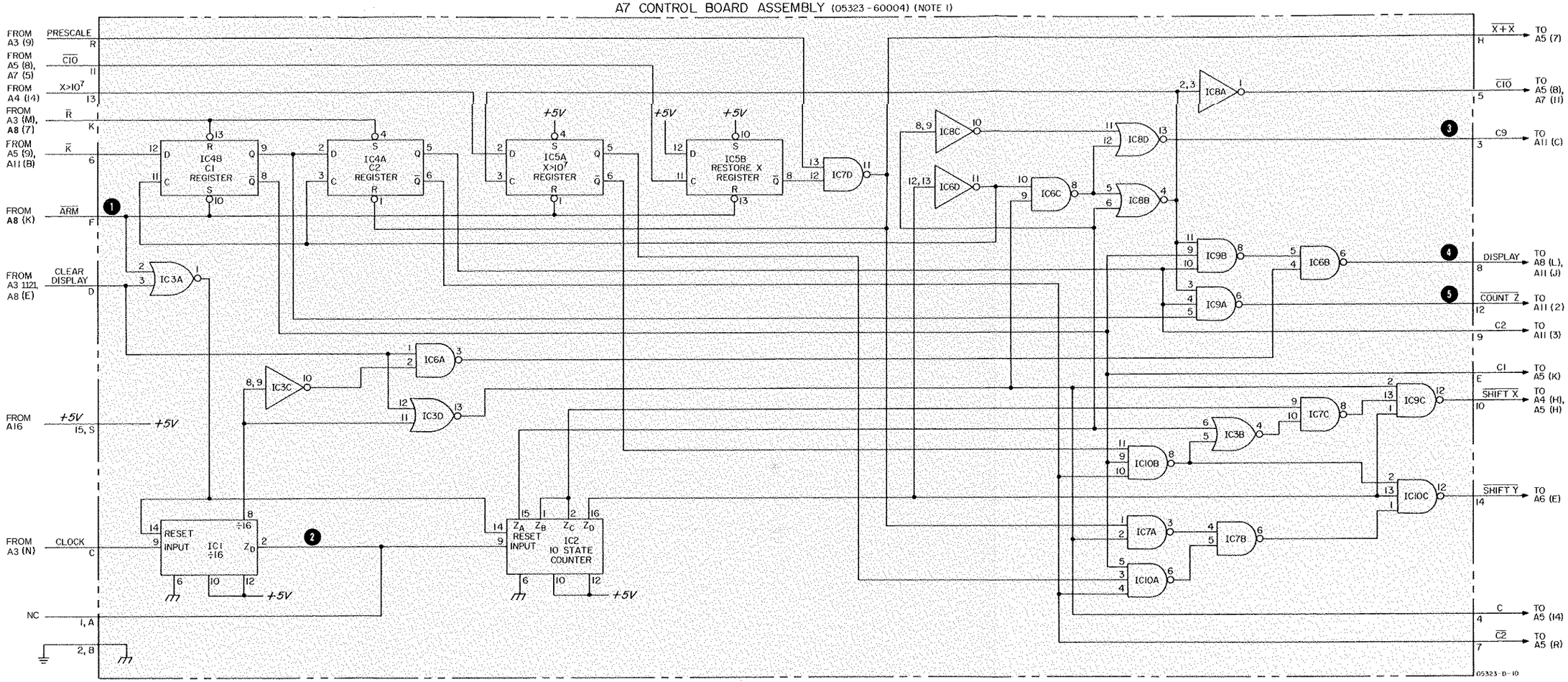


NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED ADO ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION



NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.

TABLE

REFERENCE DESIGNATIONS	HP PART NUMBER
IC1	1820-0209
2	1820-0119
3,8	1820-0328
4,5	1820-0077
6,7	1820-0054
9,10	1820-0068

REFERENCE DESIGNATIONS

A7
IC1-10

Figure 8-9. A7 Control Board Assy

A8 OPERATION

At the start of the Gate cycle, the $\overline{\text{GATE}}$ signal will go LOW which resets the D-Register to D = 15 (outputs are LLLL). At the end of the Gate cycle, the GATE signal will go HIGH which resets the D-Register to D = 0 (outputs are HHHH). At D = 0 the MSD signal goes HIGH, which allows transfer of the MSD to the Display as soon as a DISPLAY pulse occurs. Each time a COUNT D pulse occurs, the D-Register will be advanced, and a new transfer pulse will occur. D = 7 is a blank state. At D = 8, the $\overline{\text{R}}$ signal will go LOW, which resets all registers. Also, at D = 8, the ÷ 10 output from the D-Register, IC1(8), will go LOW. The $\overline{\text{PRINT}}$ = LOW signal enables a Digital Recorder, if used. At D = 9, the ARM signal will go LOW, which rearms the counter for the next Gate cycle.

When the BLANKING switch is ON and reset occurs, the first zero is displayed and the other Display positions are blanked. This process is accomplished by IC8D and the Blanking flip/flop (IC5A and IC9B) when the CLEAR DISPLAY signal goes HIGH at IC8D13. The Compute cycle starts, and the MSD is transferred to the Display at D = 0. When D = 1, the $\overline{\text{T2}}$ signal goes LOW, and the IC8D12 input becomes HIGH. Output IC8D11 now goes LOW which makes $\overline{\text{BLANK Z}}$ go LOW. Even though a transfer pulse was generated for the second Display digit, the blanking signal causes a blank-digit display. As the $\overline{\text{T3}}$ through $\overline{\text{T7}}$ transfer pulses are generated, blanking of the third through seventh Display digits will also occur.

Automatic blanking of the sixth and/or seventh Display digits will occur when Counter resolution limits are exceeded, if the BLANKING switch in ON. Gate IC9C controls the Blanking flip/flop for sixth digit transfer; gates IC8B and IC8C control the Blanking flip/flop for seventh digit transfer. Table 8-4 shows the gate input/output relationships and $\overline{\text{BLANK Z}}$ level at T6 and T7. Operation of the Blanking flip/flop may be inhibited by setting S4 (BLANKING) to OFF, which makes $\overline{\text{BLANK Z}}$ always HIGH. In this case, the Display may indicate false resolution in the sixth and seventh digits, if the selected measurement time is too short. Refer to Section III for resolution vs. measurement time considerations.

A8 TROUBLESHOOTING

Check the +5 Vdc at pin 15, S. Check the $\overline{\text{GATE}}$, COUNT D and DISPLAY waveforms. Examine the Za, Zb, Zc, Zd outputs from the D Register; the Za waveform should show D = 0 through D = 9 (or D = 15) levels. Check the MSD, $\overline{\text{T2}}$, $\overline{\text{T3}}$, $\overline{\text{T4}}$, $\overline{\text{T5}}$, $\overline{\text{T6}}$ and $\overline{\text{T7}}$ transfer pulse waveforms; all pulses should be similar, except for $\overline{\text{T4}}$ which is a long pulse (approximately 50 μsec). If any transfer pulses are missing, check the gates between the D-Register and the signal output with the Logic Probe. Check the $\overline{\text{R}}$, $\overline{\text{ARM}}$, and ARM waveforms with an oscilloscope. If any of these signals are missing, use the Logic Probe to isolate the defective gate element.

If the blanking feature does not operate in accordance with Table 8-4, check the levels of the RPM, MSD < 2, .2, .1, .04, .01, and BLANKING signals with the Logic Probe while operating the Hz/RPM, MEASUREMENT TIME, and BLANKING switches. $\overline{\text{BLANK Z}}$ can be checked with the oscilloscope, and the Logic Probe can be used to isolate a defective gate element in the Blanking Logic or a defective Blanking flip/flop.

COUNTER SETTINGS

MODE	CHECK
MEASUREMENT TIME	.01
TIME BASE	INT
Hz/RPM	Hz
BLANKING	ON

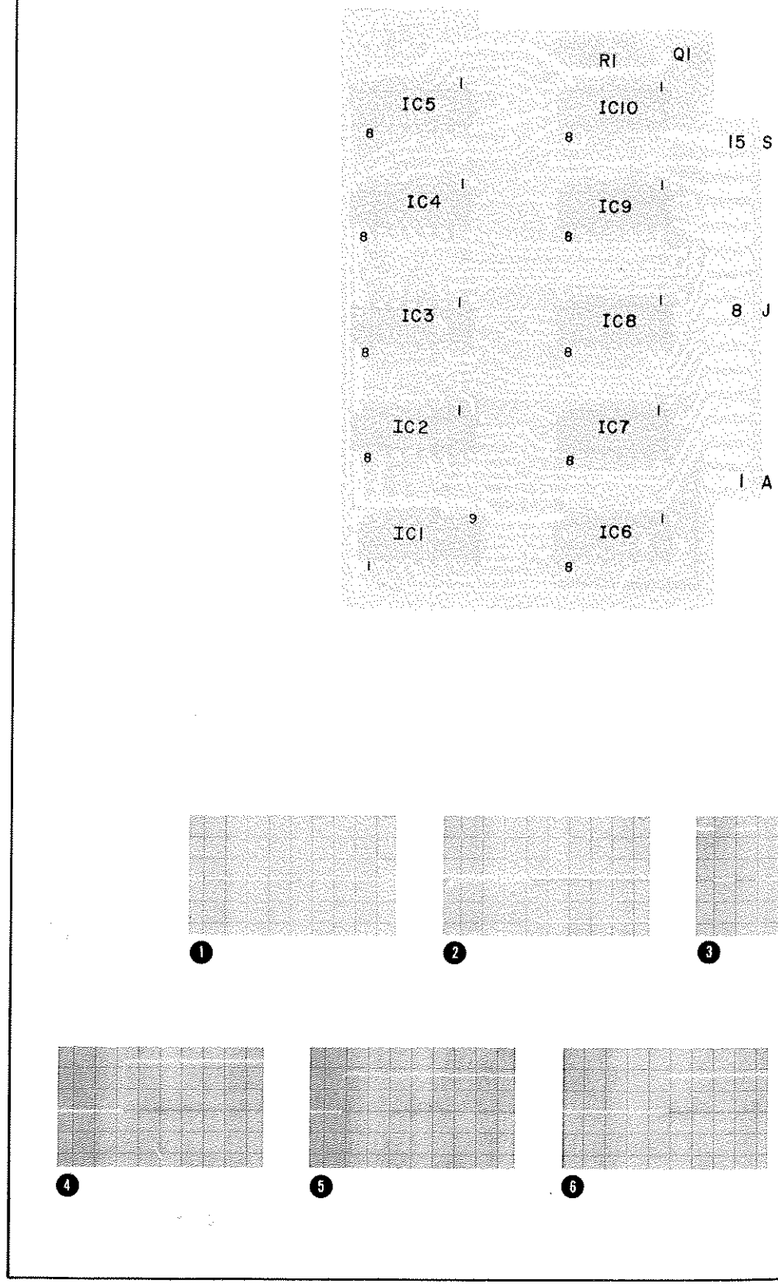
All waveforms taken with HP 180A Oscilloscope, HP 1801A Vertical Plug-in, HP 1821A Time Base Plug-in, HP 10004A 10:1 Divider Probe. Center line of graticule is zero volts.

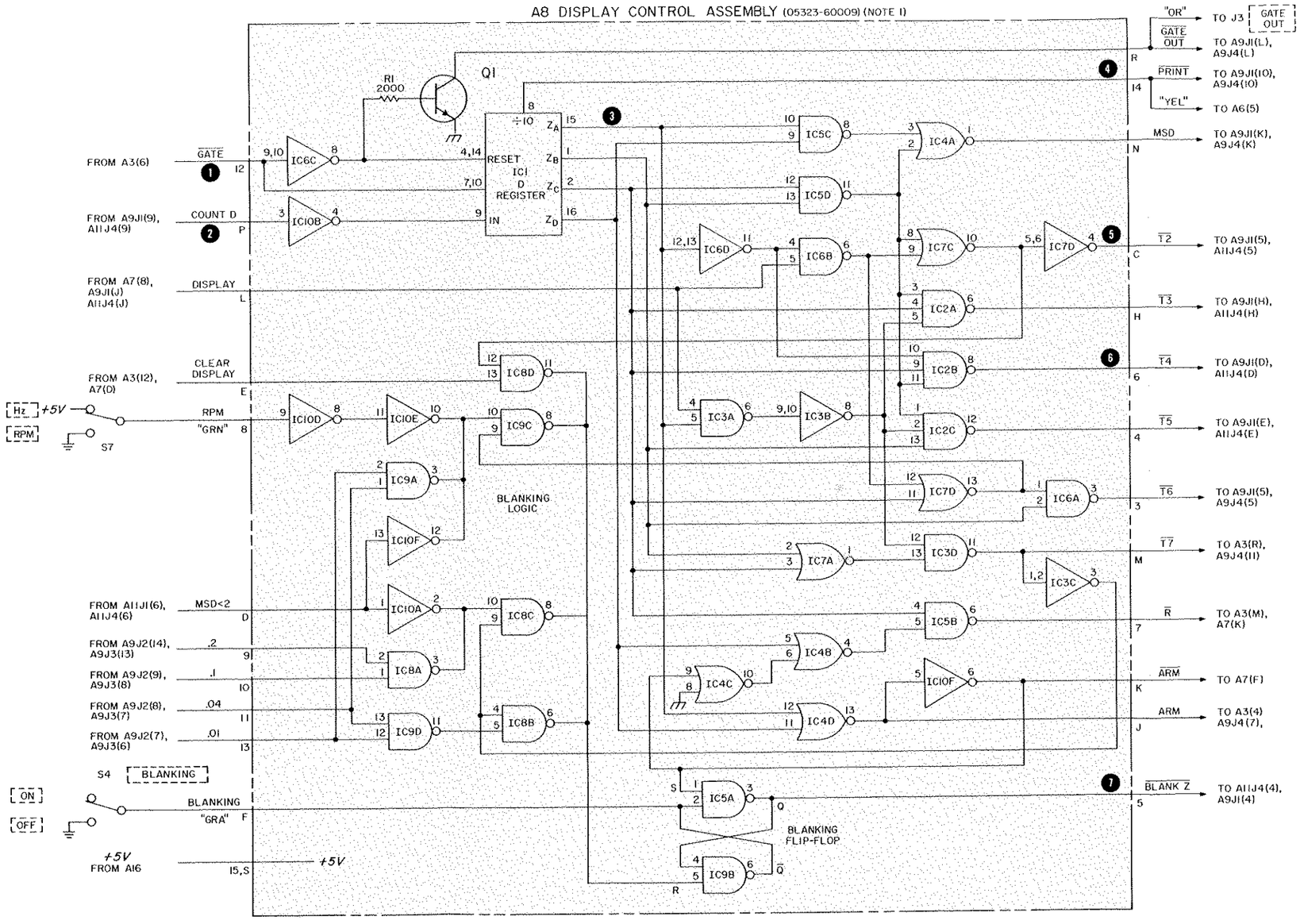
WAVEFORM NO.	Oscilloscope Settings				
	SENS V/CM	AC	DC	SLOPE + -	SWEEP /CM
1	.2		x	x	2 ms
2-Upper	.2(1)		x	x	50 μs
2-Lower	.2(1)		x	x	.2 μs
3	.2		x	x	50 μs
4	.2		x	x	5 μs
5	.2		x	x	.5 μs
6	.2		x	x	10 μs
7	.2		x	x	20 μs

(1) Baseline of each trace corresponds to zero volts dc.

Table 8-4. $\overline{\text{BLANK Z}}$ Level at D = 5 and D = 6

MEASUREMENT TIME	S7 = Hz				S7 = RPM			
	MSD < 2 = HIGH		MSD < 2 = LOW		MSD < 2 = HIGH		MSD < 2 = LOW	
.2 = LOW	HIGH	HIGH	HIGH	LOW	HIGH	HIGH	HIGH	LOW
.1 = LOW	HIGH	HIGH	HIGH	LOW	HIGH	HIGH	HIGH	LOW
.04 = LOW	HIGH	LOW	LOW	LOW	HIGH	LOW	HIGH	LOW
.01 = LOW	HIGH	LOW	LOW	LOW	HIGH	LOW	HIGH	LOW
	D = 5	D = 6	D = 5	D = 6	D = 5	D = 6	D = 5	D = 6





NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY [illegible] FOR COMPLETE DESCRIPTION.
2. UNLESS [illegible] INDICATED:

TABLE

REFERENCE DESIGNATIONS	HP PART NUMBERS
IC1	1820-0119
2	1820-0068
3,5,6	1820-0054
4,7	1820-0328
8,9	1820-0094
10	1820-0307
Q1	1854-0071

REFERENCE DESIGNATIONS

NO PREFIX	A8
	IC1-10
	Q1
	R1
S4,7	

05323-D-11

Figure 8-10. A8 Display Control Board Assy

AS OPERATION

The A9 Connector Board Assembly serves as an interface and test board for the Counter. Interboard connections are made between connectors XA2-XA8 and XA17 (±12V Supply). Connector J1 is a test connector with criticalsignals available at its pins. Connector J2 is connected by a wiring harness directly to J6, REMOTE PROGRAM connector. Connector J3, push-on connectors, and iiard-wiring are used to connect to other points within the Counter. Connector J4 is a pressure connection to A11.

L1 through L8 are decoupling chokes. C1, R1, and CR1 are used to supply a reset pulse to A3 when the Counter is turned on.

A9 TROUBLESHOOTING

Troubles in A9 can be determined by checking waveforms or logic levels at the inputs and outputs of the Counter PC boards. When power or a signal is absent at its normal destination, the Logic Probe, DC Voltmeter, or Oscilloscope can be used to locate the fault. If any of the chokes (L1-L8) are open, voltage will be absent as shown in Table 8-5. The oscilloscope can be used lo check lor cxccssive ripple or noise, which would indicate a shorted choke. Check the MANUAL RESET line waveform if the Counter fails to reset when ac power is applied.

COUNTER SETTINGS

AC POWER. . . . . OFF-ON-OFF
MODE . . . . . CHECK
MEASUREMENTTIME. 01
TIME BASE . . . . . INT

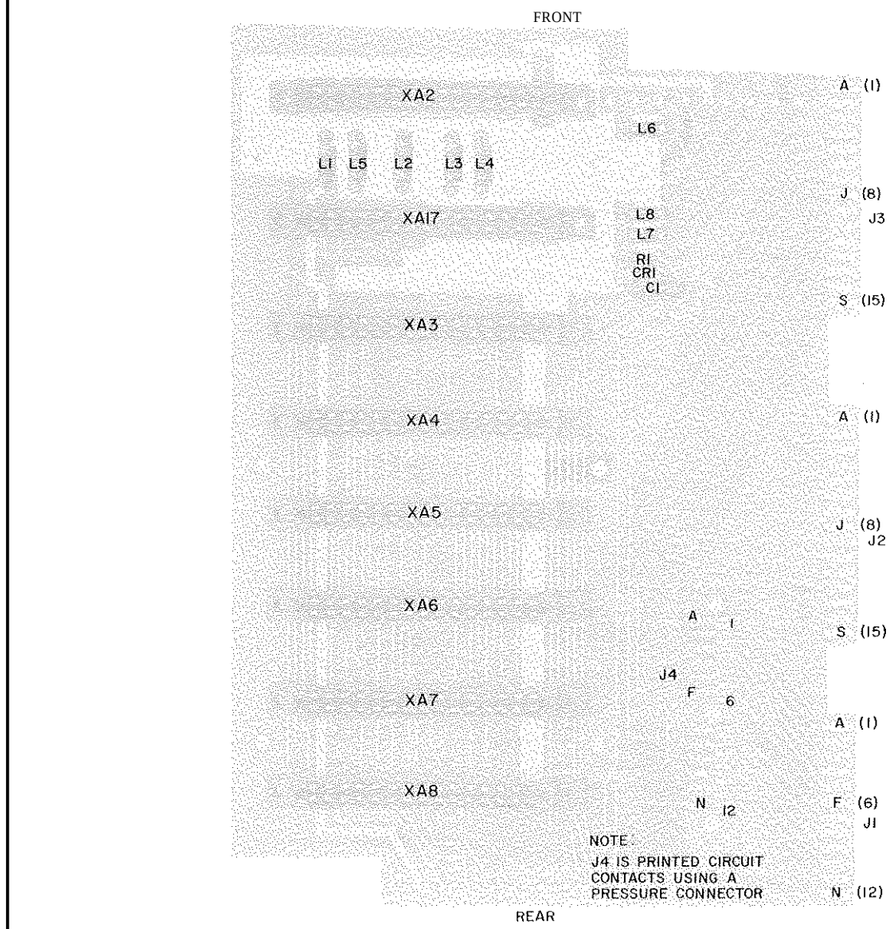
All waveforms taken with HP 180A Oscilloscope, HP 1801A Vertical Plug-in, HP 1821A Time base plug-in, HP 10004A 10:1 Divider Probe. Center line of graticule is zero volts.

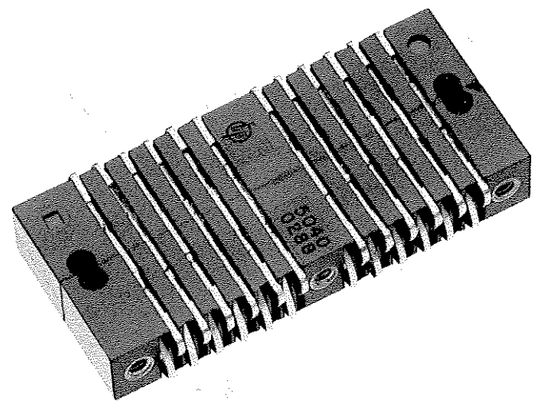
WAVEFORM NO.	Oscilloscope Settings				
	SENS V/CM	AC	DC	SLOPE + -	SWEEP /CM
1	.2		x	x	.2 sec

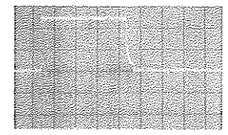
Table 8-5. Open Choke Symptoms

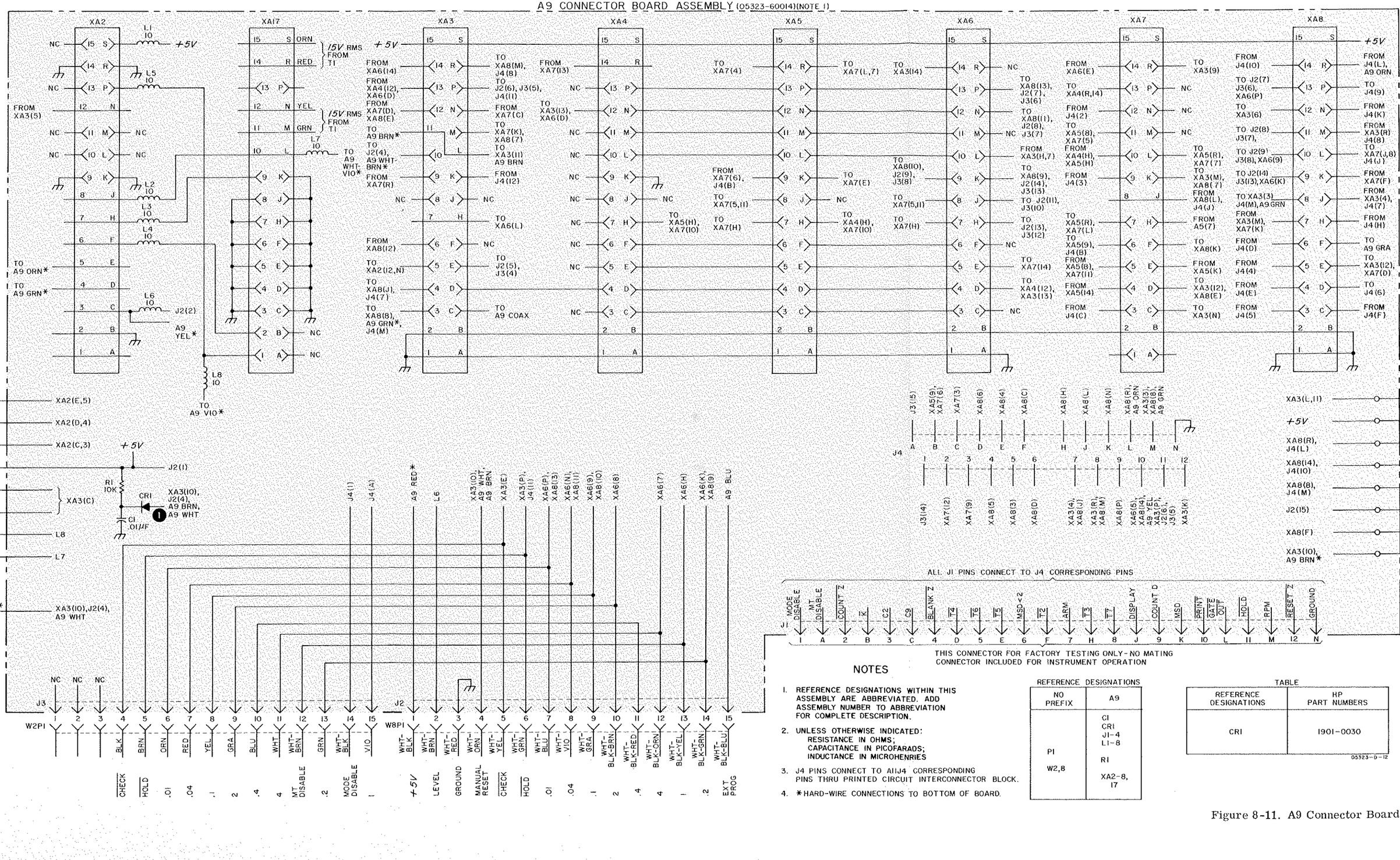
OPEN CHOKE	POWER ABSENT	
	VOLTAGE	LOCATION
L1	+5	
L2	+12	A2(8, J)
L3	+12	A2(7, H)
L4	-12	A2(6, F)
L5	-12	A2(P)
L6	LEVEL	A2(3, C)
L7	+12	A15(WHT-VIO) and TP(1)
L8	-12	A15(VIO)

(1) +12V Test Point (TP) located between A15 and J7.









NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.
2. UNLESS OTHERWISE INDICATED:
   RESISTANCE IN OHMS;
   CAPACITANCE IN PICOFARADS;
   INDUCTANCE IN MICROHENRIES
3. J4 PINS CONNECT TO A11J4 CORRESPONDING PINS THRU PRINTED CIRCUIT INTERCONNECTOR BLOCK.
4. *HARD-WIRE CONNECTIONS TO BOTTOM OF BOARD.

REFERENCE DESIGNATIONS

NO PREFIX	A9
P1	C1 CR1 J1-4 L1-8
W2,8	R1
	XA2-8, 17

TABLE

REFERENCE DESIGNATIONS	HP PART NUMBERS
CR1	1901-0030

05323-D-12

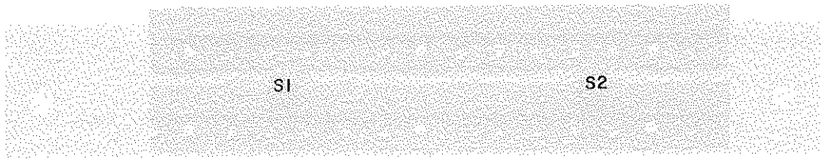
Figure 8-11. A9 Connector Board Assy

A10 OPERATION

When the EXT PROG signal from J6, REMOTE PROGRAM connector is HIGH (no connection) the MODE DISABLE and MT DISABLE signals from A11 will be LOW. This makes the wipers of the MODE switch (S1) and MEASUREMENT TIME switch (S2) LOW. As the switch position is varied, a LOW will appear at the selected contact. When the EXT PROG signal is LOW, S1 and S2 will be disabled, allowing their functions to be remotely programmed through JG, REMOTE PROGRAM conneclor.

A10 TROUBLESHOOTING

Use tlie Logic Probe to verify that tlie MODE DISABLE and MT DISABLE signals are both LOW with no connection to J6(15), EXT PROG. Ground EXT PROG, J6(15), and check to see that both signals are now HIGH. If tile above tests fail, trace the signals through A9 and A11 to JG with the Logic Probe. Check the switch outputs with the Logic Probe while operating S1 and S2. Make sure that only one output from S1 and one output from S2 are LOW at any time, when J6 is not in use (additional LOW levels indicate shorted gates or wiring).



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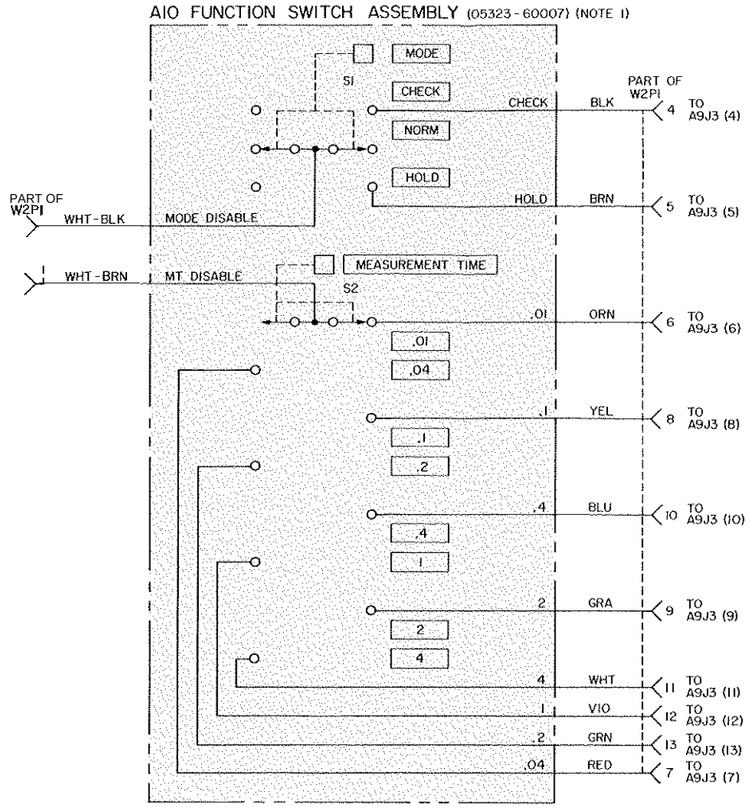
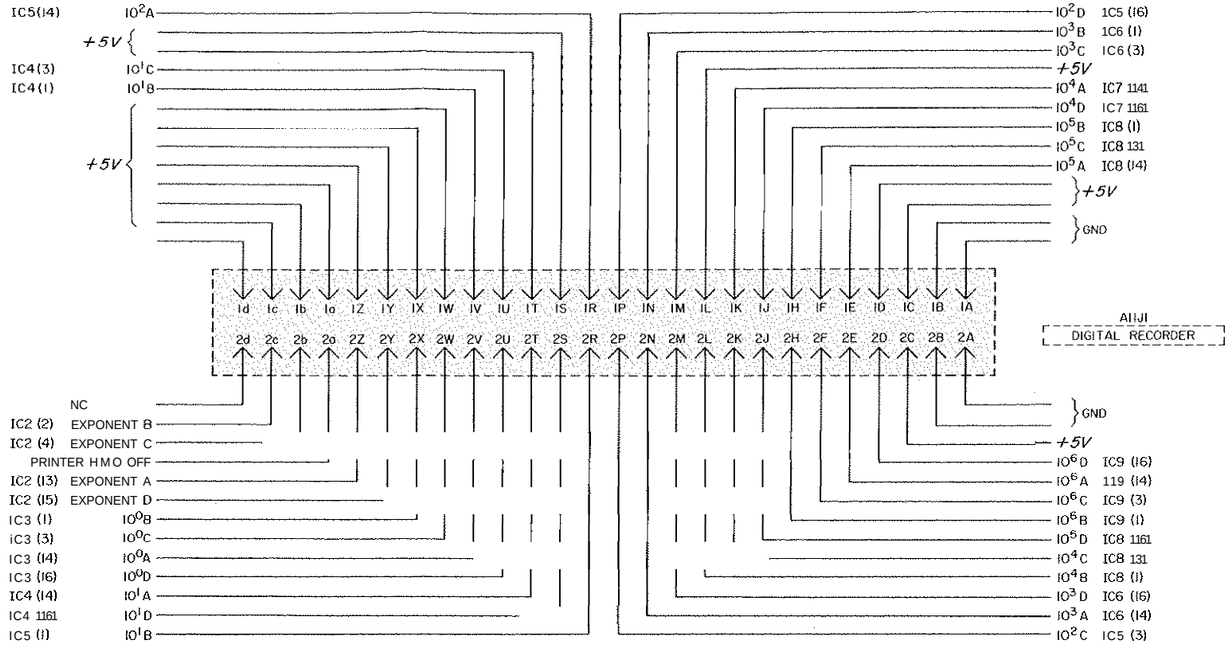


NOTES

1. REFERENCE DESIGNATIONS **WITHIN THIS** ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY **NUMBER** TO ABBREVIATION FOR **COMPLETE** DESCRIPTION

REFERENCE DESIGNATIONS

NO PREFIX	A10
P1 W2	S1,2



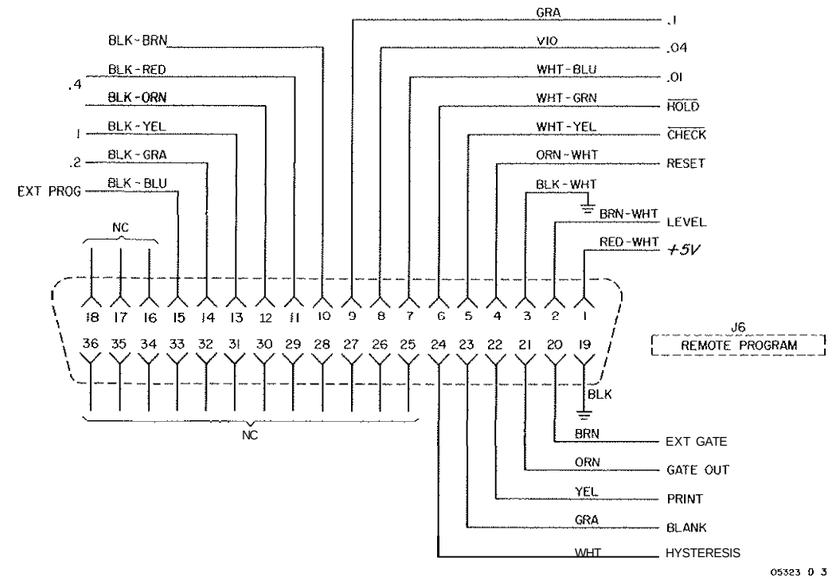


Figure 8-12. A10 Function Switch Board Assembly
J6, Remote Program Connector
A11J1, Digital Recorder Connector

Each time the Xc + Y and X + Y operations are performed during the Compute cycle, either a DISPLAY or $\overline{\text{COUNT Z}}$ pulse will be produced by A7. DISPLAY will be HIGH if a carry occurs, and $\overline{\text{COUNT Z}}$ will be LOW each time a carry docs not occur. The initial DISPLAY pulses determine the decimal point location (exponent) and measurement unit that are displayed. If the first Xc + Y operation produces a carry pulse ($\overline{K}$ = LOW) a DISPLAY pulse will appear at IC16B10. No $\overline{\text{COUNT Z}}$ pulse was generated, so the Q output of the Range Detector is still HIGH, and IC16B9 will be HIGH. The IC16B8 output and the Down input to tlre E-Register will also become LOW. The preset inputs to the E-Register determine the initiai stale of the register count. If the Hz/RPM switch, S7, is set to Hz, Ia, Ib, and Ic will be LOW, and Id will be HIGH. This will set the initial count to E = 7. If S7 is set to RPM, Ia, Ib, and Ic will be BIGII, and Id will be LOW. This will set the inilial count to E = 8, which corresponds Io a X10 operation (the clock frequency was also divided by G, which results in a X60 operation for RPM).

The first DISPLAY pulse causes the E-Register to change to E = G. The second DISPLAY pulse would make E = 5, etc., until a $\overline{K}$ = LOW signal fails lo occur. Therefore, the E-Register stores the number of times that a carry pulse was generated until a $\overline{\text{COUNT Z}}$ pulse occurs (successful subtraction). Each time an initial carry pulse occurs during the Xc + Y operation, the X-Register contents are multiplied by 10, and Xc + Y is tried again. The E-Register is actually counting the number of times that the X10 operation occurs before a successful subtraction (X + Y) occurs. Notice that no COUNT D pulses are generated even though DISPLAY pulses are occurring, because IC16D13 is LOW at this time.

When tlic first $\overline{\text{COUNT Z}}$ pulse occurs the Range Detector will be reset to Q = L, $\overline{Q}$ = H. The Q = LOW appears at IC16B9 to disable the Down input to the E-Register. The Z-Register (IC18) will advance to Z = 1. Each time a $\overline{\text{COUNT Z}}$ pulse occurs, Z will advance by one count. When a carry finally occurs, a DISPLAY pulse will bc produced at IC16A5 and IC16D12. The HIGH input to IC16D12 will cause a COUNT D pulse to occur, and the two HIGH inputs to IC16A produce a LOW G2 input lo IC9(5) which transfers the contents of the Z-Register to the Buffer Storage Register, IC8, and A12. The MSD has now been transferred to the Display, and the computer restores the remainder and performs a X10 operation. This sequence is repeated for the 2nd, 3rd, and 4th digits. When $\overline{T5}$ = LOW, the fifth digit is transferred to the Display, and tlie G1 input to the E-Buffer Storage Register goes LOW. The 4-bit BCD exponent information will now be transferred from IC12 (15, 16, 1, 2) to IC14 (14, 1, 3, 16). The IC14 outputs appear as inputs to the Exponent/Measurement Unit Decode Logic, consisting of part of IC1, IC2, IC10, and IC11 and transistors Q1, Q2, and Q3. The Decode Logic outputs are as shown in Table 8-6. The J2 outputs control the decimal point location via A12. For E = 5, 4, or 3, the J2 outputs are different as a function of the S7 position; this difference is caused by the ÷ GO operation, which can shift the decimal point position. Notice that when E = 0, all inputs to IC15B will be HIGH, and a LOW will appear at IC15B8 aid IC19C9, which resets the Range Detector to Q = L, $\overline{Q}$ = H. This inhibits IC16B, disabling the E-Register and allowing the remaining digits to be displayed even if they are zeros.

At $\overline{T6}$ =LOW, the sixth digit will be transferred from the Z-Register via IC4 to A12. At $\overline{T7}$ = LOW, the seventh digit will be transferred, and a HIGH will appear at IC12(6), the preset input, which presets the E-Register to E = 8 or E = 7.

The Z =Register is reset to Z = 0 after each digit has been calculated. The reset is accomplished by gates IC21A and IC22D. When a carry occurs during the compute cycle, the remainder is restored, and a X10 operation is iniliated by C2 = LOW. This CZ = LOW signal appears at IC19D12, causing IC19D11 to go HIGH. The blanking conditions have been previously described as part of A8. When a $\overline{\text{BLANK Z}}$ = LOW signal occurs, one input Io gates IC13(A, 33, C, D) will go LOW. This presents a blank state (binary 15) to the Buffer Storage Registers (IC3-IC9).

If the HYSTERESIS switch, S5, is OFF, input IC21B10 will be LOW, which makes IC21B8 always HIGH. Gate IC16C will be enabled, allowing gating of COUNT D pulses, and the Up input to the E-Register will be disabled. By setting S5 to ON, input IC21B10 will be HIGH. When the other inputs to IC21B are HIGH, IC21B8 will go LOW. Input IC21B9 will be HIGH when Z = 8 or 9, $\overline{K}$ = HIGH (no carry pulse), and C9 = HIGH. IC21B12 mill be HIGH if MSD = HIGH. IC21B13 will be IIIGII if tlie $\overline{Q}$ output of the MSD < 2 Memory is HIGH, which occurs only when Z = 1 or Blank (MSD < 2). Suppose that the MSD changes from 1 to 9 (which might cause the Display and measurement unit to change if hysteresis was not used). Before the MSD < 2 Memory can change state, its $\overline{Q}$ output will be HIGH. A LOW output at IC21B8 will occur which produces an extra COUNT D pulse (setting D = 1 in the Display Register) and an Up input pulse to the E-Register. The first digit of the Display will remain blanked. The first digit of F (9) will be loaded at $\overline{T2}$ = LOW into tlie seconcl Display position. The change in exponent shifts the decimal point to mainlain the correct measurement unit and decimal point.

The $\overline{\text{HOLD}}$ signal will be HIGH until Q5 conducts, which causes $\overline{\text{HOLD}}$ = LOW. Q5 will conduct when J1-2(a) goes IIIGH, which prevents the Display from changing while the Digital Recorder is printing the data (HOLD-OFF VOLTAGE).

The $\overline{\text{PRINT}}$ signal will go LOW when D = 8. It is available at J1-1(d) for a Digital Recorder (PRINT COMMAND). Two gates (IC11C and IC11A) are used as inverters lor the EXT PROG signal to supply the MODE DISABLE and MT DISABLE signals to A10.

Check the +5 Vdc at the red push-on connector. Use the oscilloscope to check transfer, DISPLAY, $\overline{\text{COUNT Z}}$, $\overline{K}$, C9, ARM, COUNT D and $\overline{\text{RESET Z}}$ waveforms. If the exponent or measurement unit displayed is incorrect, use the Logic Probe with Table 8-6 to check the E-Hegistcr, E-Buffer Storage Register, signal $\overline{\text{RPM}}$ and the Decimal/Measurement Unit Decode Logic. Observe the waveforms of the Za output of the E-Register and reset input of the Range Detector.

To check the operation of the Z-Register and Buffer Storage Registers, connect a clip lead between the bare test point (located between IC15 and IC19, top of A11 board) and chassis ground. With the MEASUREMENT TIME set to 1, tlie Display should shift from 11.11111 MHz through 88.88888 MHz to 99.99990 MHz as long as the tcst point is grounded. Use the Logic Probe to isolate a defective Buffer Storage Register. The oscilloscope may be used lo monitor the input and gate waveforms for the Buffer Storage Register.

Incorrecl displayed digits may be caused by failure of the Z-Register to reset correctly. Observe the waveforms at the reset (test point may be used) ancl input pins of the Z-Register with the oscilloscope. Blanking operation may bc checked by observing the $\overline{\text{BLANK Z}}$ waveform and operation of the four blanking gates (IC13A-D). Check the operation of the hysteresis circuits by decreasing the input frequency so that the MSD changes from 1 to 9 and observe the waveforms at IC21B8 and IC12(15); also, check the MSD < 2 signal with the Logic Probe. The MSD < 2 Decode Logic inay be checked with tile oscilloscope or Logic Probe (test point grounded). If the $\overline{\text{ARMED}}$ or $\overline{\text{COUNTING}}$ signals do not occur, check the waveform of the GATE OUT signal (J3) and IC1B8. Operation of **Q4,** Q5, IC11A and IC11C may be checked with the Logic Probe. An erratic GATE OUT signal may be caused by an open COUNTING lamp.

If COUNT D pulses are not generaled correctly and the trouble is difficult to isolate, a dual-trace oscilloscope is helpful. Both inputs to a dual NAND or NOR gate may be monitored with the A and B inputs while the oscilloscope is externally triggered by the DISPLAY signal. This technique is also useful when troubleshooting a problem in the hysteresis circuits (MSD< 2 Decode Logic, MSD< 2 Memory, Hysteresis Gate) or display circuits (Z-Register, Range Detector, IC19D).

Fig

A10 FUNCTION SWITCH BOARD
J6, REMOTE PROGRAM CONN
A11J1, DIGITAL RECORDER CONN

(See P:

COUNTER SETTINGS

A. MODE . . . . . NORM
MEASUREMENTTIME 01
TIME BASE . . . . . INT
LEVEL . . . . . PRESET
ATTEN. X1
AC-DC. . . . . DC
Hz/RPM . . . . . Hz
BLANKING . . . . . ON
HYSTERESIS. . . . . ON
INPUT . . 10.2240 kHz, decrease io 9.9200 kHz

(Display should be X9.9200 kHz, where X = Blank digit.)

B. same as A, except:

HYSTERESIS. . . . . OFF

(Display should be 9.9200 kHz)

C. Same as A, except:

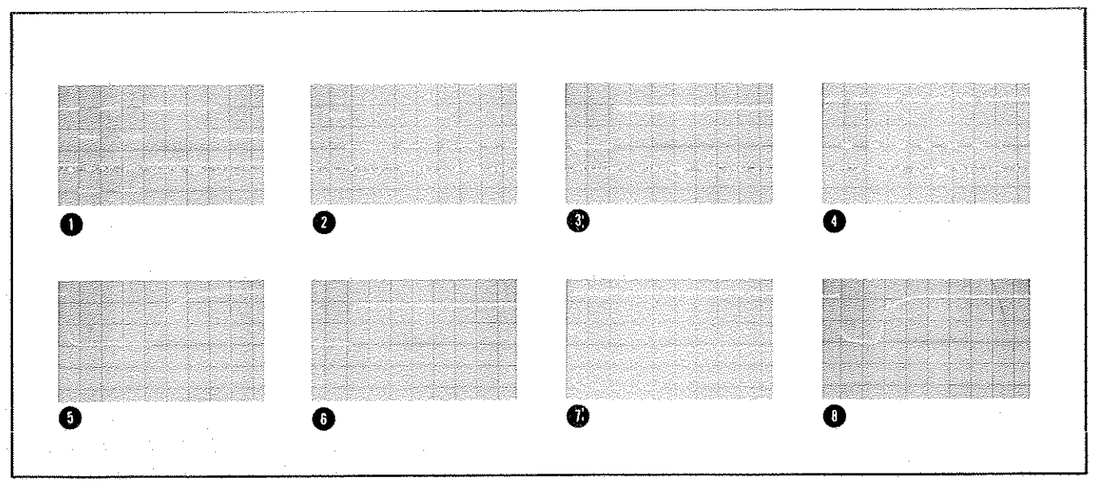
INPUT . . . . . 10.2240 kHz

D. MODE . . . . . CHECK
MEASUREMENTTIME 01
TIME BASE . . . . . INT

All waveforms taken with HP 180A Oscilloscope, HP 1801A Vertical Plug-in, HP 1821A Time Base Plug-in, HP 10004A 10:1 Divider Probe. Center line of graticule is zero volts.

WAVEFORM NO.	COUNTER SETTING	Oscilloscope Setting				
		SENS V/CM	AC	DC	SLOPE + -	SWEEP /CM
1-Upper	A	2(1)		x	x	50 μs
1-Lower	B	.2(1)		x	x	50 μs
2	C	.2		x	x	40 μs
3	D	.2		x	x	.4 μs
4	D	.2		x	x	40 μs
5	D	.2		x	x	.2 μs
6	A	.2		x	x	4 μs
1-Upper	A	.2(1)		x	x	4 μs
7-Lower	A	.2(1)		x	x	.2 μs
8	D	.2		x	x	1 μs

(1) Lower edge of traces corresponds to eero volts dc.



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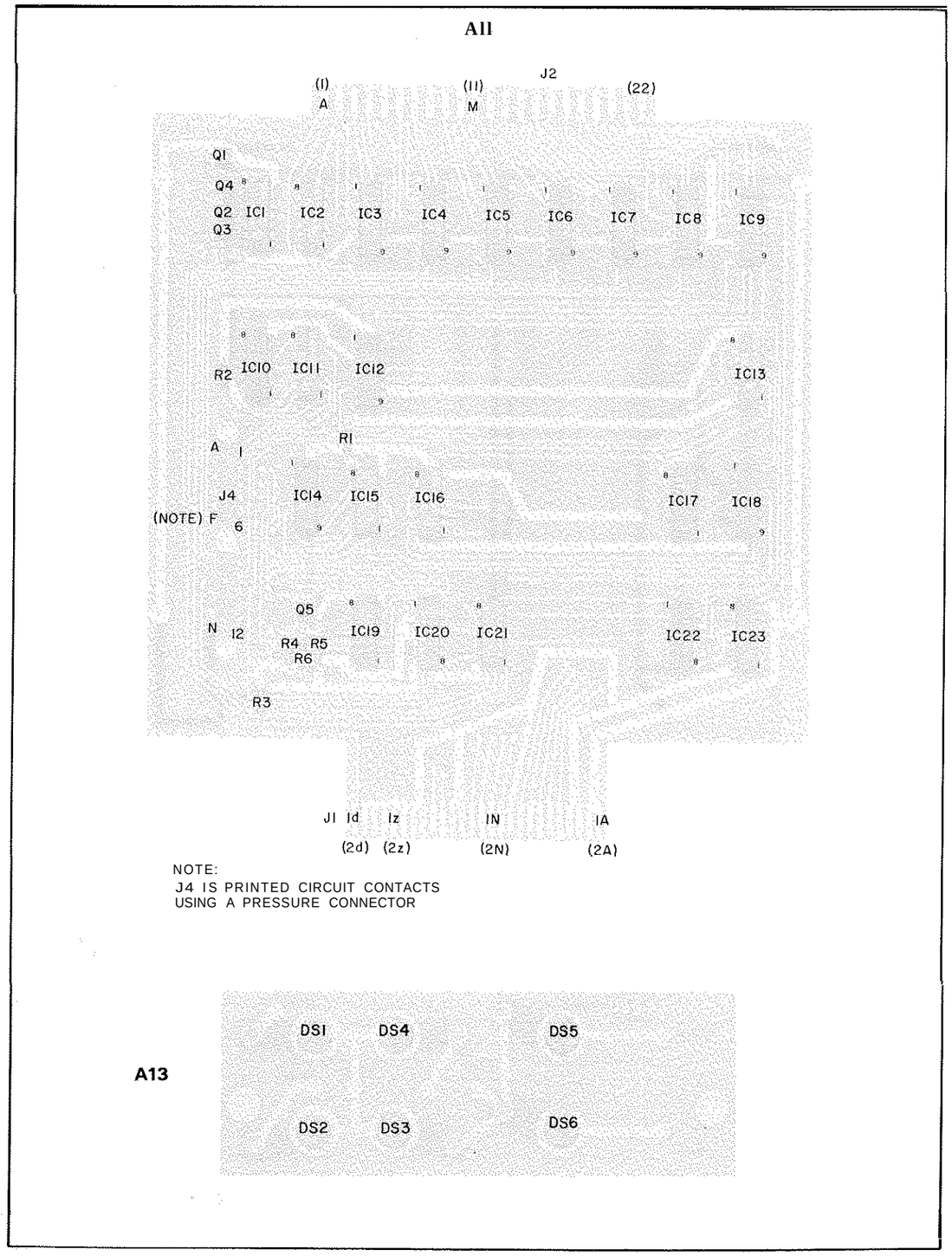

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PART OF A11 MAIN BOARD ASSEMBLY (05323-60001) (NOTE 1)

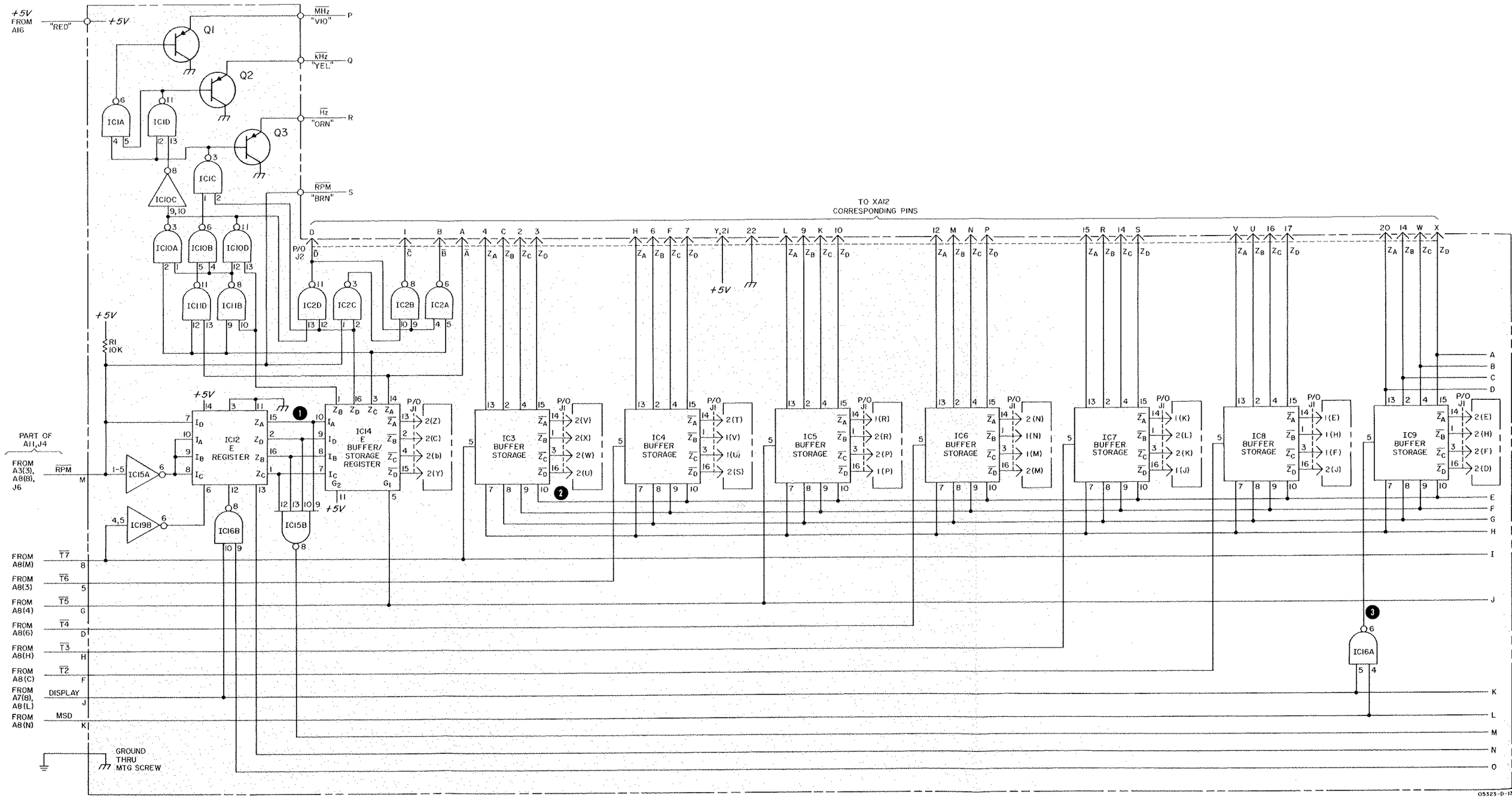


Figure 8-13. A11 Main Board Assy
A13 Annunciator Board Assy
(Sheet 1 of 2)

A13 OPERATION

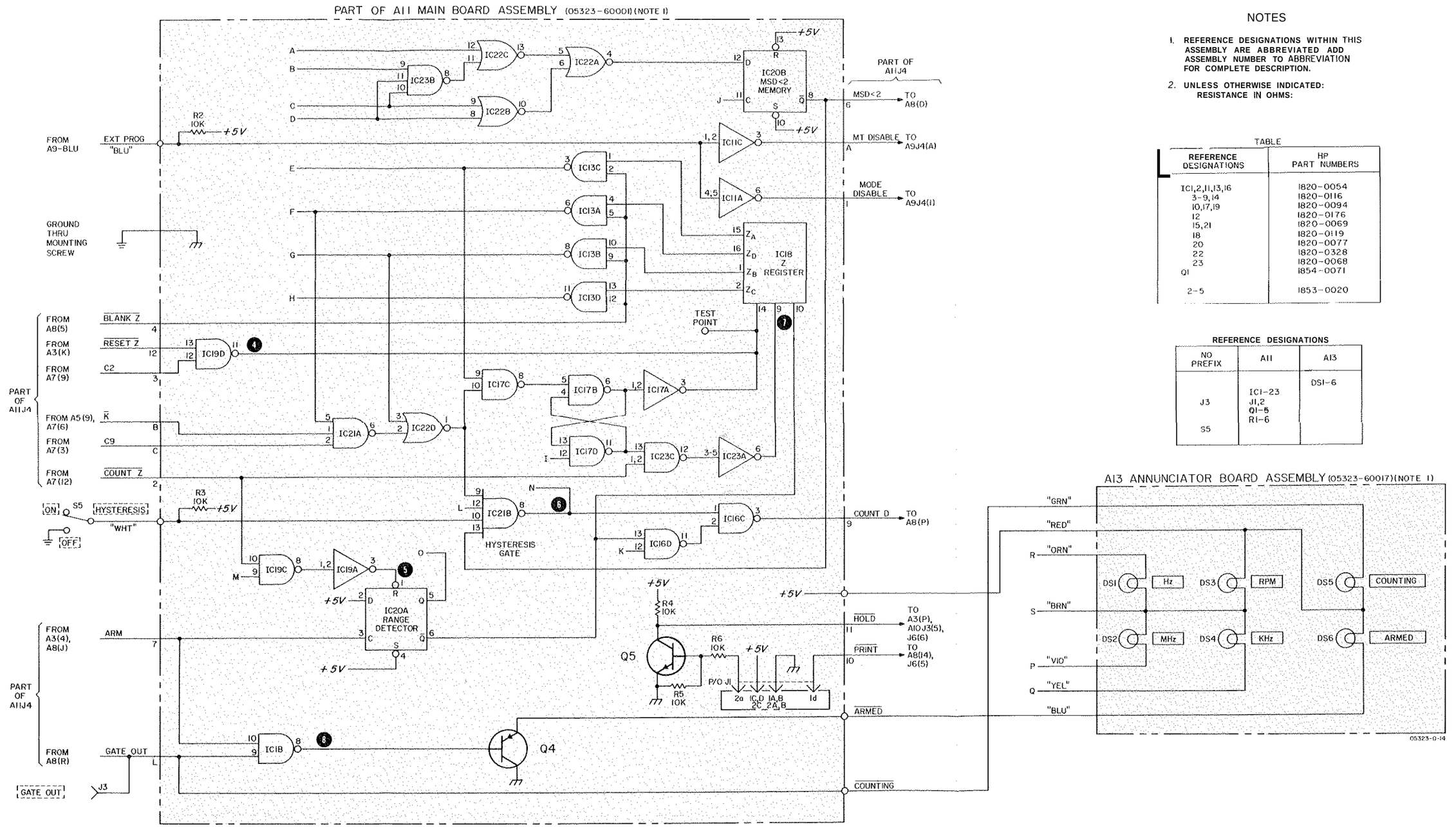
The COUNTING, ARMED and RPM lamps receive +5 Vdc from A11 on the Red wire. COUNTING, $\overline{\text{ARMED}}$ and $\overline{\text{RPM}}$ will go LOW when enabled by A11 to complete the circuit and turn the lamp on. When the Hz/RPM switch (S7) is set to Hz, signal $\overline{\text{RPM}}$ will be HIGH, so the BRN wire will be at +5 Vdc. When the Exponent/Measurement Unit Decode Logic is enabled in A11 either the VIO, YEL, or ORN wires will go LOW to turn either the MHz, kHz, or Hz lamp on.

A13 TROUBLESHOOTING

Use the Logic Probe or DC Voltmeter to check the +5 Vdc at the RED and BRN wires; then, check the other wires. To replace DS1-DS6, rotate the metal contact to the bulb out of the way and remove the bulb from rear of board.

Table 8-6. A11 Exponent/Measurement Unit Selection

E-COUNT	S7 POSITION	IC14 (ABCD)	J2 OUTPUTS	A13 LAMP STATUS			
				MHz	kHz	Hz	RPM
8	Hz	HHHL	A = H, B = L I = L, D = H	ON	OFF	OFF	OFF
	RPM	N/A	N/A	N/A	N/A	N/A	N/A
7	Hz	LLLH	A = L, B = H I = H, D = L	ON	OFF	OFF	OFF
	RPM	Same	Same	OFF	OFF	OFF	ON
6	Hz	HLLH	A = H, B = H I = H, D = L	ON	OFF	OFF	OFF
	RPM	Same	Same	OFF	OFF	OFF	ON
5	Hz	LHLH	A = L, B = H, I = H, D = H	OFF	ON	OFF	OFF
	RPM	Same	A = L, B = H I = L, D = H	OFF	OFF	OFF	ON
4	Hz	HHLH	A = H, B = H I = H, D = H	OFF	ON	OFF	OFF
	RPM	Same	A = H, B = H, I = L, D = H	OFF	OFF	OFF	ON
3	Hz	LLHH	A = L, B = L, I = H, D = H	OFF	ON	OFF	OFF
	RPM	Same	A = L, B = L, I = L, D = H	OFF	OFF	OFF	ON
2	Hz	HLHH	A = H, B = L, I = H, D = H	OFF	OFF	ON	OFF
	RPM	Same	A = H, B = L, I = L, D = H	OFF	OFF	OFF	ON
1	Hz	LHHH	A = L, B = H, I = H, D = L	OFF	OFF	ON	OFF
	RPM	Same	Same	OFF	OFF	OFF	ON
0	Hz	HABH	A = H, B = H, I = H, D = L	OFF	OFF	ON	OFF
	RPM	Same	Same	OFF	OFF	OFF	ON



NOTES

1. **REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.**
2. **UNLESS OTHERWISE INDICATED: RESISTANCE IN OHMS:**

TABLE

REFERENCE DESIGNATIONS	HP PART NUMBERS
IC1,2,11,13,16	1820-0054
3-9,14	1820-0116
10,17,19	1820-0094
12	1820-0176
15,21	1820-0069
18	1820-0119
20	1820-0077
22	1820-0328
23	1820-0068
Q1	1854-0071
2-5	1853-0020

REFERENCE DESIGNATIONS

NO PREFIX	A11	A13
J3	IC1-23 J1,2 Q1-5 R1-6	DS1-6
S5		

Figure **8-13.** A11 Main Board Assy
A13 Annunciator Board Assy
(Sheet 2 **of** 2)

A14 OPERATION

This assembly includes a 10 MHz oscillator, 10 MHz multiplier, output one-shot multivibrator and a driver. Oscillator frequency and crystal current arc adjusted by C5 and R6 respectively. The oscillator section consists of Q1, Q2 and Q3. The multiplier section consists of two tuned amplifiers whose output is shaped by Q7 and Q8. Driver Q9 provides positive pulses at pin **3.** With TIME BASE switch S3 set to EXT, operating voltage for the oscillator is disconnected, and an external standard frequency (1, 2.5, 5, or 10 MHz) may be connected lo the time base INPUT connector, J1, on rear panel.

A14 TROUBLESHOOTING

Measure dc voltages coining into the board (+12V at pin 14, -12V at pin 15, and +5. 1V at pin 4). Make waveform measurements to determine which stage is not operating. If oscillator section is not working, try adjusting RG following adjustment procedure below. IC the preceding checks fail to locate the problem, replace 10 MHz crystal (part of A15). NOTE: Whenever crystal is changed, RG and C5 must he adjusted. Be sure to use a 50:1 attenuator probe when making waveform measurements.

A14 ADJUSTMENTS

a. L2, 3, 4, and 5 adjustment:

1. Set TIME BASE switch Lo EXT
2. Connect 1 MHz standard to time base INPUT jack on rear panel.
3. Connect oscilloscope through 50:1 probe to pin 1. NOTE: Do not use extender board during adjustment procedure.
4. Adjust L2, 3, 4, and 5 for maximum output (should be greater than 0. 7 Vrms, 2V peak-to-peak).

b. RG and C5 Adjustment:

1. Set TIME BASE switch to INT.
2. Connect an electronic counter to TIME BASE INPUT jack on rear panel.
3. Adjust C5 for 10 MHz (±11 Hz). NOTE: IC crystal or heater (A15 Assembly) has been changed it may be necessary to select C4 to permit oscillator tuning lo 10 MHz.
4. Clip a current probe over the orange wire coming from pin 12. Connect probe through probe amplifier to oscilloscope. Set oscilloscope to . 05V/cm and probe amplifier to 5 mA/cm.
5. Adjust R6 for 20 mA P-P on oscilloscope.
6. Readjust C5 for 10 MHz ± 1 count on test counter.

COUNTER SETTINGS

MODE	NORM
MEASUREMENT TIME	.1
TIME BASE	INT

All waveforms taken with HP 175A Oscilloscope and HP 10002A 50:1 Divider Probe. Center line of graticule is zero volts.

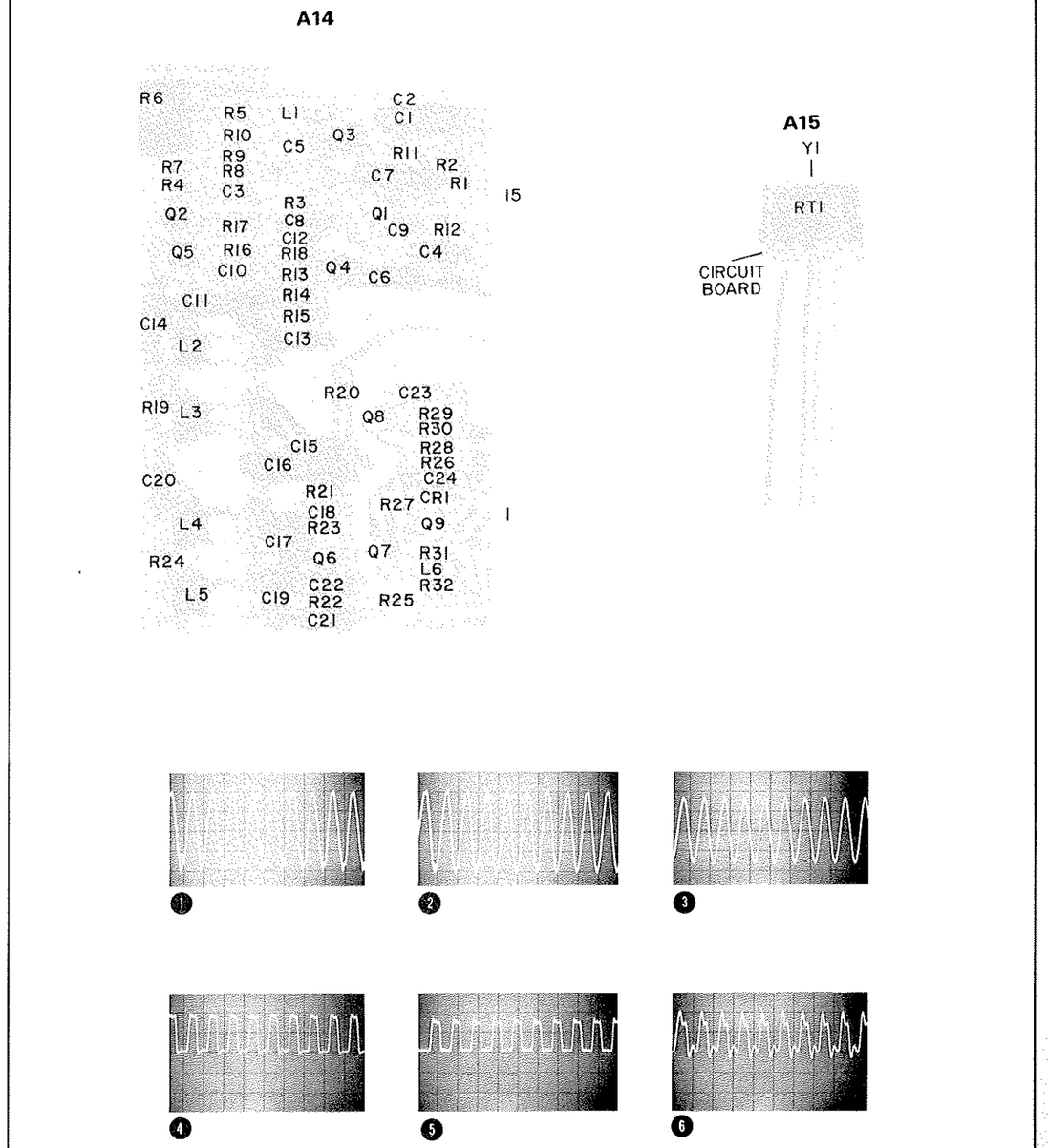
WAVEFORM NO.	Oscilloscope Settings				
	SENS V/CM	AC	DC	SLOPE + -	SWEEP /CM
1	.005	x		x	.1 μs
2	.02	x		x	.1 μs
3	.02		x	x	1 μs
4	05		x	x	.1 μs
5	05		x	x	.1 μs
6	.02		x	x	.1 μs

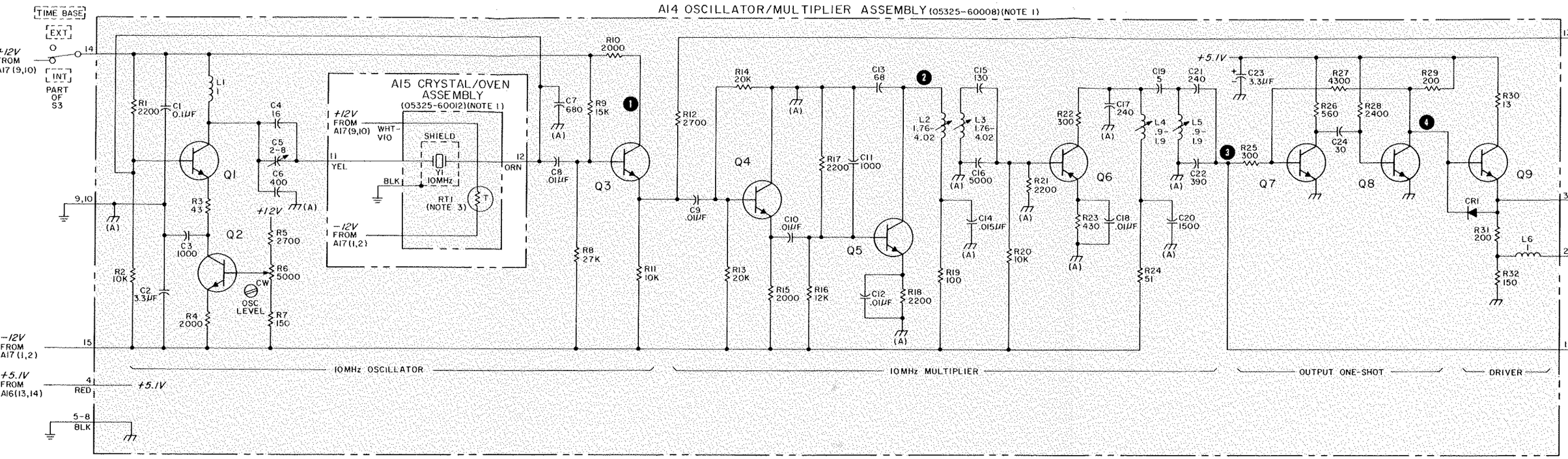
A15 OPERATION

This assembly contains the 10 MHz crystal for A14, and heater RT1 which maintains crystal temperature. The heater operates on 24 volts (+12V and -12V supplied by A17).

A15 TROUBLESHOOTING

If oscillator frequency will not stay within specified limit, it may be due to a faulty heater. Check resistance of RT1 (should be 60 to 80 ohms at room temperature). If heater check is satisfactory, replace crvstal.





NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.
2. UNLESS OTHERWISE INDICATED:
   RESISTANCE IN OHMS;
   CAPACITANCE IN PICOFARADS;
   INDUCTANCE IN MICROHENRIES
3. RESISTANCE OF HEATER ELEMENT SHOULD BE BETWEEN 60 AND 80Ω AT ROOM TEMPERATURE WITH NO POWER APPLIED

TABLE

UEFERENCE DESIGNATIONS	HP PART NUMBERS
CR1	1910-0022
Q1	1854-0019
2-4	1854-0071
5,6	1853-0036 2N3906
7	1854-0005 2N708
8,9	1854-0009 2N709

REFERENCE DESIGNATIONS

NO PREFIX	A15	A14
J1		C1-24 CR1 L1-6 Q1-9 R1-32
S3	RT1	
	Y1	

05323 D-15

Figure 8-14. A14 Oscillator/Multiplier Board Assy
A15 Crystal/Oven 10 MHz Assy

A16 OPERATION

This circuit supplies +175V and +5.1 Vdc. The +175V supply is series regulated and operates the digital display tubes in A12. The +5.1V supply is used to supply the integrated circuits and A13 lamps. The +5.1V supply is series regulated and receives operating bias from the -12V supply on A17. Q1 is located on the rear panel of the Counter.

A16 TROUBLESHOOTING

Makcvoltage andresistancc measurements. If trouble is encountered with the +5.1V supply, check to see that -12V bias is at pin 15.

WARNING

USE EXTREME CAUTION WHEN TROUBLESHOOTING THIS ASSEMBLY AS +175 VOLTS IS PRESENT AT MANY POINTS ON BOARD.

A17 OPERATION

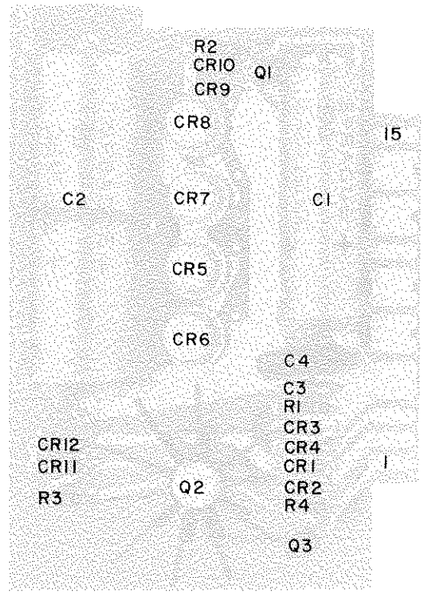
This assembly supplies +12V and -12V. The two regulator circuits depend on each other for operating bias. The -12V supply also gives bias to the +5.1V regulator on A16. If the +12V or -12V regulator is overloaded, it will turn off the other regulator. This, in turn, will shut off the regulator being overloaded. To restore power, reset switch S1 most he momentarily closed (push down), or AC line voltage interrupted.

A17 TROUBLESHOOTING

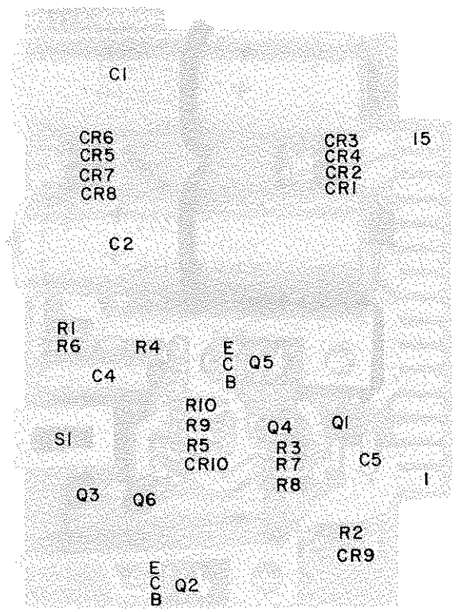
If there is no output, try pushing rcsct switch S1 on board. If supply docs not restart, alternately disconnect leads from XA17 (pins 9, 10, and 1, 2) while trying reset switch again. Make resistance measurements to check diodes and transistors.

CAUTION

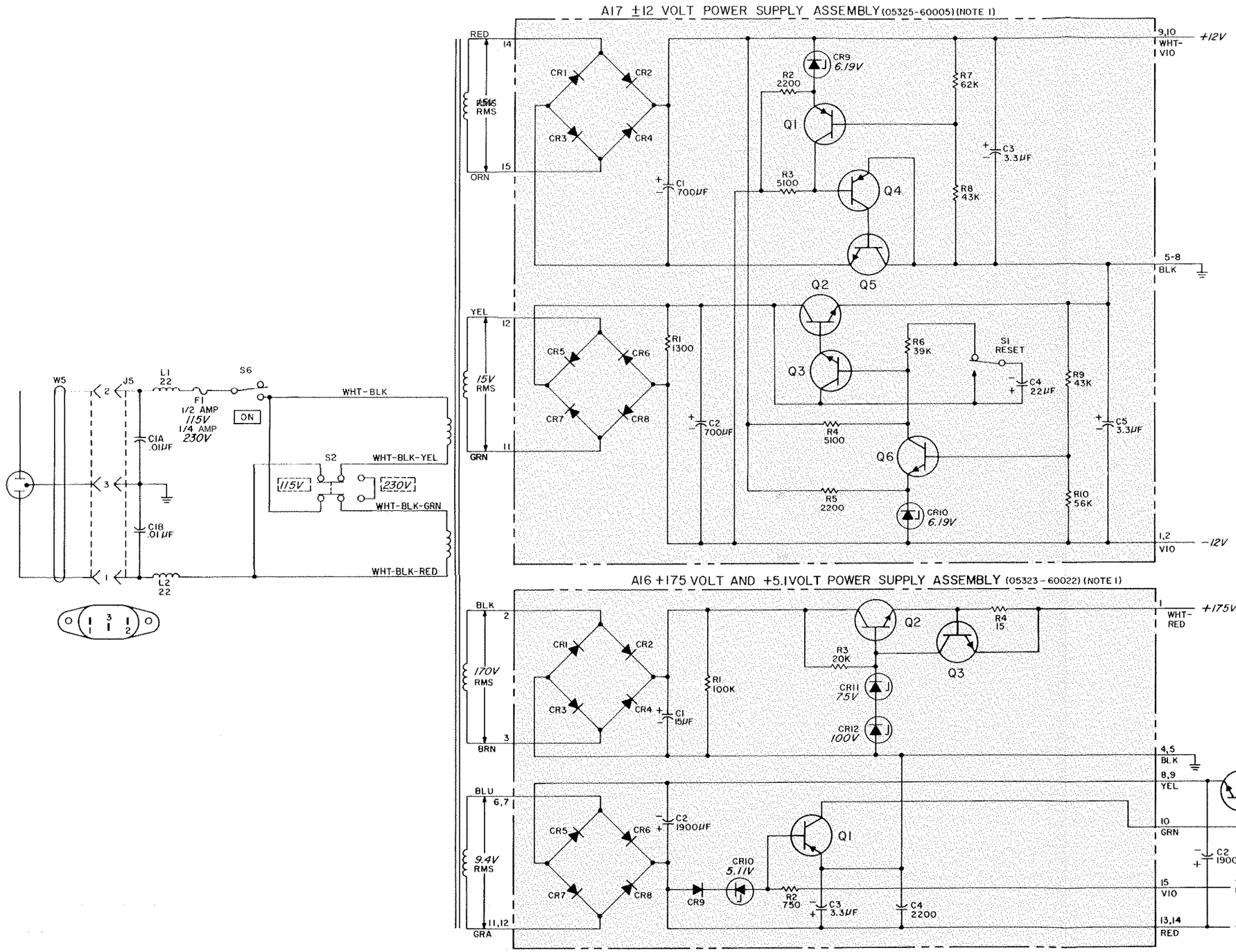
Do not short metal plates protruding from board. These arc heat sinks for A17Q2 and Q5 and arc "Hot" to the collectors of these transistors.



A16



A17



NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.
2. UNLESS OTHERWISE INDICATED:
   RESISTANCE IN OHMS,
   CAPACITANCE IN PICOFARADS.
   INDUCTANCE IN MICROHENRIES

TABLE

REFERENCE DESIGNATIONS	HP PART NUMBERS
A17	
CR1-8, 9,10	1901-0049 1902-3114
Q1,4	1853-0020
2,5	1854-0300
3	1854-0071
A16	
CR1-4	1901-0028
5-8	1901-0200
9	1901-0040
10	1902-3094
11	1902-3429
12	1902-3394
Q1	1853-0020
2	1854-0232
3	1854-0071
NO PREFIX	
Q1	1854-0063 2N3055

REFERENCE DESIGNATIONS

NO PREFIX	A17	A16
	CR1-10	CR1-12
L1,2	Q1-6 R1-10	Q1-3 R1-4
S2,6 T1 W5		

Figure 8-15. A16 +5.1V/+175V Power Supp

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Tel. 3-6019
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Taipei
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Lusaka
Zambia, Central Africa

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Hewlett-Packard Export Marketing
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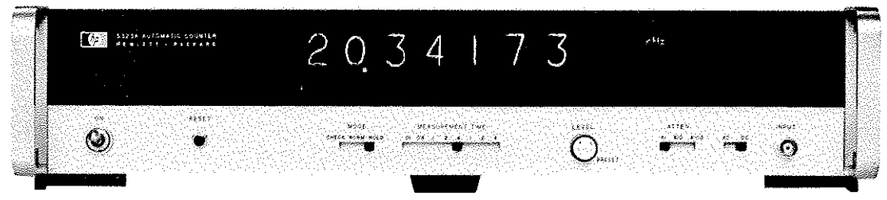

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