

## Errata

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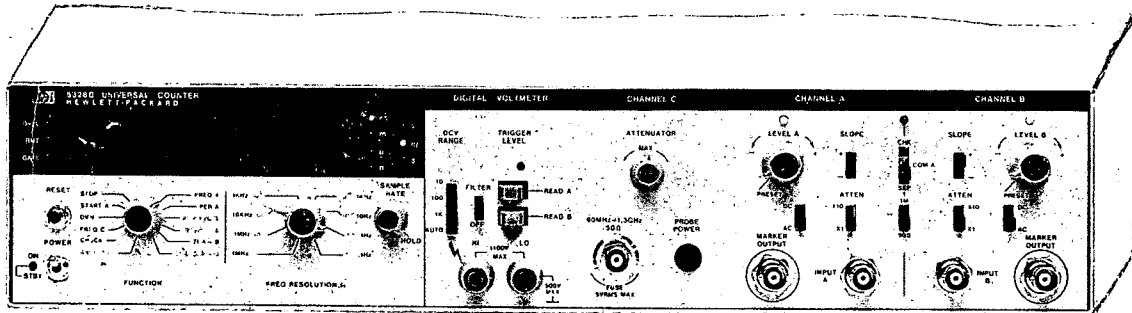
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OPERATING AND SERVICE MANUAL

# 5328B Universal Counter



OPTION 050 SHOWN



**HEWLETT  
PACKARD**

## OPERATING AND SERVICE MANUAL

# Model HP 5328B Universal Counter

### SERIAL NUMBERS

This manual applies directly to Hewlett-Packard Model 5328B Universal Counters with serial numbers prefixed 2510A.

The manual for a Model 5328B with a serial number prefix higher than the one listed above will include a "Manual Changes" supplement which will describe what changes, if any, need to be made to the manual to make it match the instrument it accompanies.

### OPTIONS

This manual provides operating and/or performance testing information for the Model 5328B Options listed below.

- Option 010 - High Stability Oven Oscillator
- Option 021 - Digital Voltmeter
- Option 031 - Channel "C"
- Option 050 - Combination of Options 021 and 031

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MANUAL PART NUMBER 05328-901  
Microfiche Part Number 05328-9011z

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## SAFETY CONSIDERATIONS

### GENERAL

This product and related documentation must be reviewed for familiarization with safety markings and instructions before operation.

This product is a Safety Class I instrument (provided with a protective earth terminal).

### BEFORE APPLYING POWER

Verify that the product is set to match the available line voltage and the correct fuse is installed. Refer to Section II, Installation.

### SAFETY EARTH GROUND

An uninterruptible safety earth ground must be provided from the mains power source to the product input wiring terminals or supplied power cable.

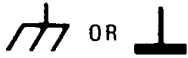
## SAFETY SYMBOLS



Instruction manual symbol; the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual.



Indicates hazardous voltages.



Indicates terminal is connected to chassis when such connection is not apparent.



Alternating current.



Direct current.

### WARNING

The **WARNING** sign denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a **WARNING** sign until the indicated conditions are fully understood and met.

### CAUTION

The **CAUTION** sign denotes a hazard. It calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product. Do not proceed beyond a **CAUTION** sign until the indicated conditions are fully understood and met.

## SAFETY INFORMATION

### WARNING

Any interruption of the protective grounding conductor (inside or outside the instrument) or disconnecting the protective earth terminal will cause a potential shock hazard that could result in personal injury. (Grounding one conductor of a two conductor outlet is not sufficient protection.)

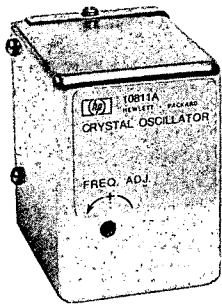
Whenever it is likely that the protection has been impaired, the instrument must be made inoperative and be secured against any unintended operation.

If this instrument is to be energized via an autotransformer (for voltage reduction) make sure the common terminal is connected to the earthed pole terminal (neutral) of the power source.

Instructions for adjustments while covers are removed and for servicing are for use by service-trained personnel only. To avoid dangerous electric shock, do not perform such adjustments or servicing unless qualified to do so.

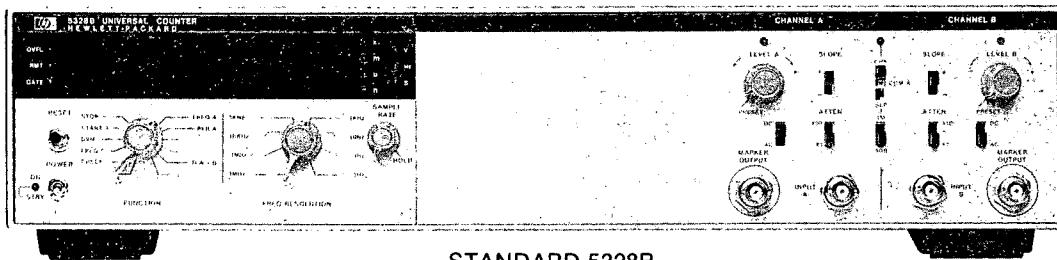
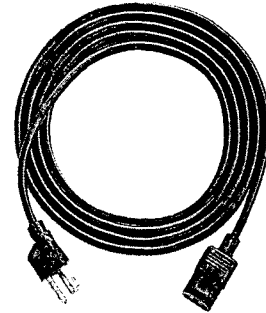
For continued protection against fire, replace the line fuse(s) only with 250V fuse(s) of the same current rating and type (for example, normal blow, time delay). Do not use repaired fuses or short circuited fuseholders.

Model 5328B  
Operation

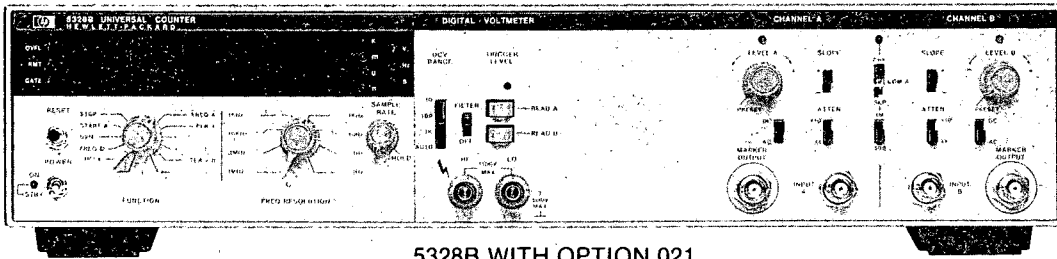


OPTION 010  
OVEN  
OSCILLATOR

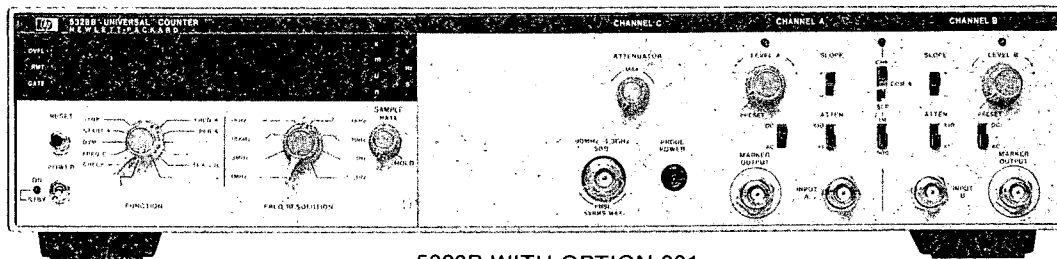
POWER CABLE  
(See Table 2-1)



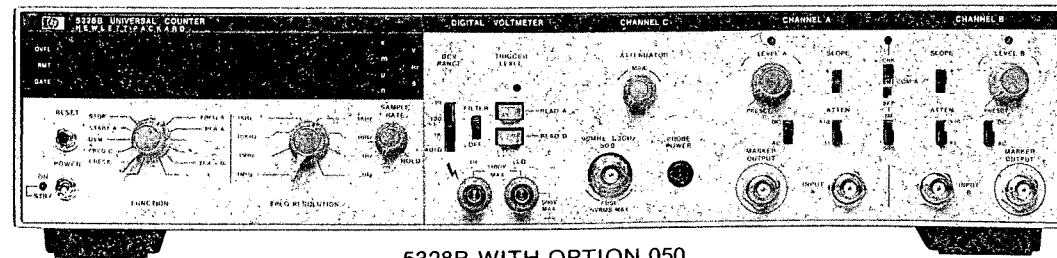
STANDARD 5328B



5328B WITH OPTION 021



5328B WITH OPTION 031



5328B WITH OPTION 050

Figure 1-1. HP 5328B Universal Counter

## SECTION I GENERAL INFORMATION

### 1-1. INTRODUCTION

This manual provides operating information for the standard Hewlett-Packard Model 5328B Universal Counter. It also provides operating instructions for Model 5328Bs having the following options —

- Option 010 – High-stability Time Base Oscillator (Actually, no special instructions are required for this Option.)
- Option 021 – Digital Voltmeter
- Option 031 – Channel “C” (90-1300 MHz frequency range)
- Option 050 – Combination of Option 021 and Option 031

### 1-2. DESCRIPTION

The Model 5328B in its standard configuration (i.e., without options), measures —

- frequency
- period, period average
- time interval, time interval average
- frequency ratio
- totalization

The Model 5328B's Specifications are given in *Table 1-1*.

The Model 5328B's capabilities can be expanded by adding optional circuits, as described below.

OPTION 010 – High-stability Time Base Oscillator.

OPTION 021 – Digital Voltmeter

OPTION 031 – Channel “C”

OPTION 050 – Provides OPTION 021 (Digital Voltmeter) and OPTION 031 (Channel “C”)

The Model 5328B's measurement results are presented via a front-panel display that consists of nine seven-segment LED numeric positions,\* plus additional indicators for measurement units and decimal point position. Additionally, an electrical representation of the output is available at the Model 5328B's rear-panel HP-IB connector.

The standard Model 5328B has two independently-controllable input channels (“A” and “B”) that can be used for frequency or time-interval measurements. Each of these channels has its own attenuator, trigger slope selector, level control, ac/dc coupling selector, and oscilloscope marker output; however a front-panel CHK/COM A/SEP switch allows Channel “B” to be controlled by Channel “A”'s controls, which makes set-ups easier for some applications.

\*NOTE: Depending on the measurement being made, and the setting of the Model 5328B's controls, the numeric portion of the display may consist of fewer than nine digits.



**Model 5328B**  
**General Information**

The Model 5328B's rear-panel connectors include a gate output, a time base output, and an input for an external frequency standard.

A rear-panel ARM switch allows the Model 5328B to be "armed" by the signal being measured (ARM switch OFF) or by another input signal (ARM switch ON).

The Model 5328B's rear panel includes some additional holes, normally filled by plug buttons, to allow for easy installation (at the factory) of such options as rear-panel input, etc.

**NOTE**

The Model 5328B is not set up for field-installation (i.e., addition) of the Options described in this manual.

**1-3. INSTRUMENT IDENTIFICATION**

Each HP 5328B is identified by a Serial Number as described in paragraph 1-4 below. The contents of this manual apply to a Model 5328B whose Serial Number Prefix is listed under "SERIAL NUMBERS" on the title page.

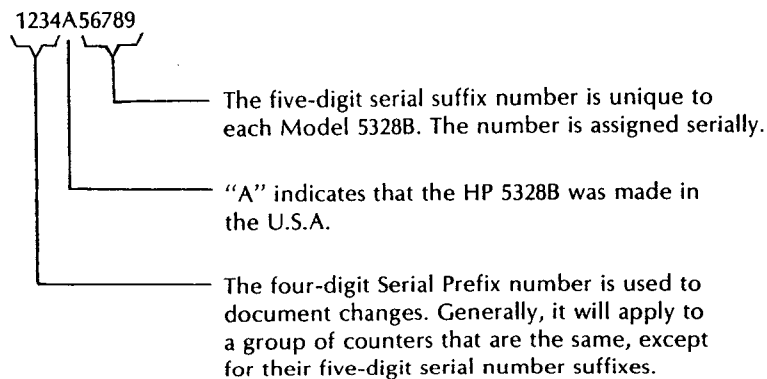
A HP 5328B manufactured after this manual was printed may have a Serial Number Prefix that is not listed on the title page. This unlisted Serial Number Prefix indicates that the Model 5328B in question may be different from those described in this manual. The manual for this new Model 5328B is accompanied by a "Manual Changes" supplement containing "change" information that explains how to adapt the manual to the newer Model 5328B.

In addition to "change" information, the supplement may contain information for correcting errors in the manual. To keep this manual as current and accurate as possible, Hewlett-Packard recommends that you periodically request the latest "Manual Changes" supplement. The supplement for this manual is identified with the manual's Part Number and Print Date, both of which appear on the manual's title page. Complimentary copies of the supplement are available from Hewlett-Packard.

For information concerning a Serial Number Prefix that is not listed on the title page or in the "Manual Changes" supplement, contact your nearest Hewlett-Packard office.

**1-4. Serial Number**

Each Model 5328B is identified by a unique serial number having the format —



The HP 5328B's Serial Number is printed on a label attached to its rear panel.

## 1-5. Series Number

Some parts in the HP 5328B may have a "SERIES" number on them.

The SERIES number is similar in function to the prefix portion of the Model 5328B's Serial Number. Generally, all parts having the same HP Part Number are the same; parts having the same Part Number, but different SERIES numbers are similar, but not identical.

## 1-6. APPLICATIONS

Specific applications information for the Model 5328B is provided in Section 3 of this manual. The general applications of the Model 5328B are described below. The standard Model 5328B can directly count (or measure the period of) signals in the range from dc to 100 MHz. Its high sensitivity, and signal conditioning circuits (which include attenuators, and trigger selection controls) allow measurements to be made on almost any signal in its frequency range. The Model 5328B's "arming" input for a measurement can be selected by a rear-panel switch; this selectable "arming" capability is useful in applications such as measurements of burst frequency or pulse amplitude.

The standard Model 5328B's single-shot resolution of 10 nS allows the counter to be used in such applications as —

- timing mechanical and/or electromechanical devices (such as relays)
- time-of-flight (ballistics) measurements
- sonar ranging
- radio ranging
- navigation

The Model 5328B's standard "A"-and-"B"-Channel Input Module provides resolution to 10 nS and HP-IB (Hewlett-Packard Interface Bus) programming capability; this is useful in such measurement applications as —

- computer/peripheral timing
- logic timing
- radar ranging
- optical ranging.

Using time interval averaging, the Model 5328B can measure time intervals as short 100 pS with a resolution to 10 pS. Uses for this capability include measurements of —

- cable length
- phase
- logic timing
- integrated circuit propagation delay

The optional integrating Digital Voltmeter (Option 021 or part of Option 050) measures trigger levels (this is critical in most time-interval measurements) and external voltages.

**Model 5328B**  
**General Information**

The optional 90-1300 MHz "C"-Channel (Option 031 or part of Option 050) allows a higher range of frequencies to be counted by the Model 5328B. Signals applied to the "C"-Channel input are pre-scaled (i.e. divided) by "4".

Full bandwidth, sensitivity, and signal conditioning of the "A" and "B" and (optional) "C" inputs are provided for ratio, totalizing, or scaling measurements.

The Model 5328B's HP-IB interface (standard) can output measurement data and can be controlled (i.e. be fully programmed) via the Hewlett-Packard Interface Bus (HP-IB). The Model 5328B is interfaced to HP-IB-compatible instruments, calculators, or computers simply by connecting it with an HP-IB cable. The HP-IB capability allows complete "hands-off" operation for the most-involved systems applications.

**1-7. SPECIFICATIONS**

Specifications for the Model 5328B, and the Options listed below, are listed in *Table 1-1*.

Option 010      Option 021      Option 031      Option 050

Table 1-1. Model 5328B Specifications

**INPUT CHARACTERISTICS**

(Channel A and B)

**Range:**

- DC Coupled: 0 to 100 MHz
- AC Coupled: 20 Hz to 100 MHz
- AC Coupled (50Ω): 200 kHz to 100 MHz
- Common A: 0 to 10 MHz

**Sensitivity (x 1):**

- 0 to 40 MHz Sine wave: 25 mV rms
- 40 MHz to 100 MHz Sine wave: 50 mV rms
- 5 ns Pulse: 140 mV p-p

**Dynamic Range (x 1):**

- 0 to 40 MHz: 71 mV to 3 V p-p
- 40 MHz to 100 MHz: 141 mV to 1.5 V p-p

**Signal Operating Range (x 1, DC):** ± 2.5 V DC

**Trigger Level Range (x 1):**

- Preset: 0V NOMINAL
- Adjustable: ± 2.5 V
- Useable Range: 20% to 80% of Signal Amplitude

**Coupling:** AC or DC, Switchable

**Impedance:**

- Separate: 1 MΩ NOMINAL shunted with <100 pF, or 50Ω NOMINAL, switchable
- Common: 500 kΩ NOMINAL, shunted with <150 pF, or 50Ω NOMINAL, switchable

**Attenuators (NOMINAL):** x 1, x 10, Switchable

**Slope:** Independent + or - Slope, Switchable

**Channel Input:** Separate, Common A or Check

**Damage Level:**

- 1 MΩ, x 1, DC Coupled:**
  - DC to 50 kHz ..... 250 V rms
  - 50 kHz to 2.5 MHz ..... 1.25 × 10<sup>7</sup> V rms/Freq
  - 2.5 MHz to 100 MHz ..... 5 V rms

- 1 MΩ, x 10, DC Coupled:**
  - DC to 500 kHz ..... 250 V rms
  - 0.5 to 25 MHz ..... 1.25 × 10<sup>8</sup> V rms/Freq
  - 25 to 100 MHz ..... 5 V rms

- AC Coupled:**
  - DC to 20 Hz ..... 200 V (Peak AC + DC)
  - 20 Hz to 100 MHz ..... Same as DC coupled.

- 50Ω Position:**
  - DC to 100 MHz ..... 5 V rms

**CROSS TALK**

Measurements made above 20 MHz with input signals applied to both channels may be affected by cross talk. During dual channel measurements, input signals with similar amplitudes greater than 75mV (nominal) are recommended for both channels.

**FREQUENCY A MEASUREMENT**

- Range:** 0 to 100 MHz, Direct Count
- LSD\*\* Displayed:** 1 MHz to 0.1 Hz in decade steps
- Resolution:** Same as LSD\*\*
- Accuracy:** ± Resolution, ± Time Base Error × Freq

**PERIOD A MEASUREMENT**

- Range:** 100 ns to 1 × 10<sup>7</sup> s
- LSD\*\* Displayed:** 10 ns to 0.1 s in decade steps

- ✗ **Resolution:** ± LSD\*\* ± Trigger Error\*\*
- ✗ **Accuracy:** ± Resolution, ± Time Base Error × Period

**PERIOD AVERAGE A MEASUREMENT**

- Range:** 100 ns to 1 × 10<sup>7</sup> s
- LSD\*\* Displayed:**

$$\frac{10 \text{ ns}}{\text{Number of Periods Averaged}}$$

- Resolution:**

$$\pm \text{LSD} \pm \frac{\text{Trigger Error}^{**}}{\text{Number of Periods Averaged}}$$

**Accuracy:** ± Resolution, ± Time Base Error × Period

**TIME INTERVAL A TO B MEASUREMENTS**

- Range:** 10 ns to 1 × 10<sup>7</sup> s
- Minimum Pulse Width:** 10 ns
- LSD\*\* Displayed:** 10 ns to 0.1 s in decade steps
- Resolution:** ± LSD\*\* ± Trigger Error\*\* ± Trigger Level Timing Error\*\*
- Accuracy:** ± Resolution, ± Time Base Error × T.I.

**TIME INTERVAL AVERAGE A TO B MEASUREMENTS**

No more than one STOP pulse allowed for each START pulse, otherwise measurement scaling will occur.

- Range:** 0.1 ns to 1 s
- LSD\*\* Displayed:**

$$\frac{10 \text{ ns}}{\sqrt{\text{Number of Intervals Averaged}}}$$

- Resolution:**

$$\pm \text{LSD}^{**} \pm \frac{\text{Trigger Error}^{**}}{\sqrt{\text{Number of Intervals Averaged}}} \pm \text{Trigger Level Error}^{**} \pm 10 \text{ ps}$$

**Accuracy:** ± Resolution, ± 2 ns ± Time Base Error × T.I.

**Minimum Pulse Width:** 10 ns

**Minimum Dead Time:** 40 ns (10 MHz maximum repetition rate)

**RATIO MEASUREMENTS**

**Note** — The ratio of the frequency at B (or C for C/A Function when Option 031 is installed) to the frequency at A is measured for N counts of A, where N is selected by the resolution switch (N=1 to 1 × 10<sup>7</sup> in decade steps).

- Range:** A: 0 to 10 MHz,  
B: 0 to 100 MHz,  
C: 90 MHz to 1300 MHz (Option 031)

- LSD\*\* Displayed:**

$$1 \text{ part in } \frac{B}{A} \times N \text{ (or } \frac{C}{A} \times N)$$

- Resolution:** ± LSD
- Accuracy:** ± Resolution, ± Trigger Error\*\* of A × Frequency of B (or C) (N > 1)  
(For N = 1, add ± 12 ns × Frequency of B (or C))

Table 1-1. Model 5328B Specifications (Continued)

**TOTALIZING AND SCALING MEASUREMENTS**

**Start A:** Totalizes A/N, where A is the number of events on input A and N is the scaling factor as selected on the resolution switch (N = 1 to  $1 \times 10^7$  in decade steps). The scaled output (A/N) is available at the rear panel time base output. For N > 1.

**Range:**

N = 1	0 to 100 MHz
N > 1	0 to 10 MHz

\* Specifications describe the instrument's warranted performance. Supplemental characteristics are intended to provide information useful in applying the instrument by giving TYPICAL or NOMINAL but nonwarranted performance parameters.

\*\* See notes/definitions section for further information.

**GENERAL**

**Display:** 8 digit LED display (Standard)  
9 digit LED display (Option 031)

**Blanking:** Suppresses leading zeros.

**Storage:** Holds reading between measurements but can be overridden by rear panel switch.

**Sample Rate:** Variable from less than 2 ms between measurements to infinity (hold).

**Gate Time:** For frequency measurements, gate time is the reciprocal of the selected resolution (for Option 031, frequency C, the gate time is four times the reciprocal of resolution).

**Gate Time Range:** 1  $\mu$ s to 10 s (4  $\mu$ s to 40 s for Option 031, frequency C). Minimum signal burst measureable is 8  $\mu$ s.

**Gate Output:** Rear Panel output, TTL levels. High when counter gate is open.

**Check Signal:** Place function switch in Freq. A and input section in check (CHK) — counter displays 100 MHz  $\pm$  1 count.

**Time Base Output:** Rear panel output, TTL levels.

**Time Base (Standard):**

Frequency: 10 MHz

Aging Rate:  $< 3 \times 10^{-7}$ /month

Temperature:  $< 2.5 \times 10^{-6}$ , 0 to 50°C, ref. to 25°C.

Line Voltage:  $< 1 \times 10^{-7}$  for 10% change

**Ext Freq Std Input:** Input: 30 kHz to 10 MHz signal of amplitude  $> 1.0$  V rms into 1 k $\Omega$ . Maximum Input: 5 V p-p. Input other than 10 MHz will give scaled readings. External frequency standard must be 10 MHz for Period Average, Time Interval Average, Period (N = 1) and Time Interval (N = 1).

**Trigger Lights:** Light is on when input is above trigger level; off when input is below trigger level; blinking when channel is triggering. Operates over frequencies from 0 to 100 MHz.

**Marker Outputs:** Channel A and B Schmitt trigger outputs available on front panel. NOMINALLY 0 mV to +300 mV levels into 50 $\Omega$ ;  $< 20$  ns delay; outputs protected to  $\pm 5$  V DC.

**Arm:** Rear Panel Switch turns arming ON or OFF. With arming ON, the measurement is armed by an input other than the input involved in the measurement. The following are armed by an event at B: Freq A, Period A, Period Avg A, Freq C, DVM and Ratio C/A. The following are armed by an event at C: T.I. A  $\rightarrow$  B; T.I. Avg A  $\rightarrow$  B; and Ratio B/A.

**HP-IB INTERFACE**

HP-IB interface provides both digital output of measurement data ("talker"), as well as remote control inputs ("listener"), on the HP-IB.

**Programmable Functions:** Function, resolution, sample rate (maximum or manual control), arming, display modes, measurement modes, output mode, and reset commands. Trigger level, trigger slope, input impedance, coupling, separate/common/check, invert A and B. Trigger level is programmable in 10 mV steps in  $\times 1$ ; 100 mV in  $\times 10$ . Trigger level accuracy under remote control in  $\times 1$ :  $\pm 35$  mV.

**HP-IB Commands:** Unlisten, untalk, local lockout, device clear, serial poll enable, serial poll disable, go to local, selected device clear, and group execute trigger.

**Service Request (SRQ):** If enabled, indicates end of measurement.

**Maximum Data Output Rate:** 500 readings per second.

**Operating Temperature:** 0° to 50°C.

**Power Requirements:** 100/120/220/240 V rms, +5%, -10% (Switch selectable); 48-66 Hz; 150 VA Max.

**Accessories Furnished:** Power cord

**Weight:** Net 8.5 kg (18 lb., 12 oz.)

Shipping 11.2 kg (24 lb., 12 oz.)

**TIME BASE OPTION**

**OPTION 010 — High Stability Time Base (Oven)**

**Frequency:** 10 MHz

**Aging Rate:**  $< 5 \times 10^{-10}$ /day after 24 hour warm up

**Short Term:**  $< 1 \times 10^{-10}$  rms for 1 s averaging time

**Temperature:**  $< 7 \times 10^{-9}$  0° to 50°C

**Line Voltage:**  $< 5 \times 10^{-9}$  for 10% variation

**Warm Up:**  $< 5 \times 10^{-9}$  in 20 minutes

**DIGITAL VOLTMETER OPTION**

Trigger levels of input channels A and B and external voltages may be measured with DVM Option 021.

**OPTION 021 — High Performance Digital Voltmeter\*\*\***

**Ranges:**  $\pm 10$ ,  $\pm 100$ ,  $\pm 1000$  V DC and autoranging

**Full Range Display Resolution (1 sec. Meas. Time):**

$\pm 1000.00$  V DC

$\pm 125.000$  V DC

$\pm 12.5000$  V DC

**Sensitivity:**

10  $\mu$ V for measurement time of 10 s (N = 107)

100  $\mu$ V for measurement time of 1 s (N = 106)

1 mV for measurement time of 100 ms (N = 105)

10 mV for measurement time of 10 ms (N = 104)

100mV for measurement time of 1 ms (N = 103)

**Accuracy (20 Min. Warm Up):**  $\pm 0.03\%$  of reading,  $\pm 0.004\%$  of range. For 1000 V range:  $\pm 0.087\%$  of reading,  $\pm 0.004\%$  of range.

**Temperature Coefficient:**  $\pm 0.002\%$  of reading/ $^{\circ}$ C,  $\pm 0.001\%$  of range/ $^{\circ}$ C.

**Response Time (Filter Off, Step Input):** 10 ms

**Input:** 10 M $\Omega$  NOMINAL, floating pair

**Maximum Input:**

High to Low:  $\pm 1100$  V all ranges

Low to Chassis Ground:  $\pm 500$  V

**Normal Mode Rejection Ratio:**  $> 80$  dB at 50 Hz or greater, with filter on.

**Effective Common Mode Rejection Ratio (1k $\Omega$  Unbalance):**

DC:  $> 120$  dB

AC:  $> 120$  dB for multiples of 50/60 Hz with filter on

**Trigger Level Display ( $\times 1$ ):**

**Resolution:** 1 mV

**Accuracy:** 4% of reading  $\pm 25$  mV (NOMINAL)

**Note —** Readings are automatically multiplied by attenuator setting.

\*\*\* Performance: 60 days at 23°C  $\pm$  5°C and R.H.  $< 80\%$ .

Table 1-1. Model 5328B Specifications (Continued)

**C CHANNEL OPTION**

**OPTION 031 — 1300 MHz C Channel**

**INPUT CHARACTERISTICS**

- Sensitivity:** 20 mV rms
- Coupling:** AC
- Trigger Level:** 0 V NOMINAL, Fixed
- Impedance:** 50Ω NOMINAL
- Maximum Input:** 5 V rms, ± 5 V DC
- Input Protection:** Fused input
- Attenuator:** AGC and variable attenuator for optimum noise suppression on signals to 5 V rms.

**FREQUENCY C MEASUREMENT**

- Range:** 90 to 1300 MHz, prescaled by 4
- LSD\*\* Displayed:** 1 MHz to 0.1 Hz in decade steps
- Resolution:** Same as LSD\*\*
- Accuracy:** ± Resolution ± Time Base Error × Frequency

**GENERAL**

**Probe Power:** Power to operate 10855A or HP active probe is available on the front panel.

**NOTES/DEFINITIONS**

**Trigger Error:**

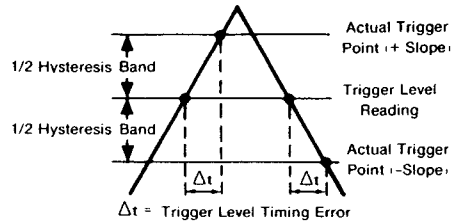
$$\text{Trigger Error} = 1.4 \frac{\sqrt{e_i^2 + e_n^2}}{\text{Input Voltage Slew Rate at Trigger Point}}$$

Where  $e_i$  = Effective rms noise of counter's input channel (300 μV TYPICAL)

$e_n$  = rms noise voltage of input signal for a 100 MHz bandwidth

**Note —** The above assumes that both start and stop signal slew rates are the same.

**Trigger Level and Trigger Point (x 1):**



**Trigger Level Timing Error (x 1):** Trigger Level Timing Error as it applies to Time Interval measurements:

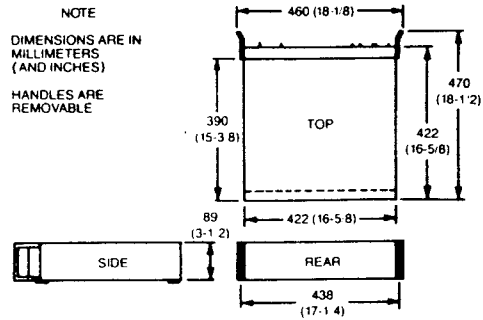
$$\pm \frac{1/2 \text{ Hysteresis Band}}{|\text{Input slew rate at START trigger point}|}$$

$$\pm \frac{1/2 \text{ Hysteresis Band}}{|\text{Input slew rate at STOP trigger point}|}$$

**Time Interval Averaging:**

Time Interval Averaging is a statistical process. Resolution is calculated for a 2 Sigma ( $\sigma$ ) confidence level.

**Dimensions:**



Model 5328B  
General Information

**1-8. OPTIONS**

The options available for the Model 5328B, are listed in *Table 1-2*, below.

If the Option is ordered at the time the Model 5328B is ordered, it will be installed at the factory, and the instrument will be ready for operation when received.

To order any of the options listed in *Table 1-2* for field installation in a Model 5328B that has already been shipped, order by the HP Part Number (given in the table's right-hand column).

*Table 1-2. Options*

Opt. No.	Description	HP Part Number
010	High-stability Time Base Aging rate: $5 \times 10^{-10}$ day	See Note at bottom of table
021	High-performance Digital Voltmeter Floating high-accuracy Digital Voltmeter for trigger level and external dc voltage measurements.	See Note at bottom of table
031	Channel C Frequency measurements to 1300 MHz; 20 mV sensitivity (prescaled by 4)	See Note at bottom of table
050	Combination of Option 021 (High-performance Digital Voltmeter) and Option 031 (Channel "C"), which are described above, and elsewhere throughout this manual	See Note at bottom of table
907	Front Handle Kit	5061-0088
908	Rack Flange Kit (for instruments without handles)	5061-9674
909	Rack and Handle Kit	5061-0075

**NOTE**

To order parts for field installation of options, refer to the following tables:

Option 010	Table 1-2a
Option 021	Table 1-2b
Option 031	Table 1-2c
Option 050	Table 1-2d

The following is a list of procedures for field installation of each option and where the procedures are in the manual:

Option 010	Page 8-20
Option 021	Page 8-110
Option 031	Page 8-124
Option 050	Combine Option 021 and 031 procedures.

Table 1-2a. Option 010 Field Installation Parts

Reference Designator	HP Part Number	Description	Qty.
A3	05328-60018	Bd Ay-Oven Osc. Option 010	1
A3A1	10811-60111	Quartz Oscillator 10 MHz	1
	0380-0640	Standoff-Threaded Nylon	1
H34	0570-0111	Screw, 6-32 Nylon Mach	1
H40	2360-0113	Screw, 6-32 SS Mach	3
H49	3050-0003	Washer, #6 Flat Fiber	2

Table 1-2b. Option 021 Field Installation Parts

Reference Designator	HP Part Number	Description	Qty.
A5	05328-60012	Bd Ay-PS Autorange	1
A6	05328-60013	Bd Ay-Buffer Amplifier	1
A7	05328-60014	Bd Ay-Voltage/Frequency Converter	1
A17	05328-60015	Bd Ay-DVM Front Panel Switch	1
J210/J211	1510-0091	Binding Post/Banana Plug Connector	2
J210A/J211A	2950-0144	Nut-Hex 3/8-32	2
J210B/J211B	2420-0001	Nut-Hex 6-32 W/Lockwasher	2
A6MP3/A6MP4	0370-2486	Pushbutton-Jade Gray	2
MP18	05328-20227	Front Panel-DVM	1
H59	2360-0476	Screw, Mach 6-32 .188 In Lg (to secure front panel)	8

Table 1-2c. Option 031 Field Installation Parts

Reference Designator	HP Part Number	Description	Qty.
A8	05328-60025	Bd Ay-1.3 GHz	1
J310	05305-60205	Connector Assembly-BNC	1
J310F1	2110-0301	Fuse, .125 Amp	1
J311	<del>05328-60018</del>	Cable Ay-Probe Power <i>05328-60113 JR</i>	1
J311A	2950-0001	Nut, Hex 3/8-32	1
H23	0370-1005	Knob-Base-PTR 3/8 JGK	1
MP19	05328-20228	Front Panel, C-Channel	1
H59	2360-0476	Screw-Mach 6-32, .188 In Lg (to secure Front Panel)	8
A1U37	1818-2274	ROM, C-Channel Option Replaces Standard A1U37 ROM	1

Table 1-2d. Option 050 Field Installation Parts

Reference Designator	HP Part Number	Description	Qty.
MP20	05328-20229	Front Panel, Option 050	1
Option 021	All Parts listed in Table 1-2b, EXCEPT: MP18, Option 021 Front Panel.		
Option 031	All Parts listed in Table 1-2c, EXCEPT: MP19, Option 031 Front Panel. H59, 6-32 Machine Screws for securing the Front Panel. (A set of 8 are already included in Option 021 parts.)		



### 1-9. ACCESSORIES AVAILABLE

Table 1-3 lists accessories available.

1. The test leads listed in Table 1-3 are used with the (optional) Digital Voltmeter.
2. The coaxial cable listed is used with input "A", "B", or (optional) "C".
3. The Rack Flange Kit is used to install the Model 5328B in a rack mount cabinet.

Table 1-3. Accessories Available

Description	HP Part Number
HP Interface Bus Interconnect Cable Length: 1 m (3.3 feet) 2 m (6.6 feet) 4 m (13.2 feet) 0.5 m (1.6 feet)	10833A 10833B 10833C 10833D
Front Handle Kit*	5061-0088
Rack Flange Kit* (for instrument without handles)	5061-0074
Rack and Handle Kit*	5061-0075
Test Leads Dual banana plug to alligator clips Length: 150 cm (60 inches)	11002A
Test Leads Dual banana plug to pencil probe and alligator clips Length: 150 cm (60 inches)	11003A
Cable, coaxial, 50-ohms Terminated at each end with UG-88C/U BNC Male Length: 120 cm (48 inches)	10503A
*Installation instructions included with kit	

### 1-10. RECOMMENDED TEST EQUIPMENT

Equipment recommended for testing and/or servicing the Model 5328B is listed in Table 1-4. Unless otherwise indicated, all equipment listed is made Hewlett-Packard. If the recommended equipment is not available, other equipment may be used, provided it meets the required characteristics.

Table 1-4. Recommended Test Equipment

Instrument Type	Required Characteristic	Recommended Instrument
VHF Signal Generator	Freq Range: 500 kHz to 512 MHz	HP 8640A/B
Synthesized Signal Generator	Freq Range: 1MHz to 1300 MHz	HP 8550A/C with Option 100
Sweep Oscillator	Freq Range: 0.01 GHz to 1.4 GHz	HP 8620C with HP 86222A

Table 1-4. Recommended Test Equipment (continued)

Instrument Type	Required Characteristic	Recommended Instrument												
RF Plug-in		HP 86602B												
Power/Meter/Sensor	Range: -20 dBm to + 20 dBm	HP 436A and HP 8481A												
Test Oscillator	Freq Range: 10 Hz to 10 MHz Amplitude: 5V p-p	HP 654A <i>AL</i>												
Termination, Feed-through (Two required)	50 ohms $\pm$ 1%	HP 10100C												
Function Generator	Freq Range: 0.01 Hz to 13 MHz	HP 3312A												
Adapter, BNC	"T" (m) (f) (f)	1250-0781												
Adapter, Type "N" (Two required)	N (m) to BNC (f)	1250-0780												
Adapter, Type "N"	N (m) to BNC (m)	1250-0082												
Power Splitter	Freq Range: dc to 18 GHz	HP 11667A												
Attenuator	10 dB	HP 8491A (Option 010)												
DC Standard	<table border="1"> <thead> <tr> <th>Range (<math>\pm</math>)</th> <th>Resolution</th> <th>Accuracy</th> </tr> </thead> <tbody> <tr> <td>0-10V</td> <td>100 <math>\mu</math>V</td> <td>&lt;100 <math>\mu</math>V</td> </tr> <tr> <td>10-100V</td> <td>1 mV</td> <td>&lt;1 mV</td> </tr> <tr> <td>100-1000V</td> <td>1 V</td> <td>10 mV</td> </tr> </tbody> </table>	Range ( $\pm$ )	Resolution	Accuracy	0-10V	100 $\mu$ V	<100 $\mu$ V	10-100V	1 mV	<1 mV	100-1000V	1 V	10 mV	Fluke 343A
Range ( $\pm$ )	Resolution	Accuracy												
0-10V	100 $\mu$ V	<100 $\mu$ V												
10-100V	1 mV	<1 mV												
100-1000V	1 V	10 mV												
Calculator	HP-IB Compatible	HP 9825A* <i>AL</i>												
HP-IB Calculator Interface	Connects HP 9825A to HP-IB	HP 98034A*												
Oscilloscope	Bandwidth: 50 MHz Sensitivity: 50 mV/major div	HP 1725A <i>AL</i>												
Digital Voltmeter	10V Range 0.01% Accuracy, plus ohmmeter range to 1 Mohm	HP 3468B												
Logic Clip	$\geq 0.4 \times$ Supply voltage = Logic High	HP 548A												
DC Power Supply	0-10V Stable to $\pm 1$ mV	HP 6214B <i>AL</i>												
RMS Voltmeter	RMS AC Voltage 0-10V Range	HP 3400A												
Logic Probe	TTL Compatible	HP 10525T												
Logic Pulser	TTL Compatible	HP 10526T												
Pulse Generator	0.5 Hz to 25 MHz at 1V	HP 8008A <i>AL</i>												
Signature Analyzer	TTL Compatible	HP 5005B												
<p>*HP 9825A should have —                      HP 98213A General Extended I/O ROM or                      HP 98214A Plotter-General-Extended I/O ROM or                      HP 98216A Plotter-General-Extended I/O ROM</p>														

## SECTION II INSTALLATION

### 2-1. INTRODUCTION

This section provides installation instructions for the HP Model 5328B Universal Counter. It also includes information about initial inspection and damage claims, preparation for use, packaging, storage, and shipment.

### 2-2. SAFETY CONSIDERATIONS

The warnings and cautions below must be followed for your protection and to avoid damage to equipment.

**WARNING**

**BE SURE ALL ELECTRICALLY OPERATED EQUIPMENT YOU USE IS PROPERLY GROUNDED.**

**CAUTION**

**Be sure to turn electrical power off whenever you are connecting or disconnecting test equipment, installing or removing parts, etc.**

### 2-3. INITIAL INSPECTION

Inspect the shipping container for damage. If the shipping container or cushioning material is damaged, it should be kept until the contents of the shipment have been checked for completeness and the counter has been checked mechanically and electrically.

The contents of the shipment should be as shown in *Figure 1-1*. Procedures for checking electrical performance are given in Section 4 of this manual.

If the contents are incomplete, if there is mechanical damage or defect, or if the Model 5328B fails its performance test (see Section 4 of this manual), notify the nearest Hewlett-Packard office.

If the shipping container is damaged, or the cushioning material shows signs of stress, notify the carrier as well as the Hewlett-Packard office. Keep the shipping materials for the carrier's inspection. The HP office will arrange for repair or replacement at HP's option without waiting for a claim settlement.

### 2-4. PREPARATION FOR USE

**CAUTION**

- To prevent damage to the HP 5328B, make the line voltage selection before connecting it to line power.
- Also, be sure the line power cord is connected to a line power socket that is provided with a protective ground contact.
- Be sure the correct-value line fuse is installed for the line voltage to be used.

## 2-5. Power Requirements

The Model 5328B can be operated on single-phase 100V, 120V, 220V, or 240V ac power; these are "nominal" voltages, actual line voltages may vary from -10% to +5% from these values. A chart indicating these voltages, the voltage limits, and the appropriate fuse to use is presented in *Table 2-1*.

The Model 5328B requires 150VA (maximum).

The power line frequency must be in the range from 48 to 66 Hz.

Table 2-1. Line Fuses

Line Voltage (Nominal and Range)	Line Fuse	
	Rating	HP Part Number
100V 90V to 105V	2.0A 250V	2110-0002
120V 108V to 126V	Fast- blow	
220V 198V to 231V	1.0A 250V	2110-0001
240V 216V to 252V	Fast- blow	



## 2-6. Line Voltage and Fuse Selection

To avoid damage to the Model 5328B,

1. Its rear-panel line voltage selector switches must be set to the positions corresponding to the nominal line voltage being used (i.e., "100V", "120V", "220V", or "240V"). The switch settings are illustrated near the switches at the left-hand side of the rear panel.
2. A line fuse of the correct rating must be installed. The line fuse values for the Model 5328B's operating voltage ranges are listed near the line fuse holder on the Model 5328B's rear panel, and in *Table 2-1* in this manual section.

To configure the Model 5328B for operation from a specific nominal line voltage

- a. Disconnect the ac power cable.
- b. Set the rear-panel line selector switches as required.
- c. Install the appropriate (1.0-amp or 2.0-amp) fuse.
- d. Reconnect the ac power cable.

## 2-7. Power Cable

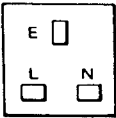

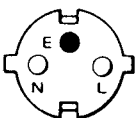
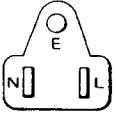
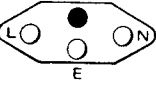
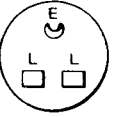
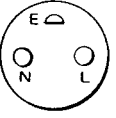
**WARNING**

**TO PROTECT OPERATING AND SERVICING PERSONNEL, THE MODEL 5328B IS EQUIPPED WITH A THREE-PIN POWER RECEPTACLE. THE CENTER PIN OF THE RECEPTACLE CONNECTS THE INSTRUMENT'S CHASSIS AND PANELS TO EARTH GROUND WHEN USED WITH A PROPERLY WIRED THREE-CONDUCTOR OUTLET AND POWER CABLE. IMPROPERLY GROUNDED EQUIPMENT CAN RESULT IN HAZARDOUS POTENTIALS BETWEEN UNITS.**

To accommodate to the different power receptacles used throughout the world, the Model 5328B is supplied with a power cord appropriate for the destination country. The power cords available are shown in *Figure 2-1*.

Model 5328B  
Installation

Figure 2-1. Power Cables Available

PLUG TYPE	CABLE HP PART NO.	*C D	PLUG DESCRIPTION	CABLE LENGTH (INCHES)	CABLE COLOR	FOR USE IN COUNTRY
<b>250V</b> 	8120-1351 8120-1703	0 6	Straight **BS1363A 90°	90 90	Mint Gray Mint Gray	United Kingdom, Cyprus, Nigeria Rhodesia, Singapore
<b>250V</b> 	8120-1369 8120-0696	0 4	Straight **NZSS198/ASC112 90°	79 87	Gray Gray	Australia, New Zealand
<b>250V</b> 	8120-1689 8120-1692	7 2	Straight **CEE7-Y11 90°	79 79	Mint Gray Mint Gray	East and West Europe, Saudi Arabia, Egypt, So Africa, India (Unpolarized in many nations)
<b>125V</b> 	8120-1348 8120-1398 8120-1754 8120-1378 8120-1521 8120-1676	5 5 7 1 6 2	Straight **NEMA5-15P 90° Straight **NEMA5-15P 90° Straight **NEMA5-15P 90° Straight **NEMA5-15P 90°	80 80 36 80 80 30	Black Black Black Jade Gray Jade Gray Jade Gray	United States, Canada, Japan (100V or 200V), Mexico, Philippines, Taiwan
<b>250V</b> 	8120-2104	3	Straight **SEV1011 1959-24507 Type 12	79	Gray	Switzerland
<b>250V</b> 	8120-0698	6	Straight **NEMA6-15P			United States, Canada
<b>220V</b> 	8120-2956 8120-2957	2 3	Straight **DHCK 107 90°	79 79	Gray Gray	Denmark

\*CD = Check Digit (refer to Section VI).

\*\*Part number shown for plug is industry identifier for plug only. Number shown for cable is HP Part Number for complete cable including plug.

E = Earth Ground    L = Line    N = Neutral

## 2-8. Interconnections

The Model 5328B's power cable requirements are described above.

## 2-9. BNC CONNECTORS

Except for its rear-panel HP-IB connection (use of which is not required for basic operations of the counter) all signal connections to the Model 5328B are made via standard BNC connectors. Hewlett-Packard offers a variety of cables and adapters that can be used with the Model 5328B's BNC connectors; refer to a current HP catalog or to your local Hewlett-Packard Sales and Service Office for additional information. A listing of the Model 5328B's BNC connectors is provided in Table 2-2.

Table 2-2. Model 5328B Mating Connectors

Connector	Industry Identification	HP Part Number	Alternate Source
Channel "A" INPUT (A12J2)	BNC, male	1250-0118	Bendix 30384-1
Channel "A" MARKER OUTPUT (A19J2)	BNC, female	1250-1163	none
Channel "B" INPUT (A12J3)	BNC, male	1250-0118	Bendix 30384-1
Channel MARKER OUTPUT (A19J4)	BNC, female	1250-1163	none
Channel "C" INPUT (J311)	BNC, female	1250-0186	Specialty Connector Co 28JR129-1
Digital Voltmeter "High" INPUT (J210)	Banana, female	1510-0091	none
Digital Voltmeter "Low" INPUT (J211)	Banana, female	1510-0091	none
Inhibit Open Collector (rear) J1	BNC, female	1250-0083	none
Gate Out (rear) (J1)	BNC, female	1250-0083	none
TB Out (rear) (J3)	BNC, female	1250-0083	none
OSC EXT (rear) (J4)	BNC, female	1250-0083	none
HP-IB Connector (rear) (A15J6)	Microribbon, female	1251-3283	none

## 2-10. HP-IB (HEWLETT-PACKARD INTERFACE BUS)

A standard feature of the Model 5328B is its capability to be connected to other units via the Hewlett-Packard Interface Bus (HP-IB).\*

Via the HP-IB the Model 5328B can "TALK ONLY", sending data to some other device (such as a printer); or it can be "ADDRESSABLE", receiving commands from a device connected to it as a "controller". (A typical "controller" is an HP Calculator, such as the Model 9826.)

The HP-IB cable connectors include locking screws to lock them together. When you have connected each cable to its mating connector, beginning with the connector on the Model 5328B, tighten the locking screws; this will keep the cables from accidentally coming loose.

### NOTE

On HP-IB cables — black screws have metric threads, silver screws have English threads. The connection at the Model 5328B requires metric threads. Do not try to mate black and silver locking screws.



To prevent possible damage to the Model 5328B, be sure you turn the line power off before connecting or disconnecting any cable (especially the HP-IB cable).



Be sure to unlock cable connectors before you try to separate a cable from its mating connector. Failure to do so can cause you to strain the cable, damaging it internally; it can also cause you to damage the connectors.

HP-IB cables are available as listed in Table 2-3 below. For more information about HP-IB, refer to the current Hewlett-Packard catalog or contact your local HP Sales and Service Office.

Table 2-3. HP-IB Cables Available

Cable Length	Hewlett-Packard Product Number
1 m (3.3 ft)	HP10833A
2m (6.6 ft)	HP10833B
4 m (13.2 ft)	HP10833C
0.5 m (1.6 ft)	HP10833D

\*HP-IB is Hewlett-Packard's implementation of IEEE standard 488-1978 and IEC 625-1.



## 2-11. Operating Environment

While it is operating, the Model 5328B's environmental conditions should be limited as follows —

Temperature ..... 0°C to 50°C, (32 F to 122 F)

The maximum and minimum temperatures are also listed as part of the Model 5328B's Specifications in *Table 1-1*. If these limits are exceeded at the installation site, auxiliary cooling or heating should be used to keep the environment within allowable limits. A one-inch space should be kept clear above the Model 5328B in order to allow for the circulation of cooling air. Also, you should be sure to keep clear the fan intake at the rear of the instrument.

## 2-12. INSTALLATION INSTRUCTIONS

The Model 5328B can be installed for use in any of several ways —

- It can be operated on a bench, individually, or as part of a "system" of instruments that are connected and operated via HP-IB. Additional information is provided below.
- It can be installed and operated in a rack, individually or as part of a "system". Additional information is provided below.
- It can be installed in a Transit Case for additional protection during transit. Additional information is provided below.

## 2-13. Bench Operation

The Model 5328B's cabinet has plastic feet and fold-away tilt stands for convenience in bench operation. The tilt stands allow the instrument to be tilted for easier use of its front-panel controls and indicators.

## 2-14. Rack Mounting

The standard Model 5328B is ready for bench operation as shipped from the factory. To mount the Model 5328B in a rack, it is necessary to order and install the rack flange kit listed in *Table 1-2*.



**Ambient temperature in the rack during operation of the Model 5328B should not exceed 50°C (122 F). Be sure that the Model 5328B's position in the rack allows sufficient air circulation and that nearby equipment does not discharge hot air directly onto the instrument.**

## 2-15. Transit Cases

Hewlett-Packard offers Transit Cases that can be used to protect an individual instrument that is often transported. Some Transit Case versions are large enough that they allow groups of instruments (i.e., "systems") to be protected as they are transported, without having to disconnect the system connections during transit. For additional information about HP's transit cases and their possible use with the Model 5328B, contact your local Hewlett-Packard Sales and Service Office.

## 2-16. MODIFICATIONS

Field-installation of any of the Model 5328B Options listed below is possible. If you want to have any one or more of the Options listed below added to a Model 5328B that was originally ordered (and shipped) without it, contact your local Hewlett-Packard Sales and Service Office.

- Option 010 – High-stability Oscillator
- Option 021 – Digital Voltmeter
- Option 031 – 90 MHz to 1300 MHz “C” Channel
- Option 050 – combination of Option 021 and Option 031, described above.

## 2-17. STORAGE AND SHIPMENT

### 2-18. Environment

The HP 5328B Universal Counter can be stored or shipped in environments within the following limits —

Maximum Temperature	.....	+75°C (167°F)
Minimum Temperature	.....	-40°C (-40°F)
Altitude (unpressurized)	.....	7,6 km (25,000 feet)

The Model 5328B should also be protected from temperature extremes which could cause condensation inside it.

### 2-19. Packaging

**Tagging for Service.** If the Model 5328B is being returned to Hewlett-Packard for service, please complete one of the blue repair tags located at the end of this section and attach it to the unit.

**Original Packaging.** Containers and materials identical to those used in factory packaging are available through Hewlett-Packard offices. If the Model 5328B is being returned to HP for servicing, attach a tag indicating the type of service required, return address, model number, and full serial number. Also mark the container “FRAGILE” to ensure careful handling. In any correspondence, refer to the unit by Model Number and full Serial Number.

**Other Packaging.** The following general instructions should be used for re-packing with commercially available materials.

- a. Wrap the Model 5328B in heavy paper or plastic. (If shipping to a Hewlett-Packard office or service center, attach a tag indicating the type of service required, return address, model number, and full serial number.)
- b. Use a strong shipping container. A double-wall carton made of 350-pound test material is adequate.
- c. Use a layer of shock-absorbing material 75 to 100 mm (3 to 4 inches) thick around all sides of the Model 5328B to provide firm cushioning and prevent movement inside the container. Protect the front panel with cardboard.
- d. Seal the shipping container securely.
- e. Mark the shipping container “FRAGILE” to ensure careful handling.
- f. In any correspondence, refer to the unit by Model Number and full Serial Number.

### 2-20. Storage

If the Model 5328B is to be stored for an extended period of time, it should be enclosed in a clean, dry, sealed container. See specifications in Section 1 for storage environment limitations.



Should one of your HP instruments need repair, the HP service organization is ready to serve you. However, you can help us serve you more effectively. When sending an instrument to HP for repair, please fill out this card and attach it to the product. Increased repair efficiency and reduced turn-around time should result.

COMPANY \_\_\_\_\_

ADDRESS \_\_\_\_\_

TECHNICAL CONTACT PERSON \_\_\_\_\_

PHONE NO. \_\_\_\_\_ EXT. \_\_\_\_\_

MODEL NO. \_\_\_\_\_ SERIAL NO. \_\_\_\_\_

MODEL NO. \_\_\_\_\_ SERIAL NO. \_\_\_\_\_

P.O. NO. \_\_\_\_\_ DATE \_\_\_\_\_

Accessories returned with unit

NONE  CABLE(S)

POWER CABLE  ADAPTER(S)

OTHER \_\_\_\_\_ over \_\_\_\_\_



Should one of your HP instruments need repair, the HP service organization is ready to serve you. However, you can help us serve you more effectively. When sending an instrument to HP for repair, please fill out this card and attach it to the product. Increased repair efficiency and reduced turn-around time should result.

COMPANY \_\_\_\_\_

ADDRESS \_\_\_\_\_

TECHNICAL CONTACT PERSON \_\_\_\_\_

PHONE NO. \_\_\_\_\_ EXT. \_\_\_\_\_

MODEL NO. \_\_\_\_\_ SERIAL NO. \_\_\_\_\_

MODEL NO. \_\_\_\_\_ SERIAL NO. \_\_\_\_\_

P.O. NO. \_\_\_\_\_ DATE \_\_\_\_\_

Accessories returned with unit

NONE  CABLE(S)

POWER CABLE  ADAPTER(S)

OTHER \_\_\_\_\_ over \_\_\_\_\_



Should one of your HP instruments need repair, the HP service organization is ready to serve you. However, you can help us serve you more effectively. When sending an instrument to HP for repair, please fill out this card and attach it to the product. Increased repair efficiency and reduced turn-around time should result.

COMPANY \_\_\_\_\_

ADDRESS \_\_\_\_\_

TECHNICAL CONTACT PERSON \_\_\_\_\_

PHONE NO. \_\_\_\_\_ EXT. \_\_\_\_\_

MODEL NO. \_\_\_\_\_ SERIAL NO. \_\_\_\_\_

MODEL NO. \_\_\_\_\_ SERIAL NO. \_\_\_\_\_

P.O. NO. \_\_\_\_\_ DATE \_\_\_\_\_

Accessories returned with unit

NONE  CABLE(S)

POWER CABLE  ADAPTER(S)

OTHER \_\_\_\_\_ over \_\_\_\_\_



Should one of your HP instruments need repair, the HP service organization is ready to serve you. However, you can help us serve you more effectively. When sending an instrument to HP for repair, please fill out this card and attach it to the product. Increased repair efficiency and reduced turn-around time should result.

COMPANY \_\_\_\_\_

ADDRESS \_\_\_\_\_

TECHNICAL CONTACT PERSON \_\_\_\_\_

PHONE NO. \_\_\_\_\_ EXT. \_\_\_\_\_

MODEL NO. \_\_\_\_\_ SERIAL NO. \_\_\_\_\_

MODEL NO. \_\_\_\_\_ SERIAL NO. \_\_\_\_\_

P.O. NO. \_\_\_\_\_ DATE \_\_\_\_\_

Accessories returned with unit

NONE  CABLE(S)

POWER CABLE  ADAPTER(S)

OTHER \_\_\_\_\_ over \_\_\_\_\_



Should one of your HP instruments need repair, the HP service organization is ready to serve you. However, you can help us serve you more effectively. When sending an instrument to HP for repair, please fill out this card and attach it to the product. Increased repair efficiency and reduced turn-around time should result.

COMPANY \_\_\_\_\_

ADDRESS \_\_\_\_\_

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PHONE NO. \_\_\_\_\_ EXT. \_\_\_\_\_

MODEL NO. \_\_\_\_\_ SERIAL NO. \_\_\_\_\_

MODEL NO. \_\_\_\_\_ SERIAL NO. \_\_\_\_\_

P.O. NO. \_\_\_\_\_ DATE \_\_\_\_\_

Accessories returned with unit

NONE  CABLE(S)

POWER CABLE  ADAPTER(S)

OTHER \_\_\_\_\_ over \_\_\_\_\_



Should one of your HP instruments need repair, the HP service organization is ready to serve you. However, you can help us serve you more effectively. When sending an instrument to HP for repair, please fill out this card and attach it to the product. Increased repair efficiency and reduced turn-around time should result.

COMPANY \_\_\_\_\_

ADDRESS \_\_\_\_\_

TECHNICAL CONTACT PERSON \_\_\_\_\_

PHONE NO. \_\_\_\_\_ EXT. \_\_\_\_\_

MODEL NO. \_\_\_\_\_ SERIAL NO. \_\_\_\_\_

MODEL NO. \_\_\_\_\_ SERIAL NO. \_\_\_\_\_

P.O. NO. \_\_\_\_\_ DATE \_\_\_\_\_

Accessories returned with unit

NONE  CABLE(S)

POWER CABLE  ADAPTER(S)

OTHER \_\_\_\_\_ over \_\_\_\_\_

5955-8108

Service needed

- CALIBRATION ONLY
- REPAIR       REPAIR & CAL

OTHER \_\_\_\_\_

Observed symptoms/problems

FAILURE MODE IS:

- CONSTANT     INTERMITTENT

SENSITIVE TO:

- COLD     HEAT     VIBRATION

FAILURE SYMPTOMS/SPECIAL CONTROL SETTINGS \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

If unit is part of system list model number(s) of other interconnected instruments. \_\_\_\_\_

9320-3896

Printed in U.S.A.

Service needed

- CALIBRATION ONLY
- REPAIR       REPAIR & CAL

OTHER \_\_\_\_\_

Observed symptoms/problems

FAILURE MODE IS:

- CONSTANT     INTERMITTENT

SENSITIVE TO:

- COLD     HEAT     VIBRATION

FAILURE SYMPTOMS/SPECIAL CONTROL SETTINGS \_\_\_\_\_

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If unit is part of system list model number(s) of other interconnected instruments. \_\_\_\_\_

9320-3896

Printed in U.S.A.

Service needed

- CALIBRATION ONLY
- REPAIR       REPAIR & CAL

OTHER \_\_\_\_\_

Observed symptoms/problems

FAILURE MODE IS:

- CONSTANT     INTERMITTENT

SENSITIVE TO:

- COLD     HEAT     VIBRATION

FAILURE SYMPTOMS/SPECIAL CONTROL SETTINGS \_\_\_\_\_

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If unit is part of system list model number(s) of other interconnected instruments. \_\_\_\_\_

9320-3896

Printed in U.S.A.

Service needed

- CALIBRATION ONLY
- REPAIR       REPAIR & CAL

OTHER \_\_\_\_\_

Observed symptoms/problems

FAILURE MODE IS:

- CONSTANT     INTERMITTENT

SENSITIVE TO:

- COLD     HEAT     VIBRATION

FAILURE SYMPTOMS/SPECIAL CONTROL SETTINGS \_\_\_\_\_

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If unit is part of system list model number(s) of other interconnected instruments. \_\_\_\_\_

9320-3896

Printed in U.S.A.

Service needed

- CALIBRATION ONLY
- REPAIR       REPAIR & CAL

OTHER \_\_\_\_\_

Observed symptoms/problems

FAILURE MODE IS:

- CONSTANT     INTERMITTENT

SENSITIVE TO:

- COLD     HEAT     VIBRATION

FAILURE SYMPTOMS/SPECIAL CONTROL SETTINGS \_\_\_\_\_

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If unit is part of system list model number(s) of other interconnected instruments. \_\_\_\_\_

9320-3896

Printed in U.S.A.

Service needed

- CALIBRATION ONLY
- REPAIR       REPAIR & CAL

OTHER \_\_\_\_\_

Observed symptoms/problems

FAILURE MODE IS:

- CONSTANT     INTERMITTENT

SENSITIVE TO:

- COLD     HEAT     VIBRATION

FAILURE SYMPTOMS/SPECIAL CONTROL SETTINGS \_\_\_\_\_

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If unit is part of system list model number(s) of other interconnected instruments. \_\_\_\_\_

9320-3896

Printed in U.S.A.

## SECTION III OPERATION (APPLICATIONS AND PROGRAMMING)

### 3-1. BASIC COUNTER OPERATION

The HP Model 5328B Universal Counter can make the following measurements —

- Frequency
- Period
- Frequency Ratio
- Time Interval
- Totalization or Scaling

Procedures for making each of these measurements are provided later in this manual section.

The Model 5328B includes provision for remote control via the Hewlett-Packard Interface Bus (HP-IB). Instructions for this are also provided later in this manual section.

The Model 5328B's front-panel controls, connectors and indicators, including those for the optional Digital Voltmeter and the optional C Channel, are illustrated in *Figure 3-1*. Descriptions of the controls are necessarily shortened in this figure; more-detailed descriptions of these controls are given following the figure. Similarly, the Model 5328B's rear-panel controls, connectors, and indicators are described in *Figure 3-2*, with more-complete descriptions following the figure.

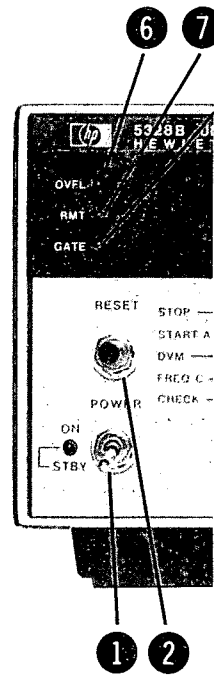
#### WARNING

**BEFORE THE INSTRUMENT IS SWITCHED ON, ALL PROTECTIVE EARTH TERMINALS, EXTENSION CORDS, AUTOTRANSFORMERS AND DEVICES CONNECTED TO IT SHOULD BE CONNECTED TO A PROTECTIVE EARTH GROUNDED SOCKET. ANY INTERRUPTION OF THE PROTECTIVE EARTH GROUND WILL CAUSE A POTENTIAL SHOCK HAZARD THAT COULD RESULT IN PERSONAL INJURY.**

#### CAUTION

**Before energizing the counter, the instrument must be set to the voltage of the power source or damage to the instrument may result. See Section II of this manual.**

1. POWER switch. In STBY position, supplies power to oven of the Option 010 High-stability Time Base (if installed), to maintain a constant temperature for the crystal. In the ON position, supplies normal operating power to the Model 5328B.
2. RESET button. Resets display and internal count to zero. When continuously depressed, lights all segments of the LED display and all annunciator LED's for LED test. Returns the Model 5328B to LOCAL CONTROL when HP-IB Interface is in use.
3. FUNCTION selector. Selects mode of operation.
  - a. RATIO C/A. Sets counter to measure the ratio of the frequency at (optional) Channel C to the frequency at Channel A.
  - b. CHECK. Applies 10 MHz to decade counting assemblies. Verifies operation of SAMPLE RATE control, RESOLUTION switch, and RESET.
  - c. FREQ C. Sets counter to measure the frequency at the (optional) Channel C input.
  - d. DVM. Sets counter to measure the voltage applied to the terminals of the (optional) Digital Voltmeter.
  - e. START A,STOP. Sets the counter to totalize the number of events at the "A" input until STOP is selected, for N=1 on the RESOLUTION switch. For N=1, the number of counts divided by N is totalized. The scaled output (i.e., frequency of A/N) is available at the rear-panel TB OUT (Time Base Output) connector.
  - f. START CLOCK. A "phantom" function, located one switch position clockwise from STOP. Totalizes the internal 10 MHz clock divided by N, where "N" is selected by the RESOLUTION switch ( $N \leq 10$ ). The scaled output (i.e., 10 MHz/N) is available at the rear-panel TB OUT (Time Base Output) connector.
  - g. DVM/A. A "phantom" function, located two switch positions clockwise from STOP. Used for scaling DVM measurements. Counter displays DVM/freq A, where freq A is  $\leq 10$  MHz.
  - h. DVM, A-B. A "phantom" function, located three switch positions to the right of STOP. The voltage at the DVM terminals is integrated over the synchronized time interval defined by events at Channels A and B. Units of the displayed reading are volt•seconds.
  - i. FREQ A. Sets counter to measure frequency at Channel A.
  - j. PER A. Sets the counter to measure period at Channel A.
  - k. PER AVG A. Sets counter to make a period average measurement of the signal at Channel A. The number of periods over which the average measurement is made is determined by "N", selected by the RESOLUTION switch.
  - l. RATIO B/A. Sets counter to measure the ratio of the frequency at Channel B to the frequency at Channel A.
  - m. T.I. A-B. Sets counter to make a time interval measurement. Start signal is applied to Channel A and the stop signal is applied to Channel B.

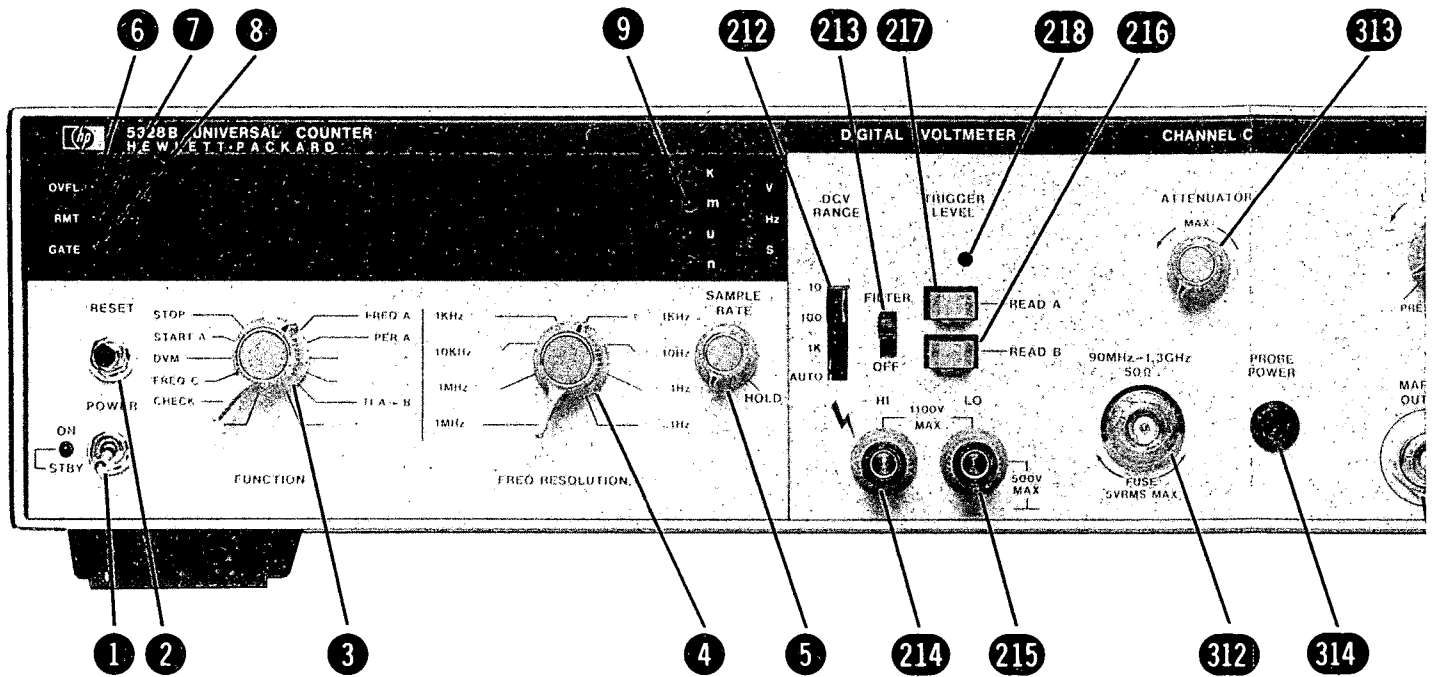


n. T.I. AVG A-B. Set time interval from measurement is r switch.

NOTE: "Phantom not labelled on th

4. FREQ RESOLUTION, N "N" for totalizing and a open for frequency me

N
1
10
100
103
104
105
106
107



n. T.I. AVG A→B. Sets counter to make a time interval average measurement of the time interval from A TO B. The number of time intervals over which the average measurement is made is determined by "N", selected by the RESOLUTION switch.

NOTE: "Phantom" functions are those which, due to relatively limited use, are not labelled on the Model 5328B's front panel.

4. FREQ RESOLUTION, N selection. Selects resolution in frequency measurements and "N" for totalizing and averaging measurements. Determines how long the main gate is open for frequency measurements.

<u>N</u>	<u>Gate Time</u>	<u>Resolution</u>
1	1 μS	1 MHz
10	10 μS	100 kHz
100	100 μS	10 kHz
103	1 mS	1 kHz
104	0.01 S	100 Hz
105	0.1 S	10 Hz
106	1.0 S	1 Hz
107	10 S	0.1 Hz

5. SAMPLE RATE control. Varies time interval from 2 mS to HOLD, which holds the measurement.

6. OVFL (OVERFLOW) annunciator. Indicates when the measurement exceeds the range of the counter.

7. RMT (ReMoTe) annunciator. Indicates when the counter is in remote mode.

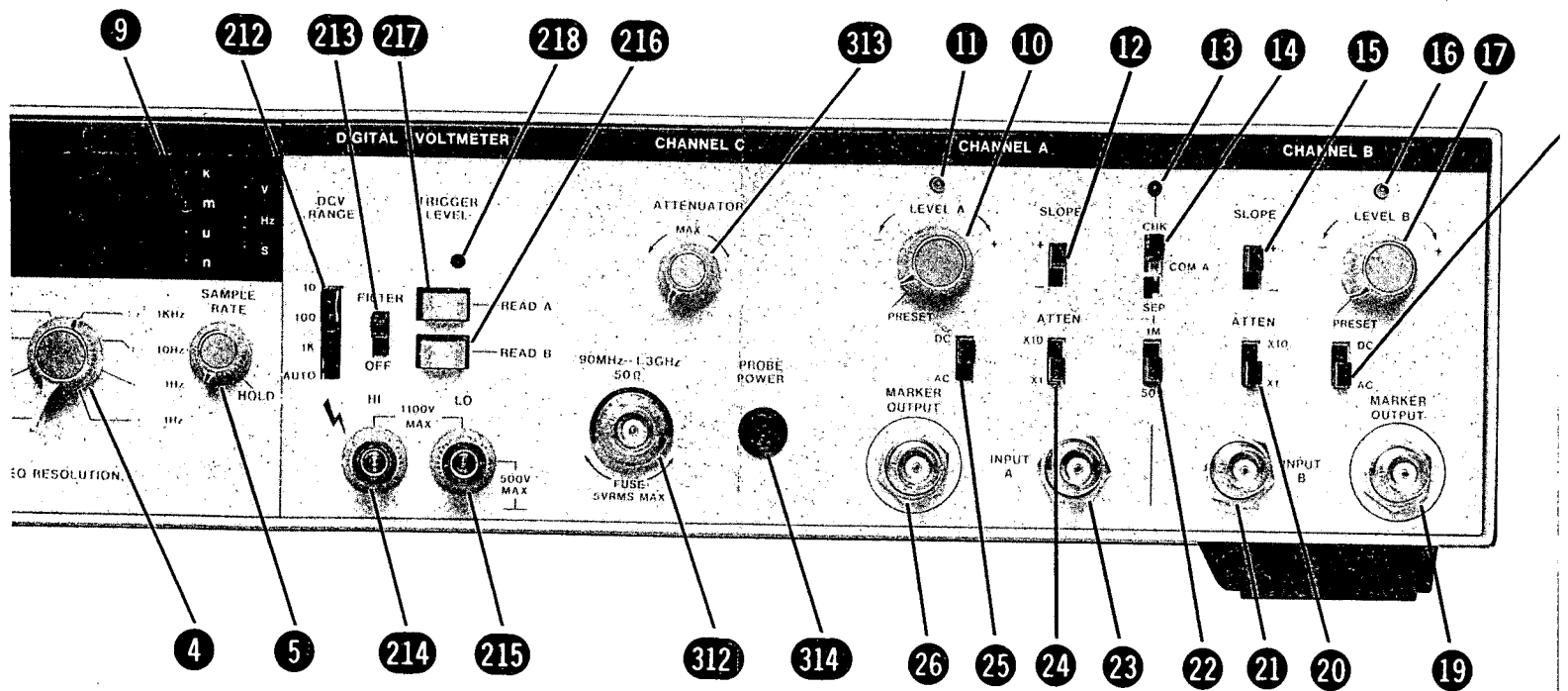
8. GATE annunciator. Indicates when the main gate is open.

9. "V", "K", "S", "m", "u", "n", "S", "Hz" indicators. Show the measurement units.

10, 17. LEVEL control. Used in conjunction with the trigger level knob to set the trigger level. With X1 attenuation, the trigger level is 100 mV.

11, 16. Trigger lights. Light blinks when the measurement is below the trigger level. Light is on when the measurement is above the trigger level.

12, 15. SLOPE switch. Selects trigger on rising or falling edge of the signal.



interval average measurement of the  
 e intervals over which the average  
 ", selected by the RESOLUTION

l, due to relatively limited use, are  
 el.

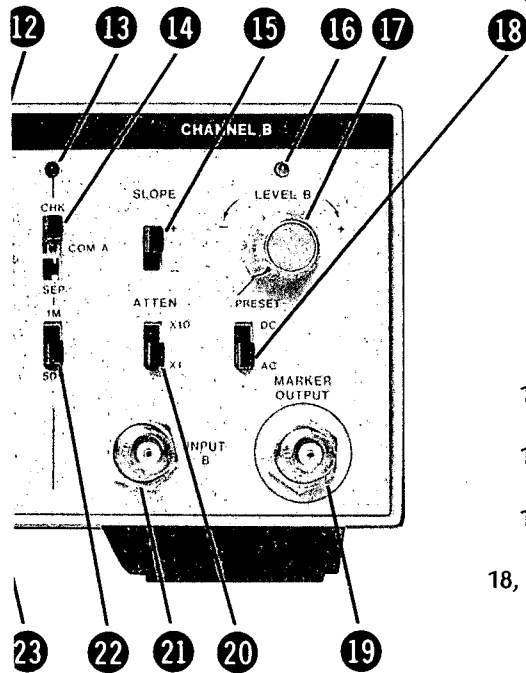
l in frequency measurements and  
 ermines how long the main gate is

in

lz  
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 lz  
 lz  
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 lz

4. SAMPLE RATE control. Varies the time between measurements, in a continuous range from 2 mS to HOLD, which holds the display indefinitely.
5. OVFL (OVERFlow) annunciator. Indicates that one or more of the most-significant digits (digits left-most from the decimal) are not displayed.
6. RMT (ReMoTe) annunciator. Lights when Model 5328B is in remote operation.
7. GATE annunciator. Indicates when the counter's main gate is open and a measurement is in progress.
8. "V", "K", "S", "m", "u", "n", and "Hz" annunciators. Indicate the units multiplier of the measurement.
- 9, 10, 17. LEVEL control. Used in conjunction with ATTEN switch to select voltage at which triggering occurs. With X1 attenuator, level is variable over  $\pm 2.5$  volts; in X10,  $\pm 25$  volts.
- 11, 16. Trigger lights. Light blinks when its channel is triggering. Light is OFF when input signal is below the trigger level. Light is ON when input signal is above trigger level.
- 12, 15. SLOPE switch. Selects triggering on either positive or negative slope of input signal.





13. CHK indicator. Lights when instrument is in CHK mode.
14. Input amplifier control switch.
  - a. CHK. With FUNCTION switch in FREQ A, counter should display 100 MHz  $\pm$ 1 count. Checks operation of phase-locked 100 MHz oscillator, SAMPLE RATE, RESOLUTION, N, and RESET.
  - b. COM A. The signal at "A" is also applied to Channel B for single-source time interval measurement. The "B" input and attenuator is disconnected from the input circuitry. Channel B coupling and attenuation are determined by the Channel A settings.
  - c. SEP. Allows independent operation of Channels A and B.
15. See "12,15", above.
16. See "11,16", above.
17. See "10,17", above.
- 18, 25. Coupling switch. Selects ac or dc coupling for input signal. When input amplifier control switch ("14") is in COM A, Channel B coupling is determined by the setting of the Channel A coupling switch.
19. MARKER OUTPUT B. Inverted Channel B Schmitt trigger output indicates when Channel B has triggered; 0 to +300 mV level into 50 ohms with less than 20 mS delay.
- 20, 24. ATTEN switch. Selects attenuation of input signal. Signal amplitude is reduced by 10 in X10. When input amplifier control switch ("14") is in COM A, Channel B attenuation is determined by Channel A attenuation switch.
- 21, 23. Channel Inputs. Input Channels B and A, respectively.
22. Input Impedance switch. Selects input impedance of 50 ohms or 1 Megohm for both channels A and B. For input amplifier control switch ("14") in COM A, impedance remains the same.
23. See "21,23", above.
24. See "20,24", above.
24. See "18,25", above.
26. MARKER OUTPUT A. Channel A Schmitt trigger output indicates when Channel A has triggered; 0 to +300 mV level into 50 ohms with less than 20 nS delay.

measurements, in a continuous range definitely.

one or more of the most-significant t displayed.

l 5328B is in remote operation.

main gate is open and a measurement

ators. Indicate the units multiplier of

N switch to select voltage at which variable over  $\pm$ 2.5 volts; in X10,  $\pm$ 25

gering. Light is OFF when input signal out signal is above trigger level.

ve or negative slope of input signal.

NOTES

1. Items "212 through 218" below are part of the Digital Voltmeter, which is not a standard part of the Model 5328B. The Digital Voltmeter is available when the Model 5328B is ordered with "Option 021" or "Option 050".
2. Operation of the Digital Voltmeter (if installed) is described in Paragraph 3-25.

212. DCV RANGE switch. Allows selection of  $\pm 10V$ ,  $\pm 100V$ ,  $\pm 1000V$ , or AUTORANGE.
213. FILTER switch. When "on", allows small signals to be measured in the presence of high common-mode noise. Response time when "on" is one second, when "off" 10 mS.
214. HI Input Terminal. Input terminal for "high" potential of external voltage. Must be less than 1100V above LO input terminal. (Types of test leads available are listed in Table 1-2.)
215. LO Input Terminal. Input terminal for "low" potential of external voltage. Must be less than 500 volts above chassis ground.
216. READ B. When depressed, measures Channel B trigger level, regardless of setting of FUNCTION switch.
217. READ A. When depressed, measures Channel A trigger level, regardless of setting of FUNCTION switch.

NOTE

The Model 5328B's "V" annunciator lights if: 1) the FUNCTION switch is set to DVM, 2) the DVM's READ B or READ A button is pressed.

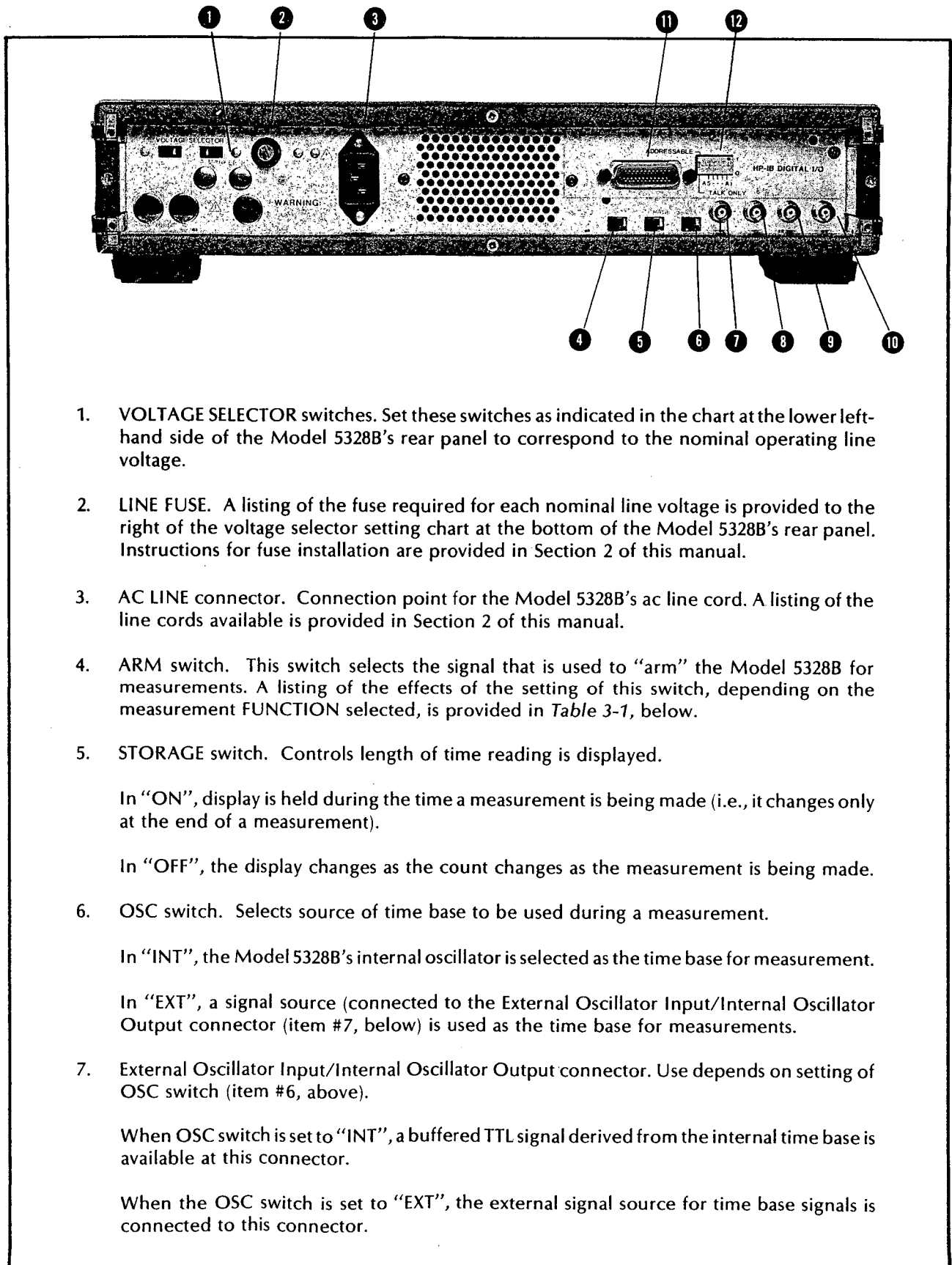
218. Access hole. Allows access to the DVM's "zero" adjustment. (The label "TRIGGER LEVEL" pertains to the READ A and READ B switches.)

NOTE

Items "312" through "314" below are part of the C Channel hardware, which is not a standard part of the Model 5328B. The C Channel is available when the Model 5328B is ordered with "Option 031" or "Option 050".

312. Input for Channel C. Frequency range allowed is 90 MHz to 1300 MHz (1.3 GHz).
313. ATTENUATOR. Attenuates Channel C input signal from 20 mV (maximum sensitivity, control fully clockwise) to 5 Vrms (minimum sensitivity, control fully counterclockwise).
314. PROBE POWER. Provides power for 1300 MHz preamplifier or active probe.

Figure 3-1. 5328B Front Panel — Operation Summary



1. **VOLTAGE SELECTOR** switches. Set these switches as indicated in the chart at the lower left-hand side of the Model 5328B's rear panel to correspond to the nominal operating line voltage.
2. **LINE FUSE**. A listing of the fuse required for each nominal line voltage is provided to the right of the voltage selector setting chart at the bottom of the Model 5328B's rear panel. Instructions for fuse installation are provided in Section 2 of this manual.
3. **AC LINE** connector. Connection point for the Model 5328B's ac line cord. A listing of the line cords available is provided in Section 2 of this manual.
4. **ARM** switch. This switch selects the signal that is used to "arm" the Model 5328B for measurements. A listing of the effects of the setting of this switch, depending on the measurement **FUNCTION** selected, is provided in *Table 3-1*, below.
5. **STORAGE** switch. Controls length of time reading is displayed.  
 In "ON", display is held during the time a measurement is being made (i.e., it changes only at the end of a measurement).  
 In "OFF", the display changes as the count changes as the measurement is being made.
6. **OSC** switch. Selects source of time base to be used during a measurement.  
 In "INT", the Model 5328B's internal oscillator is selected as the time base for measurement.  
 In "EXT", a signal source (connected to the External Oscillator Input/Internal Oscillator Output connector (item #7, below) is used as the time base for measurements.
7. **External Oscillator Input/Internal Oscillator Output** connector. Use depends on setting of **OSC** switch (item #6, above).  
 When **OSC** switch is set to "INT", a buffered TTL signal derived from the internal time base is available at this connector.  
 When the **OSC** switch is set to "EXT", the external signal source for time base signals is connected to this connector.

Figure 3-2. Model 5328B Rear Panel — Operation Summary

8. TB OUT Connector. Output signal here depends on setting of the Model 5328B's front-panel FUNCTION switch.

When the FUNCTION switch is set to "START CLOCK", the signal here is a TTL level at the frequency of the internal oscillator (10 MHz), divided by "N" (which is determined by the setting of the front-panel RESOLUTION switch).

When the FUNCTION switch is set to "START A", and the RESOLUTION switch is set to an "N" value of "10" or more, the signal here is a TTL level at the frequency of the INPUT "A" signal, divided by "N".

9. GATE OUT Connector. Signal here indicates status of the Model 5328B's main gate — "high" = "gate is open", "low" = "gate is closed".

10. INHIBIT Connector.

A TTL "low" (or "ground") signal applied here (standard TTL load impedance) prevents the Model 5328B from making a measurement.

11. HP-IB Interface Connector. Input/output connector for HP-IB data and/or control signals. For a description of HP-IB, see paragraph 3-35.

12. HP-IB Interface Address Switch. Determines the Model 5328B's HP-IB address when used with an HP-IB "controller". For a description of HP-IB, see paragraph 3-35.

**NOTE**

Additional holes, not specifically identified by number in this illustration, are provided for easy installation (at the factory, typically) of such options as rear-panel connectors that duplicate existing front-panel connectors, or connectors that provide capabilities not part of the standard Model 5328B or its standard set of Options. Any of these holes that is not used for installation of a connector will be blocked by use of a plug-button.

← THIS FIGURE BEGINS AT LEFT

Figure 3-2. Model 5328B Rear Panel — Operation Summary (Continued)

## 3-2. CONTROLS, CONNECTORS, INDICATORS — DETAILED DESCRIPTION

### 3-3. Front-panel

#### 3-4. DISPLAY

The Model 5328B's display consists of a nine-digit numeric display, plus annunciators for indicating units of measurement.

The numeric indicators are of the seven-segment LED type.

Measurement units indicated by the annunciators are — "Hz", "S", "V", and the multipliers "M" (for  $10^6$  or  $10^{-3}$ , as appropriate for the units being used), "k" (for  $10^3$ ), " $\mu$ " (for  $10^{-6}$ ), and "n" (for  $10^9$  or  $10^{-9}$ , as appropriate).

The display units and multipliers are automatically displayed, along with the correct decimal point location.

The "OVFL" indicator lights to indicate that the left-most significant digit(s) have overflowed the display.

The "RMT" indicator lights to indicate that the Model 5328B is operating under remote control via the HP-IB.

The "GATE" indicator indicates that the counter has been "armed" and that a measurement is in process.

#### 3-5. POWER

The POWER switch has two positions — "ON" and "STBY".

#### NOTE

The Model 5328B has no "on/off" switch controlling its operating power. Whenever its line cord is plugged into an operating ac line, the input to the main power transformer, plus the unregulated dc power to the (optional) high-stability oscillator oven is "on".

In its STBY position, some (but not all) of the Model 5328B's power supplies are turned off.

In its ON position, all of the Model 5328B's power supplies are turned on.

#### 3-6. RESET

The RESET pushbutton resets the display and internal count to zero, and also initiates single measurements when the SAMPLE RATE control is in the HOLD mode. Pushing the RESET button also restores the counter to local control (when not remotely locked out by the HP-IB Local Lockout universal command).

#### 3-7. SAMPLE RATE CONTROL

The SAMPLE RATE control sets the minimum time between samples. This time is continuously variable from less than two milliseconds between measurements to "HOLD", which holds the display indefinitely. The counter will internally (self) arm (via the SAMPLE RATE control) only when ARMING is OFF and the FUNCTION selected is other than FREQ A, FREQ C, and RATIO C/A.

### 3-8. ARMING

The counter may be armed internally (i.e., made ready to start a measurement) by the SAMPLE RATE control, or externally by the input signal itself, (arming off) or by a signal not directly involved in the measurement (arming on). Table 3-1 is an arming status table. A rear-panel switch turns ARMING either ON or OFF. The counter is armed within one microsecond after the event at the "B" arming input, and is armed within ten microseconds after the event of the "C" arming input.

Table 3-1. Arming Status

FUNCTION	ARMING OFF Armed by . . .	ARMING ON Armed by . . .
FREQ A	"A" input	"B" input
PERIOD A	SAMPLE RATE	"B" input
PERIOD AVG A	SAMPLE RATE	"B" input
T.I. A TO B	SAMPLE RATE	"C" input
T.I. AVG A TO B	SAMPLE RATE	"C" input
FREQ C	"C" input	"B" input
DVM	SAMPLE RATE	"B" input
RATIO B/A	SAMPLE RATE	"C" input
RATIO C/A	"C" input	"B" input
DVM/A	SAMPLE RATE	"B" input
DVM A TO B	SAMPLE RATE	"C" input
CHECK	Internal	"B" input
START	Measurement controlled by FUNCTION switch	
START CLOCK	Measurement controlled by FUNCTION switch	

### 3-9. RESOLUTION, N SWITCH

The RESOLUTION, N switch determines the amount of time that the counter's main gate is open for a particular measurement when the Main Gate Flip Flop determines the gate time. Depending on the measurement, this time results in a certain measurement resolution (e.g., frequency measurements), a number of intervals averages (e.g., period measurements), or an integration time (e.g., DVM measurements).

Table 3-2 shows the setting of the RESOLUTION switch and the corresponding time the main gate is open.

Table 3-3 summarizes the FUNCTIONS and the corresponding interpretation of the RESOLUTION N switch setting.

Table 3-2. RESOLUTION Switch Settings and Gate Times

RESOLUTION	N	GATE TIME
0.1 Hz	10 <sup>7</sup>	10 s
1 Hz	10 <sup>6</sup>	1 s
10 Hz	10 <sup>5</sup>	0.1 s
100 Hz	10 <sup>4</sup>	10 ms
1 kHz	10 <sup>3</sup>	1 ms
10 kHz	10 <sup>2</sup>	100 μs
100 kHz	10	10 μs
1 MHz	1	1 μs

Table 3-3. FUNCTIONS and RESOLUTION Switch Settings

FUNCTION	RESOLUTION, N Switch
FREQ A, FREQ C	Indicates frequency resolution in Hz.
PERIOD A, T.I. A to B	Indicates the factor (N) by which time base is scaled. Maximum resolution occurs with N=1.
PERIOD AVG A, T.I. AVG A to B	Indicates number of time intervals or periods over which the average measurement is made.
DVM	Indicates the integration time (per Table 3-2) for the measurement.
RATIO B/A, RATIO C/A, DVM/A†	Indicates the number of counts at the A input over which the ratio measurement is made. Resolution improves with increasing N.
START, START CLOCK	Indicates scale factor. In START, the frequency at A is scaled by N. In START CLOCK, internal oscillator is scaled by N.
DVM A to B†	Independent of RESOLUTION setting.
DVM/A	Indicates the number of counts at the A input over which the ratio measurement is made. (The DVM circuits are of the V to F type with the factor 10 kHz/volt.) Resolution improves with increased N. Annunciator is not displayed in units (V) but prefix (m, μ, n, etc.) is displayed.

†“Phantom” functions described in Figure 3-8

### 3-10. INPUT CHANNEL SELECTION

Two separate inputs (“A” and “B”) are provided on the Model 5328B’s universal module. These two inputs have identical specifications and controls.

The CHK/COM A/SEP switch, located between the two inputs, controls selection of input. When this switch is in its SEP position, the “A” and “B” inputs and controls operate independently of each other for applications in time interval, ratio, or other operations where the signals applied to the “A” and “B” inputs are from different sources. When the CHK/COM A/SEP switch is in its COM A position, the input circuits are connected as described below.

In the COM A position, the output of the Channel B attenuator is disconnected. The output of the Channel A attenuator is routed to the “A” and “B” input amplifiers as shown in Figure 3-3. In COM A, the Channel B AC/DC, 50-ohm/1 Megohm, and X1/X10 ATTENUator relays are disabled. The Channel A AC/DC, 50-ohm/1 Megohm, and “X1/X10” Attenuator settings determine the coupling for the Channel B amplifier (as well as for the Channel A amplifier). The impedance remains one Megohm when in COM A and in the high-impedance position (input capacitance remains <100pF). In the 50-ohm position, the impedance remains 50 ohms for COM A. The sensitivity, dynamic range, and damage levels remain unchanged.

## Model 5328B Operation

The "A" and "B" input amplifiers have independent LEVEL and SLOPE controls, regardless of the mode of operation (SEP or COM A).

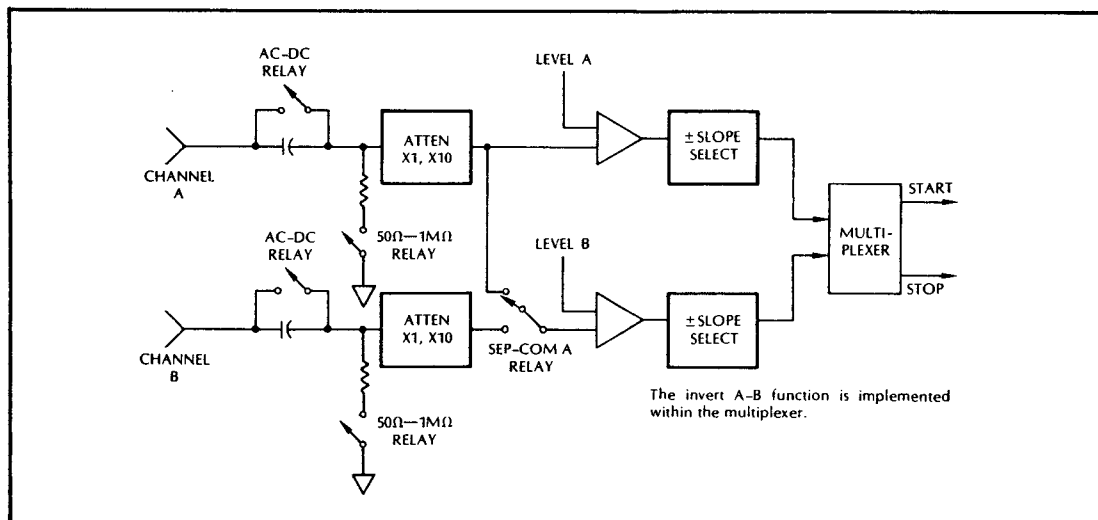


Figure 3-3. Input Switch Configuration for COM A

### 3-11. SIGNAL CONDITIONING

**AC/DC SWITCH.** The AC/DC switch controls the coupling of the external signal to the attenuator-amplifier by switching a capacitor in series in the AC position or by direct coupling in the DC position. The obvious advantage of AC coupling is to provide a DC block for signals containing a DC component. AC has the disadvantage of being unable to pass low-frequency (below 20 Hz) signals. A distinct advantage of having DC coupling cover the full bandwidth (DC-100 MHz) is that extremely accurate time interval or pulse measurements can be achieved even though pulse widths or repetition rates vary since the trigger point is independent of the duty cycle of the input signal.

**ATTENUATOR.** The attenuator (ATTEN) connects the input signal directly to the amplifier (in X1) or through a 10-to-1 attenuator (in X10) this allows the voltage range to be increased by ten times, allowing measurements of high-level signals that would otherwise be impossible without external attenuation.

**SLOPE SWITCH.** The  $\pm$ SLOPE switch (provided for each channel) determines which slope of the input signal will trigger the counter. As a simple example (see Figure 3-4), if the pulse width of a positive pulse is to be measured the Channel "A" SLOPE switch would be set to "+" and the Channel "B" SLOPE switch would be set to "-". (For time interval measurements, Channel "A" always begins the measurement and Channel "B" ends the measurement.)

#### NOTE

A simple pulse width measurement can be made by setting Channel "A"'s SLOPE to "+" and Channel "B"'s SLOPE to "-".



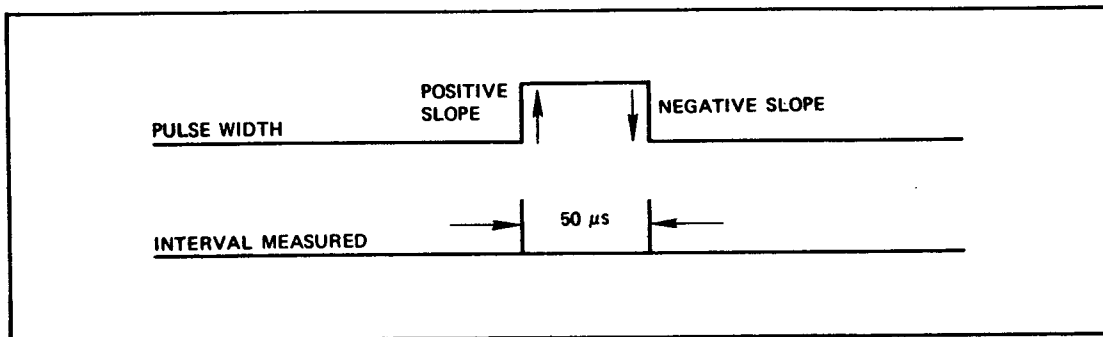


Figure 3-4. SLOPE Switch Settings

**LEVEL.** Each channel's LEVEL control can be adjusted over a range of  $\pm 2.5V$  dc (with the attenuator for that channel in its "X1" position). A typical use of the LEVEL controls is shown in Figure 3-5. You can read the triggering level if your Model 5328B includes a Digital Voltmeter module. Trigger level measurements are discussed under DVM measurements in paragraph 3-25.

**NOTE**

For a simple time interval measurement, the Channel "A" and Channel "B" "+LEVEL" settings are used to set the triggering levels.

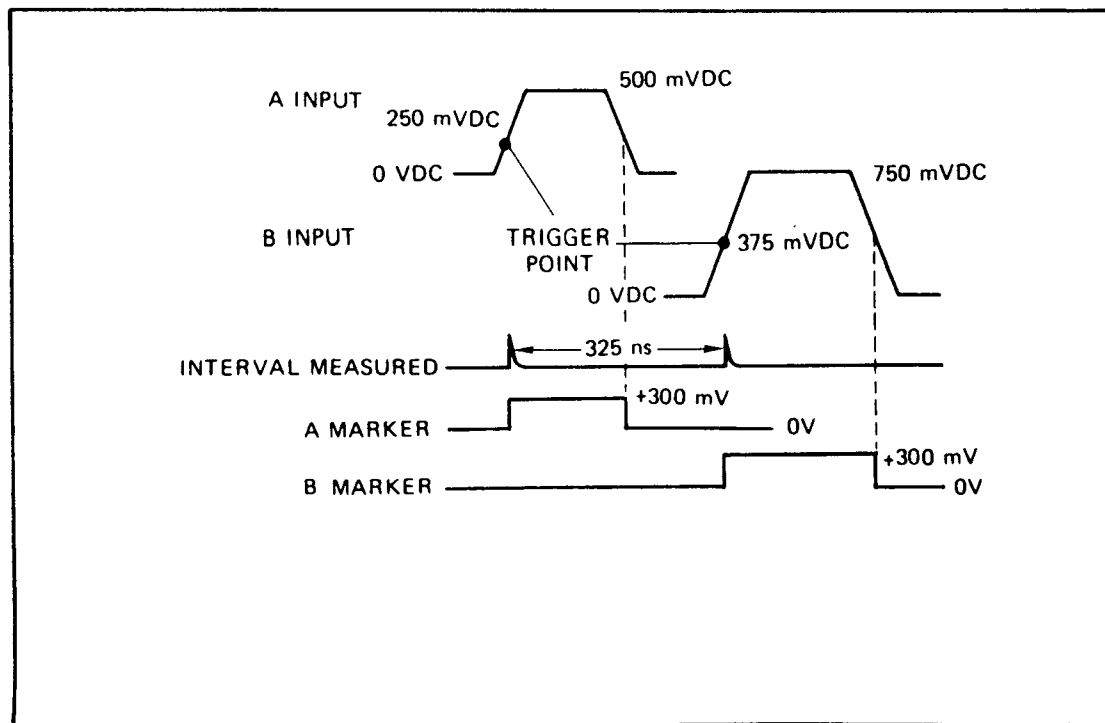


Figure 3-5. LEVEL Control Settings

### 3-12. HYSTERESIS

The width of the hysteresis band, shown in *Figure 3-6*, is determined by the sensitivity of the Model 5328B. For frequencies below 40 MHz, it is typically less than 25 mV peak-to-peak. At frequencies from 40 MHz to 100 MHz, it is typically less than 70 mV peak-to-peak. The signal must pass through the entire hysteresis band before a trigger pulse is generated. If the SLOPE switch is set to "+", the trigger pulse occurs at the top of the hysteresis band. If the SLOPE switch is set to "-", the trigger pulse occurs at the bottom of the hysteresis band.

Since trigger level measurements made by the (optional) Digital Voltmeter indicate the center of the hysteresis band (except when hysteresis compensation is in effect — see the "filter switch" paragraph under the "DIGITAL VOLTMETER MEASUREMENTS" heading (paragraph "3-25")), a better value for the actual trigger level may be obtained by subtracting one-half the hysteresis band ("-" slope) or adding one-half the hysteresis band ("+" slope). A typical value for the width of the hysteresis band is 50 mV peak-to-peak.

The value to use for the hysteresis band depends on the frequency; or, for pulses, it depends on the rise time.

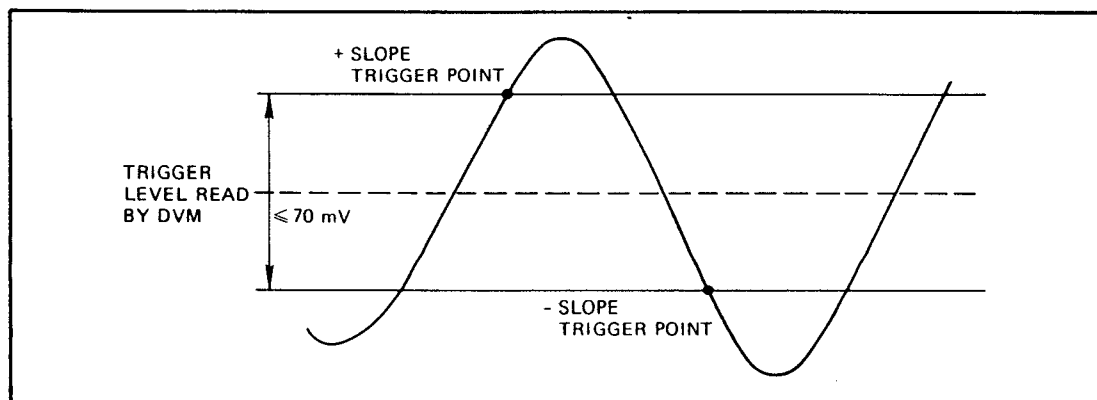


Figure 3-6. Hysteresis Band

### 3-13. MARKER OUTPUTS

The Model 5328B's front-panel MARKER OUTPUTs provide non-inverted square-wave versions of the input signal for their related channels. The output levels are — "low" = 0V, "high" = +500 mV. These outputs are useful for oscilloscope monitoring.

Time interval measurement setups can be simplified if you use an oscilloscope that allows display of the signal of interest and its associated marker output at the same time.

You can make a frequency measurement on a noisy signal with more confidence, since the markers can indicate the presence of noise triggering.

These outputs are protected from inadvertently applied voltages to  $\pm 5V$  dc.

### 3-14. TRIGGER LIGHTS

One trigger light each is provided for Channel "A" and Channel "B", to let you know if the channel is triggering. This information is also useful, since you can determine how the trigger LEVEL control must be adjusted in order to cause triggering.

For either channel, the TRIGGER light lights when the input signal is above the triggering level; it is off when the input signal is below the triggering level. When the channel is actually triggering, the TRIGGER light for that channel blinks.

The trigger lights are operative over the full frequency range of dc to 100 MHz.

The trigger lights can be used with a 10:1 oscilloscope probe to provide a logic-probe-type function. By adjusting the trigger level to one-tenth (since a 10:1 divider probe is being used) of the threshold voltage for the logic family under investigation (e.g., 0.14V for TTL), the light indicates the logic state of circuit points which are contacted with the probe. When the trigger level light is lighted, the circuit node is a "high" (i.e., above the threshold voltage). If the trigger level light is off, the node is a logic "low". If the light blinks, then pulses (up to 100 MHz rep rate) are present at the node. The trigger lights can also indicate the polarity of low-rep-rate pulses, down to 5 nS pulse width; positive pulses cause the light to blink on while negative pulses cause the light to blink off.

### 3-15. Rear Panel

#### 3-16. EXTERNAL FREQUENCY STANDARD INPUT

The rear-panel external frequency standard input ("OSC INT EXT") is useful for locking the counter to a high-stability external frequency standard. This external standard must be in the range of 30 kHz to 10 MHz, with an amplitude greater than 1V rms into 1k-ohm (maximum of 5V peak-to-peak). If the frequency is not 10 MHz, the counter operates with the frequency measurements multiplied by the factor " $10 \text{ MHz}/F_{\text{ext}}$ ", and time measurements multiplied by the factor " $F_{\text{ext}}/10 \text{ MHz}$ ". For example, in a frequency measurement, a 1 MHz external standard would give a 100-second measurement time for the RESOLUTION switch in the "0.1 Hz" position, and would display a 100 kHz input as "1000 kHz", while, in a period measurement (with RESOLUTION set for maximum) a 100 kHz input (10  $\mu$ S period) would be displayed as 1  $\mu$ S. The measurement time, however, would be unaffected.

For the Model 5328B, the external frequency must be 10 MHz for PERIOD AVG, T.I. AVG A-B, PERIOD (N=1), AND T.I. A-B (N=1). Otherwise, phase lock will not be achieved, and the time base signal will bear no relationship to the frequency of the external frequency standard.

#### 3-17. GATE OUT

This rear-panel output supplies a TTL-level which is "high" when the counter's main gate is open and "low" when it is closed. Monitoring the GATE OUT with an oscilloscope can provide this information for applications where the markers do not give the desired information.

#### 3-18. TIME BASE OUT

The rear-panel TIME BASE OUT connector supplies a TTL level output when the front-panel FUNCTION switch is set to "START CLOCK" or "START A".

In "START CLOCK", the internal oscillator's 10 MHz is divided by "N", where "N" is determined by the setting of the RESOLUTION switch.

In "START A" the Channel "A" input signal, divided by "N" (where "N" is greater than "1"), is available at the TIME BASE OUT connector.

#### 3-19. EXTERNAL FREQUENCY STANDARD

When the OSC INT EXT switch is in the INT position, the 10 MHz oscillator output is available at the rear-panel INT/EXT connector, at TTL levels. When terminated into 50 ohms, the OSC INT EXT output is a square wave of approximately one volt amplitude.

### 3-20. APPLICATIONS

This part of this manual section contains information you can use to get the most effective performance from your Model 5328B (and its options). Specific details and examples are provided for making measurements of —

- frequency
- period
- time interval and time interval average
- totalizing
- ratio

Use of the (optional) Digital Voltmeter in making measurements is also included, in addition to use of the external frequency standard input.

Programming information about use of the HP-IB interface is provided beginning at paragraph 3-27.

### 3-21. Frequency Measurements

To make a frequency measurement on a CW (continuous wave) signal below 100 MHz —

1. Set the FUNCTION switch to **FREQ A**.
2. Select the appropriate input signal conditioning (see paragraph 3-11).
3. Apply the signal to the Model 5328B's Channel "A" input.

The RESOLUTION switch determines the resolution of the measurement. Since the Model 5328B is a conventional counter, 1 Hz resolution is obtained in one second of measurement time (e.g., 0.1 Hz in ten seconds, etc.). The 0.1 Hz best-case frequency resolution limits the low-frequency measurement accuracy. In practice, low frequencies are measured by making a period or period average measurement and inverting the result to obtain frequency.

To make a frequency measurement on a CW signal in the range of 90 MHz to 1300 MHz (this requires use of the optional "C" Channel) —

1. Set the FUNCTION switch to "FREQ C"
2. Apply the signal to the Channel C input.

Be sure the signal amplitude is not greater than 5V rms.

The trigger level for the C Channel is fixed at 0V dc. If a pulse waveform is being measured, it must cross through 0V dc by at least 25 mV. Pulse widths down to 1 nS can be counted.

Signals at the Model 5328B's Channel "A" and Channel "B" inputs are counted by the "direct count" method. This method allows greater resolution per second of measurement time than "prescaling" techniques, and is important in making frequency measurements on pulse bursts since the allowable measurement time is fixed (it must be less than the width of the burst).

Signals at the Model 5328B's Channel "C" input are prescaled by a factor of "4".

When the Model 5328B's "FREQ A" or "FREQ C" FUNCTION is chosen, and the rear-panel ARM switch is set to OFF, a measurement cycle is initiated (i.e., the counter is armed) by the first trigger level crossing the "A" or "C" input. This means that pulsed signals are measured as easily as continuous wave signals if the measurement time (determined by the RESOLUTION switch) is less than the width of the pulse.

With the ARM switch ON, FREQ A and FREQ C are armed by a triggering event at the "B" input. This mode is useful whenever you want to have real time control over when a measurement is to begin. Useful applications include measuring frequency variations along a frequency burst and linearity testing of sweep generators. (Figure 3-7 illustrates the setup for measuring the linearity of a sweep generator.) The Channel "B" Trigger level is adjusted to trigger (and thereby arm) the counter at various points along the sweep out waveform. By plotting the "B" trigger levels (using the Model 5328B's optional Digital Voltmeter) and the corresponding frequency measurements made at those levels, the linearity of the generator can be determined.

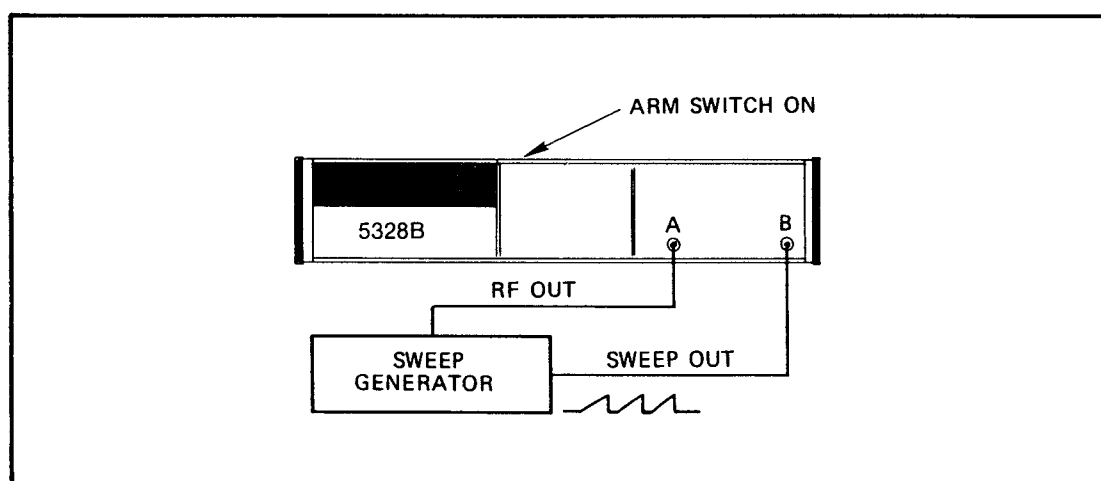


Figure 3-7. Measuring Sweep Generator Linearity

### 3-22. Period Measurements

The PERIOD and PERIOD AVG functions allow single-period measurements or multiple-period averages to be made on signals at the Channel "A" input, for frequencies up to 10 MHz. These modes are useful for making low-frequency measurements where maximum resolution is desired.

To make a PERIOD or PERIOD AVG measurement —

1. Set the FUNCTION switch to the desired function.
2. Select the appropriate input signal conditioning (see paragraph 3-11).
3. Apply the signal to the Channel "A" input.

For single-period measurements, the RESOLUTION switch scales the time base frequency which determines the resolution of the measurement. For optimum resolution, select "N=1". Other "N" values may be desirable to prevent display overflow or to get rid of unstable digits. For PERIOD AVG measurements, the RESOLUTION switch selects the number of periods over which the period average measurement is to be made (the time base is 10 MHz for this case). The PERIOD AVG mode gives increased resolution and accuracy. Trigger error is decreased by "N" and the resolution is increased by "N" (resolution = "100 nS/N" or "10 nS/N"). The measurement time is equal to the period-times-"N".

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In PERIOD and PERIOD AVG, with the rear-panel ARM switch OFF, the measurement cycle is initiated by the SAMPLE RATE control and the input signal. With the ARM switch ON, PERIOD and PERIOD AVG are armed by a trigger event at the Model 5328B's Channel "B" input. To measure the frequency of a tone burst signal, use arming and the PERIOD AVG (for increased resolution over a low-frequency measurement) as shown in Figure 3-8. Select "N" equal to or less than the number of periods in the tone burst and adjust Channel "B"'s trigger LEVEL to trigger on the first cycle of the input signal.

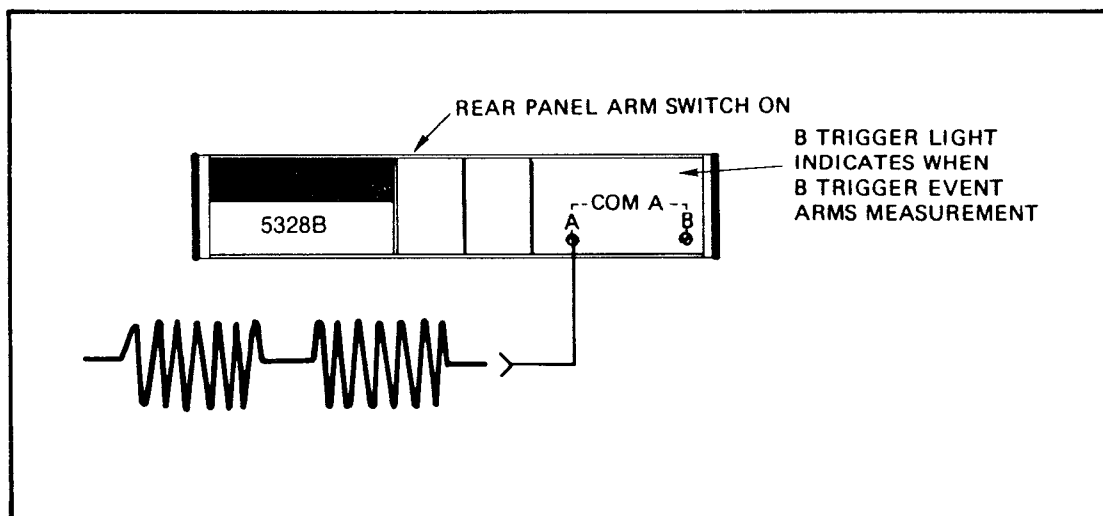


Figure 3-8. Tone Burst Measurement

### 3-23. Time Interval Measurements

One of two time-interval functions can be selected — time interval or time interval average. These functions measure the time interval between a START signal at the Channel "A" input and a STOP signal at the Channel "B" input. If both the START and STOP signals are to be derived from the same signal, place the CHK/COM A/SEP switch in the COM A position. Separate slope and level controls for each channel allow variable triggering on either positive- or negative-going slope.

In single-shot time-interval measurements, Channel "A" opens the main gate and Channel "B" closes it. While the main gate is open, 100 MHz is divided by the setting of the RESOLUTION switch and totaled by the counter. For optimum resolution, select "N=1". Other "N" values can be chosen to prevent display overflow (e.g., long time intervals) or to get rid of unstable digits. In time interval average measurements, the main gate is open for the number of time intervals selected by the RESOLUTION switch. The Model 5328B's 100 MHz clock is totaled only during the individual time intervals. The resolution of the measurement is improved by the square-root of "N".

In order to allow the synchronizers time to reset during time interval averaging there must be at least 40 nS of dead time (corresponding to a repetition rate of 25 MHz or less), and the additional constraint that the event and the current time intervals start event as shown in Figure 3-9.

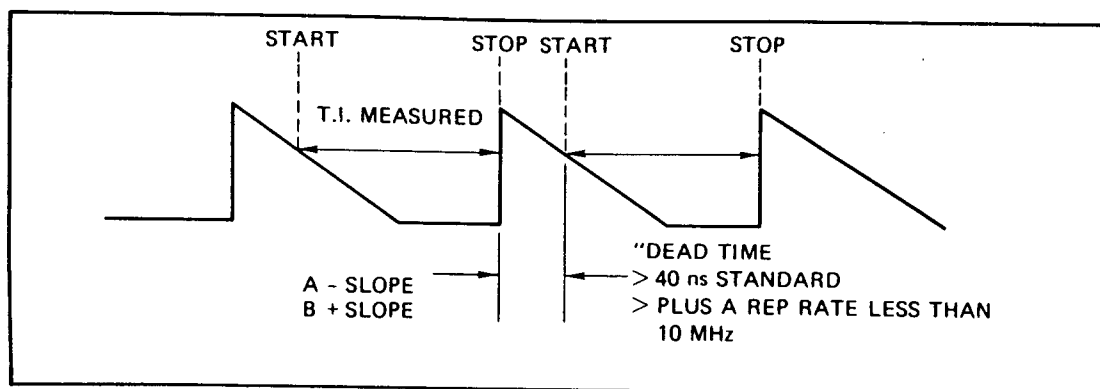


Figure 3-9. Time Interval Measurements — Dead Time

During a time interval average, there must be only one STOP pulse for each START pulse. Any extra STOP pulse which occurs before the next START pulse is accumulated and gives an erroneous reading. For example, the case illustrated in Figure 3-10 would result in a reading equal to one-half the desired time interval.

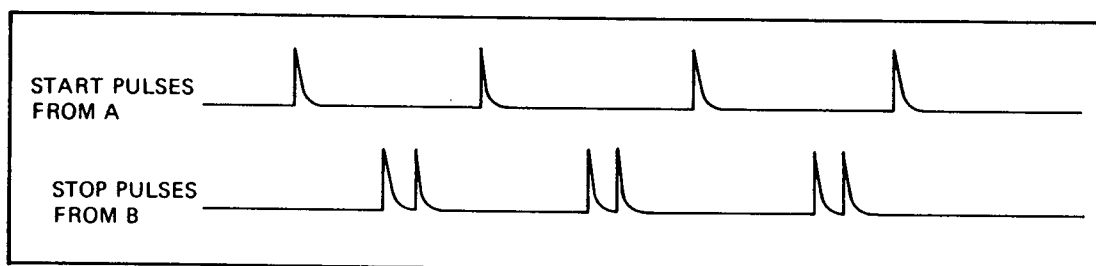


Figure 3-10. Time Interval Measurements — Multiple STOP Pulses

To set up a time interval measurement, the marker outputs can be monitored on an oscilloscope (see Figure 3-11) to indicate where the channels are triggering with relation to the time interval of interest. Voltage levels sent to the (optional) Digital Voltmeter indicate trigger levels for ease in measurement set-up.

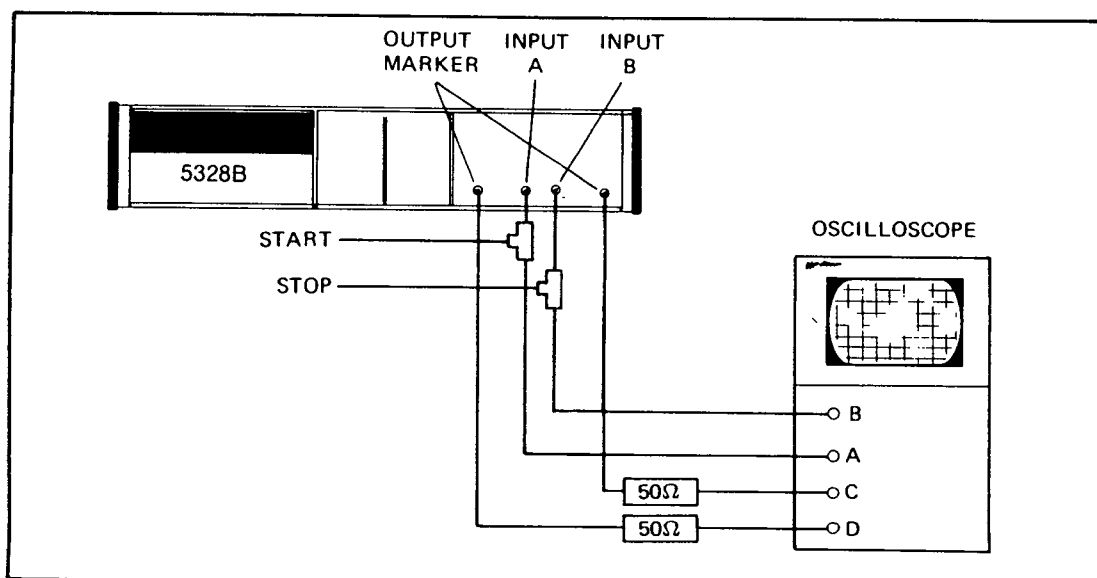


Figure 3-11. Time Interval Measurements — Monitoring Marker Outputs

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In T.I. A→B and T.I. AVG A→B, with the rear-panel ARM switch "OFF", the counter is armed by the run down of the SAMPLE RATE control.

With the rear-panel ARM switch "ON", T.I. A→B and T.I. AVG A→B are armed by an event at the (optional) Channel "C" input.

For T.I. AVG A→B, only one armed signal is required per average measurement (i.e., the counter doesn't need to be armed before each individual time interval in the time interval measurement.)

### 3-24. Totalizing Measurements

The only totalizing function available is START A. In this FUNCTION, the number of counts at the Channel "A" input are totalized if "N=1". If "N" is greater than "1", "A/N" is totalized, and the scaled output is available at the rear-panel TIME BASE OUT connector.

### 3-25. Digital Voltmeter Measurements

#### NOTE

The Digital Voltmeter is not a standard part of the Model 5328B; it is available as Option 021 or a part of Option 050.

Three modes of Digital Voltmeter (DVM) measurements are available — "DVM", "READ A" or "READ B". When a mode is selected (by pressing the appropriate pushbutton on the DVM module's front panel), the Digital Voltmeter measures the trigger level of the Channel "A" or Channel "B" input, regardless of the 5328B's FUNCTION switch setting. The "V" annunciator lights to indicate that a voltage measurement is being made. To return control to the FUNCTION selector, the trigger level pushbutton must be released (by pressing it). When the FUNCTION selector is in its "DVM" position, an external voltage applied to the Digital Voltmeter's input can be measured in a 10V, 100V, or 1000V range, or AUTO-ranging can be selected.

A filter switch allows a filter to be switched into the input path to allow the measurement of very small dc levels in the presence of high common-mode or normal-mode noise.

The trigger level voltage read by the Digital Voltmeter when "READ A" or "READ B" is pressed is a direct indication of the voltage of the center of the hysteresis band for the indicated input channel; the setting of that channel's input attenuator is automatically taken into consideration.

The Digital Voltmeter has three ranges —

±10V (±12.5V overrange)

±100V (±125V overrange)

±1000V dc.

Allowable measurement times and corresponding sensitivity are shown in the chart below —

<u>Maximum Sensitivity</u>	<u>Resolution N</u>	<u>Measurement Time</u>
100 mV	1 kHz, 10 <sup>3</sup>	1 mS
10 mV	100 Hz, 10 <sup>4</sup>	10 mS
1 mV	10 Hz, 10 <sup>5</sup>	100 mS
100 μV	1 Hz, 10 <sup>6</sup>	1 S
10 μV	0.1 Hz, 10 <sup>7</sup>	10 S



The Digital Voltmeter has a "floating" input; this allows differential voltage measurements to be made. Internal isolators and a floating power supply allow the Digital Voltmeter's output to be sent via the HP-IB. Maximum allowable voltage between the DVM's "high" and "low" inputs is 1100V dc (the "high" input must be more positive than the "low"); maximum allowable voltage between the DVM's "low" input and chassis ground is  $\pm 500V$  dc.

With the rear-panel ARM switch "ON", a DVM measurement is begun by an event at the Channel "B" input. This ability to "command" a DVM measurement can be particularly useful when measuring switching dc levels, such as those from dc supplies or digital-to-analog converters operating in computer-operated test systems. By adjusting Channel "B" to trigger on the transition from one voltage to the next, the DVM can be made to make a measurement only during the time that the voltage level is stable.

Figure 3-12 shows an example of an "armed" DVM measurement. To make such a measurement –

1. Select a measurement time that is less than the width of the step to be measured.
2. Adjust the Channel "B" trigger LEVEL to trigger on the leading edge of the step.

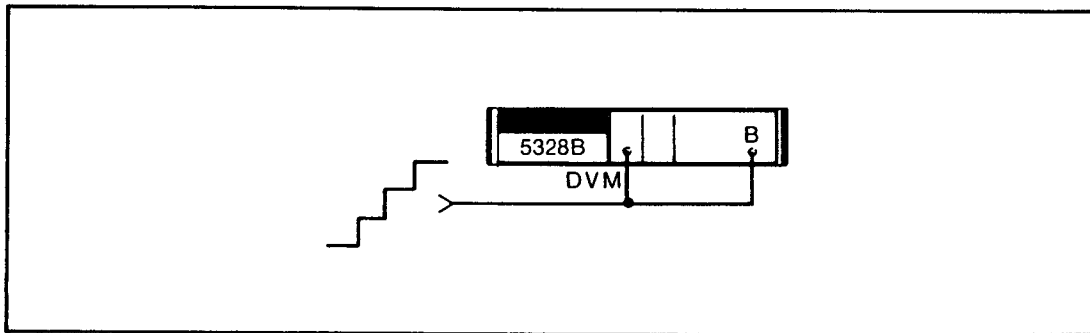


Figure 3-12. Digital Voltmeter Measurement — Armed

### 3-26. Ratio Measurements

The Model 5328B offers full bandwidth, sensitivity, and signal conditioning of the Channel "A", "B" and "C" input amplifiers.

The standard Model 5328B offers one ratio function ("B/A"); a Model 5328B with the "C" Channel option also offers a "C/A" ratio function.

The ratio of the frequency at the Channel "B" (or, optionally, the Channel "C") input to the frequency at the Channel "A" input is measured for "N" counts of the Channel "A" input, where "N" is selected by the RESOLUTION switch. The resolution of the measurement improves as "N" gets larger, and is given by "1 part in  $B/A \times N$ " (or " $C/A \times N$ "). Since the range of "A" is 0 to 10 MHz while "B" is 0 to 100 MHz, the lower frequency is normally applied to the "A" input, although there is no restriction that this be the case (i.e., ratios less than "1" can be measured). If "B/A" is greater than "1", the measurement resolution is better than switching the inputs for a ratio less than "1", provided the value of "N" remains the same.

### 3-27. PROGRAMMING (USING HP-IB)

The Model 5328B is fully compatible with the Hewlett-Packard Interface Bus (HP-IB). The counter can respond to remote control instructions and can output measurement results via the HP-IB. Thus, the Model 5328B gives all the benefits of standardized systems operation with the HP-IB. At the simplest level, the Model 5328B can output data to other devices such as the HP 5150A

## Model 5328B Operation

Thermal Printer or the HP 59303A Digital-to-Analog Converter. In more-sophisticated systems, the calculator or other system controller can remotely program the Model 5328B, trigger measurements, and read the results. Of course, a calculator or computer adds other benefits to an HP-IB-based measurement system. The calculator can manipulate data to compute the mean and standard deviation, check for linearity, compare results to limits, or perform many other functions. The Model 5328B has fully-programmable input signal conditioning control and extended measurement capability.

The paragraphs below describe how to use the HP Calculators to program the Model 5328B. Before starting to operate a system, you should familiarize yourself with the selected calculator, the capabilities of the HP-IB, and the manual operation and capabilities of the Model 5328B counter. The following HP manuals provide very useful background information —

HP 9825A Operating and Programing Manual  
HP 9825A General and Extended I/O Manuals  
HP-IB Programming Hints for Selected Instruments

Each of these manuals is included with the appropriate hardware. The HP 9825A manuals are included with the I/O cards that interface the calculators to the HP-IB.

### 3-28. Setting Address Switches

To use the Model 5328B in an HP-IB-based system, the first step is to set the rear-panel address switches shown in *Table 3-4*. The left-most switch sets the counter to "ADDRESSABLE" or "TALK ONLY" mode. "ADDRESSABLE" mode is used whenever a calculator or other controller is used within the system. "TALK ONLY" mode is used when the counter will be controlled manually, but will output its results to another device (such as a printer or digital-to-analog converter) on the bus.

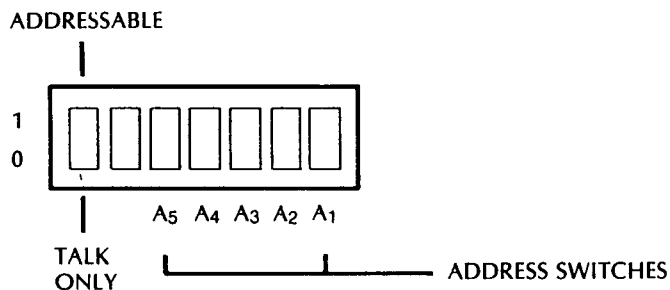
The five right-hand switches, "A5" through "A1", set the "TALK" and "LISTEN" addresses of the Model 5328B when it is used in the "ADDRESSABLE" mode. *Table 3-4* shows the possible address settings and the corresponding ASCII codes for "TALK" and "LISTEN" addresses.

The examples listed in this section assume an address setting of "11001" (decimal "25").

#### NOTES

1. The address setting "11111" (decimal "31") should not be used, since it is reserved for the "UNTALK" or "UNLISTEN" commands.
2. The setting "10101" (decimal "21") should not be used, since it is reserved for the HP 98034A Interface Card.

Table 3-4. HP-IB Addressing

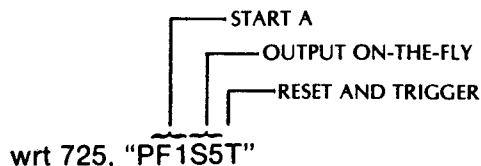
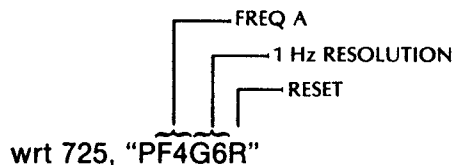
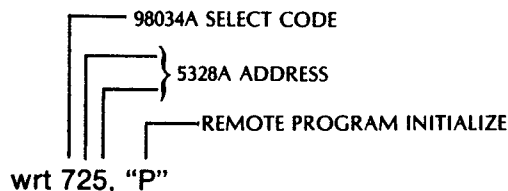


ASCII ADDRESS CODES

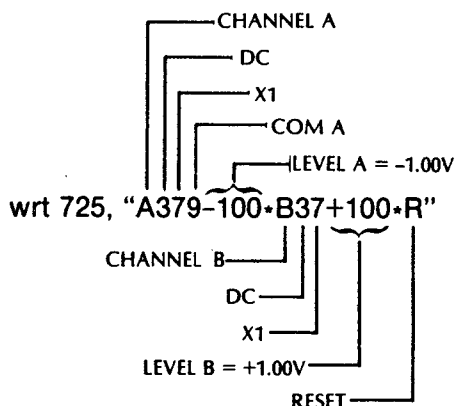
A5	A4	A3	A2	A1	ASCII LISTEN ADDRESS	ASCII TALK ADDRESS	5-Bit ±DECIMAL CODE
0	0	0	0	0	SP	@	0
0	0	0	0	1	!	A	1
0	0	0	1	0	"	B	2
0	0	0	1	1	#	C	3
0	0	1	0	0	\$	D	4
0	0	1	0	1	%	E	5
0	0	1	1	0	&	F	6
0	0	1	1	1	'	G	7
0	1	0	0	0	(	H	8
0	1	0	0	1	)	I	9
0	1	0	1	0	*	J	10
0	1	0	1	1	+	K	11
0	1	1	0	0	,	L	12
0	1	1	0	1	-	M	13
0	1	1	1	0	.	N	14
0	1	1	1	1	/	O	15
1	0	0	0	0	0	P	16
1	0	0	0	1	1	Q	17
1	0	0	1	0	2	R	18
1	0	0	1	1	3	S	19
1	0	1	0	0	4	T	20
1	0	1	0	1	5	U	21
1	0	1	1	0	6	V	22
1	0	1	1	1	7	W	23
1	1	0	0	0	8	X	24
1	1	0	0	1	9	Y	25
1	1	0	1	0	:	Z	26
1	1	0	1	1	;		27
1	1	1	0	0	<	\	28
1	1	1	0	1	=		29
1	1	1	1	0	>	—	30

### 3-29. PROGRAMMING THE MODEL 5328B

The HP 9825A Calculator uses the "cmd" and "wrt" statements to program the Model 5328B. The calculator addresses itself to "TALK" and the counter to "LISTEN", then sends a series of program codes. The codes to control the operation of the Model 5328B are listed in the program code set (see Table 3-5). Suppose you have set the counter to address "25" (decimal); typical statements to program the counter are —



The Model 5328B also allows program control of the Channel "A" and "B" input signal conditioning controls. The program codes are from the 19 groups of the Program Code Set (see Table 3-5). No more than one code from a group should be used in a program code string; use the codes in the same order in which the groups are listed.



The code "P" gives a single way to initialize the state of the counter program. "P" substitutes for —

"F0G0S0246A0246B<+000\*B02468+000\*"

The Program Code Set (see Table 3-5) shows these states in **bold** face. When other codes are included in a program code string, either "R" or "T" should be included at the end of the string. Both of these codes update the counter's program storage cells. The "T" also initiates a measurement; "R" does not. In a string of codes, the prefix letter of a two-character code need not be repeated. The prefix letter can be used just once at the beginning of a sequence of codes —

"S1S3S4S6" → "S1346"  
"A1A7A9A123\*" → "A179+123"

Table 3-5. Program Code Set

Codes shown in **bold face** are start-up conditions. These conditions are set by the code "P", Remote Program Initialize, or by the bus commands Device Clear or Selected Device Clear.

1. Initialization

P Remote Program Initialize

2. Function

<b>F0</b>	<b>Stop</b>	F8	T.I. A-B
F1	Start A	F9	Ratio B/A
†F2	Start Clock	F:	T.I. Avg. A-B
†F3	DVM/A	F<	Check
F4	Freq. A	F=	Ratio C/A
†F5	DVM/T.I. A-B	F>	Freq. C
F6	Period A	F?	DVM
F7	Per. Avg. A		

3. Time Base

Code	Freq Res	Multiplier	Time Res (Std)	Time Res (Opt. 040 and 041)
<b>G0</b>	<b>1 MHz</b>	<b>1</b>	<b>100 ns</b>	<b>10 ns</b>
G1	100 kHz	10	1 μs	100 ns
G2	10 kHz	10 <sup>2</sup>	10 μs	1 μs
G3	1 kHz	10 <sup>3</sup>	100 μs	10 μs
G4	100 Hz	10 <sup>4</sup>	1 ms	100 μs
G5	10 Hz	10 <sup>5</sup>	10 ms	1 ms
G6	1 Hz	10 <sup>6</sup>	100 ms	10 ms
G7	0.1 Hz	10 <sup>7</sup>	1 s	100 ms

4. Single-Multiple Measurement

**S0** **Single measurement.** Hold sample rate. Trigger required.  
S1 Multiple measurement. Not Hold. No trigger required.

5. Measurement Cycle

**S2** **Hold measurement until address to output.** SRQ at end of measurement.  
S3 Output only if a device is ready to accept data when 5328A is ready to output.

6. Output Mode

**S4** **Output at end of measurement - most universal.**  
S5 Output during open gate - usable only in START/STOP mode or if the decade reset is disabled.

7. Sample Rate

**S6** **Maximum**  
S7 Manual control (from front panel)

8. Arming

S: **Off**  
S: On

9. Display Storage

S< **On (normal)**  
S= Off

10. Decade Reset

S> **Normal**  
S? Disabled (for cumulative measurements)

11. Display Blanking

U **Normal Display**  
Q Blank display (digits and decimal point)

†Functions not labeled on instrument front panel.

12. Channel A Signal Conditioning

a. Impedance  
**A0** **1 Megohm**  
A1 50 Ohms  
b. Coupling  
**A2** **AC**  
A3 DC  
c. Slope  
**A4** **+slope**  
A5 -slope  
d. Attenuator  
**A6** **X10**  
A7 X1

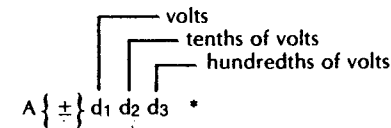
13. Separate/Common

**A8** **Separate**  
A9 Common A

14. Check

**A<** **Normal Operation**  
A?- Check, Measures internal clock

15. Trigger Level A



Permissible trigger level range: -2.50V to +2.50V.

The program sequence to set trigger level starts with the channel designation letter followed by a "+" or "-" sign. Next, three digits set the voltage level. An "\*" terminates the sequence. The same sequence must be used even to set 0 volts: †

Examples: "A+000\*" 0 volts  
"A-123\*" -1.23 volts

16. Channel B Signal Conditioning

a. Impedance  
**B0** **1 Megohm**  
B1 50 ohms  
b. Coupling  
**B2** **AC**  
B3 DC  
c. Slope  
**B4** **+slope**  
B5 -slope  
d. Attenuator  
**B6** **X10**  
B7 X1

17. Trigger Level B

B { ± } d1 d2 d3 \*

See Group 15, Trigger Level A, for details

18. Channel Invert

**B8** **Normal**  
B9 Invert A and B inputs

19. Reset; Trigger

(Also see Bus Command GET)  
R Reset, no trigger  
T Reset and trigger

† Trigger levels set to 0 volts when counter is initialized with code "P" or bus commands DCL and SDC.

### 3-30. Triggering A Measurement

The calculator must trigger each measurement when the Model 5328B is programmed for single-measurement mode, "S0". Two trigger measurements are available; the program code "T" offers the simplest way to trigger a measurement. However, the bus command "Selective Device Trigger" ("SDT") may also be used. The counter responds more quickly to SDT; the "Group Execute Trigger" ("GET") can trigger the counter simultaneously with other devices on the bus.

Using the program code "T":  
wrt 725,"T" (9825A)

Using the Selective Device Trigger:  
trg 725

Using Group Execute Trigger:  
trg 7

If the Model 5328B is programmed for multiple measurements, "S1", it will start each measurement without a trigger command (see Figure 3-13). When the Model 5328B is also programmed to wait to output, "S2", it will start a new measurement as soon as the calculator reads the previous one. In the continuous cycle mode, "S3", the Model 5328B does not wait to output, but starts a new measurement. This mode is useful in allowing you to visually monitor a series of readings.

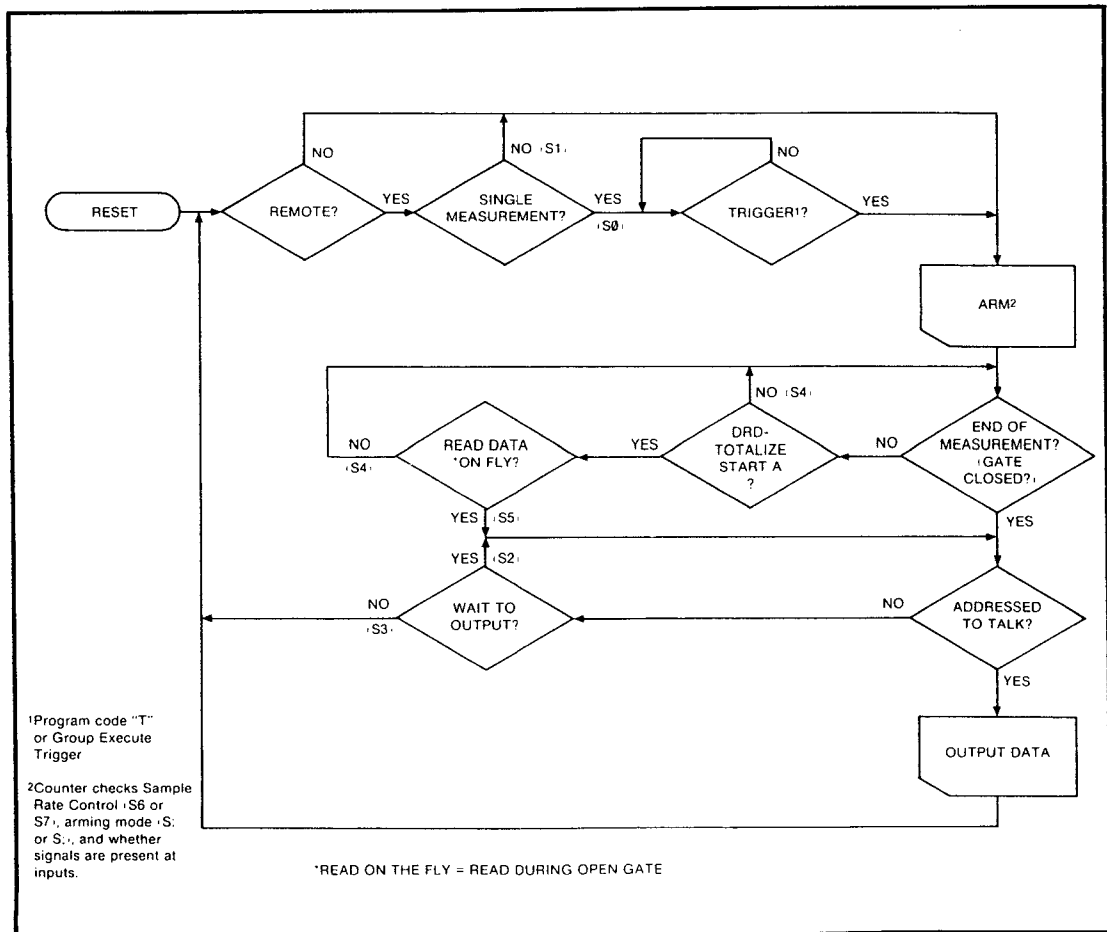


Figure 3-13. Measurement and Output Flow Chart

### 3-31. Reading A Measurement

To read a measurement from the Model 5328B to a calculator, the Model 5328B must first be addressed to "TALK" and the calculator to "LISTEN". The examples below indicate how a calculator may read a measurement from the counter.

```
0: wrt 725, "PF4G5R"
1: wrt 725, "T"
2: red 725,A
3: dsp A
4: end
*25861
```

Note that the data output string from the Model 5328B may include a leading "O" when a counter measurement overflows. The Model 9825A example above ignores all leading non-numeric characters, and won't give any indication of an overflow. The program below stores the measurement into a string variable. The string variable loads all characters (alpha and numeric), thus overflow "O" will be displayed. Line "4" takes the value of "A" and uses it for comparison in line "5".

```
0: dim A [17]
1: wrt 725, "PF4G5R"
2: wrt 725, "%"
3: red 725, A$
4: val (A$) - A
5: dsp A$, A
6: end
*14192
```

In these examples, string variable "A\$" contains all output characters, while simple variable "A" contains only the numeric data. If the display has not overflowed, a space ("SP") will replace the "O".

### 3-32. PROGRAMMING EXAMPLE

The program below illustrates how the HP 9825A calculator can control the Model 5328B counter. The program causes the Model 5328B to make a series of frequency measurements. The Model 5328B reads the measurements into memory and the results are printed.

Program	Explanation
0: dim A[10]	Dimension ten storage locations for "A"
1: rem 7	Set HP-IB to enable remote state
2: wrt 725 "PF<G64"	Program counter to frequency measurement, 1 Hz resolution
3: for I=1 to 10	
4: trg 725	Trigger counter, using Selective-Device-Triggering
5: red 725,A[I]	Read the measurement
6: prt A[I]	Print the Result
7: next I	
8: end	
*11062	

### 3-33. MEASUREMENT OUTPUT FORMAT

The Model 5328B sends the following character string to output a measurement

Position	1	2	3 through 12	13	14	15	16	17
Character	{ 0 } { SP }	{ + } { - }	{ 9 digits and decimal point . }	E	{ + } { - }	d	CR	LF

"0" in the first position indicates measurement overflow. Leading "0"'s in positions "3" to "12" are output as "SP" (space) if they occur to the left of the decimal point, except for the "0" next to the decimal point ("0.x"). The decimal point may appear at any position from "4" to "12". The output string is **always** 17 characters long. Typical character output strings are —

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
SP	+	5	0	3	.	2	1	7	6	9	8	E	+	6	CR	LF	
SP	+	SP	SP	SP	5	4	3	2	1	0	.	E	-	3	CR	LF	
0	+	0	5	3	1	.	8	5	4	2	0	E	+	6	CR	LF	

The Model 5328B inserts a "0" in position "12" of the output string for all measurements that don't use the ninth digit of the display. This extra "0" fills the output string to the standard 17 characters.

### 3-34. BUS COMMANDS

The Model 5328B obeys the following bus commands (ASCII codes shown in parentheses and in Table 3-6).

#### a. Unaddress Commands

UNL UNListen (ASCII question mark — "?")  
Clears the counter from acting as a listener.

UNT UNTALK (ASCII underscore — "\_")

Clears the counter from acting as a talker. The same result can be achieved by addressing any other device on the bus to talk.

#### b. Universal Commands

LLO Local LockOut (ASCII "DC1")

Disables all programmable front-panel control including RESET. Go To Local (GTL) must be programmed to return to manual control.

DCL Device Clear (ASCII "DC4")

Resets the programmed state of the counter to the codes shown in **bold** face in the program code set. Has the same effect as the program code "P".



SPE Serial Poll Enable (ASCII "CAN")

Sets the counter to the Serial Poll mode. When addressed to talk during the serial poll mode, the Model 5328B produces a status byte to indicate its condition. If the Model 5328B has completed a measurement, and is requesting service, the status byte contains a "1" in bit "7" (decimal value "64"). If the Model 5328B has not requested service, the status byte will be "0" in all bits. When addressed to "talk" in the Serial Poll Mode, the Model 5328B will immediately stop requesting service.

SPD Serial Poll Disable (ASCII "EM")

Terminates the Serial poll mode. The Model 5328B can resume its normal data output mode.

c. Addressed Commands

SEND

GTL Go To Local (ASCII "SOH")

Returns the Model 5328B to local (manual) control from remote (HP-IB) control.

SDC Selected Device Clear (ASCII "EOT")

Responds as with "Device Clear" or program code "P".

GÉT Group Execute Trigger (ASCII "BS")

Starts a measurement. This command provides the quickest method to start a measurement cycle.

Table 3-6. American Standard Code for Information Interchange (ASCII)

BITS					b <sub>7</sub>	0 0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 1
b <sub>4</sub>	b <sub>3</sub>	b <sub>2</sub>	b <sub>1</sub>	COLUMN	b <sub>6</sub>	0	1	2	3	4	5	6	7
				ROW	b <sub>5</sub>								
0	0	0	0	0	0	NUL	DLE	SP (blank)	0	@	P	\	p
0	0	0	1	1	1	SOH	DC1	!	1	A	Q	a	q
0	0	1	0	2	2	STX	DC2	"	2	B	R	b	r
0	0	1	1	3	3	ETX	DC3	#	3	C	S	c	s
0	1	0	0	4	4	EOT	DC4	\$	4	D	T	d	t
0	1	0	1	5	5	ENQ	NAK	%	5	E	U	e	u
0	1	1	0	6	6	ACK	SYN	&	6	F	V	f	v
0	1	1	1	7	7	BEL	ETB	'	7	G	W	g	w
1	0	0	0	8	8	BS	CAN	(	8	H	X	h	x
1	0	0	1	9	9	HT	EM	)	9	I	Y	i	y
1	0	1	0	10	10	LF	SUB	*	:	J	Z	j	z
1	0	1	1	11	11	VT	ESC	+	;	K	[	k	}
1	1	0	0	12	12	FF	FS	,	<	L	\	l	!
1	1	0	1	13	13	CR	GS	-	=	M	]	m	}
1	1	1	0	14	14	SO	RS	.	>	N	↑	n	~
1	1	1	1	15	15	SI	US	/	?	O	—	o	DEL

UNIVERSAL ADDRESS COMMANDS      UNLISTEN COMMAND      UNTALK COMMAND

LISTEN ADDRESSES      TALK ADDRESSES

DATA WHEN ATN IS HIGH.  
ADDRESSES WHEN ATN IS LOW.

### 3-35. HP INTERFACE BUS DESCRIPTION

The Hewlett-Packard Interface Bus (HP-IB) transfers data and commands between the components of an instrumentation system on 16 signal lines. The interface functions for each system component are performed within the component so only passive cabling is needed to connect the system. The cables connect all instruments, controllers, and other components of the system in parallel to the signal lines.

Eight of the lines ("DIO1" through "DIO8") are reserved for the transfer of data and other messages in a byte-serial, bit-parallel manner. Data and message transfer is asynchronous, coordinated by the three handshake lines ("DAV", "NRFD", and "NDAC"). The other five lines are for control of bus activity.

Devices connected to the bus may be "talkers", "listeners", or "controllers". The "controller" dictates the role of each of the other devices by setting the "ATN" (attention) line "low" and sending talk or listen addresses on the data lines (DIO1 through DIO8). Addresses are set into each device at the time of system configuration either by switches built into the device or by jumpers on a printed circuit board. While the ATN line is "low", all devices must listen to the data lines. When the ATN line is "high", only devices that have been addressed will actively send or receive data. All others ignore the data lines.

Several listeners can be active simultaneously, but only "talker" can be active at a time. Whenever a talk address is put on the data lines (while ATN is "low"), all other talkers will be automatically unaddressed.

Information is transmitted on the data lines under sequential control of the three handshake lines. No step in the sequence can be initiated until the previous step is completed. Information transfer can proceed as fast as devices can respond, but no faster than allowed by the slowest device presently addressed as active. This permits several devices to receive the same message byte concurrently.

The ATN line is one of the five control lines. When ATN is "low", addresses and universal commands are sent on only seven of the data lines using the ASCII (American Standard Code for Information Interchange) code. When ATN is "high", any code of eight or fewer bits understood by both talker and listener(s) may be used.

The other control lines are "IFC", "REN", "SRQ", "EOI". "IFC" (interface clear) places the interface system in a known quiescent state. "REN" (Remote ENable) is used with other coded messages to select either local or remote control of each device.

Any active device can set the SRQ (Service ReQuest) line "low". This indicates to the controller that some device on the bus (say the Model 5328B) had just completed some operation (such as making a measurement) and wants attention (such as use of the bus to send its output to a printer).

"EOI" (End Or Identify) is used by a device to indicate the end of a multiple-byte transfer sequence. When a controller sets both the ATN and EOI lines low, each device capable of a parallel poll indicates its current status on the DIO line assigned to it.

For a more-detailed description of bus operation, refer to the manual entitled "Condensed Description of the Hewlett-Packard Interface Bus", HP Part No. 59401-90030.

### 3-36. HP-IB INTERFACE OPERATION

The HP 5328B's HP-IB interface is used to remotely program the Model 5328B and deliver the measurement results to the bus. Thus, the HP-IB interface operates as both a "listener" and a "talker". As a "listener", the Model 5328B's HP-IB interface can be used to program most of the counter's mainframe controls and all of its programmable functions. The HP-IB board contains storage circuits to control the mainframe remotely, and is set up to program the storage circuits in any programmable module.

As a "talker", the Model 5328B's HP-IB interface can output measurement data in scientific (i.e., number-plus-exponent) format, with a mantissa of nine digits (whose leading zeroes are output as spaces) and a one-digit exponent. Overflow and sign information are also contained, along with a carriage return-line feed ("CR LF") termination to make it compatible with the standard HP-IB serial data format.

In addition to being a talker and listener, the Model 5328B's HP-IB interface follows a set of HP-IB commands. This includes complete service request capability. The ASCII codes used for addressing and for data are shown in *Table 3-6*. Address switch information is shown in *Table 3-4*. The program code set is shown in *Table 3-5*.

## SECTION IV PERFORMANCE TESTS

### 4-1. INTRODUCTION

This manual section contains two groups of tests you can use to check for proper operation of a Model 5328B Universal Counter.

All tests in either group can be performed without having to remove any cover from the Model 5328B.

The first test group is the "OPERATIONAL VERIFICATION". This test group, which begins at paragraph 4-3, can be used to give a high degree of confidence that the Model 5328B is operating properly, without performing the more-complete "PERFORMANCE TEST" tests. The "OPERATIONAL VERIFICATION" tests should be useful for incoming Quality Assurance, routine maintenance, and after instrument repair.

The second test group is the "PERFORMANCE TESTS". This test group, which begins at paragraph 4-11, actually tests the performance of the Model 5328B against its specifications (given in *Table 1-1* of this manual). The tests in this group are (in general) much more demanding and time-consuming than those in the "OPERATIONAL VERIFICATION" group.

Following each test group is a form on which you can record the results of your tests of the Model 5328B.

### 4-2. EQUIPMENT REQUIRED

The equipment required for the performance tests is listed in the "Recommended Test Equipment" table in Section 1 of this manual. Any equipment that satisfies the critical specifications given in the table may be substituted for the recommended model(s).

## OPERATIONAL VERIFICATION

---

### 4-3. SELF CHECK

- a. Set the Model 5328B's controls as follows —

FUNCTION .....	CHECK
RESOLUTION .....	10 kHz, 10 <sup>2</sup>
SAMPLE RATE .....	Mid-range

- b. Verify that the Model 5328B displays  $10.00 \pm 0.01$  MHz.
- c. Record the results of your test on the test record card provided.
- d. Set the Model 5328B's controls as follows —

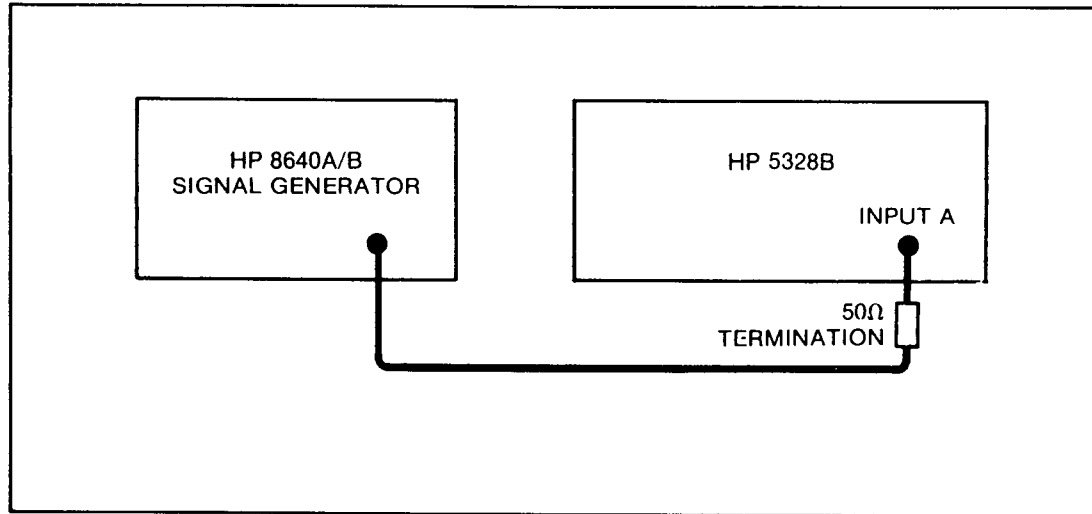
FUNCTION .....	FREQ A
CHK/COM A/SEP .....	CHK

- e. Verify that the Model 5328B's "CHECK" indicator is lighted, and that its numeric display is  $100.00 \pm 0.01$  MHz.
- f. Record the results of your test on the operational verification record provided.

**OPERATIONAL VERIFICATION (Continued)**

**4-4. 0-100 MHz SENSITIVITY — CHANNEL "A"**

- a. Set up equipment for this test as shown in *Figure 4-1*.



*Figure 4-1. Channel "A" Test Setup*

- b. Set the Model 5328B's controls as follows —

FUNCTION .....	FREQ A
RESOLUTION .....	10 kHz, 10 <sup>2</sup>
CHANNEL "A" LEVEL .....	PRESET
ATTEN A .....	X1
CHK/COM A/SEP .....	SEP
COUPLING A .....	AC
INPUT IMPEDANCE .....	1 MEGOHM

- c. Set the Signal Generator for an output of 40 MHz at 25 mV rms.
- d. Verify that the Model 5328B displays approximately 40.00 MHz, and that its Channel "A" trigger indicator is blinking.
- e. Increase the Signal Generator's output frequency and signal level to 100 MHz at 50 mV rms.
- f. Verify that the Model 5328B displays approximately 100.00 MHz, and that its Channel "A" trigger indicator is blinking.
- g. Record the results of your tests on the operational verification record card provided.
- h. Set the Model 5328B's Channel "A" input impedance to 50 ohms and remove the 50-ohm termination at its input.
- i. Repeat step "c" through "g" above.

### OPERATIONAL VERIFICATION (Continued)

#### 4-5. 0-100 MHz SENSITIVITY — CHANNEL "B"

- a. Set up equipment for this test as shown in Figure 4-2.

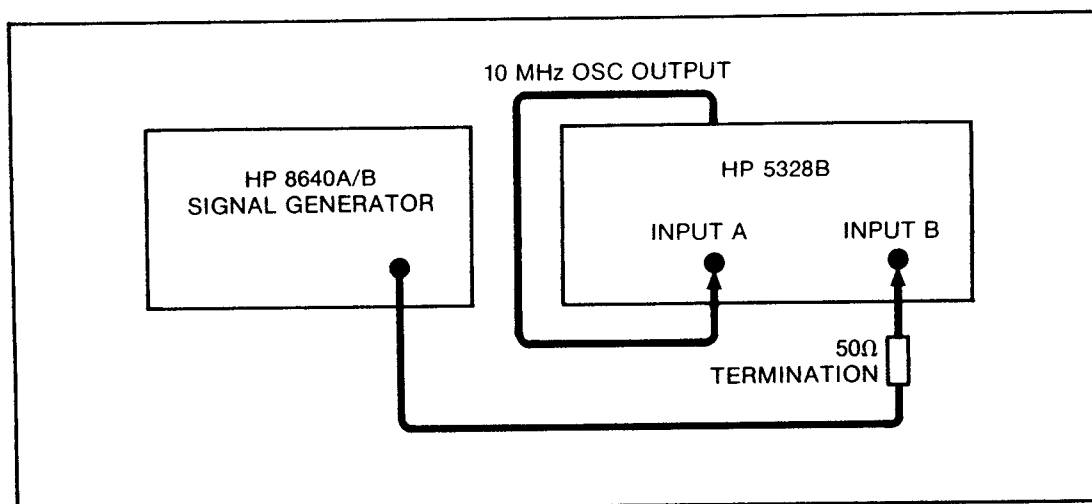


Figure 4-2. Channel "B" Test Setup

- b. Set the Model 5328B's controls as follows —

FUNCTION .....	RATIO B/A
RESOLUTION .....	10 kHz, 10 <sup>2</sup>
CHANNEL "A" LEVEL .....	PRESET
CHANNEL "B" LEVEL .....	PRESET
ATTEN (both channels) .....	X1
CHK/COM A/SEP .....	SEP
COUPLING (both channels) .....	AC
INPUT IMPEDANCE (both channels) .....	1 MEGOHM

- c. Set the Signal Generator for an output of 40 MHz at 25 mV rms.
- d. Verify that the Model 5328B displays approximately "4.00", and that its Channel "A" and Channel "B" trigger indicators are blinking.
- e. Increase the Signal Generator's output frequency and signal level to 100 MHz at 50 mV rms.
- f. Verify that the Model 5328B displays approximately "10.00", and that its Channel "A" and Channel "B" trigger indicators are blinking.
- g. Record the results of your test on the operational verification record card provided.

## OPERATIONAL VERIFICATION (Continued)

### 4-6. PERIOD MEASUREMENTS

- a. Set up equipment for this test as shown in Figure 4-3.

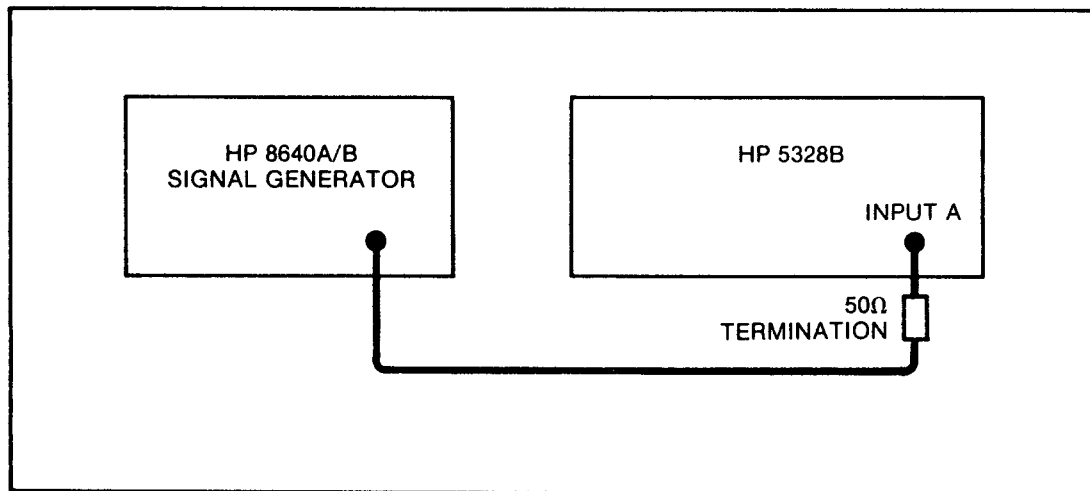


Figure 4-3. Period — Test Setup

- b. Set the Model 5328B's controls as follows —

FUNCTION .....	PER A
RESOLUTION .....	1 MHz,1
LEVEL A .....	PRESET
COUPLING A .....	AC
ATTEN A .....	X1
INPUT IMPEDANCE .....	1 MEGOHM
CHK/COM A/SEP .....	SEP

- c. Set the Signal Generator for an output of 10 MHz at 50 mV rms.
- d. The Model 5328B should display approximately 0.10  $\mu$ S (the period of a 10 MHz signal).
- e. Record the results of your test on the operational verification record card provided.



### OPERATIONAL VERIFICATION (Continued)

---

#### 4-7. TIME INTERVAL MEASUREMENTS

- a. Set up the equipment for this test as shown in *Figure 4-3*.
- b. Set the Signal Generator for an output of 5 MHz at 50 mV rms.
- c. Set the Model 5328B's controls as follows —

FUNCTION .....	T.I. A→B
RESOLUTION .....	1 MHz, 1
LEVEL (both channels) .....	PRESET
COUPLING (both channels) .....	AC
ATTEN (both channels) .....	X1
INPUT IMPEDANCE (both channels) .....	1 MEGOHM
CHK/COM A/SEP .....	COM A
SLOPE (Channel "A") .....	"+"
SLOPE (Channel "B") .....	"-"
- d. The Model 5328B should display approximately 0.10  $\mu$ S.
- e. Set the Model 5328B to T.I. AVG A→B.
- f. The Model 5328B should continue to display approximately 0.10  $\mu$ S.
- g. Record the results of your test on the operational verification record card provided.

**OPERATIONAL VERIFICATION (Continued)**

**4-8. TOTALIZING MEASUREMENTS**

- a. Set up the equipment for this test as shown in Figure 4-4.

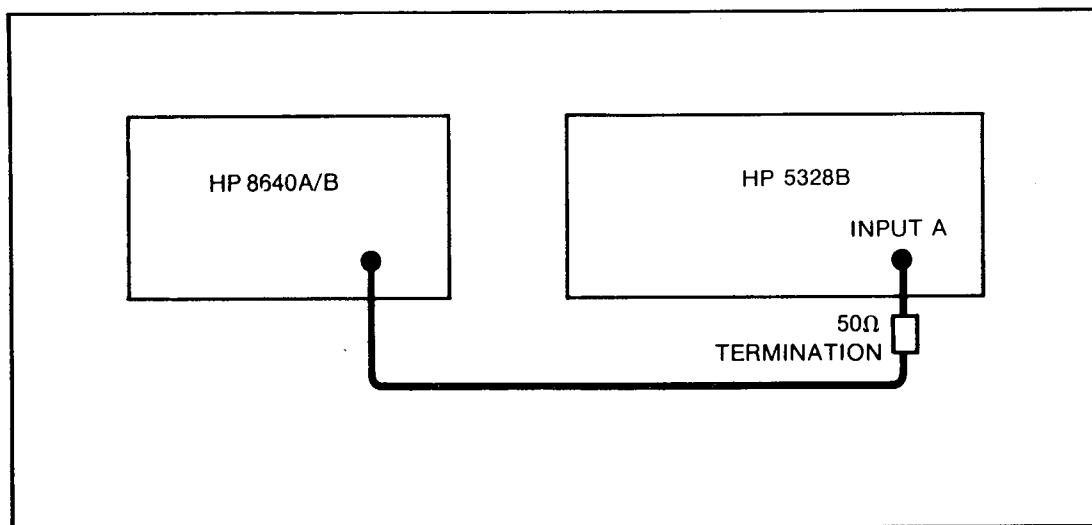


Figure 4-4. Totalizing Test (START/STOP) — Test Setup

- b. Set the Model 5328B's controls as follows —

FUNCTION .....	FREQ A
RESOLUTION .....	0.1 kHz, 10 <sup>4</sup>
LEVEL A .....	PRESET
ATTEN A .....	X1
COUPLING A .....	AC
CHK/COM A/SEP .....	SEP
INPUT IMPEDANCE .....	1 MEGOHM
SAMPLE RATE .....	Mid-range

- c. Set the Signal Generator for an output of 10 MHz at 50 mV rms.
- d. The Model 5328B should display approximately 10000.0 kHz, and its Channel "A" trigger indicator should be blinking.
- e. Set the Model 5328B's FUNCTION switch to START A.
- f. Allow the Model 5328B to totalize for 30 seconds, then set its FUNCTION switch to STOP.
- g. The Model 5328B should display approximately 300.00 m.
- h. Record the results of your test on the operational verification record card provided.

### OPERATIONAL VERIFICATION (Continued)

#### 4-9. DIGITAL VOLTMETER (OPTION 021 OR OPTION 050)

- a. Set the Model 5328B's controls as follows —

FUNCTION ..... DVM  
RESOLUTION ..... 1 Hz, 10<sup>6</sup>  
LEVEL (both channels) ..... PRESET  
ATTEN (both channels) ..... X1  
RANGE (Digital Voltmeter) ..... AUTO  
FILTER (Digital Voltmeter) ..... OFF  
READ A and READ B (Digital Voltmeter) ..... out

- b. Short (i.e., connect together) the Digital Voltmeter's input terminals.
- c. Verify that the Model 5328B displays 0.0000V ±0.4 mV.
- d. Record the results of your test on the operational verification record card provided.
- e. Disconnect the short at the Digital Voltmeter's input.
- f. Place the Digital Voltmeter in its READ A mode.
- g. Vary the Model 5328B's Channel "A" LEVEL control from fully counter-clockwise to fully clockwise. The Model 5328B's display should change from approximately -3.000V to +3.000V as you do this.
- h. Record the results of your test on the operational verification record card provided.
- i. Make sure the Digital Voltmeter's READ A and READ B buttons are both out.
- j. Short (i.e., connect together) the Digital Voltmeter's input terminals.
- k. Observe the Model 5328B's display as the Digital Voltmeter's RANGE switch is set as indicated in the chart below.

Digital Voltmeter Range	Model 5328B Display
AUTO	0.0000V ±0.4 mV
1K	0.00V ±40 mV
100	0.000V ±4 mV
10	0.0000V ±0.4 mV

- l. Record the results of your test on the operational verification record card provided.

**OPERATIONAL VERIFICATION (Continued)**

**4-10. CHANNEL C (OPTION 031 OR OPTION 050)**

- a. Set up equipment for this test as shown in Figure 4-5.

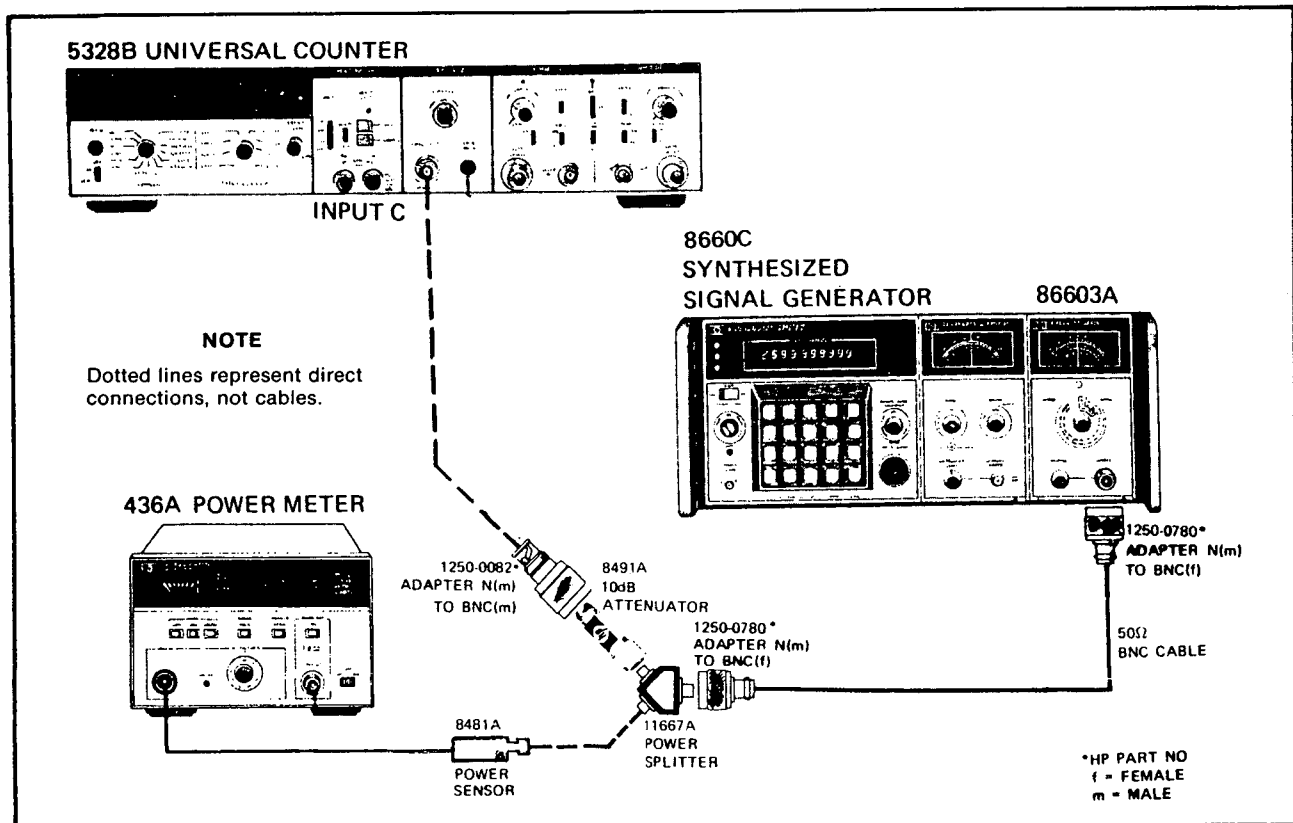


Figure 4-5. Test Setup for Channel "C"

- b. Set the Model 5328B's controls as follows —

FUNCTION .....	FREQ C
RESOLUTION .....	10 kHz, 10 <sup>2</sup>
SAMPLE RATE .....	Mid-range
CHANNEL "C" Attenuator .....	fully clockwise

- c. Set the Signal Source to provide -11 dBm at 90 MHz, as measured on a HP 436A Power Meter.
- d. Verify that the Model 5328B counts at 90 MHz.
- e. Set the Signal Source to 300 MHz, 600 MHz, 900 MHz, and 1300 MHz (at -11 dBm at each frequency), and verify that the Model 5328B counts at each frequency.
- f. Record the results of your test on the operational verification record card provided.
- g. RATIO C/A

- 1) Set up equipment for this test as shown in Figure 4-6.

**OPERATIONAL VERIFICATION (Continued)**

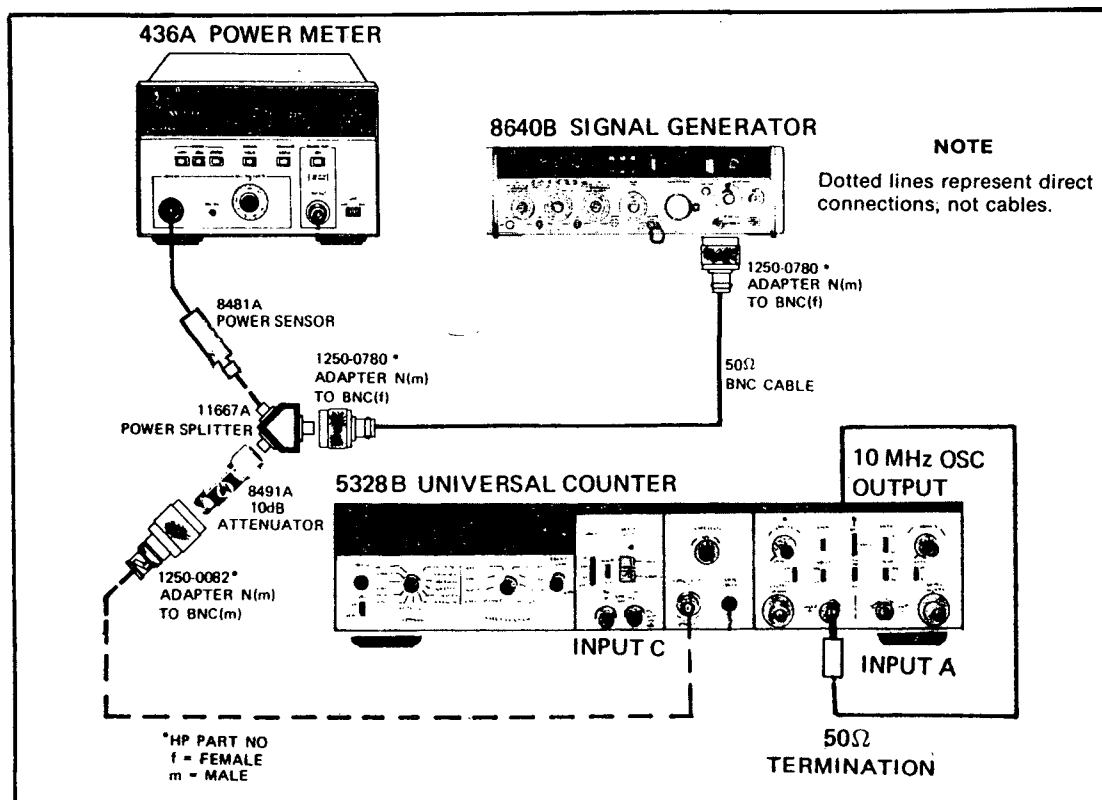


Figure 4-6. Channel "C" RATIO TEST SETUP

- 2) Set the Model 5328B's controls as follows —

FUNCTION .....	RATIO C/A
RESOLUTION .....	10 kHz, 10 <sup>2</sup>
LEVEL (Channel "A") .....	PRESET
COUPLING (Channel "A") .....	AC
ATTEN (Channel "A") .....	X1
ATTEN (Channel "C") .....	fully clockwise
CHK/COM A/SEP .....	SEP
INPUT IMPEDANCE .....	1 MEGOHM

- 3) Set the Signal Source such that the Power Meter reads -3 dBm at 100 MHz.
- 4) The Model 5328B's Channel "A" trigger indicator should be blinking and its display should read approximately 10.00. Note, you may have to adjust the SAMPLE RATE setting slightly in order to see the indicator flash.
- 5) Record the results of your tests on the operational verification record card provided.

**OPERATIONAL VERIFICATION RECORD**

Hewlett-Packard Model 5328B Universal Counter

Serial Number \_\_\_\_\_

Tests Performed by \_\_\_\_\_

Date \_\_\_\_ / \_\_\_\_ / \_\_\_\_

Test Ref	Description	Results	
		Pass	Fail
4-3	SELF CHECK		
	Check 10.00 ± 0.01 MHz	_____	_____
	Check 100.00 ± 0.01 MHz	_____	_____
4-4	0-100 MHz INPUT SENSITIVITY - CHANNEL "A"		
	1 Megohm: 40 MHz	_____	_____
	100 MHz	_____	_____
	50 ohms: 40 MHz	_____	_____
	100 MHz	_____	_____
4-5	0-100 MHz INPUT SENSITIVITY - CHANNEL "B"		
	1 Megohm: 40 MHz	_____	_____
	100 MHz	_____	_____
4-6	PERIOD MEASUREMENTS		
	PER A 0.10 μS	_____	_____
4-7	TIME INTERVAL MEASUREMENTS		
	T.I. A → B — 0.10 μS	_____	_____
	T.I. AVG A → B — 0.10 μS	_____	_____

**OPERATIONAL VERIFICATION RECORD (Continued)**

Test Ref	Description	Results	
		Pass	Fail
4-8	TOTALIZING MEASUREMENTS		
	START A/STOP	_____	_____
4-9	DIGITAL VOLTMETER (OPTION 021 OR OPTION 050)		
	Short Connector = 0.0000 ±0.4 mV	_____	_____
	Read A = (≈-3.000V to ≈+3.000V)	_____	_____
	AUTO = 0.0000V ±0.4 mV	_____	_____
	1K = 0.00V ±40 mV	_____	_____
	100 = 0.000V ±4 mV	_____	_____
	10 = 0.0000V ±0.4 mV	_____	_____
4-10	CHANNEL C (OPTION 031 OR OPTION 050)		
	90 MHz	_____	_____
	300 MHz	_____	_____
	600 MHz	_____	_____
	900 MHz	_____	_____
	1300 MHz	_____	_____
	RATIO C/A	_____	_____

**PERFORMANCE TEST**

**4-11. SELF CHECK**

- a. Set the Model 5328B's controls as follows —

FUNCTION .....	CHECK
SAMPLE RATE .....	counter-clockwise
OSC .....	INT
ARM ON/OFF (rear-panel) .....	OFF
STORAGE ON/OFF (rear-panel) .....	ON

- b. Vary the Model 5328B's RESOLUTION switch from 1 MHz ("1") to 0.1 Hz ( $10^7$ ) while observing the display.

<u>Resolution</u>	<u>Display (NOTE 1)</u>
1 MHz (1)	10. MHz
0.1 MHz (10)	10.0 MHz
10 kHz ( $10^2$ )	10.00 MHz
1 kHz ( $10^3$ )	10.000 MHz
0.1 kHz ( $10^4$ )	10.0000 MHz
10 Hz ( $10^5$ )	10.00000 MHz
1 Hz ( $10^6$ )	10.000000 MHz
.1 Hz ( $10^7$ )	OVFL 0.0000000 MHz (NOTE 2)

NOTES:

1.  $\pm 1$  count
2. After ten seconds

- c. Push and hold the Model 5328B's RESET switch.

The Model 5328B's display should show "8.8.8.8.8.8.8.8.", with all annunciators except OVFL, RMT, and GATE lighted.

- d. Set the Model 5328B's RESOLUTION control to 1 MHz (1).

- e. SAMPLE RATE and GATE light check.

Observe the flashing of the Model 5328B's GATE light as you rotate its SAMPLE RATE control between its fully counter-clockwise and fully clockwise positions.

When the SAMPLE RATE control is in its fully counter-clockwise position, gating will be so fast that the GATE indicator will appear to be lighted continuously. The gating frequency will decrease as the SAMPLE RATE control is turned clockwise. When the control is in its fully clockwise position, no gating will occur (i.e., the counter will be in "HOLD").

- f. FUNCTION control.

- 1) Set the Model 5328B's RESOLUTION switch to 1 Hz ( $10^6$ ).
- 2) Observe the Model 5328B's display as you set its FUNCTION switch to the positions listed in the chart below.



### PERFORMANCE TEST (Continued)

Display versus FUNCTION Switch Setting and Option Installation

Function	Display	
	With No Options Installed	With Indicated Option Installed (See Note)
CHECK	10.000000 MHz $\pm$ 1 count	
FREQ C	0.00 kHz	OPT. 031, 0.000 kHz
DVM	0.0000V	OPT. 021, 0.0000V $\pm$ 0.4 mV (See Note 2)
START A	0. M GATE light ON	
STOP	0. M GATE light OFF	
FREQ A	0.000 kHz	
PER A	0.00 s	
PER AVG A	0.00000 ns	
RATIO B/A	0.000000	
T.I. A $\rightarrow$ B	0.00 s	
T.I. AVG A $\rightarrow$ B	0.00000 ns	
RATIO C/A	0.00000	OPT. 031, 0.0000000

**NOTES:**

1. "OPT "021" or "OPT 031" also refer to "OPT 050", which is the combination of these two options.
2. When checking the DVM function in a HP 5328A in which the digital voltmeter has been installed, connect (short) the DVM's input terminals together and set the DVM's range switch to "AUTO".

- 3) Set the Model 5328B's controls as follows —

CHK/COM A/SEP ..... CHK  
 FUNCTION ..... FREQ A  
 RESOLUTION ..... 10 kHz, (10<sup>2</sup>)

The Model 5328B's display should show "100.00 MHz"  $\pm$ 0.01 MHz.

- 4) Record the results of your test on the performance test record provided.

**PERFORMANCE TEST (Continued)**

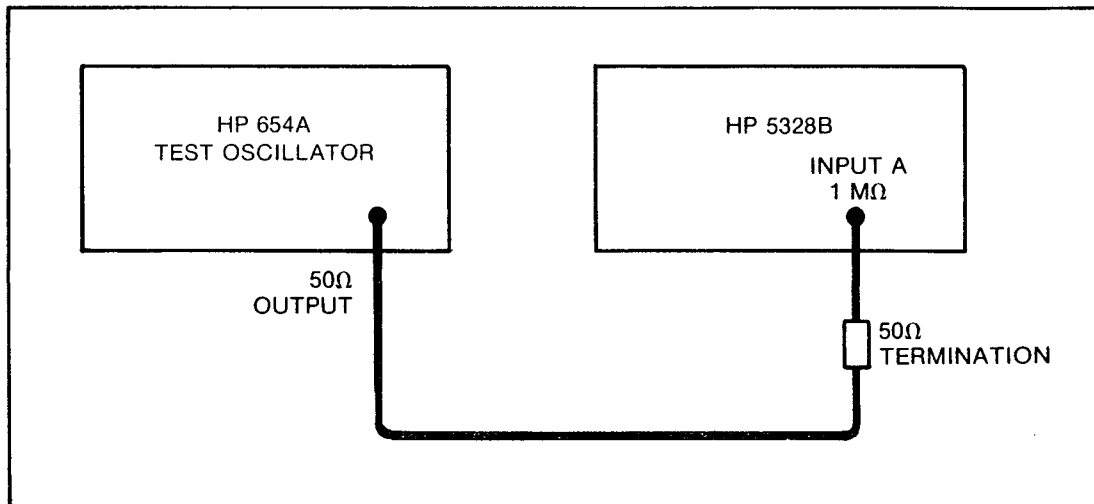
**4-12. FREQUENCY RESPONSE AND SENSITIVITY — CHANNEL A**

**Specifications:**

- 25 mV rms 0-40 MHz (dc coupled)
- 25 mV rms 20 Hz - 40 MHz (ac coupled)
- 50 mV rms 40-100 MHz

**Description:** A signal generator with calibrated output is set to the specified Model 5328B signal sensitivity level and varied over the specified frequency range. The Model 5328B must display the correct frequency.

- a. 10 Hz to 10 MHz
  - 1) Set up equipment for this test as shown in *Figure 4-7*.



*Figure 4-7. Channel A Frequency Response and Sensitivity Test Setup, 10 Hz to 10 MHz*

- 2) DC-coupled 10 Hz to 10 MHz —
  - a) Set the Model 5328B's controls as follows —

FUNCTION .....	FREQ A
RESOLUTION .....	1 Hz
SAMPLE RATE .....	fully counter-clockwise
LEVEL A .....	PRESET
COUPLING .....	DC
ATTEN .....	X1
CHK/COM A/SEP .....	SEP
ARM (rear-panel) .....	OFF

### PERFORMANCE TEST (Continued)

---

- b) Set the Test Oscillator's controls as follows —

Output level ..... 25mV rms

- c) Vary the Test Oscillator's frequency from 10 Hz to 10 MHz.

Observe that the Model 5328B displays the correct frequency for all oscillator settings.

#### NOTE

Adjust the Model 5328B's LEVEL A control as necessary to achieve a stable numeric display.

- d) Record the results of this test on the performance test record at the end of this table.

- 3) AC-coupled 20 Hz to 10 MHz —

- a) Set the Model 5328B's controls as follows —

FUNCTION ..... FREQ A  
RESOLUTION ..... 1 Hz  
SAMPLE RATE ..... fully counter-clockwise  
LEVEL A ..... PRESET  
COUPLING ..... AC  
ATTEN ..... X1  
CHK/COM A/SEP ..... SEP  
ARM (rear-panel) ..... OFF

- b) Set the Test Oscillator's controls as follows —

Output level ..... 25mV rms

- c) Vary the Test Oscillator's frequency from 20 Hz to 10 MHz.

Observe that the Model 5328B displays the correct frequency for all oscillator settings.

#### NOTE

Adjust the Model 5328B's LEVEL A control as necessary to achieve a stable numeric display.

- d) Record the results of this test on the performance test record at the end of this table.

- b. 10 MHz to 100 MHz

- 1) Set up equipment for this test as shown in *Figure 4-8*.
-

**PERFORMANCE TEST (Continued)**

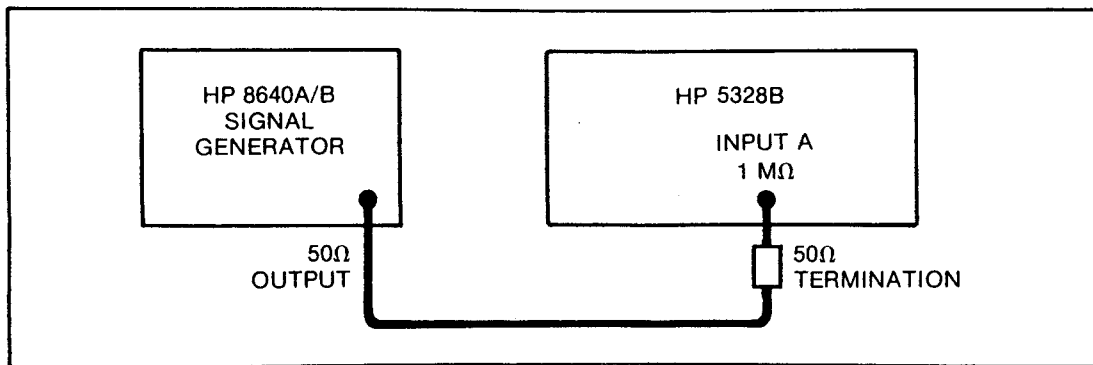


Figure 4-8. Channel A Frequency Response and Sensitivity Test Setup, 10 MHz to 100 MHz

2) DC-coupled 10 MHz to 100 MHz

- a) Set the Model 5328B's controls as follows —

FUNCTION .....	FREQ A
RESOLUTION .....	1 Hz
SAMPLE RATE .....	fully counter-clockwise
LEVEL A .....	PRESET
COUPLING .....	DC
ATTEN .....	X1
CHK/COM A/SEP .....	SEP
ARM (rear-panel) .....	OFF

- b) Set the Test Oscillator's controls as follows —

Output level ..... 25mV rms

- c) Vary the Test Oscillator's frequency from 10 MHz to 40 MHz.

Observe that the Model 5328B displays the correct frequency for all oscillator settings.

**NOTE**

Adjust the Model 5328B's LEVEL A control as necessary to achieve a stable numeric display.

- d) Record the results of this test on the performance test record at the end of this table.

- e) Set the Test Oscillator's level control to 50 mV.

- f) Vary the Test Oscillator's frequency from 40 MHz to 100 MHz.

Observe that the Model 5328B displays the correct frequency for all oscillator settings.

**NOTES**

1. Adjust the Model 5328B's LEVEL A control as necessary to achieve a stable numeric display.
2. The display will overflow if the signal being measured is 100 MHz or more.

### PERFORMANCE TEST (Continued)

---

- g) Record the results of this test on the performance test record at the end of this table.
- 3) AC-coupled 10 MHz to 100 MHz —
  - a) Set the Model 5328B's controls as follows —

FUNCTION ..... FREQ A  
RESOLUTION ..... 1 Hz  
SAMPLE RATE ..... fully counter-clockwise  
LEVEL A ..... PRESET  
COUPLING ..... AC  
ATTEN ..... X1  
CHK/COM A/SEP ..... SEP  
ARM (rear-panel) ..... OFF

- b) Set the Test Oscillator's controls as follows —  
Output level ..... 25mV rms
- c) Vary the Test Oscillator's frequency from 10 MHz to 40 MHz.

Observe that the Model 5328B displays the correct frequency for all oscillator settings.

#### NOTE

Adjust the Model 5328B's LEVEL A control as necessary to achieve a stable numeric display.

- d) Record the results of this test on the performance test record at the end of this table.
- e) Set the Test Oscillator's level control to 50 mV.
- f) Vary the Test Oscillator's frequency from 40 MHz to 100 MHz.

Observe that the Model 5328B displays the correct frequency for all oscillator settings.

#### NOTES

1. Adjust the Model 5328B's LEVEL A control as necessary to achieve a stable numeric display.
2. The display will overflow if the signal being measured is 100 MHz or more.

- g) Record the result of this test on the performance test record at the end of this table.
-

## PERFORMANCE TEST (Continued)

### 4-13. FREQUENCY RESPONSE AND SENSITIVITY — CHANNEL B

#### Specifications:

- 25 mV rms 0-40 MHz (dc coupled)
- 25 mV rms 20 Hz - 40 MHz (ac coupled)
- 50 mV rms 40-100 MHz

**Description:** The Model 5328B is set to RATIO B/A. The Model 5328B must display the indicated ratio value throughout the frequency range.

- a. 10 Hz to 10 MHz
  - 1) Set up equipment for this test as shown in *Figure 4-9*.

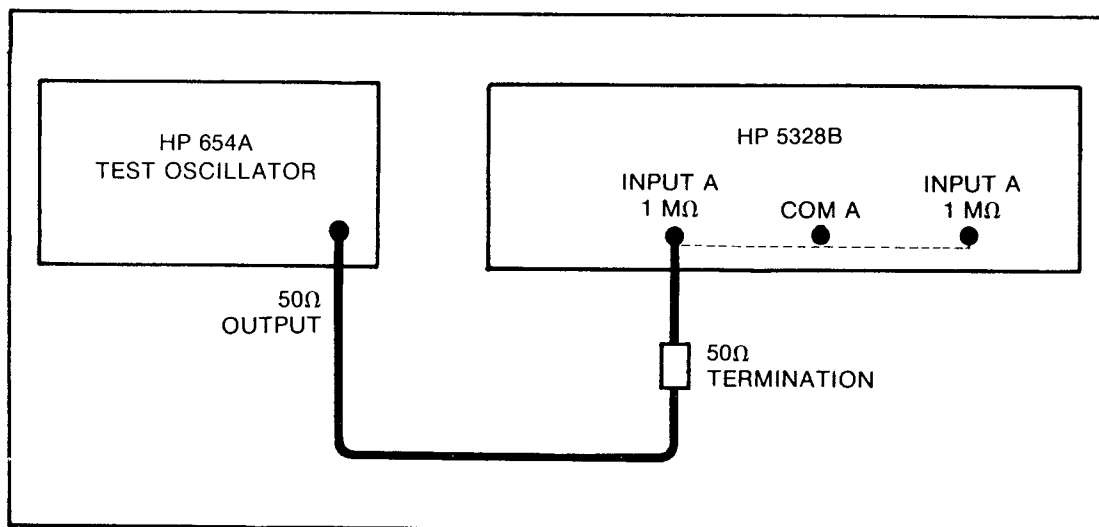


Figure 4-9. Channel B Frequency Response and Sensitivity Test Setup, 10 Hz to 10 MHz

**PERFORMANCE TEST (Continued)**

2) DC-coupled 10 Hz to 10 MHz —

a) Set the Model 5328B's controls as follows —

FUNCTION .....	RATIO B/A
RESOLUTION .....	0.1 MHz,10
SAMPLE RATE .....	Mid-range
LEVEL A .....	PRESET
LEVEL B .....	PRESET
Input Impedance .....	1 Megohm
COUPLING (both channels) .....	DC
ATTEN (both channels) .....	X1
CHK/COM A/SEP .....	COM A
ARM (rear-panel) .....	OFF

**NOTE**

In the steps below, you may have to change the SAMPLE RATE setting slightly in order to see the GATE indicator flash.

b) Set the Test Oscillator's controls as follows —

Output level ..... 25mV rms

c) Vary the Test Oscillator's frequency from 10 Hz to 10 MHz.

Observe that the Model 5328B displays "1.0 ±0.1", and that its GATE light is flashing, at all Test Oscillator frequency settings.

**NOTE**

Adjust the Model 5328B's LEVEL A and LEVEL B controls as necessary to achieve a stable numeric display.

d) Record the results of this test on the performance test record at the end of this table.

3) AC-coupled 20 Hz to 10 MHz —

a) Set the Model 5328B's controls as follows —

FUNCTION .....	RATIO B/A
RESOLUTION .....	0.1 MHz,10
SAMPLE RATE .....	Mid-range
LEVEL A .....	PRESET
LEVEL B .....	PRESET
Input Impedance .....	1 Megohm
COUPLING (both channels) .....	AC
ATTEN (both channels) .....	X1
CHK/COM A/SEP .....	COM A
ARM (rear-panel) .....	OFF

**PERFORMANCE TEST (Continued)**

- c) Vary the Test Oscillator's frequency from 20 Hz to 10 MHz.

Observe that the Model 5328B displays "1", and that its GATE light is flashing at all Test Oscillator frequency settings.

**NOTE**

Adjust the Model 5328B's LEVEL A control as necessary to achieve a stable numeric display. Adjust SAMPLE RATE slightly, if necessary to see GATE light flashing.

- d) Record the results of this test on the performance test record at the end of this table.

- b. 10 MHz to 100 MHz

- 1) Set up equipment for this test as shown in *Figure 4-10*.

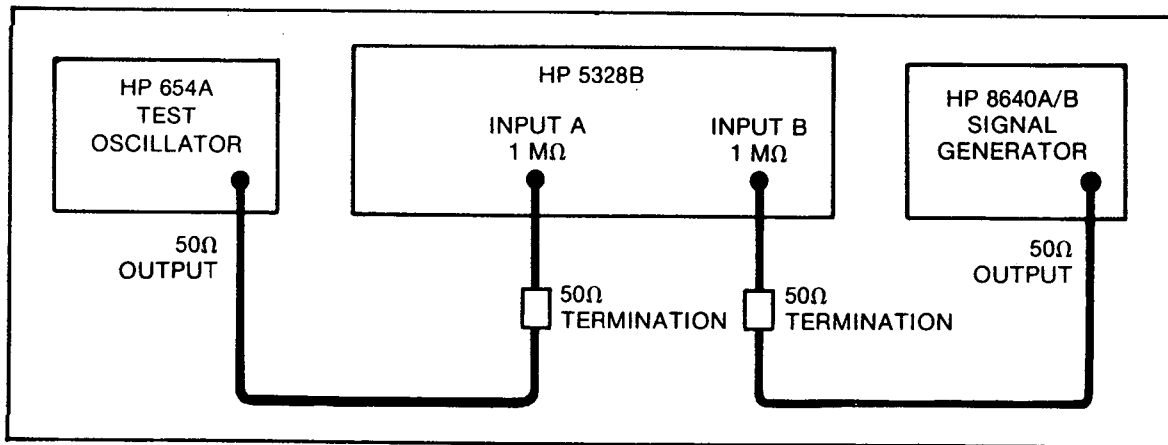


Figure 4-10. Channel B Frequency Response and Sensitivity Test Setup, 10 MHz to 100 MHz

- 2) DC-coupled 10 MHz to 100 MHz —

- a) Set the Model 5328B's controls as follows —

FUNCTION .....	RATIO B/A
RESOLUTION .....	1 Hz
SAMPLE RATE .....	fully counter-clockwise
LEVEL (both channels) .....	PRESET
COUPLING (both channels) .....	DC
ATTEN (both channels) .....	X1
CHK/COM A/SEP .....	SEP
ARM (rear-panel) .....	OFF

**NOTE**

In the steps below, you may have to change the SAMPLE RATE setting slightly in order to see the GATE indicator flash.



### PERFORMANCE TEST (Continued)

---

- b) Set the Test Oscillator's controls as follows —

Output Frequency ..... 1 MHz  
Output Level ..... 25mV rms

- c) Set the Signal Generator's controls as follows —

Output Frequency ..... 10 MHz  
Output Level ..... 25 mV rms

Observe that the Model 5328B displays approximately  $10.000\ 000 \pm 1$ , with the GATE light flashing.

- d) Mark the results of your test on the performance test card provided.

- e) Set the Signal Generator's controls as follows —

Output Frequency ..... 40 MHz  
Output Level ..... 25 mV rms

Observe that the Model 5328B displays approximately  $40.000\ 000 \pm 1$ , with the GATE light flashing.

- f) Mark the results of your test on the performance test card provided.

- g) Set the Signal Generator's controls as follows —

Output Frequency ..... 70 MHz  
Output Level ..... 50 mV rms

Observe that the Model 5328B displays approximately  $70.000\ 000 \pm 1$ , with the GATE light flashing.

- h) Mark the results of your test on the performance test card provided.

- i) Set the Signal Generator's controls as follows —

Output Frequency ..... 100 MHz  
Output Level ..... 50 mV rms

Observe that the Model 5328B displays approximately  $99.999\ 000$  or  $OVFL\ 00.000\ 000 \pm 1$ , with the GATE light flashing.

#### NOTE

The display will overflow if the signal being measured is 100 MHz or more.

- j) Mark the results of your test on the performance test card provided.
-

### PERFORMANCE TEST (Continued)

---

3) AC-coupled 10 MHz to 100 MHz —

a) Set the Model 5328B's controls as follows —

FUNCTION ..... RATO B/A  
RESOLUTION ..... 1 Hz  
SAMPLE RATE ..... fully counter-clockwise  
LEVEL (both channel) ..... PRESET  
COUPLING (both channels) ..... AC  
ATTEN (both channels) ..... X1  
CHK/COM A/SEP ..... SEP  
ARM (rear-panel) ..... OFF

**NOTE**

In the steps below, you may have to change the SAMPLE RATE setting slightly in order to see the GATE indicator flash.

b) Set the Test Oscillator's controls as follows —

Output Frequency ..... 1 MHz  
Output Level ..... 25mV rms

c) Set the Signal Generator's controls as follows —

Output Frequency ..... 10 MHz  
Output Level ..... 25 mV rms

Observe that the Model 5328B displays approximately  $10.000\ 000 \pm 1$ , with the GATE light flashing.

d) Mark the results of your test on the performance test card provided.

e) Set the Signal Generator's controls as follows —

Output Frequency ..... 40 MHz  
Output Level ..... 25 mV rms

Observe that the Model 5328B displays approximately  $40.000\ 000 \pm 1$ , with the GATE light flashing.

f) Mark the results of your test on the performance test card provided.

g) Set the Signal Generator's controls as follows —

Output Frequency ..... 70 MHz  
Output Level ..... 50 mV rms

Observe that the Model 5328B displays approximately  $70.000\ 000 \pm 1$ , with the GATE light flashing.

---

**PERFORMANCE TEST (Continued)**

---

h) Mark the results of your test on the performance test card provided.

i) Set the Signal Generator's controls as follows —

Output Frequency ..... 100 MHz  
Output Level ..... 50 mV rms

Observe that the Model 5328B displays approximately 99.999 000 or  
OVFL 00.000 000±1, with the GATE light flashing.

**NOTE**

The display will overflow if the signal being  
measured is 100 MHz or more.

j) Mark the results of your test on the performance test card provided.

**PERFORMANCE TEST (Continued)**

**4-14. PERIOD AND PERIOD AVERAGE TESTS**

**Specifications:**

PER A — the Model 5328B will measure periods of signals up to 10 MHz, with resolutions from 10 nS to 0.1 S in decade steps.

PER AVG A — the Model 5328B will measure periods of signals up to 10 MHz, with resolutions from 10 nS to 0.001 pS in decade steps.

**Description:** A 10 MHz signal from a generator drives the Model 5328B's Channel "A" as shown in Figure 4-11.

- a. Set up equipment for this test as shown in Figure 4-11.

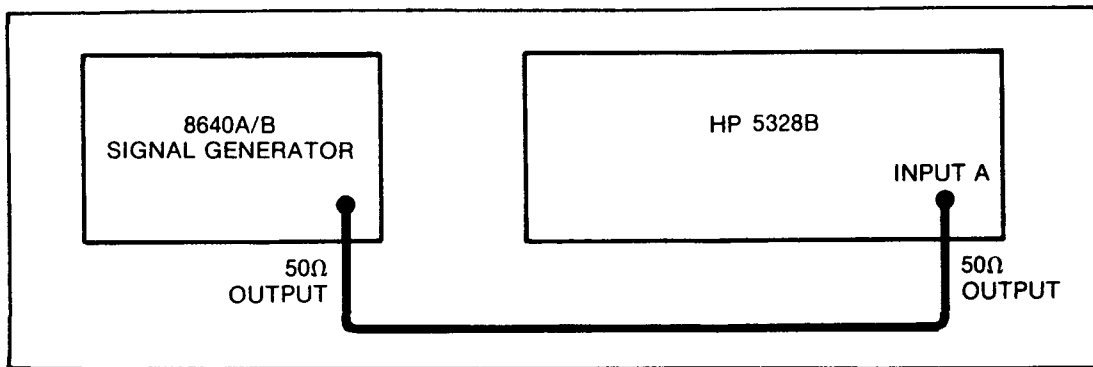


Figure 4-11. Period Test Setup — 10 MHz at 50 mV rms

- b. Set the Signal Generator for an output of 10 MHz at 50 mV rms.
- c. Set the Model 5328B's controls as follows —

FUNCTION .....	PER A
RESOLUTION .....	1 MHz,1
LEVEL A .....	PRESET
COUPLING (Channel A) .....	AC
CHK/COM A/SEP .....	SEP

Verify that the Model 5328B displays approximately  $0.10 \mu\text{S} \pm 0.01 \mu\text{S}$ .

- d. Record your results on the performance test record card provided.
- e. Set the Model 5328B's controls as follows —

FUNCTION .....	PER AVG A
RESOLUTION .....	10 kHz,10 <sup>2</sup>
SAMPLE RATE .....	Mid-range
LEVEL A .....	PRESET
COUPLING .....	AC
CHK/COM A/SEP .....	SEP

Verify that the Model 5328B displays approximately  $100.0 \text{ nS} \pm 1 \text{ nS}$ .

- f. Record your results on the performance test record card provided.

## PERFORMANCE TEST (Continued)

### 4-15. TIME INTERVAL AND TIME INTERVAL AVERAGE

**Specifications:**

T.I. A→B — the Model 5328B measures time intervals (in the range 10 nS to 10<sup>7</sup> nS) between a “START” signal at the Channel “A” input and a “STOP” signal at the Channel “B” input.

T.I. AVG A→B — the Model 5328B measures time intervals (in the range 1 nS to 1 S) between a “START” signal at the Channel “A” input and a “STOP” signal at the Channel “B” input. The number of time intervals over which the time interval measurement is made can be selected by the Model 5328B’s RESOLUTION switch.

**Description:** A common signal drives the Model 5328B’s Channel “A” and Channel “B” inputs.

- a. Set up equipment for this test as shown in Figure 4-12.

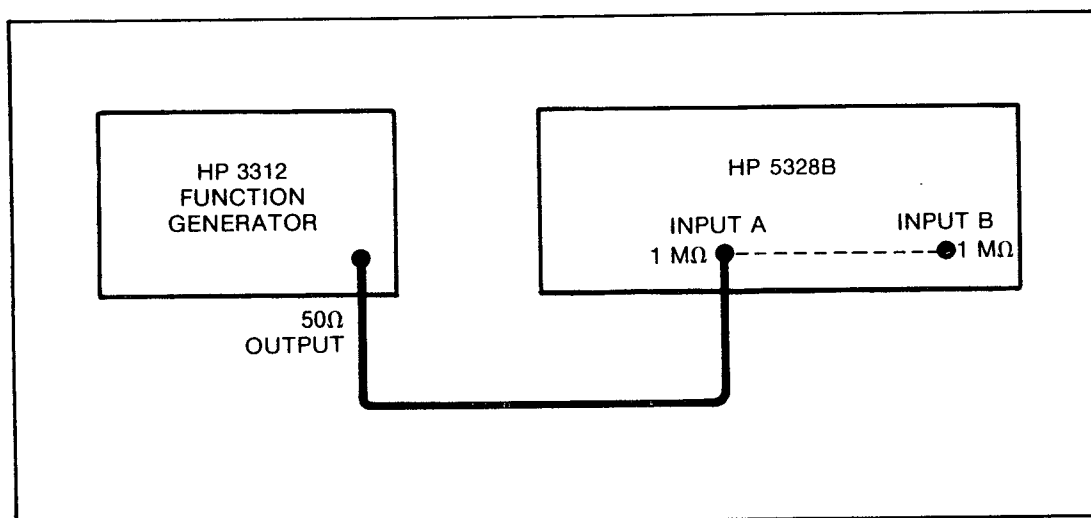


Figure 4-12. Time Interval Test Setup, 10 MHz at 50 mV rms

- b. Set the Function Generator for an output of 10 MHz at 50 mV rms.
- c. Set the Model 5328B’s controls as follows —
 

FUNCTION .....	T.I. A→B
RESOLUTION .....	1 MHz,1
LEVEL A .....	PRESET
LEVEL B .....	PRESET
COUPLING (both channels) .....	AC
ATTEN (both channels) .....	X1
CHK/COM A/SEP .....	COM A
- d. Set the Model 5328B’s Channel “A” SLOPE to “+” and its Channel “B” SLOPE to “-”.
- e. Verify that the Model 5328B’s display reads approximately 0.05 μS ±0.01 μS.

### PERFORMANCE TEST (Continued)

---

- f. Record the results of your test on the test record card provided.
- g. Set the Function Generator for an output of approximately 9.5 MHz at 50 mV rms.
- h. Set the Model 5328B's FUNCTION switch to T.I. AVG A → B, and its RESOLUTION switch to 10 kHz, 10<sup>2</sup>.
- i. Verify that the Model 5328B displays approximately 52.6 nS,  $\pm 2$  nS.
- j. Record the results of your test on the test record card provided.
- k. Change the Model 5328B's Channel "A" SLOPE to "-" and its Channel "B's" SLOPE to "+".
- l. Verify that the Model 5328B displays 52.6 nS  $\pm 2$  nS.
- m. Record the results of your test on the test record card provided.

**PERFORMANCE TEST (Continued)**

**4-16. RATIO B/A AND C/A**

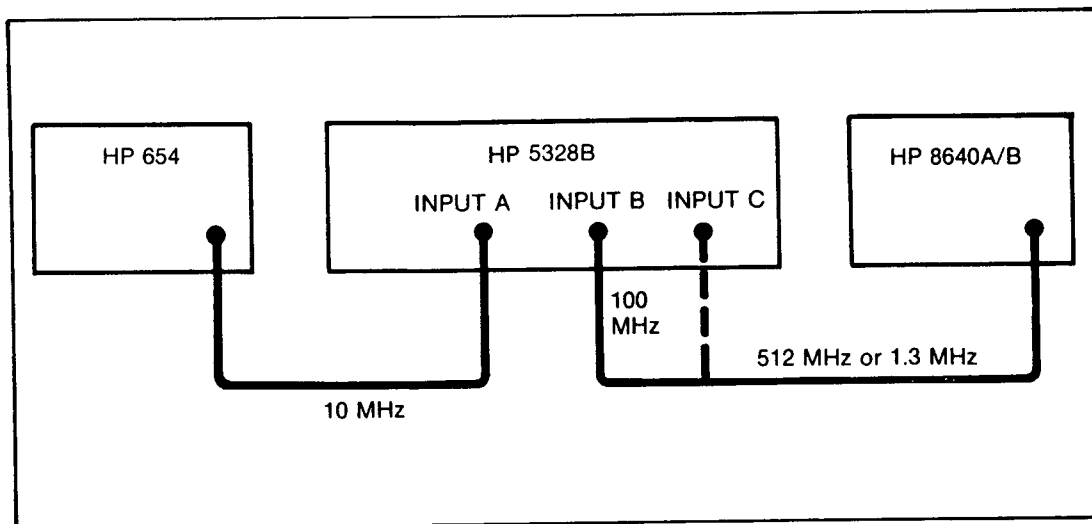
**Specifications:**

The ratio of the frequency at the Model 5328B's Channel "B" input to the frequency of the Channel "A" input signal is measured for "N" counts of the "A" signal, where "N" is selected by the Model 5328B's RESOLUTION switch, in the range of N=1 to N=107. If the optional Channel "C" is installed, the ratio of the frequency of its input signal to that of the Channel "A" input signal can be similarly measured.

<u>Input Channel</u>	<u>Frequency Range</u>
A	0-10 MHz
B	0-100 MHz
C	90-1300 MHz

**Description:** Separate input signals are applied to Channel "A" and to Channel "B" (or Channel "C", if Option 031 or Option 050) is installed. Frequencies selected are the highest specified for each individual channel.

- a. Set up equipment as shown in *Figure 4-13*.



*Figure 4-13. Ratio Measurement — Test Setup*

### PERFORMANCE TEST (Continued)

---

b. RATIO B/A

- 1) Set the lower-frequency Test Oscillator to provide a 10 MHz signal at 50 mV.
- 2) Connect the lower-frequency Test Oscillator to the Model 5328B's Channel "A" input.
- 3) Set the higher-frequency oscillator to provide a 100 MHz signal at 100 mV.
- 4) Connect the higher-frequency oscillator to the Model 5328B's Channel "B" input.
- 5) Set the Model 5328B's controls as follows —

FUNCTION .....	RATIO B/A
RESOLUTION .....	1 kHz, 10 <sup>3</sup>
LEVEL A .....	PRESET
LEVEL B .....	PRESET
COUPLING (both channels) .....	AC
ATTEN (both channels) .....	X1
CHK/COM A/SEP .....	SEP
INPUT IMPEDANCE .....	50 OHMS

- 6) Verify that the Model 5328B displays approximately  $10.000 \pm 1$ .
- 7) Record the results of your test on the test record provided.

c. RATIO C/A

**NOTE**

This test can be performed only on a Model 5328B that includes the optional Channel "C" electronics.

- 1) Set the lower-frequency Test Oscillator to provide a 10 MHz signal at 50 mV.
- 2) Connect the lower-frequency Test Oscillator to the Model 5328B's Channel "A" input.
- 3) Set the higher-frequency oscillator to provide a 1300 MHz signal at 40 mV.
- 4) Connect the higher-frequency oscillator to the Model 5328B's Channel "C" input.
- 5) Set the Model 5328B's controls as follows —

FUNCTION .....	RATIO C/A
RESOLUTION .....	0.1 MHz, 10
LEVEL A .....	PRESET
COUPLING A .....	AC
ATTEN A .....	X1
CHK/COM A/SEP .....	SEP
ATTEN C .....	fully clockwise

- 6) Verify that the Model 5328B displays approximately  $130.00 \pm 1$ .
  - 7) Record the results of your test on the test record provided.
-



**PERFORMANCE TEST (Continued)**

**4-17. CHANNEL "C" MODULE (OPTION 031 OR OPTION 050);  
FREQUENCY RESPONSE AND SENSITIVITY**

**Specification:** -21 dBm (20 mV rms) 90 MHz-1.3 GHz

**Description:** A Signal Generator is connected through a Power Splitter to the Model 5328B's Channel "C" input and a Power Meter. The Signal Generator is varied over the frequency range while the specified signal level is maintained. The counter must display the correct frequency.

- a. Set up the equipment for this test as shown in Figure 4-14.

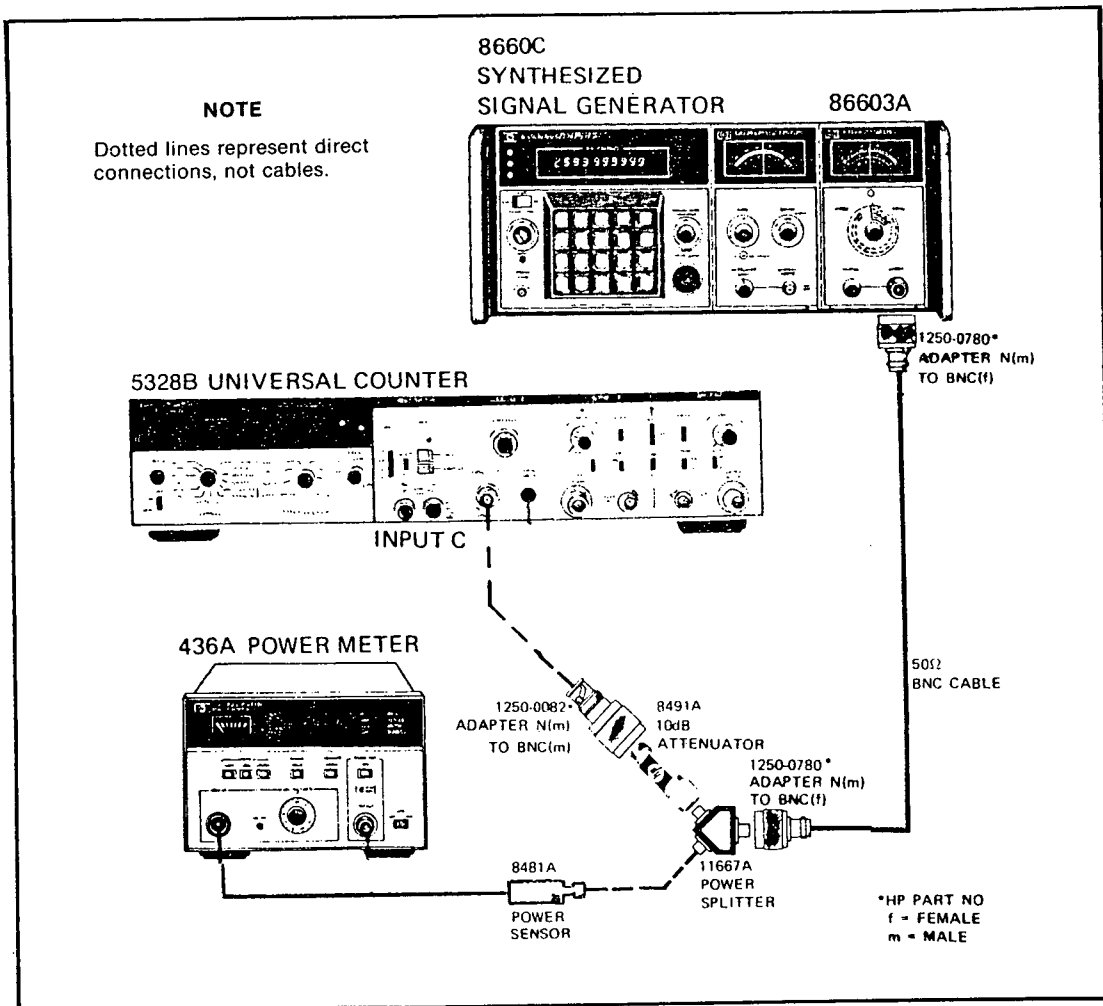


Figure 4-14. Channel "C" — Frequency Response and Sensitivity Test — Setup

- b. Set the Model 5328B's controls as follows —

FUNCTION .....	FREQ C
RESOLUTION .....	1 kHz, 103
SAMPLE RATE .....	MID-RANGE
ATTEN (Channel "C") .....	fully clockwise

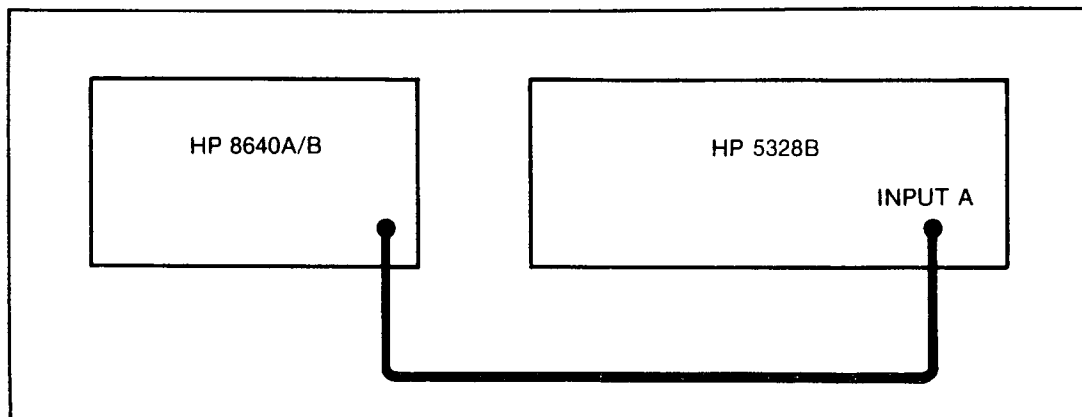
**PERFORMANCE TEST (Continued)**

- c. Set the Signal Generator's output level such that the Power Meter reads "- 11 dBm" at each of the following frequencies — 90 MHz, 300 MHz, 600 MHz, 900 MHz, and 1300 MHz.
- d. Verify that the Model 5328B displays the proper frequency for each Signal Generator output frequency.
- e. Record the results of your test on the test record card provided.

**4-18. TOTALIZE (START A/STOP)**

**Specification:** The number of counts at the Model 5328B's Channel "A" input, divided by "N" (selected by the Model 5328B's RESOLUTION switch) is displayed. Scaled output is available at the rear-panel TB OUT (Time Base Out) connector.

- a. Set up equipment for this test as shown in *Figure 4-15*.



*Figure 4-15. START/STOP — Test Setup*

- b. Set the Model 5328B's controls as follows —

FUNCTION .....	FREQ A
RESOLUTION .....	0.1 kHz, 10 <sup>4</sup>
LEVEL A .....	PRESET
ATTEN A .....	X1
COUPLING (Channel A) .....	AC
CHK/COM A/SEP .....	SEP
INPUT IMPEDANCE .....	50 ohms
SAMPLE RATE .....	Mid-range

**NOTE**

In the steps below, you may have to change the SAMPLE RATE setting slightly in order to see the GATE indicator flash.

- c. Set the Signal Generator for an output of 10 MHz at 50 mV rms.
- d. The Model 5328B should display approximately 10000.0 kHz, and its Channel "A" Trigger indicator should be flashing.

**PERFORMANCE TEST (Continued)**

- e. Set the Model 5328B's FUNCTION switch to "START A".
- f. Allow the Model 5328B to totalize for 30 seconds, then set the FUNCTION switch to "STOP". The Model 5328B should Display about "300.00 m". Record the result of your test on the performance test record provided.

**4-19. DIGITAL VOLTMETER (OPTION 021 OR OPTION 050)**

**NOTE**

This test can be performed only if your Model 5328B includes the optional Digital Voltmeter.

**Specification:** The Model 5328B will measure input voltages with a range of  $\pm 10V$ ,  $\pm 100V$ ,  $\pm 1000V$ , and AUTO RANGE.

**Description:** A precision power supply is connected to the Model 5328B's DVM input. Several voltages are selected, in order to cover the voltmeter's ranges.

- a. Set up equipment for this test as shown in Figure 4-16.

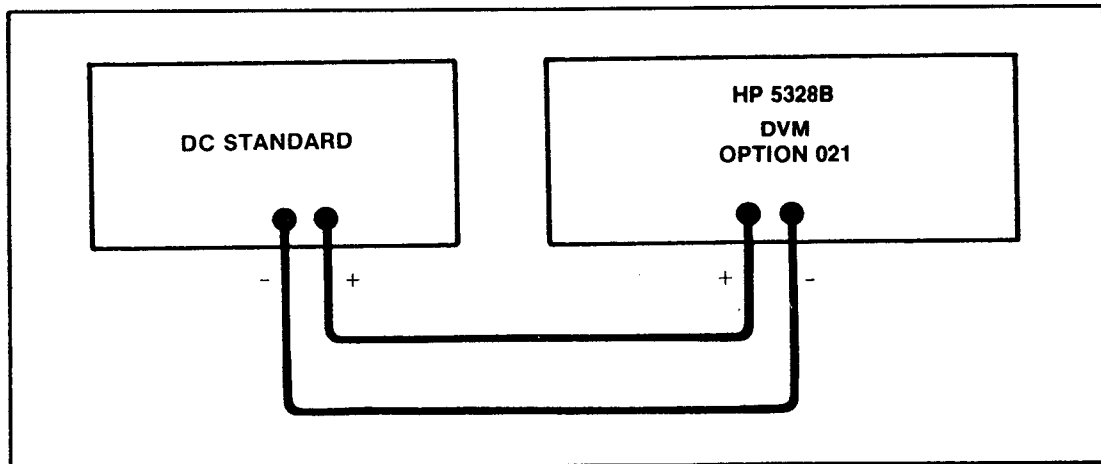


Figure 4-16. Digital Voltmeter — Test Setup

- b. Note in the space provided here the time at which you turned on the Model 5328B.

Power turned on at (time) \_\_\_\_\_.

- c. Allow 20-minute warm-up time before proceeding with the Digital Voltmeter test(s).
- d. Set the Model 5328B's controls as follows —

FUNCTION .....	DVM
RESOLUTION .....	1 Hz, $10^6$
SAMPLE RATE .....	fully counter-clockwise
FILTER .....	OFF
ATTEN ("A" and "B") .....	X1
LEVEL ("A" and "B") .....	counter-clockwise (not PRESET)
DVM RANGE .....	AUTO
READ A and READ B .....	out (i.e., not pressed)

### PERFORMANCE TEST (Continued)

---

- e. Place a jumper across the Digital Voltmeter's input connectors.
- f. Verify that the Model 5328B displays  $0.0000 \pm 0.0004$  volts.
- g. Record the results of your test on the test record card provided.
- h. Disconnect the jumper from the Digital Voltmeter's inputs.
- i. Set the DC Standard for +9.5000 volts output.
- j. Connect the DC Standard to the Digital Voltmeter.
- k. The Model 5328B's reading should be  $9.5000 \pm 0.0033$  volts.
- l. Record the results of your test on the test record card provided.
- m. Repeat steps "i" through "l" above for "-9.5000" volts.
- n. Set the DC Standard for +95.00 volts output.
- o. The Model 5328B's reading should be  $95.000 \pm 0.033$  volts.
- p. Record the results of your test on the test record card provided.
- q. Repeat steps "m" through "p" above for "-95.000" volts.



**Failure to perform steps "r" through "x" in the sequence in which they are presented may result in damage to the Model 5328B's Digital Voltmeter.**

- r. Set the DC Standard for +1000.00 volts output.
  - s. The Model 5328B's reading should be  $+1000.00 \pm 0.91$  volts.
  - t. Set the DC Standard for zero volts (0V) output.
  - u. Set the DC Standard for -1000.00 volts output.
  - v. The Model 5328B's reading should be  $-1000.00 \pm 0.91$  volts.
  - w. Record the results of your test on the test record card provided.
  - x. Set the DC Standard for zero volts (0V) output.
  - y. Press the "READ A" button on the Model 5328B's Digital Voltmeter.
-

**PERFORMANCE TEST (Continued)**

---

- z. Vary the Model 5328B's Channel "A" LEVEL control and verify that the counter display responds as shown below —

X1 ..... <-3V to >+3V (1 mV resolution)

X10 ..... <-30V to >+30V (1 mV resolution)

- aa. Press the "READ A" button, to cause it to move to its "out" position.
- ab. Press the "READ B" button on the Model 5328B's Digital Voltmeter. (This will release the Digital Voltmeter's "READ A" button.)
- ac. Vary the Model 5328B's Channel "B" LEVEL control and verify that the counter display responds as shown in step "z" above.
- ad. Record the results of your test on the test record card provided.

**PERFORMANCE TEST (Continued)**

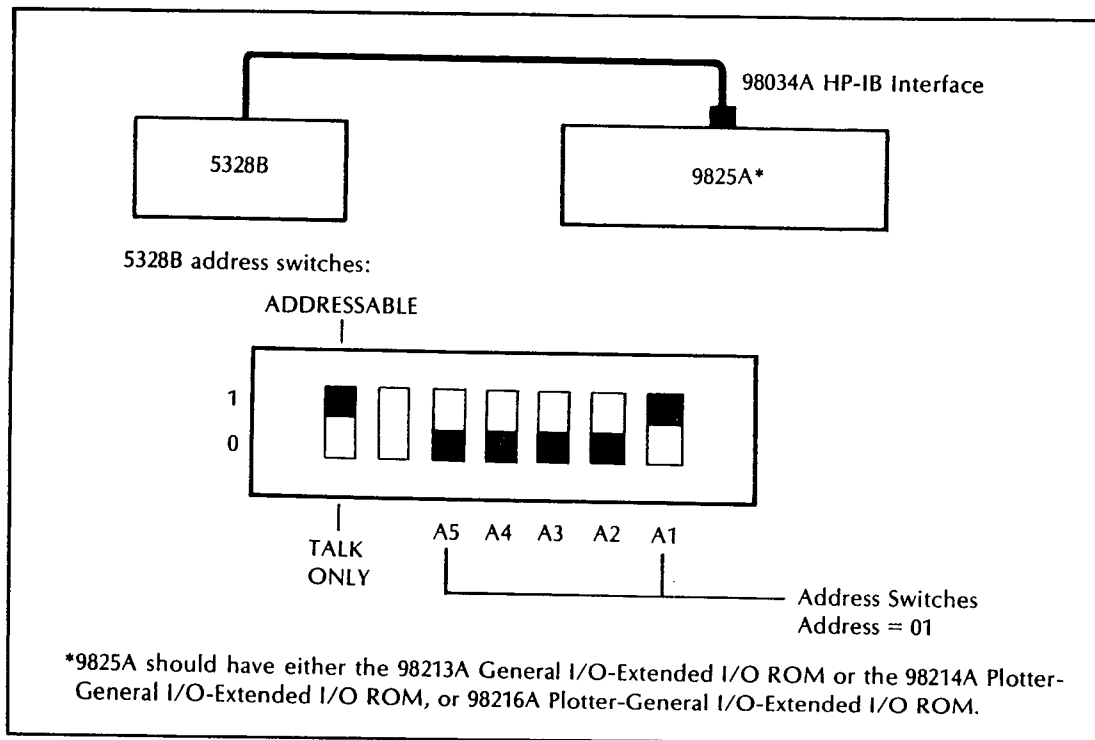
**4-20. HP-IB INTERFACE VERIFICATION PROGRAM**

A program that can be used to check for proper operation of the Model 5328B's HP-IB interface is presented in *Table 4-1*.

The program is designed to verify that the Model 5328B's HP-IB interface is working correctly, and that its front-panel control settings — including those of the (optional) Digital Voltmeter and/or Channel "C" — can be remotely performed via the HP-IB.

To verify the Model 5328B's HP-IB operation —

- a. Set up the Model 5328B as shown in *Figure 4-17*.



*Figure 4-17. HP-IB Verification — Test Connections and Address Switch Settings*

## PERFORMANCE TEST (Continued)

---

- b. You can key the program listed in *Table 4-1* into the HP 9825A, or you can load it from an HP-IB Verification Program cassette tape (HP Part Number 59300-10001; Revision "D" or later is required); this tape also contains HP-IB verification programs for the HP 59300 series of instruments.

To run the program on the cassette —

- 1) Insert the cassette into the HP 9825A.
- 2) Load file "0".
- 3) Press the Model 9825A's RUN button.
- 4) Enter "5328B" when the instrument model number is requested.

The Model 9825A will then load the Model 5328B verification program into its memory.

The Model 5328B HP-IB Verification Program goes through twelve check points for the HP-IB Interface, an additional check point for the (optional) Digital Voltmeter, an additional check point for the (optional) Channel "C" module, and six additional check points for the Channel "A" and Channel "B" Input Module. The information in *Table 4-2* tells what occurs during each test and what you should see if the test runs to successful completion. At the end of each test, the program stops and displays the current check point. To advance to the next test, simply press the Model 9825A's CONTINUE key. If you want to repeat a test, set the variable "L" to "1" via the Model 9825A's keyboard ("1-> L EXECUTE"), then press CONTINUE. To go on to the next test after looping, set "L" back to "0" when the program halts ("0-> L EXECUTE"), then press CONTINUE.

When the Model 9825A displays —

- "DVM OPTIONS 020 OR 021?" at the end of check point 12,
- "CHANNEL C OPTIONS 030 OR 031?" at the end of check point 13, —

enter "YES" CONTINUE if the Model 5328B has the option in question. Enter "NO" CONTINUE if the Model 5328B does not have the option in question.

### NOTES

1. If the Model 5328B had Option 050, enter "YES" CONTINUE to each of the above questions.
2. ALWAYS answer "YES" to the "OPTION 041?" question at the end of check point 14, since this test exercises hardware that is part of the standard Model 5328B.

*Figure 4-18* is a sample printout of the program from the HP 9825A.

```

5328A HP-IB TEST

-----
CHECK POINT 1          CHECK POINT 10        CHECK POINT 16
*REMOTE                *START A/STOP        *IMPEDANCE

-----
CHECK POINT 2          CHECK POINT 11        CHECK POINT 17
*CHECK=                *START CLOCK         *ATTENUATOR
+ 10.000000E+6

-----
CHECK POINT 3          CHECK POINT 12        CHECK POINT 18
RESOLUTION             *DVM                 *SEPARATE/COMMON
+ 10.000E+6            *DVM/A               *NORMAL/INVERTED
+ 10.0000E+6
+ 10.00000E+6
+ 10.000000E+6
+ 10.0000000E+6
+10.00000000E+6
0+0.000000000E+6

-----
CHECK POINT 4          CHECK POINT 13        CHECK POINT 19
*FREQ A                *FREQ C              *COUPLING
                       *RATIO C/A
                       *EVENTS C,A+B

-----
CHECK POINT 5          CHECK POINT 14        CHECK POINT 20
*RATIO B/A             *SAMPLE RATE         *CHECK MODE
                       *SINGLE/MULTIPLE
                       MERSMNT

-----
CHECK POINT 6          CHECK POINT 15        CHECK POINT 21
*PERIOD A              BUS COMMANDS:        *TRIGGER LEVELS
                       *LOCAL LOCKOUT
                       *DEVICE CLEAR
                       *SELECTED DEVICE
                       CLEAR
                       *GROUP EXECUTE
                       TRIGGER
                       *SERIAL POLL
                       STATUS BYTE=
                       64.00

-----
CHECK POINT 7          *GO TO LOCAL
*PER.AVG.A

-----
CHECK POINT 8
*T.I.A+B

-----
CHECK POINT 9
*T.I.AVG.A+B

-----
END OF TEST

```

Figure 4-18. Model 9825A Program Printout



Table 4-1. Model 9825A Program Listing (Part 1 of 4)

```
0: dim C$(40);dsp "MODEL 5328A FREQUENCY COUNTER"
1: prt "5328A HP-IB TEST";spc 2
2: "code":ent "select code?";S
3: if S=721;dsp "error: calculator address";wait 1000;gto "code"
4: if S>730;dsp "out of address range-high";wait 1000;gto "code"
5: if S<700;dsp "out of address range-low";wait 1000;gto "code"
6: dev "fc",S
7: prt "-----", "CHECK POINT 1"
8: rem "fc"
9: prt "*REMOTE";beep;spc 2
10: dsp "CHECK POINT 1--PRESS CONTINUE";stp
11: if L=1;gto -4
12: prt "-----", "CHECK POINT 2"
13: wrt "fc", "FF<G3S13R"
14: red "fc",C$;prt "*CHECK=",C$;beep;spc 2
15: dsp "CHECK POINT 2--PRESS CONTINUE";stp
16: if L=1;gto -4
17: prt "-----", "CHECK POINT 3", "RESOLUTION"
18: l>X
19: "LOOP":fmt 2,"G",f.0,"R"
20: wrt "fc.2",X
21: red "fc",C$;prt C$
22: X+l>X
23: if X=8;gto +2
24: gto "LOOP"
25: dsp "CHECK POINT 3--PRESS CONTINUE";beep;stp
26: if L=1;gto -9
27: prt "-----", "CHECK POINT 4"
28: wrt "fc", "F4R"
29: prt "*FREQ A";beep;spc 2
30: dsp "CHECK POINT 4--PRESS CONTINUE";stp
31: if L=1;gto -4
32: prt "-----", "CHECK POINT 5"
33: wrt "fc", "F9R"
34: prt "*RATIO B/A";beep;spc 2
35: dsp "CHECK POINT 5--PRESS CONTINUE";stp
36: if L=1;gto -4
37: prt "-----", "CHECK POINT 6"
38: wrt "fc", "F6R"
39: prt "*PERIOD A";beep;spc 2
40: dsp "CHECK POINT 6--PRESS CONTINUE";stp
41: if L=1;gto -4
42: prt "-----", "CHECK POINT 7"
43: wrt "fc", "F7R"
44: prt "*PER.AVG.A";beep;spc 2
45: dsp "CHECK POINT 7--PRESS CONTINUE";stp
46: if L=1;gto -4
47: prt "-----", "CHECK POINT 8"
```

Table 4-1. Model 9825A Program Listing (Part 2 of 4)

```
48: wrt "fc","F8R"
49: prt "*T.I.A+B";beep;spc 2
50: dsp "CHECK POINT 8--PRESS CONTINUE";stp
51: if L=1;gto -4
52: prt "-----", "CHECK POINT 9"
53: wrt "fc","F:R"
54: prt "*T.I.AVG.A+B";beep;spc 2
55: dsp "CHECK POINT 9--PRESS CONTINUE";stp
56: if L=1;gto -4
57: prt "-----", "CHECK POINT 10"
58: wrt "fc","F1R"
59: wait 1000
60: wrt "fc","F0R"
61: prt "*START A/STOP";beep;spc 2
62: dsp "CHECK POINT 10--PRESS CONTINUE";stp
63: if L=1;gto -8
64: prt "-----", "CHECK POINT 11"
65: wrt "fc","F2R"
66: prt "*START CLOCK";beep;spc 2
67: dsp "CHECK POINT 11--PRESS CONTINUE";stp
68: if L=1;gto -4
69: prt "-----", "CHECK POINT 12"
70: ent "DVM OPTIONS 020 OR 021?";C$;if C$="NO";gto +12
71: if C$="NO";gto +11
72: wrt "fc","F?R";beep
73: prt "*DVM"
74: wait 5000
75: wrt "fc","F3R";beep
76: prt "*DVM/A"
77: wait 5000
78: wrt "fc","F5R";beep
79: prt "*DVM,A+B";beep;spc 2
80: dsp "CHECK POINT 12--PRESS CONTINUE";stp
81: if L=1;gto -12
82: prt "-----", "CHECK POINT 13"
83: ent "CHANNEL C OPTIONS 030 OR 031?";C$;if C$="NO";gto +11
84: wrt "fc","F>R";beep
85: prt "*FREQ C"
86: wait 5000
87: wrt "fc","F=R";beep
88: prt "*RATIO C/A"
89: wait 5000
90: wrt "fc","F;R"
91: prt "*EVENTS C,A+B";beep;spc 2
92: dsp "CHECK POINT 13--PRESS CONTINUE";stp
93: if L=1;gto -11
94: prt "-----", "CHECK POINT 14"
95: wrt "fc","F<G1S137R"
96: dsp "MANUAL OK?--PRESS CONTINUE";stp
97: prt "*SAMPLE RATE"
98: wrt "fc","S6S0R"
```

Table 4-1. Model 9825A Program Listing (Part 3 of 4)

```
99: dsp "GATE LIGHT OFF?-PRESS CONTINUE";stp
100: prt "*SINGLE/MULTIPLE MEASINT";beep;spc 2
101: dsp "CHECK POINT 14--PRESS CONTINUE";stp
102: if L=1;gto -8
103: "15":prt "-----", "CHECK POINT 15"
104: prt "BUS COMMANDS:"
105: rem "fc";dsp "REMOTE?-PRESS CONTINUE";stp
106: llo 7;dsp "LOCAL LOCKOUT?-PRESS CONTINUE";stp
107: prt "*LOCAL LOCKOUT"
108: wrt "fc","PF<S13G3R"
109: dsp "10.000MHZ?-PRESS CONTINUE";stp
110: clr 7;prt "*DEVICE CLEAR";beep
111: dsp "DCL-PRESS CONTINUE";stp
112: wrt "fc","PF<S13G3R"
113: dsp "10.000MHZ?-PRESS CONTINUE";stp
114: clr "fc";prt "*SELECTED DEVICE CLEAR";beep
115: dsp "SDC-PRESS CONTINUE";stp
116: wrt "fc","PF<G3S03R"
117: dsp "IN HOLD?-PRESS CONTINUE";stp
118: wait 1000;trg 7;beep;wait 2000;trg "fc";beep;wait 1000
119: prt "*GROUP EXECUTE TRIGGER"
120: dsp "GET-PRESS CONTINUE";stp
121: wrt "fc","PF<G7S12R"
122: rds("fc")>A;dsp A
123: if A=0;gto -1
124: prt "*SERIAL POLL","STATUS BYTE=",A
125: dsp "SERIAL POLL-PRESS CONTINUE";stp
126: lcl 7;dsp "COUNTER IN LOCAL?-PRESS CONTINUE";stp
127: prt "*GO TO LOCAL";spc 2
128: rem "fc"
129: dsp "CHECK POINT 15-PRESS CONTINUE";stp
130: if L=1;gto "15"
131: ent "OPT 041 PROG INPUT?",C$;if C$="NO";gto "END"
132: "16":prt "-----", "CHECK POINT 16"
133: wrt "fc","PF4G4S13R"
134: dsp "STEPS 1,2-PRESS CONTINUE";stp
135: wrt "fc","A137R";wait 2000
136: wrt "fc","A0R"
137: dsp "REPEAT FOR CHNL B-PRESS CONTINUE";stp
138: wrt "fc","L137R";wait 2000
139: wrt "fc","B0R"
140: prt "*IMPEDANCE";beep;spc 2
141: dsp "CHECK POINT 16--PRESS CONTINUE";stp
142: if L=1;gto -10
143: prt "-----", "CHECK POINT 17"
144: wrt "fc","PF4G4S13A137SE137R"
145: dsp "STEP 3---PRESS CONTINUE";stp
146: wrt "fc","PF4G4S13A13SE13R";wait 2000
147: prt "*ATTENUATOR";beep;spc 2
148: dsp "CHECK POINT 17-PRESS CONTINUE";stp
149: if L=1;gto -6
```

Table 4-1. Model 9825A Program Listing (Part 4 of 4)

```
150: prt "-----", "CHECK POINT 18"
151: dsp "STEPS 4,5,6-PRESS CONTINUE";stp
152: wrt "fc","PF9C3S13A79E7R"
153: dsp "SEPRT/CMN-PRESS CONTINUE";stp
154: wrt "fc","PF4G5S13B79R";wait 2000
155: dsp "NORML/INV-PRESS CONTINUE";stp
156: prt "*SEPARATE/COMMON","*NORMAL/INVERTED";beep;spc 2
157: dsp "CHECK POINT 18-PRESS CONTINUE";stp
158: if L=1;gto -8
159: prt "-----", "CHECK POINT 19"
160: wrt "fc","PF4G4S13A79B7R"
161: dsp "STEPS 7,8--PRESS CONTINUE";stp
162: wrt "fc","PF4G4S13A379B37R"
163: prt "*COUPLING";beep;spc 2
164: dsp "CHECK POINT 19-PRESS CONTINUE";stp
165: if L=1;gto -6
166: prt "-----", "CHECK POINT 20"
167: dsp "STEP 9--PRESS CONTINUE";stp
168: wrt "fc","PF4G3S137A?R"
169: prt "*CHECK MODE";beep;spc 2
170: dsp "CHECK POINT 20-PRESS CONTINUE";stp
171: if L=1;gto -5
172: prt "-----", "CHECK POINT 21"
173: wrt "fc","PF4G6S136A379+000*B37+000*R"
174: dsp "STEPS 10,11-PRESS CONTINUE";stp
175: wrt "fc","PF4G6S136A379+040*B37+040*R"
176: prt "*TRIGGER LEVELS"
177: dsp "TRIGGER LVLS-PRESS CONTINUE";stp
178: dsp "STEPS 12,13,14,15-PRESS CONTINUE";stp
179: wrt "fc","PF:5137A379+040*B37+050*R"
180: prt "CHNL B,+SLOPE"
181: dsp "CHANNEL B,+SLOPE--PRESS CONTINUE";stp
182: wrt "fc","PF:5137A379+040*B375+050*R"
183: prt "CHNL B,-SLOPE"
184: dsp "CHNL B,-SLOPE--PRESS CONTINUE";stp
185: wrt "fc","PF:5137A379+050*B375+040*R"
186: prt "CHNL A,+SLOPE"
187: dsp "CHNL A,+SLOPE-PRESS CONTINUE";stp
188: wrt "fc","PF:5137A2795+050*B375+040*R"
189: prt "CHNL A,-SLOPE";spc 2
190: dsp "CHNL A,-SLOPE-PRESS CONTINUE";stp
191: dsp "CHECK POINT 21-PRESS CONTINUE";stp
192: if L=1;gto "16"
193: "END":dsp "END OF TEST"
194: prt "END OF TEST";beep;spc 5
195: end
*28955
```

Table 4-2. Model 9825A Program Description (Part 1 of 2)

CHECK POINT	TEST	OBSERVE ON 5328B
1	REMOTE	Front panel (RMT) annunciator should be ON.
2	CHECK	Counter should read 10.000 MHz.
3	RESOLUTION	The 9825A should print and counter display the 10 MHz check signal with resolutions from 10 kHz to 0.01 Hz.
4	FREQ A	Counter display should read 0.00000 kHz.
5	RATIO B/A	Counter display should read 0.0000000.
6	PERIOD A	Counter displays should read 0.0 s.
7	PER. AVG. A	Counter display should read 0.000000 ns.
8	T.I. A→B	Counter display should read 0.0 s.
9	T.I. AVG. A→B	Counter display should read 0.000000 ns.
10	START A/STOP	Counter display should read 0.00 n.
11	START CLOCK	In this mode (GATE) and (n) annunciators should be on and instrument should commence counting starting at 0.00.
DVM OPTIONS 021, 050		
12	DVM DVM/A DVM, A→B	The counter will first display $\pm 0.00000V$ for 5 seconds and print DVM, then display $\pm 0.00000 \mu$ for 5 seconds and print DVM/A and finally display $\pm 0.0000$ and print DVM, A→B.
CHANNEL C OPTIONS 031, 050		
13	FREQ C RATIO C/A EVENTS C, A→B	The count will first display for 5 seconds 0.0000 kHz and print FREQ C, then display 0.00000000 for 5 seconds and print RATIO C/A and finally display 0.0.0.0.0.0.0.0. and print EVENTS C, A→B.
14	SAMPLE RATE SINGLE/MULTIPLE MEASUREMENT	When calculator display MANUAL OK?, verify that front panel SAMPLE RATE control can be manually adjusted as seen from GATE LIGHT flashing rate. When calculator display GATE LIGHT OFF?, verify that GATE LIGHT is truly OFF.
HP-IB BUS COMMANDS		
15	LOCAL LOCKOUT (LLO)	When the 9825A <b>CONTINUE</b> key is pressed, verify that counter (RMT) annunciator is ON.  When the 9825A <b>CONTINUE</b> key is again pressed, verify Local lockout by pressing front panel RESET button and ensuring counter doesn't go into Local operation. (RMT annunciator OFF.)
	DEVICE CLEAR (DCL)	When the 9825A <b>CONTINUE</b> key is pressed, verify that counter displays 10.000 MHz. When the 9825A <b>CONTINUE</b> key is again pressed, counter will reset to its Remote Program Initialize mode and display (0.).
	SELECTED DEVICE CLEAR (SDC)	When the 9825A <b>CONTINUE</b> key is pressed, verify that counter displays 10.000 MHz. When the 9825A <b>CONTINUE</b> key is again pressed, counter will reset to its Remote Program Initialize mode and display (0.).
	GROUP EXECUTE TRIGGER (GET)	When the 9825A <b>CONTINUE</b> key is pressed, verify that counter is in Hold (GATE LIGHT OFF). When the 9825A <b>CONTINUE</b> key is pressed, GATE LIGHT should flash twice and counter should display 10.000 MHz.
	SERIAL POLE (SPE/SPD)	When the 9825A <b>CONTINUE</b> key is pressed, counter should display (0.0000000 MHz) and GATE LIGHT should go OFF. Calculator should print (STATUS BYTE = 64.00).
	GO TO LOCAL (GTL)	When the 9825A <b>CONTINUE</b> key is pressed, verify that counter is in Local (RMT annunciator OFF). When 9825A <b>CONTINUE</b> key is again pressed, counter will go into remote.

Table 4-2. Model 9825A Program Description (Part 2 of 2)

CHECK POINT	STEP	TEST	OBSERVE ON 5328B	
16	1	IMPEDANCE	Set up the equipment as shown in <i>Figure 4-19</i> . Set the function generator to an output of 1 kHz, 100 mV p-p centered at 0V dc as seen on the oscilloscope. Connect the function generator's output to Channel A of the counter. Set the counter's LEVEL A and B to PRESET.	
	2		When the 9825A <b>CONTINUE</b> key is pressed, observe oscilloscope display reduced to approximately half its original amplitude level. Repeat for Channel B.	
17	3	ATTENUATOR	Connect function generator's output to Channel A of the counter. When the 9825A <b>CONTINUE</b> key is pressed, observe the counter's trigger light stop blinking.	
18	4	SEPARATE/ COMMON NORMAL/ INVERTED	Connect function generator's output to Channel A of the counter.	
	5		When the 9825A <b>CONTINUE</b> key is pressed, observe counter display 1.000.	
	6		Connect function generator to Channel B. When the 9825A <b>CONTINUE</b> key is pressed, counter should display approximately 1.00 kHz.	
19	7	COUPLING	Set the function generator to a triangular pulse output of 1 kHz at 300 mV p-p with a +0.4V dc offset ( <i>Figure 4-20</i> ). Connect signal to counter's Channel A input. Counter's Channels A and B trigger lights should be blinking.	
	8		When the 9825A <b>CONTINUE</b> key is pressed, observe the counter's trigger lights stop blinking.	
20	9	CHECK MODE	When the 9825A <b>CONTINUE</b> key is pressed, counter should display 100.000 MHz $\pm 1$ count. SAMPLE RATE control can be adjusted to obtain a stable display.	
21	10	SLOPE/TRIGGER LEVEL	Set the function generator to a triangular pulse output of 1 kHz at 300 mV p-p with a +0.4V dc offset ( <i>Figure 4-20</i> ). Connect the function generator's output to Channel A of the counter. Set the counter's LEVEL A and B to PRESET.	
	11	SLOPE/TRIGGER LEVEL	When the 9825A <b>CONTINUE</b> key is pressed, observe Channels A and B trigger lights commence blinking.	
	12	CHANNEL B +SLOPE	When the 9825A <b>CONTINUE</b> key is pressed, counter should display approximately 150.00 $\mu\text{s} \pm 75 \mu\text{s}$ (wide tolerance).	
	13	CHANNEL B -SLOPE	When the 9825A <b>CONTINUE</b> key is pressed, counter should display approximately 400.00 $\mu\text{s} \pm 75 \mu\text{s}$ (wide tolerance).	
	14	CHANNEL A +SLOPE	When the 9825A <b>CONTINUE</b> key is pressed, counter should display approximately 400.00 $\mu\text{s} \pm 75 \mu\text{s}$ (wide tolerance).	
	15	CHANNEL A -SLOPE	When the 9825A <b>CONTINUE</b> key is pressed, counter should display approximately 150.00 $\mu\text{s} \pm 75 \mu\text{s}$ (wide tolerance).	
				END OF VERIFICATION

PERFORMANCE TEST (Continued)

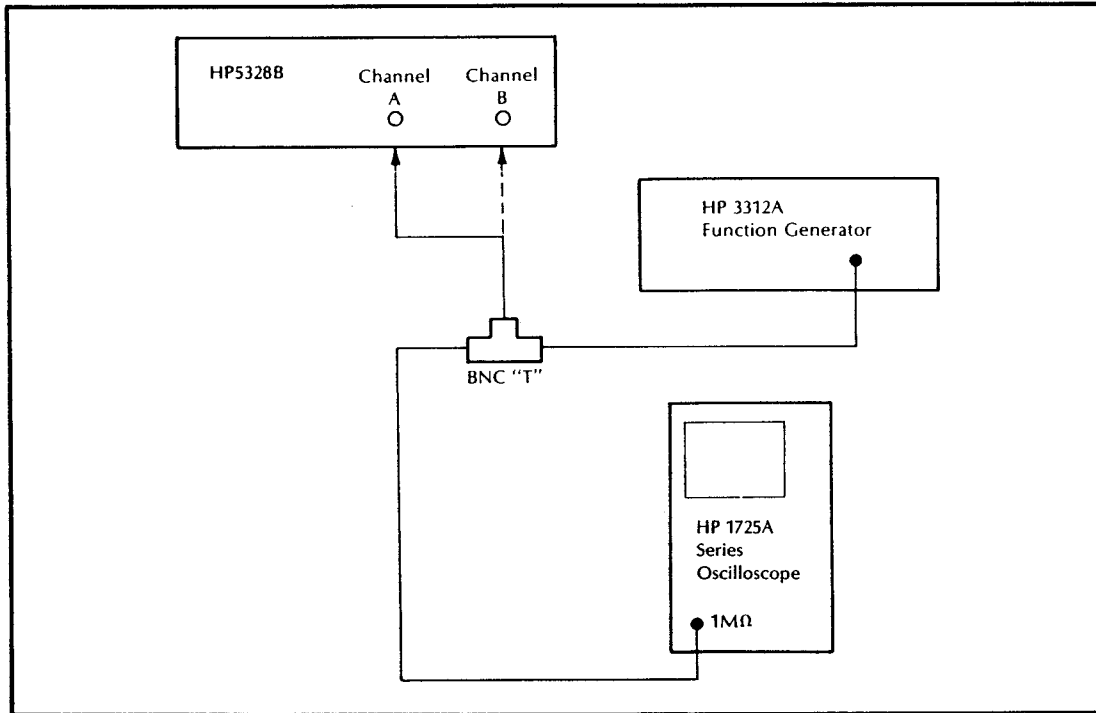


Figure 4-19. Programmable Input Module — Test Setup

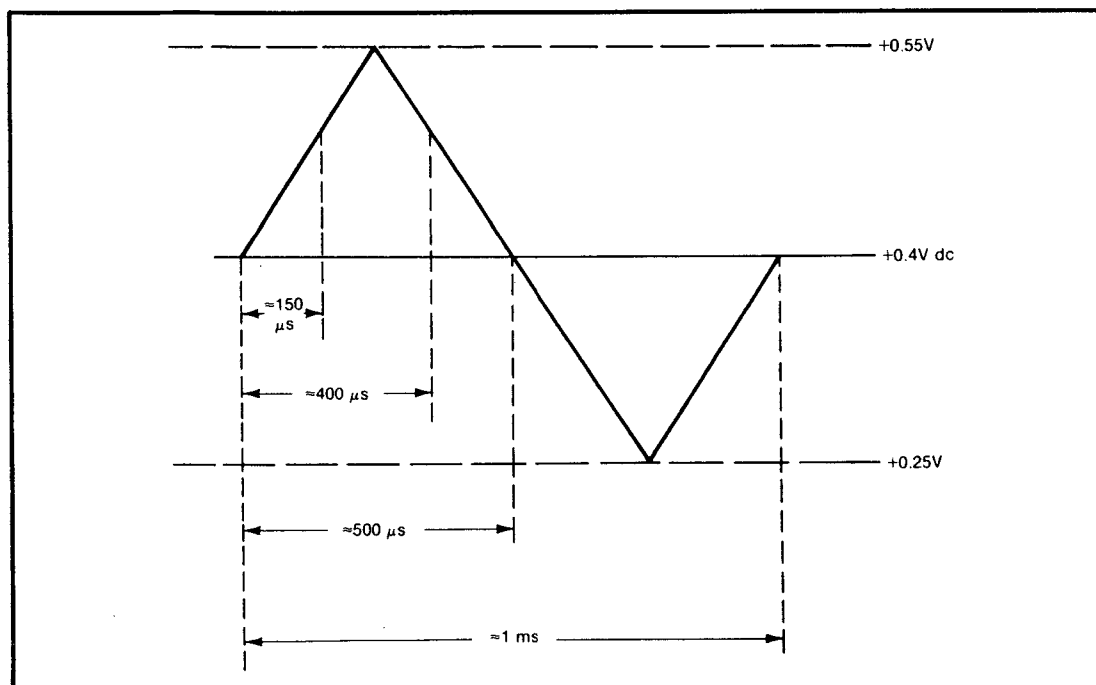


Figure 4-20. Test Waveform

**PERFORMANCE TEST (Continued)**

**4-21. REMOTE TRIGGER LEVEL TEST**

**Specification:**  $\pm 2.5$  volts  $\pm 35$  mV

**Description:** The Model 5328B is remotely programmed at a specified level, and the respective trigger level LED should begin blinking. The MARKER OUTPUT signal should intersect the applied signal at the programmed level,  $\pm 35$  mV.

- a. Connect the test setup as shown in *Figure 4-21*.

**NOTE**

Initially, connect the Model 5328B's Channel "A" MARKER OUTPUT to the Oscilloscope's Channel "B" input.

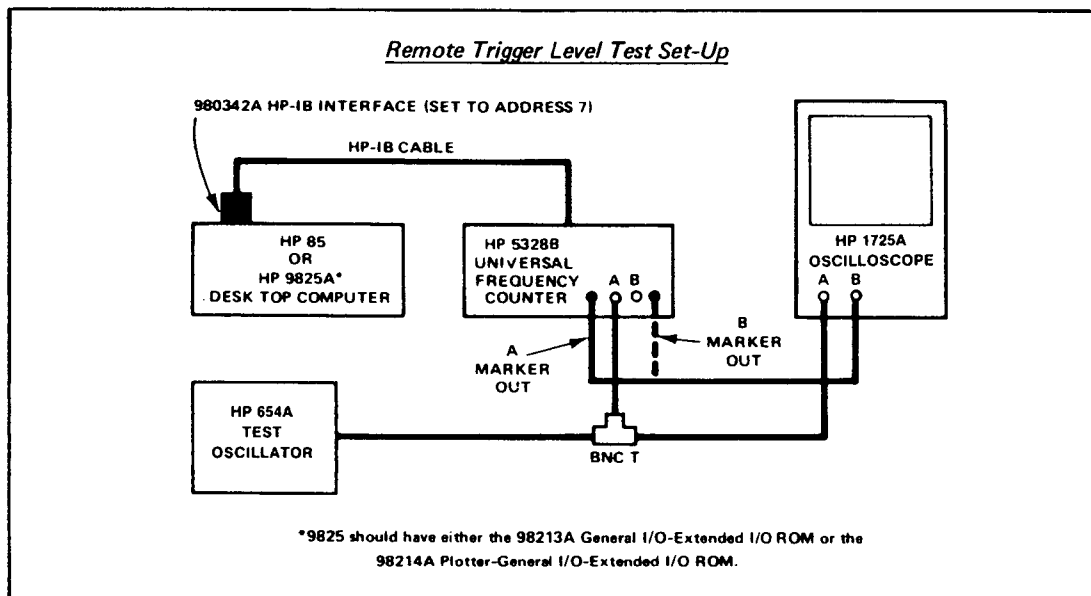


Figure 4-21. Remote Trigger Level Test Set-up

- b. Set the Model 5328B's address switches as shown in *Figure 4-22*.

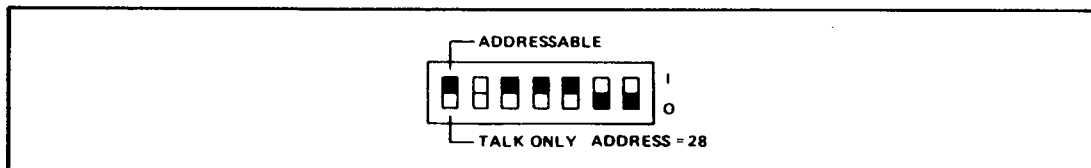


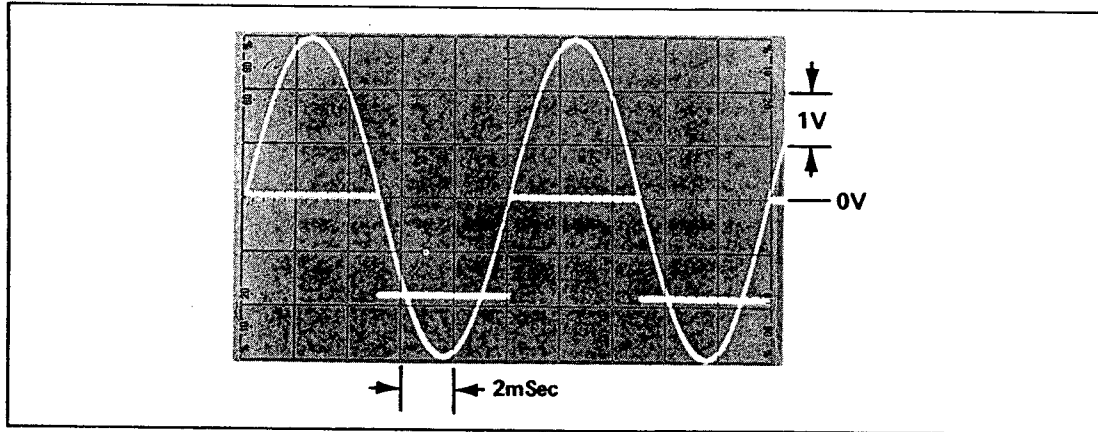
Figure 4-22. Switch Settings for Remote Trigger Level Test

- c. Execute the following statement from the controller's keyboard —  
**HP 9825A:** wrt 728, "PF4G6513A1379+000\*B137+000\*R"  
**HP 85A:** output 728; "PF4G6513A1379+000\*B137+000\*R"
- d. Set the Signal Generator for a 100 Hz signal at six volts peak-to-peak. Center the signal on the Oscilloscope's Channel "A" display.



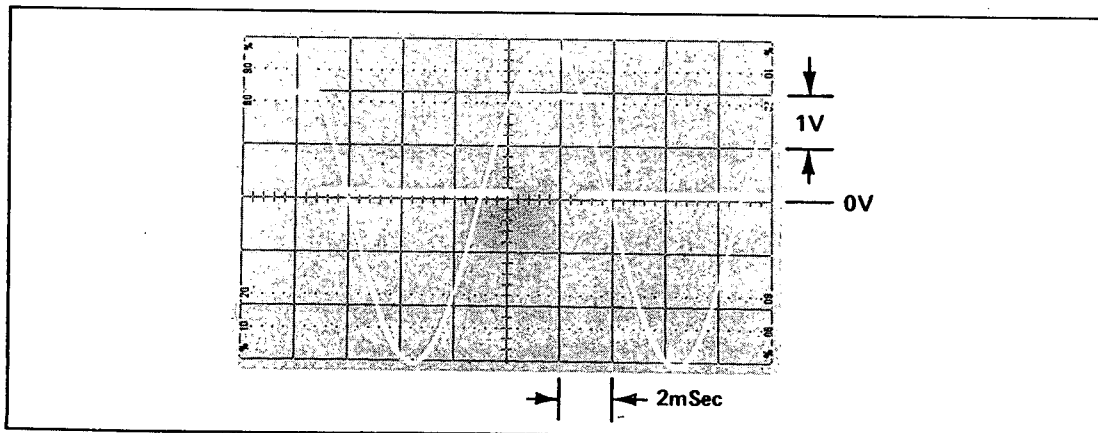
### PERFORMANCE TEST (Continued)

- e. Adjust the Oscilloscope's Channel "B" controls so the top of the Model 5328B's Channel "A" MARKER OUTPUT waveform just barely intersects the positive-slewing and negative-slewing portions of the 100 Hz sine wave as shown in *Figure 4-23*. Verify that this occurs at zero volts on the 100-Hz sine wave.



*Figure 4-23. Triggering Level Test Waveforms — I*

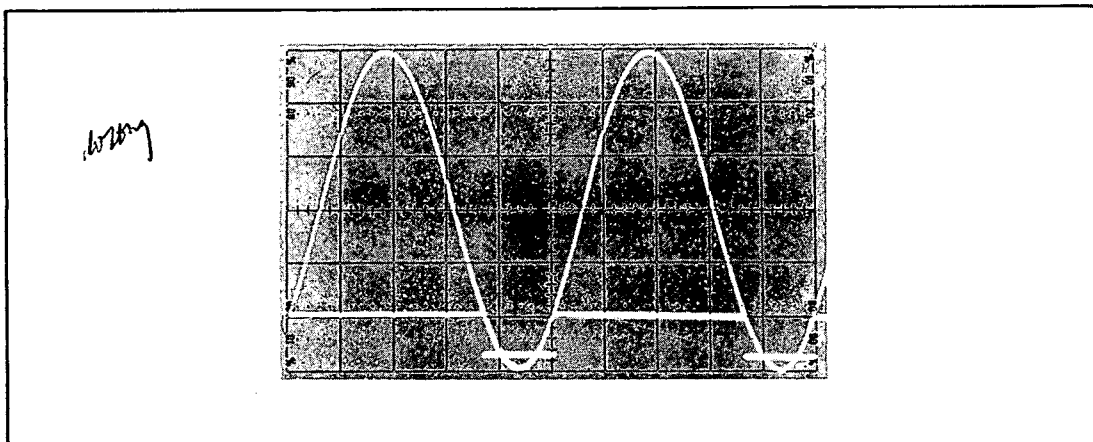
- f. Connect the Model 5328B's Channel "B" marker to the Oscilloscope's Channel "B" input.
- g. Adjust the Oscilloscope's Channel "B" controls so the top of the Model 5328B's Channel "B" MARKER OUTPUT waveform just barely intersects the positive-slewing and negative-slewing portions of the 100 Hz sine wave as shown in *Figure 4-23*. Verify that this occurs at zero volts on the 100-Hz sine wave.
- h. Execute the following statement from the controller's keyboard
- HP 9825A:** wrt 728, "PF4G6513A1379+200\*B137+200\*R"
- HP 85A:** output 728; 'PF4G6513A1379+200\*B137+200\*R"
- i. Adjust the Oscilloscope's Channel "B" controls so the top of the Model 5328B's Channel "B" MARKER OUTPUT waveform just barely intersects the positive-slewing and negative-slewing portions of the 100 Hz sine wave as shown in *Figure 4-24*. Verify that this occurs at +2 volts on the 100-Hz sine wave.



*Figure 4-24. Triggering Level Test Waveforms — II*

### PERFORMANCE TEST (Continued)

- j. Connect the Model 5328B's Channel "A" marker to the Oscilloscope's Channel "B" input.
- k. Adjust the Oscilloscope's Channel "B" controls so the top of the Model 5328B's Channel "B" MARKER OUTPUT waveform just barely intersects the positive-slewing and negative-slewing portions of the 100 Hz sine wave as shown in *Figure 4-25*. Verify that this occurs at +2 volts on the 100-Hz sine wave.
- l. Execute the following statement from the controller's keyboard —
- HP 9825A:** wrt 728, "PF4G6513A1379-200\*B137-200\*R"
- HP 85A:** output 728; "PF4G6513A1379-200\*B137-200\*R"
- m. Adjust the Oscilloscope's Channel "B" controls so the top of the Model 5328B's Channel "A" MARKER OUTPUT waveform just barely intersects the positive-slewing and negative-slewing portions of the 100 Hz sine wave as shown in *Figure 4-25*. Verify that this occurs at -2 volts on the 100-Hz sine wave.



*Figure 4-25. Triggering Level Test Waveforms — III*

- n. Connect the Model 5328B's Channel "B" MARKER OUTPUT to the Oscilloscope's Channel "B" input.
- o. Adjust the Oscilloscope's controls to position the Channel "B" marker as shown in *Figure 4-25*. Verify that the Channel "B" marker intersects the 100-Hz sine wave at -2 volts.
- p. Record the results of your tests on the test record card provided.

**PERFORMANCE TEST RECORD**

Hewlett-Packard Model 5328B Universal Counter

Serial Number \_\_\_\_\_

Tests Performed by \_\_\_\_\_

Date \_\_\_\_\_ / \_\_\_\_\_ / \_\_\_\_\_

Test Ref	Description	Results	
		Pass	Fail
4-11	SELF CHECK	_____	_____
4-12	FREQUENCY RESPONSE AND SENSITIVITY — CHANNEL "A"		
	DC 10 Hz to 10 MHz	_____	_____
	AC 20 Hz to 10 MHz	_____	_____
	DC 10 MHz to 40 MHz	_____	_____
	DC 40 MHz to 100 MHz	_____	_____
	AC 10 MHz to 40 MHz	_____	_____
	AC 40 MHz to 100 MHz	_____	_____
4-13	FREQUENCY RESPONSE AND SENSITIVITY — CHANNEL "B"		
	DC 10 Hz to 10 MHz	_____	_____
	AC 20 Hz to 10 MHz	_____	_____
	DC 10 MHz to 100 MHz	_____	_____
	10.000000 ±1	_____	_____
	40.000000 ±1	_____	_____
	70.000000 ±1	_____	_____
	100.0 ±1	_____	_____
	AC 10 MHz to 100 MHz	_____	_____
	10.000000 ±1	_____	_____
	40.000000 ±1	_____	_____
	70.000000 ±1	_____	_____
	100.0 ±1	_____	_____
4-14	PERIOD AND PERIOD AVERAGE		
	PER A 0.10 μS ±0.01 μS	_____	_____
	PER AVG A 100.0 nS +1 nS	_____	_____

**PERFORMANCE TEST RECORD (Continued)**

Test Ref	Description	Results	
		Pass	Fail
4-15	TIME INTERVAL AND TIME INTERVAL AVERAGE		
	T.I. A-B $0.05 \mu\text{S} \pm 0.01 \mu\text{S}$	_____	_____
	T.I. AVG A-B $52.6 \mu\text{S} \pm 2 \text{ nS}$ (A+, B-)	_____	_____
	T.I. AVG A-B $52.6 \mu\text{S} \pm 2 \text{ nS}$ (A-, B+)	_____	_____
4-16	RATIO B/A AND C/A		
	B/A $10.000 \pm 1$	_____	_____
	C/A (OPTION 030 OR OPTION 050) $130.00 \pm 1$	_____	_____
4-17	CHANNEL C (OPTION 031 OR OPTION 050)		
	90 MHz	_____	_____
	300 MHz	_____	_____
	600 MHz	_____	_____
	900 MHz	_____	_____
	1300 MHz	_____	_____
4-18	TOTALIZE		
	START A/STOP $300.00 \text{ m}$	_____	_____
4-19	DIGITAL VOLTMETER (OPTION 021 OR 050)		
	SHORT CONNECTORS $0.0000\text{V} \pm 0.4 \text{ mV}$	_____	_____
	$\pm 9.5000\text{V} \pm 3.3 \text{ mV}$	_____	_____
	$\pm 95.000\text{V} \pm 33 \text{ mV}$	_____	_____
	$\pm 1000.00\text{V} \pm 0.91\text{V}$	_____	_____
	READ A	_____	_____
	READ B	_____	_____
4-20	HP-IB INTERFACE VERIFICATION	_____	_____
4-21	REMOTE TRIGGER LEVEL TEST	_____	_____

## SECTION V ADJUSTMENTS

### 5-1. INTRODUCTION

This section describes the adjustments required to keep the Model 5328B operating within its specifications. Any adjustment listed in this manual section should be made only if required, either because the Model 5328B failed its performance check (see Section 4 of this manual) or because a part affecting the adjustment was replaced.

### 5-2. EQUIPMENT REQUIRED

The test equipment required for the adjustment procedure(s) given in this section is listed in *Table 1-4, Recommended Test Equipment*. Equipment other than the specified model may be substituted, provided it meets the "critical specifications" listed.

#### WARNING

**BE SURE ALL ELECTRICALLY OPERATED EQUIPMENT YOU USE IS PROPERLY GROUNDED.**

#### CAUTION

**Be sure to turn electrical power off whenever you are connecting or disconnecting test equipment, installing or removing parts, etc.**

### 5-3. FACTORY-SELECTED COMPONENTS

Some of the values in the parts lists (in Section 6) are selected during manufacturing to meet circuit requirements. These parts are marked with an asterisk (\*) in the parts lists and schematic diagrams, with the average value shown.

### 5-4. ADJUSTMENT LOCATIONS

Adjustment locations are identified in the component locators given in Section 8 of this manual.

## 5-5. SAFETY CONSIDERATIONS

This section contains warnings and cautions that must be followed for your protection and to avoid damage to the equipment.

### WARNING

**MAINTENANCE DESCRIBED HEREIN IS PERFORMED WITH POWER SUPPLIED TO THE INSTRUMENT, AND PROTECTIVE COVERS REMOVED. SUCH MAINTENANCE SHOULD BE PERFORMED ONLY BY SERVICE-TRAINED PERSONNEL WHO ARE AWARE OF THE HAZARDS (FIRE AND/OR ELECTRICAL SHOCK, FOR EXAMPLE) INVOLVED. WHERE MAINTENANCE CAN BE PERFORMED WITHOUT POWER APPLIED, THE POWER SHOULD BE REMOVED.**

**BEFORE ANY REPAIR IS COMPLETED, ENSURE THAT ALL SAFETY FEATURES ARE INTACT AND FUNCTIONING, AND THAT ALL NECESSARY PARTS ARE CONNECTED TO THEIR PROTECTIVE GROUNDING MEANS.**

## 5-6. Power Supply Adjustment

- a. With the power cord disconnected, remove the top cover of the counter.
- b. Insure the 5328B line voltage selector switch is set for the desired ac line voltage.
- c. Connect the ac line cord to the counter.
- d. Probe the solder dot labeled +5 near the space labeled "XA13" with a DVM probe.
- e. Adjust the power supply reference adjustment A2R27 for reading of +5.00V dc  $\pm$ .050V. Access A1R27 through the HP-IB board via the hole provided in the right rear of the HP-IB board, in front of the fan.
- f. Check the following voltages on the motherboard near XA13:
  - 5.2V dc  $\pm$ .050V
  - +15V dc  $\pm$ .400V
  - 15V dc  $\pm$ .400V
- g. The power supply adjustments are now complete.

## 5-7. OSCILLATOR ADJUSTMENT

### NOTE

The same procedure can be used for the standard oscillator or for the High-Stability Oven Oscillator (Option 010) — however, for the Option 010 oscillator, you should allow a 24-hour warm-up period before performing the adjustment procedure.

- a. Set up the equipment as shown in Figure 5-1.

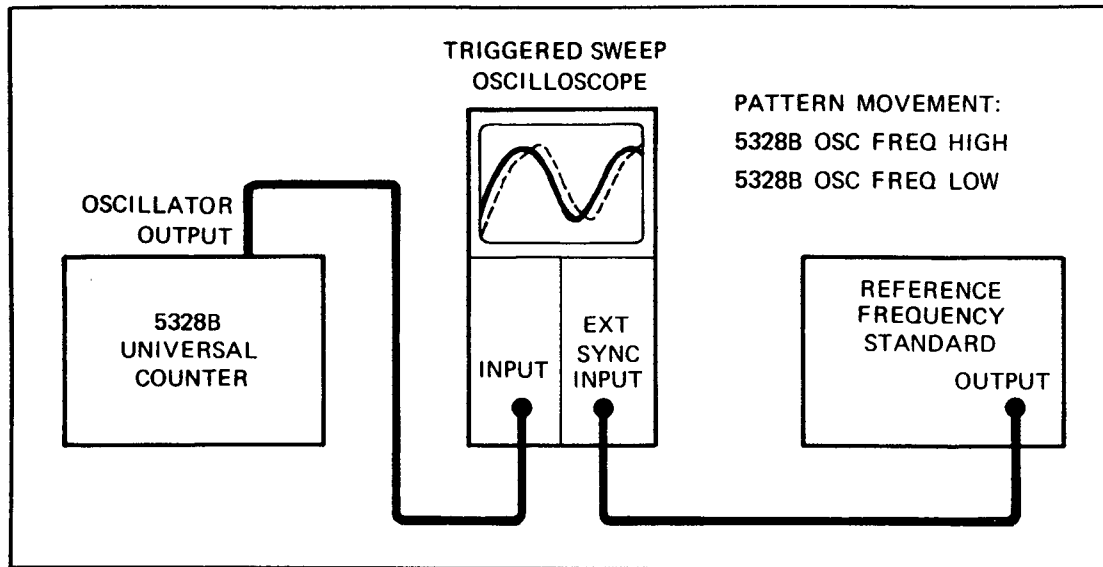


Figure 5-1. Oscillator Adjustment Setup

- b. Connect the Reference Frequency Standard (multiple of 10 MHz) to the Oscilloscope's EXTERNAL SYNC INPUT.
- c. Set the Model 5328B's rear-panel OSC INT/EXT to INT.
- d. Connect the oscillator output BNC to the Oscilloscope's Channel "A" input.
- e. Adjust the Model 5328B's oscillator frequency adjustment for minimal sideways movement of the 10 MHz displayed signal.

**NOTES**

1. If the Model 5328B has the standard oscillator, its frequency adjustment is A1C18 (on the A1 board).
  2. If the Model 5328B has the Option 010 High-Stability Oven Oscillator, the frequency adjustment control is accessible from outside the oven's can, through the hold labelled "FREQ ADJ".
- f. You can determine the approximate offset of the Model 5328B's oscillator by timing the sideways movement of the waveform on the oscilloscope's screen. Table 5-1 provides the calibration you can use; an example follows.

Table 5-1. Oscillator Offset Timing

Rate of Waveform Movement	Oscillator Offset, Based on Oscilloscope Sweep Speed of ...		
	1 us/div	0.1 us/div	0.01 us/div
1 div/1s	$1 \times 10^6$	$1 \times 10^7$	$1 \times 10^8$
1 div/10s	$1 \times 10^7$	$1 \times 10^8$	$1 \times 10^9$
1 div/100s	$1 \times 10^8$	$1 \times 10^9$	$1 \times 10^{10}$

Model 5328B  
Adjustments

For example, if the trace moves one division in ten seconds, and the Oscilloscope's sweep speed is set to 0.01 us/division, the Oscillator's signal is within  $1 \times 10^9$  of the reference frequency, as you can see from Table 5-1, above. You can verify this by making the following calculation —

$$\frac{\Delta t}{t} = \frac{\Delta f}{f}$$

$$\frac{0.01 \text{ us/div}}{10 \text{ s/div}} = 1 \times 10^9$$

**5-8. INPUT MODULE**

**5-9. Input Sensitivity**

Adjust the Channel "A" and Channel "B" INPUT sensitivity as follows —

- a. Remove the Model 5328B's top cover to gain access to variable resistors A12R28 and A12R26 on Amplifier Assembly A12 (see component/adjustment locator).
- b. Set the Model 5328B's front-panel controls as follows:

FUNCTION ..... FREQ A  
 RESOLUTION ..... 10<sup>5</sup>, 10 Hz  
 SLOPE (A) ..... +  
 AC/DC (A) ..... DC  
 ATTEN (A) ..... 1  
 LEVEL (A) ..... PRESET  
 CHK/COM A/SEP ..... SEP  
 SAMPLE RATE ..... mid-range  
 INPUT IMPEDANCE ..... 50-ohms

- c. Set the Model 5328B's rear-panel controls as follows:

STORAGE ..... ON  
 OSC ..... ON  
 ARM ..... OFF

- d. Connect the Signal Generator (or equivalent) to the Model 5328B's Channel "A" INPUT.
- e. Set the Signal Generator to 100MHz at 50 mV rms (140 mV peak-to-peak).
- f. Slowly decrease the Signal Generator's output level to 25 mV rms (70 mV peak-to-peak), while adjusting variable resistor A12R28 to obtain a stable correct display on the counter. Continue to reduce the 100MHz signal level and re-adjust A12R28 until maximum sensitivity is achieved for Channel "A".

This ends the Channel "A" sensitivity adjustment. The step below begins the Channel "B" sensitivity adjustment.

- g. Set the Model 5328B's front-panel controls as follows:

FUNCTION ..... RATIO B/A  
 RESOLUTION ..... 10<sup>3</sup>, 10 kHz  
 CHK/COM A/SEP ..... SEP  
 LEVEL B ..... PRESET



- h. With the Signal Generator set to 40 MHz at 50 mV rms at the Channel "B" INPUT, connect a second Signal Generator (set to 10 MHz at 100 mV rms to the Channel "A" INPUT).
- i. Slowly decrease the level of the signal connected to the Model 5328B's Channel "B" Input, while adjusting A12 26 to obtain a stable correct display of about "4.000" on the counter. Continue reducing the Channel "B" Input signal and adjusting A12R26 until maximum sensitivity is obtained for Channel "B".

### 5-10. 100 MHz Phase-Locked Loop Adjustment

- a. Set the Model 5328B's front-panel controls as follows:

FUNCTION .....	FREQ A
RESOLUTION .....	10 <sup>6</sup> , 1 Hz
SAMPLE RATE .....	fully counter-clockwise
CHK/COM A/SEP .....	CHK

- b. Externally trigger the Oscilloscope from the Model 5328B's 10 MHz rear-panel output (set the Model 5328B's rear-panel switch to "INT").
- c. Connect a probe from channel A on the oscilloscope to A14TP1.
- d. The Oscilloscope display of the signal at A14TP1 should look like the waveform shown in Figure 5-2. This should be a 10 MHz TTL signal with no visible phase jitter.
- e. Measure the dc voltage at A14TP5, and adjust A14C18 until this voltage is between +1.6V and +1.8V.
- f. Observe the Model 5328B's display. The counter's display should show "100 MHz" ±1 count ("OF" 00000.000 kHz).

#### NOTE

Change the resolution switch momentarily to 10<sup>5</sup> 10 Hz to observe 100,000.000kHz (100MHz without overflow indication).

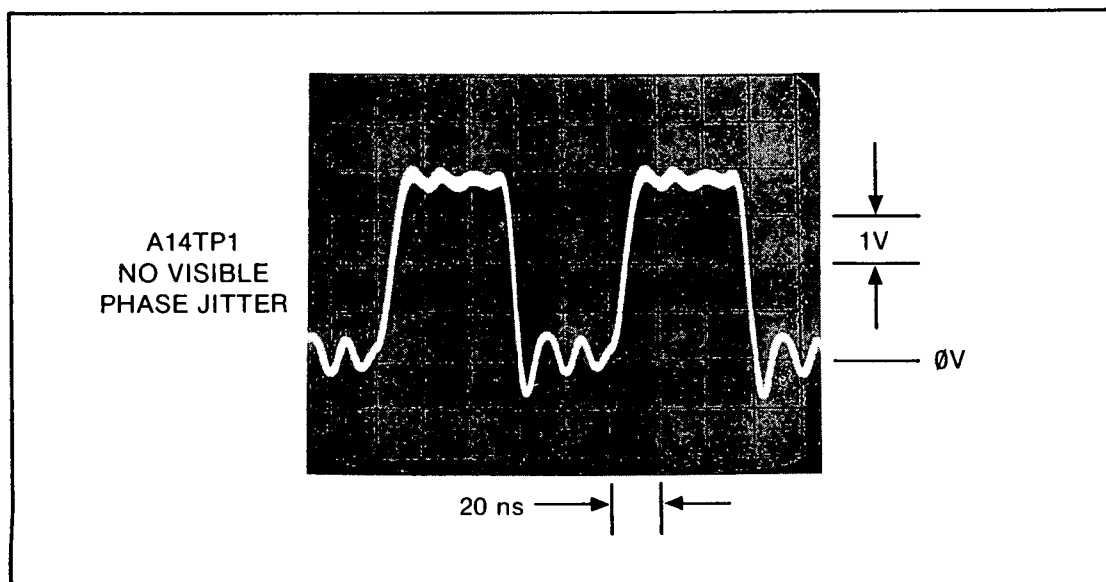


Figure 5-2. 10 MHz Time Base Waveform

### 5-11. Phase Modulator and Noise Generator Adjustments

- a. Set the HP 5328B FUNCTION switch to T.I. AVG A→B.
- b. Connect a true rms voltmeter, such as the HP3400A, to the (-) side of A14C29. Adjust A14C18 for a reading of approximately 0.8V rms (the needle of the HP3400A will bounce around but adjust for an average around 0.8V rms).
- c. Observe the noise waveform at the (-) side of A14C29 with the oscilloscope. Large noise spikes should not be present. See Figure 5-3.

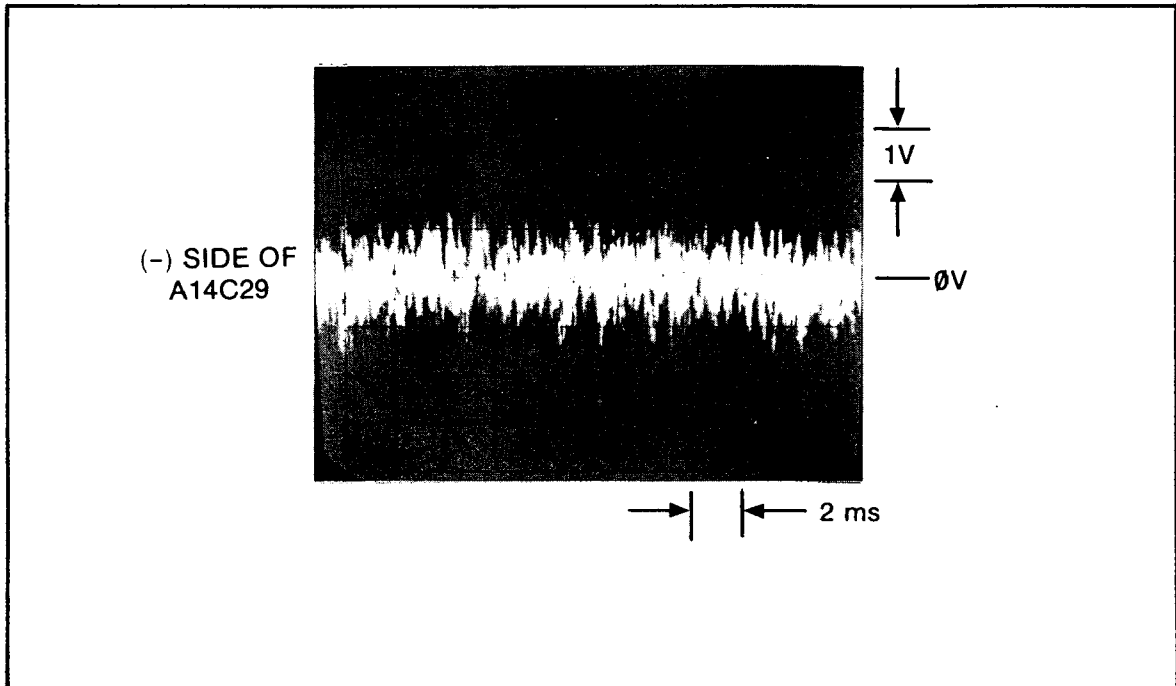


Figure 5-3. Noise Generator Waveform

- d. Observe the signal at A14TP6 with an oscilloscope (still externally triggered from the HP5328B 10 MHz output). Adjust A14C23 so that the phase jitter on the sine wave signal is the same on the positive slope as on the negative slope as shown in Figure 5-4.

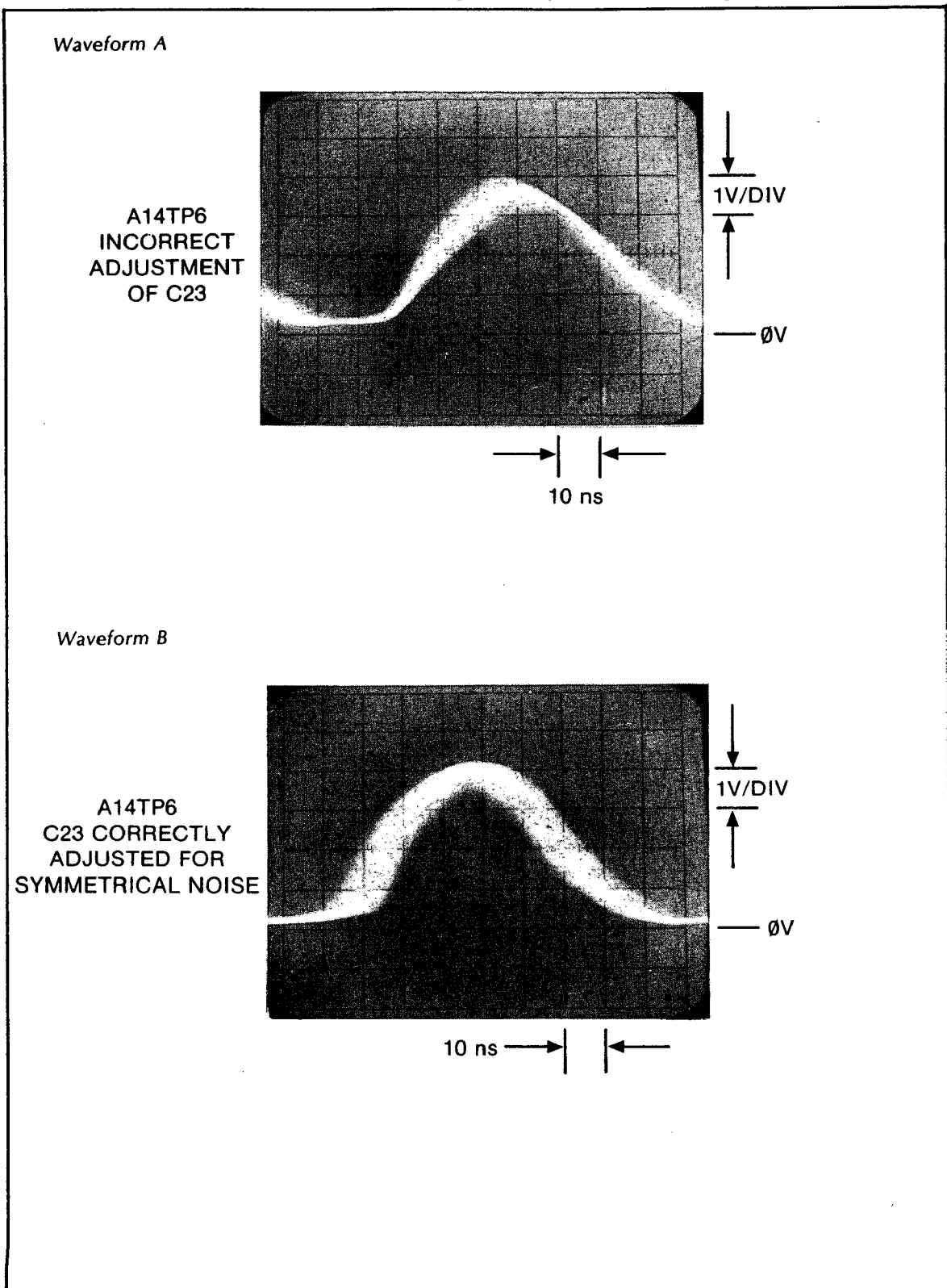


Figure 5-4. Phase Modulator Waveform

- e. Observe the 10 MHz signal at A14TP1 with the oscilloscope (still externally triggered). Observe approximately 8 nanoseconds peak-to-peak jitter on the TTL 10 MHz signal as shown in Figure 5-5.

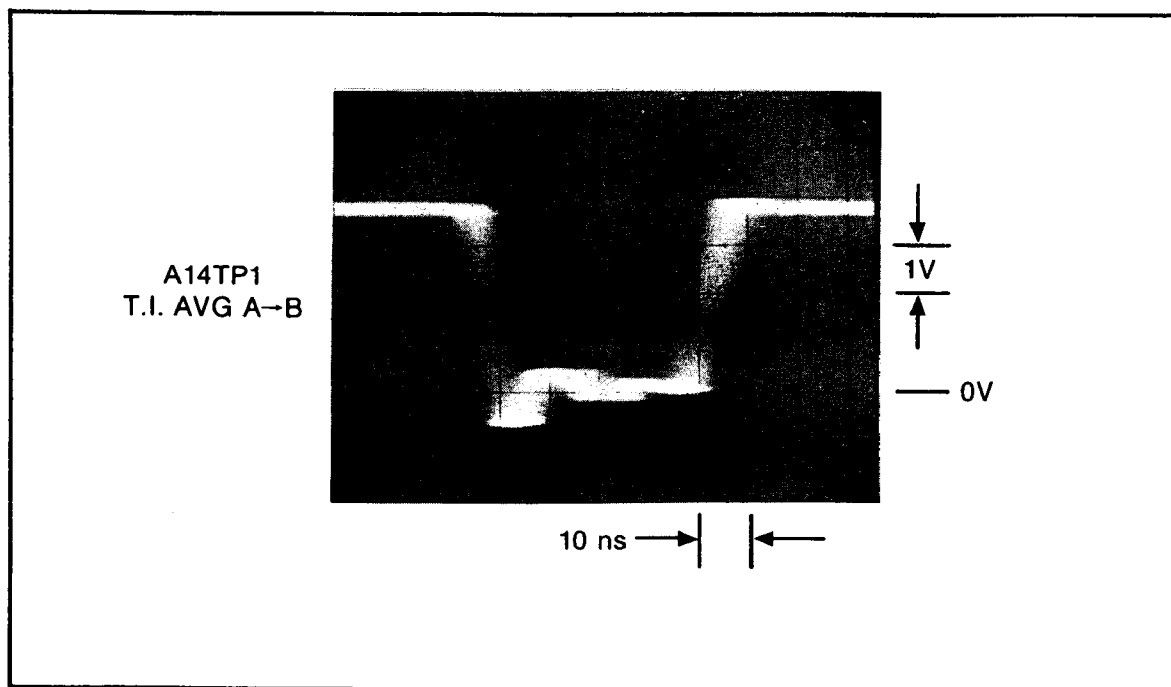


Figure 5-5. TTL 10 MHz Time Base Waveform

#### EXPLANATION

The phase jitter is added to the 10 MHz Time Base signal only in the T.I. AVG A→B function to insure averaging even when there is coherence between the repetition rate of the time intervals and the internal 10 MHz clock. To determine if the phase jitter circuit is adjusted properly, apply a stable, low frequency signal to the HP5328B A INPUT with the HP5328B in COM A. Select T.I. A→B function, RESOLUTION = 1 MHz, N = 1, (-) slope for A and (+) slope for B, and adjust trigger levels for stable triggering. The reading should be stable to  $\pm 1$  count. Switch to T.I. AVG A→B (N still = 1) and observe the display. The display should be stable to  $\pm 2$  counts.

A good source for the stable low frequency signal is the rear panel TIME BASE OUT from another 5328B. Set the FUNCTION switch to START CLOCK (a phantom function one clockwise position from STOP) and set RESOLUTION to N = 10<sup>4</sup> for a 1 kHz TIME BASE OUT signal.

### 5-12. Digital-To-Analog Converter Adjustment Procedure

5-13. The following adjustment procedure adjusts the A11 D-to-A Converter outputs for accurate rate programmed trigger levels. Measuring the DAC outputs with a DVM is NOT an equivalent procedure. Since the gain through the HP5328B input amplifiers is not exactly equal to 1.00, the signal arriving at the A12U4 comparator is not identical to the signal at the counter's input. As an example, assume the input amplifier is 0.95. Further assume an input signal which goes from 0 volts to 1.0 volt and it is desired to trigger at the 1.0 volt level. Since the signal arriving at A12U4 goes from 0 volt to 0.95 volts (due to the gain of 0.95), the trigger level specified by the DAC to A12U4 must be 0.95 volts. Triggering at 0.95 volts on the A12U4 input signal is the same as triggering at the 1.0 volt level on the original signal. The procedure described in the following paragraphs takes into account the fact that the input amplifier gain is less than 1.0.

5-14. The procedure offsets an input signal to the HP5328B by 0 volts, +2.5, and -2.5 volts and programs the A and B channel Trigger levels for 0 volts, +2.5 and -2.5 volts, respectively. For each offset, adjustments are made by observing the A (and B) Channel marker outputs and adjusting for a 50% duty cycle. A 50% duty cycle indicates that the programmed trigger level (which is the center of the hysteresis band) is exactly equal to the dc offset at the signal to the A12U4 comparator.

5-15. It is essential for the A and B INPUT Channels to be set for maximum sensitivity before performing the D-to-A Converter adjustment procedure.

Set up the equipment as shown in Figure 5-6. Set the rear panel address switches on the HP5328B as shown in Figure 5-7.

Set the HP654A test oscillator to 20 kHz at a level of 25 mV rms (70 mV peak-to-peak).

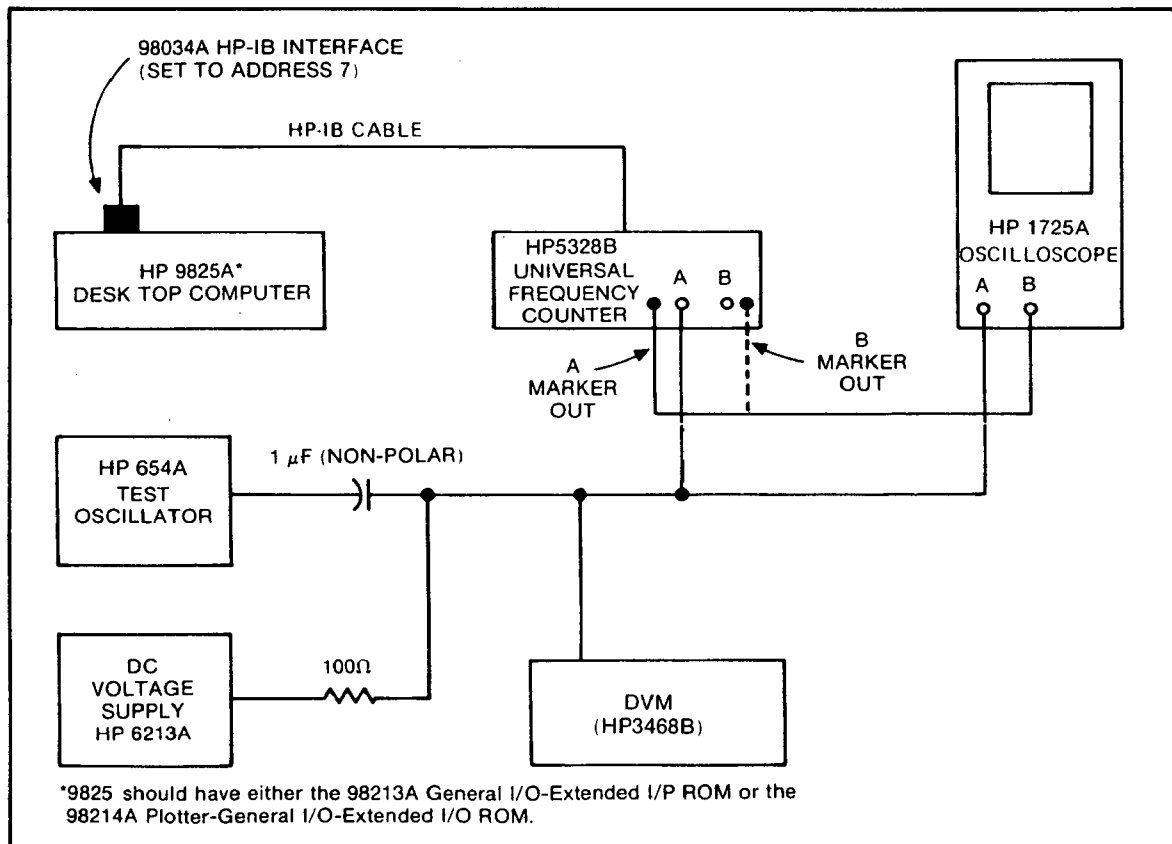


Figure 5-6. Test Setup for DAC Adjustment

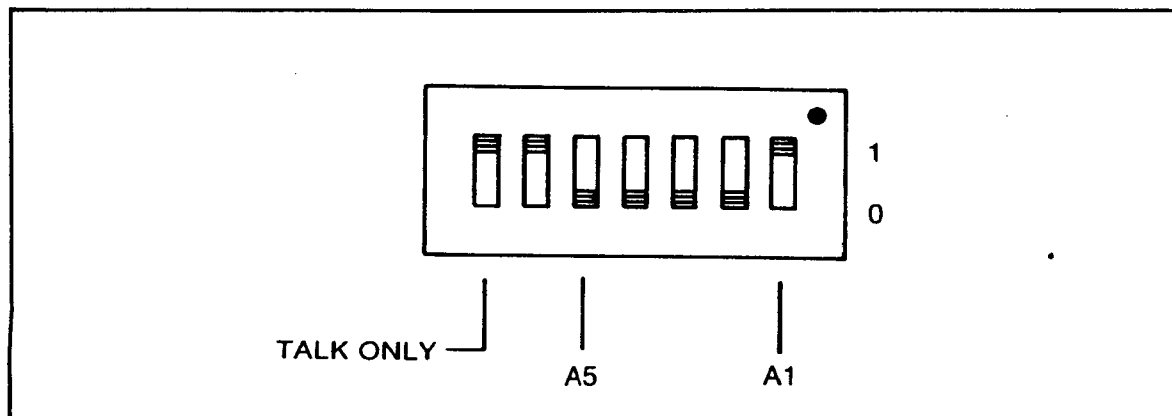


Figure 5-7. Address Switches

Model 5328B  
Adjustments

Set the oscilloscope A channel for ac coupling and 50 mV per division. Verify that the 20 kHz signal into the counter is 70 mV peak-to-peak.

- a. Disconnect the dc supply for a 0.0 volt dc offset on the input signal. Execute from the keyboard of the HP9825A the following:

wrt 701, "PF4G5S13A379+000\*B37+000\*R"

Monitoring the HP5328B MARKER A OUTPUT on the oscilloscope, adjust A11R21 for a 50% duty cycle in the MARKER OUTPUT signal as shown in *Figure 5-8*. See locations of adjustments on A11 circuit board.

- b. Connect the HP5328B MARKER B OUTPUT to the B Channel of the oscilloscope. Adjust A11R20 for a 50% duty cycle in the MARKER B OUTPUT signal. (The counter has been programmed for COM A.)
- c. Connect the power supply as in *Figure 5-6* and adjust for a dc level of 2.50 volts ( $\pm 2$  mV) as read on the DVM.
- d. Execute the following from the keyboard on the 9825A:

wrt 701, "PF4G5S13A379+250\*B37+250\*R"

(Press RECALL on 9825A and simply change DAC voltages as required)

- e. Adjust A11R18 for a 50% duty cycle on the HP5328B MARKER B OUTPUT signal.
- f. Connect the 5328B CHANNEL A MARKER OUTPUT signal to the B Channel of the oscilloscope. Adjust A11R24 for a 50% duty cycle on the A MARKER OUTPUT signal.
- g. Reconfigure the dc power supply for negative voltages and set the voltage for -2.50 volts ( $\pm 2$  mV).
- h. Execute the following from the keyboard of the 9825A:

wrt 701, "PF4G5S1S3A379-250\*B37-250\*R"

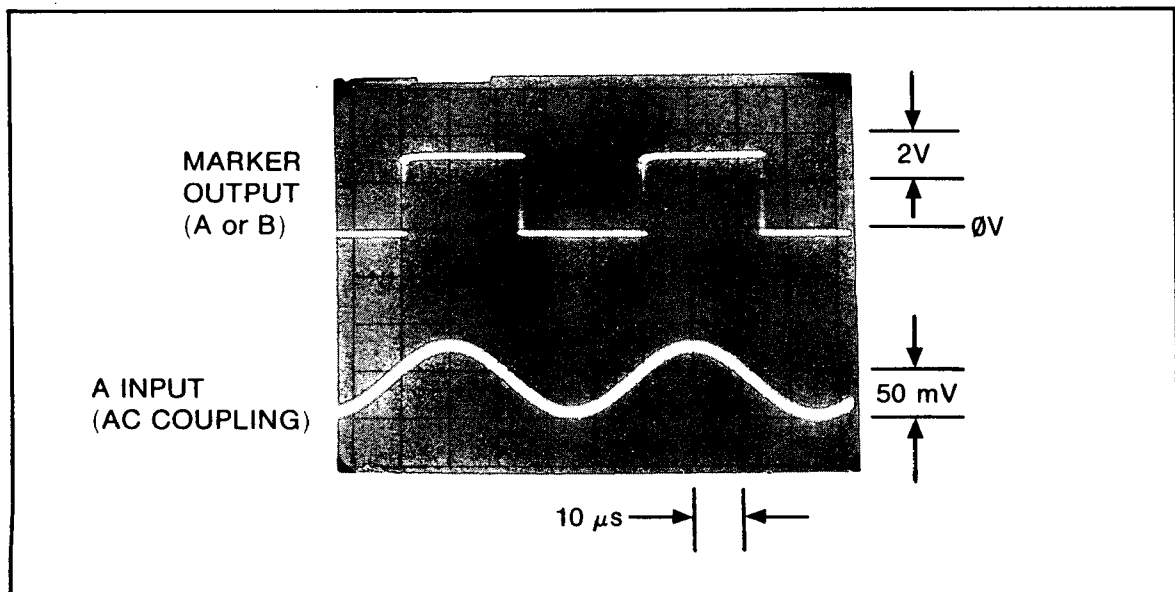


Figure 5-8. Input Signal vs Marker Out

- i. Adjust A11R26 for a 50% duty cycle on the A MARKER OUTPUT signal.
- j. Connect the HP5328B B MARKER OUTPUT to the B Channel of the oscilloscope. Adjust A11R17 for a 50% duty cycle on the B MARKER OUTPUT signal.

**5-16. DIGITAL VOLTMETER (OPTION 021 OR PART OF OPTION 050)**

- a. Set the 5328B FUNCTION switch to DVM; RESOLUTION switch to 1 Hz, 10<sup>6</sup>; DVM RANGE switch to 10 and READ A, READ B buttons out.
- b. Place a jumper across the DVM's input connectors and adjust resistor A6R28 for a display of 0.0000 ±1 count.
- c. Disconnect the jumper from the input terminals and connect a dc standard to the DVM's input.
- d. Set the dc standard for +9.5000-volt output and adjust resistor A7R13 for a counter display of +9.5000 ±1 count.
- e. Set the dc standard for a -9.5000-volt output and adjust resistor A7R6 for a display of -9.5000 ±1 count.
- f. Set the DVM RANGE switch to 100.
- g. Set the dc standard for a +95.000-volt output and adjust resistor A6R29 for a display of +95.000 ±1 count.
- h. Set the DVM RANGE switch to 1000.
- i. Set the dc standard for a +950-volt output and adjust resistor A6R15.

5-17. If transformer T1, capacitor C14 or C18 are changed on the A5 PS Auto Range assembly, adjust capacitor C14 as follows:

- a. Connect an Oscilloscope probe to the ground connection on A5 and connect the 10:1 probe to the floating ground (A) on A5.
- b. Set the oscilloscope controls as follows:

TIME/DIV .....	5 us
VOLTS/DIV .....	0.02
AC/DC .....	AC
Trigger Source .....	Internal

- c. Adjust capacitor A5C14 for minimum signal on the floating ground.

**5-18. C CHANNEL (OPTION 031 OR PART OF OPTION 050)**

- a. Remove the top cover of the 5328B to gain access to variable resistors A8R12, A8A1R13, and R22.
- b. Place the A8 assembly on two extender boards (HP Part No. 05328-62016).
- c. Set the counter front panel controls as follows:

FUNCTION ..... FREQ C  
RESOLUTION ..... 0.1 kHz, 10<sup>4</sup>  
SAMPLE RATE ..... midrange  
CHANNEL C ATTN ..... fully cw

- d. Set A8R12 fully ccw.
- e. Connect the HP8660C Signal Generator (or equivalent) to INPUT C. Set the signal generator to 1.299 GHz at 100 mV rms (-7dBm).
- f. Slowly decrease the signal generator output level while adjusting variable resistor A8A1R22 for maximum sensitivity (at least 20 mv rms, -21 dBm) and a correct stable display.
- g. Set the signal generator to 90 MHz and an output level of 100 mV rms. Slowly decrease the generator's output level until the counter displays erroneous readings above 100 MHz. (For example, 101.nnnnn).
- h. Adjust resistor A8R12 cw until the counter stops gating.
- i. Set the signal to 90 MHz at 125 mV rms (approximatley -5 dBm).
- j. Connect the voltmeter from A8A1 (pin 1) to ground.
- k. Adjust resistor A8 A1R13 until the voltage at pin 1 switches from approximately 12-15 volts to less than 10 volts.



## SECTION VI REPLACEABLE PARTS

### 6-1. INTRODUCTION

This section contains listings of replaceable parts for the Model 5328B Universal Counter. Table 6-1 provides a reference index to this section's parts list tables.

### 6-2. EXCHANGE ASSEMBLIES

At Hewlett-Packard's option, some replacement parts for the HP 5328B may be available on an "exchange" basis. Exchange parts have been factory-repaired and tested. They are available only on an "exchange" or "trade-in" basis, and require that a defective equivalent part be returned for credit; thus, you can't order an "exchange" for spare parts stocking — you will have to order the new-part number.

Because a part may be added to or removed from the exchange program at any time, without notice, it is not practical to list exchange parts in this manual. If you find a replacement part is needed, you can ask your nearest Hewlett-Packard Sales Office if an exchange part is available.

If you are ordering an exchange part, you should keep the old part until the new one arrives. You can then use the new part's shipping container to return the old part to Hewlett-Packard.

### 6-3. PARTS LISTS

Replaceable parts for the HP 5328B and its sub-assemblies are listed as follows:

- Parts for the entire product are listed in Tables 6-2 through 6-11.

*Table 6-1. Circuit Diagrams and Parts Lists*

Assy Ref Des	Description	HP Part No.	Circuit Diagram	Parts List Table
A1	Motherboard Assembly	05328-60049	8-A-10	6-2
A2	Power Supply Assembly	05328-60034	8-D-2	6-3
A3	Support Board Assembly	05328-60018	8-A-16	6-4
	Oven Oscillator — 10 MHz	10811-60111	8-A-22	6-4
A4	Function Selector Assembly	05328-60005	8-A-13	6-5
A5	PS Autorange Assembly (See NOTE 1)	05328-60012	8-BB-2	6-6
A6	Buffer Amplifier Assembly (See NOTE 1)	05328-60013	8-BB-3	6-6
A7	VF Converter Assembly (See NOTE 1)	05328-60014	8-BB-4	6-6
A8	1300 MHz C Channel Assembly (See NOTE 2)	05328-60025	8-BC-3	6-7
A8A1	1.3 GHz Board Assembly (See NOTE 2)	05305-60006	8-BC-2	6-7

Table 6-1. Circuit Diagrams and Parts Lists (continued)

Assy Ref Des	Description	HP Part No.	Circuit Diagram	Parts List Table
A9	Not Assigned			
A10	Synchronizer Assembly	05328-60020	8-BA-9	6-8
A11	DAC Assembly	05328-60023	8-BA-11	6-8
A12	Amplifier Assembly	05328-60041	8-BA-8	6-8
A13	Not Assigned			
A14	Multiplier Assembly	05328-60010	8-BA-10	6-8
A15	HP-IB Interface Assembly	05328-60043	8-C-2	6-9
A16	Display Assembly	05328-60033	8-A-14	6-10
A17	DVM Front Board Assembly (See NOTE 1)	05328-60015		6-6
A18	Not Assigned			
A19	Switch Control Assembly	05328-60021	8-BA-7	6-8

**NOTES —**

1. Part of (optional) Digital Voltmeter (Option 021 or part of Option 050)
2. Part of (optional) 90-1300 MHz "C" Channel (Option 031 or part of Option 050)

Within each Parts List table below:

- a. Electrical components and mechanical parts are listed in alphanumeric order by reference designation.
- b. Some mechanical parts closely related to a specific electrical component may be listed after the component's entry, with or without a separate reference designation.

The information given for each part consists of:

- a. The Reference Designator ("Ref. Des.") for the part.
- b. The Hewlett-Packard number.
- c. A "Check Digit", in the "CD" column.

The "Check Digit" is based on the HP Part Number, and is used to help reduce part-number problems when parts are ordered.

- d. The number of times ("Qty") each part (by HP Part Number) occurs in the list.

The quantity information for each part is given only once — at the first occurrence of the HP Part Number in the list. Later entries having the same HP Number will have no number in the "Qty" column.

The "Qty" information in any list is for that list only.

- e. The description of the part.
- f. A typical manufacturer of the part, in a five-digit code.  
A Manufacturer's-code-to-name conversion list is provided in Table 6-11.
- g. The manufacturer's number for the part.

#### **6-4. HOW TO ORDER A PART**

To order a part that is listed in one of the Parts Lists:

- a. Give the Hewlett-Packard part number.
- b. Indicate the quantity required.
- c. Address the order to the nearest Hewlett-Packard office.

To order a part that is *not* listed in any of the Parts Lists:

- a. Give the unit's Model Number ("HP 5328B").
- b. Give the unit's complete Serial Number.  
(See information at the front of this manual about where to find the Serial Number.)
- c. Give a description of the part and its use.
- d. Give the quantity of parts required.
- e. Address your order to the Hewlett-Packard office closest to you.

#### **6-5. HEWLETT-PACKARD'S DIRECT MAIL ORDER SYSTEM**

Within the United States, Hewlett-Packard can supply parts through a direct mail order system. Advantages of using the system are:

- a. Ordering and shipment are done directly, via the HP Parts Center in Mountain View, California.
- b. There is no maximum or minimum amount for any mail order. (There is a minimum order amount for parts ordered through a local HP office when the order requires billing and invoicing).
- c. Transportation charges are pre-paid. (However, there is a handling charge for each order).
- d. There are no invoices. To provide these advantages, a check or money order must accompany each order.

For mail-order forms and specific information about the direct mail order system, contact the Hewlett-Packard office closest to you. Addresses and phone numbers of these HP offices are given in Appendix F of this manual.

#### **6-6. SPARE PARTS KIT**

Stocking spare parts for an instrument is often done to ensure quick return to service after a malfunction occurs. Hewlett-Packard has a Spare Parts Kit available for this purpose. The kit consists of selected replaceable assemblies and components for this instrument. The contents of the kit and the Recommended Spares list are based on failure reports and repair data, and parts support for one year. A recommended Spare Parts Kit may be ordered through your nearest Hewlett-Packard office.

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1	05328-60049	4	1	BD AY-MOTHER	28480	05328-60049
A1C1				NOT ASSIGNED		
A1C2				NOT ASSIGNED		
A1C3	0180-0100	3	1	CAPACITOR-FXD 4.7UF+-10% 35VDC TA	56289	150D475X9035B2
A1C4	0160-0161	4	3	CAPACITOR-FXD .01UF +-10% 200VDC POLYE	28480	0160-0161
A1C5	0180-0106	9	7	CAPACITOR-FXD 60UF+-20% 6VDC TA	56289	150D606X0006B2
A1C6	0140-0177	0	1	CAPACITOR-FXD 400PF +-1% 300VDC MICA	72136	DM15F401F0300WV1CR
A1C7	0170-0024	9	2	CAPACITOR-FXD .022UF +-20% 200VDC POLYE	28480	0170-0024
A1C8	0180-0195	6	1	CAPACITOR-FXD .33UF+-20% 35VDC TA	56289	150D334X0035A2
A1C9				NOT ASSIGNED		
A1C10	0160-0314	9	1	CAPACITOR-FXD .01UF +-5% 400VDC POLYE	84411	663UW10354W2
A1C11-				NOT ASSIGNED		
A1C16				NOT ASSIGNED		
A1C17*	0160-2264	2	1	CAPACITOR-FXD 20PF +-5% 500VDC CER 0+-30	28480	0160-2264
A1C18	0121-0060	0	1	CAPACITOR-V TRMR-CER 2-8PF 350V PC-MTG	52763	304322 2/8PF NPO
A1C19				NOT ASSIGNED		
A1C20	0160-0161	4		CAPACITOR-FXD .01UF +-10% 200VDC POLYE	28480	0160-0161
A1C21	0180-0210	6	5	CAPACITOR-FXD 3.3UF+-20% 15VDC TA	56289	150D335X0015A2
A1C22	0160-2055	9	10	CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A1C23-				NOT ASSIGNED		
A1C28				NOT ASSIGNED		
A1C29	0180-0230	0	4	CAPACITOR-FXD 1UF+-20% 50VDC TA	56289	150D105X0050A2
A1C30	0160-0153	4	1	CAPACITOR-FXD 1000PF +-10% 200VDC POLYE	28480	0160-0153
A1C31	0180-0230	0		CAPACITOR-FXD 1UF+-20% 50VDC TA	56289	150D105X0050A2
A1C32				NOT ASSIGNED		
A1C33	0160-4554	7	7	CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C34	0180-0210	6		CAPACITOR-FXD 3.3UF+-20% 15VDC TA	56289	150D335X0015A2
A1C35	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C36	0180-0210	6		CAPACITOR-FXD 3.3UF+-20% 15VDC TA	56289	150D335X0015A2
A1C37	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C37	0180-0106	9		CAPACITOR-FXD 60UF+-20% 6VDC TA	56289	150D606X0006B2
A1C38	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A1C39	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C40	0180-0155	8	6	CAPACITOR-FXD 2.2UF+-20% 20VDC TA	56289	150D225X0020A2
A1C41	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C42	0180-0155	8		CAPACITOR-FXD 2.2UF+-20% 20VDC TA	56289	150D225X0020A2
A1C43	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C44	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C45	0180-0210	6		CAPACITOR-FXD 3.3UF+-20% 15VDC TA	56289	150D335X0015A2
A1C46	0180-0210	6		CAPACITOR-FXD 3.3UF+-20% 15VDC TA	56289	150D335X0015A2
A1C47	0160-4084	8	1	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A1C48	0180-0155	8		CAPACITOR-FXD 2.2UF+-20% 20VDC TA	56289	150D225X0020A2
A1C49	0180-0155	8		CAPACITOR-FXD 2.2UF+-20% 20VDC TA	56289	150D225X0020A2
A1C50	0160-3879	7	5	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A1C51	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A1C52	0180-0155	8		CAPACITOR-FXD 2.2UF+-20% 20VDC TA	56289	150D225X0020A2
A1C53	0180-0155	8		CAPACITOR-FXD 2.2UF+-20% 20VDC TA	56289	150D225X0020A2
A1CR1	1901-0040	1	21	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1CR2				NOT ASSIGNED		
A1CR3	1901-0999	9	19	DIODE-SCHOTTKY 20V 10NS DO-35	28480	1901-0999
A1CR4				NOT ASSIGNED		
A1CR5	1901-0050	3	10	DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A1CR6	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A1CR7	1901-0535	9	2	DIODE-SM SIG SCHOTTKY	28480	1901-0535
A1CR8	1902-3082	9	1	DIODE-ZNR 4.64V 5X DO-35 PD=.4W	28480	1902-3082
A1CR9	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1CR10	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1CR11	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1CR12	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1CR13	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1CR14	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1CR15	1901-0999	9		DIODE-SCHOTTKY 20V 10NS DO-35	28480	1901-0999

See introduction to this section for ordering information  
\*Indicates factory selected value

Model 5328B  
Replaceable Parts

Table 6-2. Replaceable Parts (continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1CR16	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1CR17	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1CR18	1901-0999	9		DIODE-SCHOTTKY 20V 10NS DO-35	28480	1901-0999
A1CR19	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1CR20	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1CR21	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1L1	9100-2276	9	1	INDUCTOR RF-CH-MLD 100UH 10% .105DX.26LG	28480	9100-2276
A1Q1	1854-0071	7	10	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q2	1853-0015	7	2	TRANSISTOR PNP SI PD=200MW FT=500MHZ	28480	1853-0015
A1Q3	1853-0015	7		TRANSISTOR PNP SI PD=200MW FT=500MHZ	28480	1853-0015
A1Q4	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q5	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q6	1854-0092	2	1	TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A1Q7	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q8	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q9	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q10	1853-0036	2	6	TRANSISTOR PNP SI PD=310MW FT=250MHZ	28480	1853-0036
A1R1	0698-3444	1	1	RESISTOR 316 1% .125W F TC=0+-100	24546	C4-1/8-T0-316R-F
A1R2	1810-0055	5	5	NETWORK-RES 9-SIP10.0K OHM X 8	28480	1810-0055
A1R3	0683-2725	8	4	RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A1R4*	0683-3355	2	1	RESISTOR 3.3M 5% .25W FC TC=-900/+1100	01121	CB3355
A1R5	1810-0055	5		NETWORK-RES 9-SIP10.0K OHM X 8	28480	1810-0055
A1R6	0683-3315	4	1	RESISTOR 330 5% .25W FC TC=-400/+600	01121	CB3315
A1R7	0683-1035	1	35	RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R8	0683-4725	2	8	RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A1R9	0683-1525	4	4	RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	CB1525
A1R10	0683-1025	9	19	RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A1R11	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A1R12	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A1R13	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R14	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A1R15	1810-0041	9	1	NETWORK-RES 9-SIP2.7K OHM X 8	28480	1810-0041
A1R16				NOT ASSIGNED		
A1R17	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R18	0683-1525	4		RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	CB1525
A1R19	1810-0055	5		NETWORK-RES 9-SIP10.0K OHM X 8	28480	1810-0055
A1R20	0683-1525	4		RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	CB1525
A1R21	0698-4037	0	2	RESISTOR 46.4 1% .125W F TC=0+-100	24546	C4-1/8-T0-46R4-F
A1R22	0683-2715	6	8	RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A1R23	0683-2015	9	5	RESISTOR 200 5% .25W FC TC=-400/+600	01121	CB2015
A1R24	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A1R25	0683-1525	4		RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	CB1525
A1R26	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A1R27	0757-0928	6	1	RESISTOR 1.5K 2% .125W F TC=0+-100	24546	C4-1/8-T0-1501-G
A1R28	1810-0055	5		NETWORK-RES 9-SIP10.0K OHM X 8	28480	1810-0055
A1R29	0757-0952	6	1	RESISTOR 15K 2% .125W F TC=0+-100	24546	C4-1/8-T0-1502-G
A1R30	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R31	0683-5105	4		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A1R32	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R33	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R34	0683-2715	6		RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A1R35	0683-5115	6	3	RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A1R36	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R37	0683-2715	6		RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A1R38	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R39	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R40	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R41	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R42	1810-0055	5		NETWORK-RES 9-SIP10.0K OHM X 8	28480	1810-0055
A1R43	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A1R44	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R45	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035

See introduction to this section for ordering information  
\*Indicates factory selected value

Table 6-2. Replaceable Parts (continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1R46	0683-1545	8	1	RESISTOR 150K 5% .25W FC TC=-800/+900	01121	CB1545
A1R47				NOT ASSIGNED		
A1R48	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R49-				NOT ASSIGNED		
A1R51						
A1R52	0683-5635	5	1	RESISTOR 56K 5% .25W FC TC=-400/+800	01121	CB5635
A1R53				NOT ASSIGNED		
A1R54				NOT ASSIGNED		
A1R55	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A1R56	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A1R57	0683-6815	5	1	RESISTOR 680 5% .25W FC TC=-400/+600	01121	CB6815
A1R58	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A1R59	0683-5605	9	10	RESISTOR 56 5% .25W FC TC=-400/+500	01121	CB5605
A1R60	0683-5605	9		RESISTOR 56 5% .25W FC TC=-400/+500	01121	CB5605
A1R61	0683-5605	9		RESISTOR 56 5% .25W FC TC=-400/+500	01121	CB5605
A1R62	0683-5605	9		RESISTOR 56 5% .25W FC TC=-400/+500	01121	CB5605
A1R63	0683-5605	9		RESISTOR 56 5% .25W FC TC=-400/+500	01121	CB5605
A1R64	0683-5605	9		RESISTOR 56 5% .25W FC TC=-400/+500	01121	CB5605
A1R65	0683-5605	9		RESISTOR 56 5% .25W FC TC=-400/+500	01121	CB5605
A1R66	0683-5605	9		RESISTOR 56 5% .25W FC TC=-400/+500	01121	CB5605
A1R67	0683-5605	9		RESISTOR 56 5% .25W FC TC=-400/+500	01121	CB5605
A1R68	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R69	0757-0935	5	1	RESISTOR 3K 2% .125W F TC=0+-100	24546	C4-1/8-T0-3001-G
A1R70	0757-0950	4	1	RESISTOR 12K 2% .125W F TC=0+-100	24546	C4-1/8-T0-1202-G
A1R71	0757-0279	0	1	RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A1R72	0757-0931	1	1	RESISTOR 2K 2% .125W F TC=0+-100	24546	C4-1/8-T0-2001-G
A1R73	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R74	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R75	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R76	0683-1015	7	1	RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A1R77	0683-5605	9		RESISTOR 56 5% .25W FC TC=-400/+500	01121	CB5605
A1R78	0683-4315	6	1	RESISTOR 430 5% .25W FC TC=-400/+600	01121	CB4315
A1R79	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A1R80	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R81	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R82	0683-6825	7	1	RESISTOR 6.8K 5% .25W FC TC=-400/+700	01121	CB6825
A1R83	0698-4037	0		RESISTOR 46.4 1% .125W F TC=0+-100	24546	C4-1/8-T0-46R4-F
A1R84	0757-0422	5	1	RESISTOR 909 1% .125W F TC=0+-100	24546	C4-1/8-T0-909R-F
A1S1	3101-1977	1	3	SWITCH-SL DPDT SUBMIN .5A 125VAC PC	28480	3101-1977
A1S2	3101-1977	1		SWITCH-SL DPDT SUBMIN .5A 125VAC PC	28480	3101-1977
A1S3	3101-1977	1		SWITCH-SL DPDT SUBMIN .5A 125VAC PC	28480	3101-1977
A1U1	1820-0055	6	2	IC CNTR TTL DECD SYNCHRO POS-EDGE-TRIG	01295	SN7490AN
A1U2	1820-1056	9	1	IC SCHMITT-TRIG TTL NAND QUAD 2-INP	01295	SN74132N
A1U3	1820-0175	1	1	IC INV TTL HEX 1-INP	01295	SN7405N
A1U4*	1820-1401	8	1	IC MISC	28480	1820-1401
A1U5	1820-0513	1	2	IC GATE TTL AND QUAD 2-INP	01295	SN7409N
A1U6	1820-0292	1	4	IC GATE TTL EXCL-OR QUAD 2-INP	01295	SN7486N
A1U7	1820-0511	9	1	IC GATE TTL AND QUAD 2-INP	01295	SN7408N
A1U8	1820-0174	0	6	IC INV TTL HEX	01295	SN7404N
A1U9	1820-0661	0	2	IC GATE TTL OR QUAD 2-INP	01295	SN7432N
A1U10	1820-2316	6	1	IC CNTR IIL DECD HEX	28480	IDB2-4
A1U11	1820-0513	1		IC GATE TTL AND QUAD 2-INP	01295	SN7409N
A1U12	1820-3237	2	1	IC LCH TTL ALS TRANSPARENT NEG-EDGE-TRIG	28480	1820-3237
A1U13				NOT ASSIGNED		
A1U14	1820-1442	7	1	IC CNTR TTL LS DECD ASYNCHRO	01295	SN74LS290N
A1U15	1820-0803	2	1	IC GATE ECL OR-NOR TPL	04713	MC10105P
A1U16	1820-0537	9	1	IC SCHMITT-TRIG TTL NAND DUAL 4-INP	01295	SN7413N
A1U17	1820-0068	1	2	IC GATE TTL NAND TPL 3-INP	01295	SN7410N
A1U18	1820-0174	0		IC INV TTL HEX	01295	SN7404N
A1U19	1820-0077	2	2	IC FF TTL D-TYPE POS-EDGE-TRIG CLEAR	01295	SN7474N
A1U20	1820-0055	6		IC CNTR TTL DECD SYNCHRO POS-EDGE-TRIG	01295	SN7490AN
A1U21	1820-2317	7	1	IC MISC IIL	28480	IDB9-TL
A1U22	1820-0269	4	2	IC GATE TTL NAND QUAD 2-INP	01295	SN7403N
A1U23	1820-0328	6	2	IC GATE TTL NOR QUAD 2-INP	01295	SN7402N
A1U24	1820-0282	1		IC GATE TTL EXCL-OR QUAD 2-INP	01295	SN7486N
A1U25	1820-0301	5	5	IC LCH TTL D-TYPE 4-BIT	01295	SN7475N

See introduction to this section for ordering information  
\*Indicates factory selected value

Model 5328B  
Replaceable Parts

Table 6-2. Replaceable Parts (continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1U26	1820-0301	5		IC LCH TTL D-TYPE 4-BIT	01295	SN7475N
A1U27	1820-0301	5		IC LCH TTL D-TYPE 4-BIT	01295	SN7475N
A1U28	1820-0538	0	2	IC GATE TTL NOR DUAL 4-INP	01295	SN7423N
A1U29	1820-0282	1		IC GATE TTL EXCL-OR QUAD 2-INP	01295	SN7486N
A1U30	1820-0282	1		IC GATE TTL EXCL-OR QUAD 2-INP	01295	SN7486N
A1U31	1820-0301	5		IC LCH TTL D-TYPE 4-BIT	01295	SN7475N
A1U32	1820-0538	0		IC GATE TTL NOR DUAL 4-INP	01295	SN7423N
A1U33	1820-0174	0		IC INV TTL HEX	01295	SN7404N
A1U34	1820-0174	0		IC INV TTL HEX	01295	SN7404N
A1U35	1820-0174	0		IC INV TTL HEX	01295	SN7404N
A1U36	1820-0174	0		IC INV TTL HEX	01295	SN7404N
A1U37	1818-2252	4	1	IC-ROM-NMOS 4K USED WITHOUT OPTION 031 OR 050	28480	1818-2252
A1U37	1818-2274	0	1	IC NMOS 4096 (4K) ROM USED WITH OPTION 031 OR 050	28480	1818-2274
A1U38	1820-0661	0		IC GATE TTL OR QUAD 2-INP	01295	SN7432N
A1U39	1820-0214	9	1	IC DCDR TTL BCD-TO-DEC 4-TO-10-LINE	01295	SN7442AN
A1U40	1820-0054	5	1	IC GATE TTL NAND QUAD 2-INP	01295	SN7400N
A1U41	1820-1644	1	1	IC DCDR TTL LS BCD-TO-7-SEG 4-TO-7-LINE	01295	SN74LS248N
A1W1				NOT ASSIGNED		
A1W2	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A1W3				NOT ASSIGNED		
A1W4	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A1W5	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A1W6	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A1XA1				NOT ASSIGNED		
A1XA2				NOT ASSIGNED		
A1XA3	1251-2035	9	4	CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-2035
A1XA4A	1251-2026	8	9	CONNECTOR-PC EDGE 18-CONT/ROW 2-ROWS	28480	1251-2026
A1XA4B	1251-2026	8		CONNECTOR-PC EDGE 18-CONT/ROW 2-ROWS	28480	1251-2026
A1XA5	1251-2035	9		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-2035
A1XA5B	1251-2026	8		CONNECTOR-PC EDGE 18-CONT/ROW 2-ROWS	28480	1251-2026
A1XA6	1251-2035	9		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-2035
A1XA7	1251-2035	9		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-2035
A1XA8A	1251-2026	8		CONNECTOR-PC EDGE 18-CONT/ROW 2-ROWS	28480	1251-2026
A1XA8B	1251-2026	8		CONNECTOR-PC EDGE 18-CONT/ROW 2-ROWS	28480	1251-2026
A1XA10	1251-2026	8		CONNECTOR-PC EDGE 18-CONT/ROW 2-ROWS	28480	1251-2026
A1XA11	1251-2026	8		CONNECTOR-PC EDGE 18-CONT/ROW 2-ROWS	28480	1251-2026
A1XA12	1251-2026	8		CONNECTOR-PC EDGE 18-CONT/ROW 2-ROWS	28480	1251-2026
A1XA13				NOT ASSIGNED		
A1XA14	1251-2026	8		CONNECTOR-PC EDGE 18-CONT/ROW 2-ROWS	28480	1251-2026
A1XA-Y1	1200-0153	1	1	SOCKET-XSTR 3-CONT TO-5 DIP-SLDR	28480	1200-0153
A1XJ1	1200-0567	1	2	SOCKET-IC 28-CONT DIP DIP-SLDR	28480	1200-0567
A1XU1-				NOT ASSIGNED		
A1XU3				NOT ASSIGNED		
A1XU4	1200-0825	4	1	SOCKET-IC 20-CONT DIP DIP-SLDR	28480	1200-0825
A1XU5-				NOT ASSIGNED		
A1XU11				NOT ASSIGNED		
A1XU12	1200-0473	8	2	SOCKET-IC 16-CONT DIP DIP-SLDR	28480	1200-0473
A1XU13-				NOT ASSIGNED		
A1XU20				NOT ASSIGNED		
A1XU21	1200-0473	8		SOCKET-IC 16-CONT DIP DIP-SLDR	28480	1200-0473
A1XU22-				NOT ASSIGNED		
A1XU36				NOT ASSIGNED		
A1XU37	1200-0567	1		SOCKET-IC 28-CONT DIP DIP-SLDR	28480	1200-0567
A1Y1	0410-0405	0	1	CRYSTAL-QUARTZ 10.000 MHZ	28480	0410-0405
				A1 MISCELLANEOUS		
	0360-0124	3	13	CONNECTOR-SGL CONT PIN .04-IN-BSC-SZ RND	28480	0360-0124
	0380-0640	0	1	STANDOFF-RND .5-IN-LG 6-32THD .25-IN-OD	00000	ORDER BY DESCRIPTION

See introduction to this section for ordering information  
\*Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A2	05328-60034	7	1	BD AY - PWR SUP	28480	05328-60034
A2C1	0180-2842	4	2	CAPACITOR-FXD 4500UF+-20% 35VDC AL	28480	0180-2842
A2C2	0180-2842	4	2	CAPACITOR-FXD 4500UF+-20% 35VDC AL	28480	0180-2842
A2C3*	0160-0576	5	3	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A2C4*	0160-0576	5	3	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A2C5*	0160-2203	9	1	CAPACITOR-FXD 91PF +-5% 300VDC MICA 0+70	28480	0160-2203
A2C6*	0160-0945	2	1	CAPACITOR-FXD 910PF +-5% 100VDC MICA	28480	0160-0945
A2C7	0180-0562	1	1	CAPACITOR-FXD 33UF+-20% 10VDC TA	56289	196D336X0010KA1
A2C8	0160-3879	7	1	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C9	0180-2827	5	2	CAPACITOR-FXD 47UF+100-10% 40VDC AL	28480	0180-2827
A2C10	0180-2827	5	2	CAPACITOR-FXD 47UF+100-10% 40VDC AL	28480	0180-2827
A2C11	0180-2832	2	2	CAPACITOR-FXD 1000UF+100-10% 12VDC AL	28480	0180-2832
A2C12	0180-2832	2	2	CAPACITOR-FXD 1000UF+100-10% 12VDC AL	28480	0180-2832
A2C13	0180-0418	6	1	CAPACITOR-FXD 1UF+-20% 35VDC TA	28480	0180-0418
A2C14	0160-0570	9	1	CAPACITOR-FXD 220PF +-20% 100VDC CER	20932	5024EM100RD221M
A2C15	0160-2199	2	2	CAPACITOR-FXD 30PF +-5% 300VDC MICA	28480	0160-2199
A2C16	0160-2199	2	2	CAPACITOR-FXD 30PF +-5% 300VDC MICA	28480	0160-2199
A2C17	0180-0587	0	2	CAPACITOR-FXD 47UF+100-10% 25VDC AL	56289	672D476H025CC5B
A2C18	0180-0587	0	2	CAPACITOR-FXD 47UF+100-10% 25VDC AL	56289	672D476H025CC5B
A2C19	0160-0576	5	2	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A2C20*	0160-3879	7	2	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C21	0160-0128	3	2	CAPACITOR-FXD 2.2UF +-20% 50VDC CER	28480	0160-0128
A2C22	0160-0128	3	2	CAPACITOR-FXD 2.2UF +-20% 50VDC CER	28480	0160-0128
A2C23	0180-2821	9	3	CAPACITOR-FXD 22UF+-20% 35VDC TA	28480	0180-2821
A2C24	0180-2821	9	3	CAPACITOR-FXD 22UF+-20% 35VDC TA	28480	0180-2821
A2C25	0180-2821	9	3	CAPACITOR-FXD 22UF+-20% 35VDC TA	28480	0180-2821
A2C26	0160-4355	6	1	CAPACITOR-FXD .01UF +-10% 250VAC(RMS)	28480	0160-4355
A2CR1	1902-0774	0	2	DIODE-ZNR 12.1V 10% DO-15 PD=1W	28480	1902-0774
A2CR2	1902-0774	0	2	DIODE-ZNR 12.1V 10% DO-15 PD=1W	28480	1902-0774
A2CR3	1901-1086	7	2	DIODE-PWR RECT 50V 5A 200NS	04713	MR820
A2CR4	1901-1086	7	2	DIODE-PWR RECT 50V 5A 200NS	04713	MR820
A2CR5				NOT ASSIGNED		
A2CR6				NOT ASSIGNED		
A2CR7	1902-0522	6	2	DIODE-ZNR 1N5340B 6V 5% PD=5W IR=1UA	04713	1N5340B
A2CR8	1902-0522	6	2	DIODE-ZNR 1N5340B 6V 5% PD=5W IR=1UA	04713	1N5340B
A2CR9	1901-0040	1	2	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A2CR10	1901-0040	1	2	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A2CR11	1902-0632	9	2	DIODE-ZNR 1N5354B 17V 5% PD=5W TC=+75%	04713	1N5354B
A2CR12	1902-0632	9	2	DIODE-ZNR 1N5354B 17V 5% PD=5W TC=+75%	04713	1N5354B
A2CR13	1901-0638	3	1	DIODE-FW BRDG 100V 4A	04713	MDA-970-2
A2F1	2110-0002	9	2	FUSE 2A 250V NTD 1.25X.25 UL	75915	312002
A2F2	2110-0002	9	2	FUSE 2A 250V NTD 1.25X.25 UL	75915	312002
A2L1	9100-3017	8	2	300 MH AT 5 AMP DC	28480	9100-3017
A2L2	9100-3017	8	2	300 MH AT 5 AMP DC	28480	9100-3017
A2L3	9100-3139	5	1	INDUCTOR 75UH 15% .5DX.875LG	28480	9100-3139
A2Q1	1853-0363	8	2	TRANSISTOR PNP SI PD=50W FT=20MHZ	03508	X45H281
A2Q2	1854-0635	9	3	TRANSISTOR NPN SI PD=50W FT=20MHZ	03508	D44H5
A2Q3	1853-0326	3	1	TRANSISTOR PNP SI PD=1W FT=50MHZ	04713	MPS-U51
A2Q4	1854-0634	8	1	TRANSISTOR NPN SI PD=1W FT=50MHZ	04713	MPS-U01
A2Q5	1854-0492	6	2	TRANSISTOR NPN SI PD=350MW FT=250MHZ	04713	MPS3643
A2Q6	1853-0016	8	2	TRANSISTOR PNP SI T0-92 PD=300MW	28480	1853-0016
A2Q7	1853-0363	8	2	TRANSISTOR PNP SI PD=50W FT=20MHZ	03508	X45H281
A2Q8	1854-0635	9	3	TRANSISTOR NPN SI PD=50W FT=20MHZ	03508	D44H5
A2Q9	1854-0492	6	2	TRANSISTOR NPN SI PD=350MW FT=250MHZ	04713	MPS3643
A2Q10	1853-0016	8	2	TRANSISTOR PNP SI T0-92 PD=300MW	28480	1853-0016
A2Q11	1854-0635	9	3	TRANSISTOR NPN SI PD=50W FT=20MHZ	03508	D44H5
A2Q12	1884-0055	0	1	THYRISTOR-TRIAC	28480	1884-0055
A2R1	0812-0094	5	2	RESISTOR 390 3% 3W PW TC=0+-20	28480	0812-0094
A2R2	0812-0094	5	2	RESISTOR 390 3% 3W PW TC=0+-20	28480	0812-0094
A2R3	0683-1015	7	3	RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A2R4	0683-1015	7	3	RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A2R5	0683-1025	9	11	RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025

See introduction to this section for ordering information.  
\*Indicates factory selected value



Model 5328B  
Replaceable Parts

Table 6-3. Replaceable Parts (continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A2R6	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A2R7	0683-6815	5	2	RESISTOR 680 5% .25W FC TC=-400/+600	01121	CB6815
A2R8	0683-6815	5		RESISTOR 680 5% .25W FC TC=-400/+600	01121	CB6815
A2R9	0698-3620	5	2	RESISTOR 100 5% 2W MO TC=0+-200	28480	0698-3620
A2R10	0698-3620	5		RESISTOR 100 5% 2W MO TC=0+-200	28480	0698-3620
A2R11	0683-8245	9	1	RESISTOR 820K 5% .25W FC TC=-800/+900	01121	CB8245
A2R12	0683-1055	5	1	RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A2R13	0683-4725	2	2	RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A2R14	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A2R15	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A2R16	0698-3160	8	1	RESISTOR 31.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3162-F
A2R17	0757-0428	1	1	RESISTOR 1.62K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1621-F
A2R18	0757-0454	3	1	RESISTOR 33.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3322-F
A2R19	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A2R20	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A2R21	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A2R22	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A2R23	0757-0283	6	2	RESISTOR 2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2001-F
A2R24	0757-0283	6		RESISTOR 2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2001-F
A2R25	0757-0280	3	3	RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A2R26	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A2R27	2100-1738	9	1	RESISTOR-TRMR 10K 10% C TOP-ADJ 1-TRN	73138	82PR10K
A2R28	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A2R29	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A2R30	0683-1135	2	1	RESISTOR 11K 5% .25W FC TC=-400/+800	01121	CB1135
A2R31	0683-2715	6	1	RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A2R32	0811-3050	7	1	RESISTOR .75 5% .5W PW TC=0+-150	75042	BW20-1-3/4-J
A2R33	0683-1015	7		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A2R34	0812-0021	8	2	RESISTOR .47 5% 3W PW TC=0+-90	91637	CW2B1-3-T2-47/100-J
A2R35	0812-0021	8		RESISTOR .47 5% 3W PW TC=0+-90	91637	CW2B1-3-T2-47/100-J
A2R36	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A2R37	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A2R38	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A2R39	0683-1815	5	1	RESISTOR 180 5% .25W FC TC=-400/+600	01121	CB1815
A2R40	0698-3441	8	1	RESISTOR 215 1% .125W F TC=0+-100	24546	C4-1/8-T0-215R-F
A2U1	1826-0065	0	2	IC COMPARATOR PRCN 8-DIP-P PKG	S0545	UPC311C
A2U2	1826-0065	0		IC COMPARATOR PRCN 8-DIP-P PKG	S0545	UPC311C
A2U3	1820-0477	6	2	IC OP AMP GP 8-DIP-P PKG	S0545	UPC301AC
A2U4	1820-0477	6		IC OP AMP GP 8-DIP-P PKG	S0545	UPC301AC
A2U5	1820-0439	0	1	IC V RGLTR 14-DIP-P	07263	723PC
A2U6	1990-0845	1	1	OPTO-ISOLATOR IF=50MA-MAX VAX=250V	28480	1990-0845
A2XF1	2110-0269	0	2	FUSEHOLDER-CLIP TYPE, 25D-FUSE	28480	2110-0269
A2XF2	2110-0269	0		FUSEHOLDER-CLIP TYPE, 25D-FUSE	28480	2110-0269
A2XQ1	1200-0666	1	5	SOCKET-XSTR 3-CONT	28480	1200-0666
A2XQ2	1200-0666	1		SOCKET-XSTR 3-CONT	28480	1200-0666
A2XQ3-				NOT ASSIGNED		
A2XQ6				NOT ASSIGNED		
A2XQ7	1200-0666	1		SOCKET-XSTR 3-CONT	28480	1200-0666
A2XQ8				NOT ASSIGNED		
A2XQ9				NOT ASSIGNED		
A2XQ10				NOT ASSIGNED		
A2XQ11	1200-0666	1		SOCKET-XSTR 3-CONT	28480	1200-0666
A2XQ12	1205-0011	0	1	HEAT SINK TO-5/TO-39-CS	28480	1205-0011

See introduction to this section for ordering information  
\*Indicates factory selected value

Table 6-4. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A3	05328-60018	7	1	BD AY-OVEN OSC OPTION 010	28480	05328-60018
A3A1	10811-60111	8	1	QUARTZ OSC 10MHZ	28480	10811-60111
A3C1	0180-2125	6	1	CAPACITOR-FXD 15UF+-5% 20VDC TA	56289	150D156X5020B2
A3C2	0160-3466	8	1	CAPACITOR-FXD 100PF +-10% 1KVDC CER	28480	0160-3466
A3C3	0160-4084	8	1	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A3C4*	0180-2818	4	1	CAPACITOR-FXD 2.2UF+-20% 35VDC TA	28480	0180-2818
A3C5	0180-0116	1	1	CAPACITOR-FXD 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A3J1	1251-2035	9	1	CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-2035
A3L1	9140-0131	5	1	INDUCTOR RF-CH-MLD 10MH 5% .25DX.75LG	28480	9140-0131
A3L2	9100-1788	6	1	CORE-FERRITE CHOKE-WIDEBAND; IMP:>680	28480	9100-1788
A3MP1	0380-0310	1	1	STANDOFF-RVT-0N .75-IN-LG 6-32THD	00000	ORDER BY DESCRIPTION
A3R1	0683-0825	5	1	RESISTOR 8.2 5% .25W FC TC=-400/+500	01121	CB82G5
A3R2	0757-0200	7	1	RESISTOR 5.62K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5621-F
A3R3	0757-0439	4	1	RESISTOR 6.81K 1% .125W F TC=0+-100	24546	C4-1/8-T0-6811-F
A3R4	0683-1225	1	1	RESISTOR 1.2K 5% .25W FC TC=-400/+700	01121	CB1225
A3R5	0683-1015	7	1	RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A3U1	1820-0439	0	1	IC V RGLTR 14-DIP-P	07263	723PC
A3W1	8159-0005	0	1	RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005

See introduction to this section for ordering information  
\*Indicates factory selected value

Model 5328B  
Replaceable Parts

Table 6-4. Replaceable Parts (continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A3A1	10811-60115	2	1	CIRCUIT BOARD COMPONENTS SERIES 2332A	28480	10811-60115
A3A1C1	0121-0511	6	1	TUNING CAPACITOR	28480	0121-0511
A3A1C2	0160-0576	5	9	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A3A1C3	0160-5109	0	1	CAPACITOR-FXD 15PF +-5% 50VDC CER 0+-30	28480	0160-5109
A3A1C4	0160-0576	5	5	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A3A1C5	0160-0576	5	5	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A3A1C6	0160-4935	8	1	CAPACITOR-FXD 510PF +-1% 100VDC CER	28480	0160-4935
A3A1C7	0160-0576	5	3	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A3A1C8	0160-5110	3	1	CAPACITOR-FXD 62PF +-1% 50VDC CER 0+-30	28480	0160-5110
A3A1C9	0160-4019	9	2	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-4019
A3A1C10	0160-3874	2	2	CAPACITOR-FXD 10PF +- .5PF 200VDC CER	28480	0160-3874
A3A1C11	0160-4019	9	9	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-4019
A3A1C12	0160-4512	7	2	CAPACITOR-FXD 120PF +-5% 200VDC CER	28480	0160-4512
A3A1C13	0160-3879	7	4	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3A1C14	0160-0576	5	5	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A3A1C15	0180-2617	1	1	CAPACITOR-FXD 6.8UF+-10% 35VDC TA	25088	D6R8G51B35K
A3A1C16	0160-0576	5	5	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A3A1C17	0160-3874	2	2	CAPACITOR-FXD 10PF +- .5PF 200VDC CER	28480	0160-3874
A3A1C18	0160-4947	2	1	CAPACITOR-FXD 2UF +-20% 50VDC MET-POLYE	28480	0160-4947
A3A1C19	0160-3879	7	7	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3A1C20	0160-3879	7	7	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3A1C21	0160-0576	5	5	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A3A1C22	0160-0576	5	5	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A3A1C23	0160-4512	7	7	CAPACITOR-FXD 120PF +-5% 200VDC CER	28480	0160-4512
A3A1C24	0160-0576	5	5	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A3A1C25	0160-3277	9	1	CAPACITOR-FXD .01UF +-20% 50VDC CER	51642	150-050-X7R-103M
A3A1C26	0160-3879	7	7	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3A1C27	0160-3872	0	1	CAPACITOR-FXD 2.2PF +- .25PF 200VDC CER	28480	0160-3872
A3A1CR1	0122-0244	4	1	DIODE-VVC 100PF 5% C4/C25-MIN=2 BVR=30V	28480	0122-0244
A3A1CR2	1901-0869	2	1	DIODE-CUR RGLTR 1N5297 DO-7	04713	1N5297
A3A1CR3	1902-0984	4	1	DIODE-ZNR 6.4V 2% DO-7 PD=.4W TC=+.002%	28480	1902-0984
A3A1CR4	1901-0535	9	3	DIODE-SM SIG SCHOTTKY	28480	1901-0535
A3A1CR5	1901-0535	9	9	DIODE-SM SIG SCHOTTKY	28480	1901-0535
A3A1CR6	1901-0535	9	9	DIODE-SM SIG SCHOTTKY	28480	1901-0535
A3A1E1	9170-0029	3	1	FERRITE BEAD (FOR Q1)	28480	9170-0029
A3A1F1	2110-0617	2	1	FUSE-THERMAL	28480	2110-0617
A3A1L1	9100-2280	5	5	INDUCTOR RF-CH-MLD 220UH 10% .105DX.26LG	28480	9100-2280
A3A1L2	9140-0352	2	1	INDUCTOR RF-CH-MLD 330NH 1% .105DX.26LG	28480	9140-0352
A3A1L3	9140-0353	3	1	INDUCTOR RF-CH-MLD 430NH 1% .105DX.26LG	28480	9140-0353
A3A1L4	9100-2276	9	1	INDUCTOR RF-CH-MLD 100UH 10% .105DX.26LG	28480	9100-2276
A3A1L5	9100-2280	5	5	INDUCTOR RF-CH-MLD 220UH 10% .105DX.26LG	28480	9100-2280
A3A1L6	9100-2280	5	5	INDUCTOR RF-CH-MLD 220UH 10% .105DX.26LG	28480	9100-2280
A3A1L7	9100-2280	5	5	INDUCTOR RF-CH-MLD 220UH 10% .105DX.26LG	28480	9100-2280
A3A1L8	9100-2280	5	5	INDUCTOR RF-CH-MLD 220UH 10% .105DX.26LG	28480	9100-2280
A3A1Q1	1854-0853	3	3	TRANSISTOR, SPL 2N5179	28480	1854-0853
A3A1Q2	1854-0853	3	3	TRANSISTOR, SPL 2N5179	28480	1854-0853
A3A1Q3	1854-0853	3	3	TRANSISTOR, SPL 2N5179	28480	1854-0853
A3A1Q4	1854-0831	7	2	TRANSISTOR NPN 2N6429A T0-92 PD=625MW	04713	2N6429A
A3A1Q5	1854-0831	7	7	TRANSISTOR NPN 2N6429A T0-92 PD=625MW	04713	2N6429A
A3A1Q6	1854-0023	9	1	TRANSISTOR NPN SI T0-18 PD=360MW	28480	1854-0023
A3A1Q7	1854-0701	0	2	TRANSISTOR NPN SI DARL T0-220AB PD=70W	04713	MJE2100
A3A1Q8	1854-0701	0	0	TRANSISTOR NPN SI DARL T0-220AB PD=70W	04713	MJE2100
A3A1Q9	1854-0833	9	1	TRANSISTOR NPN PD=600MW FT=600MHZ	28480	1854-0833
A3A1R1	0698-7284	5	5	RESISTOR 100K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1003-F
A3A1R2	0698-7284	5	5	RESISTOR 100K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1003-F
A3A1R3	0699-0073	8	2	RESISTOR 10M 1% .125W F TC=0+-150	28480	0699-0073
A3A1R4	0699-0073	8	8	RESISTOR 10M 1% .125W F TC=0+-150	28480	0699-0073
A3A1R5	0698-7263	0	1	RESISTOR 13.3K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1332-F
A3A1R6	2100-2522	1	1	RESISTOR-TRMR 10K 10% C SIDE-ADJ 1-TRN	30983	ET50X103
A3A1R7	0698-7272	1	1	RESISTOR 31.6K 1% .05W F TC=0+-100	24546	C3-1/8-T0-3162-F
A3A1R8	0698-7232	3	3	RESISTOR 681 1% .05W F TC=0+-100	24546	C3-1/8-T0-681R-F
A3A1R9	0698-7256	1	2	RESISTOR 6.81K 1% .05W F TC=0+-100	24546	C3-1/8-T0-6811-F
A3A1R10	0698-7256	1	1	RESISTOR 6.81K 1% .05W F TC=0+-100	24546	C3-1/8-T0-6811-F

See introduction to this section for ordering information  
\*Indicates factory selected value

Table 6-4. Replaceable Parts (continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A3A1R11	0698-7244	7	1	RESISTOR 2.15K 1% .05W F TC=0+-100	24546	C3-1/8-T0-2151-F
A3A1R12	0698-7261	8	1	RESISTOR 11K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1102-F
A3A1R13	0698-7224	3	1	RESISTOR 316 1% .05W F TC=0+-100	24546	C3-1/8-T0-316R-F
A3A1R14	0698-7280	1	1	RESISTOR 68.1K 1% .05W F TC=0+-100	24546	C3-1/8-T0-6812-F
A3A1R15	0698-7284	5	1	RESISTOR 100K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1003-F
A3A1R16	0698-7235	6	1	RESISTOR 909 1% .05W F TC=0+-100	24546	C3-1/8-T0-909R-F
A3A1R17	0698-7260	7	2	RESISTOR 10K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1002-F
A3A1R18	0698-3903	7	5	RESISTOR 8.6K .1% .05W F TC=0+-10	28480	0698-3903
A3A1R19	0698-3903	7	5	RESISTOR 8.6K .1% .05W F TC=0+-10	28480	0698-3903
A3A1R20*			1	JUMPER		
A3A1R20*	0698-7239	0	1	RESISTOR 1.33K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1331-F
A3A1R21	0698-3903	7	5	RESISTOR 8.6K .1% .05W F TC=0+-10	28480	0698-3903
A3A1R22	0698-8827	4	2	RESISTOR 1M 1% .125W F TC=0+-100	28480	0698-8827
A3A1R23	0698-8827	4	2	RESISTOR 1M 1% .125W F TC=0+-100	28480	0698-8827
A3A1R24	0699-0071	6	1	RESISTOR 4.64M 1% .125W F TC=0+-100	28480	0699-0071
A3A1R25	0698-7273	2	1	RESISTOR 34.8K 1% .05W F TC=0+-100	24546	C3-1/8-T0-3482-F
A3A1R26	0698-3903	7	5	RESISTOR 8.6K .1% .05W F TC=0+-10	28480	0698-3903
A3A1R27	0698-3903	7	5	RESISTOR 8.6K .1% .05W F TC=0+-10	28480	0698-3903
A3A1R28	0698-7265	2	1	RESISTOR 16.2K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1622-F
A3A1R29	0698-7260	7	2	RESISTOR 10K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1002-F
A3A1R30	0698-7267	4	1	RESISTOR 19.6K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1962-F
A3A1R31	0698-7220	9	1	RESISTOR 215 1% .05W F TC=0+-100	24546	C3-1/8-T0-215R-F
A3A1R32	0698-7250	5	2	RESISTOR 3.83K 1% .05W F TC=0+-100	24546	C3-1/8-T0-3831-F
A3A1R33	0698-7284	5	1	RESISTOR 100K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1003-F
A3A1R34	0698-7247	0	1	RESISTOR 2.87K 1% .05W F TC=0+-100	24546	C3-1/8-T0-2871-F
A3A1R35	0698-7250	5	1	RESISTOR 3.83K 1% .05W F TC=0+-100	24546	C3-1/8-T0-3831-F
A3A1R36	0698-7284	5	1	RESISTOR 100K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1003-F
A3A1R37	0698-7232	3	1	RESISTOR 681 1% .05W F TC=0+-100	24546	C3-1/8-T0-681R-F
A3A1R38	0698-8812	7	2	RESISTOR 1 1% .125W F TC=0+-100	28480	0698-8812
A3A1R39	0698-8812	7	2	RESISTOR 1 1% .125W F TC=0+-100	28480	0698-8812
A3A1R40	0698-7229	8	1	RESISTOR 511 1% .05W F TC=0+-100	24546	C3-1/8-T0-511R-F
A3A1R41	0698-7215	2	1	RESISTOR 133 1% .05W F TC=0+-100	24546	C3-1/8-T0-133R-F
A3A1R42	0698-7232	3	1	RESISTOR 681 1% .05W F TC=0+-100	24546	C3-1/8-T0-681R-F
A3A1T1	9100-0423	4	1	TRANSFORMER RF; WIND 9T PRI & 3T SEC	28480	9100-0423
A3A1U1	1826-0611	2	1	IC OP AMP GP DUAL 8-DIP-P PKG	04713	LM2904N
A3A1U2	1826-0316	4	1	V REF T0-5	27014	LH0070-1H
A3A1U3	1826-0072	9	1	IC OP AMP LOW-BIAS-H-IMPD T0-99 PKG	07263	UA208H
A3A1XF1	1251-1556	7	2	CONNECTOR-SGL CONT SKT .018-IN-BSC-SZ	28480	1251-1556
A3A1Y1	10811-60108	3	1	CRYSTAL-10MHZ W/R20 TEMP SET (REPAIR ONLY)	28480	10811-60108
	2260-0009	3	1	NUT-HEX-W/LKW 4-40-THD .094-IN-THK	00000	ORDER BY DESCRIPTION

See introduction to this section for ordering information  
\*Indicates factory selected value

Model 5328B  
Replaceable Parts

Table 6-4. Replaceable Parts (continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
				CIRCUIT BOARD MISCELLANEOUS PARTS		
	1200-0868	5	1	SOCKET-STRP 7-CONT DIP-SLDR	28480	1200-0868
	0360-1244	0	3	TERMINAL-STUD SPCL-FDTHRU PRESS-MTG	28480	0360-1244
	3050-0588	9	2	WASHER-FL NM NO. 6 .145-IN-ID .23-IN-OD	28480	3050-0588
	0360-1682	0	2	TERMINAL-STUD SGL-TUR PRESS-MTG	28480	0360-1682
	10811-40002	4	1	FOAM SHEET-(BELOW OVEN CONTROLLER ASSY)	28480	10811-40002
				TRANSISTOR MOUNTING HARDWARE		
	2200-0103	2	1	SCREW-MACH 4-40 .25-IN-LG PAN-HD-POZI	28480	2200-0103
	2190-0004	9	1	WASHER-LK INTL T NO. 4 .115-IN-ID	28480	2190-0004
	3050-1021	7	1	WASHER-SHLDR NO.4 .116-IN-ID .215-IN-OD	28480	3050-1021
	0340-0864	6	1	INSULATOR-XSTR THRM-CNDCT	28480	0340-0864
				MASS ASSEMBLY AND COVERS		
MP25	10811-60106	1	1	OVEN MASS ASS. W/THERMISTOR	28480	10811-60106
MP26	10811-20202	4	1	MASS COVER W/XISTOR CUT-OUTS	28480	10811-20202
MP27	10811-20203	5	1	MASS COVER W/TUNING CAP HOLE	28480	10811-20203
	0520-0166	3	1	SCREW-MACH 2-56 .375-IN-LG 82 DEG	00000	ORDER BY DESCRIPTION
				MECHANICAL PARTS		
MP28	10811-20206	8	1	OUTER HOUSING (FOAMED)	28480	10811-20206
MP29	10811-20211	5	1	BOTTOM COVER	28480	10811-20211
MP30	10811-40001	3	1	FOAM COOKIE UNDER BOT COV	28480	10811-40001
				MISCELLANEOUS PARTS		
	3030-0827	7	1	SCREW-SKT BTN HD CAP 4-40 .188-IN-LG ALY	00000	ORDER BY DESCRIPTION
	2200-0101	0	1	SCREW-MACH 4-40 .188-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	7120-7912	0	1	INFO LABEL 10811A	28480	7120-7912
	7121-0331	5	1	INFO LABEL 10811-60101	28480	7121-0331
A3A2	10811-60003	7	1	EDGE CONNECTOR AND CABLE W3	28480	10811-60003

See introduction to this section for ordering information  
\*Indicates factory selected value

Table 6-5. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A4	05328-60005	2	1	BD AY-FUNCT SEL	28480	05328-60005
A4C1				NOT ASSIGNED		
A4C2	0160-3879	7	1	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A4C3	0160-0576	5	1	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A4C4	0140-0215	7	2	CAPACITOR-FXD 80PF +-2% 300VDC MICA	72136	DM15E800G0300WV1CR
A4C5	0140-0215	7		CAPACITOR-FXD 80PF +-2% 300VDC MICA	72136	DM15E800G0300WV1CR
A4C6	0160-2055	9	6	CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A4C7	0180-0210	6	2	CAPACITOR-FXD 3.3UF+-20% 15VDC TA	56289	150D335X0015A2
A4C8	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A4C9	0180-0210	6		CAPACITOR-FXD 3.3UF+-20% 15VDC TA	56289	150D335X0015A2
A4C10	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A4C11	0160-0342	3	1	CAPACITOR-FXD 800PF +-1% 300VDC MICA	28480	0160-0342
A4C12	0140-0214	6	1	CAPACITOR-FXD 60PF +-5% 300VDC MICA	72136	DM15E600J0300WV1CR
A4C13	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A4C14	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A4C15	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A4C16	0140-0202	2	1	CAPACITOR-FXD 15PF +-5% 500VDC MICA	72136	DM15C150J0500WV1CR
A4C17	0160-4040	6	1	CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A4MP1	4040-0752	9	1	EXTR-PC BD YEL POLYC .062-BD-THKNS	28480	4040-0752
A4MP2	1480-0116	8	1	PIN-GRV .062-IN-DIA .25-IN-LG STL	28480	1480-0116
A4Q1	1854-0215	1	3	TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A4Q2	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A4Q3	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A4R1	0683-5115	6	5	RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A4R2	0683-5115	6		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A4R3				NOT ASSIGNED		
A4R4	0683-5115	6		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A4R5	0683-5115	6		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A4R6	0683-2025	1	4	RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A4R7	0683-1815	5	7	RESISTOR 180 5% .25W FC TC=-400/+600	01121	CB1815
A4R8	0683-2025	1		RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A4R9	0683-1815	5		RESISTOR 180 5% .25W FC TC=-400/+600	01121	CB1815
A4R10	0683-2025	1		RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A4R11	0683-1815	5		RESISTOR 180 5% .25W FC TC=-400/+600	01121	CB1815
A4R12	0683-2025	1		RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A4R13	0683-1815	5		RESISTOR 180 5% .25W FC TC=-400/+600	01121	CB1815
A4R14	0683-1825	7	11	RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A4R15	0683-4315	6	2	RESISTOR 430 5% .25W FC TC=-400/+600	01121	CB4315
A4R16	0683-1825	7		RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A4R17	0683-1815	5		RESISTOR 180 5% .25W FC TC=-400/+600	01121	CB1815
A4R18	0683-1815	5		RESISTOR 180 5% .25W FC TC=-400/+600	01121	CB1815
A4R19	0683-1825	7		RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A4R20	0683-8205	1	2	RESISTOR 82 5% .25W FC TC=-400/+500	01121	CB8205
A4R21	0683-1315	0	2	RESISTOR 130 5% .25W FC TC=-400/+600	01121	CB1315
A4R22	0683-1825	7		RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A4R23	0683-1825	7		RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A4R24	0683-1825	7		RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A4R25	0683-1035	1	1	RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A4R26	0683-4315	6		RESISTOR 430 5% .25W FC TC=-400/+600	01121	CB4315
A4R27	0683-2715	6	3	RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A4R28	0683-3315	4	1	RESISTOR 330 5% .25W FC TC=-400/+600	01121	CB3315
A4R29	0683-1825	7		RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A4R30	0683-1825	7		RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A4R31	0683-2725	8	3	RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A4R32	0683-2725	8		RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A4R33	0683-2725	8		RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A4R34	0683-1825	7		RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A4R35	0683-1815	5		RESISTOR 180 5% .25W FC TC=-400/+600	01121	CB1815
A4R36	0683-8205	1		RESISTOR 82 5% .25W FC TC=-400/+500	01121	CB8205
A4R37	0683-1315	0		RESISTOR 130 5% .25W FC TC=-400/+600	01121	CB1315
A4R38	0683-5115	6		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A4R39	0683-2715	6		RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A4R40	0683-2715	6		RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715

See introduction to this section for ordering information  
\*Indicates factory selected value

Model 5328B  
Replaceable Parts

Table 6-5. Replaceable Parts (continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A4R41	0683-6815	5	1	RESISTOR 680 5% .25W FC TC=-400/+600	01121	CB6815
A4R42	0683-1825	7		RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A4R43	1810-0041	9	1	NETWORK-RES 9-SIP2.7K OHM X 8	28480	1810-0041
A4R44	1810-0080	6	1	NETWORK-RES 8-SIP500.0 OHM X 7	28480	1810-0080
A4R45	0698-3447	4	1	RESISTOR 422 1% .125W F TC=0+-100	24546	C4-1/8-T0-422R-F
A4R46	0683-1825	7		RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A4U1	1820-1225	4	1	IC FF ECL D-M/S DUAL	04713	MC10231P
A4U2	1820-1052	5	1	IC XLTR ECL ECL-T0-TTL QUAD 2-INP	04713	MC10125L
A4U3	1820-0629	0	2	IC FF TTL S J-K NEG-EDGE-TRIG	01295	SN74S112N
A4U4	1820-0629	0		IC FF TTL S J-K NEG-EDGE-TRIG	01295	SN74S112N
A4U5	1820-0622	3	1	IC MUXR/DATA-SEL TTL 8-T0-1-LINE 8-INP	01295	SN74151AN
A4U6	1820-0829	2	1	IC MUXR/DATA-SEL ECL 8-T0-1-LINE 8-INP	04713	MC10164L
A4U7	1820-0809	8	1	IC RCVR ECL LINE RCVR QUAD 2-INP	04713	MC10115P
A4U8	1820-0802	1	1	IC GATE ECL NOR QUAD 2-INP	04713	MC10102P
A4U9	1820-0328	6	1	IC GATE TTL NOR QUAD 2-INP	01295	SN7402N
A4U10	1820-0691	6	1	IC GATE TTL S AND-OR-INV	01295	SN74S64N

See introduction to this section for ordering information  
\*Indicates factory selected value

Table 6-6. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A5	05328-60012	1	1	BD AY-PS AUTO RN	28480	05328-60012
ASC1	0170-0066	9	1	CAPACITOR-FXD .027UF +-10% 200VDC POLYE	28480	0170-0066
ASC2	0140-0208	8	2	CAPACITOR-FXD 680PF +-5% 300VDC MICA	72136	DM15F681J0300WV1CR
ASC3	0160-2146	9	2	CAPACITOR-FXD .02UF +80-20% 100VDC CER	28480	0160-2146
ASC4	0160-2146	9		CAPACITOR-FXD .02UF +80-20% 100VDC CER	28480	0160-2146
ASC5	0140-0208	8		CAPACITOR-FXD 680PF +-5% 300VDC MICA	72136	DM15F681J0300WV1CR
ASC6	0180-1746	5	7	CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
ASC7	0180-0197	8	2	CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
ASC8	0180-0106	9		CAPACITOR-FXD 60UF+-20% 6VDC TA	56289	150D606X0006B2
ASC9	0180-0106	9		CAPACITOR-FXD 60UF+-20% 6VDC TA	56289	150D606X0006B2
ASC10	0180-0106	9		CAPACITOR-FXD 60UF+-20% 6VDC TA	56289	150D606X0006B2
ASC11	0160-3060	8	1	CAPACITOR-FXD .1UF +-20% 25VDC CER	28480	0160-3060
ASC12	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
ASC13	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
ASC14	0121-0168	9	1	CAPACITOR-V TRMR-POSTN .2-1.5PF 600V	28480	0121-0168
ASC15	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
ASC16	0150-0050	9	1	CAPACITOR-FXD 1000PF +80-20% 1KVDC CER	28480	0150-0050
ASC17	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
ASC18	0150-0011	2	1	CAPACITOR-FXD 1.5PF +-20% 500VDC TI DIOX	28480	0150-0011
ASC19	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
ASC20	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
ASC21	0180-0230	0		CAPACITOR-FXD 1UF+-20% 50VDC TA	56289	150D105X0050A2
ASCR1	1901-0999	9		DIODE-SCHOTTKY 20V 10NS DO-35	28480	1901-0999
ASCR2	1901-0999	9		DIODE-SCHOTTKY 20V 10NS DO-35	28480	1901-0999
ASCR3	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
ASCR4	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
ASCR5	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
ASCR6	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
ASCR7	1902-3224	1	2	DIODE-ZNR 17.8V 5% DO-35 PD=.4W	28480	1902-3224
ASCR8	1902-3224	1		DIODE-ZNR 17.8V 5% DO-35 PD=.4W	28480	1902-3224
ASCR9	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
ASCR10	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
ASCR11	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
ASCR12	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
ASCR13	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
ASCR14	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
ASCR15	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
ASCR16	1902-0126	6	2	DIODE-ZNR 2.61V 5% DO-7 PD=.4W TC=-.072%	28480	1902-0126
ASCR17	1902-0126	6		DIODE-ZNR 2.61V 5% DO-7 PD=.4W TC=-.072%	28480	1902-0126
ASCR18	1901-0999	9		DIODE-SCHOTTKY 20V 10NS DO-35	28480	1901-0999
ASCR19	1901-0999	9		DIODE-SCHOTTKY 20V 10NS DO-35	28480	1901-0999
ASCR20	1901-0999	9		DIODE-SCHOTTKY 20V 10NS DO-35	28480	1901-0999
ASL1	9140-0114	4	1	INDUCTOR RF-CH-MLD 10UH 10% .166DX.385LG	28480	9140-0114
ASMP1	4040-0753	0	1	EXTR-PC BD GRN POLYC .062-BD-THKNS	28480	4040-0753
ASMP2	1480-0116	8	2	PIN-GRV .062-IN-DIA .25-IN-LG STL	28480	1480-0116
ASP1				NOT ASSIGNED		
ASP2	1251-3768	7	1	CONTACT-CONN U/W-POST-TYPE MALE DPSLDR	28480	1251-3768
ASQ1	1854-0514	3	2	TRANSISTOR NPN SI PD=1W FT=150MHZ	28480	1854-0514
ASQ2	1854-0514	3		TRANSISTOR NPN SI PD=1W FT=150MHZ	28480	1854-0514
ASQ3	1854-0215	1	13	TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
ASQ4	1853-0036	2		TRANSISTOR PNP SI PD=310MW FT=250MHZ	28480	1853-0036
ASQ5	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
ASQ6	1855-0367	6	1	TRANSISTOR-UJT P ON N	28480	1855-0367
ASQ7	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
ASQ8	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
ASQ9	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
ASR1	0683-3915	0	1	RESISTOR 390 5% .25W FC TC=-400/+600	01121	CB3915
ASR2	0683-4715	0	2	RESISTOR 470 5% .25W FC TC=-400/+600	01121	CB4715
ASR3	0683-4715	0		RESISTOR 470 5% .25W FC TC=-400/+600	01121	CB4715
ASR4	0683-4325	8	2	RESISTOR 4.3K 5% .25W FC TC=-400/+700	01121	CB4325
ASR5	0683-4325	8		RESISTOR 4.3K 5% .25W FC TC=-400/+700	01121	CB4325

See introduction to this section for ordering information  
\*Indicates factory selected value



Table 6-6. Replaceable Parts (continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A5R6	0683-3315	4	2	RESISTOR 330 5% .25W FC TC=-400/+600	01121	CB3315
A5R7	0683-3315	4		RESISTOR 330 5% .25W FC TC=-400/+600	01121	CB3315
A5R8	0683-5625	3	2	RESISTOR 5.6K 5% .25W FC TC=-400/+700	01121	CB5625
A5R9	0683-1135	2	2	RESISTOR 11K 5% .25W FC TC=-400/+800	01121	CB1135
A5R10	0683-1025	9	11	RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A5R11	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A5R12	0683-1135	2		RESISTOR 11K 5% .25W FC TC=-400/+800	01121	CB1135
A5R13	0683-5625	3		RESISTOR 5.6K 5% .25W FC TC=-400/+700	01121	CB5625
A5R14	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A5R15	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A5R16	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A5R17	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A5R18	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A5R19	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A5R20	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A5R21	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A5R22	0683-6825	7	6	RESISTOR 6.8K 5% .25W FC TC=-400/+700	01121	CB6825
A5R23	0683-3025	3	9	RESISTOR 3K 5% .25W FC TC=-400/+700	01121	CB3025
A5R24	0683-6825	7		RESISTOR 6.8K 5% .25W FC TC=-400/+700	01121	CB6825
A5R25	0683-3025	3		RESISTOR 3K 5% .25W FC TC=-400/+700	01121	CB3025
A5R26	0683-3025	3		RESISTOR 3K 5% .25W FC TC=-400/+700	01121	CB3025
A5R27	0683-6825	7		RESISTOR 6.8K 5% .25W FC TC=-400/+700	01121	CB6825
A5R28	0683-4745	6	1	RESISTOR 470K 5% .25W FC TC=-800/+900	01121	CB4745
A5R29	0683-1035	1	4	RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A5R30	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A5R31	0683-3025	3		RESISTOR 3K 5% .25W FC TC=-400/+700	01121	CB3025
A5R32-				NOT ASSIGNED		
A5R34						
A5R35	0683-3025	3		RESISTOR 3K 5% .25W FC TC=-400/+700	01121	CB3025
A5R36	0683-3025	3		RESISTOR 3K 5% .25W FC TC=-400/+700	01121	CB3025
A5R37	0683-3025	3		RESISTOR 3K 5% .25W FC TC=-400/+700	01121	CB3025
A5R38	0683-3025	3		RESISTOR 3K 5% .25W FC TC=-400/+700	01121	CB3025
A5R39	0683-4715	0		RESISTOR 470 5% .25W FC TC=-400/+600	01121	CB4715
A5R40	0683-3025	3		RESISTOR 3K 5% .25W FC TC=-400/+700	01121	CB3025
A5R41	0683-1015	7	2	RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A5R42	0683-6825	7		RESISTOR 6.8K 5% .25W FC TC=-400/+700	01121	CB6825
A5R43	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A5R44	0683-6825	7		RESISTOR 6.8K 5% .25W FC TC=-400/+700	01121	CB6825
A5R45	0683-6825	7		RESISTOR 6.8K 5% .25W FC TC=-400/+700	01121	CB6825
A5R46	0683-1015	7		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A5R47	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A5R48	0698-0021	4	1	RESISTOR 3.3 10% .5W CC TC=0+412	01121	EB33G1
A5R49				NOT ASSIGNED		
A5R50	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A5T1	9100-3575	3	1	TRANSFORMER FREQ=60KHZ;PRI=17V;SEC=23.5	28480	9100-3575
ASU1	1820-0077	2	1	IC FF TTL D-TYPE POS-EDGE-TRIG CLEAR	01295	SN7474N
ASU2	1820-0537	9	1	IC SCHMITT-TRIG TTL NAND DUAL 4-INP	01295	SN7413N
ASU3	1820-0584	6	2	IC GATE TTL L NOR QUAD 2-INP	01295	SN74L02N
ASU4	1826-0174	2	1	IC COMPARATOR GP QUAD 14-DIP-P PKG	28480	1826-0174
ASU5	1820-0584	6		IC GATE TTL L NOR QUAD 2-INP	01295	SN74L02N
ASU6	1820-0281	0	1	IC FF TTL J-K M/S PULSE CLEAR DUAL	01295	SN74107N
ASU7	1820-0907	7	2	IC GATE TTL NAND TPL 3-INP	01295	SN7412N
ASU8	1820-0054	5	2	IC GATE TTL NAND QUAD 2-INP	01295	SN7400N
ASU9	1820-0907	7		IC GATE TTL NAND TPL 3-INP	01295	SN7412N
ASU10	1820-0054	5		IC GATE TTL NAND QUAD 2-INP	01295	SN7400N
ASU11	1820-0175	1	1	IC INV TTL HEX 1-INP	01295	SN7405N
ASU12	1990-0543	6	3	OPTO-ISOLATOR LED-PXSTR IF=150MA-MAX	01295	TIL116
ASU13	1990-0543	6		OPTO-ISOLATOR LED-PXSTR IF=150MA-MAX	01295	TIL116
ASU14	1990-0543	6		OPTO-ISOLATOR LED-PXSTR IF=150MA-MAX	01295	TIL116

See introduction to this section for ordering information  
\*Indicates factory selected value

Table 6-6. Replaceable Parts (continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A6	05328-60013	2	1	BD AY-BUFF AMP	28480	05328-60013
A6C1	0160-0168	1	1	CAPACITOR-FXD .1UF +-10% 200VDC POLYE	28480	0160-0168
A6C2	0160-2055	9	7	CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A6C3	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A6C4	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A6C5	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A6C6	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A6C7	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A6C8	0150-0050	9	1	CAPACITOR-FXD 1000PF +80-20% 1KVDC CER	28480	0150-0050
A6C9				NOT ASSIGNED		
A6C10	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A6CR1	1901-0376	6	2	DIODE-GEN PRP 35V 50MA D0-35	28480	1901-0376
A6CR2	1901-0376	6		DIODE-GEN PRP 35V 50MA D0-35	28480	1901-0376
A6K1	0490-1406	1	1	RELAY-REED 1A 1A 1200VDC 5VDC-COIL 10VA	28480	0490-1406
A6K2	0490-0764	2	2	RELAY-REED 1A 100MA 125VDC 4.5VDC-COIL	28480	0490-0764
A6K3	0490-0764	2		RELAY-REED 1A 100MA 125VDC 4.5VDC-COIL	28480	0490-0764
A6MP1	4040-0754	1	1	EXTR-PC BD BLU POLYC .062-BD-THKNS	28480	4040-0754
A6MP2	1480-0116	8	1	PIN-GRV .062-IN-DIA .25-IN-LG STL	28480	1480-0116
A6MP3	0370-2486	5	2	PUSHBUTTON .230X.390X.397 IN H: JADE	28480	0370-2486
A6MP4	0370-2486	5		PUSHBUTTON .230X.390X.397 IN H: JADE	28480	0370-2486
A6P1				NOT ASSIGNED		
A6P2	1251-3768	7	3	CONTACT-CONN U/W-POST-TYPE MALE DPSLDR	28480	1251-3768
A6Q1	1853-0020	4	3	TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A6Q2	1853-0020	4		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A6Q3	1853-0020	4		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A6R1	0686-3045	3	3	RESISTOR 300K 5% .5W CC TC=0+882	01121	EB3045
A6R2	0686-3045	3		RESISTOR 300K 5% .5W CC TC=0+882	01121	EB3045
A6R3	0686-3045	3		RESISTOR 300K 5% .5W CC TC=0+882	01121	EB3045
A6R4	0698-7618	9	14	RESISTOR 888K 1% .25W F TC=0+-50	19701	MF52C1/4-T2-8883-F
A6R5	0698-7618	9		RESISTOR 888K 1% .25W F TC=0+-50	19701	MF52C1/4-T2-8883-F
A6R6	0698-7618	9		RESISTOR 888K 1% .25W F TC=0+-50	19701	MF52C1/4-T2-8883-F
A6R7	0698-7618	9		RESISTOR 888K 1% .25W F TC=0+-50	19701	MF52C1/4-T2-8883-F
A6R8	0698-7618	9		RESISTOR 888K 1% .25W F TC=0+-50	19701	MF52C1/4-T2-8883-F
A6R9	0698-7618	9		RESISTOR 888K 1% .25W F TC=0+-50	19701	MF52C1/4-T2-8883-F
A6R10	0698-7618	9		RESISTOR 888K 1% .25W F TC=0+-50	19701	MF52C1/4-T2-8883-F
A6R11	0698-7618	9		RESISTOR 888K 1% .25W F TC=0+-50	19701	MF52C1/4-T2-8883-F
A6R12	0698-7618	9		RESISTOR 888K 1% .25W F TC=0+-50	19701	MF52C1/4-T2-8883-F
A6R13	0698-7618	9		RESISTOR 888K 1% .25W F TC=0+-50	19701	MF52C1/4-T2-8883-F
A6R14	0698-6626	7	1	RESISTOR 345K 1% .125W F TC=0+-25	28480	0698-6626
A6R15	2100-2503	8	2	RESISTOR-TRMR 20K 10% C SIDE-ADJ 17-TRN	32997	3009P-1-203
A6R16	0698-7618	9		RESISTOR 888K 1% .25W F TC=0+-50	19701	MF52C1/4-T2-8883-F
A6R17	0698-7618	9		RESISTOR 888K 1% .25W F TC=0+-50	19701	MF52C1/4-T2-8883-F
A6R18	0698-3152	8	1	RESISTOR 3.48K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3481-F
A6R19	0698-3550	0	1	RESISTOR 127K 1% .125W F TC=0+-25	28480	0698-3550
A6R20	0698-7618	9		RESISTOR 888K 1% .25W F TC=0+-50	19701	MF52C1/4-T2-8883-F
A6R21	0698-7618	9		RESISTOR 888K 1% .25W F TC=0+-50	19701	MF52C1/4-T2-8883-F
A6R22	0683-7545	0	1	RESISTOR 750K 5% .25W FC TC=-800/+900	01121	CB7545
A6R23				NOT ASSIGNED		
A6R24	0683-9145	0	2	RESISTOR 910K 5% .25W FC TC=-800/+900	01121	CB9145
A6R25				NOT ASSIGNED		
A6R26	0683-9145	0		RESISTOR 910K 5% .25W FC TC=-800/+900	01121	CB9145
A6R27	0683-2725	8	1	RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A6R28	2100-2706	3	1	RESISTOR-TRMR 10K 10% C SIDE-ADJ 17-TRN	32997	3009P-1-103
A6R29	2100-2503	8		RESISTOR-TRMR 20K 10% C SIDE-ADJ 17-TRN	32997	3009P-1-203
A6S1	3101-1884	9	1	SWITCH-PB 2-STATION 10MM C-C SPACING	28480	3101-1884
A6U1	1826-0250	5	1	IC OP AMP T0-99 PKG	27014	LH0042CH(SEL)
A6W1	05328-60102	0	1	CBL AY-HP DVM HI	28480	05328-60102
A6W2	05328-60103	1	1	CBL AY-HP DVM LO	28480	05328-60103
A6W3	8159-0005	0	1	RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005

See introduction to this section for ordering information  
\*Indicates factory selected value

Table 6-6. Replaceable Parts (continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A7	05328-60014	3	1	BD AY-V/F CONV	28480	05328-60014
A7C1	0180-0197	8	4	CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A7C2	0160-2150	5	3	CAPACITOR-FXD 33PF +-5% 300VDC MICA	28480	0160-2150
A7C3	0160-2150	5	5	CAPACITOR-FXD 33PF +-5% 300VDC MICA	28480	0160-2150
A7C4	0180-0197	8	3	CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A7C5	0160-2249	3	1	CAPACITOR-FXD 4.7PF +- .25PF 500VDC CER	28480	0160-2249
A7C6	0170-0055	6	2	CAPACITOR-FXD .1UF +-20% 200VDC POLYE	28480	0170-0055
A7C7	0160-2150	5	6	CAPACITOR-FXD 33PF +-5% 300VDC MICA	28480	0160-2150
A7C8	0170-0055	6	6	CAPACITOR-FXD .1UF +-20% 200VDC POLYE	28480	0170-0055
A7C9	0160-2055	9	1	CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A7C10	0140-0196	3	1	CAPACITOR-FXD 150PF +-5% 300VDC MICA	72136	DM15F151J0300WV1CR
A7C11	0160-2205	1	1	CAPACITOR-FXD 120PF +-5% 300VDC MICA	28480	0160-2205
A7C12*	0160-2307	4	1	CAPACITOR-FXD 47PF +-5% 300VDC MICA	28480	0160-2307
A7C13				NOT ASSIGNED		
A7C14	0180-0197	8	8	CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A7C15	0180-0197	8	8	CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A7CR1	1902-0680	7	2	DIODE-ZNR 1N827 6.2V 5% DO-7 PD=.4W	24046	1N827
A7CR2	1901-0040	1	5	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A7CR3	1901-0040	1	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A7CR4	1902-0680	7	1	DIODE-ZNR 1N827 6.2V 5% DO-7 PD=.4W	24046	1N827
A7CR5	1901-0179	7	6	DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A7CR6	1901-0179	7	7	DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A7CR7	1901-0179	7	7	DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A7CR8	1901-0179	7	7	DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A7CR9	1901-0040	1	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A7CR10	1901-0040	1	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A7CR11	1901-0040	1	7	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A7CR12	1901-0179	7	1	DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A7CR13	1901-0179	7	7	DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A7L1	9140-0144	0	2	INDUCTOR RF-CH-MLD 4.7UH 10% .10SDX.26LG	28480	9140-0144
A7L2	9100-2265	6	1	INDUCTOR RF-CH-MLD 10UH 10% .10SDX.26LG	28480	9100-2265
A7L3	9140-0144	0	6	INDUCTOR RF-CH-MLD 4.7UH 10% .10SDX.26LG	28480	9140-0144
A7L4	9100-2268	9	1	INDUCTOR RF-CH-MLD 22UH 10% .10SDX.26LG	28480	9100-2268
A7MP1	4040-0755	2	1	EXTR-PC BD VIO POLYC .062-BD-THKNS	28480	4040-0755
A7MP2	1480-0116	8	1	PIN-GRV .062-IN-DIA .25-IN-LG STL	28480	1480-0116
A7MP3	7100-0102	4	1	CAN-SQ .688-IN-DP-OUT .566-IN-WD-OUT	28480	7100-0102
A7Q1	1855-0056	0	1	TRANSISTOR J-FET P-CHAN D-MODE TO-92 SI	07263	2N4342
A7Q2	1855-0081	1	1	TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0081
A7Q3	1853-0020	4	1	TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A7Q4	1854-0071	7	6	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A7Q5	1854-0092	2	4	TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A7Q6	1854-0092	2	2	TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A7Q7	1854-0092	2	2	TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A7Q8	1854-0092	2	2	TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A7Q9	1854-0071	7	7	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A7Q10	1854-0071	7	7	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A7Q11	1854-0071	7	7	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A7Q12	1854-0071	7	7	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A7Q13	1854-0071	7	7	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A7R1*	0757-0276	7	2	RESISTOR 61.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-6192-F
A7R1*	0757-0316	6	2	RESISTOR 42.2 1% .125W F TC=0+-100	24546	C4-1/8-T0-42R2-F
A7R1*	0757-0384	8	2	RESISTOR 20 1% .125W F TC=0+-100	19701	MF4C1/8-T0-20R0-F
A7R1*	0757-0399	5	2	RESISTOR 82.5 1% .125W F TC=0+-100	24546	C4-1/8-T0-82R5-F
A7R2*	0698-3157	3	2	RESISTOR 19.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1962-F
A7R2*	0698-3159	5	2	RESISTOR 26.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2612-F
A7R2*	0698-3160	8	2	RESISTOR 31.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3162-F
A7R2*	0698-3162	0	2	RESISTOR 46.4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4642-F
A7R2*	0757-0460	1	2	RESISTOR 61.9K 1% .125W F TC=0+-100	24546	C4-1/8-T0-6192-F
A7R2*	0757-0463	4	2	RESISTOR 82.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-8252-F
A7R3	0698-7610	1	4	RESISTOR 1.74K .5% .125W F TC=0+-25	19701	MF4C1/8-T9-1741-D
A7R4	0757-0421	4	2	RESISTOR 825 1% .125W F TC=0+-100	24546	C4-1/8-T0-825R-F
A7R5	0698-3435	0	2	RESISTOR 38.3 1% .125W F TC=0+-100	24546	C4-1/8-T0-38R3-F
A7R6	2100-2931	6	2	RESISTOR-TRMR 500 10% C SIDE-AOJ 17-TRN	32997	3009P-1-501
A7R7	0683-2225	3	3	RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225

See introduction to this section for ordering information  
\*Indicates factory selected value

Table 6-6. Replaceable Parts (continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number	
A7R8	0683-1525	4	3	RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	CB1525	
A7R9	0683-1525	4		RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	CB1525	
A7R10	0683-2225	3		RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225	
A7R11	0757-0421	4		RESISTOR 825 1% .125W F TC=0+-100	24546	C4-1/8-T0-825R-F	
A7R12	0698-3435	0		RESISTOR 38.3 1% .125W F TC=0+-100	24546	C4-1/8-T0-383R-F	
A7R13	2100-2931	6	3	RESISTOR-TRMR 500 10% C SIDE-ADJ 17-TRN	32997	3009P-1-501	
A7R14*	0698-3157	3		RESISTOR 19.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1962-F	
A7R14*	0698-3159	5		RESISTOR 26.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2612-F	
A7R14*	0698-3160	8		RESISTOR 31.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3162-F	
A7R14*	0698-3162	0		RESISTOR 46.4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4642-F	
A7R14*	0757-0460	1		RESISTOR 61.9K 1% .125W F TC=0+-100	24546	C4-1/8-T0-6192-F	
A7R14*	0757-0463	4		RESISTOR 82.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-8252-F	
A7R15	0698-7610	1		RESISTOR 1.74K .5% .125W F TC=0+-25	19701	MF4C1/8-T9-1741-D	
A7R16*	0757-0276	7		RESISTOR 61.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-6192-F	
A7R16*	0757-0316	6	RESISTOR 42.2 1% .125W F TC=0+-100	24546	C4-1/8-T0-422R-F		
A7R16*	0757-0384	8	RESISTOR 20 1% .125W F TC=0+-100	19701	MF4C1/8-T0-20R0-F		
A7R16*	0757-0399	5	RESISTOR 82.5 1% .125W F TC=0+-100	24546	C4-1/8-T0-82R5-F		
A7R17	0683-2225	3	4	RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225	
A7R18	0683-7515	4		RESISTOR 750 5% .25W FC TC=-400/+600	01121	CB7515	
A7R19	0683-3615	7		RESISTOR 360 5% .25W FC TC=-400/+600	01121	CB3615	
A7R20	0683-1225	1		RESISTOR 1.2K 5% .25W FC TC=-400/+700	01121	CB1225	
A7R21	0683-3615	7		RESISTOR 360 5% .25W FC TC=-400/+600	01121	CB3615	
A7R22	0683-1025	9	12	RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025	
A7R23	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025	
A7R24	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025	
A7R25	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025	
A7R26	0698-7610	1		RESISTOR 1.74K .5% .125W F TC=0+-25	19701	MF4C1/8-T9-1741-D	
A7R27	0698-7610	1		RESISTOR 1.74K .5% .125W F TC=0+-25	19701	MF4C1/8-T9-1741-D	
A7R28	0683-3325	6	3	RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325	
A7R29	0683-2225	3		RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225	
A7R30	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025	
A7R31	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025	
A7R32	0683-3325	6		RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325	
A7R33	0683-6815	5	1	RESISTOR 680 5% .25W FC TC=-400/+600	01121	CB6815	
A7R34	0683-6815	5		RESISTOR 680 5% .25W FC TC=-400/+600	01121	CB6815	
A7R35	0683-3325	6		RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325	
A7R36	0683-3915	0		RESISTOR 390 5% .25W FC TC=-400/+600	01121	CB3915	
A7R37	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025	
A7R38	0683-7515	4		RESISTOR 750 5% .25W FC TC=-400/+600	01121	CB7515	
A7R39	0683-2225	3	1	RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225	
A7R40	0683-4715	0		RESISTOR 470 5% .25W FC TC=-400/+600	01121	CB4715	
A7R41	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025	
A7R42	0683-7515	4		RESISTOR 750 5% .25W FC TC=-400/+600	01121	CB7515	
A7R43	0683-1215	9		RESISTOR 120 5% .25W FC TC=-400/+600	01121	CB1215	
A7R44	0683-2015	9	2	RESISTOR 200 5% .25W FC TC=-400/+600	01121	CB2015	
A7R45*	0683-6815	5		RESISTOR 680 5% .25W FC TC=-400/+600	01121	CB6815	
A7R46	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025	
A7R47	0683-2015	9		RESISTOR 200 5% .25W FC TC=-400/+600	01121	CB2015	
A7R48	0683-7515	4	6	RESISTOR 750 5% .25W FC TC=-400/+600	01121	CB7515	
A7R49	0683-1225	1		RESISTOR 1.2K 5% .25W FC TC=-400/+700	01121	CB1225	
A7R50*	0683-2225	3		RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225	
A7R51	0683-9115	4		RESISTOR 910 5% .25W FC TC=-400/+600	01121	CB9115	
A7R52	0683-1525	4		2	RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	CB1525
A7R53	0683-1515	2			RESISTOR 150 5% .25W FC TC=-400/+600	01121	CB1515
A7R54	0683-1025	9	RESISTOR 1K 5% .25W FC TC=-400/+600		01121	CB1025	
A7R55	0683-1515	2	RESISTOR 150 5% .25W FC TC=-400/+600		01121	CB1515	
A7R56			NOT ASSIGNED				
A7R57	0683-8205	1	RESISTOR 82 5% .25W FC TC=-400/+500		01121	CB8205	
A7R58	0757-0465	6	1	RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F	
A7R59	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025	
A7R60	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025	
A7R61	0683-1005	5		RESISTOR 10 5% .25W FC TC=-400/+500	01121	CB1005	
A7U1	1820-0174	0		1	IC INV TTL HEX	01295	SN7404N
A7U2	1820-0802	1			IC GATE ECL NOR QUAD 2-INP	04713	MC10102P
A7U3	1820-0477	6	IC OP AMP GP 8-DIP-P PKG		S0545	UPC301AC	
A7U4	1820-0477	6	IC OP AMP GP 8-DIP-P PKG		S0545	UPC301AC	
A7U5	1820-0099	8	IC CNTR TTL BIN ASYNCHRO NEG-EDGE-TRIG		01295	SN7493N	

See introduction to this section for ordering information  
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Model 5328B  
Replaceable Parts

Table 6-6. Replaceable Parts (continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A7U6	1820-0055	6	1	IC CNTR TTL DECD SYNCHRO POS-EDGE-TRIG	01295	SN7490AN
A7U7	1820-0054	5	1	IC GATE TTL NAND QUAD 2-INP	01295	SN7400N
A7U8	1820-0269	4	1	IC GATE TTL NAND QUAD 2-INP	01295	SN7403N
A7U9	1820-0817	8	1	IC FF ECL D-M/S DUAL	04713	MC10131P
A7U10				NOT ASSIGNED		
A7U11	1820-0809	8	2	IC RCVR ECL LINE RCVR QUAD 2-INP	04713	MC10115P
A7U12	1820-0809	8		IC RCVR ECL LINE RCVR QUAD 2-INP	04713	MC10115P
A7U13	1826-0059	2	1	IC OP AMP GP TO-99 PKG	01295	LM201AL
A7U14	1820-0077	2	1	IC FF TTL D-TYPE POS-EDGE-TRIG CLEAR	01295	SN7474N
	0360-0065	1	4	TERMINAL-STUD FKD-TUR SWGFRM-MTG	28480	0360-0065

See introduction to this section for ordering information  
\*Indicates factory selected value

Table 6-6. Replaceable Parts (continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A17	05328-60015	4	1	BD AY-DVM FR PNL	28480	05328-60015
A17J1	1251-3761	0	2	CONNECTOR 4-PIN F POST TYPE	28480	1251-3761
A17J2	1251-3833	7	2	CONNECTOR 3-PIN F POST TYPE	28480	1251-3833
A17P1	1251-3761	0		CONNECTOR 4-PIN F POST TYPE	28480	1251-3761
A17P2	1251-3833	7		CONNECTOR 3-PIN F POST TYPE	28480	1251-3833
A17S1	3101-1872	5	1	SWITCH-SL DP4T STD .3A 30VDC PC	28480	3101-1872
A17S2	3101-0540	2	1	SWITCH-SL SPDT MINTR 1A 125VAC PC	28480	3101-0540

See introduction to this section for ordering information  
\*Indicates factory selected value

Model 5328B  
Replaceable Parts

Table 6-7. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A8	05328-60025	6	1	BD AY 1.3GHZ	28480	05328-60025
A8A1	05305-60006	6	1	BD AY 1.3GHZ	28480	05305-60006
A8C1	0180-0106	9		CAPACITOR-FXD 60UF+-20% 6VDC TA	56289	150D606X0006B2
A8C2	0180-0106	9		CAPACITOR-FXD 60UF+-20% 6VDC TA	56289	150D606X0006B2
A8C3	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A8C4	0140-0202	2	3	CAPACITOR-FXD 15PF +-5% 500VDC MICA	72136	DM15C150J0500WV1CR
A8C5	0140-0202	2		CAPACITOR-FXD 15PF +-5% 500VDC MICA	72136	DM15C150J0500WV1CR
A8C6	0140-0202	2		CAPACITOR-FXD 15PF +-5% 500VDC MICA	72136	DM15C150J0500WV1CR
A8C7	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A8C8	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A8C9	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A8C10	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A8C11	0180-0230	0		CAPACITOR-FXD 1UF+-20% 50VDC TA	56289	150D105X0050A2
A8C12	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A8C13	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A8C14	0160-2204	0	1	CAPACITOR-FXD 100PF +-5% 300VDC MICA	28480	0160-2204
A8C15	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A8C16	0180-0061	5	1	CAPACITOR-FXD 100UF+75-10% 16VDC AL	56289	30D107G016DC2
A8C17	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A8C18	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A8C19	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A8CR1	1901-0999	9		DIODE-SCHOTTKY 20V 10NS D0-35	28480	1901-0999
A8CR2	1901-0999	9		DIODE-SCHOTTKY 20V 10NS D0-35	28480	1901-0999
A8CR3	1901-0999	9		DIODE-SCHOTTKY 20V 10NS D0-35	28480	1901-0999
A8CR4	1901-0999	9		DIODE-SCHOTTKY 20V 10NS D0-35	28480	1901-0999
A8CR5	1902-3059	0	2	DIODE-ZNR 3.83V 5% D0-35 PD=.4W	28480	1902-3059
A8CR6	1902-3059	0		DIODE-ZNR 3.83V 5% D0-35 PD=.4W	28480	1902-3059
A8CR7	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS D0-35	28480	1901-0040
A8CR8	1901-0535	9		DIODE-SM SIG SCHOTTKY	28480	1901-0535
A8CR9	1902-3024	9	1	DIODE-ZNR 2.87V 5% D0-7 PD=.4W TC=-.07%	28480	1902-3024
A8F1	2110-0301	1		FUSE .125A 125V .281X.093	28480	2110-0301
A8F2	2110-0301	1		FUSE .125A 125V .281X.093	28480	2110-0301
A8J1	0360-0124	3		CONNECTOR-SGL CONT PIN .04-IN-BSC-SZ RND	28480	0360-0124
A8J2	0360-0124	3		CONNECTOR-SGL CONT PIN .04-IN-BSC-SZ RND	28480	0360-0124
A8J3	0360-0124	3		CONNECTOR-SGL CONT PIN .04-IN-BSC-SZ RND	28480	0360-0124
A8J4				NOT ASSIGNED		
A8J5				NOT ASSIGNED		
A8L1	9100-2274	7	2	INDUCTOR RF-CH-MLD 68UH 10% .105DX.26LG	28480	9100-2274
A8L2	9100-2274	7		INDUCTOR RF-CH-MLD 68UH 10% .105DX.26LG	28480	9100-2274
A8L3	9100-1788	6	1	CORE-FERRITE CHOKE-WIDEBAND; IMP:>680	28480	9100-1788
A8MP1	4040-0747	2	1	EXTR-PC BD GRA POLYC .062-BD-THKNS	28480	4040-0747
A8MP2	1480-0116	8		PIN-GRV .062-IN-DIA .25-IN-LG STL	28480	1480-0116
A8MP3	2360-0205	3	2	SCREW-MACH 6-32 .75-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A8MP4	2360-0205	3		SCREW-MACH 6-32 .75-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A8MP5	05305-00008	2	1	COV-HSG	28480	05305-00008
A8MP6	05305-20107	4	1	HSG-AMP	28480	05305-20107
A8Q1	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A8Q2	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A8Q3	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A8Q4	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A8Q5	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A8Q6	1853-0036	2		TRANSISTOR PNP SI PD=310MW FT=250MHZ	28480	1853-0036
A8Q7	1853-0036	2		TRANSISTOR PNP SI PD=310MW FT=250MHZ	28480	1853-0036
A8Q8	1853-0036	2		TRANSISTOR PNP SI PD=310MW FT=250MHZ	28480	1853-0036
A8Q9	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A8Q10	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A8Q11	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904

See introduction to this section for ordering information  
\*Indicates factory selected value

Table 6-7. Replaceable Parts (continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
ABR1	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
ABR2	0683-5115	6		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
ABR3	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
ABR4	2100-0645	5	2	RESISTOR-VAR CONTROL CCP 50K 10% LIN	01121	73M4N056L503U
ABR5				NOT ASSIGNED		
ABR6	0683-3005	9	2	RESISTOR 30 5% .25W FC TC=-400/+500	01121	CB3005
ABR7	0683-2725	8		RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
ABR8	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
ABR9	0683-2725	8		RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
ABR10	0683-3005	9		RESISTOR 30 5% .25W FC TC=-400/+500	01121	CB3005
ABR11	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
ABR12	2100-2522	1	1	RESISTOR-TRMR 10K 10% C SIDE-ADJ 1-TRN	30983	ET50X103
ABR13	0683-7525	6	1	RESISTOR 7.5K 5% .25W FC TC=-400/+700	01121	CB7525
ABR14	0683-2715	6		RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
ABR15	0683-5125	8	1	RESISTOR 5.1K 5% .25W FC TC=-400/+700	01121	CB5125
ABR16	0683-5115	6		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
ABR17	0698-3381	5	2	RESISTOR 150 5% .125W CC TC=-330/+800	01121	BB1515
ABR18	0698-3113	1	2	RESISTOR 100 5% .125W CC TC=-270/+540	01121	BB1015
ABR19	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
ABR20	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
ABR21	0683-1225	1	1	RESISTOR 1.2K 5% .25W FC TC=-400/+700	01121	CB1225
ABR22	0683-5105	4		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
ABR23	0683-2015	9		RESISTOR 200 5% .25W FC TC=-400/+600	01121	CB2015
ABR24	0698-3381	5		RESISTOR 150 5% .125W CC TC=-330/+800	01121	BB1515
ABR25	0698-3113	1		RESISTOR 100 5% .125W CC TC=-270/+540	01121	BB1015
ABR26	0698-3378	0	2	RESISTOR 51 5% .125W CC TC=-270/+540	01121	BB5105
ABR27	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
ABR28	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
ABR29	0757-0417	8	1	RESISTOR 562 1% .125W F TC=0/+100	24546	C4-1/8-T0-562R-F
ABR30	0698-3437	2	1	RESISTOR 133 1% .125W F TC=0/+100	24546	C4-1/8-T0-133R-F
ABR31	0698-3378	0		RESISTOR 51 5% .125W CC TC=-270/+540	01121	BB5105
ABR32	0683-2015	9		RESISTOR 200 5% .25W FC TC=-400/+600	01121	CB2015
ABR33				NOT ASSIGNED		
ABR34	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
ABR35	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
ABR36	0683-2715	6		RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
ABR37	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
ABR38*	0683-5105	4	3	RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
ABR39	0683-2015	9		RESISTOR 200 5% .25W FC TC=-400/+600	01121	CB2015
ABR40	0683-5135	0	1	RESISTOR 51K 5% .25W FC TC=-400/+800	01121	CB5135
ABR41	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
ABR42	0683-3035	5	2	RESISTOR 30K 5% .25W FC TC=-400/+800	01121	CB3035
ABR43	0683-2015	9		RESISTOR 200 5% .25W FC TC=-400/+600	01121	CB2015
ABR44	2100-0645	5		RESISTOR-VAR CONTROL CCP 50K 10% LIN	01121	73M4N056L503U
ABR45	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
ABTP1	0360-0124	3		CONNECTOR-SGL CONT PIN .04-IN-BSC-SZ RND	28480	0360-0124
ABTP2	0360-0124	3		CONNECTOR-SGL CONT PIN .04-IN-BSC-SZ RND	28480	0360-0124
ABTP3	0360-0124	3		CONNECTOR-SGL CONT PIN .04-IN-BSC-SZ RND	28480	0360-0124
ABTP4	0360-0124	3		CONNECTOR-SGL CONT PIN .04-IN-BSC-SZ RND	28480	0360-0124
ABU1	1820-0328	6		IC GATE TTL NOR QUAD 2-INP	01295	SN7402N
ABU2	1820-0269	4		IC GATE TTL NAND QUAD 2-INP	01295	SN7403N
ABU3	1820-0077	2		IC FF TTL D-TYPE POS-EDGE-TRIG CLEAR	01295	SN7474N
ABU4	1820-0068	1		IC GATE TTL NAND TPL 3-INP	01295	SN7410N
ABU5	1820-0616	5	1	IC MUXR/DATA-SEL TTL 2-T0-1-LINE QUAD	07263	9322PC
ABU6	1820-0301	5		IC LCH TTL D-TYPE 4-BIT	01295	SN7475N
ABU7	1820-1052	5	1	IC XLTR ECL ECL-T0-TTL QUAD 2-INP	04713	MC10125L
ABU8	1820-0493	6	1	IC OP AMP GP 8-DIP-P PKG	27014	LM307N
ABU9	1DC9-0001	9	1	IC-DIGITAL BI-QUIN ECL COUNTER	28480	1DC9-0001
ABW1	05328-60112	2	1	CBL AY-1.3GHZ	28480	05328-60112
ABW2	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
ABW3	05328-60123	5	1	CBL AY-EXT LINE	28480	05328-60123
ABW4	05328-60129	1	1	CBL AY-EXT LINE	28480	05328-60129
ABXA1	1251-4277	5	1	CONNECTOR 10-PIN F POST TYPE	28480	1251-4277

See introduction to this section for ordering information  
\*Indicates factory selected value



Table 6-7. Replaceable Parts (continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A8XU1- A8XU8 A8XU9	1200-0475	0	1	NOT ASSIGNED CONNECTOR-SGL CONT SKT .017-IN-BSC-SZ	28480	1200-0475
A8A1	05305-60006	6		BD AY-1.3GHZ SERIES 1608	28480	05305-60006
A8A1C1	0160-3878	6	10	CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A8A1C2	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A8A1C3	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A8A1C4	0160-0570	9	3	CAPACITOR-FXD 220PF +-20% 100VDC CER	20932	5024EM100RD221M
A8A1C5	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A8A1C6	0160-0570	9		CAPACITOR-FXD 220PF +-20% 100VDC CER	20932	5024EM100RD221M
A8A1C7	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A8A1C8	0160-0570	9		CAPACITOR-FXD 220PF +-20% 100VDC CER	20932	5024EM100RD221M
A8A1C9	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A8A1C10	0160-3876	4	1	CAPACITOR-FXD 47PF +-20% 200VDC CER	28480	0160-3876
A8A1C11	0160-2599	6	1	CAPACITOR-FXD 680PF +-10% 200VDC CER	28480	0160-2599
A8A1C12	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A8A1C13	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A8A1C14	0160-3873	1	1	CAPACITOR-FXD 4.7PF +-5PF 200VDC CER	28480	0160-3873
A8A1C15	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A8A1C16	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A8A1C17	0160-4445	5	1	CAPACITOR-FXD 1.5PF +-25PF 100VDC CER	28480	0160-4445
A8A1C18	0160-4248	6	1	CAPACITOR-FXD 1000PF +-10% 50VDC CER	26654	3BX050S102K(D)
A8A1CR1	1902-0032	3	2	DIODE-ZNR 5.49V 5% DO-35 PD=.4W	28480	1902-0032
A8A1CR2	1901-0050	3	2	DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A8A1CR3	1902-3171	7	1	DIODE-ZNR 11V 5% DO-35 PD=.4W TC=+.062%	28480	1902-3171
A8A1CR4	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A8A1CR5	1901-0639	4	4	DIODE-PIN	28480	5082-3080
A8A1CR6	1901-0639	4		DIODE-PIN	28480	5082-3080
A8A1CR7	1902-0032	3		DIODE-ZNR 5.49V 5% DO-35 PD=.4W	28480	1902-0032
A8A1CR8	1901-0639	4		DIODE-PIN	28480	5082-3080
A8A1CR9	1901-0639	4		DIODE-PIN	28480	5082-3080
A8A1CR10	1901-0179	7	3	DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A8A1CR11	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A8A1CR12	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A8A1CR13	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A8A1E1	05305-00010	6	3	CLAMP-GRNDING	28480	05305-00010
A8A1E2	05305-00010	6		CLAMP-GRNDING	28480	05305-00010
A8A1E3	05305-00010	6		CLAMP-GRNDING	28480	05305-00010
A8A1L1	9140-0144	0	2	INDUCTOR RF-CH-MLD 4.7UH 10% .105DX.26LG	28480	9140-0144
A8A1L2	9100-2265	6	1	INDUCTOR RF-CH-MLD 10UH 10% .105DX.26LG	28480	9100-2265
A8A1L3	9140-0144	0		INDUCTOR RF-CH-MLD 4.7UH 10% .105DX.26LG	28480	9140-0144
A8A1P1	1251-4249	1	10	CONTACT-CONN U/W-POST-TYPE DPSLDR	28480	1251-4249
A8A1R1	0698-6648	3	4	RESISTOR 620 5% .125W CC TC=-330/+800	01121	BB6215
A8A1R2	0698-5426	3	3	RESISTOR 10K 10% .125W CC TC=-350/+857	01121	BB1031
A8A1R3	0698-6648	3		RESISTOR 620 5% .125W CC TC=-330/+800	01121	BB6215
A8A1R4	0698-7102	6	1	RESISTOR 5.1K 5% .125W CC TC=-350/+857	01121	BB5125
A8A1R5	0698-5426	3		RESISTOR 10K 10% .125W CC TC=-350/+857	01121	BB1031
A8A1R6	0698-6648	3		RESISTOR 620 5% .125W CC TC=-330/+800	01121	BB6215
A8A1R7	0698-6648	3		RESISTOR 620 5% .125W CC TC=-330/+800	01121	BB6215
A8A1R8	0683-2265	1	1	RESISTOR 22M 5% .25W FC TC=-900/+1200	01121	CB2265
A8A1R9	0698-3378	0		RESISTOR 51 5% .125W CC TC=-270/+540	01121	BB5105
A8A1R10	0698-6984	0	1	RESISTOR 470 5% .125W CC TC=-330/+800	01121	BB4715
A8A1R11	0698-7243	6	1	RESISTOR 1.96K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1961-F
A8A1R12	0698-5426	3		RESISTOR 10K 10% .125W CC TC=-350/+857	01121	BB1031
A8A1R13	2100-1738	9	1	RESISTOR-TRMR 10K 10% C TOP-ADJ 1-TRN	73138	82PR10K
A8A1R14	0698-7288	9	4	RESISTOR 147K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1473-F
A8A1R15	0698-7288	9		RESISTOR 147K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1473-F
A8A1R16	0698-7288	9		RESISTOR 147K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1473-F
A8A1R17	0698-7288	9		RESISTOR 147K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1473-F
A8A1R18	0698-5174	8	1	RESISTOR 200 5% .125W CC TC=-330/+800	01121	BB2015
A8A1R19	0698-5177	1	1	RESISTOR 820 5% .125W CC TC=-330/+800	01121	BB8215
A8A1R20	0683-9105	2	1	RESISTOR 91 5% .25W FC TC=-400/+500	01121	CB9105

See introduction to this section for ordering information  
\*Indicates factory selected value

Table 6-7. Replaceable Parts (continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A8A1R21	0698-4132	6	1	RESISTOR 62 5% .125W CC TC=-270/+540	01121	BB6205
A8A1R22	2100-1986	9	1	RESISTOR-TRMR 1K 10% C TOP-ADJ 1-TRN	73138	82PR1K
A8A1R23	0698-3442	9	1	RESISTOR 237 1% .125W F TC=0+-100	24546	C4-1/8-T0-237R-F
A8A1R24	0698-3378	0		RESISTOR 51 5% .125W CC TC=-270/+540	01121	BB5105
A8A1R25	0811-3468	1	1	RESISTOR 240 1% .05W PwW TC=+5900+-300	28480	0811-3468
A8A1U1	1820-0223	0	1	IC OP AMP GP TO-99 PKG	3L585	CA301AT
A8A1U2	5088-7017	4	1	1.3GHZ AMP	28480	5088-7017
A8A1U3	1820-1811	4	1	IC DRVR ECL	28480	1820-1811
A8A1U4	1820-1694	1	1	IC CNTR ECL BIN	28480	1820-1694

See introduction to this section for ordering information  
\*Indicates factory selected value

Model 5328B  
Replaceable Parts

Table 6-8. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A10	05328-60020	1	1	BD AY-SYNCHRON	28480	05328-60020
A10C1	0180-0428	8	2	CAPACITOR-FXD 68UF+-20% 6VDC TA	28480	0180-0428
A10C2	0180-0428	8		CAPACITOR-FXD 68UF+-20% 6VDC TA	28480	0180-0428
A10C3	0160-2055	9	1	CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A10C4	0160-3879	7	4	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A10C5	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A10C6	0121-0059	7	1	CAPACITOR-V TRMR-CER 2-8PF 350V PC-MTG	52763	304324 2/8PF NPO
A10C7	0160-2244	8	1	CAPACITOR-FXD 3PF +- .25PF 500VDC CER	28480	0160-2244
A10C8	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A10C9	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A10CR1	1902-3036	3	1	DIODE-ZNR 3.16V 5% D0-7 PD=.4W TC=-.064%	28480	1902-3036
A10J1	1200-0548	8	3	SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0548
A10J2	1200-0548	8		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0548
A10J3	1200-0548	8		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0548
A10MP1	4040-0748	3	1	EXTR-PC BD BLK POLYC .062-BD-THKNS	28480	4040-0748
A10MP2	1480-0116	8	1	PIN-GRV .062-IN-DIA .25-IN-LG STL	28480	1480-0116
A10Q1	1854-0071	7	1	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A10R1	0683-3315	4	2	RESISTOR 330 5% .25W FC TC=-400/+600	01121	CB3315
A10R2	0683-3315	4		RESISTOR 330 5% .25W FC TC=-400/+600	01121	CB3315
A10R3	1810-0080	6	5	NETWORK-RES 8-SIP500.0 OHM X 7	28480	1810-0080
A10R4	0683-5115	6	7	RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A10R5	1810-0080	6		NETWORK-RES 8-SIP500.0 OHM X 7	28480	1810-0080
A10R6	0683-2025	1	3	RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A10R7	0683-2225	3	3	RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225
A10R8	0683-4725	2	1	RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A10R9	0683-5115	6		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A10R10	0683-3025	3	1	RESISTOR 3K 5% .25W FC TC=-400/+700	01121	CB3025
A10R11	0683-1815	5	1	RESISTOR 180 5% .25W FC TC=-400/+600	01121	CB1815
A10R12	0683-5115	6		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A10R13	0683-9115	4	2	RESISTOR 910 5% .25W FC TC=-400/+600	01121	CB9115
A10R14	1810-0080	6		NETWORK-RES 8-SIP500.0 OHM X 7	28480	1810-0080
A10R15	0683-9115	4		RESISTOR 910 5% .25W FC TC=-400/+600	01121	CB9115
A10R16	1810-0080	6		NETWORK-RES 8-SIP500.0 OHM X 7	28480	1810-0080
A10R17	0683-5115	6		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A10R18	0683-2025	1		RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A10R19				NOT ASSIGNED		
A10R20	0683-2025	1		RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A10R20	0683-5115	6		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A10R21	0683-2225	3		RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225
A10R22	1810-0080	6		NETWORK-RES 8-SIP500.0 OHM X 7	28480	1810-0080
A10R23	0683-2225	3		RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225
A10R24	0683-1035	1	2	RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A10R25	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A10R26	1810-0020	4	1	NETWORK-RES 8-SIP1.5K OHM X 7	28480	1810-0020
A10R27	0683-1025	9	1	RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A10R28	0683-5115	6		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A10R29	0683-5115	6		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A10R30	0698-7212	9	1	RESISTOR 100 1% .05W F TC=0+-100	24546	C3-1/8-T0-100R-F
A10S1	3101-1596	0	1	SWITCH-SL DPDT MINTR 1A 125VAC PC	28480	3101-1596
A10TP1	0360-0124	3	4	CONNECTOR-SGL CONT PIN .04-IN-BSC-SZ RND	28480	0360-0124
A10TP2	0360-0124	3		CONNECTOR-SGL CONT PIN .04-IN-BSC-SZ RND	28480	0360-0124
A10TP3	0360-0124	3		CONNECTOR-SGL CONT PIN .04-IN-BSC-SZ RND	28480	0360-0124
A10TP4	0360-0124	3		CONNECTOR-SGL CONT PIN .04-IN-BSC-SZ RND	28480	0360-0124
A10U1	1820-1320	0	1	IC RCVR ECL LINE RCVR TPL 2-INP	04713	MC10216L
A10U2	1820-1049	0	2	IC BFR TTL NON-INV HEX	01295	SN74367N
A10U3	1820-0802	1	5	IC GATE ECL NOR QUAD 2-INP	04713	MC10102P
A10U4	1820-0802	1		IC GATE ECL NOR QUAD 2-INP	04713	MC10102P
A10U5	1820-0802	1		IC GATE ECL NOR QUAD 2-INP	04713	MC10102P

See introduction to this section for ordering information  
\*Indicates factory selected value

Table 6-8. Replaceable Parts (continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A10U6	1820-0817	8	1	IC FF ECL D-M/S DUAL	04713	MC10131P
A10U7				NOT ASSIGNED		
A10U8	1820-0833	8	2	IC LCH TTL COM CLEAR 8-BIT	07263	9334PC
A10U9	1820-1049	0		IC BFR TTL NON-INV HEX	01295	SN74367N
A10U10	1820-0802	1		IC GATE ECL NOR QUAD 2-INP	04713	MC10102P
A10U11	1820-1359	5	1	IC MUXR/DATA-SEL ECL 4-TO-1-LINE DUAL	04713	MC10174P
A10U12	1820-0803	2	2	IC GATE ECL OR-NOR TPL	04713	MC10105P
A10U13	1820-0803	2		IC GATE ECL OR-NOR TPL	04713	MC10105P
A10U14	1820-0802	1		IC GATE ECL NOR QUAD 2-INP	04713	MC10102P
A10U15	1820-0833	8		IC LCH TTL COM CLEAR 8-BIT	07263	9334PC
A10U16	1820-1245	8	1	IC DCDR TTL LS 2-TO-4-LINE DUAL 2-INP	01295	SN74LS155N
A10U17	1820-1208	3	1	IC GATE TTL LS OR QUAD 2-INP	01295	SN74LS32N
A10W1	05328-60114	4	1	CBL AY-EXT LINE	28480	05328-60114

See introduction to this section for ordering information  
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Table 6-8. Replaceable Parts (continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A11	05328-60023	4	1	BD AY-DAC	28480	05328-60023
A11C1	0180-0374	3	2	CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A11C2	0160-3879	7	11	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A11C3	0180-2617	1	4	CAPACITOR-FXD 6.8UF+-10% 35VDC TA	25088	D6R8GS1B35K
A11C4	0180-2617	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	25088	D6R8GS1B35K
A11C5	0160-2743	2	2	CAPACITOR-FXD 33PF +-10% 200VDC CER	28480	0160-2743
A11C6	0180-0374	3		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A11C7	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A11C8	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A11C9	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A11C10	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A11C11	0160-2743	2		CAPACITOR-FXD 33PF +-10% 200VDC CER	28480	0160-2743
A11C12	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A11C13	0180-2617	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	25088	D6R8GS1B35K
A11C14	0180-2617	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	25088	D6R8GS1B35K
A11C15	0160-0572	1	1	CAPACITOR-FXD 2200PF +-20% 100VDC CER	28480	0160-0572
A11C16	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A11C17	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A11C18	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A11C19	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A11C20	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A11CR1	1901-0179	7	12	DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A11CR2	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A11CR3	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A11CR4	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A11CR5	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A11CR6	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A11CR7	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A11CR8	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A11CR9	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A11CR10	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A11CR11	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A11CR12	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A11CR13	1902-0680	7	2	DIODE-ZNR 1N827 6.2V 5% DO-7 PD=.4W	24046	1N827
A11CR14	1902-0680	7		DIODE-ZNR 1N827 6.2V 5% DO-7 PD=.4W	24046	1N827
A11CR15	1901-0040	1	2	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A11CR16	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A11J1	1200-0548	8	1	SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0548
A11MP1	4040-0748	3	1	EXTR-PC BD BLK POLYC .062-BD-THKNS	28480	4040-0748
A11MP2	1480-0116	8	1	PIN-GRV .062-IN-DIA .25-IN-LG STL	28480	1480-0116
A11Q1	1855-0081	1	2	TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0081
A11Q2	1855-0416	6	2	TRANSISTOR J-FET P-CHAN D-MODE TO-18 SI	28480	1855-0416
A11Q3	1855-0416	6		TRANSISTOR J-FET P-CHAN D-MODE TO-18 SI	28480	1855-0416
A11Q4	1855-0081	1		TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0081
A11Q5	1853-0020	4	1	TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A11Q6				NOT ASSIGNED		
A11Q7	1854-0071	7	2	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A11Q8	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A11R1	0683-6215	9	4	RESISTOR 620 5% .25W FC TC=-400/+600	01121	CB6215
A11R2	0757-0438	3	2	RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A11R3	0683-2015	9	4	RESISTOR 200 5% .25W FC TC=-400/+600	01121	CB2015
A11R4	0683-4315	6	4	RESISTOR 430 5% .25W FC TC=-400/+600	01121	CB4315
A11R5	0698-3153	9	4	RESISTOR 3.83K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3831-F
A11R6	0683-6215	9		RESISTOR 620 5% .25W FC TC=-400/+600	01121	CB6215
A11R7*	0698-3136	8		RESISTOR 17.8K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1782-F
A11R7*	0698-3136	8	6	RESISTOR 17.8K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1782-F
A11R7*	0698-3157	3	4	RESISTOR 19.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1962-F
A11R7*	0757-0199	3	4	RESISTOR 21.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2152-F
A11R7*	0757-0447	4	4	RESISTOR 16.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1622-F

See introduction to this section for ordering information  
\*Indicates factory selected value

Table 6-8. Replaceable Parts (continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number	
A11R8	0683-2015	9	4	RESISTOR 200 5% .25W FC TC=-400/+600	01121	CB2015	
A11R9	0698-3152	8		RESISTOR 3.48K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3481-F	
A11R10	0683-4315	6		RESISTOR 430 5% .25W FC TC=-400/+600	01121	CB4315	
A11R11*	0698-3136	8		RESISTOR 17.8K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1782-F	
A11R11*	0698-3157	3		RESISTOR 19.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1962-F	
A11R11*	0757-0199	3		RESISTOR 21.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2152-F	
A11R11*	0757-0447	4	RESISTOR 16.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1622-F		
A11R12	0698-3152	8	2	RESISTOR 3.48K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3481-F	
A11R13	0683-1015	7		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015	
A11R14	0698-3153	9		RESISTOR 3.83K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3831-F	
A11R15	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025	
A11R16	0683-1055	5		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055	
A11R17	2100-2705	2	4	RESISTOR-TRMR 1K 10% C SIDE-ADJ 17-TRN	32997	3009P-1-102	
A11R18	2100-2705	2		RESISTOR-TRMR 1K 10% C SIDE-ADJ 17-TRN	32997	3009P-1-102	
A11R19	0683-1035	1	2	RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035	
A11R20	2100-2503	8		RESISTOR-TRMR 20K 10% C SIDE-ADJ 17-TRN	32997	3009P-1-203	
A11R21	2100-2503	8		RESISTOR-TRMR 20K 10% C SIDE-ADJ 17-TRN	32997	3009P-1-203	
A11R22	0683-1025	9	5	RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025	
A11R23	0683-1055	5		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055	
A11R24	2100-2705	2		RESISTOR-TRMR 1K 10% C SIDE-ADJ 17-TRN	32997	3009P-1-102	
A11R25	0683-1015	7		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015	
A11R26	2100-2705	2		RESISTOR-TRMR 1K 10% C SIDE-ADJ 17-TRN	32997	3009P-1-102	
A11R27	0698-3152	8		RESISTOR 3.48K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3481-F	
A11R28*	0698-3136	8	3	RESISTOR 17.8K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1782-F	
A11R28*	0698-3157	3		RESISTOR 19.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1962-F	
A11R28*	0757-0199	3		RESISTOR 21.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2152-F	
A11R28*	0757-0447	4		RESISTOR 16.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1622-F	
A11R29	0698-3153	9		RESISTOR 3.83K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3831-F	
A11R30	0698-3152	8	6	RESISTOR 3.48K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3481-F	
A11R31	0683-4315	6		RESISTOR 430 5% .25W FC TC=-400/+600	01121	CB4315	
A11R32	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F	
A11R33	0698-3136	8		RESISTOR 17.8K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1782-F	
A11R33*	0698-3136	8		RESISTOR 17.8K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1782-F	
A11R33*	0698-3157	3		RESISTOR 19.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1962-F	
A11R33*	0757-0199	3		RESISTOR 21.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2152-F	
A11R33*	0757-0447	4		RESISTOR 16.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1622-F	
A11R34	0683-2015	9		RESISTOR 200 5% .25W FC TC=-400/+600	01121	CB2015	
A11R35	0698-3153	9		RESISTOR 3.83K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3831-F	
A11R36	0683-6215	9		RESISTOR 620 5% .25W FC TC=-400/+600	01121	CB6215	
A11R37	0683-4315	6		RESISTOR 430 5% .25W FC TC=-400/+600	01121	CB4315	
A11R38	0683-2015	9		RESISTOR 200 5% .25W FC TC=-400/+600	01121	CB2015	
A11R39	0683-6215	9		RESISTOR 620 5% .25W FC TC=-400/+600	01121	CB6215	
A11R40			NOT ASSIGNED				
A11R41	0757-0924	2	1	RESISTOR 1K 2% .125W F TC=0+-100	24546	C4-1/8-T0-1001-G	
A11R42	0683-1525	4		RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	CB1525	
A11R43	0683-1525	4		RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	CB1525	
A11R44	0757-0421	4	2	RESISTOR 825 1% .125W F TC=0+-100	24546	C4-1/8-T0-825R-F	
A11R45	0683-1045	3		RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045	
A11R46	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025	
A11R47	0757-0421	4		RESISTOR 825 1% .125W F TC=0+-100	24546	C4-1/8-T0-825R-F	
A11R48	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025	
A11R49	1810-0055	5	1	NETWORK-RES 9-SIP10.0K OHM X 8	28480	1810-0055	
A11R50	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025	
A11R51	0683-2055	7		RESISTOR 2M 5% .25W FC TC=-900/+1100	01121	CB2055	
A11R52	0683-2055	7		RESISTOR 2M 5% .25W FC TC=-900/+1100	01121	CB2055	
A11R53*	0683-1225	1		RESISTOR 1.2K 5% .25W FC TC=-400/+700	01121	CB1225	
A11R53*	0683-1525	4		RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	CB1525	
A11R53*	0683-1625	5		RESISTOR 1.6K 5% .25W FC TC=-400/+700	01121	CB1625	
A11R53*	0683-1825	7		RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825	
A11TP1	0360-0124	3		6	CONNECTOR-SGL CONT PIN .04-IN-BSC-SZ RND	28480	0360-0124
A11TP2	0360-0124	3			CONNECTOR-SGL CONT PIN .04-IN-BSC-SZ RND	28480	0360-0124
A11TP3	0360-0124	3	CONNECTOR-SGL CONT PIN .04-IN-BSC-SZ RND		28480	0360-0124	
A11TP4	0360-0124	3	CONNECTOR-SGL CONT PIN .04-IN-BSC-SZ RND		28480	0360-0124	
A11TP5	0360-0124	3	CONNECTOR-SGL CONT PIN .04-IN-BSC-SZ RND		28480	0360-0124	
A11TP6	0360-0124	3	CONNECTOR-SGL CONT PIN .04-IN-BSC-SZ RND		28480	0360-0124	

See introduction to this section for ordering information  
\*Indicates factory selected value

Model 5328B  
Replaceable Parts

Table 6-8. Replaceable Parts (continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A11U1	1826-0059	2	2	IC OP AMP GP T0-99 PKG	01295	LM201AL
A11U2	1820-0693	8	1	IC FF TTL S D-TYPE POS-EDGE-TRIG	01295	SN74S74N
A11U3	1826-0161	7	2	IC OP AMP GP QUAD 14-DIP-P PKG	04713	MLM324P
A11U4	1826-0059	2		IC OP AMP GP T0-99 PKG	01295	LM201AL
A11U5	1820-3475	0	1	IC SCHMITT-TRIG TTL LS NAND QUAD 2-INP	28480	1820-3475
A11U6	1826-0161	7		IC OP AMP GP QUAD 14-DIP-P PKG	04713	MLM324P
A11U7	1820-0976	0	4	IC SHF-RGTR CMOS D-TYPE SERIAL-IN	3L585	CD4015BE
A11U8	1820-1265	2	6	IC MULTR CMOS	04713	MC14527BCP
A11U9	1820-1265	2		IC MULTR CMOS	04713	MC14527BCP
A11U10	1820-1265	2		IC MULTR CMOS	04713	MC14527BCP
A11U11				NOT ASSIGNED		
A11U12	1820-1265	2		IC MULTR CMOS	04713	MC14527BCP
A11U13	1820-1265	2		IC MULTR CMOS	04713	MC14527BCP
A11U14	1820-1265	2		IC MULTR CMOS	04713	MC14527BCP
A11U15	1820-0976	0		IC SHF-RGTR CMOS D-TYPE SERIAL-IN	3L585	CD4015BE
A11U16	1820-0976	0		IC SHF-RGTR CMOS D-TYPE SERIAL-IN	3L585	CD4015BE
A11U17				NOT ASSIGNED		
A11U76	1820-0976	0		IC SHF-RGTR CMOS D-TYPE SERIAL-IN	3L585	CD4015BE
A11U77						

See introduction to this section for ordering information  
\*Indicates factory selected value

Table 6-8. Replaceable Parts (continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A12	05328-60041	6	1	BD AY-AMPLIFIER	28480	05328-60041
A12C1	0160-3879	7	17	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C2	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C3	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C4	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C5	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C6	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C7	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C8	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C9	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C10	0160-0128	3	2	CAPACITOR-FXD 2.2UF +-20% 50VDC CER	28480	0160-0128
A12C11	0160-0128	3		CAPACITOR-FXD 2.2UF +-20% 50VDC CER	28480	0160-0128
A12C12	0160-0428	8	5	CAPACITOR-FXD 68UF+-20% 6VDC TA	28480	0160-0428
A12C13	0160-0428	8		CAPACITOR-FXD 68UF+-20% 6VDC TA	28480	0160-0428
A12C14	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C15	0160-0576	5	2	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A12C16	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A12C17	0160-0415	3	2	CAPACITOR-FXD 10UF+-20% 25VDC TA	28480	0160-0415
A12C18	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C19	0160-0415	3		CAPACITOR-FXD 10UF+-20% 25VDC TA	28480	0160-0415
A12C20	0160-0428	8		CAPACITOR-FXD 68UF+-20% 6VDC TA	28480	0160-0428
A12C21	0160-0428	8		CAPACITOR-FXD 68UF+-20% 6VDC TA	28480	0160-0428
A12C22	0160-4423	9	4	CAPACITOR-FXD 470PF +-20% 500VDC CER	51642	200-500-X7R-471M
A12C23	0160-4423	9		CAPACITOR-FXD 470PF +-20% 500VDC CER	51642	200-500-X7R-471M
A12C24	0160-4423	9		CAPACITOR-FXD 470PF +-20% 500VDC CER	51642	200-500-X7R-471M
A12C25	0160-4423	9		CAPACITOR-FXD 470PF +-20% 500VDC CER	51642	200-500-X7R-471M
A12C26*	0150-0059	8	2	CAPACITOR-FXD 3.3PF +- .25PF 500VDC CER	28480	0150-0059
A12C26*	0160-2242	6	1	CAPACITOR-FXD 2.4PF +- .25PF 500VDC CER	28480	0160-2242
A12C26*	0160-2244	8	1	CAPACITOR-FXD 3PF +- .25PF 500VDC CER	28480	0160-2244
A12C26*	0160-2249	3	1	CAPACITOR-FXD 4.7PF +- .25PF 500VDC CER	28480	0160-2249
A12C26*	0160-2255	1	2	CAPACITOR-FXD 8.2PF +- .25PF 500VDC CER	28480	0160-2255
A12C27				NOT ASSIGNED		
A12C28				NOT ASSIGNED		
A12C29*	0150-0059	8		CAPACITOR-FXD 3.3PF +- .25PF 500VDC CER	28480	0150-0059
A12C29*	0160-2246	0	1	CAPACITOR-FXD 3.6PF +- .25PF 500VDC CER	28480	0160-2246
A12C29*	0160-2247	1	1	CAPACITOR-FXD 3.9PF +- .25PF 500VDC CER	28480	0160-2247
A12C29*	0160-2252	8	1	CAPACITOR-FXD 6.2PF +- .25PF 500VDC CER	28480	0160-2252
A12C29*	0160-2255	1		CAPACITOR-FXD 8.2PF +- .25PF 500VDC CER	28480	0160-2255
A12C30	0160-4424	0	2	CAPACITOR-FXD .047UF +-20% 500VDC CER	51642	400-500-X7R-473M
A12C31	0160-4424	0		CAPACITOR-FXD .047UF +-20% 500VDC CER	51642	400-500-X7R-473M
A12C32	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C33				NOT ASSIGNED		
A12C34	0160-0428	8		CAPACITOR-FXD 68UF+-20% 6VDC TA	28480	0160-0428
A12C35				NOT ASSIGNED		
A12C36				NOT ASSIGNED		
A12C37	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C38	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C39	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C40	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C41	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12CR1	1902-3082	9	3	DIODE-ZNR 4.64V 5% DO-35 PD=.4W	28480	1902-3082
A12CR2	1901-0040	1	10	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A12CR3	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A12CR4	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A12CR5	1901-0376	6	4	DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A12CR6	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A12CR7	1902-3048	7	2	DIODE-ZNR 3.48V 5% DO-35 PD=.4W	28480	1902-3048
A12CR8	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A12CR9	1902-3048	7		DIODE-ZNR 3.48V 5% DO-35 PD=.4W	28480	1902-3048
A12CR10	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376

See introduction to this section for ordering information  
\*Indicates factory selected value



Table 6-8. Replaceable Parts (continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A12CR11	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS D0-35	28480	1901-0040
A12CR12	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS D0-35	28480	1901-0040
A12CR13	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS D0-35	28480	1901-0040
A12CR14	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS D0-35	28480	1901-0040
A12CR15	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS D0-35	28480	1901-0040
A12CR16	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS D0-35	28480	1901-0040
A12CR17	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS D0-35	28480	1901-0040
A12CR18	1902-3082	9		DIODE-ZNR 4.64V 5% D0-35 PD=.4W	28480	1902-3082
A12CR19	1902-3082	9		DIODE-ZNR 4.64V 5% D0-35 PD=.4W	28480	1902-3082
A12J1	1200-0548	8	1	SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0548
A12K1	0490-0642	5	1	RELAY-REED 2C 500MA 28VDC 5VDC-COIL 3VA	28480	0490-0642
A12K2	0490-1175	1	7	RELAY-REED 1A 500MA 100VDC 5VDC-COIL	28480	0490-1175
A12K3	0490-1183	1	3	RELAY-REED 1B 500MA 100VDC 5VDC-COIL	28480	0490-1183
A12K4	0490-1175	1		RELAY-REED 1A 500MA 100VDC 5VDC-COIL	28480	0490-1175
A12K4	05328-80041	8	1	RELAY-SHIELDED	28480	05328-80041
A12K5	0490-1183	1		RELAY-REED 1B 500MA 100VDC 5VDC-COIL	28480	0490-1183
A12K6	0490-1175	1		RELAY-REED 1A 500MA 100VDC 5VDC-COIL	28480	0490-1175
A12K7	0490-1175	1		RELAY-REED 1A 500MA 100VDC 5VDC-COIL	28480	0490-1175
A12K8	0490-1175	1		RELAY-REED 1A 500MA 100VDC 5VDC-COIL	28480	0490-1175
A12K9	0490-1175	1		RELAY-REED 1A 500MA 100VDC 5VDC-COIL	28480	0490-1175
A12K10	0490-1175	1		RELAY-REED 1A 500MA 100VDC 5VDC-COIL	28480	0490-1175
A12K11	0490-1183	1		RELAY-REED 1B 500MA 100VDC 5VDC-COIL	28480	0490-1183
A12L1	9100-2288	3	2	INDUCTOR RF-CH-MLD 1MH 10% .105DX.26LG	28480	9100-2288
A12L2	9100-2288	3		INDUCTOR RF-CH-MLD 1MH 10% .105DX.26LG	28480	9100-2288
A12L3	9140-0178	0	2	INDUCTOR RF-CH-MLD 12UH 10% .166DX.385LG	28480	9140-0178
A12L4	9140-0178	0		INDUCTOR RF-CH-MLD 12UH 10% .166DX.385LG	28480	9140-0178
A12MP1	4040-0748	3	1	EXTR-PC BD BLK POLYC .062-BD-THKNS	28480	4040-0748
A12MP2	1480-0116	8	1	PIN-GRV .062-IN-DIA .25-IN-LG STL	28480	1480-0116
A12Q1	1854-0071	7	2	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A12Q2	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A12Q3	1855-0213	1	2	TRANSISTOR-JFET DUAL N-CHAN D-MODE T0-78	28480	1855-0213
A12Q4	1855-0213	1		TRANSISTOR-JFET DUAL N-CHAN D-MODE T0-78	28480	1855-0213
A12R1	0698-7260	7	2	RESISTOR 10K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1002-F
A12R2	0698-7260	7		RESISTOR 10K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1002-F
A12R3	1810-0080	6	1	NETWORK-RES 8-SIP500.0 OHM X 7	28480	1810-0080
A12R4	0683-3925	2	2	RESISTOR 3.9K 5% .25W FC TC=-400/+700	01121	CB3925
A12R5	0698-7252	7	2	RESISTOR 4.64K 1% .05W F TC=0+-100	24546	C3-1/8-T0-4641-F
A12R6	0683-3925	2		RESISTOR 3.9K 5% .25W FC TC=-400/+700	01121	CB3925
A12R7	0757-0199	3	1	RESISTOR 21.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2152-F
A12R8	0698-7252	7		RESISTOR 4.64K 1% .05W F TC=0+-100	24546	C3-1/8-T0-4641-F
A12R9	0683-8215	3	2	RESISTOR 820 5% .25W FC TC=-400/+600	01121	CB8215
A12R10	0683-8215	3		RESISTOR 820 5% .25W FC TC=-400/+600	01121	CB8215
A12R11	0698-7236	7	2	RESISTOR 1K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1001-F
A12R12	0683-1025	9	1	RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A12R13	0698-7236	7		RESISTOR 1K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1001-F
A12R14	0683-1035	1	4	RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A12R15	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A12R16	0683-5115	6	4	RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A12R17	0683-5115	6		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A12R18	0683-2215	1	2	RESISTOR 220 5% .25W FC TC=-400/+600	01121	CB2215
A12R19	0683-2215	1		RESISTOR 220 5% .25W FC TC=-400/+600	01121	CB2215
A12R20	0683-1005	5	2	RESISTOR 10 5% .25W FC TC=-400/+500	01121	CB1005
A12R21	0683-1005	5		RESISTOR 10 5% .25W FC TC=-400/+500	01121	CB1005
A12R22	0683-2025	1	1	RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A12R23	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A12R24	0683-2225	3	1	RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225
A12R25	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A12R26	2100-2632	4	2	RESISTOR-TRMR 100 10% C SIDE-ADJ 1-TRN	30983	ET50X101
A12R27	0698-7229	8	2	RESISTOR 511 1% .05W F TC=0+-100	24546	C3-1/8-T0-511R-F
A12R28	2100-2632	4		RESISTOR-TRMR 100 10% C SIDE-ADJ 1-TRN	30983	ET50X101
A12R29	0698-7230	1	4	RESISTOR 562 1% .05W F TC=0+-100	24546	C3-1/8-T0-562R-F
A12R30	0698-7230	1		RESISTOR 562 1% .05W F TC=0+-100	24546	C3-1/8-T0-562R-F

See introduction to this section for ordering information  
\*Indicates factory selected value

Table 6-8. Replaceable Parts (continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A12R31	0698-7229	8		RESISTOR 511 1% .05W F TC=0+-100	24546	C3-1/8-T0-511R-F
A12R32	0698-7230	1		RESISTOR 562 1% .05W F TC=0+-100	24546	C3-1/8-T0-562R-F
A12R33	0683-5115	6		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A12R34	0698-7188	8	2	RESISTOR 10 1% .05W F TC=0+-100	24546	C3-1/8-T0-10R-F
A12R35	0698-7230	1		RESISTOR 562 1% .05W F TC=0+-100	24546	C3-1/8-T0-562R-F
A12R36	0698-7188	8		RESISTOR 10 1% .05W F TC=0+-100	24546	C3-1/8-T0-10R-F
A12R37	0683-1055	5	4	RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A12R38	0683-1055	5		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A12R39	0683-1055	5		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A12R40	0683-5115	6		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A12R41	0683-1055	5		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A12R42	0698-6400	5	2	RESISTOR 900K 1% .25W F TC=0+-100	19701	MF52C1/4-T0-9003-F
A12R43	0757-0465	6	2	RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A12R44	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A12R45	0698-6400	5		RESISTOR 900K 1% .25W F TC=0+-100	19701	MF52C1/4-T0-9003-F
A12R46	0757-1000	7	2	RESISTOR 51.1 1% .5W F TC=0+-100	28480	0757-1000
A12R47	0757-1000	7		RESISTOR 51.1 1% .5W F TC=0+-100	28480	0757-1000
A12R48	0757-0931	1	2	RESISTOR 2K 2% .125W F TC=0+-100	24546	C4-1/8-T0-2001-G
A12R49	0757-0900	4	2	RESISTOR 100 2% .125W F TC=0+-100	24546	C4-1/8-T0-101-G
A12R50	0757-0931	1		RESISTOR 2K 2% .125W F TC=0+-100	24546	C4-1/8-T0-2001-G
A12R51	0757-0900	4		RESISTOR 100 2% .125W F TC=0+-100	24546	C4-1/8-T0-101-G
A12R52	0698-5218	1	2	RESISTOR 30K .5% .125W F TC=0+-100	24546	C4-1/8-T0-3002-D
A12R53*	0683-1015	7	2	RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A12R54				NOT ASSIGNED		
A12R55				NOT ASSIGNED		
A12R56	0698-5218	1		RESISTOR 30K .5% .125W F TC=0+-100	24546	C4-1/8-T0-3002-D
A12R57*	0683-1015	7		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A12R58	0757-0279	0	1	RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A12U1	1820-0577	7	2	IC INV TTL HEX 1-INP	01295	SN7416N
A12U2	1820-0805	4	1	IC GATE ECL EXCL-OR/NOR TPL 2-INP	04713	MC10107P
A12U3	1820-0577	7		IC INV TTL HEX 1-INP	01295	SN7416N
A12U4	1826-0426	7	1	IC COMPARATOR HS DUAL 16-DIP-C PKG	34335	AM687ADL
A12W1	05328-60111	1	2	CBL AY-RF A & B IN	28480	05328-60111
A12W2	05328-60111	1		CBL AY-RF A & B IN	28480	05328-60111

See introduction to this section for ordering information  
\*Indicates factory selected value

Table 6-8. Replaceable Parts (continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A14	05328-60010	9	1	BD AY-MULTIPLIER	28480	05328-60010
A14C1	0160-3878	6	6	CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A14C2	0170-0066	9	1	CAPACITOR-FXD .027UF +-10% 200VDC POLYE	28480	0170-0066
A14C3	0160-0161	4	1	CAPACITOR-FXD .01UF +-10% 200VDC POLYE	28480	0160-0161
A14C4	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A14C5	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A14C6	0180-1714	7	1	CAPACITOR-FXD 330UF+-10% 6VDC TA	56289	150D337X9006S2
A14C7	0160-4084	8	4	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A14C8	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A14C9	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A14C10	0180-0210	6	7	CAPACITOR-FXD 3.3UF+-20% 15VDC TA	56289	150D335X0015A2
A14C11	0180-0210	6		CAPACITOR-FXD 3.3UF+-20% 15VDC TA	56289	150D335X0015A2
A14C12	0160-2055	9	4	CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A14C13	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A14C14	0180-0210	6		CAPACITOR-FXD 3.3UF+-20% 15VDC TA	56289	150D335X0015A2
A14C15	0180-0210	6		CAPACITOR-FXD 3.3UF+-20% 15VDC TA	56289	150D335X0015A2
A14C16	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A14C17	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A14C18	0121-0437	5		CAPACITOR-V TRMR-CER 10-60PF 250V PC-MTG	28480	0121-0437
A14C19*	0140-0191	8	1	CAPACITOR-FXD 56PF +-5% 300VDC MICA	72136	DM15E560J0300WV1CR
A14C20	0160-4084	8		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A14C21	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A14C22	0140-0149	6	1	CAPACITOR-FXD 470PF +-5% 300VDC MICA	72136	DM15F471J0300WV1CR
A14C23	0121-0437	5		CAPACITOR-V TRMR-CER 10-60PF 250V PC-MTG	28480	0121-0437
A14C24	0180-0210	6		CAPACITOR-FXD 3.3UF+-20% 15VDC TA	56289	150D335X0015A2
A14C25				NOT ASSIGNED		
A14C26	0180-0210	6		CAPACITOR-FXD 3.3UF+-20% 15VDC TA	56289	150D335X0015A2
A14C27	0140-0192	9	1	CAPACITOR-FXD 68PF +-5% 300VDC MICA	72136	DM15E680J0300WV1CR
A14C28				NOT ASSIGNED		
A14C29	0180-0210	6		CAPACITOR-FXD 3.3UF+-20% 15VDC TA	56289	150D335X0015A2
A14C30	0160-4084	8		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A14C31				NOT ASSIGNED		
A14C32	0160-4084	8		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A14CR1	0122-0299	9	1	DIODE-VVC 82PF 5% C2/C20-MIN=2 BVR=20V	28480	0122-0299
A14CR2	0122-0015	7	1	DIODE-VVC 150PF 10% D0-14 Q=1750-MIN	28480	0122-0015
A14CR3	1902-1293	0	1	DIODE-ZNR 10V 10% D0-7 PD=.4u	28480	1902-1293
A14L1	9100-2204	3	1	INDUCTOR RF-CH-MLD 60NH 10% .095DX.25LG	28480	9100-2204
A14L2*	9100-2259	8	1	INDUCTOR RF-CH-MLD 1.5UH 10% .105DX.26LG	28480	9100-2259
A14MP1	4040-0752	9	1	EXTR-PC BD YEL POLYC .062-BD-THKNS	28480	4040-0752
A14MP2	1480-0116	8	1	PIN-GRV .062-IN-DIA .25-IN-LG STL	28480	1480-0116
A14Q1	1854-0092	2	2	TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A14Q2	1854-0092	2		TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A14Q3	1853-0016	8	1	TRANSISTOR PNP SI T0-92 PD=300MW	28480	1853-0016
A14Q4	1854-0071	7	1	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A14R1				NOT ASSIGNED		
A14R2				NOT ASSIGNED		
A14R3	0683-1025	9	4	RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A14R4	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A14R5	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A14R6	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A14R7	0683-5135	0	2	RESISTOR 51K 5% .25W FC TC=-400/+800	01121	CB5135
A14R8	0683-0475	1	1	RESISTOR 4.7 5% .25W FC TC=-400/+500	01121	CB475
A14R9	0683-6815	5	1	RESISTOR 680 5% .25W FC TC=-400/+600	01121	CB6815
A14R10	0683-3915	0	1	RESISTOR 390 5% .25W FC TC=-400/+600	01121	CB3915
A14R11	0683-8225	5	2	RESISTOR 8.2K 5% .25W FC TC=-400/+700	01121	CB8225
A14R12	0683-5115	6	3	RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A14R13	0683-2715	6	1	RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A14R14	0683-3335	8	1	RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A14R15	0683-5125	8	1	RESISTOR 5.1K 5% .25W FC TC=-400/+700	01121	CB5125

See introduction to this section for ordering information  
\*Indicates factory selected value

Table 6-8. Replaceable Parts (continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A14R16	0683-5115	6	1	RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A14R17	0683-3935	4		RESISTOR 39K 5% .25W FC TC=-400/+800	01121	CB3935
A14R18	0683-5115	6		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A14R19	0683-5135	0		RESISTOR 51K 5% .25W FC TC=-400/+800	01121	CB5135
A14R20	0683-2745	2		RESISTOR 270K 5% .25W FC TC=-800/+900	01121	CB2745
A14R21	0683-1045	3	2	RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A14R22	0683-1045	3		RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A14R23	0683-1135	2		RESISTOR 11K 5% .25W FC TC=-400/+800	01121	CB1135
A14R24- A14R27				NOT ASSIGNED		
A14R28	2100-2522	1	1	RESISTOR-TRMR 10K 10% C SIDE-ADJ 1-TRN	30983	ET50X103
A14R29	0683-8225	5		RESISTOR 8.2K 5% .25W FC TC=-400/+700	01121	CB8225
A14R30	0683-2725	8		RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A14R31	0683-1135	2		RESISTOR 11K 5% .25W FC TC=-400/+800	01121	CB1135
A14R32	0683-4745	6		RESISTOR 470K 5% .25W FC TC=-800/+900	01121	CB4745
A14R33	0683-1535	6	1	RESISTOR 15K 5% .25W FC TC=-400/+800	01121	CB1535
A14R34	1810-0080	6		NETWORK-RES 8-SIP500.0 OHM X 7	28480	1810-0080
A14TP1	0360-0124	3	8	CONNECTOR-SGL CONT PIN .04-IN-BSC-SZ RND	28480	0360-0124
A14TP2	0360-0124	3		CONNECTOR-SGL CONT PIN .04-IN-BSC-SZ RND	28480	0360-0124
A14TP3	0360-0124	3		CONNECTOR-SGL CONT PIN .04-IN-BSC-SZ RND	28480	0360-0124
A14TP4	0360-0124	3		CONNECTOR-SGL CONT PIN .04-IN-BSC-SZ RND	28480	0360-0124
A14TP5	0360-0124	3		CONNECTOR-SGL CONT PIN .04-IN-BSC-SZ RND	28480	0360-0124
A14TP6	0360-0124	3	3	CONNECTOR-SGL CONT PIN .04-IN-BSC-SZ RND	28480	0360-0124
A14TP7	0360-0124	3		CONNECTOR-SGL CONT PIN .04-IN-BSC-SZ RND	28480	0360-0124
A14TP8	0360-0124	3		CONNECTOR-SGL CONT PIN .04-IN-BSC-SZ RND	28480	0360-0124
A14U1	1820-1383	5	1	IC CNTR ECL BCD POS-EDGE-TRIG	04713	MC10138L
A14U2	1820-0810	1		IC RCVR ECL LINE RCVR TPL 2-INP	04713	MC10116F
A14U3	1820-1119	5		IC OSC ECL	04713	MC1648L
A14U4	1820-0630	3		IC MISC TTL	04713	MC4044P
A14U5	1820-0054	5		IC GATE TTL NAND QUAD 2-INP	01295	SN7400N
A14U6	1820-0493	6	2	IC OP AMP GP 8-DIP-P PKG	27014	LM307N
A14U7	1820-0493	6		IC OP AMP GP 8-DIP-P PKG	27014	LM307N

See introduction to this section for ordering information  
\*Indicates factory selected value

Model 5328B  
Replaceable Parts

Table 6-8. Replaceable Parts (continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A19	05328-60021	2	1	BD AY-SWITCH	28480	05328-60021
A19C1	0180-0106	9	1	CAPACITOR-FXD 60UF+-20% 6VDC TA	56289	150D606X0006B2
A19C2	0160-3879	7	6	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A19C3	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A19C4	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A19C5	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A19C6	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A19C7	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A19C8	0180-1746	5	2	CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A19C9	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A19CR1				NOT ASSIGNED		
A19CR2	1901-0040	1	14	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A19CR3	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A19CR4	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A19CR5	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A19CR6	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A19CR7	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A19CR8	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A19CR9	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A19CR10	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A19CR11	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A19CR12	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A19CR13	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A19CR14	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A19CR15	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A19DS1	1990-0485	5	2	LED-LAMP LUM-INT=800UCD IF=30MA-MAX	28480	5082-4984
A19DS2	1990-0486	6	1	LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	5082-4684
A19DS3	1990-0485	5		LED-LAMP LUM-INT=800UCD IF=30MA-MAX	28480	5082-4984
A19J1	1251-2034	8	1	CONNECTOR-PC EDGE 10-CONT/ROW 2-ROWS	28480	1251-2034
A19J2	1250-1163	0	2	CONNECTOR-RF BNC FEM SGL-HOLE-RR 50-OHM	28480	1250-1163
A19J3	1251-1626	2	1	CONNECTOR-PC EDGE 12-CONT/ROW 2-ROWS	28480	1251-1626
A19J4	1250-1163	0		CONNECTOR-RF BNC FEM SGL-HOLE-RR 50-OHM	28480	1250-1163
A19MP1	2190-0060	7	2	WASHER-LK INTL T 1/4 IN .256-IN-ID	28480	2190-0060
A19MP2	2190-0060	7		WASHER-LK INTL T 1/4 IN .256-IN-ID	28480	2190-0060
A19MP3	2950-0072	3	2	NUT-HEX-DBL-CHAM 1/4-32-THD .062-IN-THK	00000	ORDER BY DESCRIPTION
A19MP4	2950-0072	3		NUT-HEX-DBL-CHAM 1/4-32-THD .062-IN-THK	00000	ORDER BY DESCRIPTION
A19R1	2100-3516	5	2	RESISTOR-VAR W/SW 10K 20% LIN SPST-NO	01121	WRS46056S103M
A19R2	0683-1035	1	9	RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A19R3	0683-2225	3	1	RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225
A19R4	0683-2025	1	3	RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A19R5	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A19R6				NOT ASSIGNED		
A19R7	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A19R8	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A19R9	0683-5115	6	1	RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A19R10	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A19R11	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A19R12	0683-3315	4	3	RESISTOR 330 5% .25W FC TC=-400/+600	01121	CB3315
A19R13	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A19R14	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A19R15	0683-2025	1		RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A19R16	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A19R17	0683-1525	4	4	RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	CB1525
A19R18	0683-2715	6	2	RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A19R19	0683-2715	6		RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A19R20	0683-1525	4		RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	CB1525
A19R21	0683-6815	5	2	RESISTOR 680 5% .25W FC TC=-400/+600	01121	CB6815
A19R22	0683-1525	4		RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	CB1525
A19R23	0683-3315	4		RESISTOR 330 5% .25W FC TC=-400/+600	01121	CB3315
A19R24	0683-3315	4		RESISTOR 330 5% .25W FC TC=-400/+600	01121	CB3315
A19R25	0683-2025	1		RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025

See introduction to this section for ordering information  
\*Indicates factory selected value

Table 6-8. Replaceable Parts (continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A19R26	0683-1525	4		RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	CB1525
A19R27	0683-6815	5		RESISTOR 680 5% .25W FC TC=-400/+600	01121	CB6815
A19R28	2100-3516	5		RESISTOR-VAR W/SW 10K 20% LIN SPST-NO	01121	WRS4G056S103M
A19R29	0698-8072	1	2	RESISTOR 39K 5% .125W CC TC=-466/+875	01121	BB3935
A19R30	0698-8072	1		RESISTOR 39K 5% .125W CC TC=-466/+875	01121	BB3935
A19S1	3101-2334	6	7	SWITCH-SL DPDT SUBMIN .5A 125VAC/DC PC	28480	3101-2334
A19S2	3101-2334	6		SWITCH-SL DPDT SUBMIN .5A 125VAC/DC PC	28480	3101-2334
A19S3	3101-2334	6		SWITCH-SL DPDT SUBMIN .5A 125VAC/DC PC	28480	3101-2334
A19S4	3101-1313	9	1	SWITCH-SL DP3T MINTR .5A 125VAC/DC PC	28480	3101-1313
A19S5	3101-2334	6		SWITCH-SL DPDT SUBMIN .5A 125VAC/DC PC	28480	3101-2334
A19S6	3101-2334	6		SWITCH-SL DPDT SUBMIN .5A 125VAC/DC PC	28480	3101-2334
A19S7	3101-2334	6		SWITCH-SL DPDT SUBMIN .5A 125VAC/DC PC	28480	3101-2334
A19S8	3101-2334	6		SWITCH-SL DPDT SUBMIN .5A 125VAC/DC PC	28480	3101-2334
A19TP1	0360-0124	3	1	CONNECTOR-SGL CONT PIN .04-IN-BSC-SZ RND	28480	0360-0124
A19U1	1820-1052	5	1	IC XLTR ECL ECL-T0-TTL QUAD 2-INP	04713	MC10125L
	05328-40004	9	3	SPACER-LED SHT	28480	05328-40004

See introduction to this section for ordering information  
\*Indicates factory selected value

Table 6-9. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A15	05328-60043	8	1	BD AY-HP IB	28480	05328-60043
A15C1	0160-2453	1	1	CAPACITOR-FXD .22UF +-10% 80VDC POLYE	28480	0160-2453
A15C2	0170-0040	9	1	CAPACITOR-FXD .047UF +-10% 200VDC POLYE	56289	292P47392
A15C3				NOT ASSIGNED		
A15C4	0160-0154	5	1	CAPACITOR-FXD 2200PF +-10% 200VDC POLYE	28480	0160-0154
A15C5	0160-0161	4		CAPACITOR-FXD .01UF +-10% 200VDC POLYE	28480	0160-0161
A15C6	0170-0024	9		CAPACITOR-FXD .022UF +-20% 200VDC POLYE	28480	0170-0024
A15C7	0180-0229	7	2	CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2
A15C8	0180-0229	7		CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2
A15C9	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A15C10	0160-3878	6	1	CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A15CR1	1901-0999	9		DIODE-SCHOTTKY 20V 10NS DO-35	28480	1901-0999
A15CR2	1901-0999	9		DIODE-SCHOTTKY 20V 10NS DO-35	28480	1901-0999
A15CR3	1901-0999	9		DIODE-SCHOTTKY 20V 10NS DO-35	28480	1901-0999
A15CR4	1901-0999	9		DIODE-SCHOTTKY 20V 10NS DO-35	28480	1901-0999
A15CR5	1901-0999	9		DIODE-SCHOTTKY 20V 10NS DO-35	28480	1901-0999
A15CR6	1901-0999	9		DIODE-SCHOTTKY 20V 10NS DO-35	28480	1901-0999
A15J1A	1200-0485	2	2	SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0485
A15J1B	1200-0485	2		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0485
A15J2-				NOT ASSIGNED		
A15J4				SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0548
A15J5	1200-0548	8	1	SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0548
A15J6	1251-3283	1	1	CONNECTOR 24-PIN F MICRORIBBON	28480	1251-3283
A15MP1	1400-0531	3	2	CLAMP-CABLE .13-DIA .375-WD ABS	28480	1400-0531
A15MP2	1400-0531	3		CLAMP-CABLE .13-DIA .375-WD ABS	28480	1400-0531
A15MP3	0380-0643	3	3	STANDOFF-HEX .255-IN-LG 6-32THD	00000	ORDER BY DESCRIPTION
A15MP4	0380-0643	3		STANDOFF-HEX .255-IN-LG 6-32THD	00000	ORDER BY DESCRIPTION
A15MP5				NOT ASSIGNED		
A15MP6	1530-1098	4	2	CLEVIS 0.070-IN W SLT: 0.454-IN PIN CTR	00000	ORDER BY DESCRIPTION
A15MP7	1530-1098	4		CLEVIS 0.070-IN W SLT: 0.454-IN PIN CTR	00000	ORDER BY DESCRIPTION
A15Q1	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A15Q2	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A15Q3	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A15Q4	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A15Q5	1853-0036	2		TRANSISTOR PNP SI PD=310MW FT=250MHZ	28480	1853-0036
A15R1	0683-3035	5		RESISTOR 30K 5% .25W FC TC=-400/+800	01121	CB3035
A15R2	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A15R3	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A15R4	0683-2715	6		RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A15R5				NOT ASSIGNED		
A15R6				NOT ASSIGNED		
A15R7	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A15R8	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A15R9	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A15R10	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A15R11	0757-0446	3	1	RESISTOR 15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1502-F
A15R12	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A15R13	0683-2715	6		RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A15R14	0683-2715	6		RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A15R15	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A15R16	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A15R17	0683-1535	6	1	RESISTOR 15K 5% .25W FC TC=-400/+800	01121	CB1535
A15R18	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A15R19	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A15R20	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A15R21	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A15R22	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A15R23	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A15R24	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A15R25	0683-2725	8		RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725

See introduction to this section for ordering information  
\*Indicates factory selected value

Table 6-9. Replaceable Parts (continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A15R26	0683-2025	1	1	RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A15R27	0683-3025	3	1	RESISTOR 3K 5% .25W FC TC=-400/+700	01121	CB3025
A15R28	0698-3154	0	1	RESISTOR 4.22K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4221-F
A15R29	1810-0136	3	2	NETWORK-RES 10-SIP MULTI-VALUE	28480	1810-0136
A15R30	1810-0136	3		NETWORK-RES 10-SIP MULTI-VALUE	28480	1810-0136
A15R31	1810-0055	5	4	NETWORK-RES 9-SIP10.0K OHM X 8	28480	1810-0055
A15R32	1810-0055	5		NETWORK-RES 9-SIP10.0K OHM X 8	28480	1810-0055
A15R33	1810-0055	5		NETWORK-RES 9-SIP10.0K OHM X 8	28480	1810-0055
A15R34	1810-0055	5		NETWORK-RES 9-SIP10.0K OHM X 8	28480	1810-0055
A15R35	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A15R36	0683-2715	6		RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A15S1	3101-1973	7	1	SWITCH-SL 7-1A DIP-SLIDE-ASSY .1A 50VDC	28480	3101-1973
A15U1	1820-0261	6	1	IC MV TTL MONOSTBL	01295	SN74121N
A15U2	1820-0706	4	1	IC COMPTT TTL MAGTD 5-BIT	07263	9324PC
A15U3	1820-0615	4	5	IC MUXR/DATA-SEL TTL 8-TO-1-LINE 8-INP	04713	MC8312P
A15U4	1820-1199	1	3	IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A15U5	1820-1209	4	3	IC BFR TTL LS NAND QUAD 2-INP	01295	SN74LS38N
A15U6	1820-0615	4		IC MUXR/DATA-SEL TTL 8-TO-1-LINE 8-INP	04713	MC8312P
A15U7	1820-1478	9	1	IC CNTR TTL LS BIN ASYNCHRO	01295	SN74LS93N
A15U8	1820-0615	4		IC MUXR/DATA-SEL TTL 8-TO-1-LINE 8-INP	04713	MC8312P
A15U9	1820-1199	1		IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A15U10	1820-1209	4		IC BFR TTL LS NAND QUAD 2-INP	01295	SN74LS38N
A15U11	1820-1112	8	2	IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
A15U12	1820-0615	4		IC MUXR/DATA-SEL TTL 8-TO-1-LINE 8-INP	04713	MC8312P
A15U13	1820-0111	5	1	IC DCDR TTL BCD-TO-DEC 4-TO-10-LINE	04713	MC8301P
A15U14	1820-1430	3	2	IC CNTR TTL LS BIN SYNCHRO POS-EDGE-TRIG	01295	SN74LS161AN
A15U15	1820-1444	9	1	IC MUXR/DATA-SEL TTL LS 2-TO-1-LINE QUAD	01295	SN74LS298N
A15U16	1820-1209	4		IC BFR TTL LS NAND QUAD 2-INP	01295	SN74LS38N
A15U17	1820-1197	9	3	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A15U18	1820-1425	6	1	IC SCHMITT-TRIG TTL LS NAND QUAD 2-INP	01295	SN74LS132N
A15U19	1820-1729	3	3	IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A15U20	1820-1198	0	2	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS03N
A15U21	1820-1199	1		IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A15U22	1818-2253	5	1	IC NMOS 4096 (4K) ROM	28480	1818-2253
A15U23	1820-1430	3		IC CNTR TTL LS BIN SYNCHRO POS-EDGE-TRIG	01295	SN74LS161AN
A15U24	1820-1411	0	1	IC LCH TTL LS D-TYPE 4-BIT	01295	SN74LS75N
A15U25	1820-1197	9		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A15U26	1820-1729	3		IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A15U27	1820-1198	0		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS03N
A15U28	1820-1885	2	2	IC RGTR TTL LS D-TYPE QUAD	04713	SN74LS173N
A15U29	1820-1197	9		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A15U30	1820-1211	8	1	IC GATE TTL LS EXCL-OR QUAD 2-INP	01295	SN74LS86N
A15U31	1820-1112	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
A15U32	1820-0615	4		IC MUXR/DATA-SEL TTL 8-TO-1-LINE 8-INP	04713	MC8312P
A15U33	1820-1729	3		IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A15U34	1820-1885	2		IC RGTR TTL LS D-TYPE QUAD	04713	SN74LS173N
A15W1	05328-60110	0	2	CBL AY-HPIB SING BLUE	28480	05328-60110
A15W2	05328-60110	0		CBL AY-HPIB SING BLUE	28480	05328-60110
A15XJ1	1200-0567	1	2	SOCKET-IC 28-CONT DIP DIP-SLDR	28480	1200-0567
A15XU1- A15XU21 A15XU22	1200-0567	1		NOT ASSIGNED SOCKET-IC 28-CONT DIP DIP-SLDR	28480	1200-0567

See introduction to this section for ordering information  
 \*Indicates factory selected value



Table 6-10. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A16	05328-60033	6	1	BD AY-DISPLAY	28480	05328-60033
A16C1	0180-0124	1	1	CAPACITOR-FXD 200UF+75-10% 6VDC AL	56289	30D2076006DC2
A16CR1	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A16CR2	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A16CR3	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A16CR4	1901-0999	9		DIODE-SCHOTTKY 20V 10NS DO-35	28480	1901-0999
A16CR5	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A16CR6	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A16DS1	1990-0437	7	9	DISPLAY-NUM-SEG 1-CHAR .43-H	28480	5082-7751
A16DS2	1990-0437	7		DISPLAY-NUM-SEG 1-CHAR .43-H	28480	5082-7751
A16DS3	1990-0437	7		DISPLAY-NUM-SEG 1-CHAR .43-H	28480	5082-7751
A16DS4	1990-0437	7		DISPLAY-NUM-SEG 1-CHAR .43-H	28480	5082-7751
A16DS5	1990-0437	7		DISPLAY-NUM-SEG 1-CHAR .43-H	28480	5082-7751
A16DS6	1990-0437	7		DISPLAY-NUM-SEG 1-CHAR .43-H	28480	5082-7751
A16DS7	1990-0437	7		DISPLAY-NUM-SEG 1-CHAR .43-H	28480	5082-7751
A16DS8	1990-0437	7		DISPLAY-NUM-SEG 1-CHAR .43-H	28480	5082-7751
A16DS9	1990-0437	7		DISPLAY-NUM-SEG 1-CHAR .43-H	28480	5082-7751
A16DS10	1990-0404	8	11	LED-LAMP LUM-INT=300UCD IF=50MA-MAX	28480	5082-4480
A16DS11	1990-0404	8		LED-LAMP LUM-INT=300UCD IF=50MA-MAX	28480	5082-4480
A16DS12	1990-0404	8		LED-LAMP LUM-INT=300UCD IF=50MA-MAX	28480	5082-4480
A16DS13	1990-0404	8		LED-LAMP LUM-INT=300UCD IF=50MA-MAX	28480	5082-4480
A16DS14	1990-0404	8		LED-LAMP LUM-INT=300UCD IF=50MA-MAX	28480	5082-4480
A16DS15	1990-0404	8		LED-LAMP LUM-INT=300UCD IF=50MA-MAX	28480	5082-4480
A16DS16	1990-0404	8		LED-LAMP LUM-INT=300UCD IF=50MA-MAX	28480	5082-4480
A16DS17	1990-0404	8		LED-LAMP LUM-INT=300UCD IF=50MA-MAX	28480	5082-4480
A16DS18	1990-0404	8		LED-LAMP LUM-INT=300UCD IF=50MA-MAX	28480	5082-4480
A16DS19	1990-0404	8		LED-LAMP LUM-INT=300UCD IF=50MA-MAX	28480	5082-4480
A16DS20	1990-0404	8		LED-LAMP LUM-INT=300UCD IF=50MA-MAX	28480	5082-4480
A16MP1	3130-0384	3	8	CONTACT-SPRING .15-WD PAL-7	28480	3130-0384
A16MP2	3130-0384	3		CONTACT-SPRING .15-WD PAL-7	28480	3130-0384
A16MP3	3130-0384	3		CONTACT-SPRING .15-WD PAL-7	28480	3130-0384
A16MP4	3130-0384	3		CONTACT-SPRING .15-WD PAL-7	28480	3130-0384
A16MP5	3130-0384	3		CONTACT-SPRING .15-WD PAL-7 PART OF S3 & S4	28480	3130-0384
A16MP6	3130-0384	3		CONTACT-SPRING .15-WD PAL-7	28480	3130-0384
A16MP7	3130-0384	3		CONTACT-SPRING .15-WD PAL-7	28480	3130-0384
A16MP8	3130-0384	3		CONTACT-SPRING .15-WD PAL-7 PART OF S3 & S4	28480	3130-0384
A16MP9	5001-0157	7	2	SPRING-PC	28480	5001-0157
A16MP10	5001-0157	7		SPRING-PC PART OF S3 & S4	28480	5001-0157
A16MP11	5040-6948	8	2	INSUL-MALE	28480	5040-6948
A16MP12	5040-6948	8		INSUL-MALE PART OF S3 & S4	28480	5040-6948
A16MP13	5040-6949	9	2	INSUL-FEM	28480	5040-6949
A16MP14	5040-6949	9		INSUL-FEM PART OF S3 & S4	28480	5040-6949
A16MP15	05328-40003	8		SPACER-LED LONG	28480	05328-40003
A16P1	1251-2582	1	1	CONNECTOR-PC EDGE 24-CONT/ROW 2-ROWS	28480	1251-2582
A16Q1	1853-0326	3	9	TRANSISTOR PNP SI PD=1W FT=50MHZ	04713	MPS-U51
A16Q2	1853-0326	3		TRANSISTOR PNP SI PD=1W FT=50MHZ	04713	MPS-U51
A16Q3	1853-0326	3		TRANSISTOR PNP SI PD=1W FT=50MHZ	04713	MPS-U51
A16Q4	1853-0326	3		TRANSISTOR PNP SI PD=1W FT=50MHZ	04713	MPS-U51
A16Q5	1853-0326	3		TRANSISTOR PNP SI PD=1W FT=50MHZ	04713	MPS-U51
A16Q6	1853-0326	3		TRANSISTOR PNP SI PD=1W FT=50MHZ	04713	MPS-U51
A16Q7	1853-0326	3		TRANSISTOR PNP SI PD=1W FT=50MHZ	04713	MPS-U51
A16Q8	1853-0326	3		TRANSISTOR PNP SI PD=1W FT=50MHZ	04713	MPS-U51
A16Q9	1853-0326	3		TRANSISTOR PNP SI PD=1W FT=50MHZ	04713	MPS-U51
A16Q10	1854-0492	6		TRANSISTOR NPN SI PD=350MW FT=250MHZ	04713	MPS3643

See introduction to this section for ordering information  
\*Indicates factory selected value

Table 6-10. Replaceable Parts (continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A16Q11	1854-0492	6		TRANSISTOR NPN SI PD=350MW FT=250MHZ	04713	MPS3643
A16Q12	1854-0492	6		TRANSISTOR NPN SI PD=350MW FT=250MHZ	04713	MPS3643
A16Q13	1854-0492	6		TRANSISTOR NPN SI PD=350MW FT=250MHZ	04713	MPS3643
A16Q14	1854-0492	6		TRANSISTOR NPN SI PD=350MW FT=250MHZ	04713	MPS3643
A16Q15	1854-0492	6		TRANSISTOR NPN SI PD=350MW FT=250MHZ	04713	MPS3643
A16Q16	1854-0492	6		TRANSISTOR NPN SI PD=350MW FT=250MHZ	04713	MPS3643
A16Q17	1854-0492	6		TRANSISTOR NPN SI PD=350MW FT=250MHZ	04713	MPS3643
A16Q18	1854-0492	6		TRANSISTOR NPN SI PD=350MW FT=250MHZ	04713	MPS3643
A16Q19	1854-0492	6		TRANSISTOR NPN SI PD=350MW FT=250MHZ	04713	MPS3643
A16Q20	1854-0492	6		TRANSISTOR NPN SI PD=350MW FT=250MHZ	04713	MPS3643
A16Q21	1854-0492	6		TRANSISTOR NPN SI PD=350MW FT=250MHZ	04713	MPS3643
A16Q22A	1854-0492	6	13	TRANSISTOR NPN SI PD=350MW FT=250MHZ	04713	MPS3643
A16R1	0683-3905	8	3	RESISTOR 39 5% .25W FC TC=-400/+500	01121	CB3905
A16R2	0683-3905	8		RESISTOR 39 5% .25W FC TC=-400/+500	01121	CB3905
A16R3	0683-3905	8		RESISTOR 39 5% .25W FC TC=-400/+500	01121	CB3905
A16R4	1810-0213	7	1	NETWORK-RES 9-SIP10.0 OHM X 8	91637	CSP09C01-100J
A16R5	0683-1005	5	2	RESISTOR 10 5% .25W FC TC=-400/+500	01121	CB1005
A16R6	2100-3455	1	1	RESISTOR-VAR CONTROL CCP 2.5M 20% 10CW	01121	WP46048P255RZ
A16R7	0683-2005	7	1	RESISTOR 20 5% .25W FC TC=-400/+500	01121	CB2005
A16R8	0683-3325	6	2	RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A16R9	0683-3325	6		RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A16R10	0683-1005	5		RESISTOR 10 5% .25W FC TC=-400/+500	01121	CB1005
A16R11	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A16S1	3101-2245	8	1	SWITCH-TGL SUBMIN DPDT 2A 250VAC PC	28480	3101-2245
A16S2	3101-1940	8	1	SWITCH-PB DPDT MOM .02A 20VAC	28480	3101-1940
A16S3	3130-0498	0	1	SHAFT & INDEX ASSEMBLY 1.562 STRUT CTR	28480	3130-0498
A16S4	3130-0499	1	1	SHAFT & INDEX ASSEMBLY 1.562 STRUT CTR	28480	3130-0499
A16XDS1	1200-0638	7	9	SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0638
A16XDS2	1200-0638	7		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0638
A16XDS3	1200-0638	7		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0638
A16XDS4	1200-0638	7		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0638
A16XDS5	1200-0638	7		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0638
A16XDS6	1200-0638	7		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0638
A16XDS7	1200-0638	7		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0638
A16XDS8	1200-0638	7		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0638
A16XDS9	1200-0638	7		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0638
				MISCELLANEOUS PARTS		
	05328-20252	7	4	SPCR-STANDOFF	28480	05328-20252
	05328-40003	8	12	SPACER-LED LONG	28480	05328-40003

See introduction to this section for ordering information  
\*Indicates factory selected value

Table 6-11. Replaceable Parts (continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
CABINET PARTS AND HARDWARE						
B1	3160-0209	4	1	FAN-TBAX 32-CFM 105-125V 50/60-HZ	23936	8500D
C1				NOT ASSIGNED		
C2	0160-4355	6	2	CAPACITOR-FXD .01UF +-10% 250VAC(RMS)	28480	0160-4355
C3	0160-4355	6		CAPACITOR-FXD .01UF +-10% 250VAC(RMS)	28480	0160-4355
F1	2110-0001	8	1	FUSE 1A 250V NTD 1.25X.25 UL	75915	312001
H1	2190-0060	7	7	WASHER-LK INTL T 1/4 IN .256-IN-ID	28480	2190-0060
H2	3050-0017	9	3	WASHER-FL MTLT 1/4 IN .26-IN-ID	28480	3050-0017
H3	2190-0060	7		WASHER-LK INTL T 1/4 IN .256-IN-ID	28480	2190-0060
H4	2950-0052	9	3	NUT-HEX-DBL-CHAM 1/4-40-THD .062-IN-THK	00000	ORDER BY DESCRIPTION
H5	3101-0851	8	1	CAP-PUSHBUTTON BLACK; .2-IN DIA; .155-IN	28480	3101-0851
H6	2190-0060	7		WASHER-LK INTL T 1/4 IN .256-IN-ID	28480	2190-0060
H7	3050-0052	2	1	WASHER-FL MTLT NO. 8 .168-IN-ID	28480	3050-0052
H8	2190-0060	7		WASHER-LK INTL T 1/4 IN .256-IN-ID	28480	2190-0060
H9	2950-0052	9		NUT-HEX-DBL-CHAM 1/4-40-THD .062-IN-THK	00000	ORDER BY DESCRIPTION
H10	2950-0001	8		NUT-HEX-DBL-CHAM 3/8-32-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
H11	2190-0858	1	3	WASHER-FL MTLT 5/16 IN .375-IN-ID	28480	2190-0858
H12	2190-0016	3	4	WASHER-LK INTL T 3/8 IN .377-IN-ID	28480	2190-0016
H13	2950-0001	8		NUT-HEX-DBL-CHAM 3/8-32-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
H14	0370-2994	0	2	KNOB	28480	0370-2994
H15	2190-0858	1		WASHER-FL MTLT 5/16 IN .375-IN-ID	28480	2190-0858
H16	2190-0016	3		WASHER-LK INTL T 3/8 IN .377-IN-ID	28480	2190-0016
H17	2950-0001	8		NUT-HEX-DBL-CHAM 3/8-32-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
H18	0370-2994	0		KNOB	28480	0370-2994
H19	2190-0060	7		WASHER-LK INTL T 1/4 IN .256-IN-ID	28480	2190-0060
H20	3050-0017	9		WASHER-FL MTLT 1/4 IN .26-IN-ID	28480	3050-0017
H21	2190-0060	7		WASHER-LK INTL T 1/4 IN .256-IN-ID	28480	2190-0060
H22	2950-0072	3	2	NUT-HEX-DBL-CHAM 1/4-32-THD .062-IN-THK	00000	ORDER BY DESCRIPTION
H23	0370-1005	2	2	KNOB-BASE-PTR 3/8 JGK .125-IN-ID	28480	0370-1005
H24	0370-1097	2	2	KNOB-BASE-PTR 1/2 JGK .125-IN-ID	28480	0370-1097
H25	2950-0035	8	4	NUT-HEX-DBL-CHAM 15/32-32-THD	00000	ORDER BY DESCRIPTION
H26	2950-0035	8		NUT-HEX-DBL-CHAM 15/32-32-THD	00000	ORDER BY DESCRIPTION
H27	2950-0035	8		NUT-HEX-DBL-CHAM 15/32-32-THD	00000	ORDER BY DESCRIPTION
H28	2950-0035	8		NUT-HEX-DBL-CHAM 15/32-32-THD	00000	ORDER BY DESCRIPTION
H29	0370-1097	2		KNOB-BASE-PTR 1/2 JGK .125-IN-ID	28480	0370-1097
H30	6960-0002	4	1	PLUG-HOLE DOME-HD FOR .5-D-HOLE STL	28480	6960-0002
H31	6960-0001	3	1	PLUG-HOLE DOME-HD FOR .375-D-HOLE STL	28480	6960-0001
H32	2420-0014	0	1	NUT-HEX-DBL-CHAM 6-32-THD .125-IN-THK	00000	ORDER BY DESCRIPTION
H33	0340-0765	6	1	INSULATOR-XSTR KAPTON	28480	0340-0765
H34	0570-0111	3	1	SCREW-MACH 6-32 .375-IN-LG RD-HD-SLT	00000	ORDER BY DESCRIPTION
H35	2190-0017	4	1	WASHER-LK HLCL NO. 8 .168-IN-ID	28480	2190-0017
H36	0380-0643	3		STANDOFF-HEX .255-IN-LG 6-32THD	00000	ORDER BY DESCRIPTION
H37	2950-0001	8		NUT-HEX-DBL-CHAM 3/8-32-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
H38	2190-0016	3		WASHER-LK INTL T 3/8 IN .377-IN-ID	28480	2190-0016
H39	2510-0043	6	1	SCREW-MACH 8-32 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
H40	2360-0113	2	1	SCREW-MACH 6-32 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
H41	2360-0117	6	1	SCREW-MACH 6-32 .375-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
H42	2360-0119	8	1	SCREW-MACH 6-32 .438-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
H43	2680-0128	7	1	SCREW-MACH 10-32 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
H44	2360-0359	8	1	SCREW-MACH 6-32 .375-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
H45	2360-0125	6	1	SCREW-MACH 6-32 .75-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
H46	2360-0115	4	2	SCREW-MACH 6-32 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
H47	2190-0858	1		WASHER-FL MTLT 5/16 IN .375-IN-ID	28480	2190-0858
H48	3050-0017	9		WASHER-FL MTLT 1/4 IN .26-IN-ID	28480	3050-0017
H49	3050-0003	3	1	WASHER-FL NM NO. 6 .141-IN-ID .375-IN-OD	28480	3050-0003
H50	3050-0001	1	1	WASHER-FL MTLT NO. 8 .172-IN-ID	28480	3050-0001
H51	3050-0010	2	1	WASHER-FL MTLT NO. 6 .147-IN-ID	28480	3050-0010
H52	0515-1331	5	1	SCREW-METRIC SPECIALTY M4 X 0.7 THD; 6	28480	0515-1331
H53	2950-0052	9		NUT-HEX-DBL-CHAM 1/4-40-THD .062-IN-THK	00000	ORDER BY DESCRIPTION
H54	2420-0001	5		NUT-HEX-W/LKWR 6-32-THD .109-IN-THK	00000	ORDER BY DESCRIPTION
H55	2190-0016	3		WASHER-LK INTL T 3/8 IN .377-IN-ID	28480	2190-0016

See introduction to this section for ordering information  
\*Indicates factory selected value

Table 6-11. Replaceable Parts (continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
H56	2190-0060	7		WASHER-LK INTL T 1/4 IN .256-IN-ID	28480	2190-0060
H57	2190-0011	8	1	WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0011
H58	0515-0896	5	1	SCREW-MACH M4 X 0.7 10MM-LG	28480	0515-0896
H59	2360-0476	0	1	SCREW-MACH 6-32 .188-IN-LG 100 DEG	00000	ORDER BY DESCRIPTION
H60	2950-0001	8		NUT-HEX-DBL-CHAM 3/8-32-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
H61	2950-0072	3		NUT-HEX-DBL-CHAM 1/4-32-THD .062-IN-THK	00000	ORDER BY DESCRIPTION
H62	0380-0529	4	1	STANDOFF-HEX 1.25-IN-LG 6-32THD	00000	ORDER BY DESCRIPTION
H63	1400-0249	0	2	CABLE TIE .062-.625-DIA .091-WD NYL	06383	PLT1M-8
H64	1400-0249	0		CABLE TIE .062-.625-DIA .091-WD NYL	06383	PLT1M-8
H65	1200-0547	7	1	LOCK-DUAL INLINE PKG IC FOR 14 PIN	28480	1200-0547
H66	2360-0115	4		SCREW-MACH 6-32 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
J1	1250-0082	0	4	ADAPTER-COAX STR M-BNC M-N	28480	1250-0082
J2	1250-0082	0		ADAPTER-COAX STR M-BNC M-N	28480	1250-0082
J3	1250-0082	0		ADAPTER-COAX STR M-BNC M-N	28480	1250-0082
J4	1250-0082	0		ADAPTER-COAX STR M-BNC M-N	28480	1250-0082
J5	1251-2357	8	1	CONNECTOR-AC PWR HP-9 MALE FLG-MTG	28480	1251-2357
J6-				NOT ASSIGNED		
J209				NOT ASSIGNED		
J210	1510-0091	3	2	BINDING POST SGL SGL-TUR JGK RED	28480	1510-0091
J210A	2950-0144	0	2	NUT-HEX-DBL-CHAM 3/8-32-THD .188-IN-THK	00000	ORDER BY DESCRIPTION
J210B	2420-0001	5	3	NUT-HEX-W/LKWR 6-32-THD .109-IN-THK	00000	ORDER BY DESCRIPTION
J211	1510-0091	3		BINDING POST SGL SGL-TUR JGK RED	28480	1510-0091
J211A	2950-0144	0		NUT-HEX-DBL-CHAM 3/8-32-THD .188-IN-THK	00000	ORDER BY DESCRIPTION
J211B	2420-0001	5		NUT-HEX-W/LKWR 6-32-THD .109-IN-THK	00000	ORDER BY DESCRIPTION
J212-				NOT ASSIGNED		
J309				NOT ASSIGNED		
J310	1250-1899	9	1	ADAPTER-COAX STR F-BNC M-SMC	28480	1250-1899
J310F1	2110-0301	1	3	FUSE .125A 125V .281X.093	28480	2110-0301
J311	05328-60113	3	1	CBL AY-PROBE PWR	28480	05328-60113
J311A	2950-0001	8	6	NUT-HEX-DBL-CHAM 3/8-32-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
MP1	5021-5801*	0	1	FRAME, FRONT, FULL (METRIC)	28480	5021-5801- 5021-8401
MP2	5021-5802	1	1	FRAME, REAR	28480	5021-5802
MP3	5021-5831	6	1	SIDE STRUTS	28480	5021-5831
MP4	5020-8895*	6	1	HANDLE FRONT	28480	5020-8895- 5021-8495
MP5	5040-7201*	8	1	FOOT(STANDARD)	28480	5040-7201- 5041-8801
MP6	5040-7202	9	1	TRIM, TOP	28480	5040-7202- 5041-8802
MP7	05328-00001	2	1	BRKT-MAIN	28480	05328-00001
MP8	05328-00002	3	1	BRKT-CORNER	28480	05328-00002
MP9	05328-00003	4	1	BRKT-FRONT	28480	05328-00003
MP10	05328-00006	7	1	BRKT PWR SUP-FAN	28480	05328-00006
MP11	05328-00042	5	1	PNL REAR	28480	05328-00042- 05328-00034
MP12	05328-00043	6	1	PLT-COV HP18	28480	05328-00043- 05328-00014
MP13	1460-1345	5	1	TILT STAND SST	28480	1460-1345- 5062-3751
MP14	5061-9451	8	1	COV-SIDE	28480	5061-9451- 60133
MP15	05328-60130	4	1	COV-TOP	28480	05328-60130- 5062-3746
MP16	5061-9446	1	1	COV-BOTTOM	28480	5061-9446- 5062-3746
MP16A	05328-60015	4	1	INSULATOR-POWER SUPPLY	28480	05328-60015
MP17	05328-20226	5	1	PNL-FRT STD	28480	05328-20226
MP18	05328-20227	6	1	PNL-FRT DVM	28480	05328-20227
MP19	05328-20228	7	1	PNL-FRT C CHAN	28480	05328-20228
MP20	05328-20229	8	1	PNL-FRT DVM/*C*	28480	05328-20229
MP21	4040-1062	6	1	PANEL 1.18-IN-WD	28480	4040-1062- 05328-20225
MP22	05328-20219	6	1	PANEL-DISPLAY	28480	05328-20219
MP23	0370-1005	2	1	KNOB-BASE-PTR 3/8 JGK .125-IN-ID	28480	0370-1005
MP24	5061-9498	3	1	HANDLES, FRONT	28480	5061-9498- 5062-3798
MP25	05328-20223	2	1	HP18 SHIELD	28480	05328-20223
S1	3101-1609	6	1	SWITCH-SL 2-DPDT STD 1.5A 250VAC	28480	3101-1609
T1	9100-3046	3	1	TRANSFORMER-POWER 100/120/220/240V	28480	9100-3046
W1	8120-1378	1	1	CABLE ASSY 18AWG 3-CNDCT JGK-JKT	28480	8120-1378
W2	8120-2176	9	1	CABLE ASSY 26AWG 28-CNDCT	28480	8120-2176
W3	8120-0520	3	3	CABLE ASSY 26AWG 14-CNDCT	28480	8120-0520
W4	8120-0520	3		CABLE ASSY 26AWG 14-CNDCT	28480	8120-0520
W5	8120-0520	3		CABLE ASSY 26AWG 14-CNDCT	28480	8120-0520

See introduction to this section for ordering information  
\*Indicates factory selected value

Table 6-11. Replaceable Parts (continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
XF1A	2110-0564	8	1	FUSEHOLDER BODY 12A MAX FOR UL	H9027	031.1657
XF1B	2110-0565	9	1	FUSEHOLDER CAP 12A MAX FOR UL	28480	2110-0565
XF1C	2110-0569	3	1	FUSEHOLDER COMPONENT NUT; THREAD M12.7	28480	2110-0569
XF1D	1400-0090	9	1	FUSEHOLDER COMPONENT FOR USE ON	28480	1400-0090
				MISCELLANEOUS		
	0340-1102	7	1	INSULATOR-XFORMR	28480	0340-1102
	7120-0644	1	1	LABEL-WARNING 1.25-IN-WD 2-IN-LG AL	28480	7120-0644
	8159-0005	0	6	RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
	05305-20105	2	1	INSUL	28480	05305-20105

See introduction to this section for ordering information  
 \*Indicates factory selected value

Table 6-12. Code List of Manufacturers

Mfr Code	Manufacturer Name	Address	Zip Code
H9027	SCHURTER A G H	LUZERN SW	
00000	ANY SATISFACTORY SUPPLIER		
01121	ALLEN-BRADLEY CO	MILWAUKEE WI	53204
01295	TEXAS INSTR INC SEMICOND CMPNT DIV	DALLAS TX	75222
04713	MOTOROLA SEMICONDUCTOR PRODUCTS	PHOENIX AZ	85008
06383	PANDUIT CORP	TINLEY PARK IL	60477
07263	FAIRCHILD SEMICONDUCTOR DIV	MOUNTAIN VIEW CA	94042
23936	PAHOTR DIV WILLIAM J PURDY	BURLINGAME CA	94010
24546	CORNING GLASS WORKS (BRADFORD)	BRADFORD PA	16701
27014	NATIONAL SEMICONDUCTOR CORP	SANTA CLARA CA	95051
28480	HEWLETT-PACKARD CO CORPORATE HQ	PALO ALTO CA	94304
30983	MEPCO/ELECTRA CORP	SAN DIEGO CA	92121
52763	STETTNER ELECTRONICS INC	CHATTANOOGA TN	13035
56289	SPRAGUE ELECTRIC CO	NORTH ADAMS MA	01247
72136	ELECTRO MOTIVE CORP	FLORENCE SC	06226
75915	LITTELFUSE INC	DES PLAINES IL	60016
84411	TRW CAPACITOR DIV	OGALLALA NE	69153
91637	DALE ELECTRONICS INC	COLUMBUS NE	68601

5328B  
Replaceable Parts

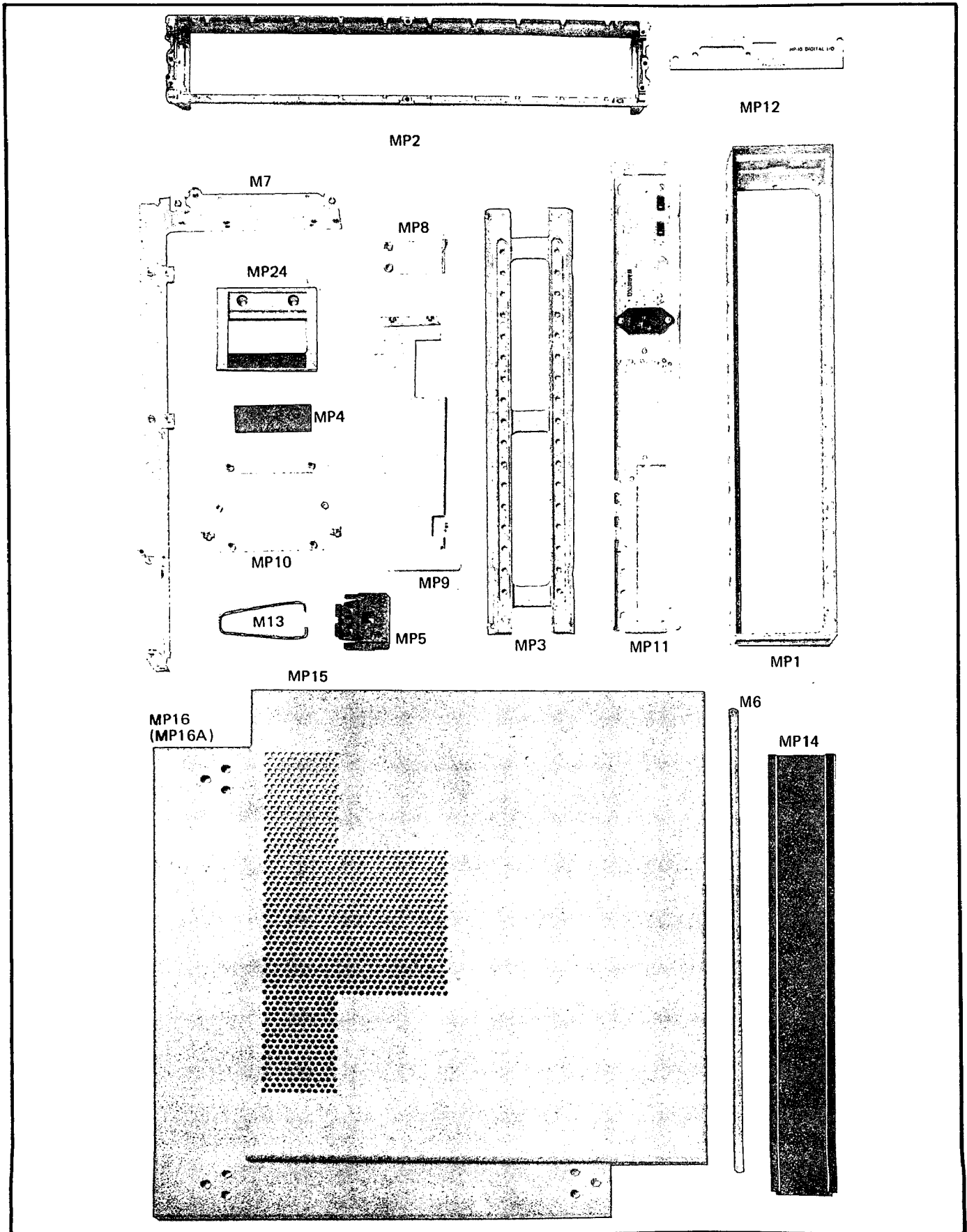
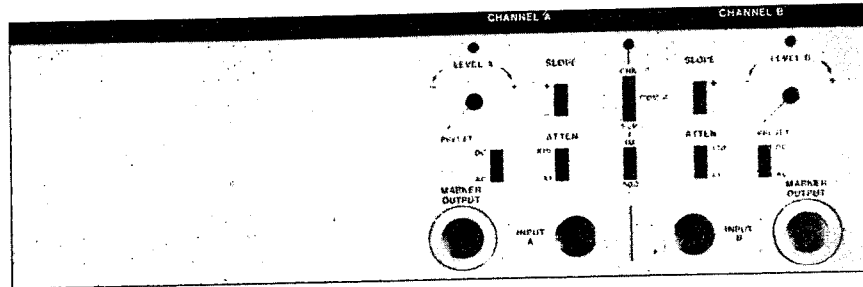


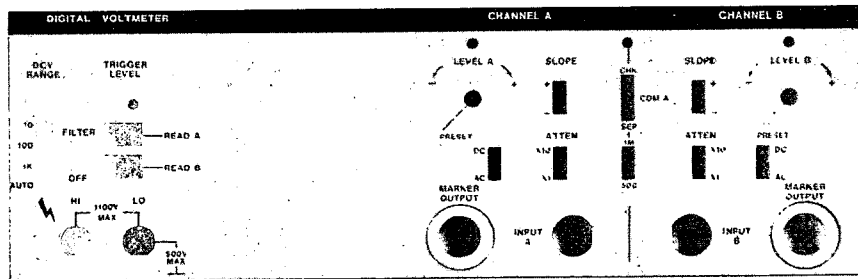
Figure 6-1. Cabinet Parts



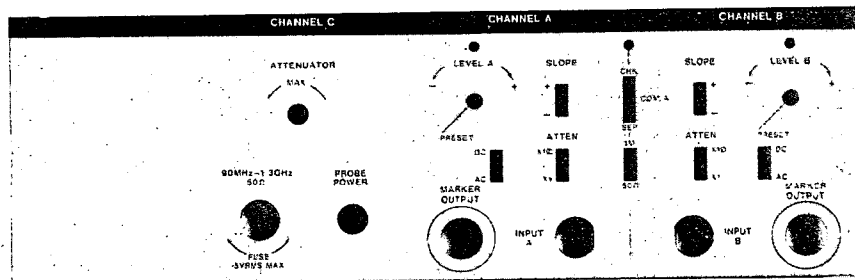
MP21



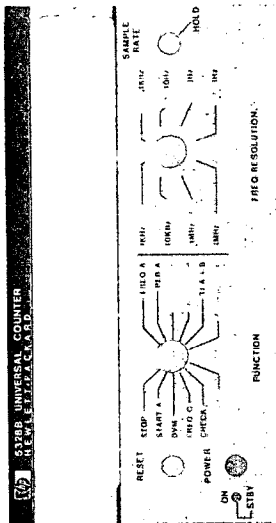
MP17



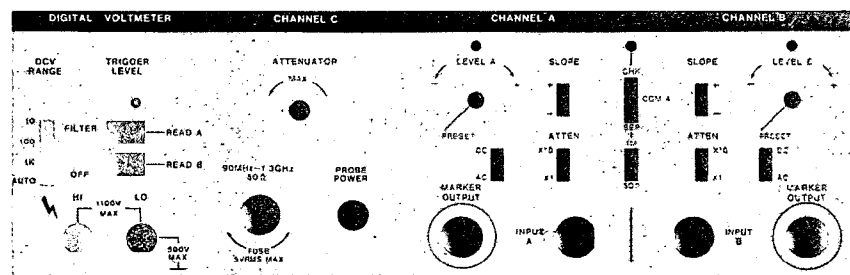
MP18



MP19



MP22



MP20

Figure 6-1. Cabinet Parts (continued)



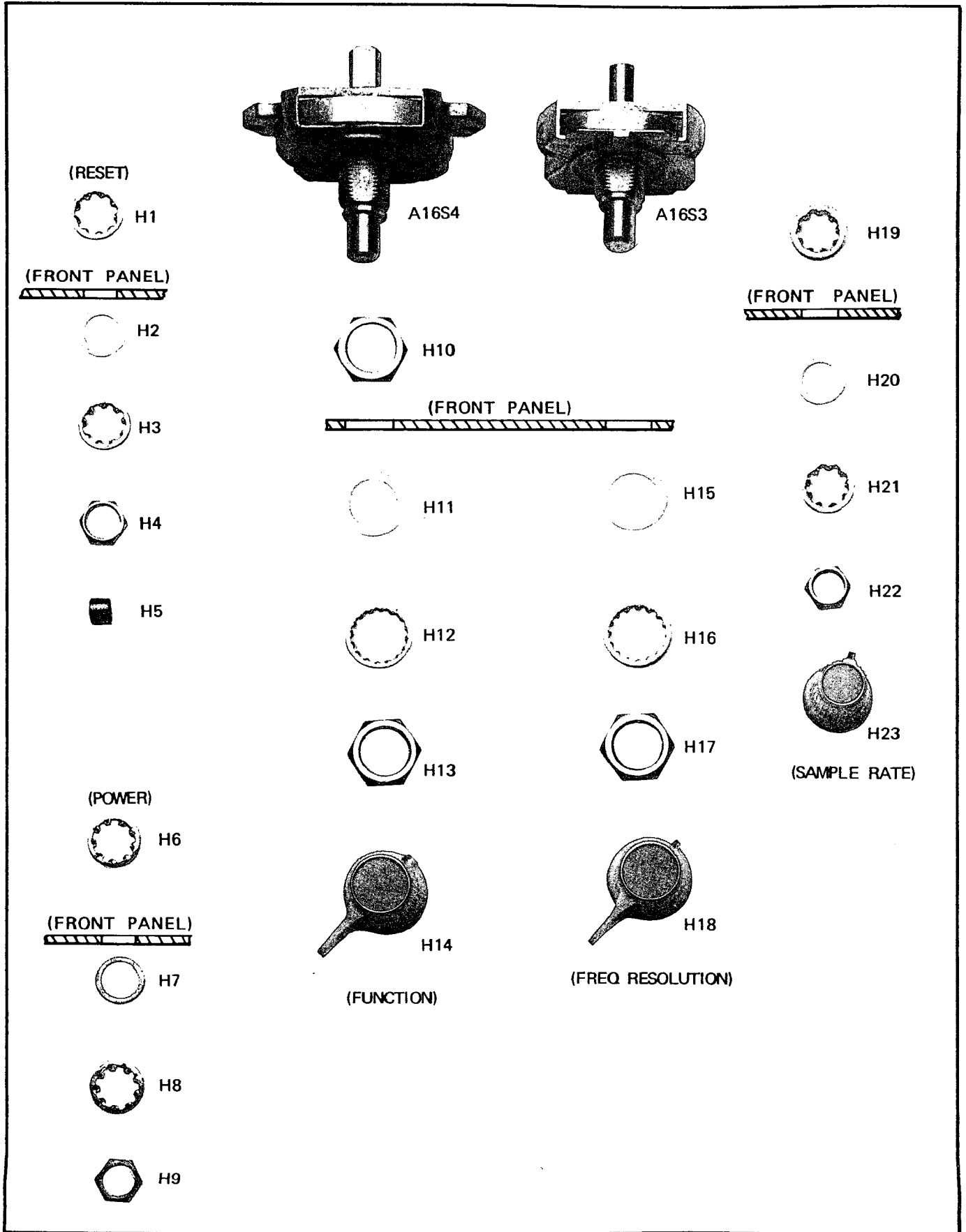


Figure 6-2. Front Panel Display Hardware

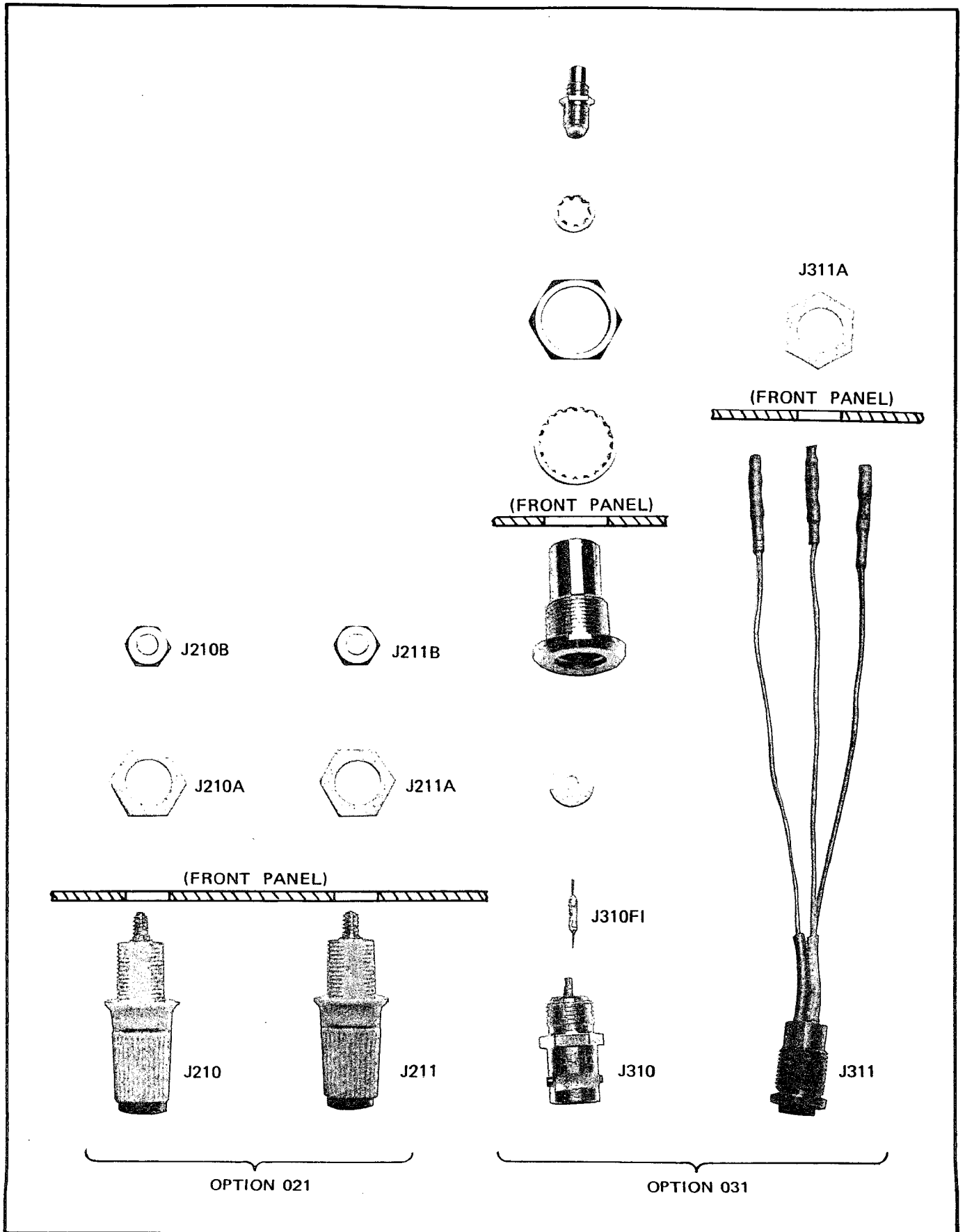


Figure 6-3. Option 050 (Options 021 & 031) Front Panel Hardware

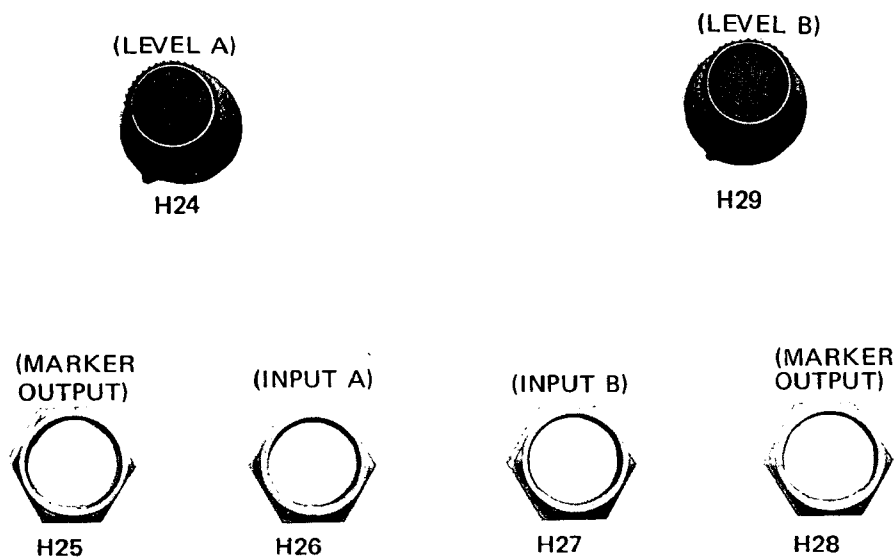


Figure 6-4. Programmable Input Front Panel Hardware

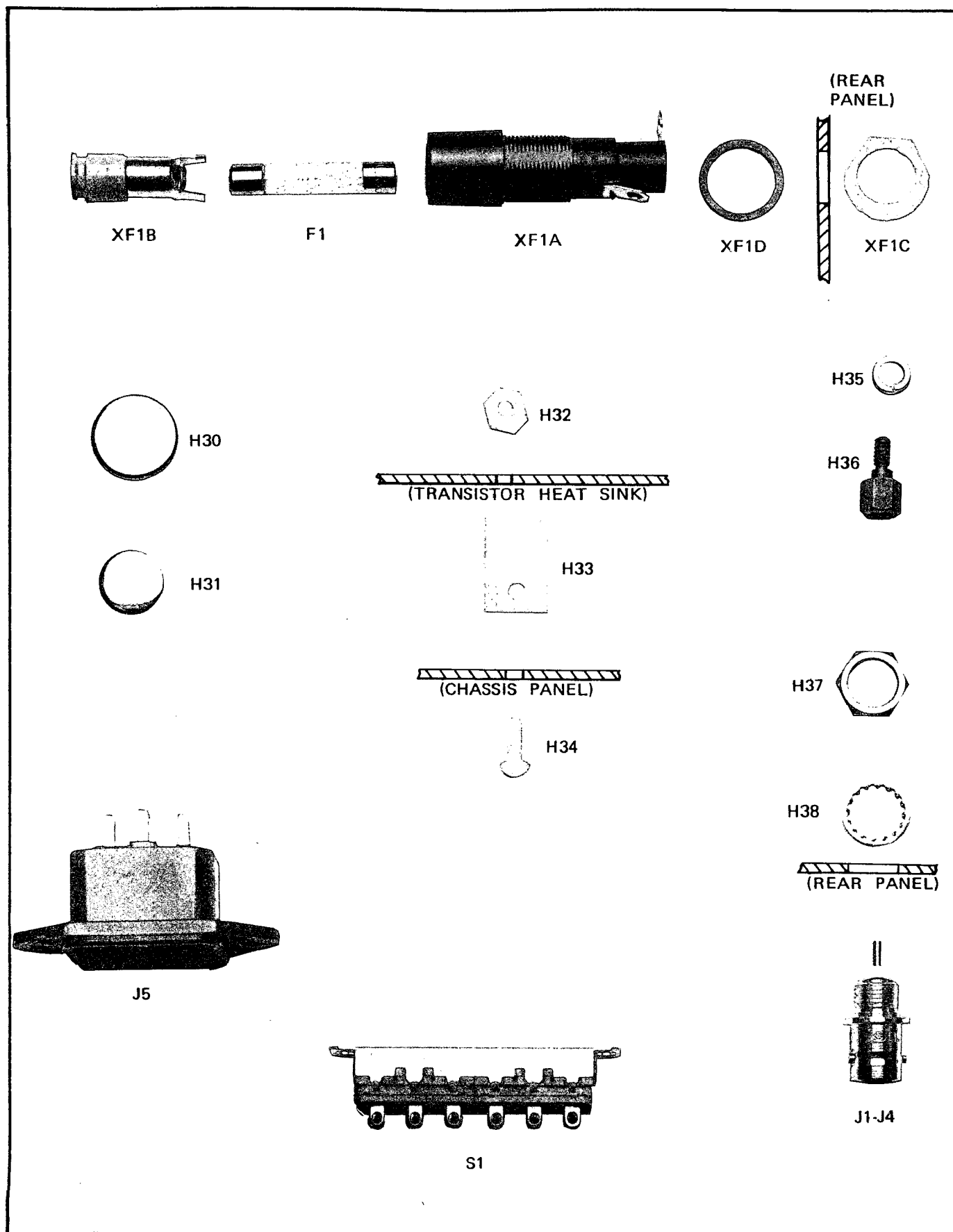


Figure 6-5. Rear Panel Chassis Parts

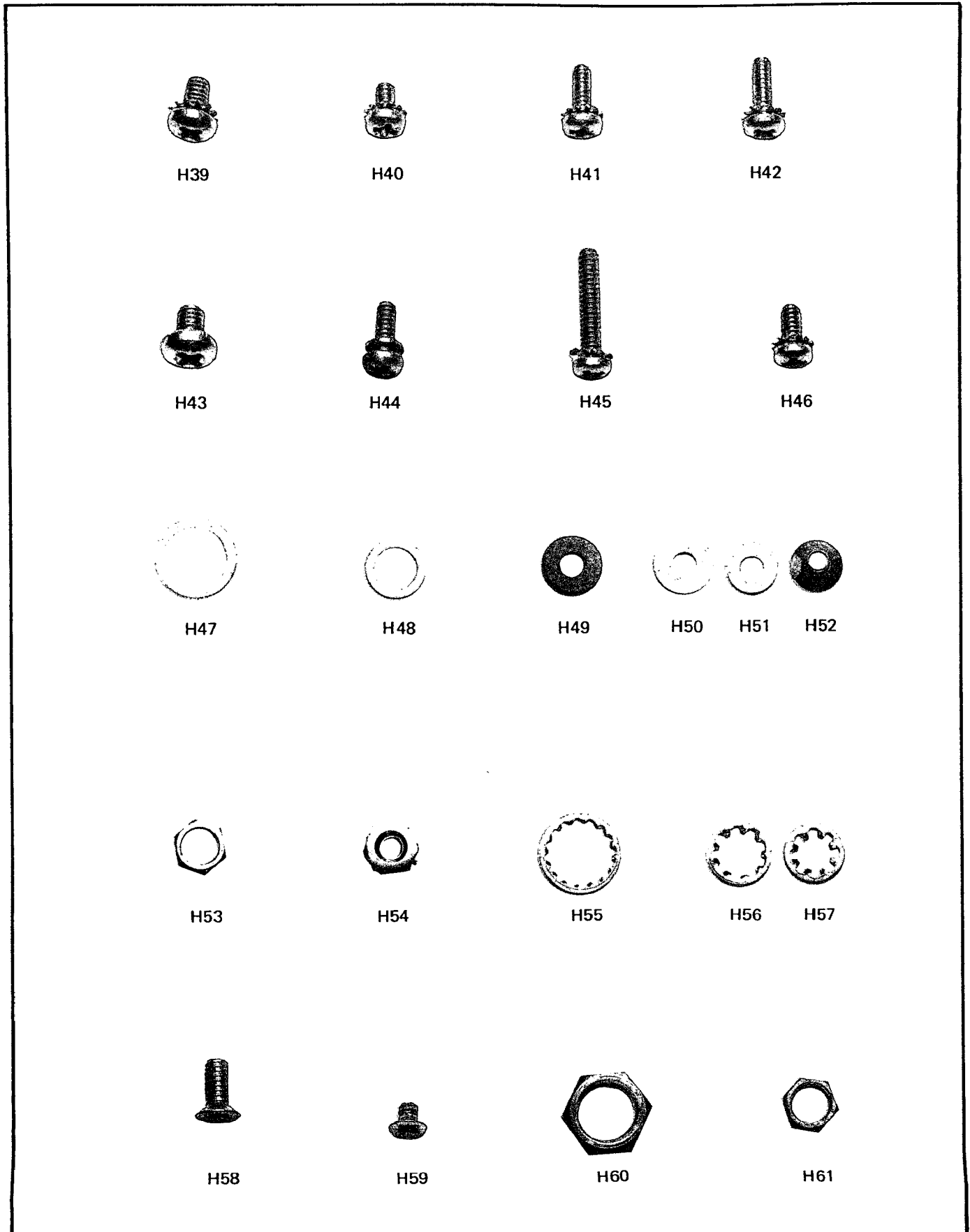
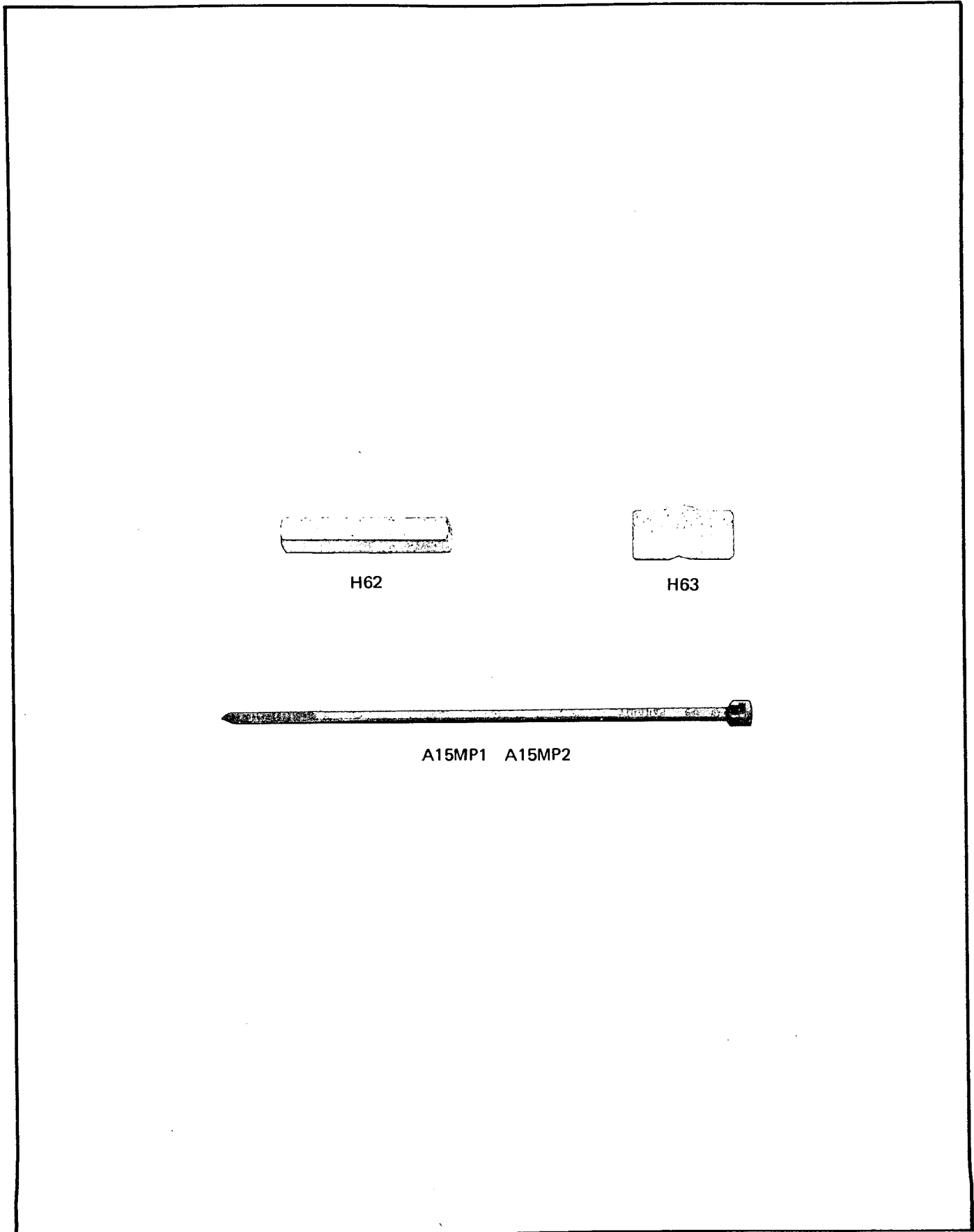


Figure 6-6. Miscellaneous Cabinet Hardware



H62

H63

A15MP1 A15MP2

Figure 6-7. Internal Cabinet Parts

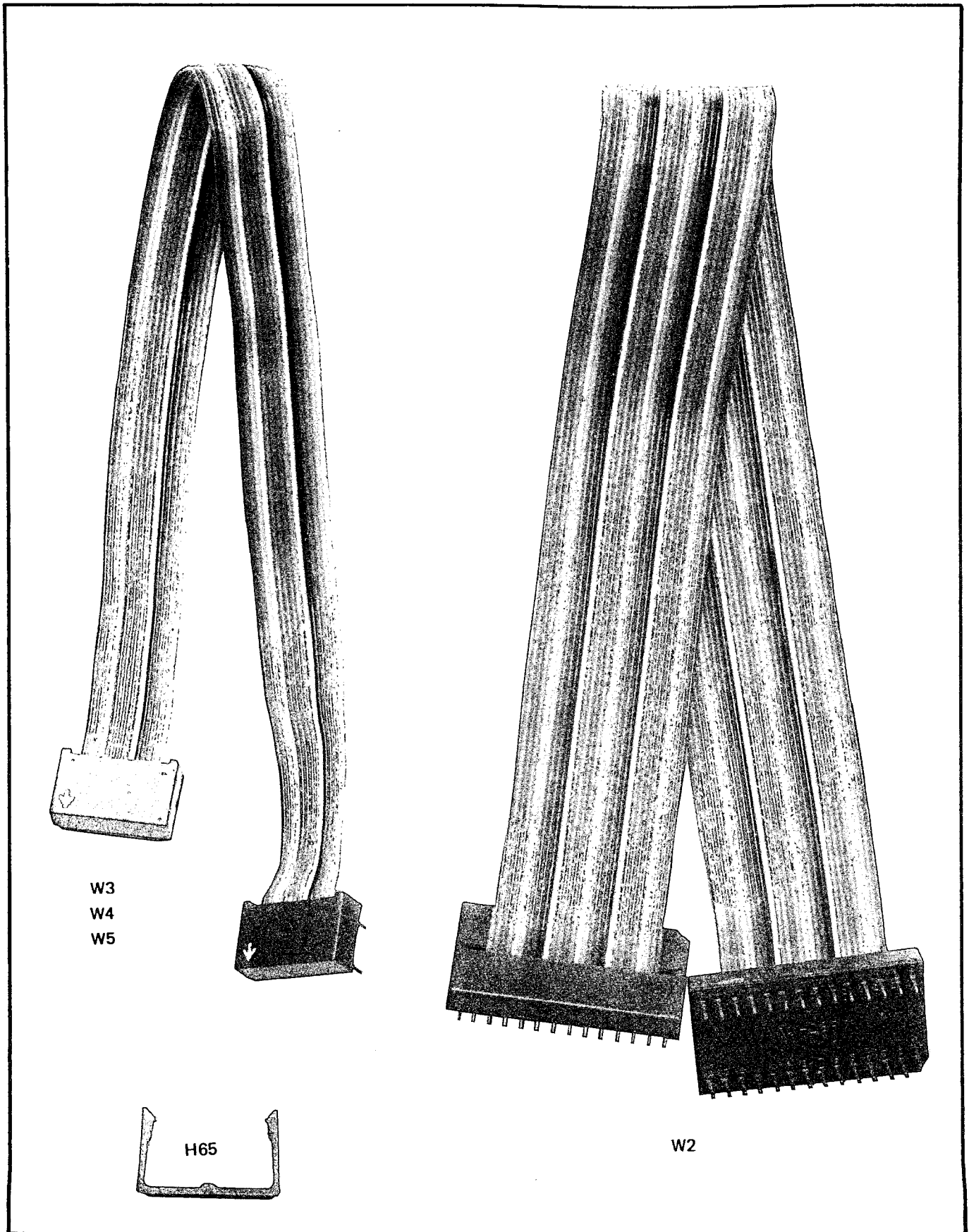


Figure 6-8. Ribbon Cables

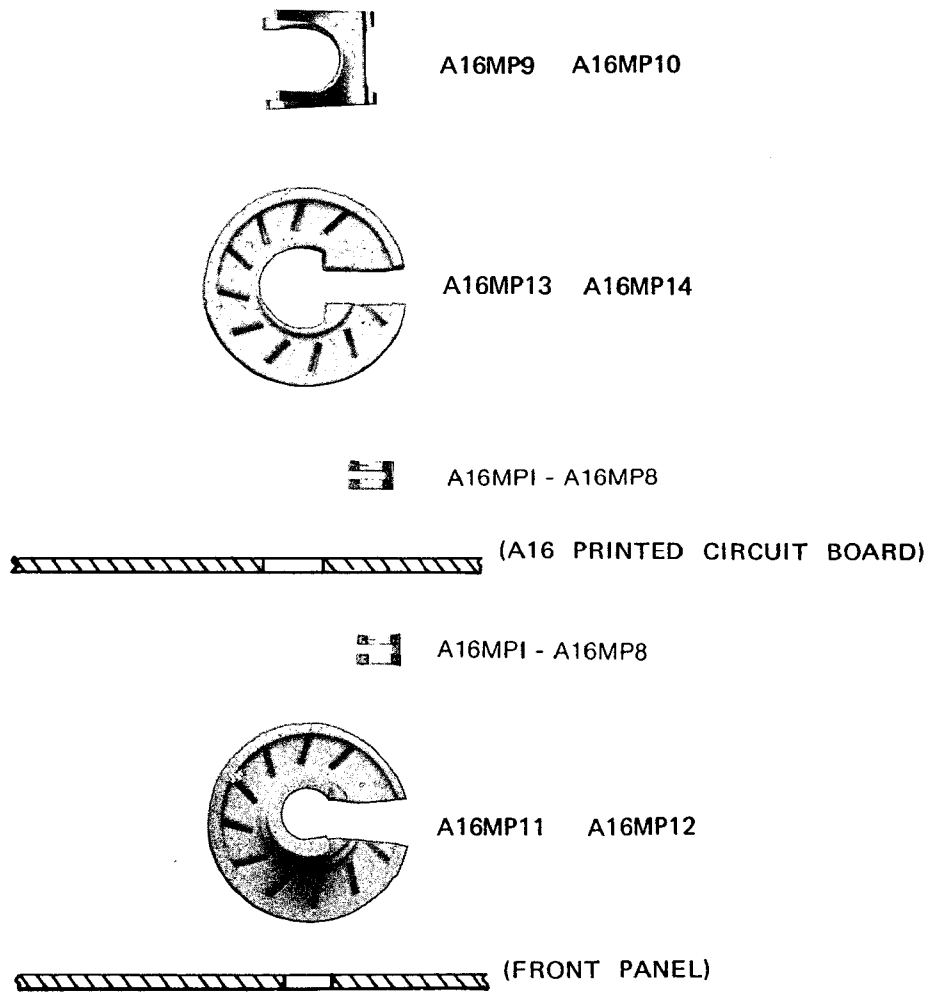


Figure 6-9. Display Panel Switch Assembly A16S3 and A16S4



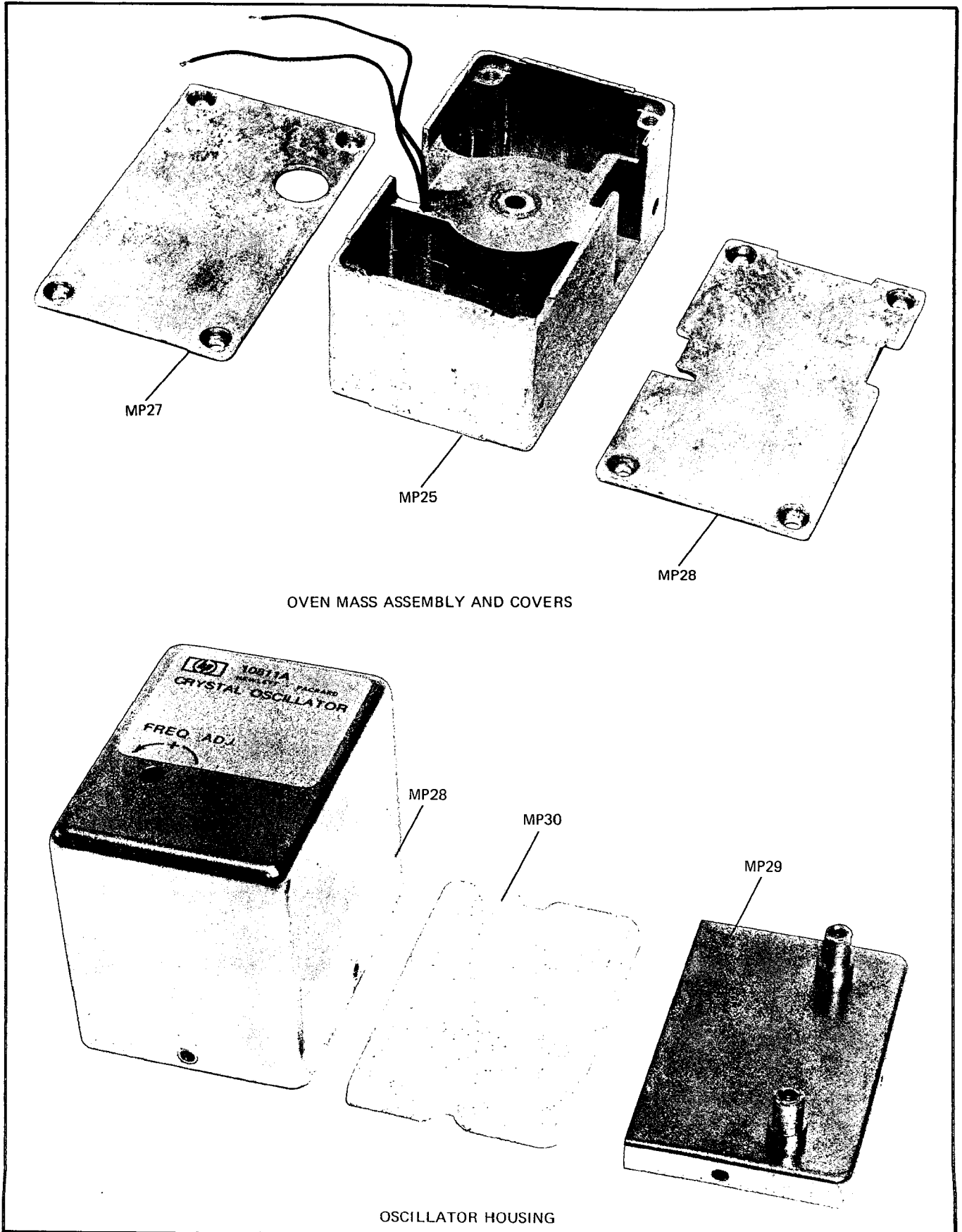


Figure 6-10. Option 010 Oven Oscillator Mechanical Parts

## SECTION VII MANUAL CHANGES

### 7-1. INTRODUCTION

7-2. This section contains information for adapting this manual to instruments with serial prefixes other than that listed on the title page. Refer to Section I for additional important information about serial number coverage.

### 7-3. MANUAL CHANGES

7-4. Instruments having serial number prefixes higher than those listed on the title page of this manual are covered with a "Manual Changes" sheet included with this manual. If this change sheet is missing, the information can be supplied by any Hewlett-Packard Sales and Service Office listed at the back of this manual.

7-5. If your instrument's serial number prefix is lower than that listed on the title page of this manual, this manual must be modified to correctly apply to your instrument. To determine which changes must be made to this manual, locate your instrument's serial number prefix in *Table 7-1* and make the indicated changes.

*Table 7-1. Manual Backdating*

IF YOUR 5328B HAS SERIAL PREFIX	THEN MAKE THE FOLLOWING CHANGES TO THIS MANUAL
2450	1
2408	1, 2

#### Change 1 (2450A)

##### Table 6-11. Cabinet Parts and Hardware:

- Change H52 from 0515-1331 to 2510-0192 machine screw 8-32 .25 inches long.
- Change H58 from 0515-0896 to 2510-0195 machine screw 8-32 .375 inches long.
- Change MP1 from 5021-5801 to 5020-8801 FRAME, FRONT.
- Change MP2 from 5021-5802 to 5020-8802 FRAME, REAR.
- Change MP3 from 5021-5831 to 5020-8831 SIDE STRUT.
- Change MP14 from 5061-9451 to 5060-9851 COVER, SIDE.
- Change MP15 from 05328-60130 to 05328-0016 COVER, TOP.
- Change MP16 from 5061-9446 to 5060-9846 COVER, BOTTOM.
- Change MP24 from 5061-9498 to 5060-9898 HANDLE, FRONT.
- Change Option 908 RACK FLANGE KIT (FOR INSTRUMENTS WITHOUT HANDLES) from 5061-9674 to 5061-0074.

#### Change 2 (2408A)

Table 6-2, A1 Motherboard (05328-60049) Replaceable Parts: Replace the parts list with the parts list shown in Table 7-2.

Figure 8-A-10, A1 Motherboard (05328-60049) Schematic Diagram: Replace the schematic with the schematic shown in Figure 7-1.

Table 7-2. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1	05328-60001	8	1	BOARD ASSY-MOTHERBOARD (SERIES 2408)	28480	05328-60001
A1C1				NOT ASSIGNED		
A1C2				NOT ASSIGNED		
A1C3	0180-0100	3	1	CAPACITOR-FXD 4.7UF+-10% 35VDC TA	56289	150D475X9035B2
A1C4	0160-0161	4	2	CAPACITOR-FXD .01UF +-10% 200VDC POLYE	28480	0160-0161
A1C5	0180-0106	9	2	CAPACITOR-FXD 60UF+-20% 6VDC TA	56289	150D606X0006B2
A1C6	0140-0177	0	1	CAPACITOR-FXD 400PF +-1% 300VDC MICA	72136	DM15F401F0300WV1CR
A1C7	0170-0024	9	1	CAPACITOR-FXD .022UF +-20% 200VDC POLYE	28480	0170-0024
A1C8	0180-0195	6	1	CAPACITOR-FXD .33UF+-20% 35VDC TA	56289	150D334X0035A2
A1C9				NOT ASSIGNED		
A1C10	0160-0314	9	1	CAPACITOR-FXD .01UF +-5% 400VDC POLYE	84411	663UU10354U2
A1C11-				NOT ASSIGNED		
A1C16				NOT ASSIGNED		
A1C17*	0160-2264	2	1	CAPACITOR-FXD 20PF +-5% 500VDC CER 0+-30	28480	0160-2264
A1C18	0121-0060	0	1	CAPACITOR-V TRMR-CER 2-8PF 350V PC-MTG	52763	304322 2/8PF NPO
A1C19				NOT ASSIGNED		
A1C20	0160-0161	4		CAPACITOR-FXD .01UF +-10% 200VDC POLYE	28480	0160-0161
A1C21	0180-0210	6	5	CAPACITOR-FXD 3.3UF+-20% 15VDC TA	56289	150D335X0015A2
A1C22	0160-2055	9	2	CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A1C23-				NOT ASSIGNED		
A1C28				NOT ASSIGNED		
A1C29	0180-0230	0	2	CAPACITOR-FXD 1UF+-20% 50VDC TA	56289	150D105X0050A2
A1C30	0160-0153	4	1	CAPACITOR-FXD 1000PF +-10% 200VDC POLYE	28480	0160-0153
A1C31	0180-0230	0		CAPACITOR-FXD 1UF+-20% 50VDC TA	56289	150D105X0050A2
A1C32				NOT ASSIGNED		
A1C33	0160-4554	7	7	CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C34	0180-0210	6		CAPACITOR-FXD 3.3UF+-20% 15VDC TA	56289	150D335X0015A2
A1C35	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C36	0180-0210	6		CAPACITOR-FXD 3.3UF+-20% 15VDC TA	56289	150D335X0015A2
A1C37	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C37	0180-0106	9		CAPACITOR-FXD 60UF+-20% 6VDC TA	56289	150D606X0006B2
A1C38	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A1C39	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C40	0180-0155	8	6	CAPACITOR-FXD 2.2UF+-20% 20VDC TA	56289	150D225X0020A2
A1C41	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C42	0180-0155	8		CAPACITOR-FXD 2.2UF+-20% 20VDC TA	56289	150D225X0020A2
A1C43	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C44	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C45	0180-0210	6		CAPACITOR-FXD 3.3UF+-20% 15VDC TA	56289	150D335X0015A2
A1C46	0180-0210	6		CAPACITOR-FXD 3.3UF+-20% 15VDC TA	56289	150D335X0015A2
A1C47	0160-4084	8	1	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A1C48	0180-0155	8		CAPACITOR-FXD 2.2UF+-20% 20VDC TA	56289	150D225X0020A2
A1C49	0180-0155	8		CAPACITOR-FXD 2.2UF+-20% 20VDC TA	56289	150D225X0020A2
A1C50	0160-3879	7	2	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A1C51	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A1C52	0180-0155	8		CAPACITOR-FXD 2.2UF+-20% 20VDC TA	56289	150D225X0020A2
A1C53	0180-0155	8		CAPACITOR-FXD 2.2UF+-20% 20VDC TA	56289	150D225X0020A2
A1CR1	1901-0040	1	12	DIODE-SWITCHING 30V 50MA 2NS D0-35	28480	1901-0040
A1CR2				NOT ASSIGNED		
A1CR3	1910-0016	0	3	DIODE-GE 60V 60MA 1US D0-7	28480	1910-0016
A1CR4				NOT ASSIGNED		
A1CR5	1901-0050	3	2	DIODE-SWITCHING 80V 200MA 2NS D0 35	28480	1901-0050
A1CR6	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS D0-35	28480	1901-0050
A1CR7	1901-0535	9	1	DIODE-SM SIG SCHOTTKY	28480	1901-0535
A1CR8	1902-3082	9	1	DIODE-ZNR 4.64V 5% D0-35 PD=.4W	28480	1902-3082
A1CR9	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS D0-35	28480	1901-0040
A1CR10	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS D0-35	28480	1901-0040
A1CR11	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS D0-35	28480	1901-0040
A1CR12	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS D0-35	28480	1901-0040
A1CR13	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS D0-35	28480	1901-0040
A1CR14	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS D0-35	28480	1901-0040
A1CR15	1910-0016	0		DIODE-GE 60V 60MA 1US D0-7	28480	1910-0016

See introduction to this section for ordering information  
\*Indicates factory selected value

Table 7-2. Replaceable Parts (continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1CR16	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1CR17	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1CR18	1910-0016	0		DIODE-GE 60V 60MA 1US DO-7	28480	1910-0016
A1CR19	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1CR20	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1CR21	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1L1	9100-2276	9	1	INDUCTOR RF-CH-MLD 100UH 10% .105DX.26LG	28480	9100-2276
A1Q1	1854-0071	7	6	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q2	1853-0015	7	2	TRANSISTOR PNP SI PD=200MW FT=500MHZ	28480	1853-0015
A1Q3	1853-0015	7		TRANSISTOR PNP SI PD=200MW FT=500MHZ	28480	1853-0015
A1Q4	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q5	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q6	1854-0092	2	1	TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A1Q7	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q8	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q9	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q10	1853-0036	2	1	TRANSISTOR PNP SI PD=310MW FT=250MHZ	28480	1853-0036
A1R1	0698-3444	1	1	RESISTOR 316 1% .125W F TC=0+-100	24546	C4-1/8-T0-316R-F
A1R2	1810-0055	5	5	NETWORK-RES 9-SIP10.0K OHM X 8	28480	1810-0055
A1R3	0683-2725	8	1	RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A1R4*	0683-3355	2	1	RESISTOR 3.3M 5% .25W FC TC=-900/+1100	01121	CB3355
A1R5	1810-0055	5		NETWORK-RES 9-SIP10.0K OHM X 8	28480	1810-0055
A1R6	0683-3315	4	1	RESISTOR 330 5% .25W FC TC=-400/+600	01121	CB3315
A1R7	0683-1035	1	20	RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R8	0683-4725	2	3	RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A1R9	0683-1525	4	4	RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	CB1525
A1R10	0683-1025	9	8	RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A1R11	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A1R12				NOT ASSIGNED		
A1R13	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R14	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A1R15	1810-0041	9	1	NETWORK-RES 9-SIP2.7K OHM X 8	28480	1810-0041
A1R16				NOT ASSIGNED		
A1R17	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R18	0683-1525	4		RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	CB1525
A1R19	1810-0055	5		NETWORK-RES 9-SIP10.0K OHM X 8	28480	1810-0055
A1R20	0683-1525	4		RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	CB1525
A1R21	0698-4037	0	2	RESISTOR 46.4 1% .125W F TC=0+-100	24546	C4-1/8-T0-46R4-F
A1R22	0683-2715	6	3	RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A1R23	0683-2015	9	1	RESISTOR 200 5% .25W FC TC=-400/+600	01121	CB2015
A1R24	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A1R25	0683-1525	4		RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	CB1525
A1R26	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A1R27	0757-0928	6	1	RESISTOR 1.5K 2% .125W F TC=0+-100	24546	C4-1/8-T0-1501-G
A1R28	1810-0055	5		NETWORK-RES 9-SIP10.0K OHM X 8	28480	1810-0055
A1R29	0757-0952	6	1	RESISTOR 15K 2% .125W F TC=0+-100	24546	C4-1/8-T0-1502-G
A1R30	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R31	0683-5105	4	1	RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A1R32	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R33	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R34	0683-2715	6		RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A1R35	0683-5115	6	1	RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A1R36	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R37	0683-2715	6		RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A1R38	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R39	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R40	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R41	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R42	1810-0055	5		NETWORK-RES 9-SIP10.0K OHM X 8	28480	1810-0055
A1R43	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A1R44	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R45	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035

See introduction to this section for ordering information  
\*Indicates factory selected value

Table 7-2. Replaceable Parts (continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1R46	0683-1545	8	1	RESISTOR 150K 5% .25W FC TC=-800/+900	01121	CB1545
A1R47				NOT ASSIGNED		
A1R48	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R49- A1R51				NOT ASSIGNED		
A1R52	0683-5635	5	1	RESISTOR 56K 5% .25W FC TC=-400/+800	01121	CB5635
A1R53				NOT ASSIGNED		
A1R54				NOT ASSIGNED		
A1R55	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A1R56	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A1R57	0683-6815	5	1	RESISTOR 680 5% .25W FC TC=-400/+600	01121	CB6815
A1R58	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A1R59	0683-5605	9	10	RESISTOR 56 5% .25W FC TC=-400/+500	01121	CB5605
A1R60	0683-5605	9		RESISTOR 56 5% .25W FC TC=-400/+500	01121	CB5605
A1R61	0683-5605	9		RESISTOR 56 5% .25W FC TC=-400/+500	01121	CB5605
A1R62	0683-5605	9		RESISTOR 56 5% .25W FC TC=-400/+500	01121	CB5605
A1R63	0683-5605	9		RESISTOR 56 5% .25W FC TC=-400/+500	01121	CB5605
A1R64	0683-5605	9		RESISTOR 56 5% .25W FC TC=-400/+500	01121	CB5605
A1R65	0683-5605	9		RESISTOR 56 5% .25W FC TC=-400/+500	01121	CB5605
A1R66	0683-5605	9		RESISTOR 56 5% .25W FC TC=-400/+500	01121	CB5605
A1R67	0683-5605	9		RESISTOR 56 5% .25W FC TC=-400/+500	01121	CB5605
A1R68	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R69	0757-0935	5	1	RESISTOR 3K 2% .125W F TC=0+/-100	24546	C4-1/8-T0-3001-G
A1R70	0757-0950	4	1	RESISTOR 12K 2% .125W F TC=0+/-100	24546	C4-1/8-T0-1202-G
A1R71	0757-0279	0	1	RESISTOR 3.16K 1% .125W F TC=0+/-100	24546	C4-1/8-T0-3161-F
A1R72	0757-0931	1	1	RESISTOR 2K 2% .125W F TC=0+/-100	24546	C4-1/8-T0-2001-G
A1R73	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R74	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R75	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R76	0683-1015	7	1	RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A1R77	0683-5605	9		RESISTOR 56 5% .25W FC TC=-400/+500	01121	CB5605
A1R78	0683-4315	6	1	RESISTOR 430 5% .25W FC TC=-400/+600	01121	CB4315
A1R79	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A1R80	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R81	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R82	0683-6825	7	1	RESISTOR 6.8K 5% .25W FC TC=-400/+700	01121	CB6825
A1R83	0698-4037	0		RESISTOR 46.4 1% .125W F TC=0+/-100	24546	C4-1/8-T0-46R4-F
A1R84	0757-0422	5	1	RESISTOR 909 1% .125W F TC=0+/-100	24546	C4-1/8-T0-909R-F
A1S1	3101-1977	1	3	SWITCH-SL DPDT SUBMIN .5A 125VAC PC	28480	3101-1977
A1S2	3101-1977	1		SWITCH-SL DPDT SUBMIN .5A 125VAC PC	28480	3101-1977
A1S3	3101-1977	1		SWITCH-SL DPDT SUBMIN .5A 125VAC PC	28480	3101-1977
A1U1	1820-0055	6	2	IC CNTR TTL DECD SYNCHRO POS-EDGE-TRIG	01295	SN7490AN
A1U2	1820-1056	9	1	IC SCHMITT-TRIG TTL NAND QUAD 2-INP	01295	SN74132N
A1U3	1820-0175	1	1	IC INV TTL HEX 1-INP	01295	SN7405N
A1U4	1820-1401	8	1	IC MISC	28480	1820-1401
A1U5	1820-0513	1	2	IC GATE TTL AND QUAD 2-INP	01295	SN7409N
A1U6	1820-0282	1	4	IC GATE TTL EXCL-OR QUAD 2-INP	01295	SN7486N
A1U7	1820-0511	9	1	IC GATE TTL AND QUAD 2-INP	01295	SN7408N
A1U8	1820-0174	0	6	IC INV TTL HEX	01295	SN7404N
A1U9	1820-0661	0	2	IC GATE TTL OR QUAD 2-INP	01295	SN7432N
A1U10	1820-1143	5	1	IC CNTR TTL DECD SYNCHRO	27014	DM8552N
A1U11	1820-0301	5	5	IC LCH TTL D-TYPE 4-BIT	01295	SN7475N
A1U12	1820-2316	6	1	IC CNTR IIL DECD HEX	28480	IDB2-4
A1U13	1820-0269	4	2	IC GATE TTL NAND QUAD 2-INP	01295	SN7403N
A1U14	1820-0513	1		IC GATE TTL AND QUAD 2-INP	01295	SN7409N
A1U15	1820-0803	2	1	IC GATE ECL OR-NOR TPL	04713	MC10105P
A1U16	1820-0537	9	1	IC SCHMITT-TRIG TTL NAND DUAL 4-INP	01295	SN7413N
A1U17	1820-0068	1	1	IC GATE TTL NAND TPL 3-INP	01295	SN7410N
A1U18	1820-0174	0		IC INV TTL HEX	01295	SN7404N
A1U19	1820-0077	2	1	IC FF TTL D-TYPE POS-EDGE-TRIG CLEAR	01295	SN7474N
A1U20	1820-0055	6		IC CNTR TTL DECD SYNCHRO POS-EDGE-TRIG	01295	SN7490AN
A1U21	1820-2317	7	1	IC MISC IIL	28480	IDB9-TL
A1U22	1820-0269	4		IC GATE TTL NAND QUAD 2-INP	01295	SN7403N
A1U23	1820-0328	6	1	IC GATE TTL NOR QUAD 2-INP	01295	SN7402N
A1U24	1820-0282	1		IC GATE TTL EXCL-OR QUAD 2-INP	01295	SN7486N
A1U25	1820-0301	5		IC LCH TTL D-TYPE 4-BIT	01295	SN7475N

See introduction to this section for ordering information  
\*Indicates factory selected value

Table 7-2. Replaceable Parts (continued)

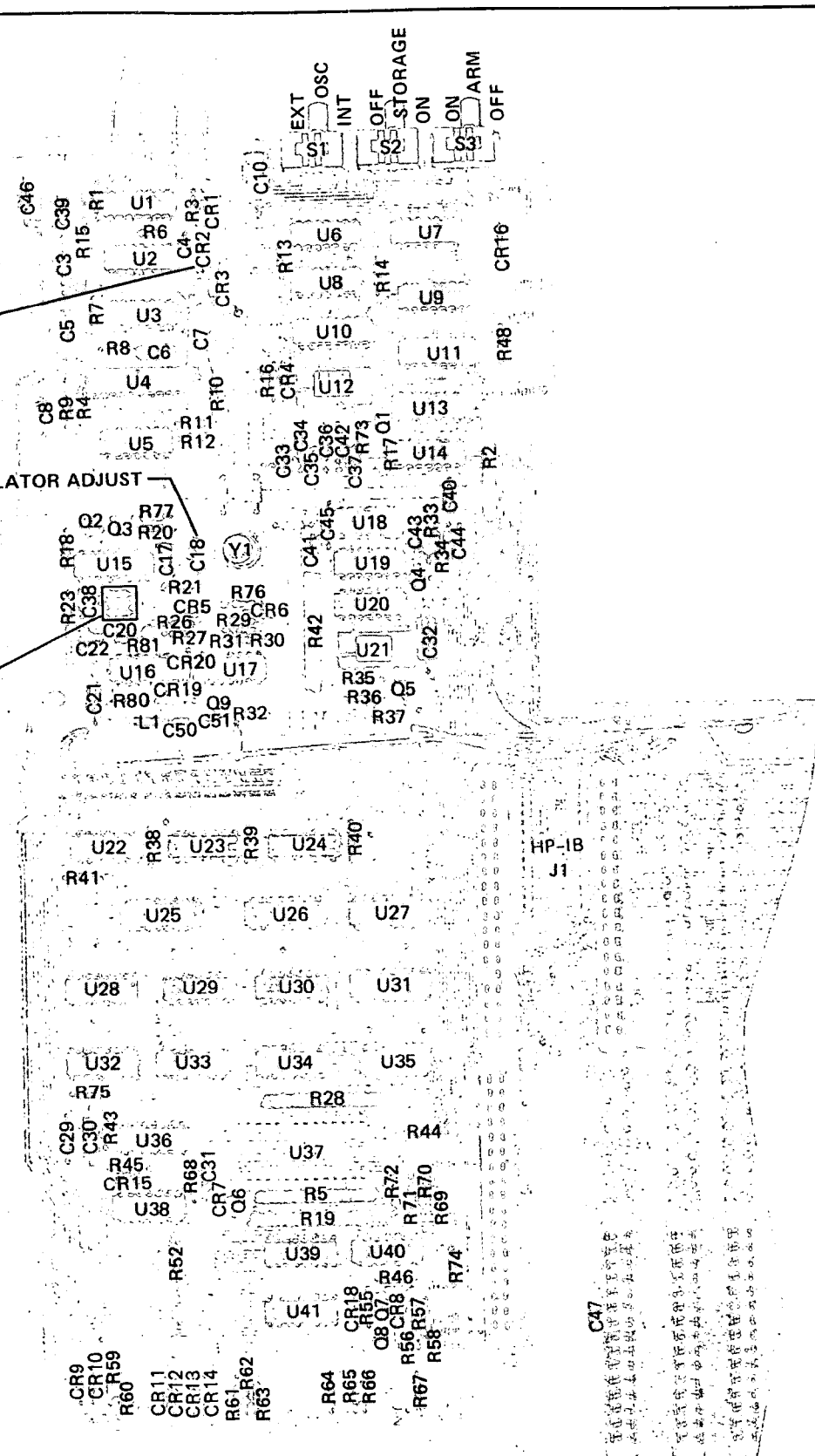
Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1U26	1820-0301	5		IC LCH TTL D-TYPE 4-BIT	01295	SN7475N
A1U27	1820-0301	5		IC LCH TTL D-TYPE 4-BIT	01295	SN7475N
A1U28	1820-0538	0	2	IC GATE TTL NOR DUAL 4-INP	01295	SN7423N
A1U29	1820-0282	1		IC GATE TTL EXCL-OR QUAD 2-INP	01295	SN7486N
A1U30	1820-0282	1		IC GATE TTL EXCL-OR QUAD 2-INP	01295	SN7486N
A1U31	1820-0301	5		IC LCH TTL D-TYPE 4-BIT	01295	SN7475N
A1U32	1820-0538	0		IC GATE TTL NOR DUAL 4-INP	01295	SN7423N
A1U33	1820-0174	0		IC INV TTL HEX	01295	SN7404N
A1U34	1820-0174	0		IC INV TTL HEX	01295	SN7404N
A1U35	1820-0174	0		IC INV TTL HEX	01295	SN7404N
A1U36	1820-0174	0		IC INV TTL HEX	01295	SN7404N
A1U37				NOT ASSIGNED		
A1U38	1820-0661	0		IC GATE TTL OR QUAD 2-INP	01295	SN7432N
A1U39	1820-0214	9	1	IC DCDR TTL BCD-TO-DEC 4-TO-10-LINE	01295	SN7442AN
A1U40	1820-0054	5	1	IC GATE TTL NAND QUAD 2-INP	01295	SN7400N
A1U41	1820-1644	1	1	IC DCDR TTL LS BCD-TO-7-SEG 4-TO-7-LINE	01295	SN74LS248N
A1XA1				NOT ASSIGNED		
A1XA2				NOT ASSIGNED		
A1XA3	1251-2035	9	4	CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-2035
A1XA4A	1251-2026	8	9	CONNECTOR-PC EDGE 18-CONT/ROW 2-ROWS	28480	1251-2026
A1XA4B	1251-2026	8		CONNECTOR-PC EDGE 18-CONT/ROW 2-ROWS	28480	1251-2026
A1XA5	1251-2035	9		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-2035
A1XA5B	1251-2026	8		CONNECTOR-PC EDGE 18-CONT/ROW 2-ROWS	28480	1251-2026
A1XA6	1251-2035	9		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-2035
A1XA7	1251-2035	9		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-2035
A1XA8A	1251-2026	8		CONNECTOR-PC EDGE 18-CONT/ROW 2-ROWS	28480	1251-2026
A1XA8B	1251-2026	8		CONNECTOR-PC EDGE 18-CONT/ROW 2-ROWS	28480	1251-2026
A1XA9				NOT ASSIGNED		
A1XA10	1251-2026	8		CONNECTOR-PC EDGE 18-CONT/ROW 2-ROWS	28480	1251-2026
A1XA11	1251-2026	8		CONNECTOR-PC EDGE 18-CONT/ROW 2-ROWS	28480	1251-2026
A1XA12	1251-2026	8		CONNECTOR-PC EDGE 18-CONT/ROW 2-ROWS	28480	1251-2026
A1XA13				NOT ASSIGNED		
A1XA14	1251-2026	8		CONNECTOR-PC EDGE 18-CONT/ROW 2-ROWS	28480	1251-2026
A1XJ1	1200-0567	1	2	SOCKET-IC 28-CONT DIP DIP-SLDR	28480	1200-0567
A1XU1-				NOT ASSIGNED		
A1XU3				NOT ASSIGNED		
A1XU4	1200-0639	8	1	SOCKET-IC 20-CONT DIP DIP-SLDR	28480	1200-0639
A1XU5-				NOT ASSIGNED		
A1XU11				NOT ASSIGNED		
A1XU12	1200-0473	8	2	SOCKET-IC 16-CONT DIP DIP-SLDR	28480	1200-0473
A1XU13-				NOT ASSIGNED		
A1XU20				NOT ASSIGNED		
A1XU21	1200-0473	8		SOCKET-IC 16-CONT DIP DIP-SLDR	28480	1200-0473
A1XU22-				NOT ASSIGNED		
A1XU36				NOT ASSIGNED		
A1XU37	1200-0567	1		SOCKET-IC 28-CONT DIP DIP-SLDR	28480	1200-0567
A1XY1	1200-0153	1	1	SOCKET-XSTR 3-CONT TO-5 DIP-SLDR	28480	1200-0153
A1Y1	0410-0405	0	1	CRYSTAL-QUARTZ 10.000 MHZ	28480	0410-0405

See introduction to this section for ordering information  
\*Indicates factory selected value

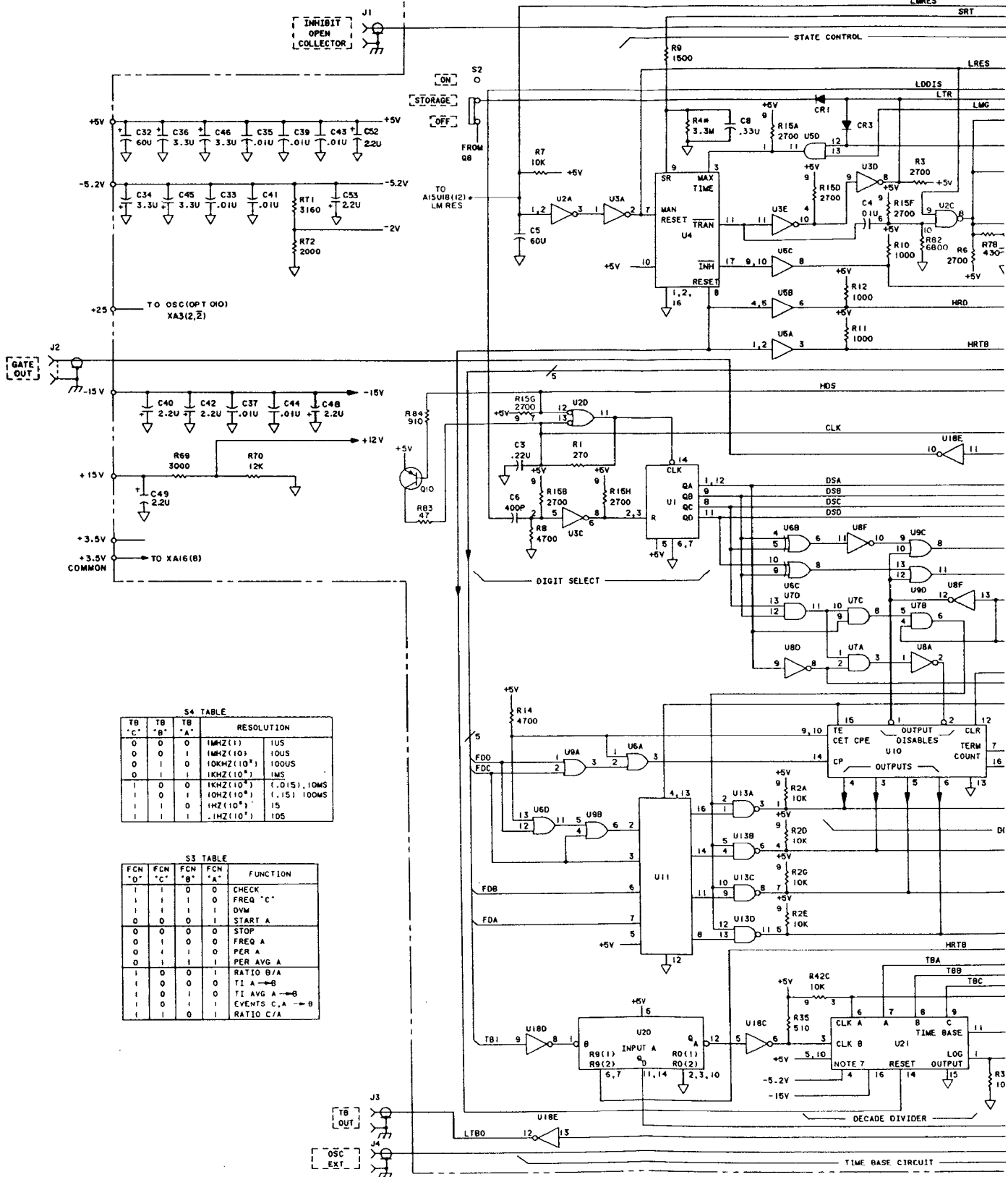
CR2 REPLACED BY  
R78 (430Ω) IN  
INSTRUMENTS WITH  
SERIAL PREFIX 1608A  
AND HIGHER

OSCILLATOR ADJUST

R22  
R24  
R25



C47



**S4 TABLE**

T8 C*	T8 B*	T8 A*	RESOLUTION
0	0	0	1MHZ(1) 1US
0	0	1	1MHZ(10) 10US
0	1	0	10KHZ(10 <sup>2</sup> ) 100US
0	1	1	1KHZ(10 <sup>3</sup> ) 1MS
1	0	0	1KHZ(10 <sup>3</sup> ) (.015), 10MS
1	0	1	10KHZ(10 <sup>4</sup> ) (.15) 100MS
1	1	0	1KHZ(10 <sup>3</sup> ) 1S
1	1	1	1MHZ(10 <sup>4</sup> ) 10S

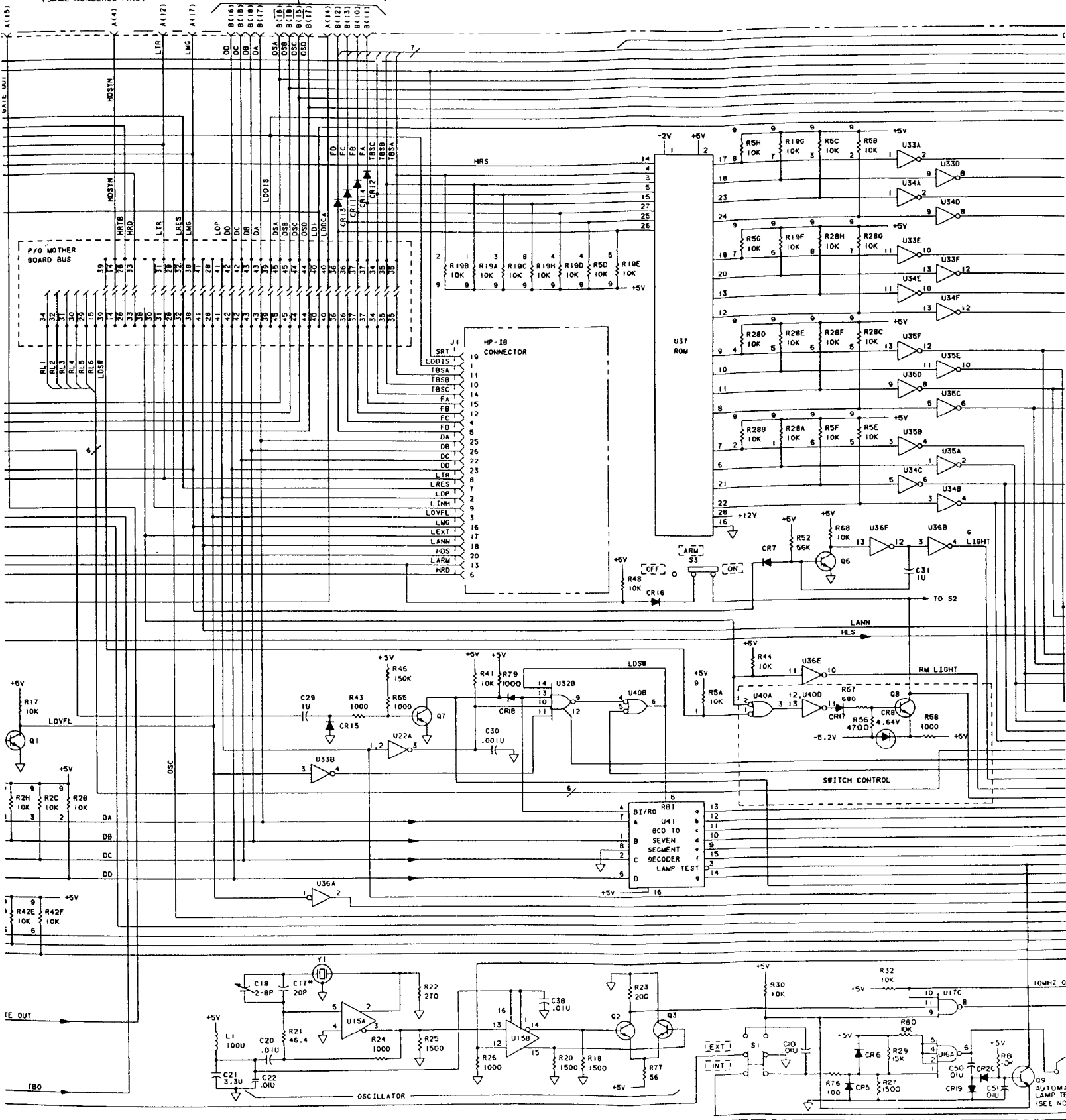
**S3 TABLE**

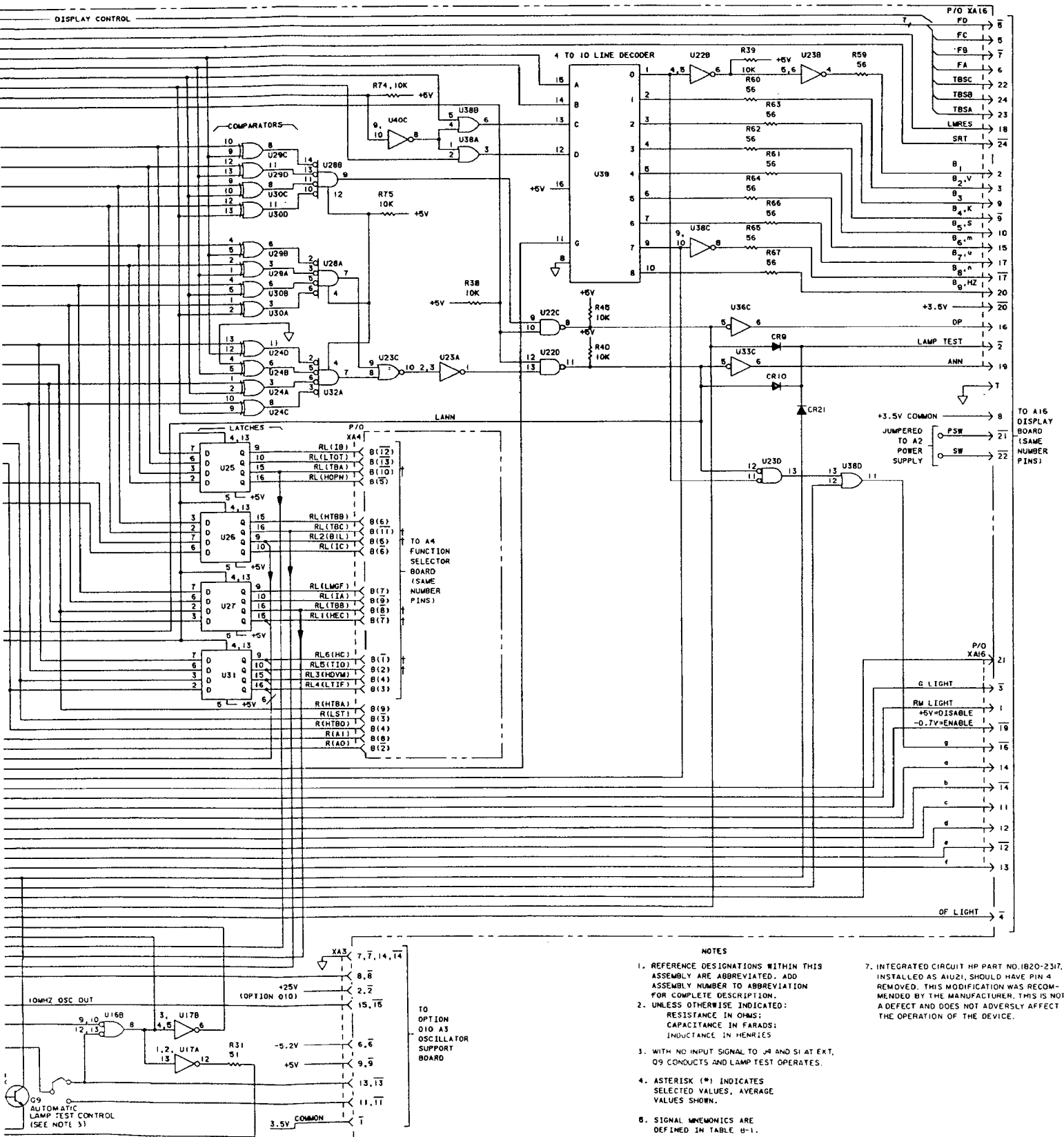
FCM O*	FCM C*	FCM B*	FCM A*	FUNCTION
1	1	0	0	CHECK "C"
1	1	1	0	FREQ "C"
1	1	1	1	DVM START A
0	0	0	0	STOP
0	1	0	0	FREQ A
0	1	1	0	PER A
0	1	1	1	PER AVG A
1	0	0	1	RATIO B/A
1	0	0	0	TI A → B
1	0	1	0	TI AVG A → B
1	0	1	1	EVENTS C, A → B
1	1	0	1	RATIO C/A





10 A4 FUNCTION SELECTOR BOARD  
(SAME NUMBERED PINS)





- 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 FARADS; INDUCTANCE IN HENRIES.
  3. WITH NO INPUT SIGNAL TO J4 AND S1 AT EXT. Q9 CONDUCTS AND LAMP TEST OPERATES.
  4. ASTERISK (\*) INDICATES SELECTED VALUES, AVERAGE VALUES SHOWN.
  5. SIGNAL MNEMONICS ARE DEFINED IN TABLE 0-1.
  6. DAGGER (†) INDICATES NO FUNCTIONAL CONNECTION-NOT USED ON ASSEMBLY.
  7. INTEGRATED CIRCUIT HP PART NO. 1B20-2317, INSTALLED AS AIU21, SHOULD HAVE PIN 4 REMOVED. THIS MODIFICATION WAS RECOMMENDED BY THE MANUFACTURER. THIS IS NOT A DEFECT AND DOES NOT ADVERSELY AFFECT THE OPERATION OF THE DEVICE.

Figure 7-1. A1 Motherboard Schematic Diagram  
7-7

*Figure 7-1*  
**A1 MOTHERBOARD SCHEMATIC DIAGRAM**

(See Page 7-7)

## SECTION VIII SERVICE

### 8-1. INTRODUCTION

This manual section contains:

- service information
- circuit diagrams
- principles of operation

### 8-2. PAGE AND REFERENCE NUMBERING

This is "Section 8" of the "5328B Operating and Service Manual".

All page numbers, (sub)section numbers, "Figure" numbers, and "Table" numbers in this section begin "8-".

In the first "general" part of this section, the reference numbers have only two parts:

- The section identifier, "8-", and ...
- A suffix number, assigned serially for each category of reference (tables, figures, etc.).

In the portions of this section dealing with specific areas of the Model 5328B, the reference numbers have three parts:

- The section identifier, "8-", and ...
- The sub-section identifier "A-", "B-", "C-", or "D-" and ...
- A suffix number, assigned serially for each category of the sub-section reference.

Sub-section A covers the Main Counter and Function Selector. Sub-section "B" covers the Input Options. sub-section "B" is further divided to describe each option and is labeled with a second letter of "A", "B", or "C" following the sub-section designator "B".

Sub-section "8-BA- " describes the Programmable Input Module  
Sub-section "8-BB- " describes the Digital Voltmeter Module  
Sub-section "8-BC- " describes the Channel C Module

Sub-section "C" describes the Hewlett Packard Interface Bus (HP-IB) board.

Sub-section "D" describes the Power Supply board.

This approach parallels the organization of Model 5328B. For example, material related to the HP-IB area of the Model 5328B is referenced by numbers beginning "8-C-".

### 8-3. SAFETY CONSIDERATIONS

This section contains warnings and cautions that must be followed for your protection and to avoid damage to the equipment.

**WARNING**

**MAINTENANCE DESCRIBED HEREIN IS PERFORMED WITH POWER SUPPLIED TO THE MODEL 5328B, AND PROTECTIVE COVERS REMOVED. SUCH MAINTENANCE SHOULD BE PERFORMED ONLY BY SERVICE-TRAINED PERSONNEL WHO ARE AWARE OF THE HAZARDS INVOLVED (FOR EXAMPLE, FIRE AND ELECTRICAL SHOCK). WHERE MAINTENANCE CAN BE PERFORMED WITHOUT POWER APPLIED, THE POWER SHOULD BE REMOVED.**

Some of the procedures in this manual section require removal of one or more of the Model 5328B's covers. Removal of a cover may allow access to a potentially lethal voltage. Be sure to use adequate protective measures to prevent personal injury.

The Model 5328B has a chassis ground which is connected to earth ground through a ground wire in the power cable, when the unit's main power cable is connected to a suitably-wired outlet. You should not attempt to defeat this grounding arrangement. If you suspect that a satisfactory ground cannot be obtained because of a fault in the power cable, replace the power cable.

#### **8-4. CIRCUIT DIAGRAMS**

A listing of the circuit diagrams (and related Parts List tables) is provided in Table 8-1.

Each circuit diagram contains:

- a table that shows all reference designations used for the assembly
- a table of active elements (diodes, transistors, and integrated circuits), including part numbers.

The schematic diagrams contain "to/from" information for inputs and outputs. This information is supplemented by an overall interconnection diagram of the Motherboard (A1) and a block diagram of each assembly.

#### **8-5. SCHEMATIC DIAGRAM SYMBOLS**

A listing of some of the symbols used in the schematic diagrams in this manual is provided in of Figure 8-1.

#### **8-6. REFERENCE DESIGNATIONS**

Assemblies such as printed circuit boards are assigned reference designation numbers in sequence — "A1", "A2", etc.

As shown in Figure 8-2, subassemblies within an assembly are given a subordinate "A" reference designation. For example, rectifier subassembly "A1" has the complete designation "A25A1".

For an individual component, the complete designator is created by adding the reference designators of the assembly and subassembly (if any) of which it is a part; for example the complete reference designation for diode "CR1" on the rectifier subassembly (see Figure 8-D-2) ("A25A1") is "A25A1CR1".

Table 8-1. Circuit Diagrams

Assy Ref Des	Description	HP Part No.	Circuit Diagram	Parts List Table
A1	Motherboard Assembly	05328-60001	8-A-10	6-2
A2	Power Supply Assembly	05328-60034	8-D-2	6-3
A3	Support Board Assembly	05328-60018	8-A-15	6-4
A3A1	Quartz Oscillator — 10 MHz	10811-60111		6-4
A4	Function Selector Assembly	05328-60005	8-A-13	6-5
A5	PS Autorange Assembly (See NOTE 1)	05328-60012	8-BB-2	6-6
A6	Buffer Amplifier Assembly (See NOTE 1)	05328-60013	8-BB-3	6-6
A7	VF Converter Assembly (See NOTE 1)	05328-60014	8-BB-4	6-6
A8	1300 MHz C Channel Assembly (See NOTE 2)	05328-60025	8-BC-3	6-7
A8A1	1.3 GHz Board Assembly (See NOTE 2)	05305-60006	8-BC-2	6-7
A9	Not Assigned			
A10	Synchronizer Assembly	05328-60020	8-BA-9	6-8
A11	DAC Assembly	05328-60023	8-BA-11	6-8
A12	Amplifier Assembly	05328-60041	8-BA-8	6-8
A13	Not Assigned			
A14	Multiplier Assembly	05328-60010	8-BA-10	6-8
A15	HP-IB Interface Assembly <sup>1</sup>	05328-60043	8-C-2	6-9
A16	Display Assembly	05328-60033	8-A-14	6-10
A17	DVM Front Board Assembly (See NOTE 1)	05328-60015		6-6
A18	Not Assigned			
A19	Switch Control Assembly	05328-60021	8-BA-7	6-8
NOTES —				
1. Part of (optional) Digital Voltmeter (Option 021 or part of Option 050)				
2. Part of (optional) 90-1300 MHz "C" Channel (Option 031 or part of Option 050)				

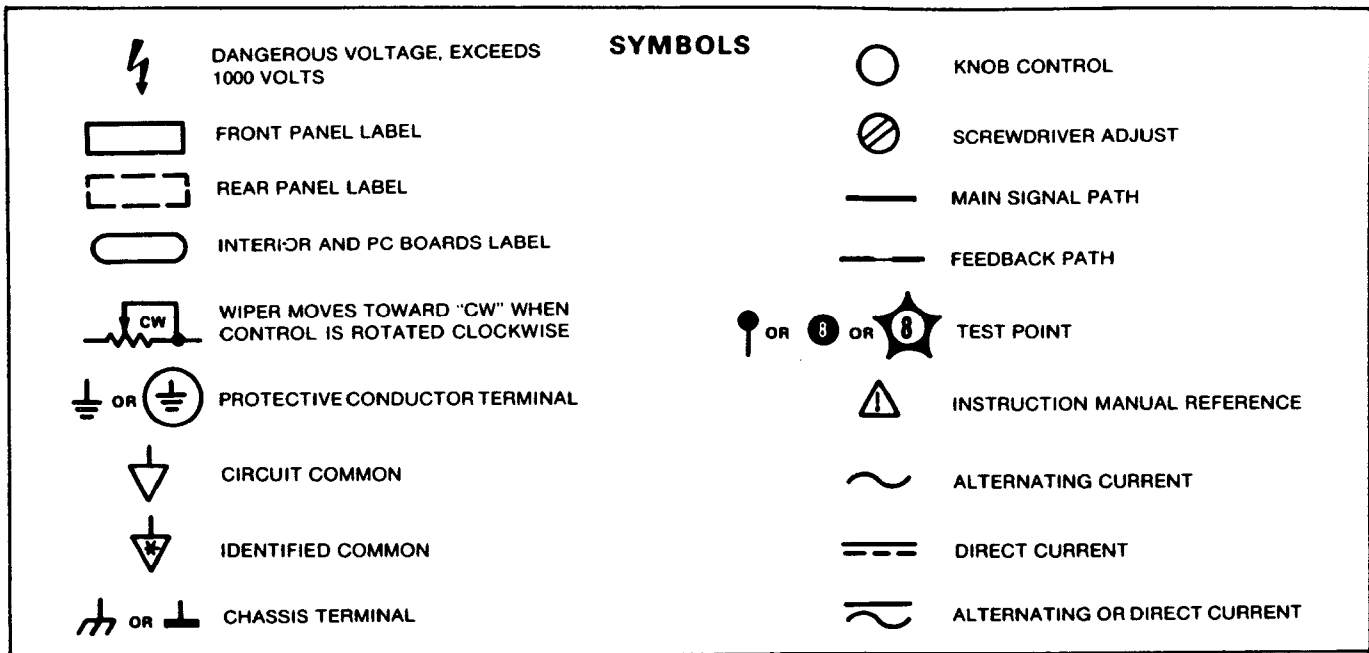


Figure 8-1. Schematic Diagram Symbols

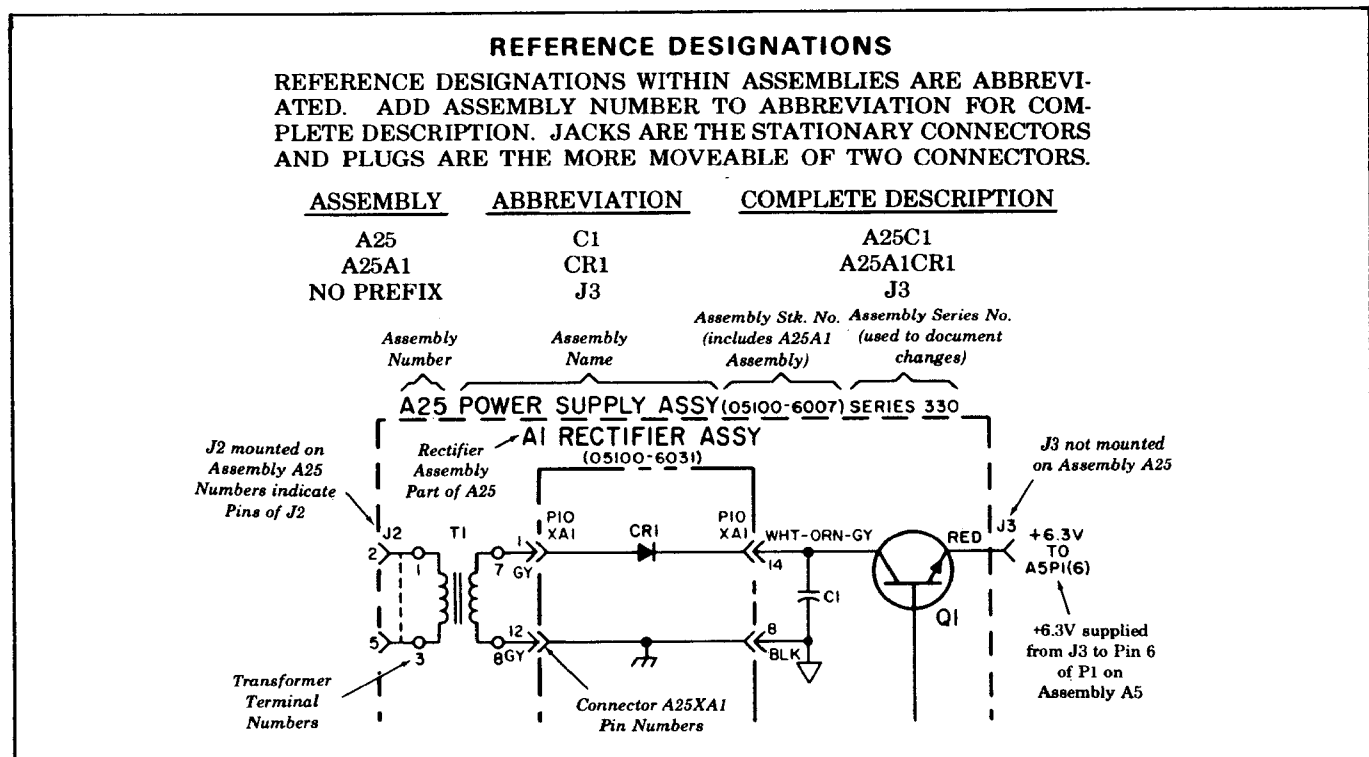


Figure 8-2. Reference Designations

### 8-7. SIGNAL NAMES

In general, the signal names used in the Model 5328B provide a very good indication of what that particular signal does. A listing of most of the Model 5328B's signal names is provided in Table 8-2.



Table 8-2. Signal Names and Descriptions

MNEMONIC	DESCRIPTION
$\frac{A}{\bar{A}}$	Output of Time Interval Unit, A Channel. ECL levels.
R(A0) R(A1)	Nonlatched ROM bits that drive Arming Multiplexer select lines on Function Selector. TTL levels.
$\frac{B}{\bar{B}}$	Output of Time Interval Unit, B Channel ECL levels.
$\frac{C}{\bar{C}}$	Output of C module, the carry input for the FS decade. ECL levels.
C ARM	Active high TTL line used for module C arming measurement.
CLK	Clock. Digital Address Clock to display. TTL levels.
Data A Data B Data C Data D	TTL 4-bit BCD code. Data going to display and HP-IB.
Digit A Digit B Digit C Digit D	TTL 4-bit digit address code. Controls interchange of data.
DVM	Frequency line counted by Function Selector to give display reading. ECL level.
F Code A (FA) F Code B (FB) F Code C (FC) F Code D (FD)	Function code from FUNCTION switch. TTL levels.
FS	Function Selector.
$\frac{GOSC}{\bar{GOSC}}$	Gated oscillator. ECL levels.
HDS	TTL level high disables synchronizers.
HDSA	Used by Option 011 HP-IB Interface to strobe bus data in remote listener.
HLS	TTL level line used to strobe latches.
RL (HOPN)	Latched ROM line which locks open Function Selector main gate.
HPL	Same as LDP.
HRD	High resets decades. TTL active high.
HRS	High strobes 4K ROM. TTL active high.
HRTB	High resets time base. TTL active high. Also resets Function Selector.
R (HTBA)	Nonlatched ROM bit which enables the TTL level Channel A signal from the Function Selector to be counted by the Time Base.
RL (HTBB)	Latch ROM bit which enables the TTL level Channel B signal from the Function Selector to be counted by the Time Base.
R (HTBO)	Nonlatched ROM bit which enables the time base to count the oscillator output.
RL (IA) RL (IB) RL (IC)	TTL level latched ROM bits that drive High Speed Multiplexer select lines on Function Selector.
LL ANN	Low annunciators. TTL active low turns RHS annunciators on. Must be timed with digit address code to display selected annunciators.
LDDCA	Low disable Decade Counting Assembly (DCA). TTL active low disables DCA so that all DCA outputs are high.
LDI	Low disable indicators. TTL active low blanks RHS annunciators and all decimal points.
LDDIS	Low display display. TTL active low blanks display except LHS annunciators.

Table 8-2. Signal Names and Descriptions (continued)

MNEMONIC	DESCRIPTION
LDP	Low decimal point. TTL active low turns decimal points on. Must be time with digit address code to display selected decimal point.
LDSW	Low disable switches. The active low disables the FUNCTION, RESOLUTION, and RESET switches. Allows module control.
LEXT	Low external. TTL active low disables FUNCTION and RESOLUTION switches for external control and lights RMT annunciator.
LINH	Low inhibit. TTL active low inhibits starting new measurement.
LMG	Low main gate. TTL active low indicates main gate open.
RL (LMGF)	Latched ROM bit to Function Selector which selects the main gate F/F on the Function Selector to establish the gate time.
LMRES	Low when RESET signal comes from display. Provides power-up type reset.
LRES	Low reset. TTL active low resets when FUNCTION, RESOLUTION, or RESET switch settings are changed. Also resets when DVM switches are changed. Provides power-up type of reset.
R (LST)	Nonlatched ROM line which is HIGH in stop totalize and LOW is start.
RL (LTOT)	Low totalize. Latched ROM bit low in TOTALIZE mode. TTL level.
LTR	Low transfer. TTL active low used in DCA.
MG MG	Main gate. Accurate signal to drive remote gate such as Channel C. ECL levels.
OSC	10 MHz oscillator. TTL level.
OSC OSC	10 MHz oscillator. ECL levels.
OVFL	Overflow. TTL active low indicates display overflow.
RG	ROM bit. Used to recognize period and institute hysteresis compensation. TTL level.
RL1 (HEC)	Latched ROM bit. TTL level enables Channel C to strobe its digit onto the bus.
RL2 (BIL)	Latched ROM bit. High for time interval average. TTL level.
RL3 (HDVM)	Latched ROM bit. Enables DVM to strobe a minus sign on the display on blank characters. TTL level.
RL4 (LTIF)	Latched ROM bit. TTL level low in Time Interval or Period measurement.
RL5 (TIO)	Latched ROM bit. TTL level used to recognize period average.
RL6 (HC)	Latched ROM bit which turns hysteresis compensation on and has a Time Interval as opposed to a Period measurement made by the Time Interval unit. TTL level.
SRT	The charge node line that controls the sample rate speed.
RL (TBA) RL (TBB) RL (TBC)	Latched ROM bits that drive Time Base Select code inputs.
TBI	TTL signal that drives Time Base.
TBO	Time Base scaled output. TTL levels.
TBS Code A (TBSA) TBS Code B (TBSB) TBS Code C (TBSC)	Time Base Code input to ROM controlled by the Time Base switch. TTL levels.
TI TI	Time interval. Output of Time Interval modulse used in time interval measurements. ECL levels.

Table 8-2. Signal Names and Descriptions (continued)

QUALIFIERS	
SIGNAL	DESCRIPTION
ADDR	H= My Listen Address
ANN	L = Annunciator On
ATN	L = Attention
B0	16 State Sequence Count for Output of ASCII Code
B1	16 State Sequence Count for Output of ASCII Code
B2	16 State Sequence Count for Output of ASCII Code
B3	16 State Sequence Count for Output of ASCII Code
BLK	16 State Sequence Count for Output of ASCII Code
D	H = Decimal Point has been Outputted
DAC	H = Data Accepted
DAV	L = Data is Valid
DIO1	HP-IB Data Bit 1
DIO2	HP-IB Data Bit 2
DIO3	HP-IB Data Bit 3
DIO4	HP-IB Data Bit 4
DIO5	HP-IB Data Bit 5
DIO6	HP-IB Data Bit 6
DIO7	HP-IB Data Bit 7
EOM	H = End of Measurement
J	Always HIGH, used for unconditional jump
LDP	L = Decimal Point On
LIS	H = Address to Listen
LLO	H = Local Lockout On
MA	L = Enable Strobe to Function Select Latch U34 and Select Bit on Module Strobe Code
MB	L = Enable Strobe to Time Base Select Latch U28 and Select Bit on Module Strobe Code
MLT	H = Make Multiple Measurements
MS	H = Module Strobe    L = FC & TB Strobe
OVFL	L = Overflow
ODV	L = Wait until Addressed
RDF	H = Read Data on the fly
REN	L = Remote Enabled
RFD	H = Ready for Data
S	H = Measurement has dimension of time
SP	H = Serial Pole Active
SRQ	L = Service Request
SWL	H = Switch to Local
TALK A	L = Talk Always
TLK	H = Address to Talk

Table 8-2. Signal Names and Descriptions (continued)

OUTPUTS	
SIGNAL	DESCRIPTION
LLIS	Unlisten
HLIS	Listen
LTLK	Untalk
HTLK	Talk
LSP	Serial Poll Disable
HSP	Serial Poll Enable
LMA	Enable Function Code Latch Input, Module Select Code. Also used in putting out Exponent
HMA	Opposite of LMA
LS	Measurement does not have dimension of time. Output POS EXP
HS	Opposite of LS
HLTCH	Latch Data into U28, U33, or U34
LRMT	Go to Local
HRMT	Go to Remote
LD	Decimal Point has not been outputted
HD	Decimal Point has been outputted
LMB	Enable Time Base Code Latch Input, Module Select Code. Also used in putting out Exponent
HMB	Opposite of LMB
LMS	Enable Function and Time Base Code Latches, Disable Module Strobe Line
HMS	Opposite of LMS
LDAV	5328A says Data Not Valid
HDAV	5328A says Data Valid
LRFD	5328A says Not Ready for Data
HRFD	5328A says Ready of Data
LDAC	5328A says Data not Accepted
HDAC	5328A says Data Accepted
LLO	Local Lockout Off
HLO	Local Lockout On
LEOM	Reset End of Measurement F/F (U11B)
HIC	Initialize 16 State Counter
HDSA	Strobe Mainframe Display and 16 State Counter
LRPR	Turn OFF Master Remote Programming Reset
HRPR	Turn ON Master Remote Programming Reset
LDDIS	Low Disable Display. TTL active low turns blanks display except LHS Annunciators
HDDIS	Opposite of LDDIS
LINH	Inhibit Counter from Arming
LRST	Turn OFF Counter Mainframe Reset
HRST	Turn ON Counter Mainframe Reset
LSRQ	Output (on U15, U24) Binary 0 on ASCII Bus
HSRQ	Output (on U15, U24) Binary 64 on ASCII Bus
ASP	Output (on U15, U24) ASCII space
LDAO	Output (on U15, U24) all HIGHS on Bus and Disarm DAC Line
HDAO	Output (on U15, U24) all HIGHS on Bus and Arm DAC Line All succeeding bits put out on U15, U24 to be put on HP-IB as ASCII Characters
ADIG	ASCII Digit from Display
ALF	ASCII Line Feed
A0	ASCII 0
ACR	ASCII Carriage Return
AE	ASCII E
ADP	ASCII Decimal Point
A3	ASCII 3
A6	ASCII 6
A9	ASCII 9
A+	ASCII +
A-	ASCII -
AOVF	ASCII Letter O

## 8-8. IDENTIFICATION MARKINGS ON PRINTED CIRCUIT BOARDS

HP printed circuit boards have four identification numbers (see Figure 8-3):

- the Hewlett-Packard "Part Number"
- the "SERIES" number
- a revision letter
- a production code

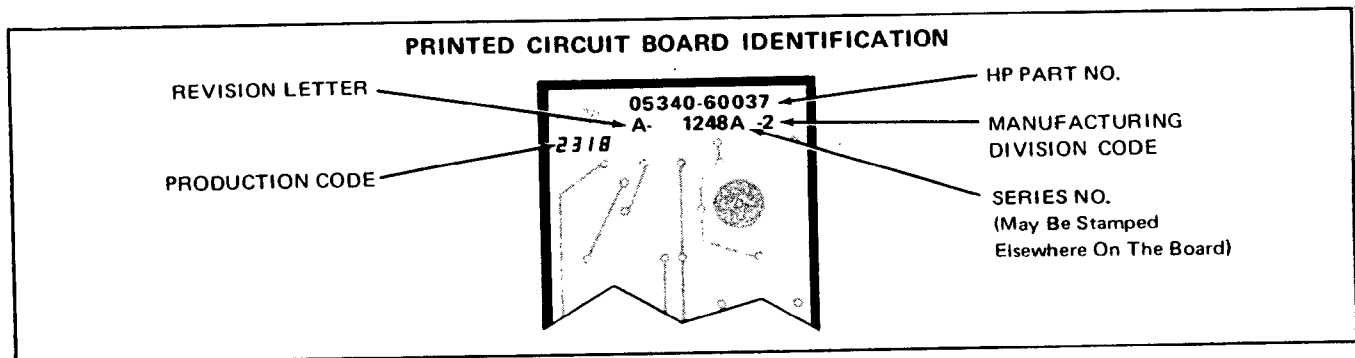


Figure 8-3. Identification Markings on Printed Circuit Boards

## 8-9. Hewlett-Packard Part Number

The Hewlett-Packard Part Number on a 5328B printed circuit board has ten digits (example: "05328-60018"), and is the primary identification. In general, all assemblies having the same part number are interchangeable. When a production change is made to an assembly that makes it incompatible with earlier versions, the HP Part Number is changed.

## 8-10. SERIES Number

The SERIES number (example: "SERIES 2408") is used to document minor changes to a part. As changes are made, the SERIES number is changed. When a replacement board is ordered, it may have a SERIES number that is different (typically higher) than that of the board it replaces. If there is a difference between the SERIES number marked on the board and the SERIES number indicated on the circuit diagram for that board, a minor difference exists. If the SERIES number on the board is lower than that on the schematic, refer to Section 7 of this manual for backdating information. If the SERIES number on the board is higher than that on the schematic in this manual, refer to the "Manual Changes" supplement that accompanies the manual for information. If the "Manual Changes" supplement is missing, contact your local Hewlett-Packard Sales and Service Office (see listing at the back of this manual).

## 8-11. Revision Letter

A "revision letter" ("A", "B", etc.) denotes a change in the layout of a printed circuit. For example, if a capacitor's type is changed (its electrical value can stay the same), and requires different spacing for its leads, the printed circuit board's layout is changed; the board's revision letter is changed to indicate this change. When a revision letter changes, the board's SERIES number is also usually changed.

## 8-12. Production Code

The production code is the four-digit seven-segment number used for production purposes.

### 8-13. Special Symbols

A triangle ("△") or square ("□") may be used on a printed circuit board to help in identifying such important things as —

- pin "1" of a DIP or flat-pack IC
- pin "1" of a resistor pack
- the tab of a "TOx" case
- the "+" side of an electrolytic capacitor
- the cathode end of a diode
- section "1" of a DIP switch

### 8-14. ASSEMBLY LOCATIONS AND COMPONENT LOCATORS

Figure 8-4, Figure 8-5, and Figure 8-6 show the front, rear, and top views of the Model 5328B, respectively. The front (Figure 8-4) and rear (Figure 8-5) views show reference designators of the front and rear panel controls, connectors, and indicators.

The top view (Figure 8-6) shows assembly locations.

The component locator for each printed circuit assembly is shown next to the schematic diagram for that assembly.

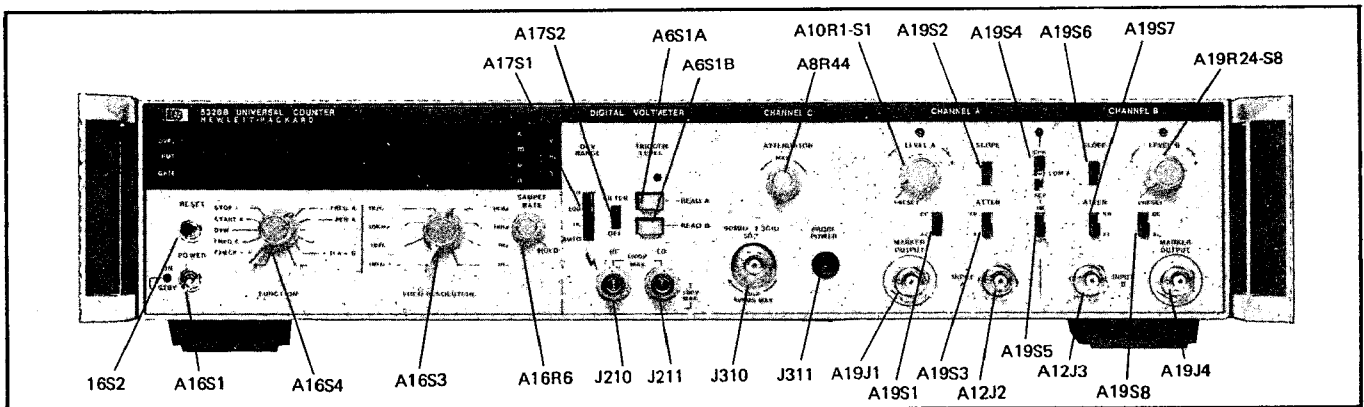


Figure 8-4. Model 5328B Front View

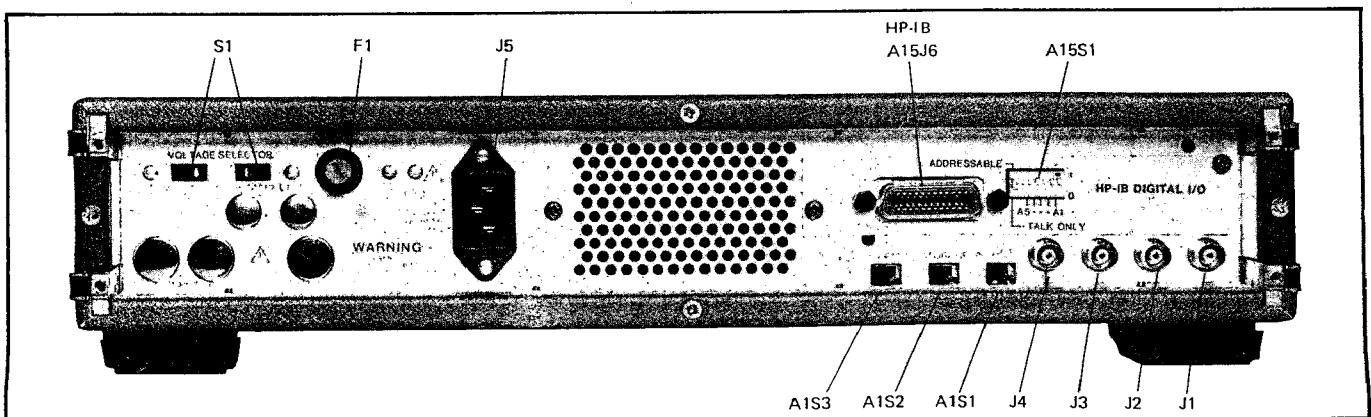


Figure 8-5. Model 5328B Rear View

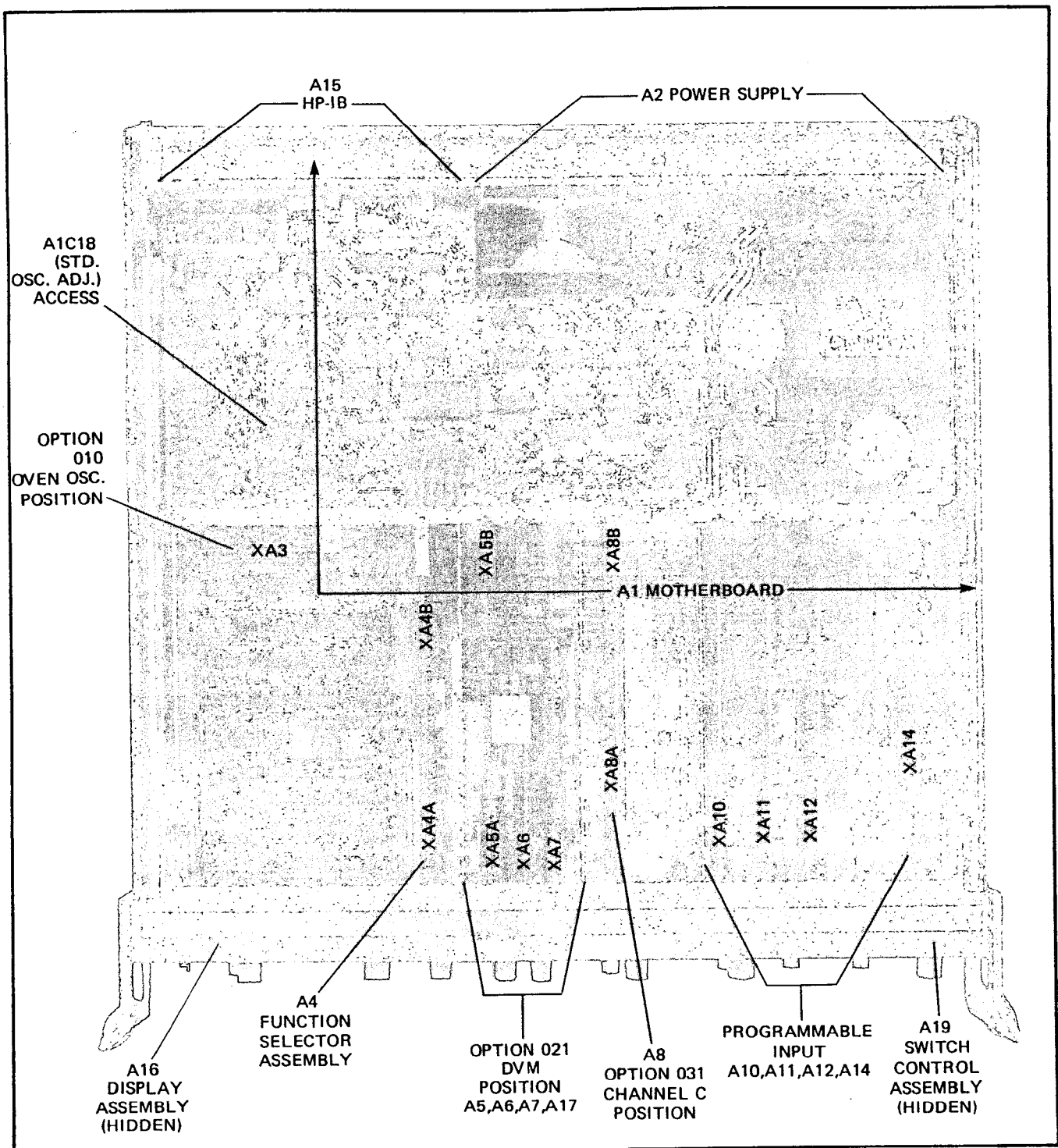


Figure 8-6. Model 5328B Top Internal View

### 8-15. FACTORY-SELECTED COMPONENTS

Factory selected parts are identified by an asterisk (“\*”) on the schematic and in the parts list. The nominal value is shown in the schematic and listed in the table of replaceable parts. A table on the schematic lists factory-selected parts by reference designator. The normal range of values are shown and the factors affecting part selection are described.

### 8-16. OVERALL DESCRIPTION

The Model 5328B is a basic universal counter mainframe that supports several options. As shown in the Overall Block Diagram (Figure 8-7), the counter is organized into several relatively independent sections that communicate via an internal 90-line bus system. Detailed descriptions of the counter's various sections are provided.

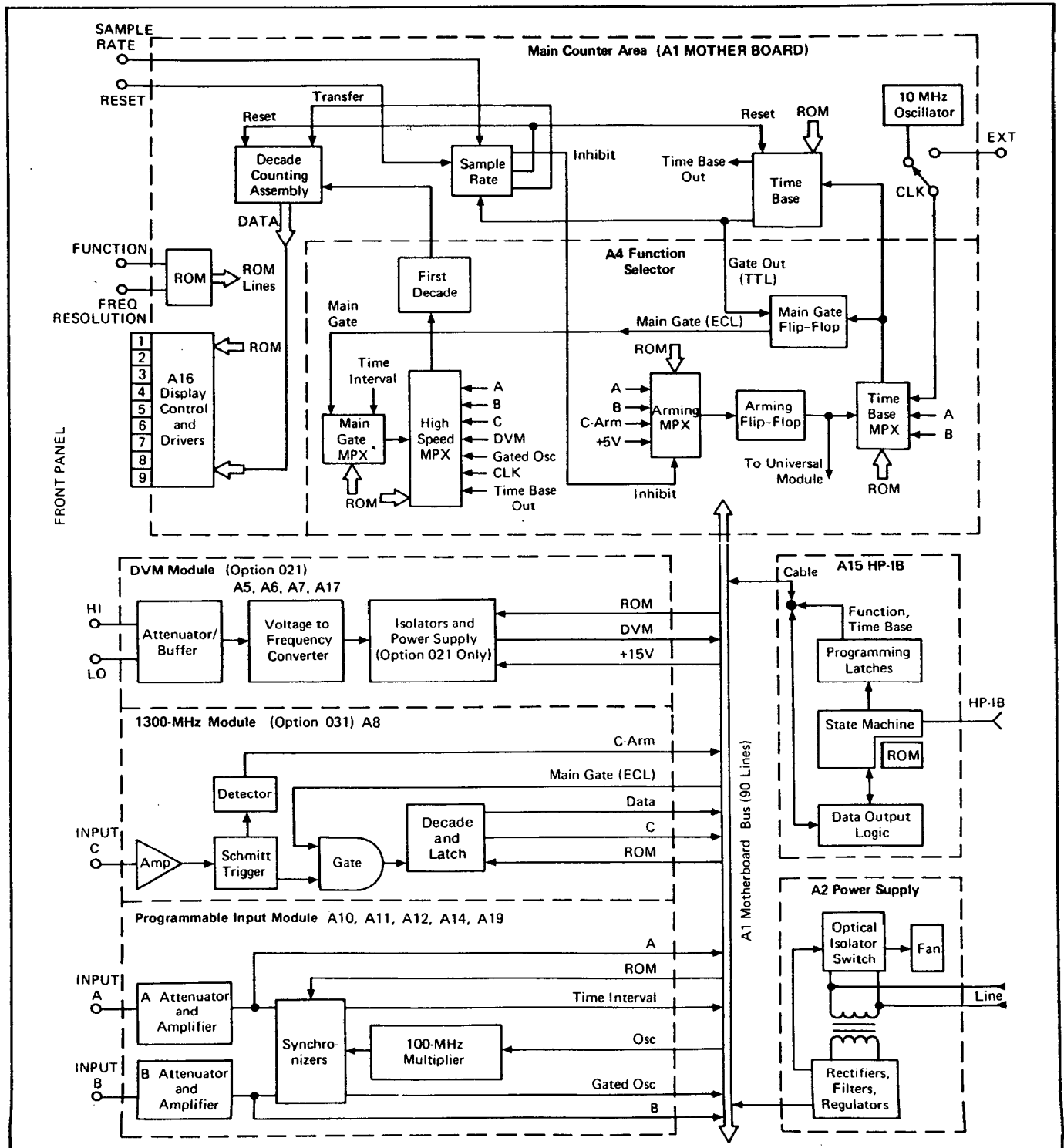


Figure 8-7. Overall Block Diagram



## 8-17. TROUBLESHOOTING OVERVIEW

The 5328B counter will be segmented into 6 different sections for the purpose of troubleshooting. See Figure 8-8.

Each of these sections performs an independent function and can be viewed as a potential problem center in a troubleshooting sense. These sections are listed below:

- Power Supply Section
- Main Counter Section
- Input Section
- HP-IB Section
- DVM Section (Option 021)
- Channel C Section (Option 031)

This sectioning closely parallels the division of the counter into operating sections as described in the overall description. The first four sections comprise the main counter and the other two sections are for extended capabilities. The HP-IB board allows remote operation of the 5328B through controllers. Option 021 allows the counter to make DC measurements of external voltages and internal counter trigger levels for more accurate time interval measurements. Option 031 adds a C Channel to the 5328B extending the frequency range of the counter to 1300 MHz.

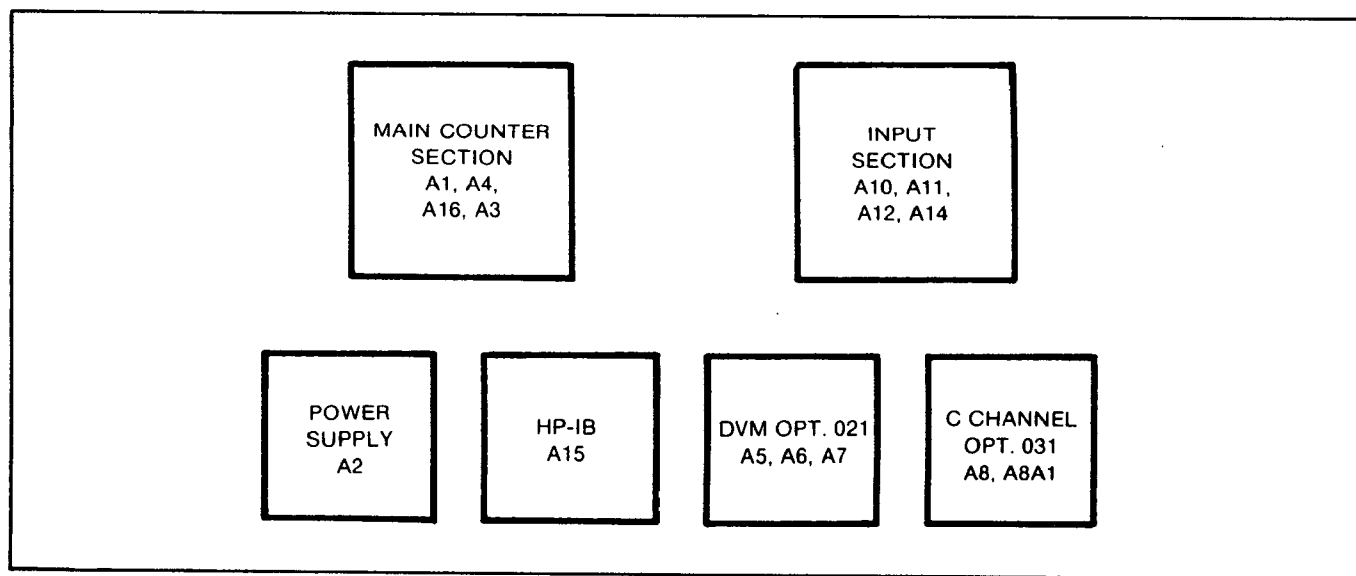


Figure 8-8. Independent Sections For Troubleshooting

Troubleshooting is approached in a hierarchical fashion. The troubleshooting procedure:

1. Identifies a faulty section.
2. Identifies a faulty board within that section.
3. Identifies the faulty component(s) on that board.

## 8-18. Troubleshooting Methodology

There are two methods to approach the troubleshooting of the counter:

1. The branching approach
2. The sequential approach

### 8-19. Branch Mode troubleshooting

In the Branching mode, identify the faulty section(s) by observing the failure symptoms and relating them to the function of each section as shown in Figure 8-9. Table 8-3, Symptoms-to-Section Troubleshooting lists some of the more common failure symptoms and the sections that they are probably related to. This is not an exhaustive list and could be greatly supplemented by experience in troubleshooting the 5328B counter. The Branching approach towards troubleshooting is not foolproof but can greatly reduce troubleshooting time by localizing the problem without sequentially going through all the sections of the counter. Upon identifying the faulty section, the next step is to identify the faulty board within that section and then troubleshooting the board to component level.

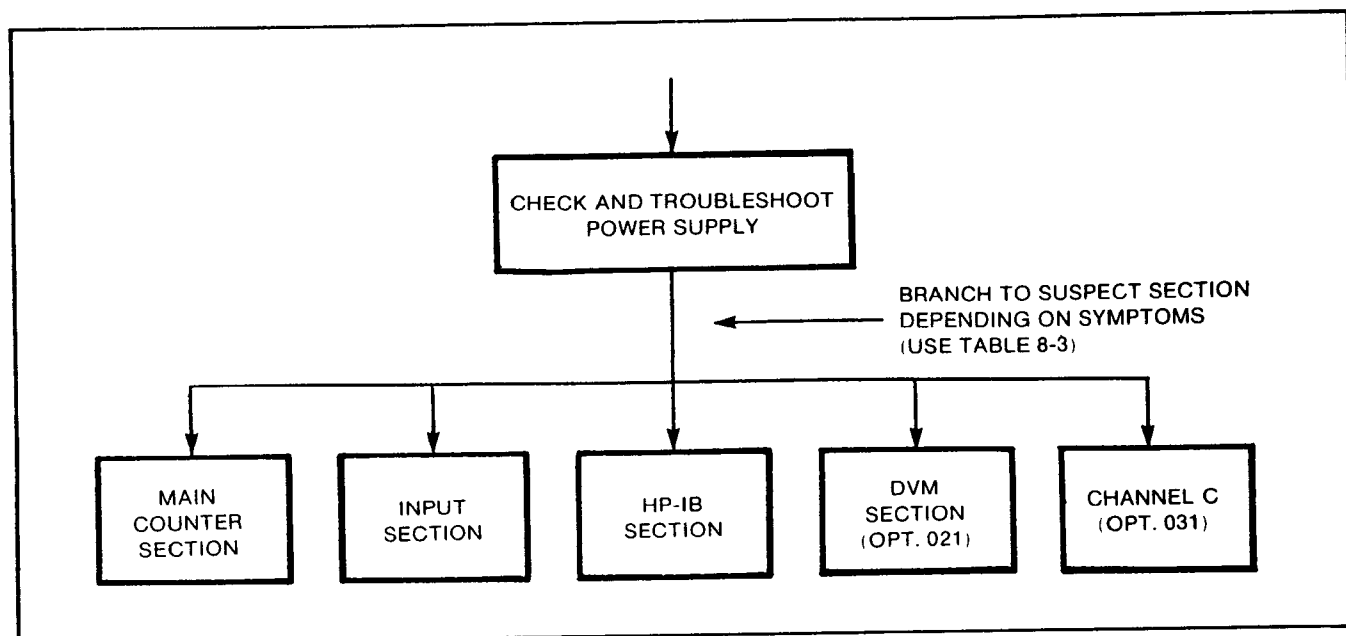


Figure 8-9. Branching Mode Troubleshooting

### 8-20. Sequential Mode Troubleshooting

In the Sequential troubleshooting mode, move through the sections of the counter shown in Figure 8-10. The sequence in Figure 8-10 is based upon a history of past failures and ease of troubleshooting each section. Depending upon the failure symptoms and prior troubleshooting experience, this sequence may be changed. The sequential method is more time consuming than branching but is more reliable in discovering a fault.

In both these troubleshooting approaches it is advisable to first check the power supply voltages before proceeding as these voltages are critical to the proper operation of every one of the sections. Also, power supply voltage variations or failures are the most common cause of failures in the 5328B.

Using either of the methods described, branching or sequential, the next step is to troubleshoot each faulty section. This will be discussed in the next few paragraphs.

### 8-21. Special Extender Board (HP Part Number 05328-62016)

A special extender board is available to make testing of certain parts of the Model 5328B easier.

Two of these boards are required to extend the A4 Function Selector.

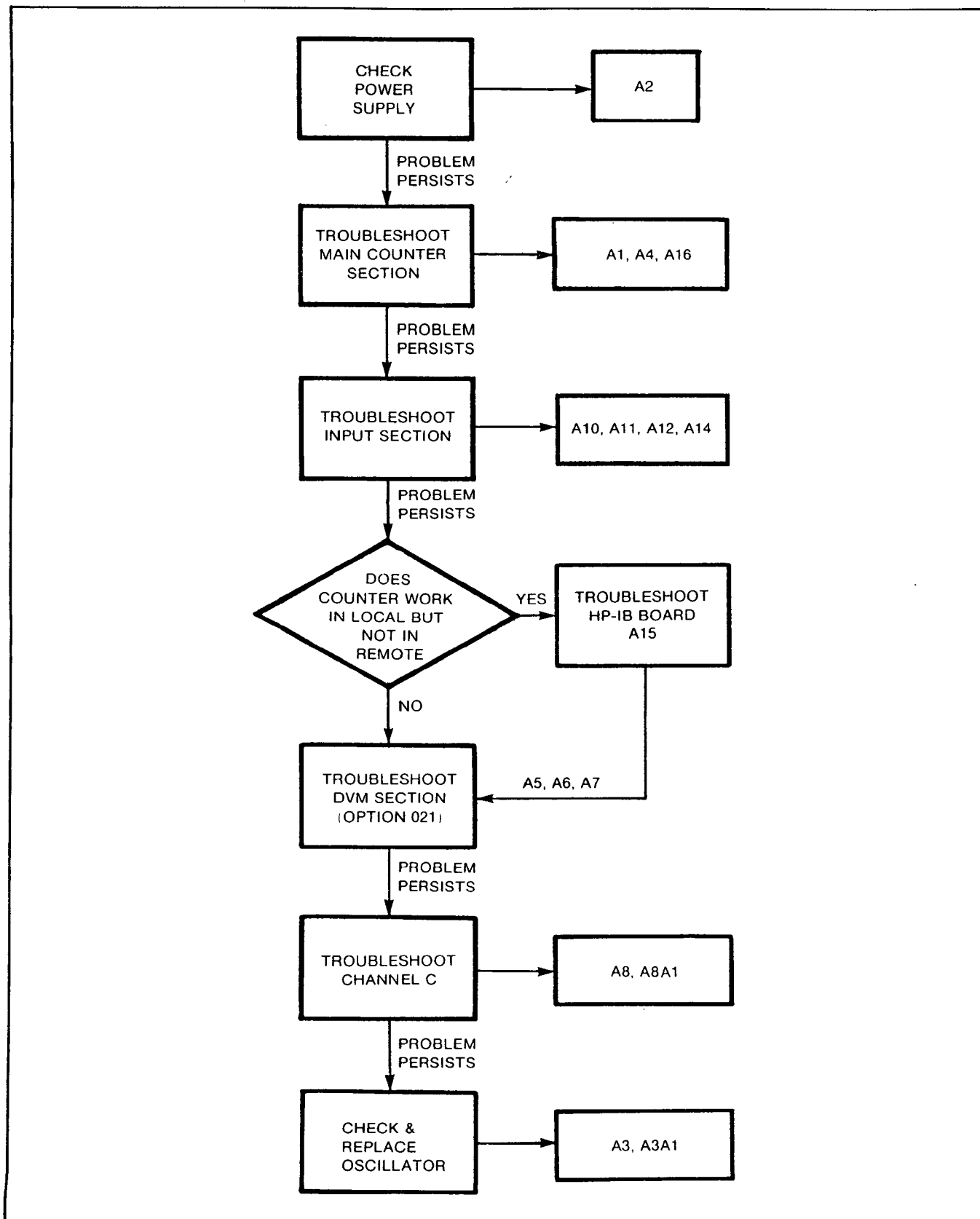


Figure 8-10. Sequential Mode Troubleshooting

## 8-22. Troubleshooting Kit 05328-60131

The troubleshooting kit consists of test cards for troubleshooting the Main Counter Section and an HP-IB test kit for troubleshooting the HP-IB board.

The kit is recommended to reduce troubleshooting time for the HP5328B.

The troubleshooting kit consists of the following parts:

Test Cards:

- Card 1: 05328-21004
- Card 2: 05328-22004

HP-IB (A15) Board Troubleshooting:

- 05328-13306: Cassette containing the HP55005A Logic Troubleshooting System and characterization data
- 05328-90106: HP-IB Troubleshooting Procedure
- 05328-13306: Modified 8120-2176 Ribbon Cables (2)
- 10230-62101: Grabber Clips (6)
- 1400-0734: 16 pin IC Test Clip (2)
- 05005-60116: Probe Ground (wire) used as a jumper
- 05328-90106: Troubleshooting Procedure for the troubleshooting kit

The following accessories are used with the test kit but are not included:

- HP 5005B Signature Multimeter
- HP85F Interfacing System containing:
  - HP85 Personal Computer
  - HP82936A ROM Drawer
  - HP82937A HP-IB Interface Module
  - 00085-15003 I/O Module
  - HP82903A 16K Memory Module
  - 00085-15005 Advanced Program ROM

Table 8-3. Symptoms to-Section Troubleshooting

Symptom	Probable Faulty Section	Probable Faulty PC Board
1. Display Blank even when reset. Power Supply OK.	Main Counter	A1/A16
2. Strange Digits	Main Counter	A1
3. No Decimal Points or All Decimal Points	Main Counter	A1/A4
4. Decimal Points/2 more Decimal Points	Main Counter	A1/A4
5. No Annunciators or wrong annunciators	Main Counter	A1/A4
6. No measurement/No gate light	Main Counter	A1/A4
7. No Reset	Main Counter	A1/A4
8. No Storage but display counts	Main Counter	A1/A4
9. Gate Time wrong	Main Counter	A1/A4

Table 8-3. Symptoms to-Section Troubleshooting (continued)

Symptom	Probable Faulty Section	Probable Faulty PC Board
10. Wrong Digits	Main Counter	A1/A4
11. No Internal oscillations on bus	Main Counter	A1/A4
12. Oscillator shows wrong frequency	Main Counter	A3/A4
13. No oscillations on bus when in external	Main Counter	A1/A4
14. No output when input is present	Input	A19
15. Offset adjust won't work	Input	A19
16. Counter doesn't work in A or B function	Input	A-10
17. Counter works in Freq. A but not in TI or Period Modes	Input	A10
18. Counter measures TI in PER or PER in TI Modes	Input	A10
19. No period measurements for $F > 10$ MHz	Input	A10
20. Slope switch doesn't work	Input	A10
21. Display blank on RESET	Main Counter	A16
22. One digit blank	Main Counter	A16
23. Segment blank across display	Main Counter	A16
24. BUS annunciators blank	Main Counter	A16
25. Trigger LEDs inoperative or markers inoperative	Input	A12/A19
26. A or P channel trigger level inoperative	Input	A12
27. Front panel input control switches inoperative	Input	A12
28. TI, Freq., Patio, TI or PER Average incorrect, yet trigger LEDs operative	Input	A12/A10
29. Doesn't count in Freq. C but Ok in CHECK	Channel C	A8
30. Sensitivity too high at $F > 500$ MHz	Channel C	A8
31. Sensitivity too low at $F > 400$ MHz	Channel C	A8
32. Double counts on C at high input levels (usually at low freq.)	Channel C	A8
33. No reading on display on DbM input	DbM	A5/A6/A7
34. Unstable voltage reading	DbM	A6/A7
35. Will not blank when in 100 ' or 1000 ' range	DbM	A5
36. No minus sign/Always minus sign	DbM	A5
37. Will not range up/down when in auto	DbM	A5

## **8-A-1. MOTHERBOARD ASSEMBLY (A1)**

### **8-A-2. General**

The Motherboard's two main circuit sections are the Model 5328B's Main Counter Section (shown at the top of the Overall Block diagram, Figure 8-7) and the multi-conductor bus that connects the counter's various functional areas. The bus is shown as a broad double-headed arrow at the lower right-hand corner of the diagram.

### **8-A-3. Main Counter Section**

The Model 5328B's Main Counter Section, shown at the top of the Overall Block Diagram (Figure 8-7), is contained entirely on the Motherboard Assembly (A1). This section contains all of the functional sub-units of a standard counter, except for input signal conditioning and special logic, which are contained in the Input Options portion of section VIII.

Referring to the blocks within this area of the diagram;  
The Display Control and Drivers:

- decode the BCD (binary-coded-decimal) data that operates the numeric portion of the display, and
- control the lighting of the display's decimal points and the measurement units indicators.

The 4K ROM (Read-Only Memory) is the Model 5328B's master controller; and it is this circuitry that gives the counter's operating subsections the capability of accepting diverse data from various combinations of Input Option modules. The ROM accepts either;

- the four-bit Function Code and the three-bit Time Base Code from the front-panel switches or,
- instructions from the HP-IB Remote Programming Board.

The ROM generates 32 bits of output data which are transmitted throughout the Model 5328B to set up each subsection for the particular measurement situation selected. Various combinations of Input Option modules can be handled without changing any part of the circuit other than the Master Controller ROM.

The Decade Counting Assembly contains:

- eight decades of BCD (binary-coded-decimal) counting logic
- latches
- output multiplexing logic

The Sample Rate Circuit controls the counter's display cycle. This circuit generates the signals "INHIBIT", "RESET", "MAIN GATE", "TRANSFER", "SAMPLE RATE", and the BCD digital address code for the strobed display.

The Time Base Assembly contains —

- eight counting decades
- output multiplexing logic
- synchronizers, to generate precise timing signals for the main gate.

The Oscillator Section contains —

- the standard room-temperature 10 MHz oscillator
- input/output logic to accept an external signal via the rear-panel or an internal signal from the (optional) crystal oven oscillator

Data from the Decade Counting Assembly or the Input Option modules is decoded and displayed on the nine-digit LED numeric display.

The Function Selector (A4) is the Model 5328B's main signal switch. It routes input signals through multiplexers to the Decade Counting Assembly and/or the Time Base. At the same time, the Function Selector interacts with the Display Control circuits to determine the beginning and end of the display cycle. The precision ECL Main Gate signal is created on the Function Selector through its interaction with the Time Base Assembly. The Function Selector also has extensive interaction with the Input Option modules; it is the main receiver of the high-speed data from the modules and the originator and receiver of module-arming pulses. The Function Selector Board is described in more detail later in this section.

#### **8-A-4. Display Control Section**

The Motherboard's Display Control Section is the interface between the Display Board (A16) and other circuits in the counter section.

The outputs of A16's FUNCTION and RESOLUTION switches go to the Motherboard ROM (A1U37). The outputs of the ROM:

- control lighting of the decimal point and measurement units indicators in the display, and—
- provide control functions for other circuits in the counter.

Data from the Data Bus is translated from BCD (Binary-Coded-Decimal) to seven-segment form in the Decoder (A1U41) and sent to the display, which is strobed by A1U39. Integrated Circuit A1U39 decodes the digital address code from BCD to one of ten forms. Leading-zero blanking is provided by the latch comprised of A1U32B and A1U40B. Latches A1U25, A1U26, A1U27, and A1U31 provide outputs related to function and time base codes for use in other sections of the instrument.

#### **8-A-5. State Control Section**

The State Control Section consists of integrated circuits A1U1 through A1U5. Decade Counter A1U1 generates the Digit Select Strobe Code for the display. Circuit A1U4 receives the Sample Rate signal and generates the main "RESET", "TRANSFER", and "INHIBIT" signals.

#### **8-A-6. Oscillator**

The Model 5328B's (standard) 10 MHz Oscillator circuit consists of —

- ECL crystal-controlled oscillator A1Y1 and A1U15,
- buffer amplifier
- level-shifting circuitry
- internal/external mode control circuitry
- control circuitry for the Option 010 Oscillator

As shown in the schematic diagram (Figure 8-A-10), an ECL "OR/NOR" gate (A1U15A) is used as an amplifier with positive feedback. The positive feedback path is from the non-inverting output, through a 10 MHz crystal and parallel configuration of fixed capacitor (A1C17) and trimmer capacitor (A1C18), to one of the gate's inputs. Negative feedback from the inverting output to the same input of the gate establishes the input bias for the gate amplifier. The non-inverting output is buffered, translated to a TTL level, and routed to a control gate (A1U17C). This gate is controlled by the rear-panel DPDT "EXT/INT" switch, and passes the internal oscillator signal when this switch is in the INT position.

When the Option 010 Oscillator is installed, its output also appears at the input of this gate through J1. However, this Option disables the mainframe oscillator, and its output is therefore passed through the control gate when in the internal oscillator operation. The output of the control gate goes to one input of gate A1U16B. The other input to this gate is the output of the external input signal Schmitt trigger gate A1U16A. When in internal mode, this signal is an "enable" signal to pass the internal oscillator signal. When in "external", with a signal input at the rear-panel OSC INT EXT connector, this signal is the external input. The output of this gate goes to the A4 Function Selector, Motherboard Bus, and EXT/INT switch (S1). The EXT/INT switch and connector are connected such that the connector inputs an EXT signal in external operation and outputs the internal oscillator in internal operation. This oscillator circuit may be modified by installing Option 010 Oven Oscillator.

### 8-A-7. Option 010 Installation and Removal Instructions

- a. Disconnect the power cable from the 5328B.

**WARNING**

**THE AC POWER CIRCUITS TO TRANSFORMER T1 AND THE UNREGULATED DC VOLTAGE ARE STILL ON EVEN WHEN THE POWER SWITCH IS OFF. CONTACT WITH THESE CIRCUITS CAN RESULT IN INJURY TO PERSONNEL OR DAMAGE TO THE EQUIPMENT.**

- b. Remove the top and bottom covers by loosening the screw at the rear of each cover assembly.
- c. Remove the 10 MHz crystal (Y1), from its socket on the motherboard.
- d. Apply power to the 5328B and check pin 2 of connector XA3 for 25 Volts, dc. Check all other voltages at connector XA3 for the values shown on the schematic diagram for the motherboard.
- e. Disconnect the power cable from the 5328B.
- f. Install the plastic support post on the motherboard by securing with a plastic screw from the bottom of the motherboard.
- g. Ensure that the oven oscillator is secured to the connector on the support board. Plug the support into XA3 on the motherboard with the stud mount facing the rear panel.
- h. Install a 6-32 X 5/16 inch screw through the 5328B main bracket into the support stud mount and tighten.
- i. Apply power to the 5328B and verify counter operation by performing the In-Cabinet Performance Check in Section IV.



### 8-A-8. Option 010 Removal

To remove the Option 010, essentially reverse the steps used to install the Option 010.

### 8-A-9. Decade Counting Assembly (DCA)

The Model 5328B's Decade Counting Assembly (DCA) consists of Decade Counter/Latches A1U10 and A1U14, and integrated circuits A4U1A, A4U3, and A4U4B on the Function Selector Board (A4). The Motherboard contains output-enable circuitry (A1U6, A1U7, and A1U9) for controlling the counter's output data, signal overflow indication, and circuitry (A1U41) for strobing data into the display. The first Decade Counter in the sequence of operation corresponds to the least-significant digit; the last Decade Counter corresponds to the most-significant digit. Digits "0" through "5" are processed by A1U10, digit "6" by A1U14, and digit "7" by A1U12.

All measurements performed by the counter result in pulses being counted in the DCA. Pulses are admitted to the DCA via the Main Gate Flip-flop on A4; this flip-flop is controlled by a "Gate Out" signal from the Time Base (A1U19), or it is held open by the "HOPN" signal from A1U25.

Data Strobe signals, TRANSFER pulses, RESET pulses, and an output-disabling signal are routed to the DCA via the Model 5328B's State Control Circuitry. These signals are processed in the DCA and are used to control transfer of the counter's output data to the latch outputs, strobe this data onto the Data Bus, disable the outputs that feed into the Data Bus, and reset the counters after a measurement cycle is over.

### 8-A-10. Time Base

The Model 5328B's Time Base circuit consists of eight-decade divider A1U21, shaping flip-flop A1U19A, and synchronization flip-flop A1U19B.

The Time Base's input, depending on the particular measurement being made, is either:

- the 10 MHz system clock, or
- the Channel "A" or Channel "B" input signal.

The Time Base's input signals are routed to it via the ROM-controlled Time Base Multiplexer (A4U10) on the Function Selector Board.

The Time Base circuit has two modes of operation, corresponding to the Model 5328B's two measurement modes.

- For frequency-or time interval-type measurements, the Time Base circuit generates a gate during which either oscillator or input pulses are counted.
- For totalization-type measurements, the Time Base circuit divides its input by "N" (which is determined by the setting of the front-panel "RESOLUTION, N" switch), and outputs the divided signal to be counted in the DCA.

The Time Base circuits outputs are generated simultaneously for either operating mode. Regardless of the type of measurement being performed, these outputs are made available to the Function Selector (A4) which selects the signal that is correct for the function.

The length of time generated by the Time Base circuit and the scale factor of the Time Base Input is determined by the Time Base Code. The counter's Mainframe ROM reads the codes of both the Time Base ("RESOLUTION, N") and FUNCTION switches and outputs the proper code to the Time Base such that the measurement resolution and scale factor agree with the information in the various RESOLUTION, N switch positions.

### 8-A-11. Function Selector (A4)

8-A-12. The Function Selector is the counter's main high-speed switching module, as shown in Figure 8-A-13. It receives high-speed differential ECL data from the Main bus (from the modules that process the signal input) and routes that data to either the Time Base or the DCA. This board also contains the Model 5328B's Main Gate Flip-flop, Arming Multiplexer and Arming Flip-flop, and the first Decade of the DCA.

#### NOTE

Refer to Table 8-2 for a listing of signal names and descriptions.

### 8-A-13. HIGH-SPEED MULTIPLEXER, MAIN GATE, AND FIRST DECADE

The high-speed Multiplexer (A4U6), is controlled by commands from the ROM in the Main Counter Section. The multiplexer selects from the signals present at its inputs the signal that will be sent to the Main Counter Section. The signals are sent via the First Decade circuit on the multiplexer board to be used as data. The signals at the inputs of the Multiplexer are:

- Channel 'A',
- Channel "B",
- Gated Oscillator ("GOSC"),
- Digital Voltmeter output ("DVM")
- Time Base Output ("TBO")
- Oscillator output ("OSC")

ROM lines "IA", "IB", and "IC" control the multiplexer's "active" address. Pin "2" ("ENABLE") of the multiplexer is the Main Gate. The Low Time Interval (LTIF), Low Main Gate FF (LMGF) or (LTOT\*LST), signal operating through A4U8 and enabled by ROM lines LMGF, LTIF, (LTO\*LST), respectively, control the Main Gate. In addition, ROM line "HOPN" can override LTIF or LMGF and lock open Main Gate A4U6(2) through A4U8C. The status of the Main Gate is detected and sent off the Function Selector Assembly by ECL-to-TTL translator A4U2D. Capacitor A4C11 and Resistor A4R35 stretch any ECL gate signal present at A4U2(10) so that the slower TTL control chip (A1U4) and gate light one-shot (A4Q6, A4U36B,E) can see the pulses and properly react. Integrated circuit A4U8D differentially drives bus lines MG and  $\overline{MG}$  to operate the remote Main Gate of Channel "C".

The output of the main multiplexer (A4U6(15)) feeds into the first binary (A4U1) of the main DCA. Integrated Circuit A4U1A is an ECL high-speed binary, the output of which is coupled to pins 14 and 15 of ECL-to-TTL translator A4U2. The TTL output of A4U2(13) clocks Schottky quinary A4U4 and A4U3. The outputs of the first decade A4U3(9), A4U4(9), A4U3(5), and A4U2(13) travel off the Function Selector board to the next DCA on the Motherboard, where they are latched and the carry feeds into the next decade of the DCA.

### 8-A-14. ARMING FLIP-FLOP AND ARMING MULTIPLEXER

The Arming Flip-flop (A4U4A), can inhibit various measurements by enabling or disabling the Time Base Multiplexer (A4U10) and the synchronizers in the Model 5328B's Programmable Input

Module. This inhibiting action occurs via the "High Disables Synchronizers" ("HDS") signal from A4U4(6). The signal which sets or enables A4U4 comes from the Arming Multiplexer (A4U5(6)). ROM lines control A4U5(10, 11) while the remaining address line (A4U5(9)) is controlled by the "Low Arm" ("LARM") signal from the rear-panel ARM switch. Integrated circuit A4U5 thus selects either "C-ARM", "A", "B", or "free-run" (+5V) as the signal to send to A4U4 as the Arming signal. The "A" and "B" signals are derived from ECL-to-TTL translator A4U2A and A4U2B, respectively. Capacitors A4C4, C5, and resistors R17 and R18 serve as pulse-stretcher timing elements to enable the narrow ECL pulses on lines  $\bar{A}$  and  $\bar{B}$  to be seen by the TTL Arming Flip-flop (A4U4).

#### 8-A-15. TIME BASE MULTIPLEXER AND MAIN GATE FLIP-FLOP

The Time Base Multiplexer, A4U10, selects either "A", "B", or "OSC" to send to the Time Base Input ("TB I") via pin "8" to the Time Base. This same signal is also sent to A4U1, the Main Gate Flip-op, as a re-synchronizing signal. ROM lines "R(HTBA)", "R(HTBO)", and "R(HTBB)" control the selection of the Time Base Input signal. the "HDS" signal to A4U1(13) or ROM line "LTOT" to A4U10(1) serve to enable or disable A4U10.

Integrated Circuit A4U1B is a high-speed ECL Flip-flop used to generate precise stable gate times for the Main Gate Multiplexer, A4U8, and the remote gate in the Frequency "C" module. A TTL replica of the Main Gate signal ("GATE OUT") is generated in the Time Base and sent to A4U1 via the line Main Gate Synchronizer on the Motherboard. Resistors R14 and R43B translate this TTL signal down to ECL levels at A4U1(10). The output of Time Base Multiplexer A4U10 via resistors A4R42 and A4R43C and capacitor A4C16 clocks A4U1(11), yielding a synchronized fast rise and fall time main gate signal on A4U1(14).

#### 8-A-16. EXAMPLE OF OPERATION

To show how the above-mentioned function selector circuits operate together, an example of the measurement of Frequency A is given below.

Assume that the counter is in the middle of its display cycle. "Low Inhibit" ("LINH") is TTL "low", "High Reset Time Base" ("HRTB") has momentarily gone "high", resetting A4U1 and A4U4 and "High Reset Decade" ("HRD") has momentarily gone "high", resetting First Decade A4U1, A4U4, and A4U3. The control chip on the Motherboard releases LINH to go "high". Integrated circuit A4U9(13) goes "low", enabling Arming Multiplexer A4U5. Assuming that "SELF ARM" has been selected, "A" will have been selected by the ROM on pins "9", "10", and "11" of A4U5. When the first "A" pulse occurs, A4U4(4) goes "low", setting A4U4. Integrated circuit A4U4(5) goes "high", turning on transistor Q1, which, in turn, pulls LINH "low" again and inhibits another measurement from starting until RESET has occurred. In a frequency measurement, the ROM selects the Oscillator signal in pin "2" of A4U10 to be sent into the Time Base. Shortly after the Time Base returns, a "high" signal on Main Gate Synchronizer drives A4U1(10) "high". On the next Oscillator signal (through A4U10), A4U10(11) gets clocked, causing A4U1(14) to go "low". This "low" signal propagates through A4U8(B,C) to A4U6(2), opening the Main Gate and initiating the count. Signal "A" has been selected on A4U6 by ROM lines R22, R23 and R24, thus each "A" event is counted into first decade A4U1A, A4U4A, and A4U3.

After the appropriate gate time has elapsed ("N" clock counts into the Time Base) the Main Gate Synchronizer signal goes "low" and the next Oscillator signal clocks Main Gate Flip-flop, A4U1, closed. Integrated circuit A4U2(10) detects the closing of the Main Gate and sends a TTL signal (LMGF) to A1U4 in the State Control section of the Motherboard, which initiates a new display cycle.

### **8-A-17. Display Assembly (A16)**

The Display Assembly (A16) contains the display (as shown in the Overall Block Diagram in Figure 8-7), in addition to switches S1 ("POWER"), S2 ("RESET"), S3 ("FUNCTION"), S4 ("FREQ RESOLUTION, N"), and variable resistor A16R6 ("SAMPLE RATE" control).

The display consists of a nine-digit seven-segment LED numeric display (DS1-DS9) and indicators for measurement units (DS10-DS16), in addition to "overflow"(OVFL) (DS17), "remote" (RMT) (DS18), and "gate" (GATE) (DS19). The display digits and the other indicators are automatically lighted, along with the correct decimal point.

The digit address code from A1U39 on the Motherboard is applied to transistors Q1 through Q9 to strobe each digit which receives the seven-segment code from A1U41 through transistors A16Q13 through A16Q20. The "GATE" (DS19), "RMT" (DS20), and "OVFL" (DS17) indicators receive signals from the Motherboard through transistors A16Q10, A16Q11, and A16Q12, respectively.

### **8-A-18. MAIN COUNTER SECTION TROUBLESHOOTING**

The Main Counter Section includes the A1 Motherboard, the A4 Function Selector Board and the A16 Display Board. This is the core counter and a majority of the control signals in the counter pass through this section. The block diagram in Figure 8-7 gives an overview of the inter-relationship between the boards in this section. Familiarity with the operation of the basic counter is recommended when troubleshooting this section.

The first step in troubleshooting this section is to identify which board (or boards) is faulty. Table 8-3, Symptoms-To-Section Troubleshooting, is used to isolate the faulty board.

A major task in troubleshooting the Main Counter section is isolating a faulty or inoperative signal or data information to one of the two boards A1 and A4. The passing back and forth of control signals between these two boards in a measurement makes this a particularly tedious task. One of the easiest solutions is board swapping.

### **8-A-19. Board Swapping**

If a known "good" A4 Function Selector Board is readily available then it can be inserted into the A1 Motherboard connector XA4 and the counter tested. If the problem disappears then the A4 Function Selector is faulty. If the problem persists then the problem resides on the A1 Motherboard.

### **8-A-20. Test Cards**

If another A4 board is not available then the test cards mentioned in the kit can be used. Two test cards provide a series of eight tests, four of which will be used in this section. The test cards are numbered 1 and 2 and each has 4 tests, one at each edge of the four edge connectors on the card. The card part numbers are as follows:

Test Card 1: 05328-21004  
Test Card 2: 05328-22004

When using the test cards, remove the A4 Function Selector assembly from connector XA4 and replace with the selected edge of the appropriate test card. The cards are keyed to prevent incorrect insertion into the connector XA4.

Each test places a static ROM code condition into the motherboard control signal circuitry, replacing the dynamic signal change of the A4 board. If that section is not functioning properly then the counter fails the test.

Tests 2, 3 and 8 provide the critical function of isolating the Motherboard from the A4 board while still allowing the motherboard to be checked for proper operation. Figure 8-A-1. shows a flowchart suggesting how to use the test cards. Test 3 places a static state into the DCA on the A1 Motherboard and will detect a fault in the DCA if the counter fails to totalize. Test 2 tests both the DCA and the Time Base circuitry. So, if the counter passes Test 3 but fails Test 2, the implication is that the DCA is functioning properly but the Time Base circuitry is faulty. Tests 2, 3 and 8 isolate the fault to either the Motherboard A1 or the Function Selector board A4. Problems on the A16 Display Board are determined by observing the front panel display. Blanked digits or single annunciators blanked generally implies a display problem. Test 8 independently detects a faulty display and may be used before the other tests if a faulty A16 board is suspected.

The next step is to troubleshoot the faulty boards within the faulty section.

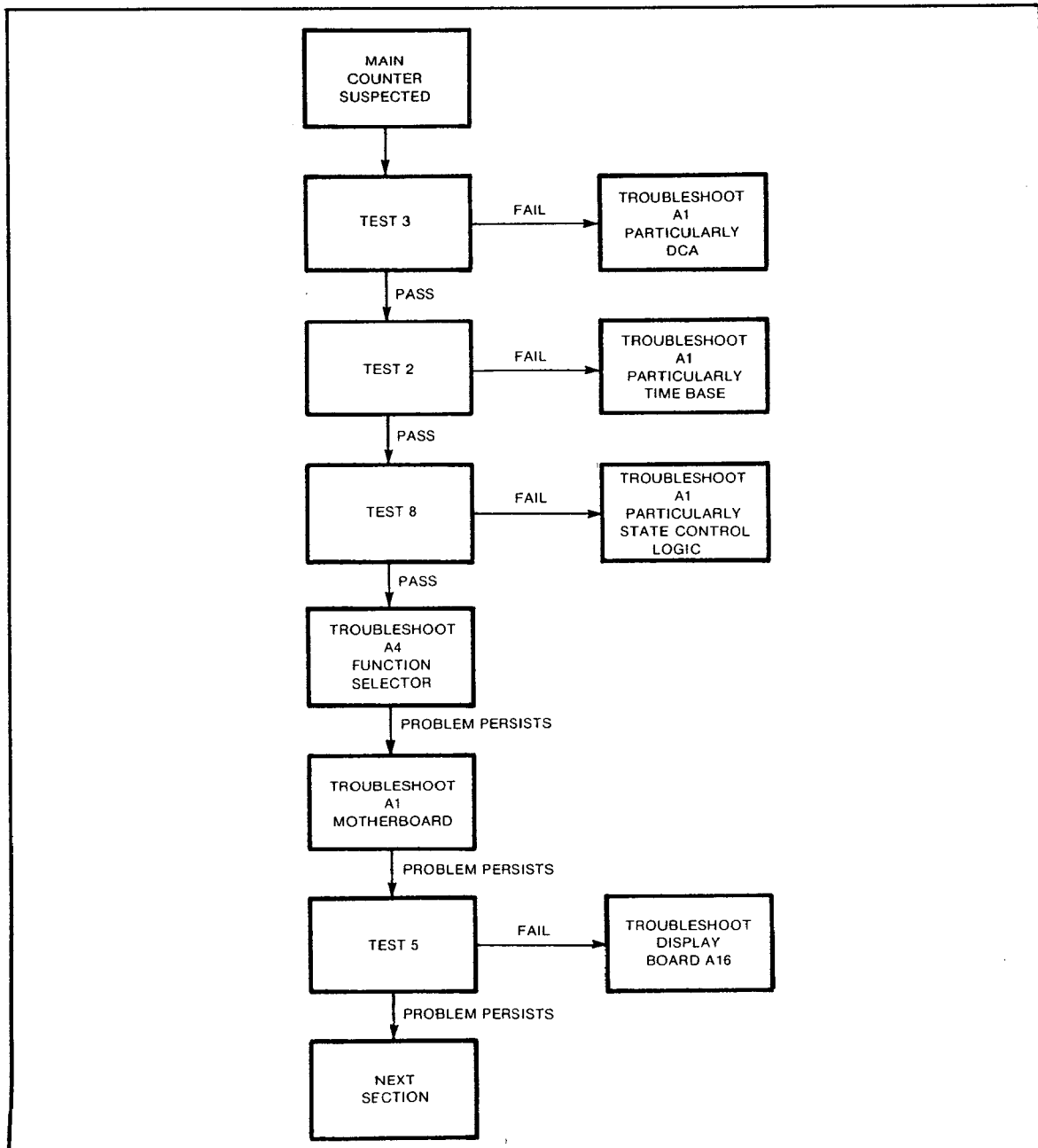


Figure 8-A-1. Main Counter Section Troubleshooting Flowchart

**8-A-21. Test Card 1, Test 3 — Decade Counting Assembly (DCA)**

**DESCRIPTION:** This test checks the Decade Counting Assembly (DCA) on the motherboard without the A4 Function Selector being used; this allows isolation of a problem source to either the Motherboard or the Function Selector.

**SETUP:** Set up equipment for this test as shown in Figure 8-A-2.

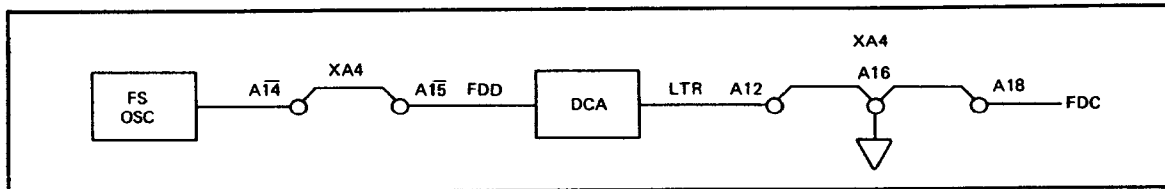


Figure 8-A-2. Test Card 1, Test 3 Setup

**PROCEDURE:** Set the FUNCTION switch to CHECK and switch ON the counter.

**DISPLAY RESULTS:**

- The display should totalize. Overflow should occur almost immediately. The decimal point moves with changing the resolution.
- as “N” is increased, the displayed digits will decrease in decade steps of “10”.

**FAILURE INDICATIONS:**

1. Count Stops or Display Does Not Totalize: The DCA may be faulty. Specifically check U10, pins 2, 14. These should normally be toggling.
2. If there is a number to the right of the decimal point when the function switch is at N=1 (1 Mhz): U10 and/or U12 may be faulty Check U10, pins 3, 4, 5, 6 and U12, pins 2, 15, 16. These should normally be toggling.
3. No overflow annunciator: U12 may be faulty. Check pin 7.

**8-A-22. Test Card 1, Test 2 — DCA and Time Base (DCA)**

**DESCRIPTION:** The proper functioning of both the DCA and the Time Base circuits can be tested without the A4 Function Selector board. Problem isolation between the A1 Motherboard and the A4 Function Selector board is possible. If the counter passed Test 3 and fails Test 2 then the problem most likely resides in the Time Base circuitry on the Motherboard.

**SETUP:** Set up equipment for this test as shown in Figure 8-A-3.

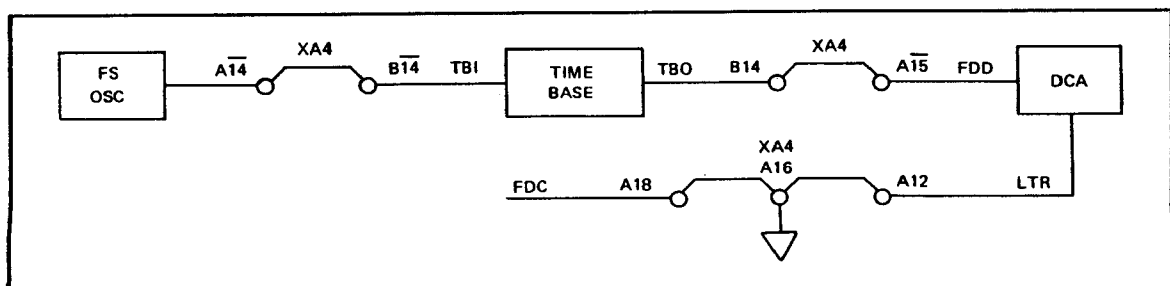


Figure 8-A-3. Test Card 1, Test 2 Setup

**PROCEDURE:** Set the FUNCTION switch to CHECK and switch ON the counter.

**DISPLAY RESULTS:** The display should totalize with no immediate overflow. Overflow will occur after a period of time if the counter is allowed to continue totalizing. The decimal point should shift on changing the resolution.

**FAILURE INDICATIONS:**

Counter stops totalizing: If the counter has passed Test 3 and fails Test 2 then the Time Base may be faulty. Check U20, pins 1, 12 and U21, pins 3, 11. When the counter is functioning normally these pins should be toggling.

**8-A-23. Test Card 2, Test 8 — Auto Sample Rate**

**DESCRIPTION:** This test allows the Sample Rate circuitry to be tested without an A4 Function Selector in the instrument. This allows for fault isolation between the Motherboard (A1) and the Function Selector (A4). The Time Base Output simulates the opening and closing of the main gate.

**SETUP:** Set up equipment for this test as shown in Figure 8-A-4.

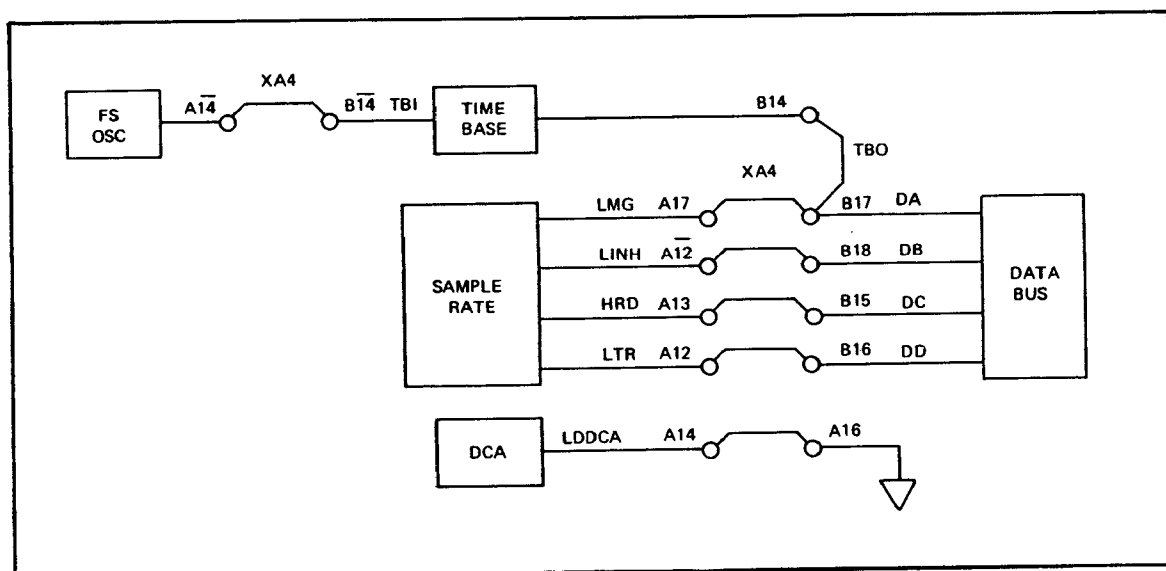


Figure 8-A-4. Test Card 2, Test 8 Setup

**PROCEDURE:** Set the FUNCTION switch to CHECK, and the RESOLUTION switch to 1 Hz (10<sup>6</sup>). Set SAMPLE RATE to mid-range.

**DISPLAY RESULTS:** The display will alternately show 11.1111111 and 33.3333333.

**FAILURE INDICATIONS:**

1. Display stuck on either 11.1111111 or 33.3333333: Check U5, pin 13; U18, pins 8, 9; U19, pin 13. The waveforms on these pins should normally be shifting up and down as the display toggles between the two values.
2. Incorrect results, e.g., the display toggles between 0.0000000 and 22.2222222: Check U18, pins 10, 11, 12, 13 and U19, pin 2.
3. Blank Display: Check "CLK" line on Motherboard between U4 and U5.

**8-A-24. Test Card 2, Test 5 — Function Code and Display**

**DESCRIPTION:** This test can be used to verify the Function Code or as a rapid way to verify a faultless display.

**SETUP:** Set up equipment for this test as shown in Figure 8-A-5.

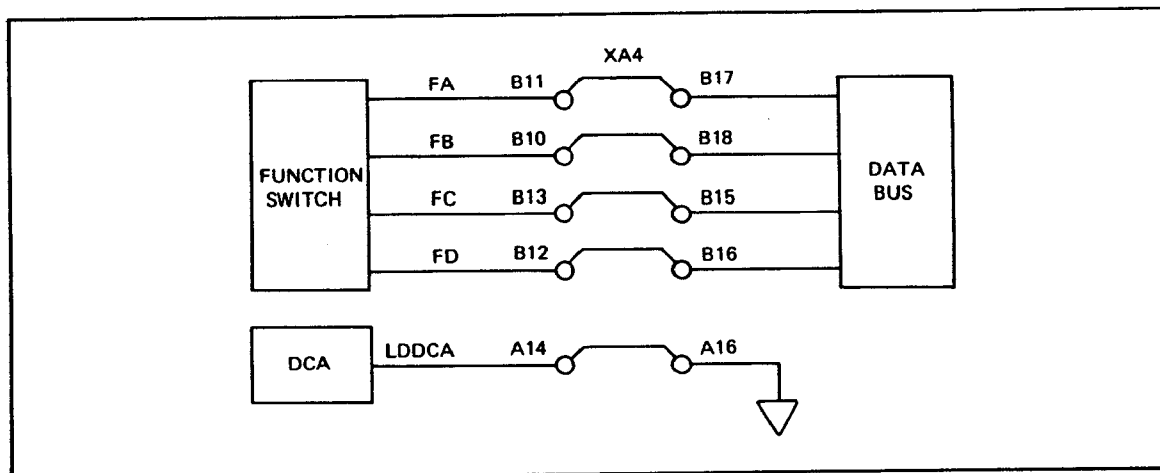


Figure 8-A-5. Test Card 2, Test 5 Setup

**PROCEDURE:** Set the RESOLUTION switch to 0.1 kHz (10<sup>4</sup>), and set the FUNCTION switch to each position listed in Table 8-A-1.

Table 8-A-1. Test Card 2, Test 5 — RESOLUTION switch settings and Display Results

FUNCTION	DISPLAY	NOTE	ANNUNCIATOR
Check Freq C	000000000 888888888	Ninth digit if Option 031 is installed.	MHz MHz
DVM START A	██████████ 7777777		V m
STOP	██████████000		m
*START CLOCK	222222222	The "phantom" (unmarked) positions of the FUNCTION switch that follow (*) are located 1, 2, and 3 switch positions clockwise from STOP, respectively.	m
*DVM/A	333333333		m
*DVM, A→B	555555555		kHz
FREQ A	444444444		ms
PER A	666666666		ns
PER AVG A	777777777		
RATIO B/A	999999999		
TI A→B	888888888		ms
TI AVG A→B	000000000		ms
EVENTS C, A→B	3.3.3.3.3.3.3.3.		
RATIO, C→A	555555555	Ninth digit if Option 031 is installed.	

\*\*"Phantom" Functions

**DISPLAY RESULTS:** See Table 8-A-1, above.



## 8-A-25. Troubleshooting The A1 Motherboard

The various tools used in troubleshooting the Motherboard are:

The troubleshooting tree in Figure 8-A-9  
Troubleshooting Motherboard Integrated Circuits, Table 8-A-2  
A1 Motherboard Waveforms, Figure 8-A-7  
Oscilloscope to observe waveforms on IC pins

The results of the tests using the test cards indicate whether the problem is in the DCA, Time Base or Sample Rate circuits. The troubleshooting tree is primarily a short-cut technique relating symptoms to the possible faults in the devices. Use it as a guide in troubleshooting the Motherboard.

The motherboard should initially be viewed as a collection of separate, but interrelated modules. Each module accomplishes some function in order to produce the appropriate display, given the desired signal processes as called up through the front panel control switches.

The front panel output is comprised of varying TTL levels. These levels are decoded by the ROM, and used to:

1. Control the board functions through the latches.
2. Determine the appropriate decimal point, annunciator and time base resolution.

The display itself is "strobed" such that while all the digits hold the same data at any given time, only one is energized at a time to display such information. Any given number on any given digit will be seen only when the seven segment decoder activates the appropriate segments and the U39 digit strobe energizes the individual digit.

U41, the seven segment decoder, receives its data from latch U11, the decade U10 and the hex decade U12. Because the appropriate data must be decoded by U41 at the correct time in relation to the "strobe" output of U39; U10, 11 and 12 are enabled with a digital signal processed by the digit address decoder. This circuit processes digit data from the digit decoder U1, which also controls the strobe time. The digit address decoder is enabled by its own independent clock, and thus the proper segments are present at the proper time to yield the appropriate display.

The format for the rest of the A1 Motherboard troubleshooting will discuss a list of symptoms and trace back to the probable cause.

Circuit elimination is the first step in the troubleshooting process. If an instrument fails in any or all functions, verify operational circuits to limit the field of inquiry. For example: If there is something on the display (e.g., "0s" but no "1s" when in check mode) then the digit decoder and strobe are functional. If changing the resolution switch changes the decimal placement, the decimal comparators are probably functional. If the gate responds to sample rate changes, the U4 state control circuitry works and if it changes with resolution settings, then the time base is also probably functional.

Problems affecting the displayed signal may be caused by circuit malfunctions in three areas:

1. Strobe circuitry
2. Decade divider/segment decoder
3. Digit decoder

Since visibility of the signal relies upon repeated triggering, the enabling signal must be long enough to allow the LED segments to respond. Otherwise, the eye will fail to detect a visual signal and the display will appear dim or blank. The usual cause of this condition is an excessively high clock frequency, causing the strobe to be too rapid and enabled for too short a time. Note, however, that the decimals will appear correct; a lamp test will enable the decimal points but not the LED segments. The cause of this is usually an open A1C3. Also, component failures may cause the digit clock to shut down, causing a blank display or decimal point blanking.

A blanked display may be caused by circuitry other than the digit decoder. The digit clock is fed through C29, Q7 and CR18 to the blanking circuitry to synchronize it with segment decoding. If C29 is open, the clock pulse is not fed to the blanking circuit with the result of a dim or blanked display with decimal points showing correctly.

Problems with decimal points and annunciator LEDs could be due to faulty digital comparators or incorrect ROM outputs. The comparators are in three basic configurations:

1. Feeding U28A and U32
2. Decoding measurement unit data
3. Feeding U28B decimal point decoding data.

The comparators themselves are exclusive-OR gates in parallel which process a combination of digit strobe and ROM levels. The comparators translate function and frequency resolution commands to specifically timed digital data which will enable the proper decimal and measurement unit LEDs. Signal tracing is helpful in determining the faulty area.

Problems with decimal points and measurement unit LEDs are also caused by malfunctioning invertors on the ROM outputs. Also, a faulty exclusive OR gate or latch may cause symptoms on the signal lines, similar to those resulting from a defective invertor. Fault symptoms of incorrect decimal points/annunciators and incorrect functions may indicate an incorrect signal input to the latches and comparators. A faulty ROM could cause the same symptoms, though quite unlikely. To verify the ROM, refer to Table 8-A-2.

Troubles in one or more functions without visible symptoms in the decimal points or annunciators are usually traceable to the ROM latches or their associated signal lines. Proper operation of signal lines are crucial because they control board operation. A failure of the instrument to self check or symptoms that indicate the absence of a signal may be caused by an improper code applied to the main gate multiplexer on the A4 Function Selector board. An occasional problem is that an incorrect signal is being counted or the same signal is counted regardless of the function selected. Check the latches that supply the appropriate level codes. While the latches themselves may not be faulty, quicker analysis is allowed by narrowing down the field of investigation.

The counter may show an intermittent failure to self check or a locked up U4. This may be due to a leaky power-up reset capacitor C5. A1C5 must charge up to a full +5V to effectively prevent U4 from going into a reset mode intermittently.

In all the cases listed above, use of Table 8-A-2 Troubleshooting A1 Motherboard Integrated Circuits. The oscilloscope patterns should be useful in determining the faulty components.

### **8-A-26. Troubleshooting The Function Selector Board A4**

By using Figure 8-A-1, board swapping or using the Symptoms-to-Section Troubleshooting Table 8-3, a faulty A4 Function Selector Board may be identified. The troubleshooting flowchart, Figure 8-A-12, may be used to find the faulty component(s) on the board.

### **8-A-27. Troubleshooting The A16 Display Board**

Display problems are usually more easily identified by observing the front panel display while changing the function and resolution switches. Use Test Card 2, Test 8. If the problem is suspected to be on the A16 board use the block diagram and troubleshooting flowchart in Figure 8-A-14.

### **8-A-28. Troubleshooting Integrated Circuits**

To troubleshoot integrated circuits on the (A1) Motherboard:

- a. Set the FUNCTION switch to CHECK.
- b. Set the FREQ RESOLUTION, N switch to 1 MHz, 1.
- c. Disconnect the Model 5328B from its ac power source.
- d. Remove the Model 5328B's top cover.
- e. Remove the Model 5328B's (A4) Function Selector Assembly.
- f. Re-connect the Model 5328B to an operating ac power source.
- g. Turn the Model 5328B's line power "on".
- h. Using a HP Model 10528A Logic Clip or HP Model 10525T Logic Probe, check for the logic states as shown in Table 8-A-2. A dark pattern in the table indicates a logic "high".

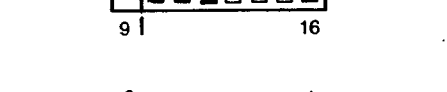
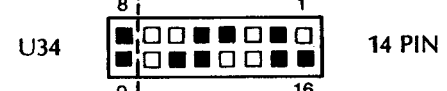
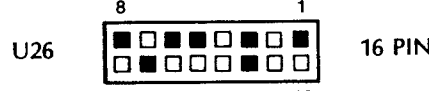
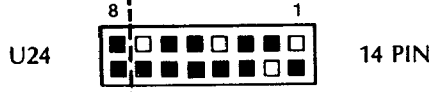
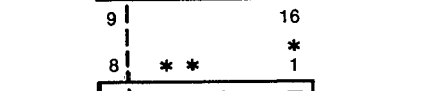
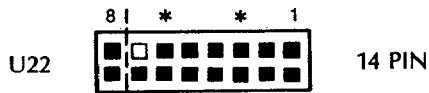
Table 8-A-2. Troubleshooting Motherboard Integrated Circuits (Part 1 of 4)

5328B Display:   
(see preceding initial conditons)

9th digit is for Option 031 installed

**NOTE**

When checking a 14-pin IC with the 16-pin logic clip, ignore the patterns for pins 8 and 9 of the Logic Clip as shown by the dotted line on the pattern.



\* Indicates dimly lit  
■ A dark pattern indicates a logic high

Table 8-A-2. Troubleshooting Motherboard Integrated Circuits (Part 2 of 4)

PINS U25		FUNCTION															
		CHECK	FREQ C	DVM	START A	STOP	*START CLOCK	*DVM/A	*DVM A-B	FREQ C	PER A	PER AVG A	RATIO B/A	TI A-B	TI AVG A-B	EVENTS C, TI A-B	RATIO C/A
INPUTS	2	L	L	H	H	H	H	H	H	L	H	H	H	H	H	H	H
	3	H	H	H	H	H	H	H	H	L	L	L	L	L	L	L	L
	6	H	L	H	H	H	H	H	H	H	H	H	H	H	H	L	L
	7	H	L	L	H	H	H	H	H	H	L	L	L	L	L	L	L
OUTPUTS	9	H	L	H	L	L	L	H	H	L	L	L	L	L	L	L	L
	10	H	H	H	L	L	L	H	H	L	L	L	L	L	L	L	L
	15	L	L	L	H	H	H	L	L	L	L	L	L	L	L	L	L
	16	L	H	L	L	L	L	L	L	L	H	H	L	H	H	H	H
U26																	
INPUTS	2	L	H	L	L	L	L	L	L	L	L	L	L	L	L	H	H
	3	H	L	H	H	H	H	L	L	H	H	H	H	H	H	L	L
	6	H	L	H	L	L	L	H	L	H	L	L	L	L	L	L	L
	7	L	H	L	L	L	L	L	L	H	H	H	L	L	L	L	H
OUTPUTS	9	L	L	L	L	L	L	L	L	L	L	L	L	H	L	L	L
	10	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	15	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	16	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
U27																	
INPUTS	2	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	3	L	L	L	H	H	H	H	H	L	H	H	H	H	H	H	H
	6	L	L	L	H	H	H	H	H	L	L	L	L	L	L	L	L
	7	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H
OUTPUTS	9	L	L	L	H	H	H	H	H	L	H	H	H	H	H	H	H
	10	L	L	H	H	H	H	H	H	L	L	L	L	L	L	L	L
	15	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	16	L	L	L	H	H	H	L	L	L	L	L	L	L	L	L	L
U31																	
INPUTS	2	H	H	L	L	L	L	L	L	H	L	L	L	L	L	L	L
	3	L	L	L	L	H	H	L	L	L	L	L	L	L	L	L	L
	6	H	H	L	H	H	H	H	H	H	L	L	H	L	L	H	H
	7	L	L	H	H	H	H	H	H	L	L	L	L	L	L	H	H
OUTPUTS	9	L	L	L	L	L	L	L	H	L	L	L	L	H	H	H	L
	10	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	15	L	L	H	H	L	L	L	L	L	L	L	L	L	L	L	L
	16	H	H	H	H	H	H	L	L	H	L	L	L	L	L	L	L

Table 8-A-2. Troubleshooting Motherboard Integrated Circuits (Part 3 of 4)

PINS U25		FREQ RESOLUTION							
		1 MHz 1	.1 MHz 10	10 kHz 10 <sup>2</sup>	1 kHz 10 <sup>3</sup>	.1 kHz 10 <sup>4</sup>	10 Hz 10 <sup>5</sup>	1 Hz 10 <sup>6</sup>	.1 Hz 10 <sup>7</sup>
INPUTS	2	L	L	L	L	L	L	L	L
	3	H	H	H	H	H	H	H	H
	6	H	H	L	L	H	H	L	L
	7	H	L	H	L	H	L	H	L
OUTPUTS	9	H	H	H	H	H	H	H	H
	10	H	H	H	H	H	H	H	H
	15	L	H	L	H	L	H	L	H
	16	L	L	L	L	L	L	L	L
U26									
INPUTS	2	L	L	L	L	L	L	L	L
	3	H	H	H	H	L	L	L	L
	6	H	H	H	H	H	H	H	H
	7	L	L	L	L	L	L	L	L
OUTPUTS	9	L	L	L	L	L	L	L	L
	10	H	H	H	H	H	H	H	H
	15	L	L	L	L	L	L	L	L
	16	L	L	L	L	H	H	H	H
U27									
INPUTS	2	L	L	L	L	L	L	L	L
	3	L	L	L	L	L	L	L	L
	6	L	L	L	L	L	L	L	L
	7	H	H	H	H	H	H	H	H
OUTPUTS	9	L	L	L	L	L	L	L	L
	10	L	L	L	L	L	L	L	L
	15	L	L	L	L	L	L	L	L
	16	L	L	H	H	L	L	H	H
U31									
INPUTS	2	H	H	H	H	H	H	H	H
	3	L	L	L	L	L	L	L	L
	6	H	H	H	H	H	H	H	H
	7	L	L	L	L	L	L	L	L
OUTPUTS	9	L	L	L	L	L	L	L	L
	10	L	L	L	L	L	L	L	L
	15	L	L	L	L	L	L	L	L
	16	H	H	H	H	H	H	H	H

Table 8-A-2. Troubleshooting Motherboard Integrated Circuits (Part 4 of 4)

**U37**

**(ROM STATES WITH A4 REMOVED)**

1	-2V	15	L
2	+5V	16	GND
3	L	17	L
4	L	18	L
5	L	19	L
6	L	20	H
7	H	21	H
8	L	22	L
9	H	23	L
10	H	24	H
11	H	25	H
12	H	26	H
13	L	27	L
14	L	28	+12V

### 8-A-29. Display Assembly (A16)

To remove the Model 5328B's Display assembly (A16) —

- a. Disconnect the Model 5328B's line cord (as a safety precaution).
- b. Remove the Model 5328B's top cover.
- c. Using a suitable flat-blade screwdriver as a prying tool, gently remove the plastic filler strip from the top of the counter's cast front-panel frame.
- d. Remove the two machine screws that secure the top of the display front panel to the top of the cast front-panel frame.
- e. Turn the Model 5328B on its side and remove the two machine screws that fasten the bottom of the display front panel to the bottom of the cast front-panel frame.
- f. Slightly loosen all remaining machine screws along the top of the cast front-panel frame. This releases the compressive force on the display front panel.
- g. Remove the Display assembly (A16), with front panel attached, by gently pushing the assembly from the rear. Note that the Display assembly is separated from the A1Motherboard assembly during this operation.
- h. Using a suitable allen wrench, remove the SAMPLE RATE control knob from the Display assembly.
- i. Remove the nuts that attach the SAMPLE RATE and RESET switches.
- j. Separate the front panel from the display assembly.

#### NOTE

If the FUNCTION or FREQ RESOLUTION switch control knob is removed, or if the associated printed circuit board switch is disassembled, the knob and switch must be aligned during replacement as described in the paragraph below.

- k. To realign the display switches with the proper knob positions:
  - 1) Set the rear wafers with the slots directly toward each other.
  - 2) Set the knob of the FUNCTION switch to START A.
  - 3) Set the knob of the FREQ RESOLUTION switch to its 0.1 kHz (10<sup>4</sup>) position.
  - 4) Tighten the two setscrews on each of the above knobs with a suitable allen wrench.



### 8-A-30. OVEN OSCILLATOR (Option 010)

8-A-31. The Option 010 Oven Oscillator is an extremely stable, compact, low-power source of 10 MHz. The crystal, along with the oscillator, circuit buffer amplifier, and oven control circuits are all mounted inside a thermally insulated housing. A block diagram of the oven oscillator is shown in Figure 8-A-19.

8-A-32. The oscillator is divided into three sections with each section contained on a separate printed circuit board. The boards are connected by cable assemblies. The arrangement allows the unit to be easily disassembled and operated in the disassembled state on the service bench. The three sections can be separated into the following subsections:

1. Oscillator
2. Automatic Gain Control
  - Impedance Matching Amplifier
  - Voltage References
3. Output Buffer Amplifier
  - Oven Heater and Controller
  - Precision Voltage Reference
  - Controller Turn-On Current Limiting Circuit
  - Heater Transistor Balance Circuit

8-A-33. The oscillator is a Colpitts-type crystal oscillator which uses the crystal as the series inductor. The crystal (Y1) is a "third overtone" crystal and is operated at 10 MHz. To keep the circuit from oscillating at the crystal's fundamental, or at a different overtone, the mode suppression network consisting of C5, L2, C6, and L3 appears capacitive only at frequencies between 9 MHz and 10.5 MHz. Below and above this frequency range, the network appears inductive. This does not allow the proper phase shift around the loop and thus suppresses oscillations at all frequencies other than 10 MHz.

8-A-34. Any reactance in series with the crystal will cause a change in frequency. Tuning capacitor C1 is available from the top of the oscillator outer housing. The change in reactance in C1 allows the oscillator's frequency to be varied over a 20 Hz ( $2 \times 10^{-6}$ ) range.

8-A-35. ELECTRONIC FREQUENCY CONTROL (EFC). To allow for a fine tuning control, a varactor (CR1) is added in parallel with the C1 tuning capacitor. The varactor's capacitance depends on the dc voltage applied to it (reverse bias). The EFC voltage range is +5V to -5V, giving a fine tuning range of about 1 Hz ( $1 \times 10^{-7}$ ). Since one side of the varactor is tied to a reference (6.4V), a full +5V applied to the EFC input will still keep CR1 reverse biased. C2 and C3 keep the EFC current from flowing into the crystal circuit.

#### NOTE

EFC is not used in the HP 5328B.

8-A-36. **AUTOMATIC GAIN CONTROL (AGC).** The Automatic Gain Control circuit consists of emitter-follower Q3 and the peak detector circuit formed by C12, C13, CR4, and CR5. The input to the AGC circuit (and output amplifiers; discussed later) is taken across capacitor C10 and applied to Q3. The signal from Q3 goes to the peak detector which develops a dc voltage to control the crystal current. This negative control voltage forms the lower half of a voltage divider for the base of Q1 (with R6 and R7) which controls the bias current and gain of Q1, thus controlling the output signal level. The voltage across C10 is proportional to the current through the crystal. As the output of the oscillator changes, the output of the peak detector circuit changes to counteract the oscillator signal change. The result is a stable output signal amplitude.

8-A-37. By adjusting the AGC voltage with R6, the amplitude for the output (at the base of Q3) can be set. R5 sets the AGC limit when R6 is at its minimum resistance.

8-A-38. **RF OUTPUT IMPEDANCE MATCHING AND OUTPUT BUFFER.** The signal for the output amplifiers is taken from the same point as the AGC (across C10). The voltage is buffered by Q5, which is an impedance matching stage. Resistors R14 and R15 set the dc bias level; R14 is bypassed by C14. The signal is then applied to the output buffer stage of Q9. R40 provides a 50 Ohm source impedance when transformed by T1. The typical gain of Q9 (base-to-collector) is approximately 2.

8-A-39. **VOLTAGE REFERENCES.** Constant current diode CR2 feeds 1 mA to zener diode CR3 providing 6.4V dc for the EFC varactor reference. R12 and C15 form a filter to attenuate noise from the zener diode. R13 provides current limiting for Q4 if the 5.7V line is shorted.

#### **8-A-40. OVEN HEATER AND CONTROLLER.**

##### **NOTE**

In the following theory of operation, the term OVEN MASS is used to describe the cast aluminum block in which the crystal and crystal electronics are located.

8-A-41. The purpose of the oven is to shield the oscillator crystal and electronics from normal ambient temperature changes. The oven controller does this by maintaining a constant oven temperature which is higher than the highest expected ambient temperature. The oven circuit is made up of three main blocks: thermistor, amplifier (controller), and heaters.

8-A-42. A thermistor (RT1) is secured with epoxy into a hole in the oven mass. U3 is the amplifier, and Q7 and Q8 are the heaters. It is the thermistor that senses the oven mass temperature. The thermistor is in one leg of a bridge circuit consisting of RT1, R18, R19, R20, and R21. When the mass temperature changes slightly, a voltage change occurs across the bridge. Amplifier U3 boosts this voltage change and then uses it to control the current through Q7 and Q8. The current flowing through Q7 and Q8 causes a power dissipation in the form of heat, and it is this heat that warms the oven mass. Therefore, when the mass temperature starts to change, the heaters are biased to adjust their power to cancel the impending temperature change.

8-A-43. **WARM-UP: GENERAL OPERATION.** If the oscillator has been off for several hours, the mass and thermistor will be at the ambient temperature. Assuming this is below the normal oven operating temperature (80° to 84°C), the resistance of the thermistor RT1 is higher than that of R18 + R20, and therefore the voltage at U3(3) is more positive than at U3(2). This causes the output of U3 to be approximately (V<sub>cc</sub> - 1.5V), supplying base current to Q8 through Q6. A separate circuit limits the collector current of Q8 and is described later.

8-A-44. As the oven mass warms up, the thermistor's resistance begins to drop, causing the voltage at both U3 inputs to drop (the other U3 input voltage drops because the voltage at the junction of R17 and R18, R19 drops due to the lower RT1 resistance). The voltage at U3(3) decreases at a faster rate than at U3(2) and eventually the U3 inputs are equal when RT1 = R20 + R18. At this

time, the oven controller “cuts back” and begins to operate in a linear mode, adjusting the collector current in Q8 (and therefore the power dissipated in Q7 and Q8) to keep the oven precisely at its set temperature.

8-A-45. The purpose of R17 is mainly to reduce the power dissipated in the thermistor which causes it to self-heat above the oven operating temperature.

8-A-46. R38 and R39 in parallel provide a means of sensing the heater current. During warm-up, the voltage across the parallel resistors is used in the current limit circuit (described later). During normal linear operation, the junction of R38 and R39 is essentially the feedback point for the oven controller loop.

8-A-47. Q6 is necessary primarily for the condition when the oscillator has been stored at  $-55^{\circ}\text{C}$ . Since U3 (at  $-55^{\circ}\text{C}$ ) cannot supply enough base current for Q8, Q6 provides the added current gain required.

8-A-48. PRECISION VOLTAGE REFERENCE. U2 is a 10.0V voltage reference. It provides a stable voltage source for the bridge and U1. A change in the bridge reference voltage changes the voltage across the thermistor and hence, the power it dissipates.

8-A-49. OVEN CONTROLLER TURN-ON CURRENT LIMITING. The turn-on current limiting circuit consists of U18 and associated components. From an initial turn-on condition, the thermistor senses the oven temperature to be low. To correct this situation, U3 attempts to drive heavy amounts of current through the Q7 and Q8 heaters. If allowed to continue this way, excessive current will flow. When  $V_{CC}$  is applied to the oven, U1B forces the voltage across R38 and R39 to equal the voltage at U1B(2) by sinking the base current from Q6. By sensing  $V_{CC}$ , the circuit transforms the heater transistors into what appears to be a fixed heater resistance of 47 Ohms typical.

8-A-50. HEATER TRANSISTOR BALANCE. Because heater transistors Q7 and Q8 are not equally spaced from the crystal, it is necessary to offset the power dissipation between the two transistors. Amplifier U1A references a voltage divider across  $V_{CC}$  (R25, R26) and a second divider (R27, R28) referenced to the midpoint between the heater transistors. This arrangement allows U1A to control the base current of Q7 to ensure the voltage at the midpoint between the heater transistors is a constant percentage of  $V_{CC}$  ( $\approx 0.57 \times V_{CC} \pm 2\%$ ).

## 8-A-51. OVEN OSCILLATOR TROUBLESHOOTING

### 8-A-52. Inspection

8-A-53. The oscillator should be inspected for indications of mechanical and electrical defects. Electronic components that show signs of overheating, leakage, frayed insulation, and other signs of deterioration should be checked and a thorough investigation of the associated circuitry should be made to verify proper operation. Mechanical parts should be inspected for excessive wear, looseness, misalignment, corrosion, and other signs of deterioration.

### 8-A-54. Special Parts Replacement Considerations

8-A-55. Several mechanical parts and components must be replaced as a pair or require other special consideration. They are:

- a. Oven mass assembly and thermistor: If the thermistor (RT1) is found to be defective, the thermistor and oven mass assembly must be replaced as one item, HP Part Number 10811-60106. Do not attempt to replace the thermistor alone.

- b. Crystal and Temperature Set Resistor: The replacement crystal for Y1 will be accompanied by the required temperature set resistor (R20) for the oven. This resistor must be installed with the new crystal. The crystal and R20 can be ordered using HP Part Number 10811-60108. If only the temperature set resistor (R20) is found to be defective, it must be replaced with the same value and tolerance. If the resistor (R20) is unreadable, the value required can be determined by finding the oven temperature value marked on the crystal (Y1). The required resistor will be either 1.3K Ohms or a jumper. Refer to *Table 6-4* in Section VI. When Y1 is replaced, the nut which secures it to the oven mass should be tightened to a torque of 0.6 newton-meters (5 in.-lbs). This will insure maximum heat transfer without over-stressing the crystal package.
- c. Oven heater transistors Q7 and Q8: Holding screws for Q7 and Q8 must also be torqued to a specific force of 0.6 newton-meters (5 in.-lbs.). There are several available pozidriv torquing screwdrivers.

**NOTE**

When re-installing or replacing one or both heater transistors (Q7 and Q8), replace both transistor insulators, HP Part Number 0340-0864. This is done to ensure the temperature stability of the oven crystal due to a balanced heat transfer to the oven mass from the heater transistors.

**8-A-56. Special Test Connector**

8-A-57. The following paragraphs describe a special connector fabricated for use in troubleshooting, alignment, and testing of the oven oscillator. (Refer to Figure 8-A-17 for photo of connector.) The connector provides the following:

- a. Two separate input leads for the power to the oscillator circuits and the oven heater/controller circuits.
- b. 10-MHz output through a female BNC.
- c. Oven monitor output for connection to a voltmeter.
- d. EFC input connection to ground.

8-A-58. The following parts are required to construct the special test connector:

- a. 15-pin pc board connector (HP Part Number 1251-0494).
- b. 6 banana plugs (HP Part Number 1251-0124).
- c. BNC female connector with ground lug and nut.

BNC connector	1250-0083
Ground lug	0360-0024
Lock washer	2190-0016
Nut	2950-0001

- d. Approximately 6 feet of 24-gauge wire.
- e. Labels for banana plugs.

8-A-59. To construct the connector:

- a. Solder the center pin of the BNC connector to pin 1 of the printed circuit connector; this is the 10 MHz output signal.
- b. Bend the BNC ground lug to align with pin 2 of the printed circuit connector.
- c. Solder one end of a 2-foot length of wire and the BNC ground lug to pin 2 of the printed circuit connector. This is the oscillator circuit common.
- d. Solder one end of a 2-foot length of wire to pin 3 of the printed circuit connector. This is the oscillator (+) supply.
- e. Connect a jumper wire between pins 5 and 6. This terminates the EFC input.
- f. Solder one end of a 2-foot length of wire to pin 11. This is the oven monitor output.
- g. Solder one end of a 2-foot length of wire to pin 14 of the printed circuit connector. This is the oven (+) supply.
- h. Solder one end of two 2-foot lengths of wire to pin 15 of the printed circuit connector. This is the oven common.
- i. Twist together one of the two wires connected to pin 15 and the wire connected to pin 14. These are the oven controller power supply inputs.
- j. Twist together the remaining wire connected to pin 15 and the wire connected to pin 11. This is the oven monitor output.
- k. Twist together the two wires connected to pins 2 and 3. These are the oscillator supply inputs.
- l. Connect one banana plug to the free end of each wire.
- m. Label each banana plug as follows:

Wire connected to:	Label as:
pin 2	oscillator supply (-)
pin 3	oscillator supply (+)
pin 11	oven monitor (+)
pin 14	oven supply (+)
pin 15 (two wires)	oven supply (-) oven monitor (-)

- n. Inspect the connector for poor solder joints, bent, or damaged pins. Double check the labeling of the plugs to be sure the polarity markings are correct. If the voltages are connected the wrong way, damage to the oven oscillator may occur.

#### 8-A-60. Types of Failures

8-A-61. Failures in the oscillator unit can be divided into two sections:

- a. Failure of the oscillator's circuits.
- b. Failure in the oven controller circuits.

8-A-62. Failures in the oscillator circuits can be divided into the following problems:

- a. No output.
- b. Output amplitude is too low or high.
- c. Output is off frequency (high or low).

8-A-63. Poor frequency stability can be difficult to troubleshoot and many times the oscillator is not at fault. Environmental conditions can affect stability and should be ruled out first.

8-A-64. Failures in the oven circuitry can be divided into the following problems:

- a. No oven current (heat).
- b. Excessive oven current (>600 mA).
- c. Oven does not cut back after warm-up (this will open the thermal fuse if allowed to continue).

8-A-65. Since the main oscillator and oven control power supply inputs are separate from each other, the defective circuit can be operated without applying power to the complete oscillator.

8-A-66. Determine which section is defective (oven or oscillator circuit), then proceed as described in the following troubleshooting section. The two circuits can be investigated separately.

#### 8-A-67. Disassembly for Troubleshooting

8-A-68. To disassemble the oscillator unit:

Step 1. Remove the three screws securing the bottom cover to the outer housing, and remove bottom cover.

Step 2. Remove the two screws securing the pc edge connector to the outer housing.

Step 3. Remove the foam sheet to expose the oven controller circuit board.

#### CAUTION

**With the cover and foam insulator removed, the thermal fuse cannot protect the oven circuit from thermal runaway. Caution should be used at all times.**

If troubleshooting the oven controller, stop here and go to paragraph 8-A-70, Oven Controller Troubleshooting. Go to Step 4 only if the trouble is in the oscillator circuit.

#### WARNING

**THE OSCILLATOR'S INTERNAL OVEN MASS TEMPERATURE MAY BE AS HIGH AS 85°C (185°F). TO AVOID SERIOUS BURNS, DO NOT REMOVE OSCILLATOR CIRCUITS AND/OR OVEN MASS ASSEMBLY FROM THE OUTER CAN UNTIL THE OSCILLATOR HAS SUFFICIENTLY COOLED (APPROXIMATELY ONE HOUR WITH BOTTOM COVER AND FOAM INSULATOR REMOVED). THE OUTER HOUSING TEMPERATURE IS NOT A RELIABLE INDICATION OF THE INTERNAL TEMPERATURE.**

Step 4. Using a long, small diameter tool, remove the complete oscillator assembly by inserting the tool into the tuning capacitor access hole (labeled **FREQ. ADJ.**) and gently pushing on the capacitor until the circuit can be grasped and removed easily.

Step 5. Using a pozidriv screwdriver, remove the two screws securing the heater transistors to the oven mass. Remove the washers and transistor insulators.

#### **NOTE**

When reassembling the oven mass, the heater transistor screws must be tightened to a torque of 0.6 newton-meters (5 in.-lbs.) (See paragraph 8-A-55(c)).

Step 6. Tilt the oven oscillator assembly back and remove the foam insulator between the oven controller assembly and the oven mass. Be careful not to break the two black thermistor wires attached to the oven controller assembly.

Step 7. Remove the eight screws (four each side) securing the covers to the oven mass assembly.

Step 8. Use two of the screws from each cover (removed in Step 7) to secure the boards to the oven mass for troubleshooting.

8-A-69. Go to paragraph 8-A-84, Oscillator Troubleshooting. When reassembling unit, reverse the above procedure.

## **8-A-70. OVEN CONTROLLER TROUBLESHOOTING**

### **8-A-71. General**

8-A-72. The oven controller section consists of three major circuits and a 10V voltage reference for increased stability of sensitive circuits. *Figure 8-A-20* shows the major circuits and active components involved in their operation.

8-A-73. The temperature sense circuit monitors the temperature of the oven mass and reduces the power drawn by the oven heater transistors when the oven mass has reached operating temperature. After power cut-back, this circuit monitors the oven mass temperature and controls the power in the heaters to maintain the constant temperature. The thermistor (RT1) has a negative temperature coefficient. At room temperature the thermistor resistance is approximately 100K Ohms, while at operating temperature ( $\approx 82^{\circ}\text{C}$ ) the resistance is approximately 9K Ohms. Shorting the thermistor to oven common makes the oven mass appear too hot to the temperature sense circuit. This in turn causes the temperature sense circuit to shut off power to the oven heaters. This technique is used in the troubleshooting procedure.

8-A-74. The warm-up current limit circuit controls the maximum current the oven may draw during warm-up (380 to 490 mA with 20V dc oven input). This circuit is only active during the warm-up phase of the oven circuit operation.

### **8-A-75. Normal Operation**

8-A-76. When the oven is tested under normal conditions ( $\approx 25^{\circ}\text{C}$  ambient temperature) it will initially draw 380 to 490 mA. After 5 to 10 minutes the oven current will start to drop. Over the next 10 to 15 minutes the oven current will fall to the 60 to 150 mA range where it will stabilize. The oven circuit should not oscillate.

**WARNING**

**DO NOT OPERATE THE OVEN CIRCUITS WHEN THE OVEN MASS IS OUTSIDE OF THE OSCILLATOR INSULATED HOUSING. DOING SO WILL OVERHEAT THE OSCILLATOR CIRCUITS INSIDE THE OVEN MASS AND CAUSE PERMANENT DAMAGE. ALL OVEN TEST POINTS ARE AVAILABLE WITH THE OVEN MASS AND OVEN CONTROLLER CIRCUIT INSIDE THE HOUSING.**

**WHEN OSCILLATOR COVER AND INSULATOR ARE REMOVED, THE THERMAL FUSE WILL NOT PROTECT CIRCUIT FROM OVERHEATING. APPLY OVEN POWER ONLY WHEN ACTUALLY MAKING MEASUREMENTS FOR TROUBLESHOOTING OR AS DIRECTED IN TROUBLESHOOTING TREE, FIGURE 8-A-21.**

#### **8-A-77. Troubleshooting Tree**

8-A-78. *Figure 8-A-21* is a troubleshooting tree for the oven circuits. The troubleshooting procedure separates the different functional circuits by monitoring the oven supply current during different operating conditions. For example, if the warm-up current is excessive, this indicates a problem in the warm-up current limit circuit, or the current control and heater circuit. If shorting the thermistor reduces the current being drawn from the power supply, this indicates the current control circuit is operating and the problem is most likely in the warm-up current limit circuit.

8-A-79. As with most troubleshooting trees, this is intended to be a guide to the trouble area. It is not a substitute for technical skill in isolating the faulty components.

8-A-80. *Table 8-A-4, Oven Circuit Voltages*, gives normal circuit voltages during warm-up, operation, and when thermistor RT1 is shorted to ground. Use this table during troubleshooting.

#### **8-A-81. Troubleshooting Cautions**

8-A-82. When oven current is excessive, turn on the power supply only long enough to make the necessary measurements. Do not leave power on if the oven is drawing excessive current. With the housing cover and foam insulator removed, the thermal fuse, F1, cannot protect the circuits in the oven mass from overheating and damage.

8-A-83. When power is applied to the oven controller circuit, it will go into its full warm-up mode. In this mode, the maximum heating power is applied to the oven mass. The oven mass is a metal casting surrounding the oscillator circuits and crystal. The OVEN MONITOR output will be approximately 1.5 volts below the oven power supply voltage. In about 10 minutes, the oven will have heated to the proper temperature. The oven controller will begin to regulate at this temperature and the OVEN MONITOR will drop to approximately 3.5 volts. It is normal for the oven temperature to drop momentarily to a low value when the temperature first reaches maximum. This lasts less than a second and is a typical circuit action.

#### **8-A-84. OSCILLATOR TROUBLESHOOTING**

8-A-85. The oscillator circuits are relatively simple and straightforward. The following paragraphs will briefly describe the major circuit areas, a troubleshooting outline, and some helpful suggestions to make the troubleshooting process easier. The oscillator consists of four sections. They are:

1. Oscillator Q1, Q2, and associated circuitry.



2. AGC Q3, CR4, CR5, and R6.
3. Output circuit Q5 and Q9.
4. 5.7V power supply CR2, CR3, and Q4.

The oscillator is the signal source. Its output level is controlled by the AGC. The 5.7V power supply provides an extra-stable clean voltage source for the oscillator circuits. The output circuits provide a high-level signal capable of driving a 50 Ohm to 1K Ohm load.

#### **8-A-86. Normal Operation**

8-A-87. The output of the oscillator circuit at Q2 collector is a 10 MHz undistorted sine wave with an amplitude of approximately 2.8V p-p. The AGC voltage (measured at CR5-C13 junction) is approximately -1.5V. The 10 MHz signal passes through Q5 to Q9 base at about the same level. The voltage gain of amplifier Q5 (base to collector) is approximately 2 with a 50 Ohm load on the output. The output of transformer T1 is approximately 1.5V p-p. All 10 MHz signals found in the oscillator will be undistorted sine waves unless otherwise noted in *Table 8-A-5, Oscillator Section Normal Voltages*.

#### **8-A-88. Troubleshooting**

8-A-89. When troubleshooting the oscillator section, remove the oven mass from the housing and the covers from the oven mass as described in paragraph 8-A-67. Connect 12V to the oscillator section; use the special connector described in paragraph 8-A-56, Special Test Connector. Set the power supply current limit to 60 mA. Do not apply power to the oven circuits!

8-A-90. Initial troubleshooting and probing should be done on the backside of the boards (trace side) while they are secured to the oven mass (see paragraph 8-A-68, step 8. This way the circuits are more easily handled. When the fault is isolated to a few components, the unit may then be disassembled for final troubleshooting and repair.

#### **8-A-91. Helpful Hints**

1. Most points in the oscillator circuits cannot be measured with a dc voltmeter. The reactance of the voltmeter probe and leads will load the circuit and give false readings. Instead, use an oscilloscope with a high input impedance probe for these measurements. *Table 8-A-5, Oscillator Section Normal Voltages*, indicates when a dc voltmeter can be used.
2. Before reinstalling the oven mass into the housing, adjust the output amplitude as instructed in paragraph 8-A-96, Output Amplitude Adjustment.

8-A-92. Symptoms of failures in the oscillator sections will generally fall into one of the following categories:

1. No output.
2. Output Amplitude is low or high.
3. Excessive drift of output frequency.

8-A-93. Troubleshooting of these faults will be discussed in the following paragraphs.

8-A-94. NO OUTPUT. This is usually easy to repair by simple signal tracing. Localized fault finding (to actual defective component) can be somewhat more difficult if the problem is in the main oscillator circuit (Q1, Q2, and AGC). If the fault appears to be in the oscillator section and does not yield to normal troubleshooting techniques, measure the AGC voltage at the junction of CR5-C13 (See Note 7 on Table 8-A-4, Oscillator Normal Voltages). If this voltage appears normal, the problem may be a defective quartz crystal (Y1). To verify this possibility, obtain a 10  $\mu$ H (HP Part No. 9100-2265) and a 12  $\mu$ H inductor (HP Part No. 9100-2242). (Use the HP numbered parts as these have been tested in the circuit.) On the oscillator board, remove the red and blue wires connecting the crystal to the board. Place the 12  $\mu$ H inductor in place of these wires. With 12V applied to the circuit, adjust the FREQ. ADJ. (C1) and the amplitude control (R6) for a good sine wave signal.

#### NOTE

At some settings of C1 and/or R6, intermittent oscillations may appear. Some minor adjustment of C1 and/or R6 should clear this. If this fails, replace the 12  $\mu$ H inductor with the 10  $\mu$ H inductor and repeat the C1/R6 adjustment.

If replacing the crystal with an inductor produces oscillation, this is a very good indication of a defective crystal. When replacing crystal Y1, read paragraph 8-A-55(b), Special Parts Replacement Considerations. If the circuit will still not oscillate, the problem is most likely one of the oscillator circuit elements.

8-A-95. OUTPUT AMPLITUDE HIGH OR LOW. Many times this can be cured by the adjustment of R6 as described in paragraph 8-A-96. If the correct amplitude cannot be obtained with this adjustment, monitor the signal at Q6 collector with an oscilloscope and set R6 to obtain an amplitude of 2.8V p-p. Then check Q5 and Q9 stages. If the R6 adjustment is not effective, investigate the operation of the AGC circuitry (Q3, CR4, CR5, C5, C6, R5, R6, R7, or Q1).

#### 8-A-96. Output Amplitude Adjustment

8-A-97. The output amplitude is adjusted by the setting of the variable resistor R6 which is in the feedback of the AGC circuitry. It is not accessible from the outside of the oscillator.

8-A-98. The following procedure should be used to adjust the output amplitude only if the output level falls outside the specified level, or repairs have been made to the main oscillator or AGC circuitry.

1. Remove oscillator from instrument.
2. Remove the three screws holding the bottom cover on the oscillator. Remove the bottom cover and allow the oscillator to cool (if previously operated).
3. Remove the two screws securing the P.C. edge connector to the outer can. Remove the top foam insulator to expose the oscillator circuits.

#### WARNING

**THE OSCILLATOR'S INTERNAL OVEN MASS TEMPERATURE MAY BE AS HIGH AS 85°C (185°F). TO AVOID SERIOUS BURNS, DO NOT REMOVE OSCILLATOR CIRCUITS AND/OR OVEN MASS ASSEMBLY FROM THE OUTER HOUSING UNTIL THE OSCILLATOR HAS SUFFICIENTLY COOLED (APPROXIMATELY 1 HOUR WITH BOTTOM COVER AND FOAM INSULATOR REMOVED). THE OUTER HOUSING TEMPERATURE IS NOT A RELIABLE INDICATION OF THE INTERNAL TEMPERATURE.**

4. Once the oscillator is cool enough to handle, remove the oscillator assembly by pushing on the tuning capacitor (FREQ. ADJ.) with a long, small diameter tool until the oscillator assembly can be removed easily.

**NOTE**

Under no circumstances should the oven circuit be operated with the oven mass removed from the outer housing. To do so will cause damage to components inside the oven mass.

5. Required Equipment:

Oscilloscope ..... HP 1715A

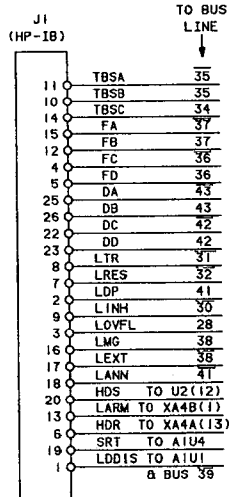
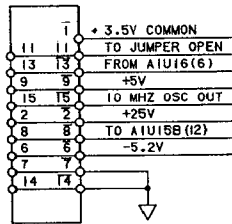
Power Supply ..... 12V dc

Preset power supply to 12V dc. Turn off power supply before proceeding to the next step.

6. Connect the power supply to pins 2 (-) and 3 (+) of the 15 pin test connector. (See instructions in paragraph 8-A-56, Special Test Connector, to fabricate the test connector.)
  - a. Insert the oscillator edge connector into the 15 pin test connector.
  - b. Connect pin 1 and 2 of the 15 pin test connector to an oscilloscope using a 50 Ohm coax cable. Set the oscilloscope to 50 Ohm input. Do not apply power to the oven circuits.
7. Turn on the power supply and adjust R6 AGC control for 1.56V p-p  $\pm$ 0.14V p-p.
8. Turn off the power supply and reassemble the oscillator if the problem is corrected.

8-A-99. EXCESSIVE DRIFT OF OUTPUT FREQUENCY. When the quartz crystal oscillator has not been operated for a long period of time, or if it has been subjected to severe thermal or mechanical shock, the oscillator may take some time to stabilize. In most cases, the crystal will drift and then stabilize at or below the specified rate within a few days after being turned on. In isolated cases, depending on the amount of time the oscillator has been off and the environmental conditions it has experienced, the oscillator may take up to 1 week to reach the specified aging rate. This should be taken into consideration if the drift rate of the unit is out of specifications. If the unit has had sufficient time to stabilize but is still out of specification, the most likely cause of excessive drift is a defective crystal (Y1). If Y1 is to be replaced, read paragraph 8-A-55(b). Other possible causes are an unstable C3 and/or C8.

(OPTION 010  
OSCILLATOR)  
XA3

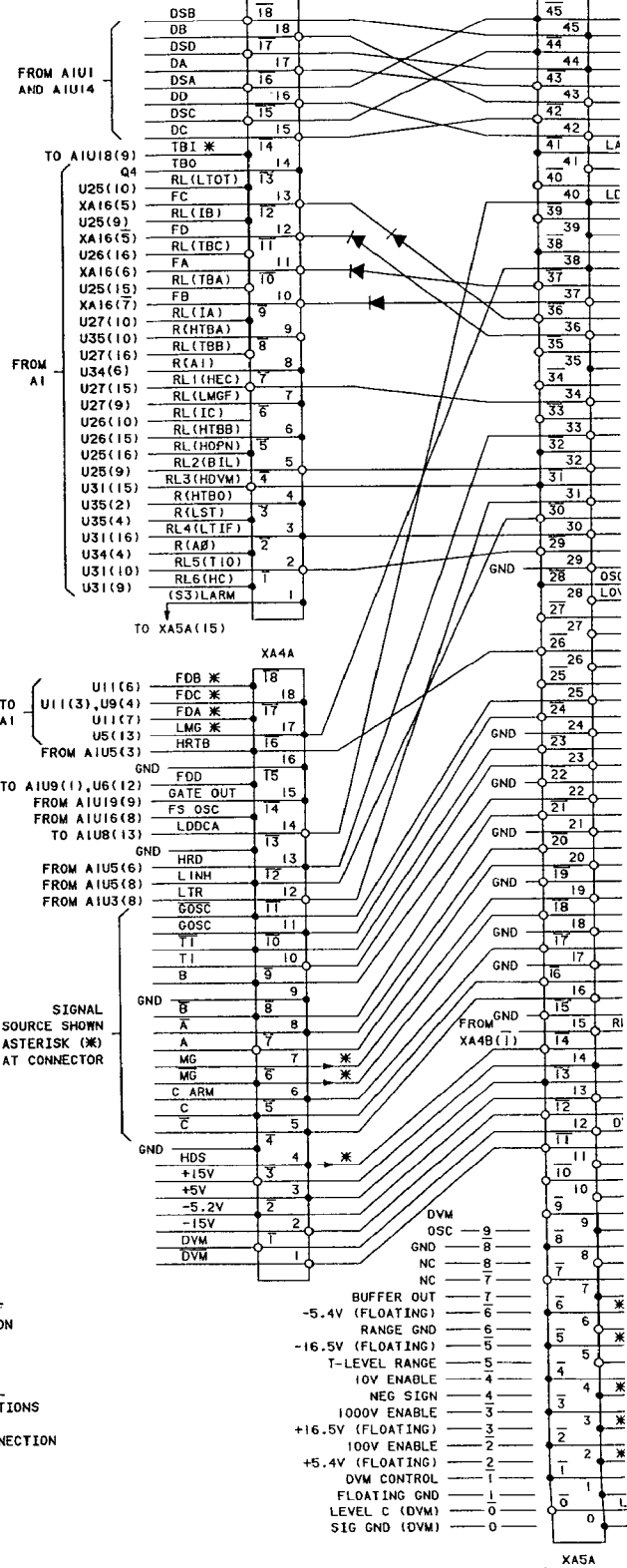


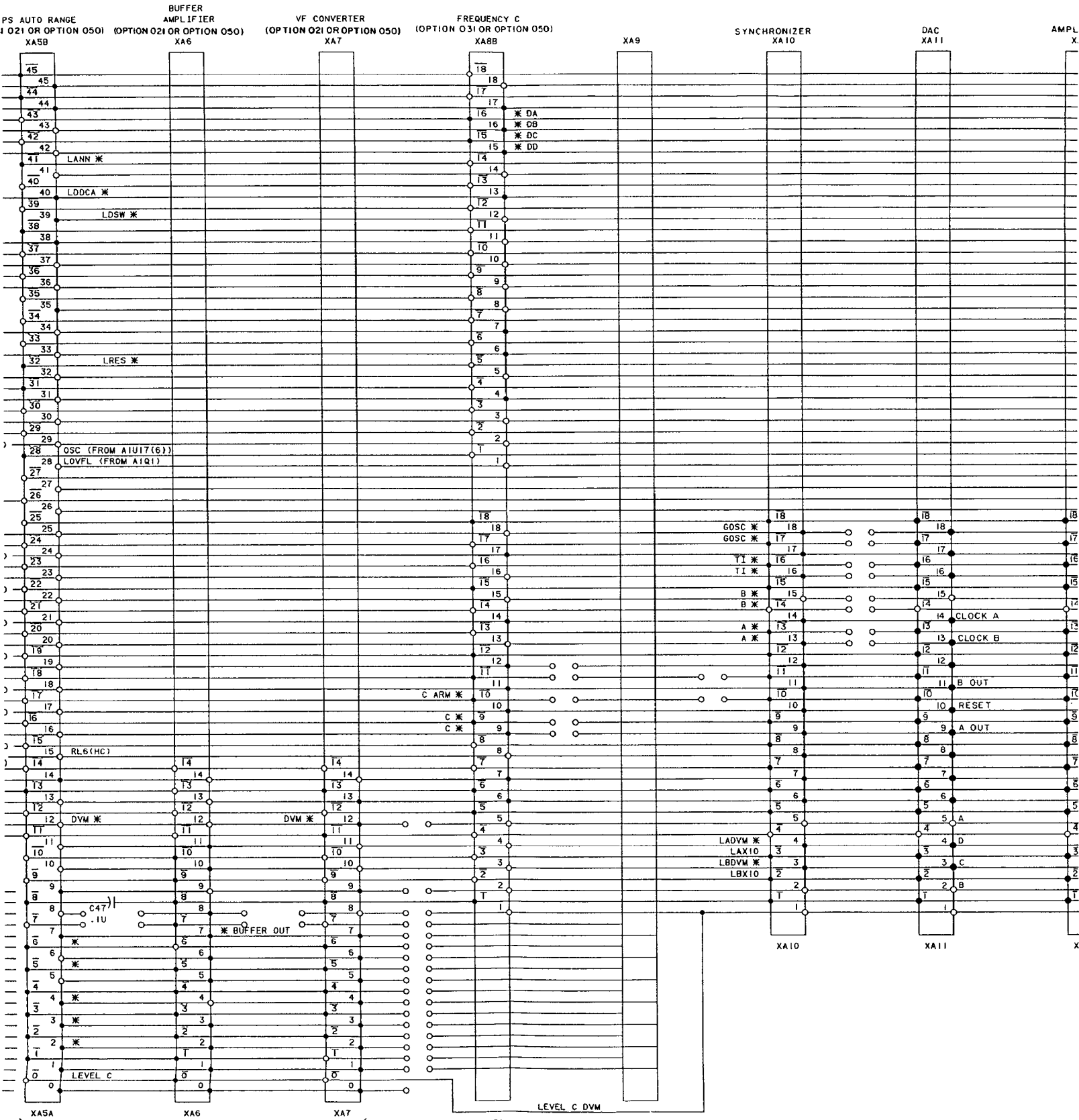
NOTES:

1. SHADED AREAS SHOW LOCATION OF CONNECTOR MOUNTING IN RELATION TO BUS LINES.
2. FOR DESCRIPTION OF MNEMONICS REFER TO TABLE B-2.
3. ASTERISK (\*) INDICATES SIGNAL SOURCE. FOR SCHEMATICS OF OPTIONS SEE OPTION MANUAL.
4. DOT (•) INDICATES ACTIVE CONNECTION TO BUS LINE AND ASSEMBLY.

FUNCTION SELECTOR  
XA4B

PS AUTO RANGE  
(OPTION 021 OR OPT10)  
XA5B





PIN NUMBERS FOR THESE CONNECTORS  
CORRESPOND WITH BUS LINE NUMBERS

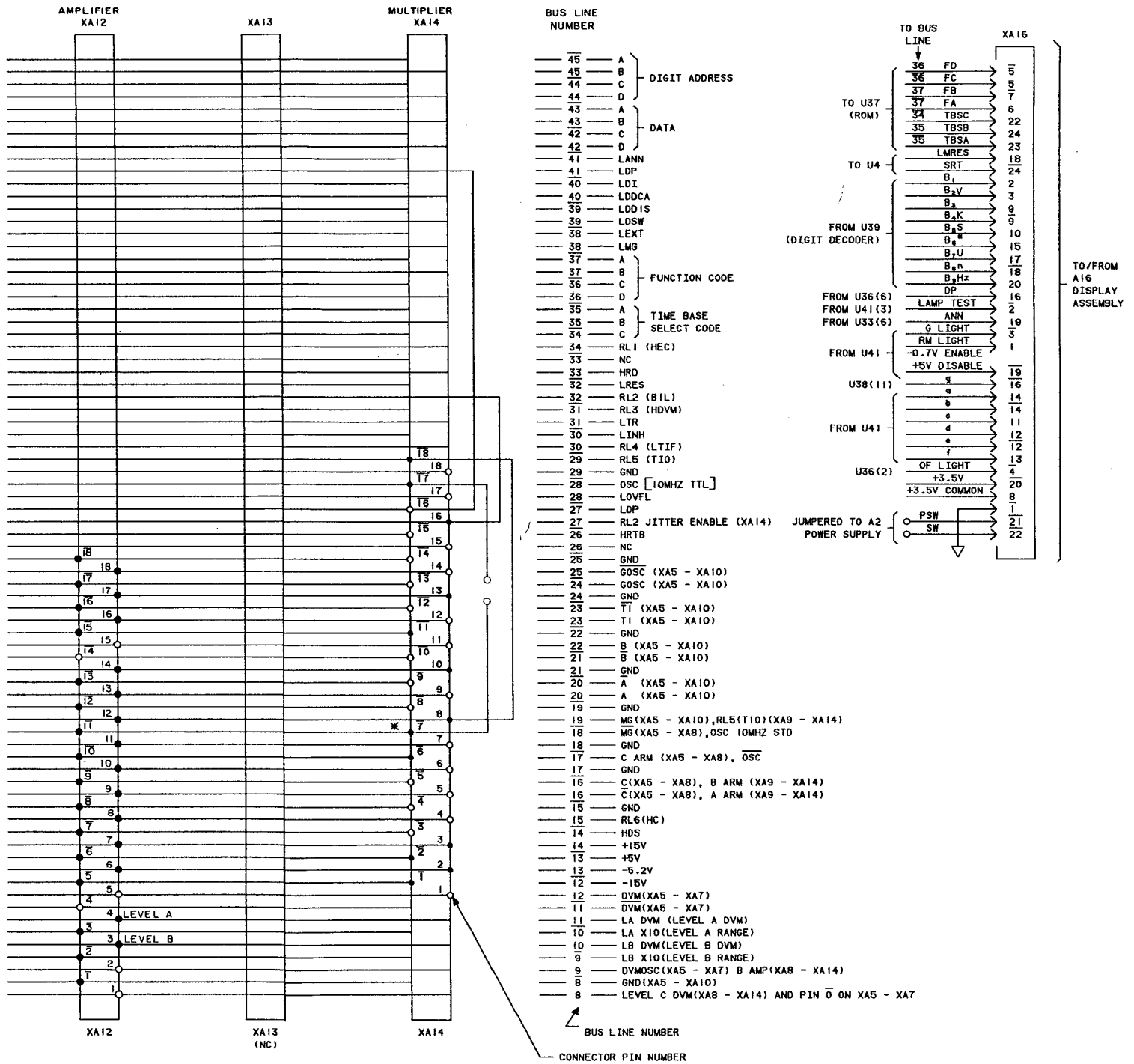


Figure 8-A-6. A1 Motherboard Interconnect Diagram



*Figure 8-A-6*  
**A1 MOTHERBOARD INTERCONNECT DIAGRAM**

(See Page 8-49)

5328B

FUNCTION: CHECK  
FREQ RESOLUTION: 1 kHz 10<sup>3</sup>

OSCILLOSCOPE

HP 1725A WITH 10: 1 PROBE  
COUPLING: DC  
SLOPE: +  
SYNCH: INT, ACF

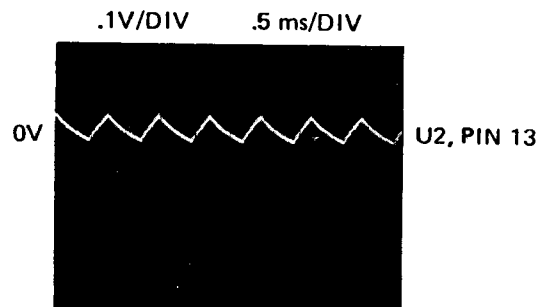
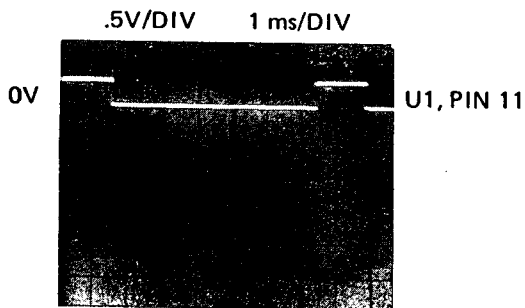
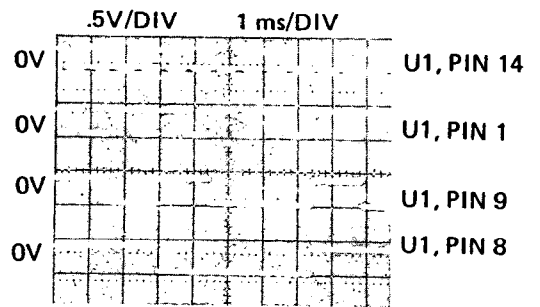
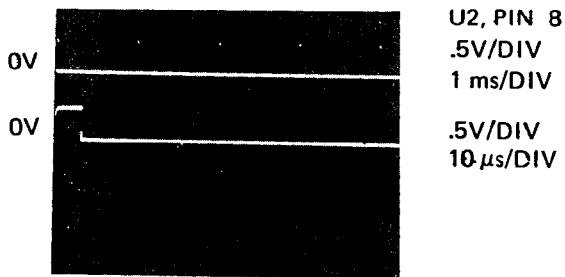
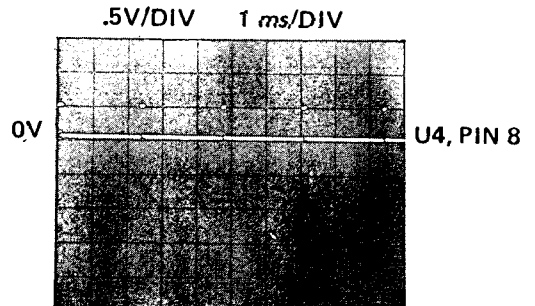
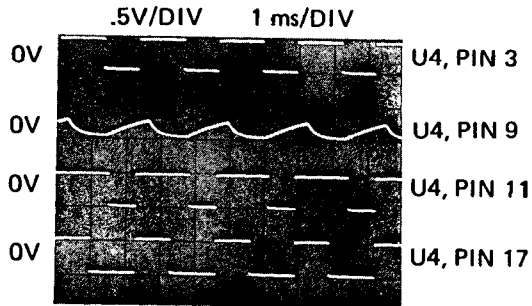


Figure 8-A-7. A1 Motherboard Waveforms (Part 1 of 3)



**5328B**

FUNCTION: CHECK  
FREQ RESOLUTION: 1 kHz 10<sup>3</sup>

**OSCILLOSCOPE**

HP 1725A WITH 10:1 PROBE  
COUPLING: DC  
SLOPE: +  
SYNCH: INT, ACF

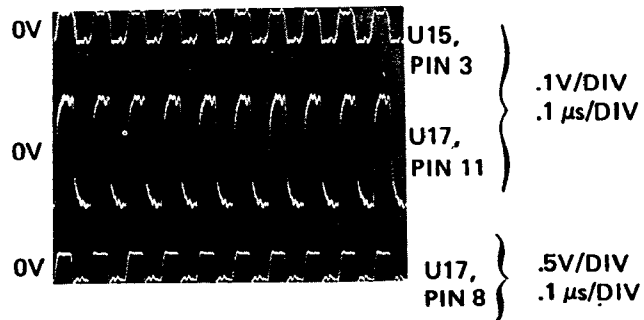
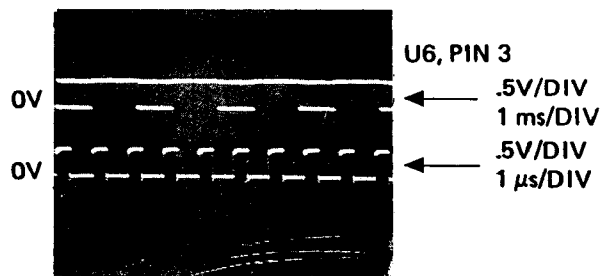
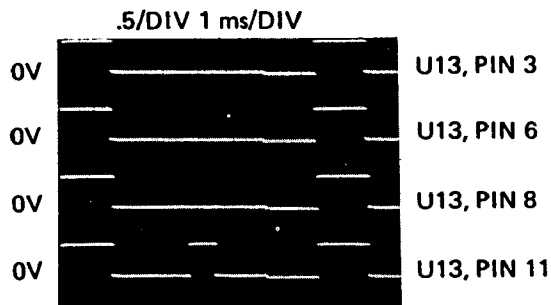
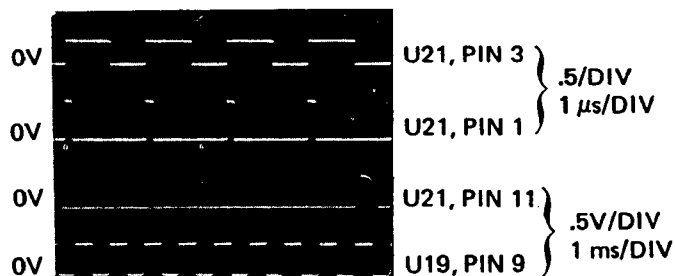
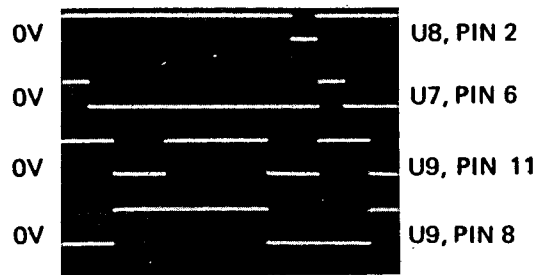
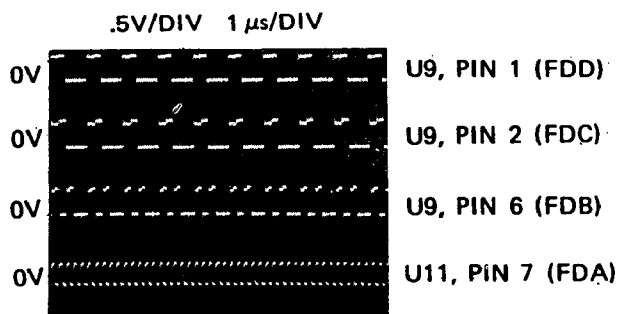


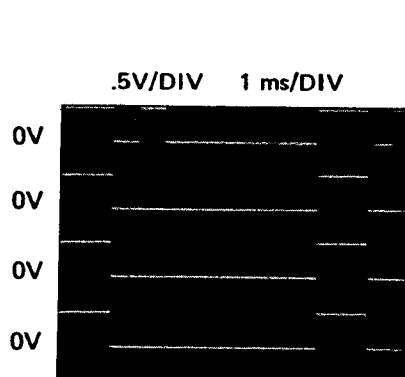
Figure 8-A-7. A1 Motherboard Waveforms (Part 2 of 3)

5328

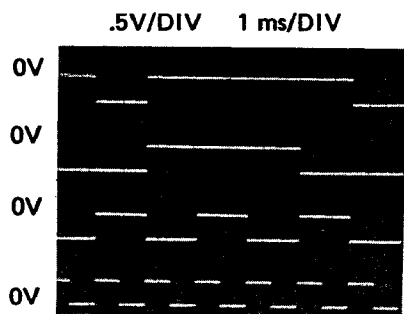
FUNCTION: CHECK  
FREQ RESOLUTION: 1 kHz 10<sup>3</sup>

OSCILLOSCOPE

HP 1725A WITH 10:1 PROBE  
COUPLING: DC  
SLOPE: +  
SYNCH: INT, ACF

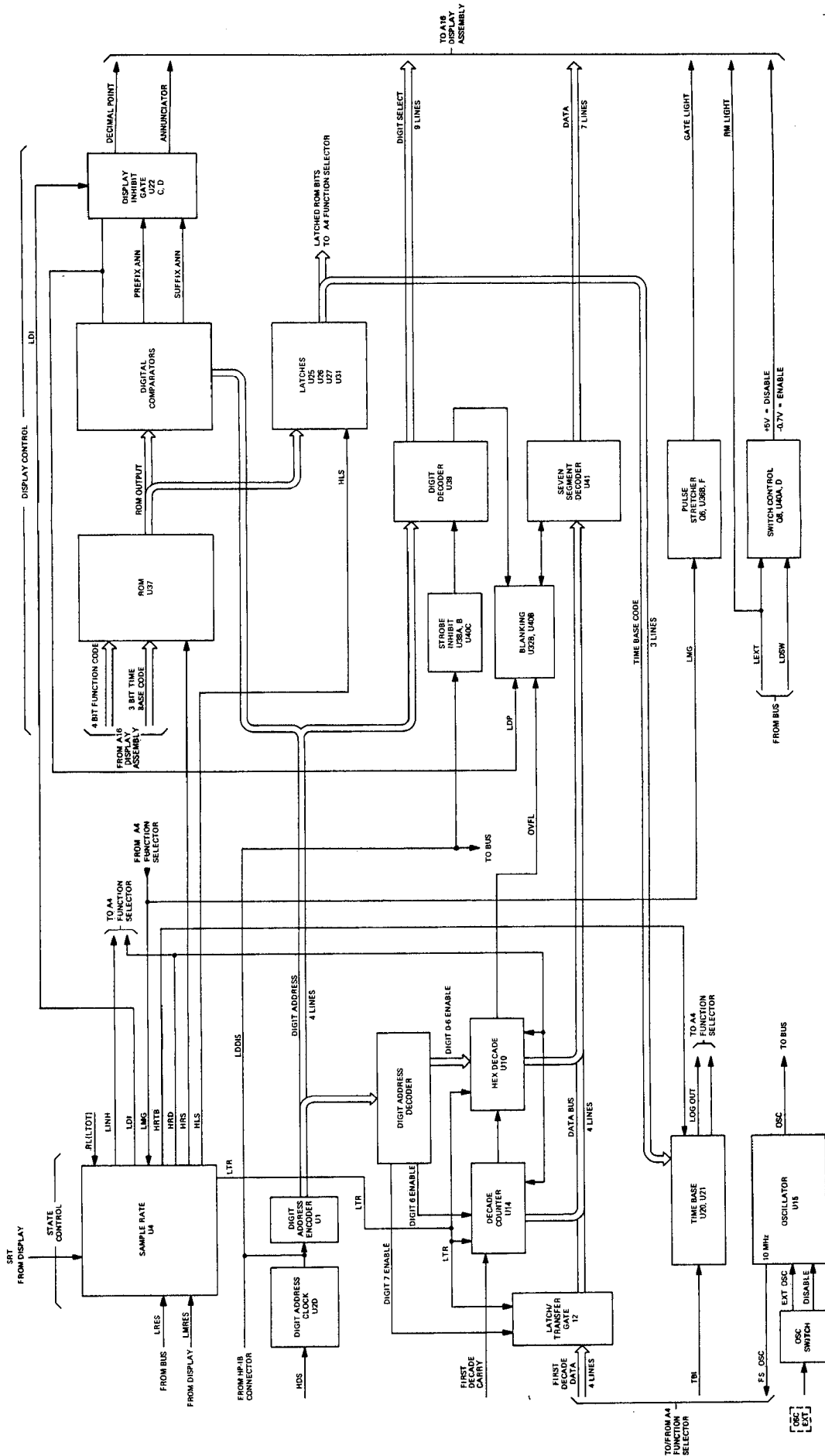


<u>DIGIT ADDRESS</u>	<u>BUS LINE NO.</u>
A	<u>45</u>
B	45
C	<u>44</u>
D	44



<u>DATA</u>	<u>BUS LINE NO.</u>
A	<u>43</u>
B	43
C	<u>42</u>
D	42

Figure 8-A-7. A1 Motherboard Waveforms (Part 3 of 3)



NOTE: REFER TO TABLE B2 FOR DESCRIPTION OF SIGNAL MNEMONICS.

Figure 8-A-8. A1 Motherboard Assembly Block Diagram 8-53



**A1 MOTHERBOARD 05328-60049  
A1 ACTIVE ELEMENTS**

REFERENCE DESIGNATIONS	PART NUMBER
C3	0180-0100
C4, C20	150D475X9035B2
C5	0160-0161
	0180-0106
C6	150D606X0006B2
	140-0177
C7	DM15F401F0300WV1CR
C8	0170-0024
	0180-0195
C10	150D334X0035A2
	0160-0314
C17	663UW10354W2
C18	0160-2264
	0121-0060
C21, C34, C36, C45, C46	30432 2/8PF NPO
	0180-0210
	150D335X0015A2
C22	0160-2055
C29, C31	0180-0230
	150D105X0050A2
C30	0160-0153
C33, C35, C37, C39, C41, C43, C44	0160-4554
C38	0160-2055
C40, C42, C48, C49, C52, C53	0180-0155
	150D225X0020A2
C47	0160-4084
C50, C51	0160-3879
CR1, CR9-CR14, CR16, CR17, CR19-CR21	1901-0040
CR3, CR15, CR18	1901-0016
CR5, CR6	1901-0050
CR7	1901-0535
CR8	1902-3082
L1	9100-2276
Q1, Q4, Q5, Q7-Q9	1854-0071
Q2, Q3	1853-0015
	2N3640
Q6	1854-0092
	2N3563
Q10	1853-0036
U1, U20	1820-0055
	SN7490N
U2	1820-1056
	SN74132N
U3	1820-0175
	SN7405N
U4	1820-1401
U5	1820-0513
U6, U24, U29, U30	1820-0282
	SN7486N
U7	1820-0511
	SN7408N
U8, U18, U33-U36	1820-0174
	SN7404N
U9, U38	1820-0661
	SN7432N
U10	1820-2316
	ID82-4
U11	1820-0513
	SN20573
U12	1820-3237
U13	NOT USED
U14	1820-1442
	SN74LS290N
U15	1820-0803
	MC10105P
U16	1820-0537
	SN7413N

**A1 MOTHERBOARD 05328-60049  
A1 ACTIVE ELEMENTS (Continued)**

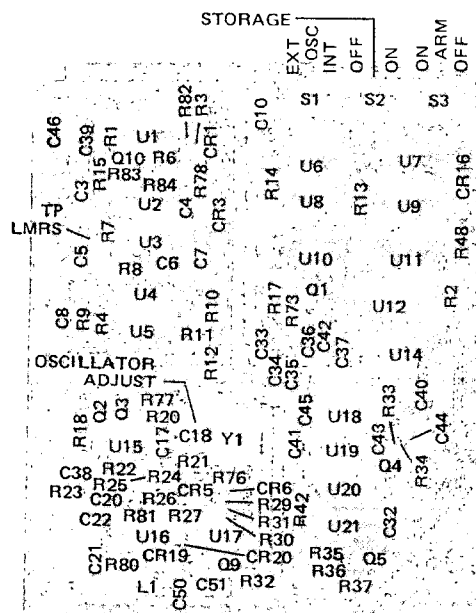
REFERENCE DESIGNATIONS	PART NUMBER
U17	1820-0068
	SN7410N
U19	1820-0077
	SN7474N
U21	1820-2317
	IDB9-TL
U22	1820-0269
	SN7403N
U23	1820-0328
	SN7402N
U25-U27, U31	1820-0301
	SN7475N
U28, U32	1820-0538
	SN7423N
U37	1818-2252
U39	1820-0214
	SN7442N
U40	1820-0054
	SN7400N
U41	1820-1644
	SN74LS248N

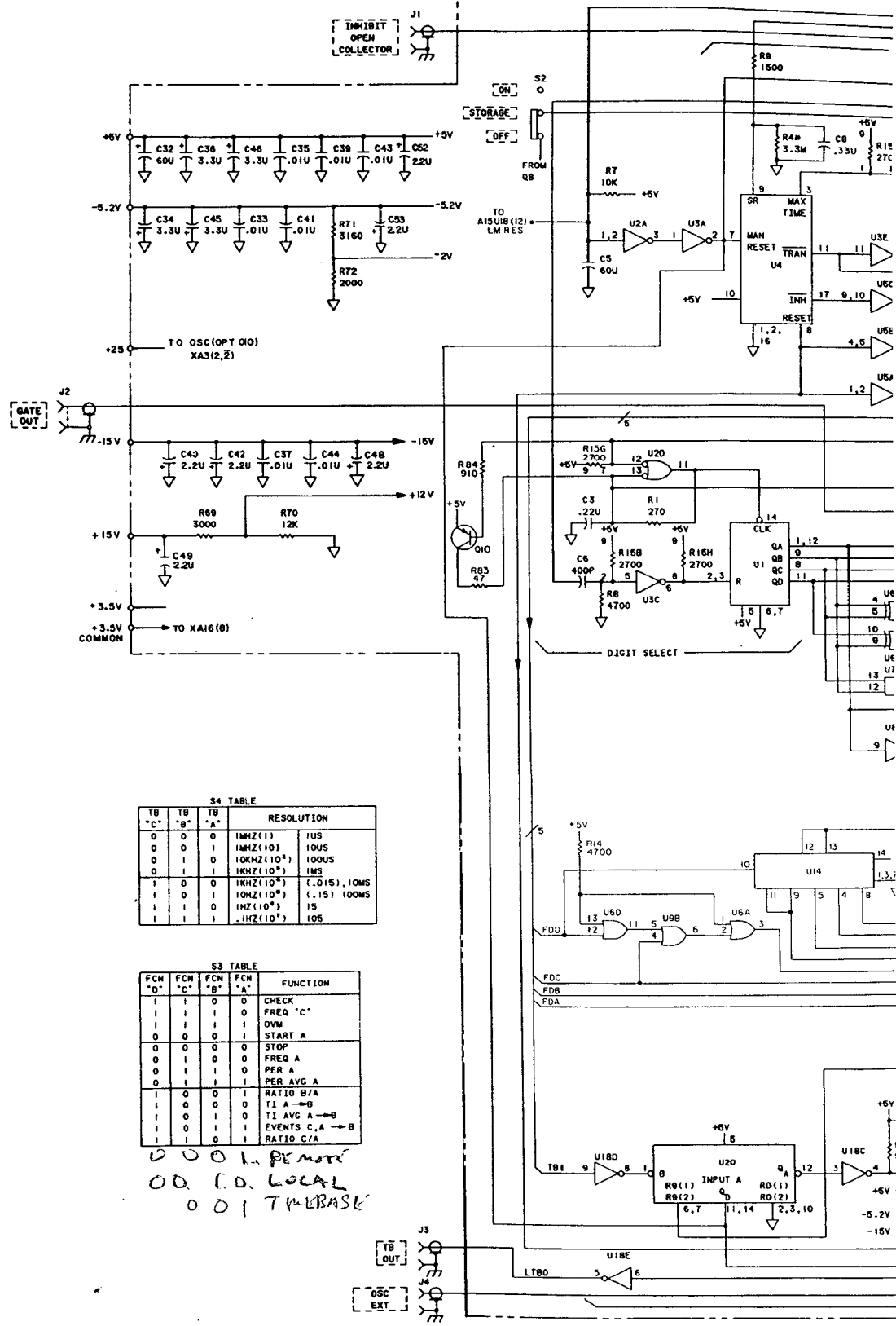
**FACTORY SELECTED PART**

REFERENCE DESIGNATOR	SELECTED FOR	NORMAL VALUE RANGE
C17	10 MHz oscillation adjusted by C18	20 pF ± 5 pF

**A1 MOTHERBOARD 05328-60049  
REFERENCE DESIGNATIONS**

A1
C1, C2, NOT ASSIGNED
C3-C8
C9 NOT ASSIGNED
C10
C11-C16 NOT ASSIGNED
C17-C18
C19 NOT ASSIGNED
C20-C22
C23-C28 NOT ASSIGNED
C29-C31
C32 NOT ASSIGNED
C33-C53
CR1
CR2, CR4 NOT ASSIGNED
CR3, CR5-CR21
L1
Q1-Q10
R1-R15
R16 NOT ASSIGNED
R17-R46
R47 NOT ASSIGNED
R48
R49-R51 NOT ASSIGNED
R52
R53, R54 NOT ASSIGNED
R55-R84
S1-S3
U1-U12
U13 NOT ASSIGNED
U14-U41





S4 TABLE

TB 'C'	TB 'B'	TB 'A'	RESOLUTION
0	0	0	1MHZ(1) 1US
0	0	1	1MHZ(10) 10US
0	1	0	10KHZ(10 <sup>3</sup> ) 100US
0	1	1	1KHZ(10 <sup>2</sup> ) 1MS
1	0	0	1KHZ(10 <sup>2</sup> ) (.015), 10MS
1	0	1	10KHZ(10 <sup>3</sup> ) (.15) 100MS
1	1	0	1HZ(10 <sup>1</sup> ) 1S
1	1	1	1HZ(10 <sup>1</sup> ) 10S

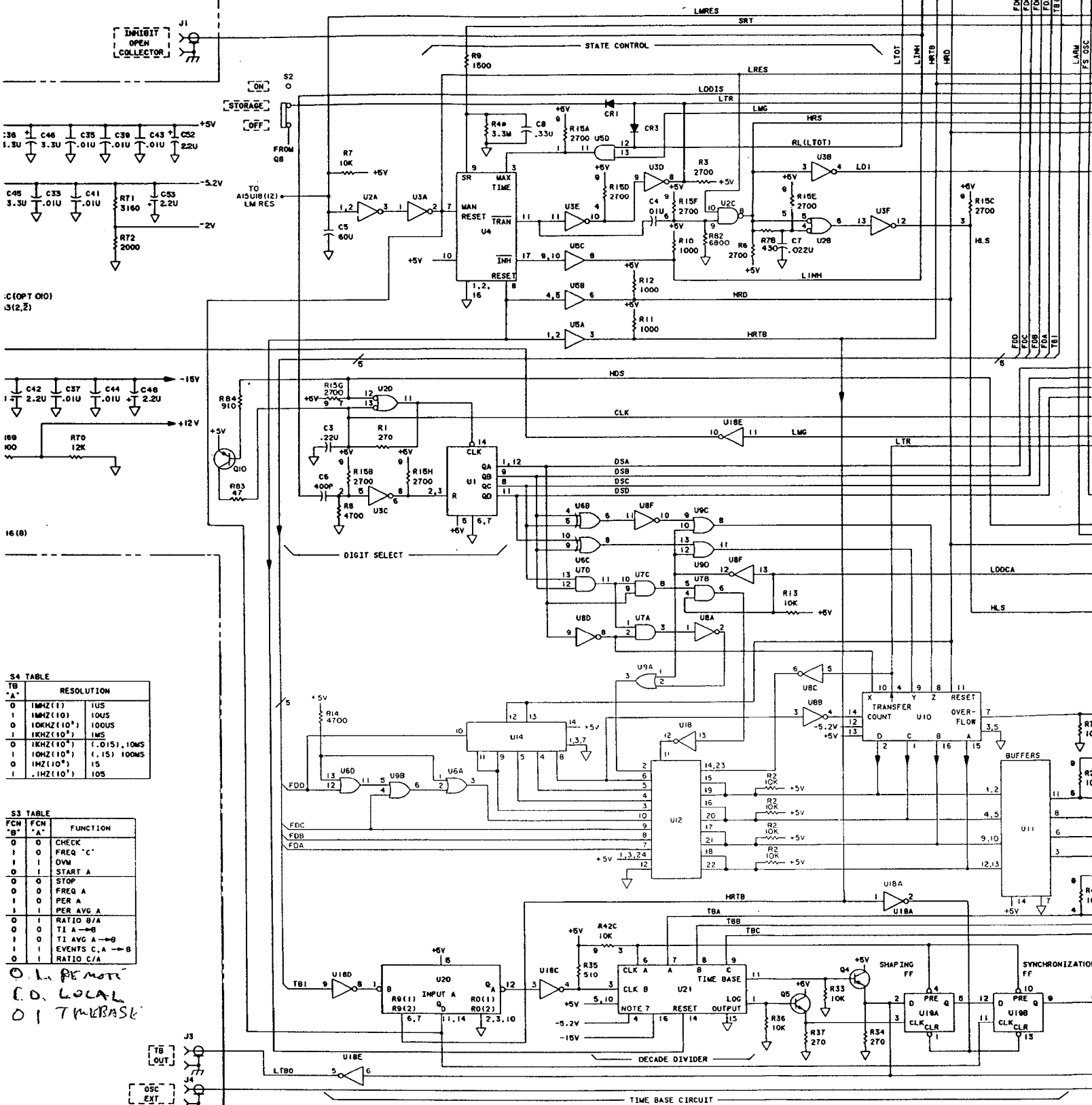
S3 TABLE

FCN 'D'	FCN 'C'	FCN 'B'	FCN 'A'	FUNCTION
1	1	0	0	CHECK
1	1	1	0	FREQ 'C'
1	1	1	1	DVM
0	0	0	1	START A
0	0	0	0	STOP
0	1	0	0	FREQ A
0	1	1	0	PER AVG A
0	1	1	1	RATIO B/A
1	0	0	0	T1 A → B
1	0	1	0	T1 AVG A → B
1	0	1	1	EVENTS C, A → B
1	1	0	1	RATIO C/A

0 0 0 1 PER AVE  
 0 0 1 0 LOCAL  
 0 0 1 1 TRKBASE

C52  
 C49

AI MOTHER BOARD ASSEMBLY (05328-60049) SERIES 2450



S4 TABLE

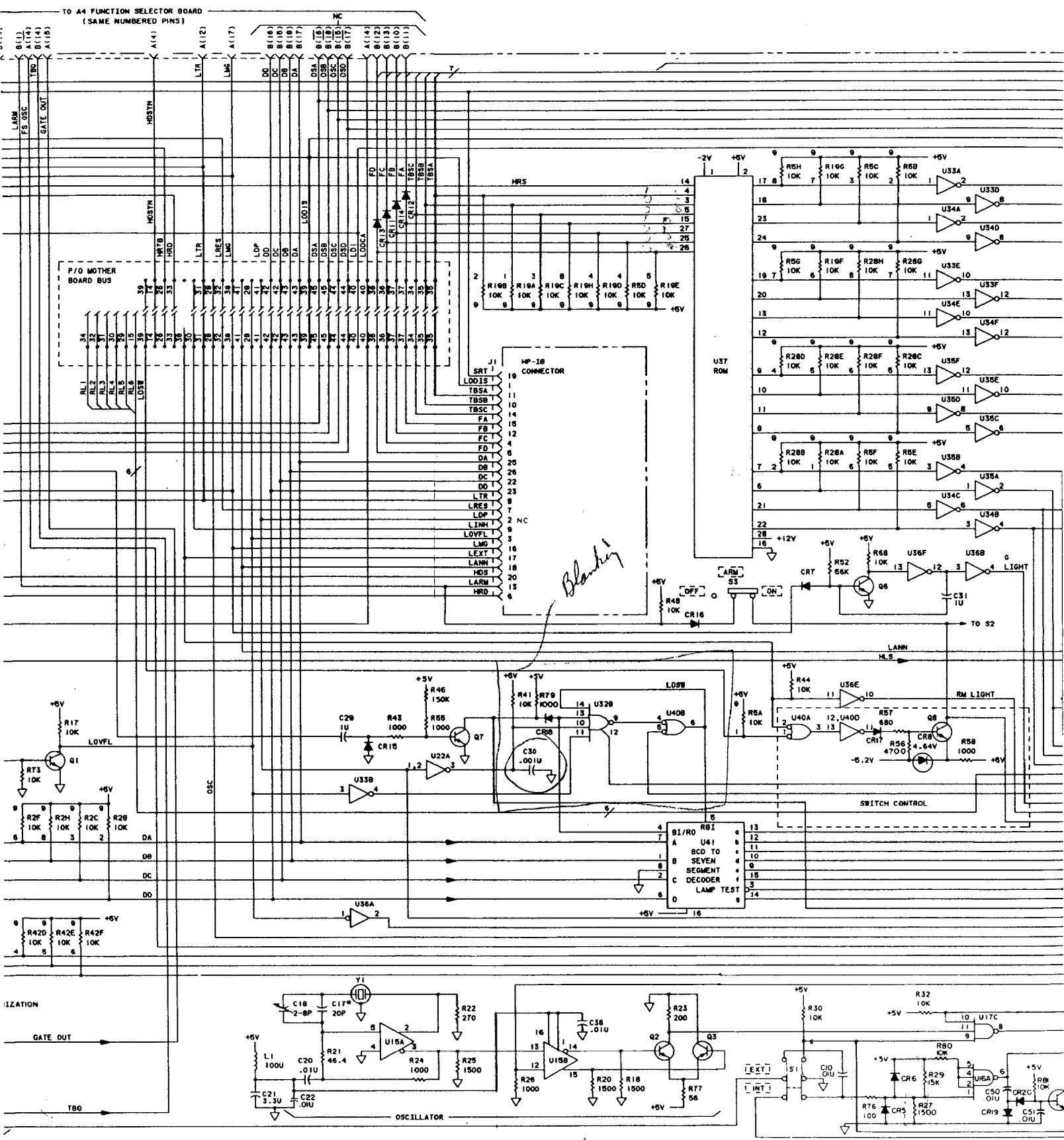
TB	RESOLUTION
0	1MHZ (1)
1	10US
0	10KHZ (10)
1	100US
0	100KHZ (10 <sup>2</sup> )
1	1MS
0	1KHZ (10 <sup>3</sup> )
1	(.01S), .10MS
0	10KHZ (10 <sup>4</sup> )
1	(.1S), 100MS
0	1HZ (10 <sup>5</sup> )
1	10S

S3 TABLE

FCN	FUNCTION
0	CHECK
1	FREQ 'C'
1	OWM
0	START A
0	STOP
0	FREQ A
1	PER A
1	PER AVG A
0	RATIO B/A
0	T1 A → B
1	T1 AVG A → B
1	EVENTS C, A → B
0	RATIO C/A

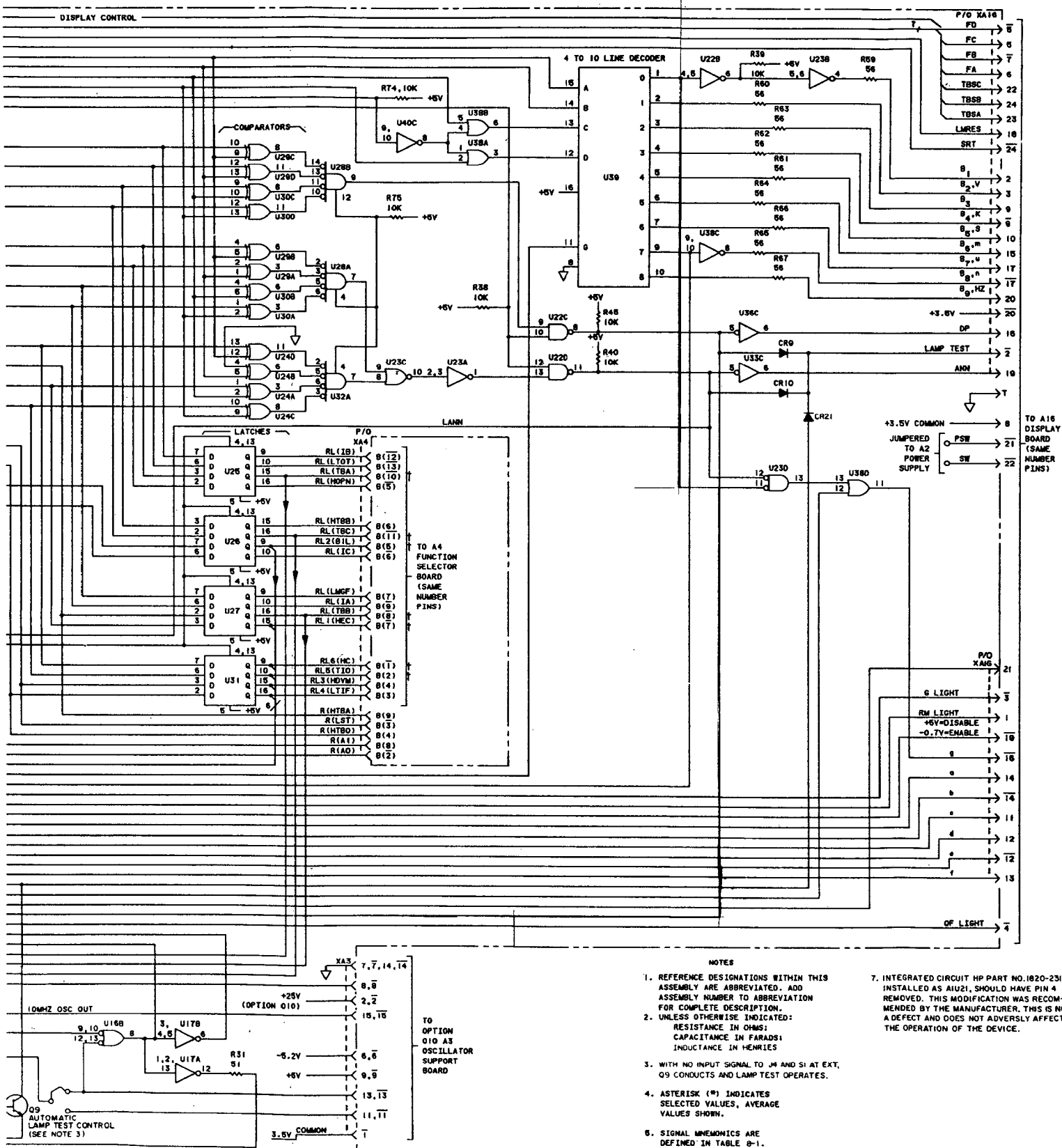
0 1 REMOTE  
 0 0 LOCAL  
 0 1 TIMEBASE





*Blanking*

*Blanking Problem  
C30 U32 on 40  
C30 curves top of signal  
from 422 pin 2*



- 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 FARADS;  
INDUCTANCE IN HENRIES
  3. WITH NO INPUT SIGNAL TO J4 AND S1 AT EXT, Q9 CONDUCTS AND LAMP TEST OPERATES.
  4. ASTERISK (\*) INDICATES SELECTED VALUES, AVERAGE VALUES SHOWN.
  5. SIGNAL MNEMONICS ARE DEFINED IN TABLE 8-1.
  6. DAGGER (†) INDICATES NO FUNCTIONAL CONNECTION—NOT USED ON ASSEMBLY.
  7. INTEGRATED CIRCUIT HP PART NO. 1820-2317, INSTALLED AS A1U21, SHOULD HAVE PIN 4 REMOVED. THIS MODIFICATION WAS RECOMMENDED BY THE MANUFACTURER. THIS IS NOT A DEFECT AND DOES NOT ADVERSELY AFFECT THE OPERATION OF THE DEVICE.

Figure 8-A-10. A1 Motherboard Assembly Schematic Diagram

*Figure 8-A-10*  
**A1 MOTHERBOARD ASSEMBLY (SCHEMATIC DIAGRAM)**

(See Page 8-55)

Table 8-A-3. 5328B Functional Signals

NOTE											
N=0-7 (Exponent of 10 on FREQ RESOLUTION, N switch. N=0 is position 1 on switch. All other positions N≠0). CLK = 10 MHz * = Don't care											
Function Switch	Displayed Number FREQ • TIME (Hz) (Seconds)	Signal to TB (Output A4U10) IF N=0 IF N≠0		Signal to 1st Decade (Output A4U6) IF N=0 IF N≠0		Arming (Output A4U5) Norm Armed		Main Gate (Input A4U6) IF N=0 IF N≠0		Gate (Options 030 and 031 (Input A8U4)	
		FREQ A	$A \cdot \frac{10^{(N+1)}}{CLK}$	CLK	CLK	A	A	A	B	MGFF	MGFF
PER A	$\frac{CLK}{10^N} \cdot PER A$	*	CLK	GOSC	TBO	Free	B	Open	TI	*	
PER A (Option 040)	$\frac{100 MHz}{10^N} \cdot PER A$	*	CLK (N=0 or 1) (N≠0 or 1)	GOSC	TBO (IF N=1, CLK)	Free	B	Open	RI	*	
PER AVG A	$CLK \cdot 10^N PER A$	*	A	GOSC	CLK	Free	B	Open	MGFF	*	
PER AVG A (Option 040 & 041)	$100 MHz \cdot 10^N PER A$	*	A	GOSC	100 MHz	Free	B	Open	MGFF	*	
TI A-B	$\frac{CLK}{10^N} \cdot TI A-B$	*	CLK	GOSC	TBO	Free	CA	Open	TI	*	
TI A-B (Option 040 & 041)	$\frac{100 MHz}{10^N} \cdot TI A-B$	*	CLK (N=0 or 1) (N≠0 or 1)	GOSC	TBO (IF N=1, CLK)	Free	CA	Open	TI	*	
TI AVG A-B	$(CLK \cdot 10^N) \cdot TI A-B$	*	B	GOSC	GOSC	Free	CA	Open	MGFF	*	
TI AVG A-B (Opt. 040 & 041)	$(100 MHz \cdot 10^N) \cdot TI A-B$	*	B	GOSC	GOSC	Free	CA	Open	MGFF	*	
FREQ C (Opt. 030 & 031)	$C \cdot \frac{10^{(N+1)}}{CLK}$	CLK	CLK	$\frac{C}{10}$	$\frac{C}{10}$	CA	B	Open	Open	MGFF	
DVM (Option 020, 021)	$DVM \cdot \frac{10^{(N+1)}}{CLK}$	CLK	CLK	DVM	DVM	Free	B	MGFF	MGFF	*	
†DVM, A-B	(In DVM, A-B TB Switch ignored)	*	*	DVM	DVM	Free	CA	TI	TI	*	
EVENTS C, A-B	(EVENTS C A-B TB Switch ignored)	*	*	$\frac{C}{10}$	$\frac{C}{10}$	Free	CA	Open	Open	TI	
START A, STOP	$\frac{A}{10^N} \cdot TI START TO STOP$	*	A	A	TBO	Free	Free	LStart	Open	*	
RATIO B/A	$B \cdot \frac{10^N}{A}$	††*	A	B	B	Free	CA	TI	MGFF	*	
RATIO C/A (Opt. 030 & 031)	$C \cdot \frac{10^N}{A}$	*	A	$\frac{C}{10}$	$\frac{C}{10}$	Free	B	Open	Open	TI IF N=0 MGFF IF N≠0	
†DVM/A	$DVM \cdot \frac{10^N}{A}$	*	A	DVM	DVM	Free	B	TI	MGFF	*	
†START CLOCK	$\frac{CLK}{10^N} \cdot TI START TO STOP$	*	CLK	*	TBO	Free	Free	Open	Open	*	
CHECK	$CLK \cdot \frac{10^{(N+1)}}{CLK}$	CLK	CLK	CLK	CLK	Free	B	MGFF	MGFF	*	

NOTES  
 † = Phantom Function (see 5328A Users Manual)  
 †† = ROM makes "A" into period = gate time  
 CA = CARM

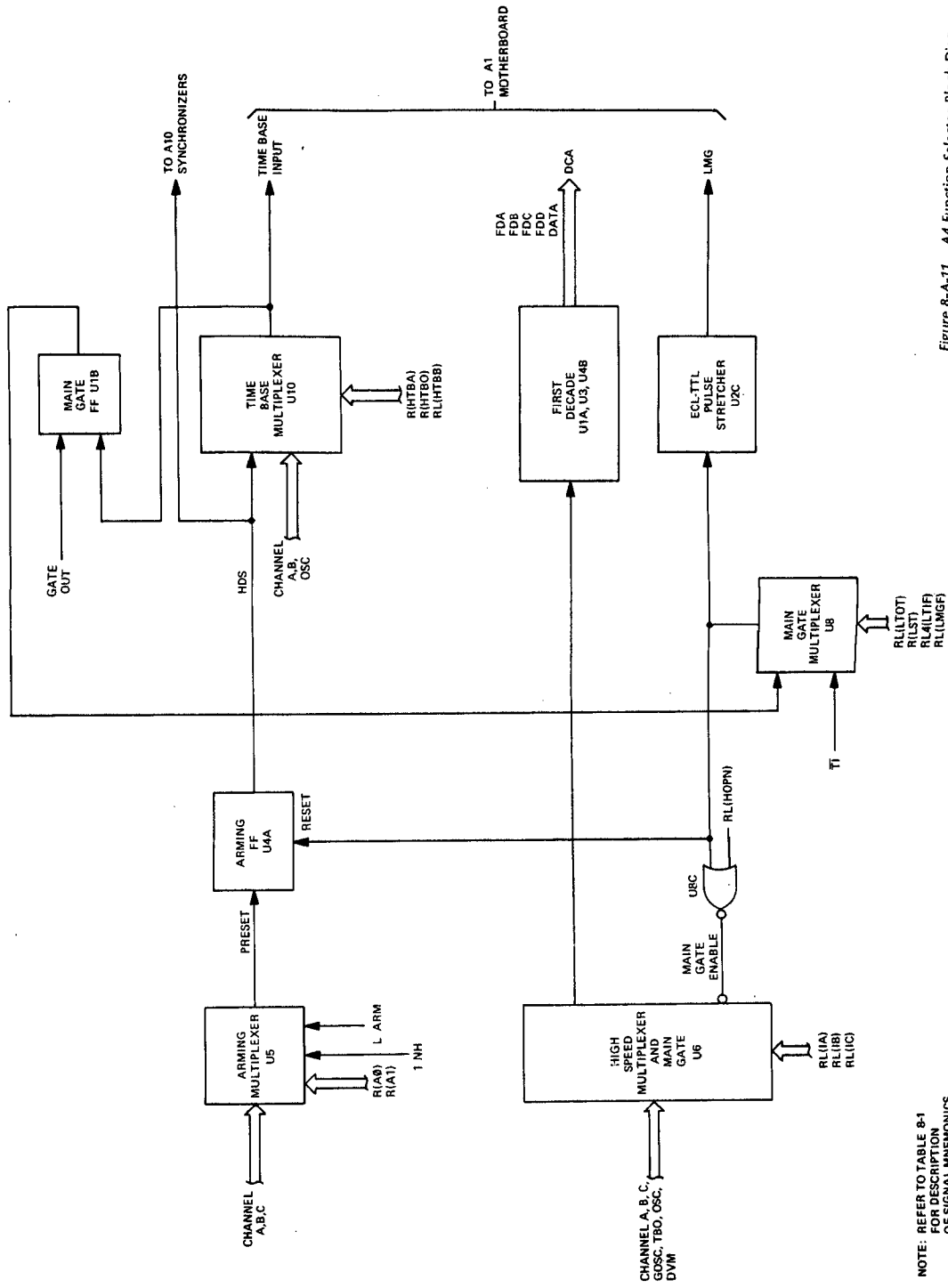


Figure 8-A-11. A4 Function Selector Block Diagram

NOTE: REFER TO TABLE 8-1 FOR DESCRIPTION OF SIGNAL MNEMONICS.

Model 5328B  
Service

A4 FUNCTION SELECTOR TROUBLE SHOOTING FLOWCHART

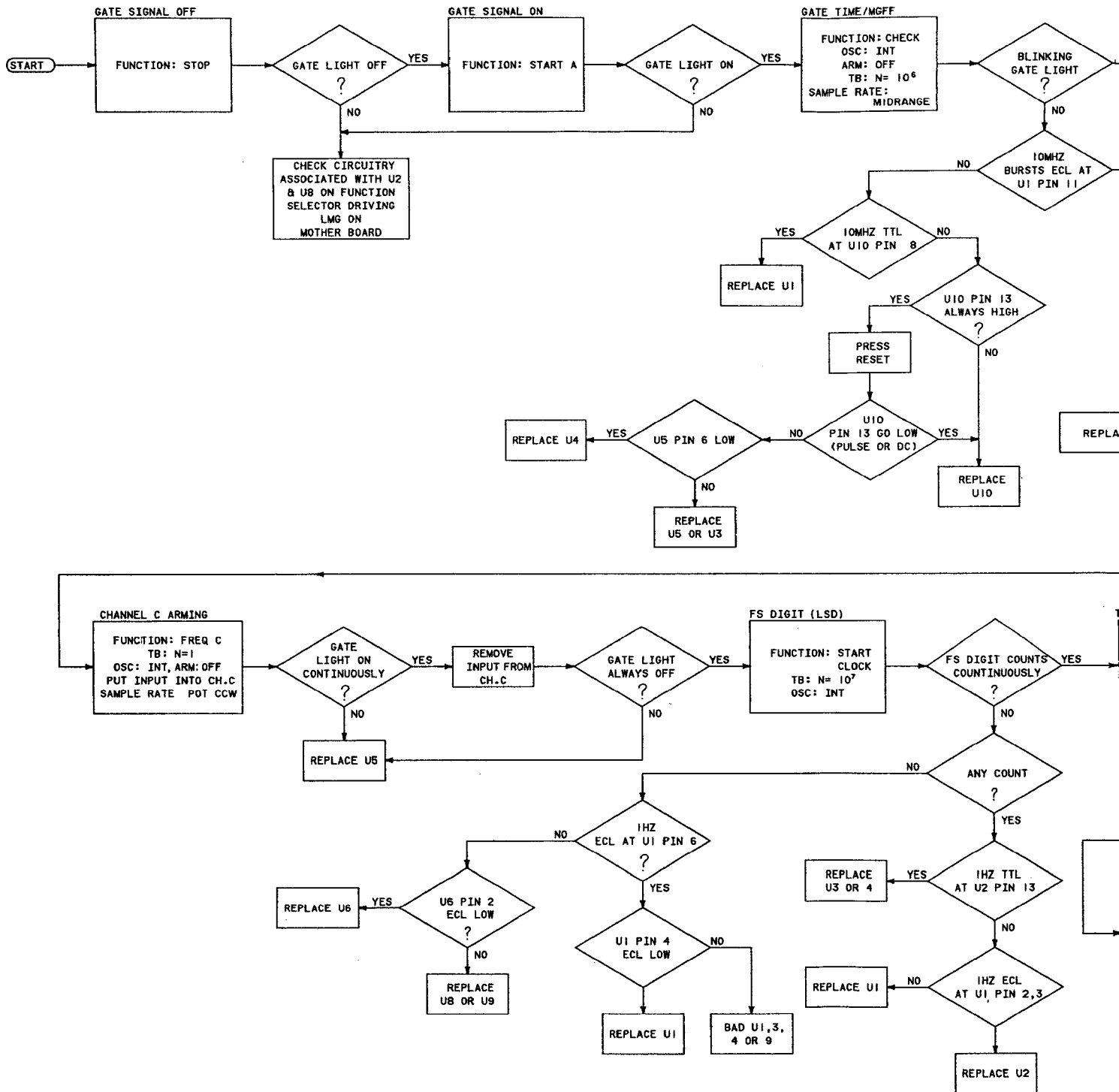
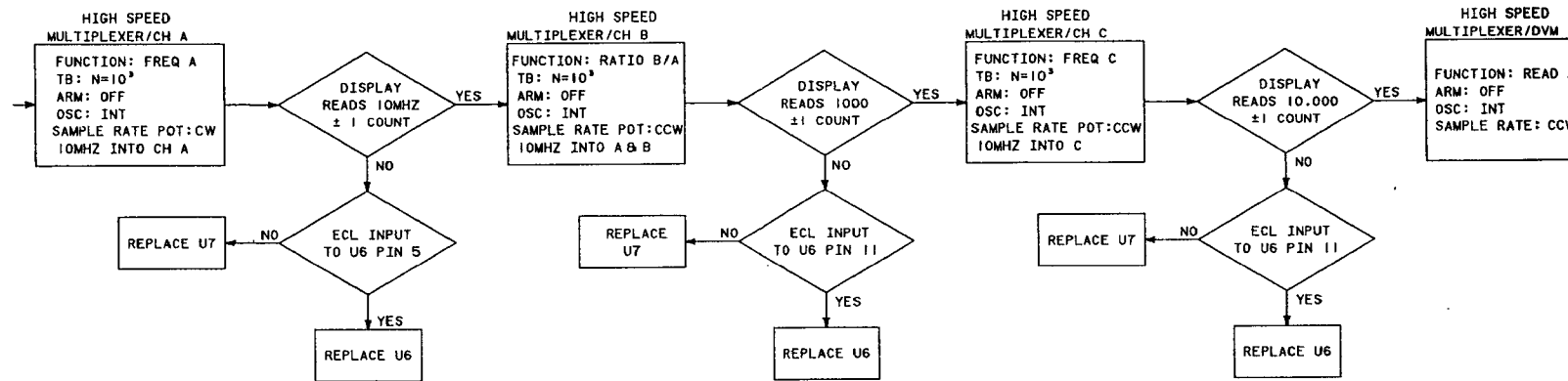
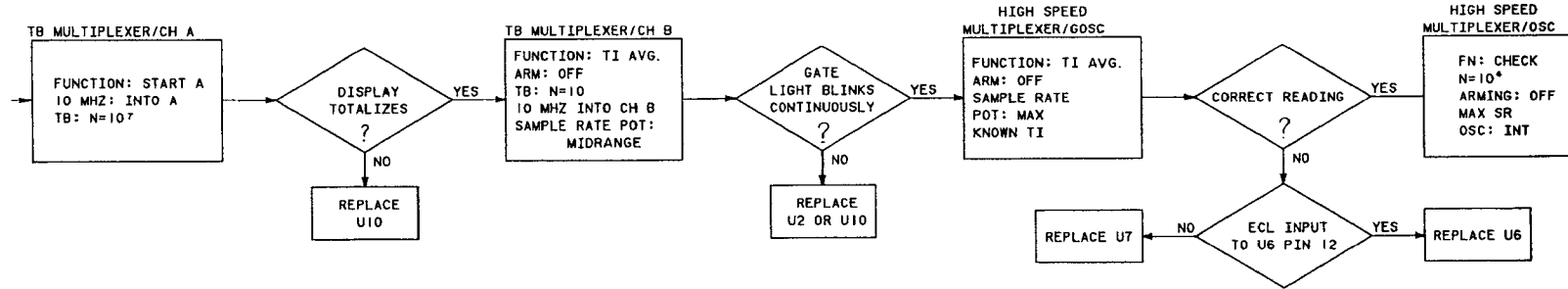
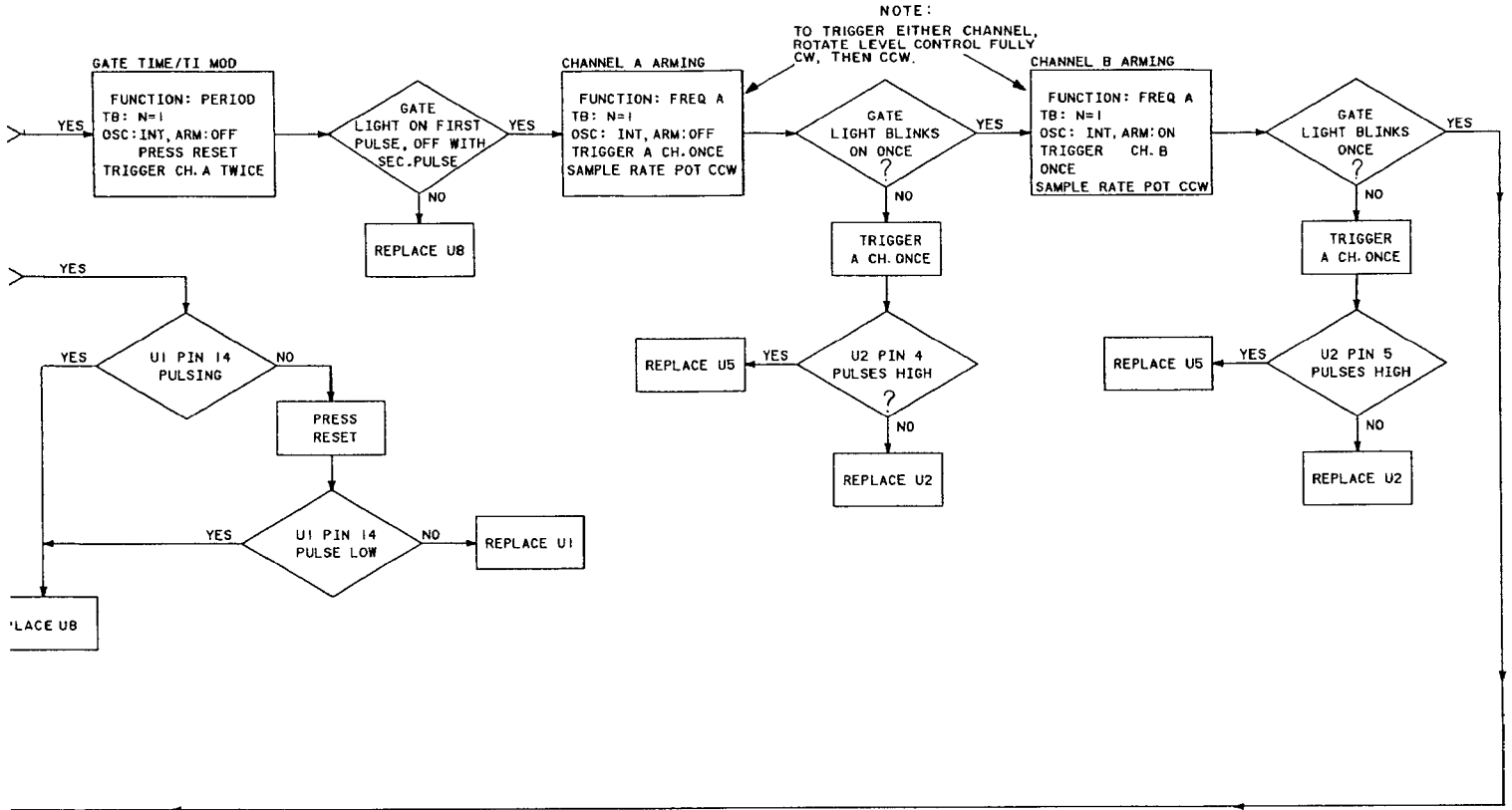


Figure 8-A-12. A4 Function Selector Troubleshooting



**A4 FUNCTION SELECTOR (BLK)**

**A4 FUNCTION SELECTOR (TROUGH)**

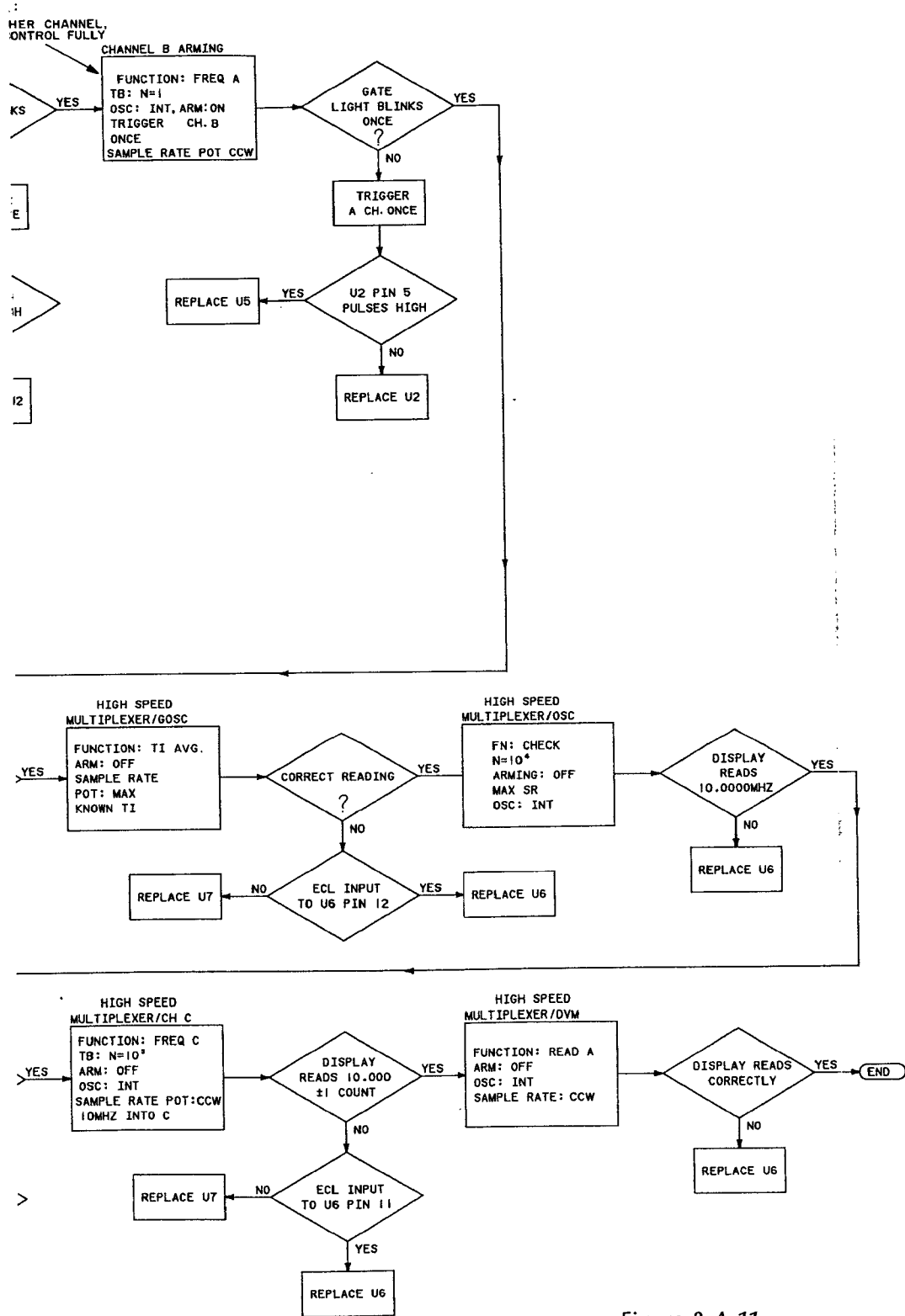


Figure 8-A-11  
**A4 FUNCTION SELECTOR (BLOCK DIAGRAM)**

(See Page 8-57)

Figure 8-A-12  
**A4 FUNCTION SELECTOR (TROUBLESHOOTING)**

(See Page 8-58)

**P1A PINS**

- 1 — DV
- 2 — -1
- 3 — +5
- 4 — HC
- 5 — C
- 6 — C
- 7 — MC
- 8 — A
- 9 — GM
- 10 — TH
- 11 — GC
- 12 — LT
- 13 — HF
- 14 — LC
- 15 — GA
- 16 — GF
- 17 — LM
- 18 — FC

\*SIGNAL SC  
 †DENOTES



REFERENCE DESIGNATIONS

A4
C1 NOT ASSIGNED
C2-C16
Q1-Q3
R1-R46
U1-U10

A4 ACTIVE ELEMENTS

REFERENCE DESIGNATIONS	PART NUMBERS
Q1-Q3	1854-0215 2N3904
U1	1820-1225 MC10231P
U2	1820-1052 MC10125L
U3, U4	1820-0629 SN74S112N
U5	1820-0622 SN74151N
U6	1820-0829 MC10164L
U7	1820-0809 MC10115P
U8	1820-0802 MC10102P
U9	1820-0328 SN7402N
U10	1820-0074 SN7454N

P1A PINS

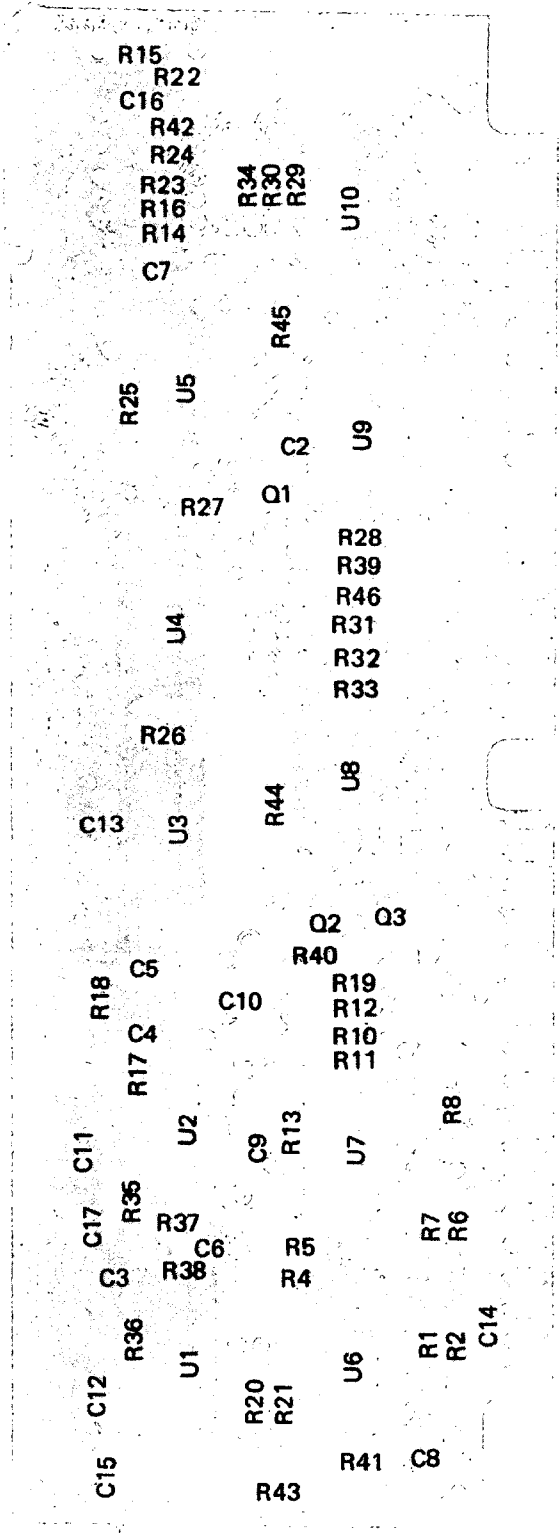
1	—	DVM†
2	—	-15V†
3	—	+5V
4	—	HDS*
5	—	C
6	—	C ARM
7	—	MG*
8	—	A
9	—	GND
10	—	TI†
11	—	GOSC
12	—	LTR†
13	—	HRD
14	—	LDDCA†
15	—	GATE OUT
16	—	GND
17	—	LMG*
18	—	FDC*

P1B PINS

1	—	LARM	1	—	RL6(HC)†
2	—	RL5(TIO)†	2	—	R(A0)
3	—	RL4(LTIF)	3	—	R(LST)
4	—	R(HTBO)	4	—	RL3(HDVM)†
5	—	RL2(BIL)†	5	—	RL(HOPN)
6	—	RL(HTBB)	6	—	RL(IC)
7	—	RL(LMGF)	7	—	RL1(HEC)†
8	—	R(A1)	8	—	RL(TBB)†
9	—	R(HTBA)	9	—	RL(IA)
10	—	FB†	10	—	RL(TBA)†
11	—	FA†	11	—	RL(TBC)†
12	—	FD†	12	—	RL(IB)
13	—	FC†	13	—	RL(LTOT)
14	—	TBO	14	—	TBI*
15	—	DATA C†	15	—	DS C†
16	—	DATA D†	16	—	DS A†
17	—	DATA A†	17	—	DS D†
18	—	DATA B†	18	—	DS B†

\*SIGNAL SOURCE

†DENOTES NO FUNCTIONAL CONNECTION — NOT USED ON ASSEMBLY



18  
18

1  
1

18  
18

COMPONENT SIDE 1  
SOLDER SIDE 1

P1B

P1A

- NOTES:
1. REFERENCE CONNECTIONS AT THIS BUS ASSEMBLY ARE INDICATED. ADD CONNECTIONS AS NECESSARY TO COMPLETE THE ASSEMBLY. UNLESS OTHERWISE INDICATED, ALL CONNECTIONS ARE TO BE MADE AT THE POINTS INDICATED IN THE SCHEMATIC.
  2. UNLESS OTHERWISE INDICATED, ALL CONNECTIONS ARE TO BE MADE AT THE POINTS INDICATED IN THE SCHEMATIC.
  3. ASTERISK (\*) INDICATES SELECTED VALUE. AVERAGE VALUE SHOWN.

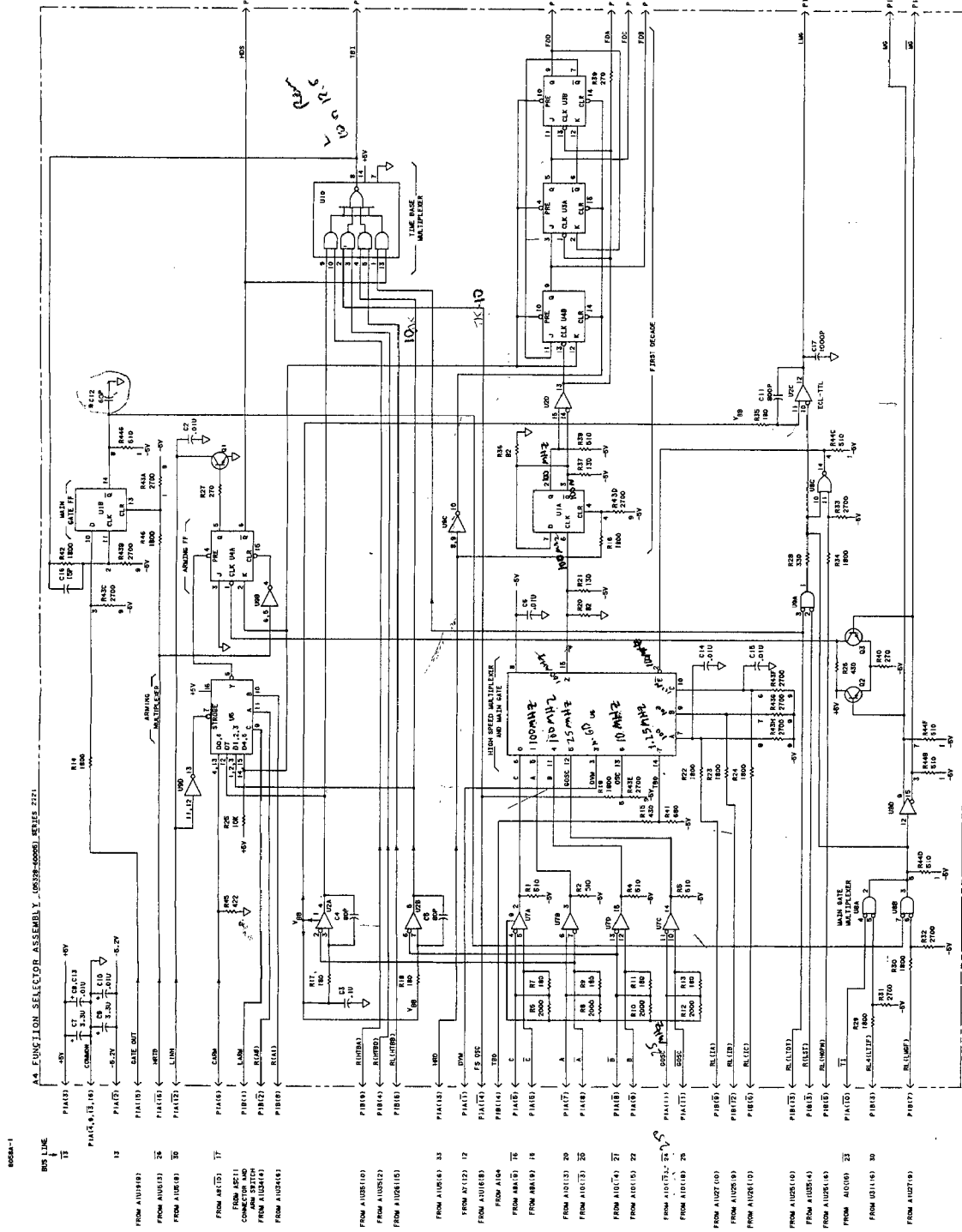


Figure 8-A-13. A4 Function Selector Assembly Schematic Diagram

**Figure 8-A-13**  
**A4 FUNCTION SELECTOR ASSEMBLY (SCHEMATIC DIAGRAM)**

(See Page 8-59)

REFERENCE DESIGNATIONS

A16
C1
CR1-CR6
DS1-DS9
DS10-DS20
P1
Q1-Q22
R1-R10
S1-S4

A16 ACTIVE ELEMENT

REFERENCE DESIGNATIONS	PART NUMBERS
CR1, CR2, CR3, CR5, CR6	1901-0040
CR4	1910-0016
DS1-DS9	1990-0452
DS10-DS20	1990-0404
Q1-Q9	1853-0326
Q10-Q22	1854-0492 2N3643

P1 PINS

1	-	RM LIGHT	1	-	GND
2	-	B1	2	-	LAMP TEST
3	-	B2	3	-	G LIGHT
4	-	LSWL	4	-	OF LIGHT
5	-	FC	5	-	FD
6	-	FA	6	-	NC
7	-	NC	7	-	FB
8	-	GND	8	-	NC
9	-	B3	9	-	B4
10	-	B5	10	-	NC
11	-	c	11	-	NC
12	-	d	12	-	e
13	-	f	13	-	NC
14	-	a	14	-	b
15	-	B6	15	-	NC
16	-	DP	16	-	g
17	-	B7	17	-	B8
18	-	LMRES	18	-	NC
19	-	ANN	19	-	+5V = DISABLE, -0.7V = ENABLE
20	-	B9	20	-	+3.5V
21	-	LEXT NC OR CLK	21	-	} POWER SWITCH
22	-	TBS C	22	-	
23	-	TBS A	23	-	+5V
24	-	TBS C	24	-	SRT

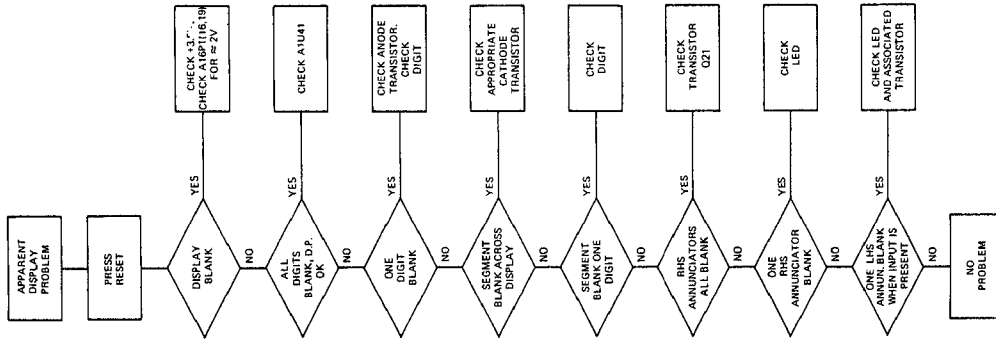
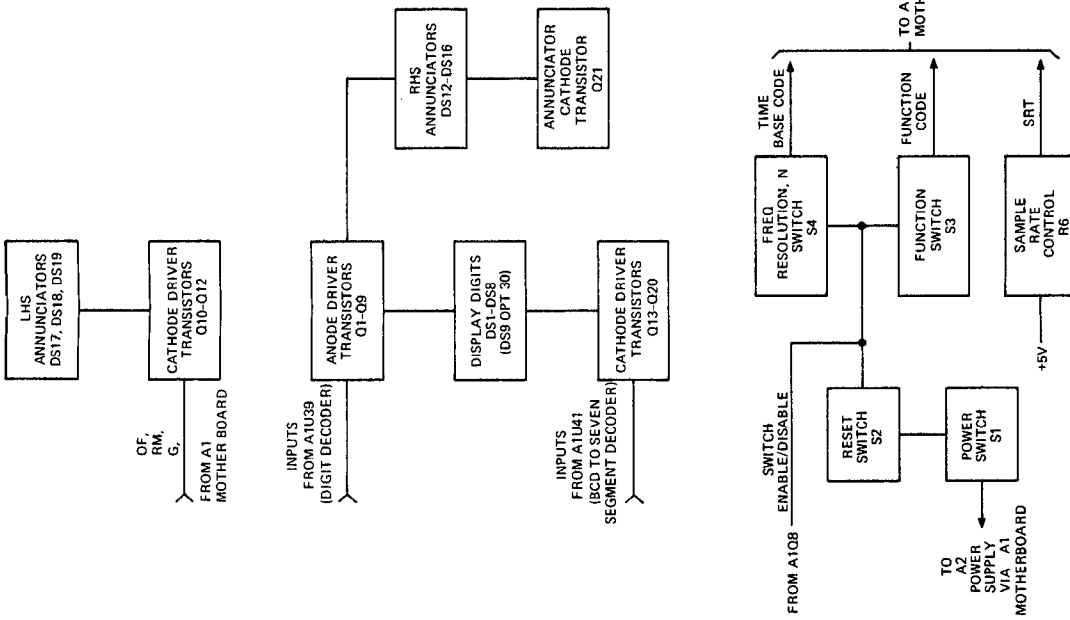


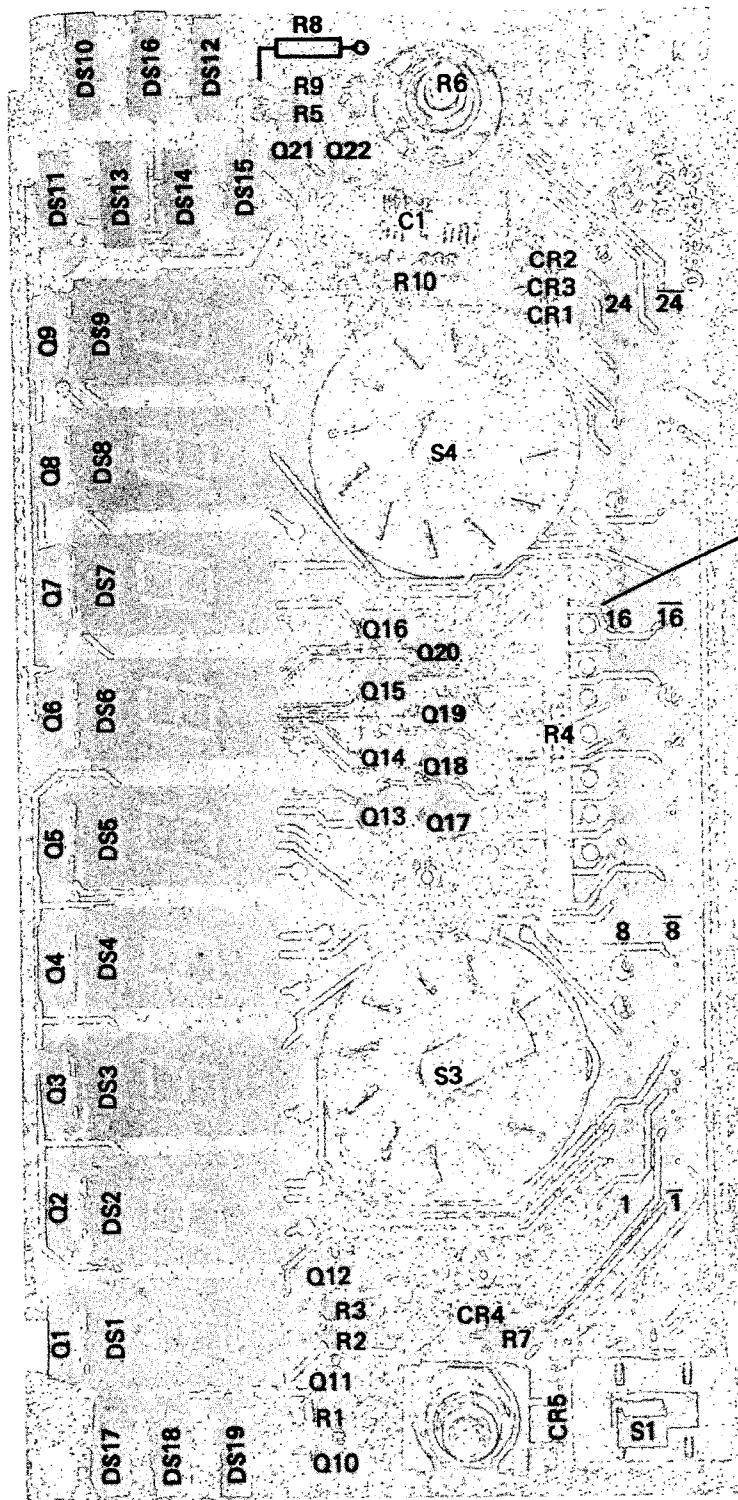
Figure 8-A-14. A16 Display Assembly Block Diagram and Troubleshooting

2

**A16 DISPLAY ASSEMBLY (BLOCK DIAGRAM & TROUBLESHOOTING)**

*Figure 8-A-14*

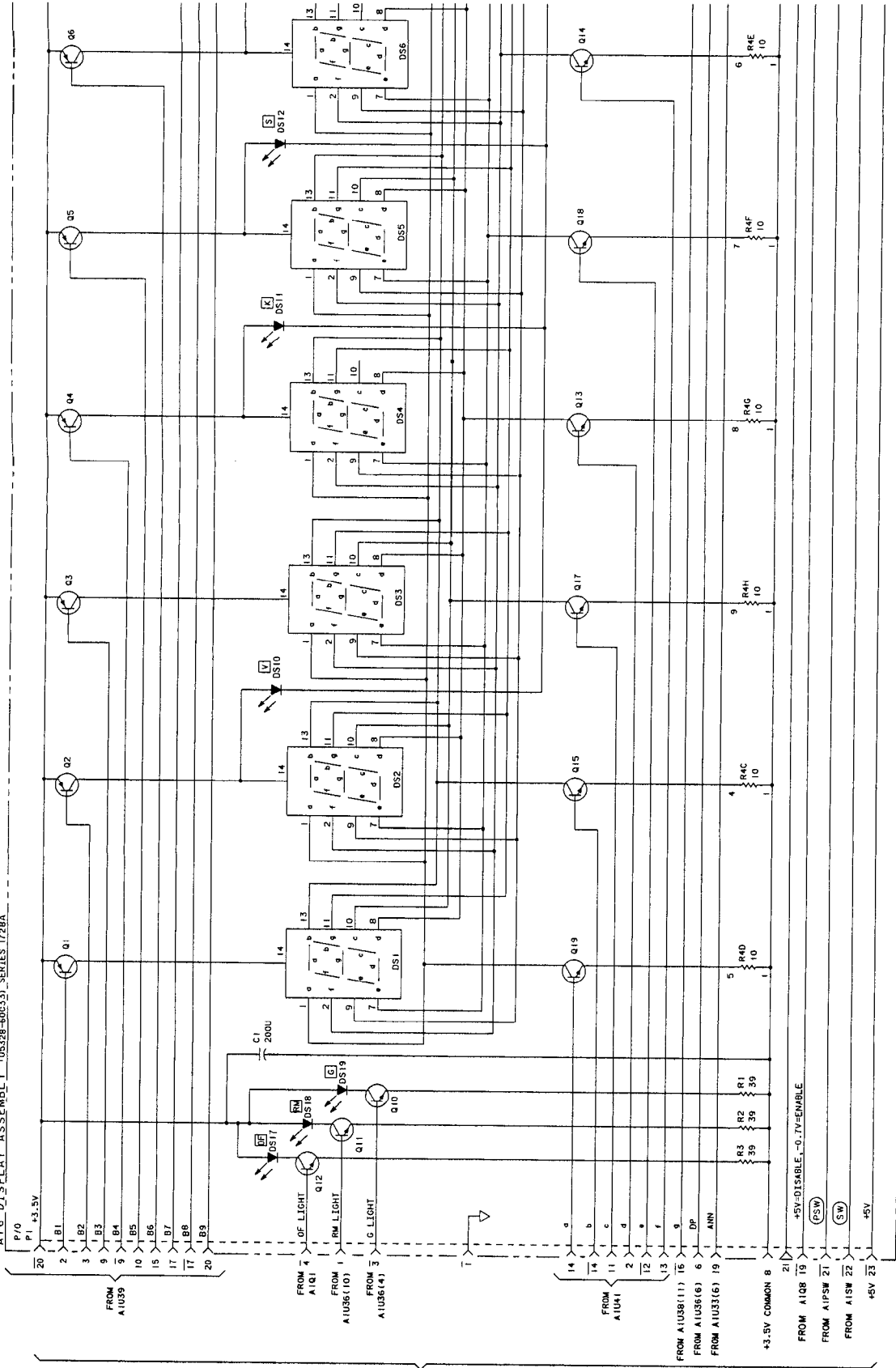
(See Page 8-61)



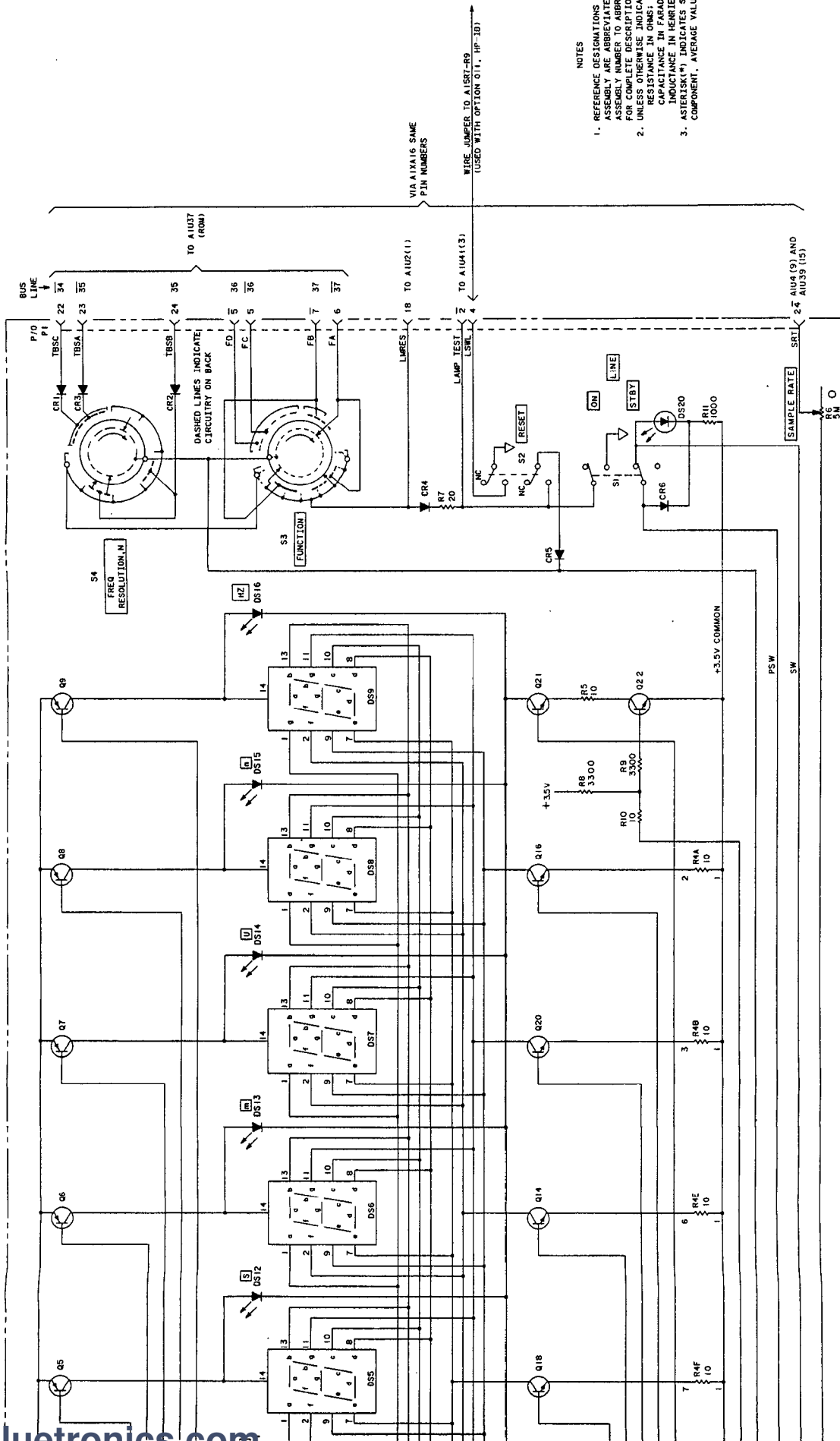
P1 ON REVERSE  
SIDE OF BOARD



A16 DISPLAY ASSEMBLY (03328-60331) SERIES 1728A

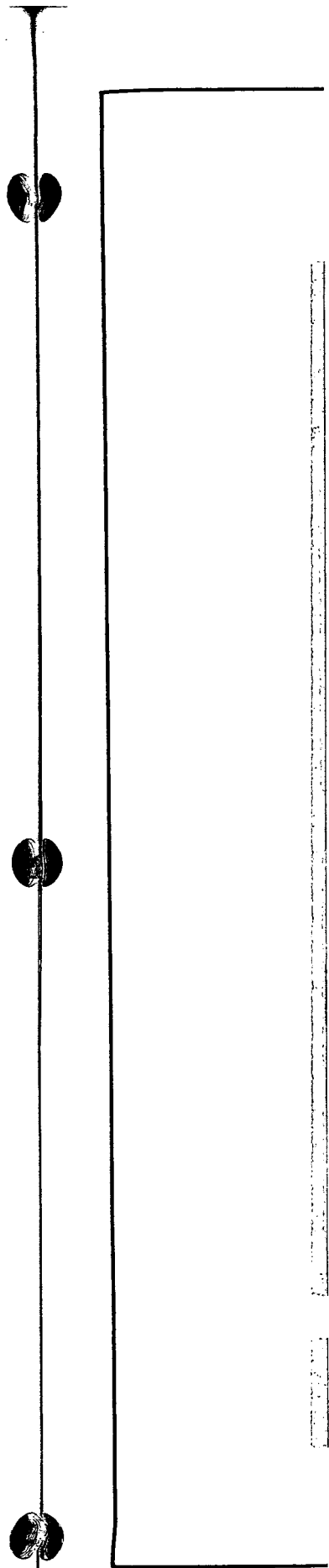


VIA  
AXIS  
ISSUE  
NUMBER  
PINS



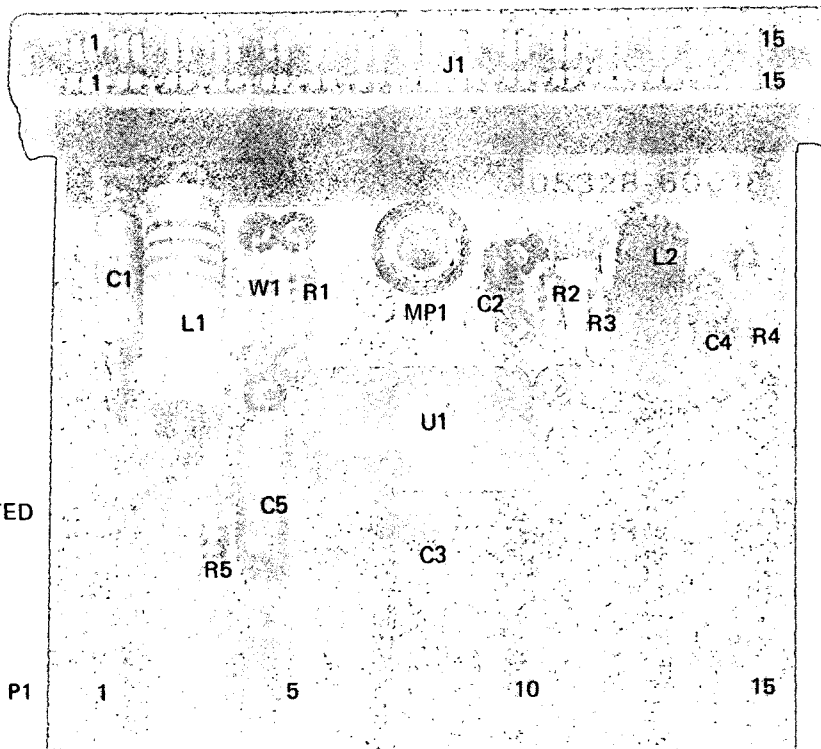
- NOTES
1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION. UNLESS OTHERWISE INDICATED: RESISTANCE IN OHMS; CAPACITANCE IN PFDAS; INDUCTANCE IN FERHES; DIMENSIONS IN INCHES UNLESS INDICATED OTHERWISE.
  2. UNLESS OTHERWISE INDICATED: RESISTANCE IN OHMS; CAPACITANCE IN PFDAS; INDUCTANCE IN FERHES; DIMENSIONS IN INCHES UNLESS INDICATED OTHERWISE.
  3. ASTERISK (\*) DESIGNATES SELECTED COMPONENT. AVERAGE VALUES SHOWN

Figure 8-A-15. A16 Display Assembly Schematic Diagram



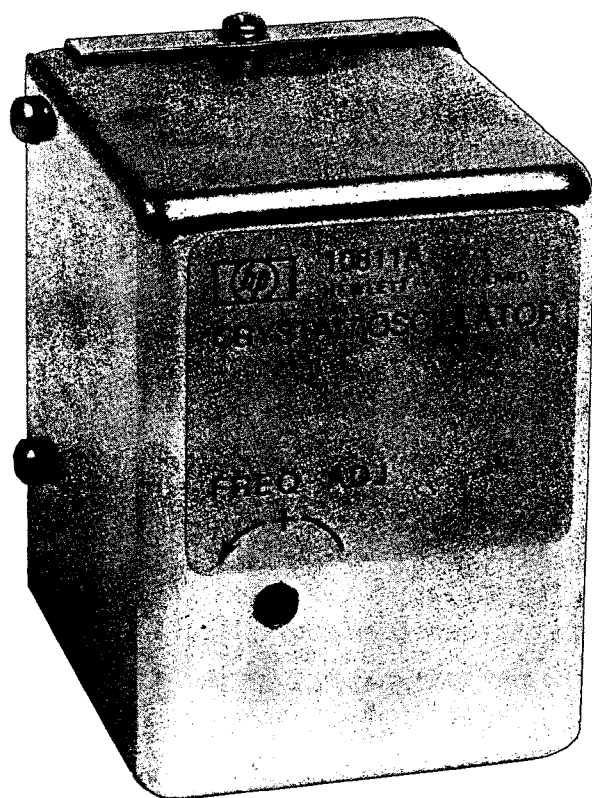
*Figure 8-A-15*  
**A16 DISPLAY ASSEMBLY (SCHEMATIC DIAGRAM)**

(See Page 8-63)



A3C4 MOUNTED  
ON REVERSE  
SIDE

COMPONENT SIDE	1	5	10	15
SOLDER SIDE	1	5	10	15



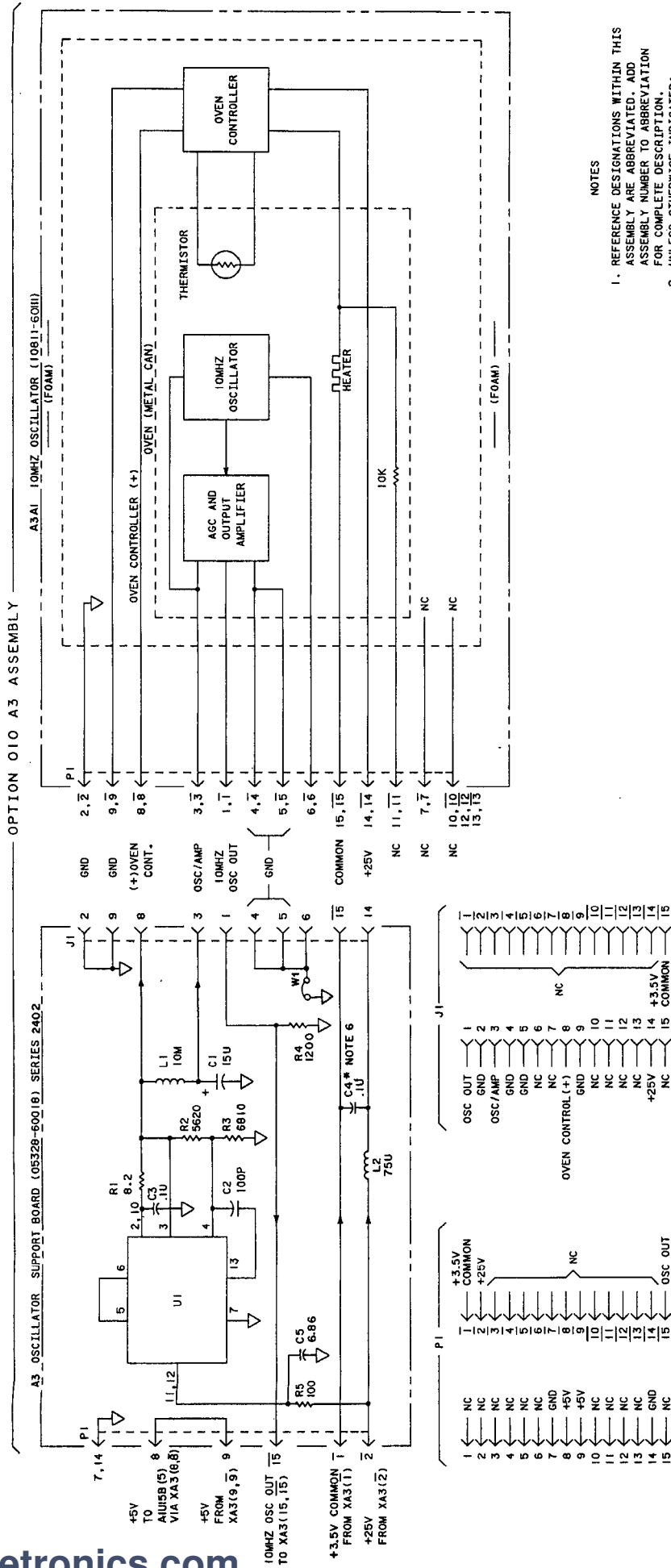


Figure 8-A-16. A3 Oscillator Support Board Schematic Diagram (Part of Option 010)

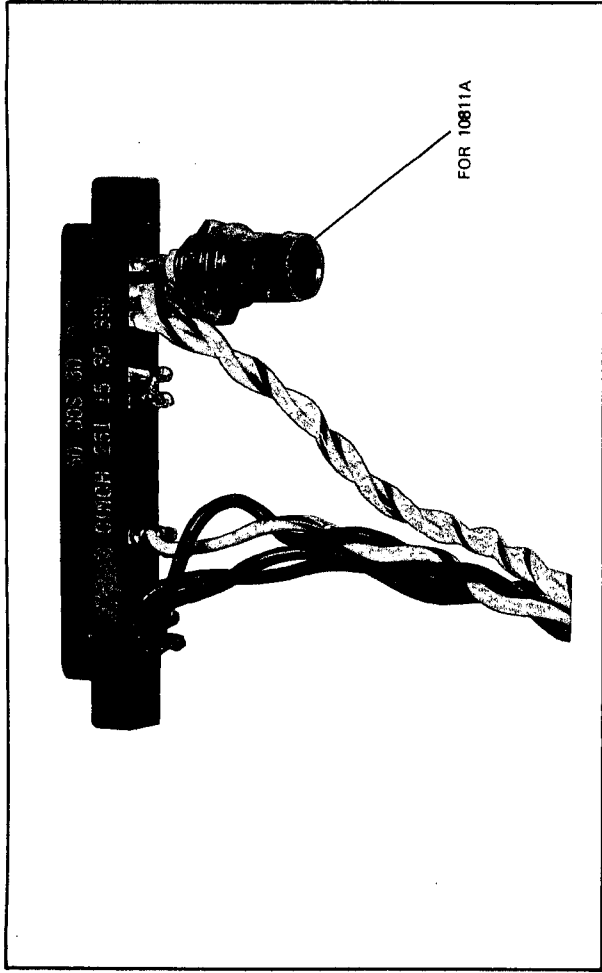


Figure 8-A-17. Special Test Connector

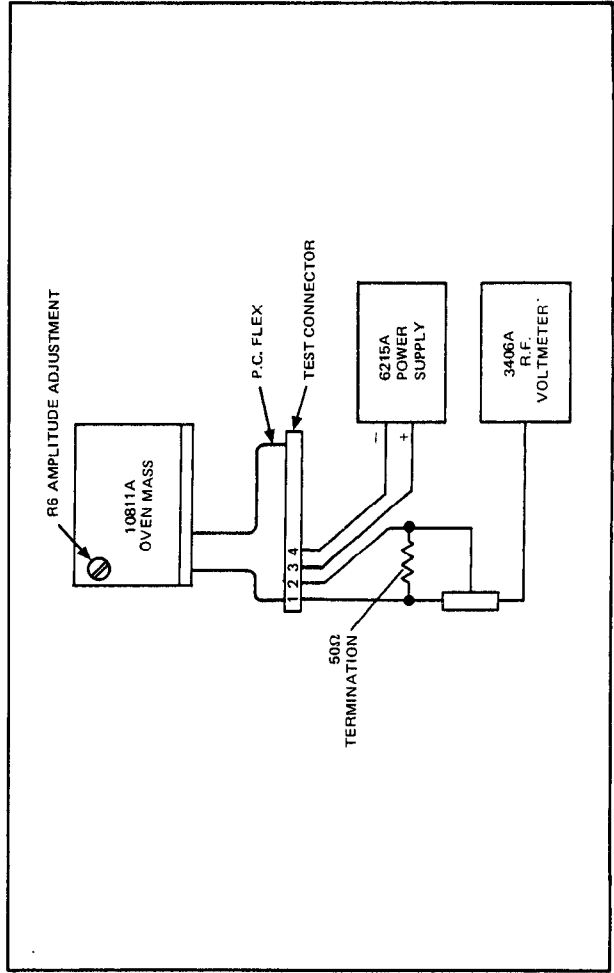
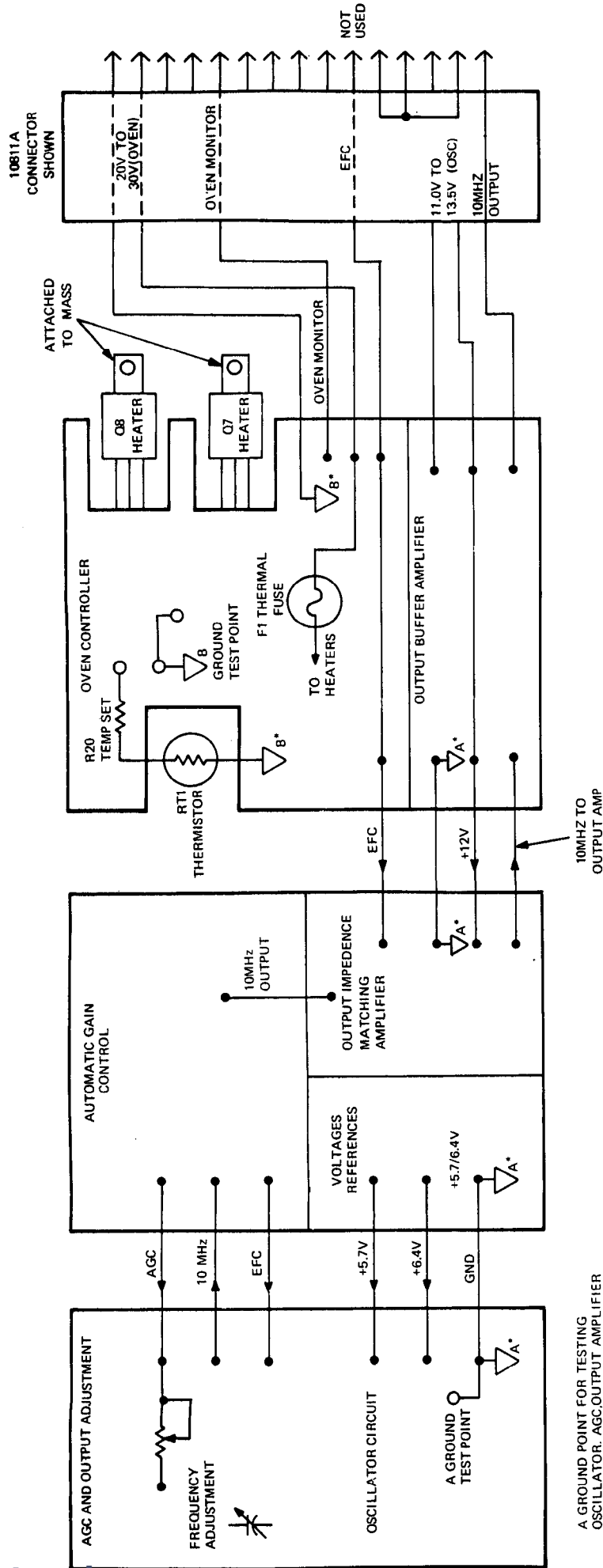


Figure 8-A-18. Output Amplitude Adjustment Setup

Figure 8-A-16  
A3 OSCILLATOR SUPPORT BOARD (SCHEMATIC DIAGRAM)

(See Page 8-65)



A GROUND POINT FOR TESTING OSCILLATOR, AGC, OUTPUT AMPLIFIER AND VOLTAGE REFERENCE

B GROUND POINT FOR TESTING OVEN CONTROLLER

B GROUND POINT FOR TESTING OVEN CONTROLLER

\* A AND B GROUNDS MAY BE TIED TOGETHER OR FLOATED AT DIFFERENT POTENTIALS EXTERNAL TO THE OSCILLATOR.

Figure 8-A-19. Oven Oscillator Overall Block Diagram

*Figure 8-A-19*  
**10811A OVEN OSCILLATOR OVERALL (BLOCK DIAGRAM)**

(See Page 8-67)



Table 8-A-4. Oven Circuit Voltages\*


VOLTAGE POINT	OVEN AT OPERATING TEMP.	OVEN COLD (JUST AFTER TURN-ON)	RT1 GROUNDED
Q6B	1.6	2.	.25
Q6C	11.4	11.4	11.4
Q6E	1.	1.3	0
Q7B	12.5	12.7	11.9
Q7C	20.	20.	20.
Q7E	11.4	11.4	11.4
Q8B	1.	1.3	0
Q8C	11.4	11.4	11.4
Q8E	.07	.23	0
U1 Pin 1	8.9	1.8	8.9
U1 Pin 2	.07	.23	0
U1 Pin 3	.2	.23	.2
U1 Pin 5	4.	4.1	3.8
U1 Pin 6	4.	4.1	3.8
U1 Pin 7	3.3	4.8	1.5
U2 Pin 2	10.	10.	10.
U3 Pin 6	3.5	19.0	.5

\*Voltage readings taken with oven supply voltage of 20V dc and insulating foam and cover removed. Voltages are approximate and will vary slightly from unit-to-unit.

Table 8-A-5. Oscillator Section Normal Voltages

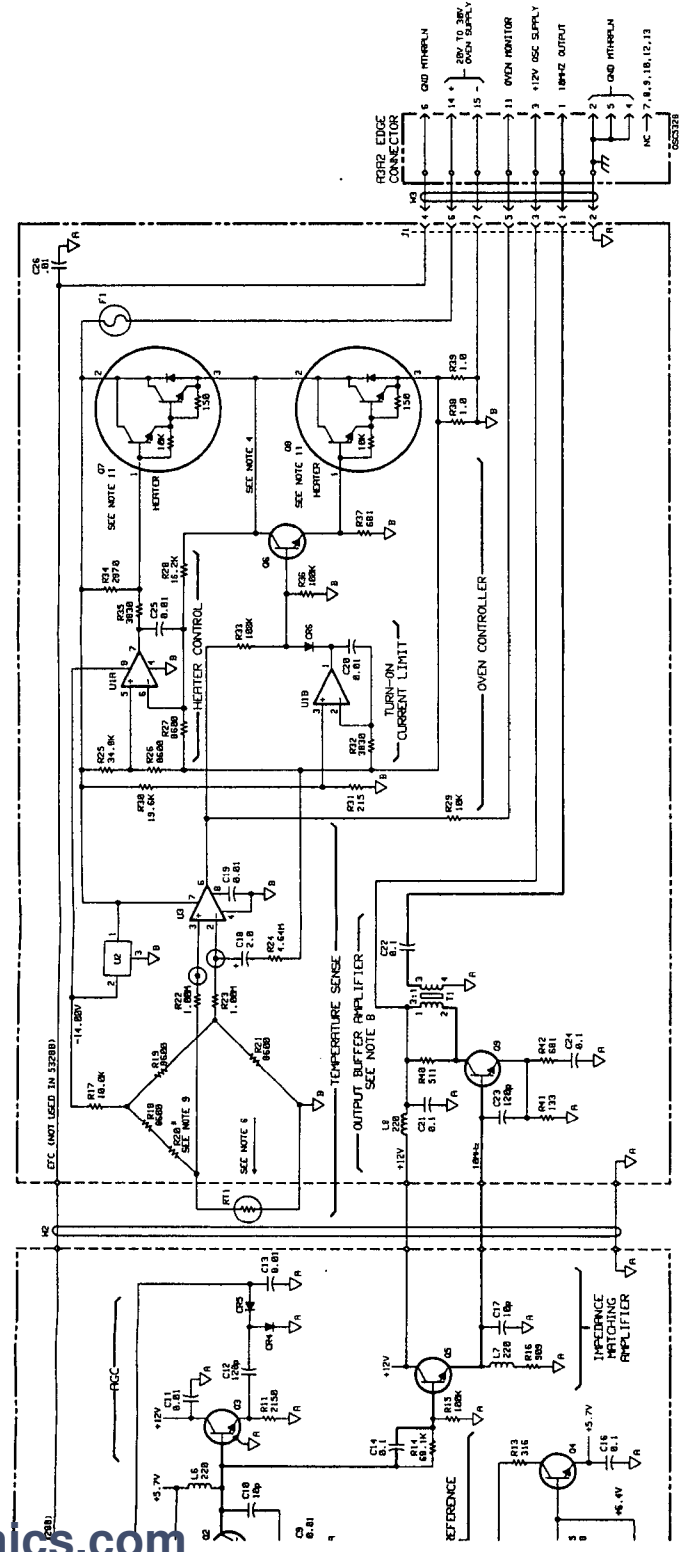
VOLTAGE POINT	NORMAL VOLTAGES		REMARKS
	AC (p-p)	DC	
C3/R3	1 to 4	—	Note 8
CR5/C13	—	-1.5	Notes 4 and 7
CR3(C)	0	6.3	Note 4
Q1(B)	1	.75	Note 8
Q1(C)	0	5.5	Note 4
Q1(E)	.9	.03	Note 8
Q2(B)	0	2.7	Note 4
Q2(C)	2.7	5.6	Note 8
Q2(E)	.06	2	Notes 4 and 5
Q3(B)	2.7	5.6	Note 8
Q3(C)	0	11.8	Note 4
Q3(E)	2.4	4.9	Notes 4 and 6
Q4(B)	0	6.3	Note 4
Q4(C)	0	10.3	Note 4
Q4(E)	0	5.6	Note 4
Q5(B)	2.7	3.1	Note 8
Q5(C)	0	11.8	Notes 8 and 9
Q5(E)	2.8	2.6	Note 8
Q9(B)	2.8	2.8	Note 8, 9
Q9(C)	5.1	11.8	Note 8, 9
Q9(E)	2.5	1.9	Note 8

NOTES:

- All voltages taken with 12V oscillator supply.
- Voltages are approximate and will vary slightly from unit-to-unit.
- All ac voltages are sine waves except Q2(E) and Q3(E).
- This dc voltage may be measured with a standard dc voltmeter. All other voltages should be measured with an oscilloscope and high impedance probe to minimize circuit loading.
- Waveform is  .06V.
- Waveform is slightly flattened on the bottom.
- This is the AGC voltage. Value shown is nominal with oscillator operating. If the oscillator is not oscillating, the AGC voltage will be ~+2.5V.
- Measure both ac and dc voltages with an oscilloscope and a high impedance probe to minimize circuit loading.
- AC voltage at Q9(C) measured with 50-ohm load on the output.







- NOTES**
1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE INTENTIONALLY LEFT UNASSIGNED FOR COMPLETE DESCRIPTION.
  2. UNLESS OTHERWISE INDICATED, CAPACITANCE IN MICROFARADS; IMPEDANCE IN OHMS; RESISTANCE IN MICROHMS.
  3. AVERAGE VALUES SHOWN FOR SELECTED COMPONENTS.
  4. THE VOLTAGE AT OR COLLECTOR SHOULD BE SET BY NOTE 10.
  5. SEE PARAGRAPH 6-A-25(b) BEFORE REPLACING THE HEATER ELEMENTS. THE HEATER ELEMENTS SHOULD BE TIGHTENED AGAINST NOT TO A TORQUE OF 11.6 NEWTON-METERS. IT IS NOT PART OF REPAIR KIT 11.
  6. THERMISTOR ROOM TEMPERATURE RESISTANCE IS 100 OHMS. THE THERMISTOR SHOULD BE REPLACED BETWEEN THE THERMISTOR AND OVEN MASS SHOULD BE GREATER THAN 100 OHMS.
  7. THIS AREA OF THE CIRCUIT BOARD IS HIGH IMPEDANCE.
  8. THE AREA MUST REMAIN CLEAN.
  9. COLLECTOR IS APPROXIMATELY 2 WITH A 20 OHM LOAD ON THE OUTPUT.
  10. PARAGRAPH 6-A-25(b) MUST BE USED FOR INITIAL SET UP. THE VALUE OF THE SUPPLY FOR INITIAL SET UP IS 20V. THE OSCILLATOR FREQUENCY IS APPROXIMATELY 18 KHZ.
  11. WHEN REINSTALLING OF AND ON INTO THE OVEN MASS (HEATER ELEMENT) IT OF APPROXIMATE 11.6 NEWTON-METERS. IT IS NOT PART OF REPAIR KIT 11.
  12. REMOVE ALL SOLDER FROM THE WELDS. SOLDER THE WELDS THROUGH THE HOLES IN THE CIRCUIT BOARD. THE INSULATION SHOULD BE SEAT AGAINST THE CIRCUIT BOARD.

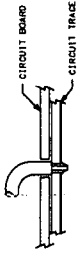


Figure 8-A-21  
OVEN CONTROLLER TROUBLESHOOTING TREE  
(See Page 8-69)

Figure 8-A-22  
10811A OVEN OSCILLATOR ASSEMBLY (SCHEMATIC DIAGRAM)  
(See Page 8-70)

## 8-BA-1. INPUT OPTIONS SECTION

The Model 5328B's Input Options Section provides the main interface between the instrument and the outside environment.

The Input Options Section has one standard module — the Programmable Input Module — which is found in all instruments. It may also include an additional one or two optional modules that extend the Model 5328B's capabilities. One of the optional modules is the Digital Voltmeter Module; the other optional module is the "C" Channel Module which extends the instrument's frequency range to 1300 MHz (1.3 GHz).

Each of the three modules operates separately from any of the others that might be installed, except that the Digital Voltmeter Module can be used to measure the trigger levels set for the "A" and "B" channels of the Programmable Input Module.

All three of these modules are described later in this manual section.

### NOTE

In order to help you know where you are in this part ("8-B-") of Section 8, the numbering scheme described in the beginning of Section 8 is modified as follows:

After the introductory material:

- Information about the Programmable Input Module is presented with headings, figure numbers and table numbers that begin "8-BA-".
- Information about the Digital Voltmeter Module is presented with headings, figure numbers and table numbers that begin "8-BB-".
- Information about the Channel "C" Module is presented with headings, figure numbers and table numbers that begin "8-BC-".

## 8-BA-2. Programmable Input Module (A10, A11, A12, A14, A19)

### 8-BA-3. INTRODUCTION

The Channel "A" and Channel "B" inputs have matched .2 ns) 100 MHz amplifiers with:

- ac or dc coupling
- $\pm 2.5V$  trigger level range
- three-position ("X1", "X10", "X20") attenuators
- 50-ohm or 1-Megohm input impedance, switch selectable
- trigger slope controls
- trigger indicators
- Channel "A" high-speed marker
- time interval "A"-to-"B" high-speed marker
- variable delay

The circuitry for the Model 5328B's Channel "A" and "B" is contained in the Programmable Input Module. This module contains:

- the main input amplifiers
- Schmitt triggers
- high-speed synchronizers for complex timing measurements.

The Model 5328B's Programmable Input Module uses a phase-locked multiplier to provide a basic clock rate of 100 MHz, which results in a basic timing unit of 10 ns. In the Time Interval Averaging FUNCTION, the multiplier, when commanded by the main-controller ROM, phase modulates the 100 MHz clock with band-limited noise to prevent the synchronous lockup problem that could otherwise be associated with this measurement.

### 8-BA-4. Principles of Operation

#### 8-BA-5. GENERAL

The Model 5328B's Programmable Input Module consists of the boards listed in Table 8-BA-1.

Table 8-BA-1. Circuit Diagrams

Assy Ref Des	Description	Circuit Diagram
A10	Synchronizer Assembly	8-BA-9
A11	DAC Assembly	8-BA-11
A12	Amplifier Assembly	8-BA-8
A14	Multiplier Assembly	8-BA-10
A19	Switch Control Assembly	8-BA-7

For the descriptions that follow, refer to the overall block diagram (Figure 8-BA-1). Also, when necessary, refer to the block or circuit diagrams for the individual boards (see Table 8-BA-1 for listing).

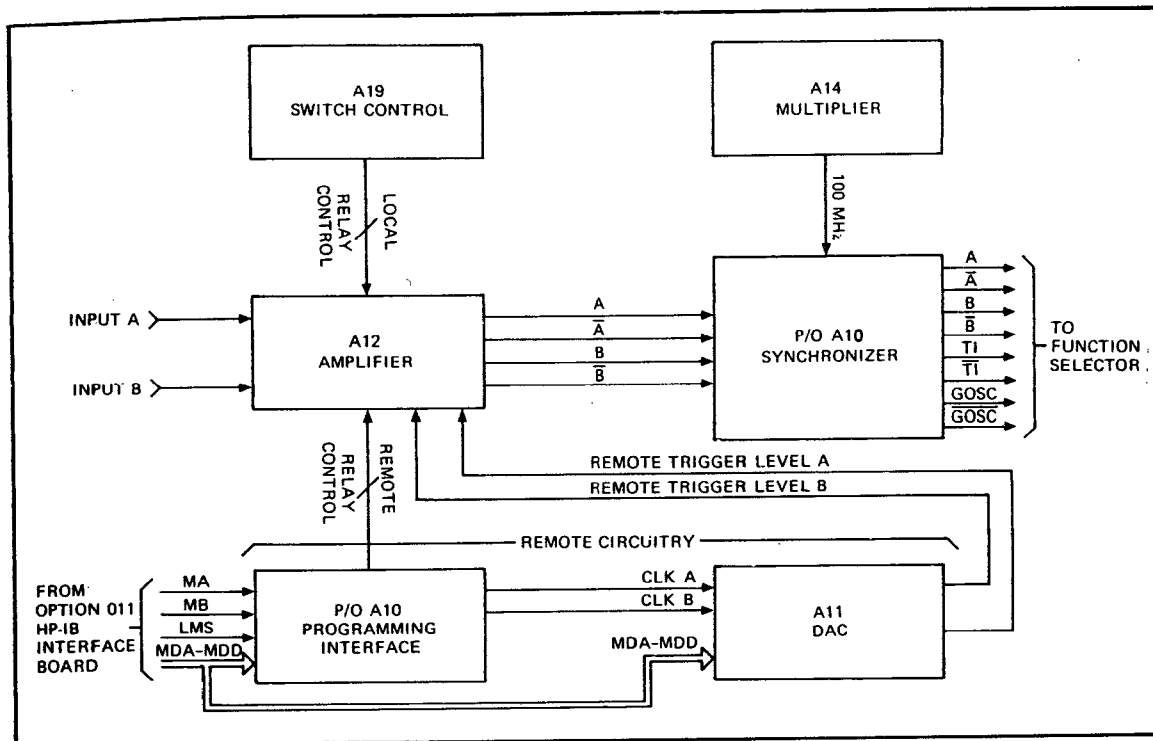


Figure 8-BA-1. Input Module — Block Diagram

In the "local" mode, the Switch Control Board (A19) generates TTL levels that control the Signal Conditioning relays on the Amplifier Board (A12). These levels allow front-panel control of the "A" and "B" channel input signal conditioning. The Switch Control Board accepts inverted "A" and "B" channel signals from the Amplifier board. These signals are routed through pulse stretcher and driver circuits to the "A" and "B" channel trigger LEDs, located on the Switch Control Board. The inverted signals are also translated from ECL to TTL levels and supplied to the "A" and "B" MARKER OUTPUTS.

Input circuitry for the "A" and "B" channels is on the Amplifier Board (A12) and part of the Synchronizer Board (A10). The Amplifier Board contains the 100 MHz "A" and "B" channels, with signal-conditioning "SLOPE", "AC/DC", "ATTENUATORS", "SEP/COM", "1M/50-OHM" controls, amplifiers, and Schmitt triggers. Signal conditioning circuitry is controlled by relays K1 through K11 synchronizing circuitry for PERIOD and Time Interval-type measurements. The "A", "A-bar", "B", "B-bar", "TI", "TI-bar", "GOSC", and "GOSC-bar" outputs from the Synchronizer Board are routed to the Function Selector (A4).

Multiplier Board A14 generates a 100 MHz differential ECL clock signal which is phase-locked to the internal 10 MHz reference oscillator. This allows the Model 5328B to accomplish 10 ns time-interval resolution. A random phase jitter circuit is also included on the Multiplier Board, to introduce phase jitter into the 100 MHz clock for time interval average measurements to be made at the frequency of the clock or at a harmonic of the clock's frequency.

The Synchronizer Board's programming interface section allows remote control of all input signal conditioning relays. The DAC board (A11) contains two identical Digital-to-Analog Converters — one for each input channel, "A" and "B", allowing remote control of trigger levels. The outputs of these DACs are sent to a relay on the Amplifier board. In "REMOTE", the relay connects these DAC levels to the Schmitt trigger on the A12 board.

There are two modes of accepting remote commands; the "non-DAC" and the "DAC control" modes.

When the Model 5328B is placed in REMOTE operation, front-panel switch control is disabled. At the same time, the programming interface takes control of the input signal conditioning relays.

In the "non-DAC" control mode, the interface accepts and decodes serial data bytes, stores the information in latches, and controls signal conditioning via the latched outputs.

When the interface receives a data byte for control of trigger levels, it goes into the "DAC control" mode. This is a result of the interface receiving a "+" or "-" on its input data lines. Once in the DAC control mode, the programming interface latches disregard the information at their inputs. At the same time, the information on the input data lines (MDA-MDD) is accepted by the DAC board (A11).

The DAC board shifts the polarity indicator and the three following numerical bytes of information into its shift registers. Following the polarity indicator and the three numerical data bytes, an asterisk ("\*") appears on the MDA-MDD lines (see Table 8-BA-2 for proper format). The asterisk causes the programming interface to revert back to the non-DAC control mode. In this mode, the DAC board stops accepting data, and the programming interface latches again accept the input data.

The DAC board processes the four serial data bytes and produces one parallel BCD output. The BCD output provides the information for generating a square-wave train by using a series of rate multipliers. The square-wave train has an average duty cycle proportional to the input code supplied to the rate multipliers. This square-wave train switches on a precision current source that feeds a voltage averager to produce a dc output.

#### **8-BA-6. Switch Control Board (A19)**

In "local" mode, -0.7V is applied to switches S1 through S8. This voltage allows the switches to control their respective functions by supplying an active "low" available at each switch. In a "closed" switch position, the -0.7V will forward-bias the associated diode, pulling its anode "low", and will cause a "low" to be sent to the Amplifier Board (A12) through J3.

In "remote" mode, +5V is applied to switches S1 through S8; this allows only the output lines, transmitted through J3, to be "high". When the switch is closed, the associated diode is reverse-biased and the line remains "high".

Trigger LEDs DS1 and DS2 are driven by the inverted "A" and "B" outputs of the Schmitt trigger (A12U4). These signals enter pins "14" and "10" of ECL-to-TTL translator A19U1. Feedback capacitors C8 and C9 stretch the 5 ns ECL pulse to approximately a 25 ms TTL output pulse. This 25 ms pulse is long enough to be seen via lighting of the associated LED. Since this pulse stretcher is dc-coupled to the Schmitt trigger, it functions like a logic probe with adjustable threshold voltage. When Channel "A"'s input is higher than its trigger level setting, its trigger LED is lighted. When the input signal is lower than its trigger level setting, the trigger LED is off. Whenever the input signal crosses the trigger threshold, the trigger LED flashes "on" or "off", depending on the polarity of the input signal.

The 5 ns inverted "A" and "B" outputs are also applied to U1's pins "2" and "6", respectively. The signals are translated from ECL to TTL levels and connected to the MARKER OUTPUTs.

#### **8-BA-7. Amplifier Board (A12)**

Since the "A" and "B" channels have identical circuitry, so only the "A" Channel circuitry will be discussed.



Table 8-BA-2. Model 5328B Input Module Program Code Set

Codes shown in **bold face** are start-up conditions. These conditions are set by the code "P", Remote Program Initialize, or by the bus commands Device Clear or Selected Device Clear.

1. Initialization  
P Remote Program Initialize

2. Function
- |     |              |    |               |
|-----|--------------|----|---------------|
| F0  | Stop         | F8 | T.I. A-B      |
| F1  | Start A      | F9 | Ratio B/A     |
| †F2 | Start Clock  | F: | T.I. Avg. A-B |
| †F3 | DVM/A        | F< | Check         |
| F4  | Freq. A      | F= | Ratio C/A     |
| †F5 | DVM/T.I. A-B | F> | Freq. C       |
| F6  | Period A     | F? | DVM           |
| F7  | Per. Avg. A  |    |               |

3. Time Base

Code	Freq Res	Multiplier	Time Res (Std)	Time Res (Opt. 040 and 041)
G0	1 MHz	1	100 ns	10 ns
G1	100 kHz	10	1 μs	100 ns
G2	10 kHz	10 <sup>2</sup>	10 μs	1 μs
G3	1 kHz	10 <sup>3</sup>	100 μs	10 μs
G4	100 Hz	10 <sup>4</sup>	1 ms	100 μs
G5	10 Hz	10 <sup>5</sup>	10 ms	1 ms
G6	1 Hz	10 <sup>6</sup>	100 ms	10 ms
G7	0.1 Hz	10 <sup>7</sup>	1 s	100 ms

4. Single-Multiple Measurement  
S0 **Single measurement.** Hold sample rate. Trigger required.  
S1 Multiple measurement. Not Hold. No trigger required.
5. Measurement Cycle  
S2 **Hold measurement until address to output.** SRQ at end of measurement.  
S3 Output only if a device is ready to accept data when 5328A is ready to output.
6. Output Mode  
S4 **Output at end of measurement - most universal.**  
S5 Output during open gate - usable only in START/STOP mode or if the decade reset is disabled.
7. Sample Rate  
S6 **Maximum**  
S7 Manual control (from front panel)
8. Arming  
S: **Off**  
S: **On**
9. Display Storage  
S< **On (normal)**  
S= **Off**
10. Decade Reset  
S> **Normal**  
S? Disabled (for cumulative measurements)
11. Display Blanking  
U **Normal Display**  
Q Blank display (digits and decimal point)

†Functions not labeled on instrument front panel.

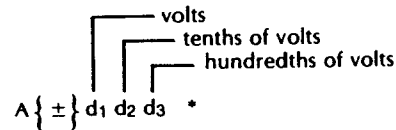
12. Channel A Signal Conditioning

- a. Impedance  
A0 **1 Megohm**  
A1 50 Ohms
- b. Coupling  
A2 **AC**  
A3 DC
- c. Slope  
A4 **+slope**  
A5 -slope
- d. Attenuator  
A6 **X10**  
A7 X1

13. Separate/Common  
A8 **Separate**  
A9 Common A

14. Check  
A< **Normal Operation**  
A? Check, Measures internal clock

15. Trigger Level A



Permissible trigger level range: -2.50V to +2.50V.

The program sequence to set trigger level starts with the channel designation letter followed by a "+" or "-" sign. Next, three digits set the voltage level. An "\*" terminates the sequence. The same sequence must be used even to set 0 volts: †

Examples: "A+000\*" 0 volts  
"A-123\*" -1.23 volts

16. Channel B Signal Conditioning

- a. Impedance  
B0 **1 Megohm**  
B1 50 ohms
- b. Coupling  
B2 **AC**  
B3 DC
- c. Slope  
B4 **+slope**  
B5 -slope
- d. Attenuator  
B6 **X10**  
B7 X1

17. Trigger Level B  
B { ± } d1 d2 d3 \*

See Group 15, Trigger Level A, for details

18. Channel Invert  
B0 **Normal**  
B9 Invert A and B inputs

19. Reset; Trigger  
(Also see Bus Command GET)  
R Reset, no trigger  
T Reset and trigger

20. Trigger levels set to 0 volts when counter is initialized with code "P" or bus commands DCL and SDC.

Input signal "A" enters the Amplifier Board through A12J2 and, depending on the setting of relay A12K7, is either ac-coupled through capacitor A12C30 or dc-coupled across relay A12K7. The signal then enters the two-position attenuator ("X1", "X10"), and is passed from the selected attenuation mode through either A12K3 or A12K8 to the input of the FET impedance-converter stage. This stage consists of A12Q3A and A12Q3B and resistors A12R32, A12R30, A12R27, and A12R28, connected in a zero-offset totem-pole configuration. The signal at the node between resistors A12R30 and A12R32 follows closely the signal at the gate of A12Q3A.

Resistor A12R28 is used to adjust any initial offset voltage. Diodes A12CR5 and A12CR6, resistors A12R39, A12R37, and A12R34, and capacitors A12C23 and A12C24 form an overvoltage-protection network to limit the signal sent to transistor A12Q3 and successive circuits to  $\pm 2.61V$ .

The SEP/COM A relays, A12K4 and A12K5, connect the input of the Channel "B" attenuator to either the "A" or "B" channel inputs. The signal then passes through A12U4, a dual Schmitt trigger. Trigger A12U4B compares the signal at pin 12 to a dc reference between  $\pm 2.5V$  on pin 11. This dc reference is selected by A12K1, and is supplied by either the DAC Board (A11) or the Switch Control Board (A19). The output of A12U4 changes state whenever the input crosses the reference voltage on A12U4(11). The output is ECL ( $-0.8V$  to  $-1.6V$ ), and drives both the "A" trigger LED circuit on the A19 board and the exclusive-OR gate, A12U2. Schmitt trigger A12U4 has approximately 15 mV peak-to-peak hysteresis at its input. Exclusive-OR gate A12U2 selects the desired slope of the input waveform. When pin 7 of A12U2 is held to an ECL "high" level (SLOPE switch in "+" position), A12U2 is an inverter. When pin "7" goes "low" (SLOPE switch in the "-" position), A12U2 does not invert the signal passing through it.

Input signal conditioning control is done by inverters A12U1 and A12U3 and relays A12K1 through A12K11. This control is supplied from either the Synchronizer Board (A10) or the Switch Control Board (A19). When the Model 5328B is in "remote", relay control is received through A12J1 from the A10 board. In the "local" mode, relay control arrives via A12P2 from the A19 board. Since all of the relay control lines contain inverters, relay activation is caused by a "high" at the input.

### 8-BA-3. Synchronizer Board (A10)

The differential "A" Channel outputs from A12U2 feed through connector A10P2 pins "7" and "8", respectively, to A10U1. Circuit A10U4 is a one-shot that triggers only on a negative edge, and, therefore, passes only triggering events that occur on the slope selected by A12U2. The output of A10U4(15) is an ECL pulse of approximately 5-to-10 ns width. In the FREQ A check mode, the oscillator signal from A10U1(2), (either 10 MHz or 100 MHz, as selected by A10S1) is injected via A10U5B to A10U10(13). The normal "A" input entering A10U10(12) is disabled at A12U4 by LCHK being "low". The oscillator signal at A10U10(13) is passed through A10U10C and A10U10D to A10U11 (a dual 4-to-1 multiplexer). In a non-inverting mode, multiplexer A10U11 always routes the "A" channel signal to the "start" synchronizer, A10U6A. In a PERIOD function, A10U11 routes the "A" channel signal to the "stop" synchronizer, A10U6B. For Time interval measurements, the "B" channel signal is supplied to "stop" synchronizer A10U6B. ROM line "R6" controls the "stop" synchronizer input switching. In REMOTE, "HINV", from A10U11(7) allows the "A" and "B" channel outputs of A10U11 to be inverted. The outputs of A10U11A feed A10U12C, which drives the "A" and "B" outputs to the Function Selector, A4.

In T.I., T.I. AVG, PER, and PER AVG functions, A10U5, A10U6, A10U12, and A10U13 are used to generate synchronized time interval and gated oscillator pulses for the mainframe. After a reset pulse arrives on the "HDS" line, the RS Flip-flops (A10U5 and A10U12) and the "D" Flip-flops (A10U6A and A10U6B) are reset. At the same time, the  $\overline{TI}$  and  $\overline{GOSC}$  outputs are at an ECL "high". When a "start" event enters A10U5D(12), it sets the A10U5A output to A10U6A(7) "high". The next clock pulse to A10U6(6) will cause A10U6A(3) to go "low". This pulls the  $\overline{TI}$  output "low", signalling to the function selector that the Time Interval has started. When  $\overline{TI}$  goes "low",  $\overline{GOSC}$  (A10U13B) starts to output oscillator pulses. When a "stop" event occurs at A10U5(10), the output of A10U12C goes "high". This, synchronous to the next clock pulse, sets A10U16(15) "high".

When A10U16(15) goes "high", the  $\overline{TI}$  and  $\overline{GOSC}$  outputs go "high", stopping the Time Interval measurement. The "Q" output of A10U6B, through A10U13C, A10U14B, and A10U14A, resets all Flip-flops, and thus prepares them for the next measurement.

ROM line "RL6(HC)", connected to A10U14(11) by A10R6, is set "low" in PERIOD measurements, holding the Stop Flip-flop (A10U5C and A10U12C) "off" until the start synchronizer, A10U6A, clocks a "high" to its "Q" output.

In a PER AVG function, where time base scaling takes place, ROM line "RL5(T10)" is driven "high". This TTL "high" is converted to an ECL "high", by resistors A10R18 and A10R21, and applied through A10U14D to A10U12(11). This causes the Stop Synchronizer Flip-flop (A10U5C and A10U12C) to remain in a "reset" condition.

The programming interface has two operating modes — "non-DAC", and "DAC control". These modes refer to the operation of the interface with respect to incoming data. When the incoming data is for control of signal conditioning (not trigger level), the interface will be in the "non-DAC" mode. The interface will be in the "DAC control" mode when incoming data is for DAC (trigger level) control.

When the Model 5328B goes into "remote", "LEXT" goes "low". The "low", on "LEXT", causes the output of the Motherboard switch control circuit to go from -0.7V to +5V. This change, disables front-panel switch control on the A16 and the A19 boards. When "LEXT" is "low", A10U17(4), connected to tri-state buffers A10U2(1) and A10U9(1,15) is also "low". This "low" returns the outputs of tri-state buffers A10U2 and A10U9 to their "active" states. With the outputs of A10U2 and A10U9 enabled, the outputs of addressable latches A10U8 and A10U15 control the A12 signal conditioning relays.

The interface is reset by a "high" on the HRPR line. This "high" is generated by the HP-IB Interface Board (A15) when it receives an ASCII "P".

When the interface is reset, it defaults to the "non-DAC" control mode. The reset causes the latched outputs of A10U8 and A10U15 to go "low". This sets A10U17(9,10) "low", giving a "low" at A10U17(8). The "low" at A10U17(8) is connected to A10U7(14), where it causes the interface to be in the "non-DAC" mode. The "low" at A10U17(8) is also connected to clock multiplexer A10U16(1) where it causes A10U16 to route clock ("LMS") pulses to only A10U8 or A10U15.

Clock multiplexer A10U16 decodes the "MA" and "MB" lines from the A15 board to determine whether the input data byte, on MDA-MDD is "A" or "B" channel information. It then routes the clock pulse to A10U8(14) for "A" channel information, or to A10U15(14) for "B" channel information. The clock pulse latches the information into the intended latch.

After reset, the interface defaults to all of the underlined functions in Table 8-BA-2, Program Code Set. To change one of the signal conditioning controls, it is necessary to program that function.

As an example, assume a channel "A" function setting of "X1" is desired. This means that an "A7" must be included in the data string sent by the system controller to the Model 5328B. When the "A" is decoded by the HP-IB Interface (A15), it causes the "MA" line to be "high" and the "MB" line to be "low". The "MA" and "MB" lines are decoded by A10U6, and it routes the following clock pulses to A10U8.

When the "7" is sent, "1110" appears at the output of ROM A10U7, on MDA-MDD, respectively. As shown in Table 8-BA-2, the "1110" at the input causes an output of "000011" on A10U7(1-6).

The clock pulse arrives at A10U8(14) and latches the "high" on A10U8(13) to A10U8(5). The "high" on A10U8(5) is buffered by A10U9, and appears at pin "13" of its output. The "high" at A10U9(13) is inverted on the A12 board and used to close the relay to "X1" attenuation on Channel "A".

All "non-DAC" information is latched in the same manner. "B"-channel information is latched into the outputs of A10U15. It has the same code into A10U7, and thus, the same code out of A10U7, for the same function as Channel "A".

Refer to Table 8-BA-2, Program Code Set, for the proper format with which to program a trigger level. The proper format is " $\pm X.YZ^*$ ", and follows an "A" or "B", which indicates the channel to which it applies.

For the following discussion, assume that a trigger level is programmed, following the proper format, and preceded by an "A".

The interface resets to the "non-DAC" mode when the A15 board receives an ASCII "P" from the system controller. When the A15 board receives the "A", the "MA" line is set "high" and the MB line is set "low". Integrated circuit A10U16 decodes the MA and MB lines, in the "non-DAC" mode, and clocks the "A"-channel latch, U8.

When a "+" or "-" appears on the MDA-MDD lines, a "high" is latched into A10U8(12). Latching occurs on the positive clock pulse transition from A10U16. The "high" at A10U8(12) will cause A10U17(8) to go "high". Pin A10U17(8) is connected to A10U7(14), where the "high" changes the input address to ROM A10U7, and locks the interface into the "DAC control" mode. The "high" at A10U17(8) is also connected to A10U16(1). A "high" at A10U16(1) causes A10U16 to supply clock pulses to either the "A"- or "B"-channel DAC. Since the condition of the MA or MB lines remains the same, the Channel "A" DAC receives the clock pulses. On the negative transition of the clock pulse, the "+" or "-" is shifted into the "A" Channel DAC shift registers (A10U7 and A10U11).

Following the format, the next data byte on MDA-MDD will be a number. The MDA-MDD lines supplied to A10U7 are also connected to the DAC Board (A11) Shift Registers. Since the interface is in the "DAC" mode, neither A10U8 nor A10U15 is clocked, and thus disregard data on MDA-MDD. The number is clocked into the "A"-channel DAC shift registers. The condition of the MA and MB lines, determines which DAC is clocked and accepts the number. Following the first number, a decimal appears at the input to ROM A10U7. When A10U7 decodes the decimal, it sends A10U7(5) "high".

This "high", applied to A10U2(15), causes A10U2 to block the clock pulse associated with the decimal data byte. In this manner, the DAC disregards the decimal.

Following the format, two more numbers are input, serially, and each is clocked into the "A"-channel DAC shift registers. The final character in the string, an asterisk ("\*"), appears on the input data lines to A10U7. When A10U7 decodes the asterisk, A10U7(5) goes "high", again blocking the positive clock pulse transition to the "A"-channel DAC. This causes the "A"-channel DAC to disregard the "\*". At the same time, A10U7(6) goes "low", allowing the negative transition of the clock pulse to latch the "low" at A10U8(13) into A10U8(12). The "low" at A10U8(12) causes A10U17(8) to go "low", returning the interface to the "non-DAC" control mode.

#### **8-BA-9. Multiplier Board (A14)**

The Multiplier section uses the phase-locked-loop method of frequency multiplication to generate the 100 MHz clock signal. The varactor-diode-tuned VCO (Voltage-controlled Oscillator), consisting of A14U3 and A14CR1, is tuned at 100 MHz by A14C19. The VCO's output is passed to decade divider A14U1, where it is divided by 10. The 10 MHz ECL output from A14U1 is translated by A14Q1 and A14Q2 to a TTL level and applied to A14U4(3). The reference input, applied to A14U4(1), is either the system clock or the phase-jittered system clock. The TTL phase detector (A14U4), in conjunction with the active filter section, generates a dc voltage at A14TP5 proportional to the phase and/or frequency difference between the reference and feedback inputs to A14U4. This correction voltage, applied to varactor diode A14CR1, adjusts the frequency of the VCO until there is zero phase and frequency difference between the reference and feedback signals.

The phase jitter circuit consists of a Random Noise Generator, an Amplifier, a Phase Modulator, and an Output Buffer Amplifier.

Random noise is generated by reverse-biased zener diode A14CR3. The noise is coupled by A14C24 to amplifier A14U7 where the noise is amplified and passed to amplifier A14U6. Variable resistor A14R28 adjusts the amplitude of the noise from A14U6.

The phase modulator consists of a varactor diode (A14CR2) in a tuned LC circuit. The input to this circuit, applied at the base of A14Q3, is the 10 MHz system clock. The amplified noise from A14U6 is applied across varactor diode A14CR2, thus causing a phase shift, of the 10 MHz clock, proportional to the noise signal amplitude. The phase-modulated 10 MHz signal is routed through emitter-follower Buffer Amplifier A14Q4 to ROM-controlled multiplexer A14U4. Gate A14U5 accepts the phase-modulated signal at pin "13", and the system clock at pin "9". ROM line "RL2" selects output from A14U5D in Time Interval Average, and from A14U5C in all other functions.

### **8-BA-10. DAC Board (A11)**

Since this board contains two identical DACs (Digital-to-Analog Converters), only the Channel "A" converter will be discussed.

For the description that follows, assume that the Channel "A" DAC is programmed for a +2.22V trigger level. Refer to Table 8-BA-2, Program Code Set, for an explanation of the format.

The first data byte, a "+", appears on the input data lines, MDA-MDD. This data byte is supplied to the inputs of shift registers A11U7 and A11U11. A "LMS" clock pulse, routed through A10U6, applied to A11U7(1), shifts the "+" into A11U7 and A11U11. The next three data bytes, all "2"'s are shifted into A11U7 and A11U11 in the same manner.

With the "+" and three numerals shifted into A11U7 and A11U11, the shift registers provide a parallel-BCD output. This parallel output is static until the Channel "A" DAC is reprogrammed. The parallel output is supplied to the input of rate multiplier chain, A11U8, A11U9, and A11U10.

The output of the oscillator consisting of A11U5C and related components is coupled through A11Q7 to the clock input of rate multipliers, A11U8, A11U9, and A11U10. The clock signal is also supplied through inverter A11U5D to "D" flip-flop A11U2A, a synchronizer and wave shaper.

With 1000 pulses entering pin "9" of each rate multiplier, the output at A11U10(6) will be 222 pulses. These pulses are supplied through level-shifter-and-inverter A11U5B to A11U2(12). The input pulses are synchronized and shaped by A11U2A. The "Q" and " $\bar{Q}$ " outputs from A11U2A supply level-shifter networks composed of resistors A11R31, A11R34, and A11R36 and A11R37, A11R38, and A11R39. The pulse outputs from the level-shifter networks arrive at the cathode of A11CR6 and the anode of A11CR8.

The "+" shifted into A11U11 causes A11U6(2,6) to go "high". The "highs" on pins "2" and "6" cause pins "1" and "7" to go "low". The "low" at A11U6(1) causes A11CR11 to be forward-biased. Forward-biasing A11CR11 causes A11U6A to sink all of the current from the positive current source. This disables the positive current source, A11U3A and A11Q3. With A11U6(7) "low", A11CR12 is reverse-biased, enabling the negative current source A11U3B and A11Q4.

The signal at the anode of A11CR8 is the inverted output from the rate multipliers. When the anode of A11CR8 is "low", A11CR8 is reverse-biased, and current flows through A11CR10 into A11U4(2). When the anode of A11CR8 is "high", A11CR8 is forward-biased, and current flows from A11Q4 through A11CR8.

Averager A11U4 converts the current pulses supplied via A11CR10 into a dc output voltage. The averager generates the output voltage proportional to the duty cycle of the input current pulses.

**8-BA-11. IN-CABINET PERFORMANCE CHECK**

The Performance Check and Operational Verification procedures for the Model 5328B are given in Section 4 of this manual.

**8-BA-12. EXTENDER BOARD(S)**

A special extender board (HP Part Number 05328-62016) is available to make testing of certain parts of the Model 5328B either easier.

- One of these boards is required to extend the A10 or A14 Assembly.
- Two of these boards are required to extend the (optional) Frequency "C" Assembly (A8).

**8-BA-13. TROUBLESHOOTING THE PROGRAMMABLE ("A" AND "B") INPUT Module**

This section performs input signal conditioning in both the local mode and the remote mode through a controller. Thus troubleshooting is divided into two sections: local mode and remote mode troubleshooting. Figure 8-BA-12 shows a recommended troubleshooting sequence.

**8-BA-14. Local Mode Troubleshooting**

Local Mode Troubleshooting consists of the troubleshooting flow charts in Figure 8-BA-4, Figure 8-BA-5, and Figure 8-BA-6. These flow charts are intended to help isolate "local" operation problems.

The flow chart in Figure 8-BA-4 is intended for overall "local" operation troubleshooting. Table 8-BA-3, "Relay Operation", shows required levels, control lines, and the relay involved for any function. Table 8-BA-4, "Relay Control Logic", shows the output line and level required for proper relay operation in a function. These tables (Table 8-BA-3 and Table 8-BA-4) are to be used with the Local Mode Troubleshooting Flowchart Figure 8-BA-4.

Table 8-BA-3. Relay Operation

J-1 Pin #	Function	J-1 Pin		Relay Controlled
		HI	LO	
2	Ch A Slope	—	+	—
5	Ch B Slope	—	+	—
6	Ch B Atten	X1	X10	K6, K11
7	Ch B Coupling	DC	AC	K9
8	Ch B Impedance	50Ω	1 MEG	K10
10	SEP/COM	COM	SEP	K4, K5
12	Ch A Atten	X1	X10	K3, K8
13	Ch A Impedance	50Ω	1 MEG	K2
14	Ch A Coupling	DC	AC	K7

NOTE: Nongrounded pins on J-1 should float to TTL high.

The troubleshooting flowchart in Figure 8-BA-5 is designed to aid in troubleshooting problems in the phase-locked loop on the Multiplier Assembly (A14). The troubleshooting flowchart in Figure 8-BA-6 is for suspected phase jitter problems.

Table 8-BA-4. Relay Control Logic

Function	Channel A	Channel B
Slope + -	A10J3 Pin 2 low A10J3 Pin 2 high	A10J3 Pin 5 low A10J3 Pin 5 high
Atten X1 X10	A10J3 Pin 12 high A10J3 Pin 12 low	A10J3 Pin 6 high A10J3 Pin 6 low
Coupling AC DC	A10J3 Pin 14 low A10J3 Pin 14 high	A10J3 Pin 7 low A10J3 Pin 7 high
Impedance 50Ω 1 Meg	A10J3 Pin 13 high A10J3 Pin 13 low	A10J3 Pin 8 high A10J3 Pin 8 low
SEP, COM A, CHK	SEP A10J3 Pin 10 low COM A A10J3 Pin 10 high	

The programming interface section of the Synchronizer Board (A10) is used only when the Model 5328B is in "remote"; it is used in conjunction with the DAC (A11) board to control "A"- and "B"-channel signal conditioning. When the Model 5328B is in remote, addressable latches U8 and U15 control all of the signal conditioning relays. The DAC board is also used in "remote" to allow programming of the "A" and "B" channel trigger levels.

#### 8-BA-15. Remote Mode Troubleshooting

The following information includes Programming Logic Troubleshooting and DAC Troubleshooting. These areas will help isolate "remote" operation problems where the HP-IB Interface operates correctly in "local" control.

Programming Logic Troubleshooting includes Table 8-BA-5 and Table 8-BA-6. Table 8-BA-5 ("Program Interface Operation") shows the necessary levels that the A10 must generate in any function. Input and output codes for the ROM (A10U7) are contained in Table 8-BA-6.

Table 8-BA-5. Program Interface Operation (Part 1 of 2)

Program Code	Function	Channel A A10 Assy Logic Levels	Channel B A10 Assy Logic Levels	9825A Program Steps
A0	1 MegΩ	A10U8 Pin 7 Low A10U9 Pin 9 Low		wrt 701, "PR"; dsp "A0B0"; stp
B0	1 MegΩ		A10U15 Pin 7 Low A10U2 Pin 9 Low	
A1	50Ω	A10U8 Pin 7 High A10U9 Pin 9 High		wrt 701, "PA1B1R"; dsp "A1B1"; stp
B1	50Ω		A10U15 Pin 7 High A10U2 Pin 9 High	
A2	AC	A10U8 Pin 6 Low A10U9 Pin 11 Low		wrt 701, "PR"; dsp "A2B2"; stp
B2	AC		A10U15 Pin 6 Low A10U2 Pin 3 Low	
A3	DC	A10U8 Pin 6 High A10U9 Pin 11 High		wrt 701, "PA3B3R"; dsp "A3B3"; stp
B3	DC		A10U15 Pin 6 High A10U2 Pin 3 High	

Table 8-BA-5. Program Interface Operation (Part 1 of 2) (continued)

Program Code	Function	Channel A A 10 Assy Logic Levels	Channel B A 10 Assy Logic Levels	9825A Program Steps
A4	+SLOPE	A10U8 Pin 4 Low A10U9 Pin 3 Low	A10U15 Pin 4 Low A10U2 Pin 7 Low	wrt 701, "PR"; dsp "A4B4"; stp
B4	+SLOPE			
A5	-SLOPE	A10U8 Pin 4 High A10U9 Pin 3 High	A10U15 Pin 4 High A10U2 Pin 7 High	wrt 701, "PA5B5R"; dsp "A5B5"; stp
B5	-SLOPE			
A6	X10	A10U8 Pin 5 Low A10U9 Pin 13 Low	A10U15 Pin 5 Low A10U2 Pin 5 Low	wrt 701, "PR"; dsp "A6B6"; stp
B6	X10			
A7	X1	A10U8 Pin 5 High A10U9 Pin 13 High	A10U15 Pin 5 High A10U2 Pin 5 High	wrt 701, "PA7B7R"; dsp "A7B7"; stp
B7	X1			
A+1	DAC	A10U8 Pin 12 High A10U17 Pin 8 High	A10U15 Pin 12 High A10U17 Pin 8 High	wrt 701, "PA+1R"; dsp "A+1"; stp
B+1	DAC			
A*	NORM	A10U8 Pin 12 Low A10U17 Pin 8 Low	A10U15 Pin 12 Low A10U17 Pin 8 Low	wrt 701, "PA*R"; dsp "A*"; stp
B*	NORM			

Table 8-BA-5. Program Interface Operation (Part 2 of 2)

Program Code	Function	A 10 Assy Logic Levels	9825A Program Step
A8	Separate	A10U8 Pin 9 Low A10U9 Pin 7 Low	wrt 701, "PR"; dsp "A8"; stp
A9	Common A	A10U8 Pin 9 High A10U9 Pin 7 High	wrt 701, "PA9R"; dsp "A9"; stp
B8	Normal	A10U15 Pin 9 Low A10U9 Pin 5 Low	wrt 701, "PR"; dsp "B8"; stp
B9	Inverted	A10U15 Pin 9 High A10U9 Pin 5 High	wrt 701, "PB9R"; dsp "B9"; stp
A<	Normal Op	A10U8 Pin 10 Low	wrt 701, "PR"; dsp "A<"; stp
A?	Check	A10U8 Pin 10 High	wrt 701, "PA?R"; dsp "A?"; stp



Table 8-BA-6. ROM (A10U7) Input/Output Codes

Input Code					Output Code						
A10U7 Pins					A10U7 Pins						
14	13	12	11	10	6	5	4	3	2	1	
0	0	0	0	0	0	0	0	1	1	0	
0	0	0	0	1	0	0	0	1	1	1	
0	0	0	1	0	0	0	0	1	0	0	
0	0	0	1	1	0	0	0	1	0	1	
0	0	1	0	0	0	0	0	0	0	0	
0	0	1	0	1	0	0	0	0	0	1	
0	0	1	1	0	0	0	0	0	1	0	
0	0	1	1	1	0	0	0	0	1	1	
0	1	0	0	0	0	0	1	0	0	0	
0	1	0	0	1	0	0	1	0	0	1	
0	1	0	1	0	0	0	1	1	1	0	
0	1	0	1	1	0	0	1	1	1	1	
0	1	1	0	0	0	0	1	0	1	0	
0	1	1	0	1	0	0	1	1	1	1	
0	1	1	1	0	0	1	1	1	1	1	
0	1	1	1	1	0	1	1	0	0	0	
0	1	1	1	1	1	0	0	1	1	1	
1	0	0	0	0	0	1	0	0	1	1	0
1	0	0	0	1	0	1	0	0	1	1	1
1	0	0	1	0	0	1	0	0	1	0	0
1	0	0	1	1	0	1	0	0	1	0	1
1	0	1	0	0	0	1	0	0	0	0	1
1	0	1	0	1	0	1	0	0	0	0	0
1	0	1	1	0	0	1	0	0	0	1	0
1	0	1	1	1	0	1	0	0	0	1	1
1	1	0	0	0	0	1	0	1	0	0	0
1	1	0	0	1	0	1	0	1	0	0	1
1	1	0	1	0	0	0	1	1	1	1	0
1	1	0	1	1	0	1	0	1	1	1	1
1	1	1	0	0	0	1	0	1	0	1	0
1	1	1	0	1	0	1	0	1	1	1	1
1	1	1	1	0	0	1	1	0	1	0	0
1	1	1	1	1	0	1	1	0	0	0	0
1	1	1	1	1	1	0	0	1	0	1	1

DAC Troubleshooting includes a checkout procedure that does not require a programming source. Table 8-BA-7 ("DAC Logic Levels") gives the required logic output levels for proper operation. The information in Table 8-BA-8 ("DAC Signals") is designed to aid in troubleshooting. It should be used to troubleshoot problems where the logic levels are correct, yet the analog output is incorrect.

Table 8-BA-7. A11 DAC Logic Levels

	Least Significant Digit U10(14)				U9(13)				Most Significant Digit U8(12)		Sign TP2(1)	Output TP5(6)
	14	15	2	3	14	15	2	3	14	15		
Reset Pulse U11 Pin 14	0	0	0	0	0	0	0	0	0	0	0	0.000 ±0.050Vdc
1 Pulse J1 Pin 14(13)	0	1	0	0	0	0	0	0	0	0	0	-0.020 ±0.050Vdc
2 Pulses J1 Pin 14(13)	0	1	0	0	0	1	0	0	0	0	0	-0.220 ±0.070Vdc
3 Pulses J1 Pin 14(13)	0	1	0	0	0	1	0	0	0	1	0	-2.220 ±0.070Vdc
4 Pulses J1 Pin 14(13)	0	1	0	0	0	1	0	0	0	1	1	+2.220 ±0.070Vdc

**NOTE**

This procedure does not exercise every bit. If DAC symptoms are that **some** voltages are not programmable, exercise each bit high by leaving that bit not shorted to ground.

Table 8-BA-8. A11 DAC Signals

	TP3(4)	A11U2 Pin 8(6) Pin 9(5)	Anode CR5, CR6(2, 4)	Cathode CR8 CR10(1, 3)	TP5(6)
Reset Pulse U11 Pin 14	No Pulses	No Pulses	No Pulses	No Pulses	0.00 ±0.05V dc
1 Pulse J1 Pin 14(13)	10 ms ±4 ms period pulses	10 ms ±4 ms period pulses	10 ms ±4 ms period pulses	≈+13V dc	-0.02 ±0.05V dc
2 Pulses J1 Pin 14(13)	1 ms ±0.4 ms period pulses	1 ms ±0.4 ms period pulses	1 ms ±0.4 ms period pulses	≈+13V dc	-0.22 ±0.07V dc
3 Pulses J1 Pin 14(13)	100 μs ±40 μs period pulses	100 μs ±40 μs period pulses	100 μs ±40 μs period pulses	≈+13V dc	-2.22 ±0.07V dc
4 Pulses J1 Pin 14(13)	100 μs ±40 μs period pulses	100 μs ±40 μs period pulses	≈-13V dc	100 μs ±40 μs period pulses	+2.22 ±0.07V dc
<b>NOTE</b>					
<i>Pulse period is approximate; 40% variation may be normal since pulse spacing is not constant out of rate multiplier. Fainter pulses between brighter pulses may be seen. This is normal.</i>					

8-BA-16. PROGRAMMING LOGIC TROUBLESHOOTING

To troubleshoot a remote programming problem:

- a. Set up the equipment as shown in Figure 8-BA-2.

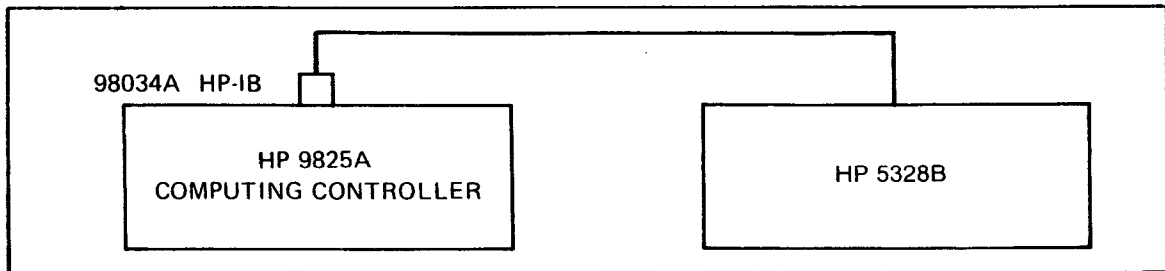


Figure 8-BA-2. Set-up for Programming Logic Troubleshooting

- b. Set the Model 5328B's rear-panel address switches as shown in Figure 8-BA-3.

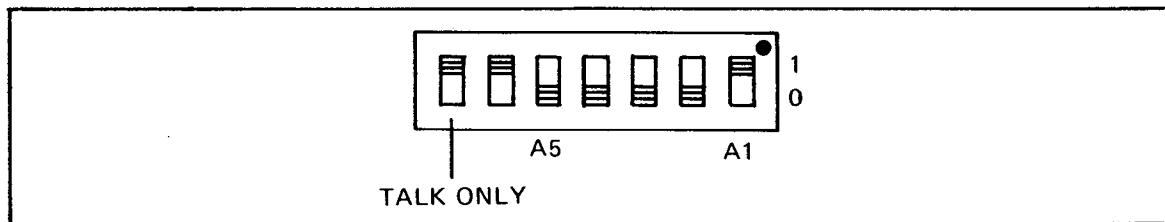


Figure 8-BA-3. Address Switch Setting for Programming Logic Troubleshooting

- c. Program the Model 5328B, using the Model 9825A.
  - 1) Find the line containing the inoperative function in Table 8-BA-5.
  - 2) Press the appropriate keys on the Model 9825A to cause the indicated "Program Steps" to be displayed.
  - 3) Press the Model 9825A's EXECUTE key.

- d. Using a logic probe, check the levels on the same line of Table 8-BA-5 as the program code you chose in step "1".
- e. Repeat for all inoperative functions. Suspect any integrated circuits which generate an incorrect output level.

#### 8-BA-17. DAC TROUBLESHOOTING

To perform DAC troubleshooting —

- a. Check the +5V, -5.2V, +15V, and -15V supply lines on the Motherboard (A1). (Refer to the A2 troubleshooting procedure for repair.)

- b. Check for a clock signal at U5(8,11), and on Q7's collector.

If the clock signal is not correct, suspect U5, Q7, or C12.

- c. Perform the following setup procedure:

- 1) Turn the Model 5328B's power off.
- 2) Unplug the 14-conductor cable from A11J1.
- 3) Remove the DAC Board (A11) from the Model 5328B.
- 4) Install jumpers in J1 as follows:

from pin 8 to pin 10  
from pin 5 to pin 6  
from pin 4 to pin 7  
from pin 3 to pin 12

#### NOTE

Be sure the jumper from pin "8" to pin "10" does not short to any of the other jumpers.

- 5) Reinstall the DAC board, using a HP 05328-62016 extender board, into XA11.
  - 6) Apply power to a HP 10526T Logic Pulser.
  - 7) Connect an HP 3468A Voltmeter between A11TP5 and the Model 5328B's chassis, so you can monitor the Channel "A" DAC output).
  - 8) Turn the Model 5328B's power "on".
- d. Pulse A11U11(14) with the Logic Pulser.

This resets the DAC storage registers.

If the Voltmeter's display is  $0V \pm 50$  mV, perform step "e".

If the Voltmeter's display is not  $0V \pm 50$  mV, refer to Table 8-BA-7, and check the logic levels listed on line "1" (Reset Pulse U11(14)) for an improper level. Suspect any integrated circuit listed, if it has an improper output.

- e. Pulse A11J1(14) once with the Logic Pulser, and verify line "2" of Table 8-BA-7.
- f. Pulse A11J1(14) three more times, stopping after each pulse to verify the next line of Table 8-BA-7.
- g. Steps "d" through "f" checked the Channel "A" DAC. To check the Channel "B" DAC —
- h. Change the Voltmeter connector connections to A11TP6 and the Model 5328B's chassis.
- i. Repeat step "d" through step "f", pulsing A11J1(13) instead of A11J1(14).

**NOTE**

The numbers in parentheses in Table 8-BA-7 refer to pins related to Channel "B".

- j. If the Channel "A" and Channel "B" DAC output voltages were the same as listed in Table 8-BA-7, the board is functioning correctly. If an output is not correct, suspect the integrated circuit that generates the level. If the digital outputs are correct and the analog output is incorrect, continue in step "k", below.
- k. Reset the storage registers (U16, U15, U11, U10) by pulsing A11U10(14) with a Logic pulser.  
Use an Oscilloscope to check the signals listed in line "1" of Table 8-BA-8.
- l. Pulse A11J1(14).
- m. Using the Oscilloscope, Check for signals in line "2" of Table 8-BA-8.
- n. Pulse A11J1(14) three more times, stopping after each pulsing to verify the corresponding line in Table 8-BA-8 with an Oscilloscope.

Steps "k" through "h" have checked the Channel "A" DAC signal path. To check the Channel "B" DAC, perform steps "k" through "h", above, except pulse A11J1(13) instead of A11J1(14). Stop after each pulsing to verify the locations listed in parentheses in Table 8-BA-8.

- o. Refer to Table 8-BA-9 to match the symptom detected with the probable cause of the trouble.

Table 8-BA-9. A11 DAC Troubleshooting

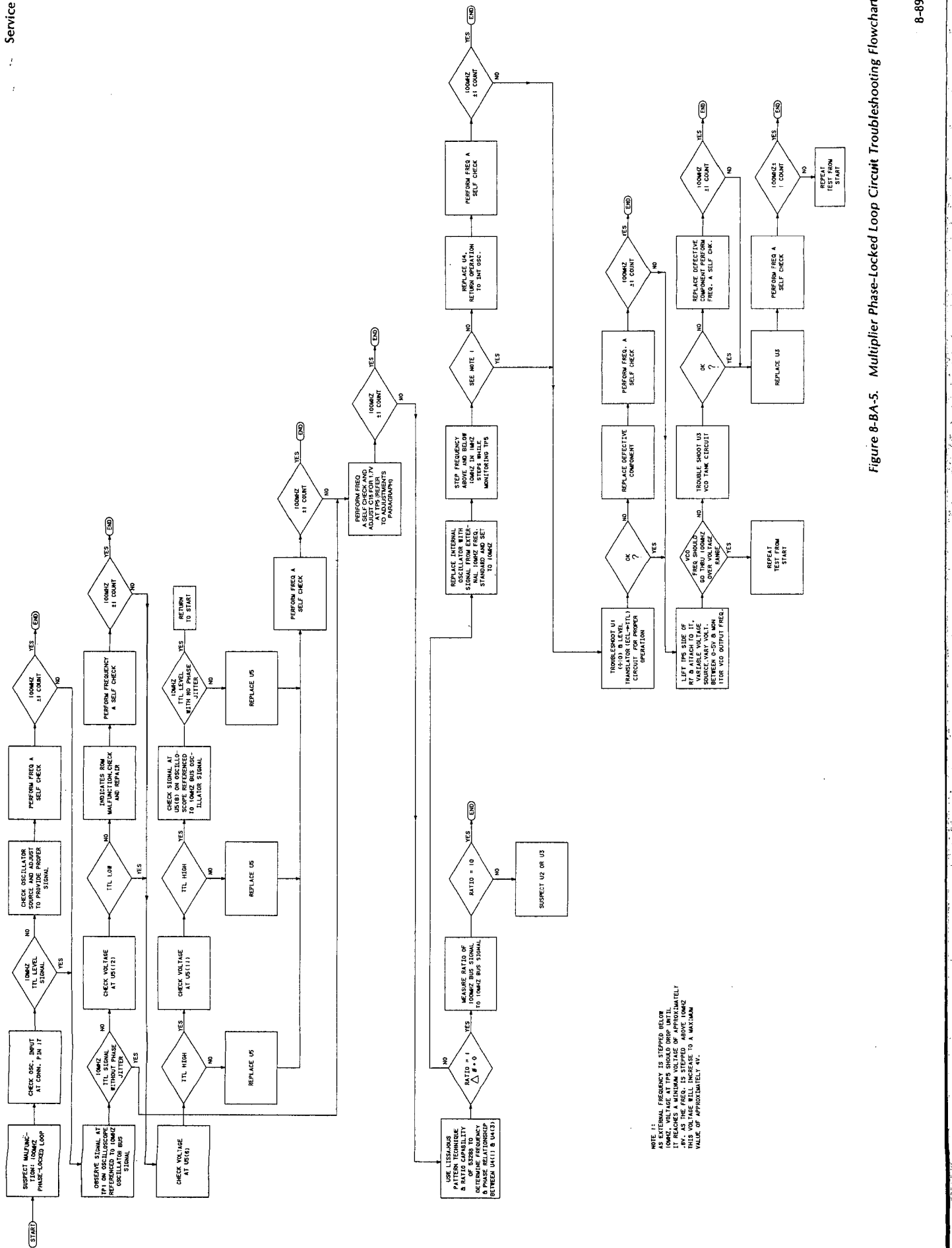
Symptom	Probable Cause
Pulses wrong at TP4	U12, U13, or U14
Pulses wrong at TP3	U8, U9, or U10
Pulses wrong at U2 output	U2
Pulses wrong at drain of Q2	Q2, CR2, CR4, U1, or U3
Pulses wrong at drain of Q1	Q1, CR1, CR3, U1, or U3
Pulses wrong at drain of Q4	Q4, CR8, CR10, U4, or U3
Pulses wrong at drain of Q3	Q3, CR5, CR6, U4, or U3
If Pulses at all points good	U4 for Channel A U1 for Channel B





*Figure 8-BA-4*  
**“LOCAL” MODE TROUBLESHOOTING FLOWCHART**

(See Page 8-87)



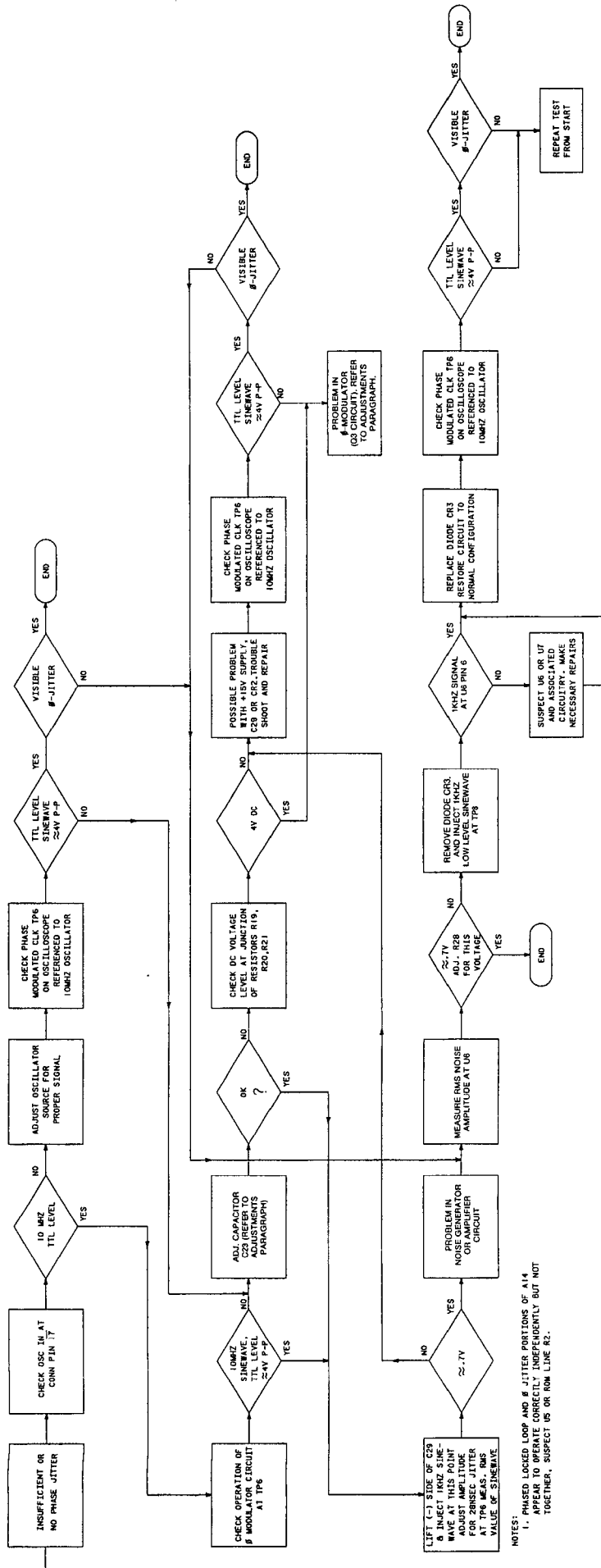
NOTE 1:  
AS EXTERNAL FREQUENCY IS STEPPED BELOW 100KHZ, THE FREQUENCY SHOULD APPROXIMATELY REACHES A MINIMUM VOLTAGE OF APPROXIMATELY 0.5V. AS THE FREQ. IS STEPPED ABOVE 100KHZ, THE FREQUENCY SHOULD APPROXIMATELY REACHES TO A MAXIMUM VALUE OF APPROXIMATELY 5V.

Figure 8-BA-5. Multiplier Phase-Locked Loop Circuit Troubleshooting Flowchart



*Figure 8-BA-5*  
**MULTIPLIER PHASE-LOCK-LOOP CIRCUIT  
TROUBLESHOOTING FLOWCHART**

(See Page 8-89)



NOTES:  
 1. PHASED LOCKED LOOP AND # JITTER PORTIONS OF A14  
 ARE TO BE ADJUSTED SEPARATELY BUT NOT  
 TOGETHER. SUSPECT U8 OR ROW LINE R2.

Figure 8-BA-6. Multiplier Phase/Jitter Troubleshooting Flowchart

*Figure 8-BA-6*  
**MULTIPLIER PHASE/JITTER**  
**TROUBLESHOOTING FLOWCHART**

(See Page 8-91)

### 8-BA-18. REMOVAL AND REPLACEMENT INSTRUCTIONS

Removal and replacement instructions are provided for the counter's cover, the Time Interval Module (assemblies A10 and A19).

#### 8-BA-19. Instrument Cover Removal

To remove the Model 5328B's top or bottom cover:

- a. Remove the screw at the rear of the cover that secures the cover to the counter's frame.
- b. Slide the cover toward the rear of the counter and lift it off.

To replace the Model 5328B's top or bottom cover, reverse the procedure above.

#### WARNING

**THE AC LINE (MAINS) (110V/120V/220V/240V) WIRES ARE EXPOSED WHEN EITHER THE TOP OR BOTTOM IS REMOVED. USE EXTREME CAUTION DURING TROUBLESHOOTING, ADJUSTMENT, OR REPAIR.**

**REDUCE THE CHANCE OF PERSONAL INJURY OR DAMAGE TO THE COUNTER BY ALWAYS DISCONNECTING THE AC POWER CORD BEFORE YOU REMOVE OR REPLACE THE COUNTER'S COVERS OR ANY ASSEMBLY OR COMPONENT WITHIN THE COUNTER.**

#### 8-BA-20. Time Interval Module (A10 And A19) Removal

To remove the Time Interval Module:

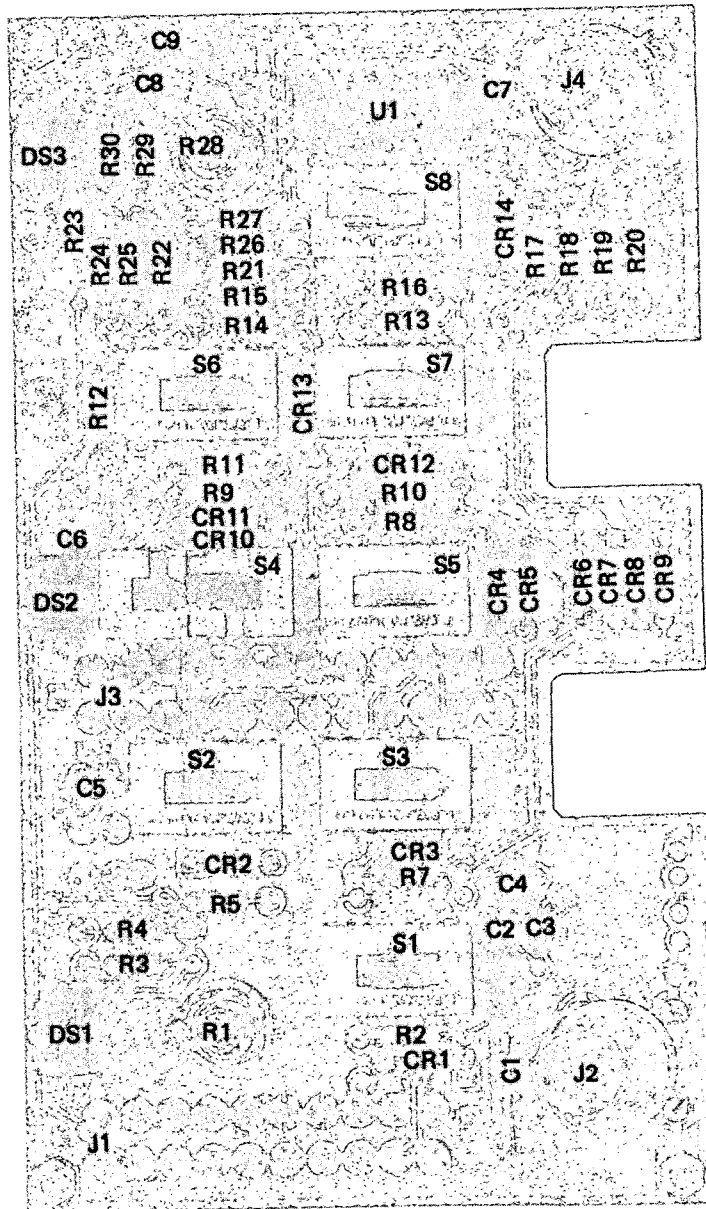
- a. Disconnect the Model 5328B's line cord (as as safety precaution).
- b. Remove the Model 5328B's top cover.
- c. Using a suitable flat-blade screwdriver as a prying tool, gently remove the plastic filler strip from the top of the counter's cast front-panel frame.
- d. Remove the two machine screws that secure the top of the module front panel to the top of the cast front-panel frame.
- e. Turn the Model 5328B on its side and remove the two machine screws that fasten the bottom of the module front panel to the bottom of the cast front-panel frame.
- f. Slightly loosen all remaining machine screws along the top of the cast front-panel frame. This releases the compressive force on the module front panel.
- g. Using a suitable allen wrench, remove the LEVEL A control knob from the module front panel.
- h. Remove the A19 Attenuator assembly, with front panel attached, by gently pushing the assembly from the rear. Note that the attenuator assembly is separated from the A10 Synchronizer assembly during this operation.

**Model 5328B  
Service**

- i. Remove the front panel from the A19 Attenuator assembly by removing the nut attached to each connector and removing the LEVEL B control knob.
- j. Remove the A10 Synchronizer assembly by pulling the assembly upward.

This ends the Time Interval Module removal procedure.

The procedure for replacing the Time Interval Module is essentially the reverse of the above procedure.



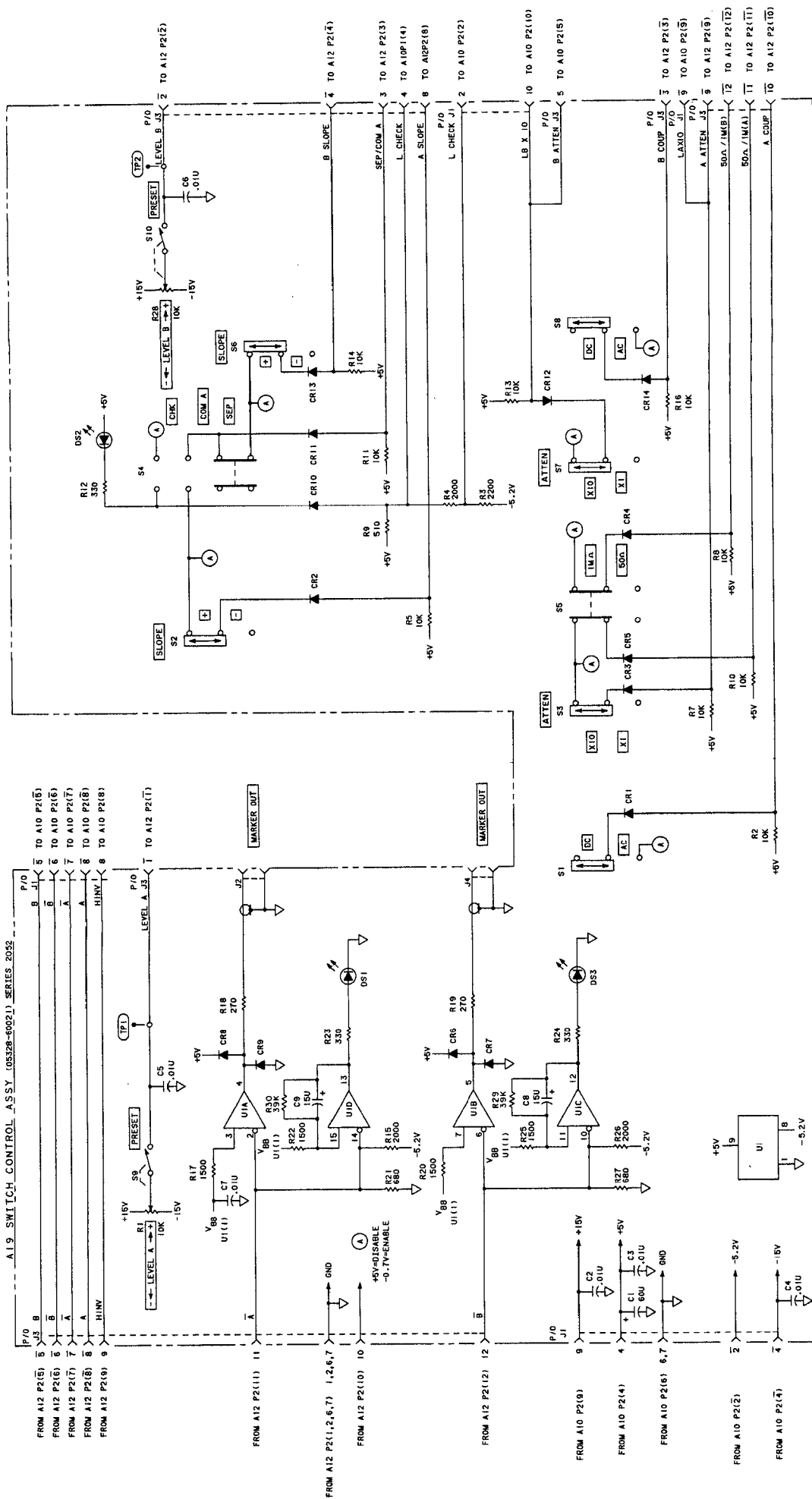


Figure 8-BA-7. A19 Switch

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 FARADS;
3. R1 AND S9 ARE PART OF THE SAME COMPONENT
4. R28 AND S10 ARE PART OF THE SAME COMPONENT

A19 REFERENCE DESIGNATORS	
CI-C5	
CR1-CR14	
DS1-DS3	
J1-J4	
R1-R5	
R7-R28	
S1-S10	
UI	
A19 ACTIVE ELEMENTS	
CR1, CR2, CR3	
CR4, CR5, CR6	
CR7, CR8, CR9	
CR10, CR11, CR12	1001-0040
CR13, CR14	
UI	1820-1082 MC10125L

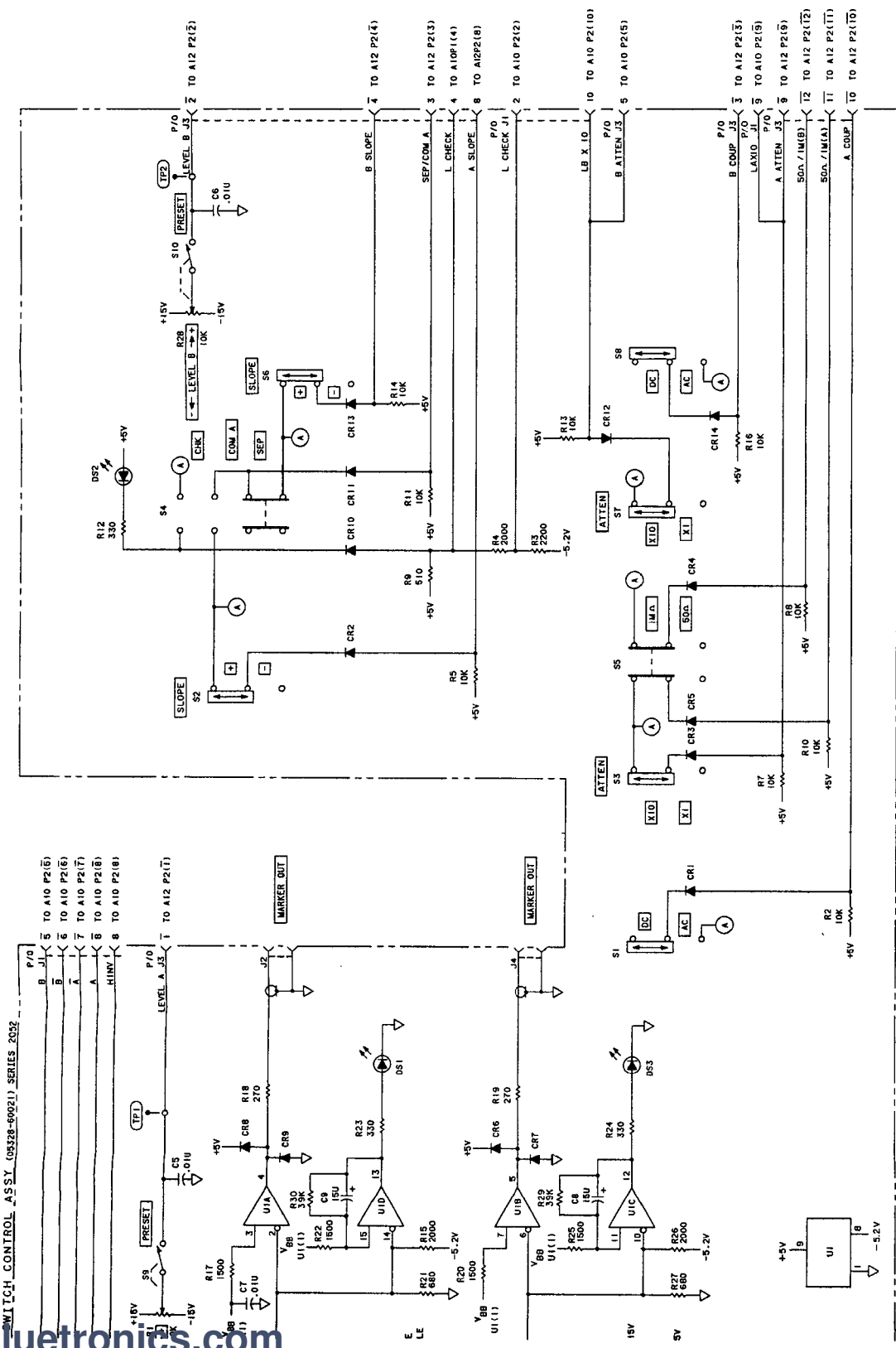


Figure 8-BA-7. A19 Switch Control Assembly Schematic Diagram



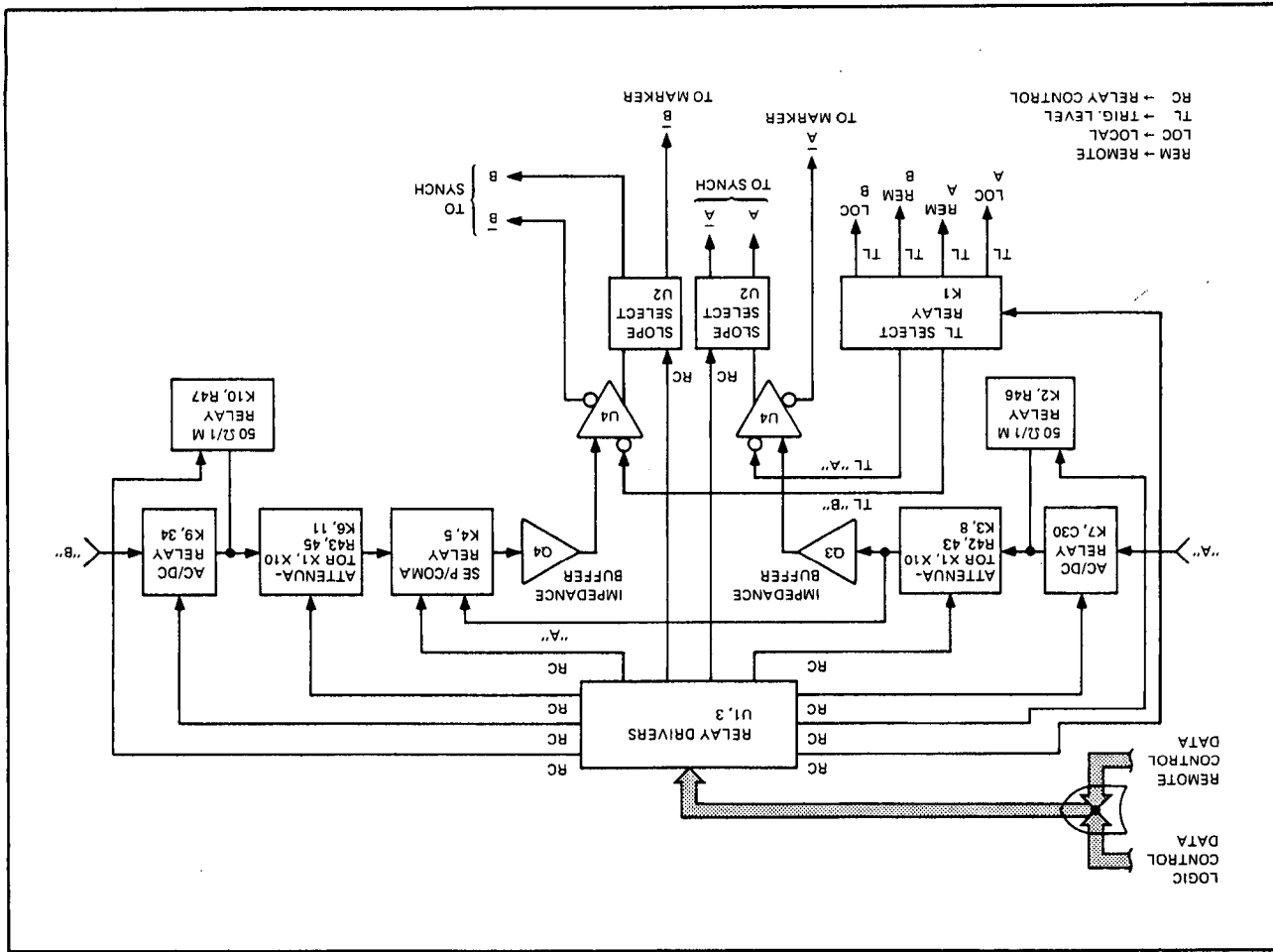
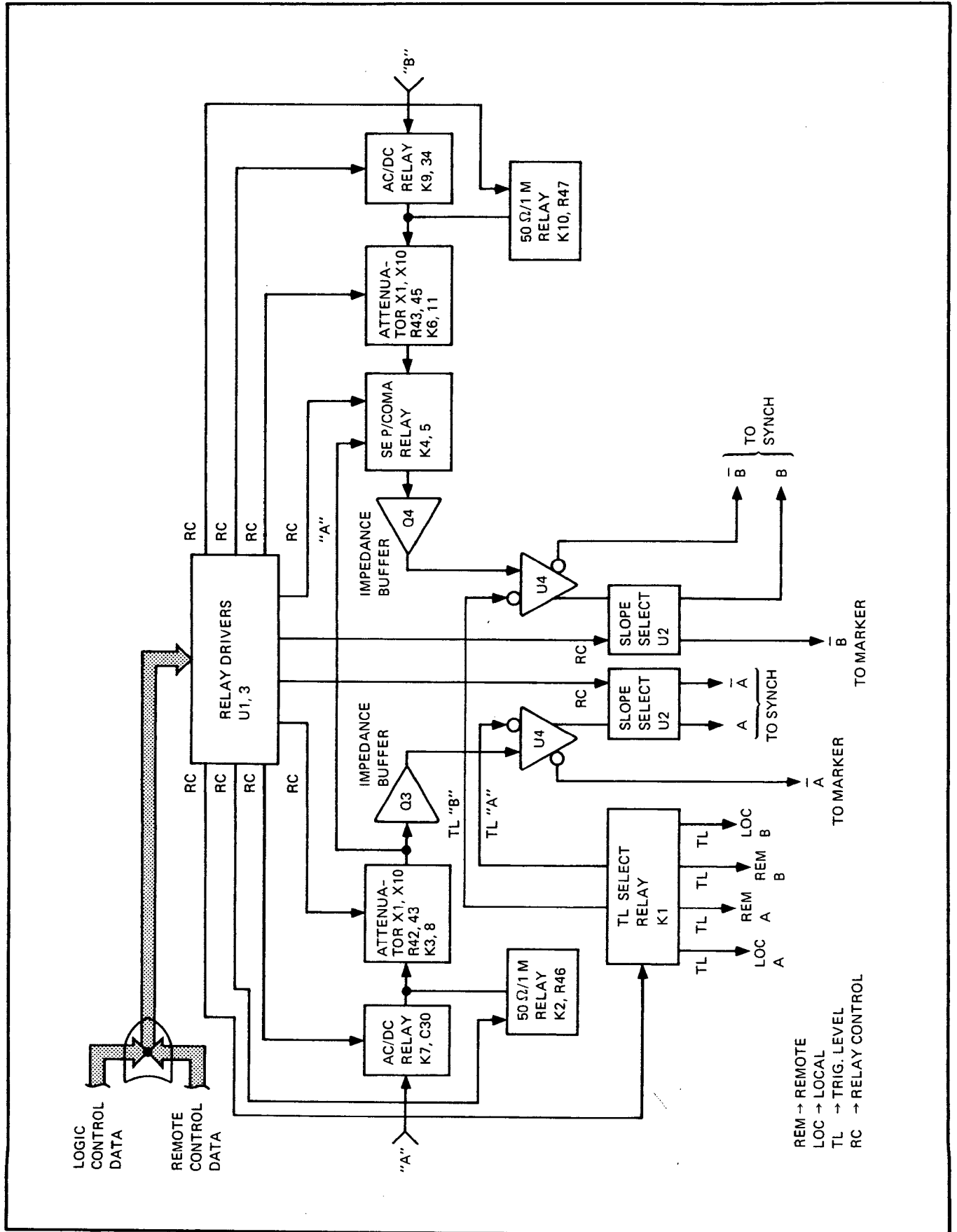


Figure 8-BA-7  
A19 SWITCH CONTROL ASSEMBLY (SCHEMATIC DIAGRAM)

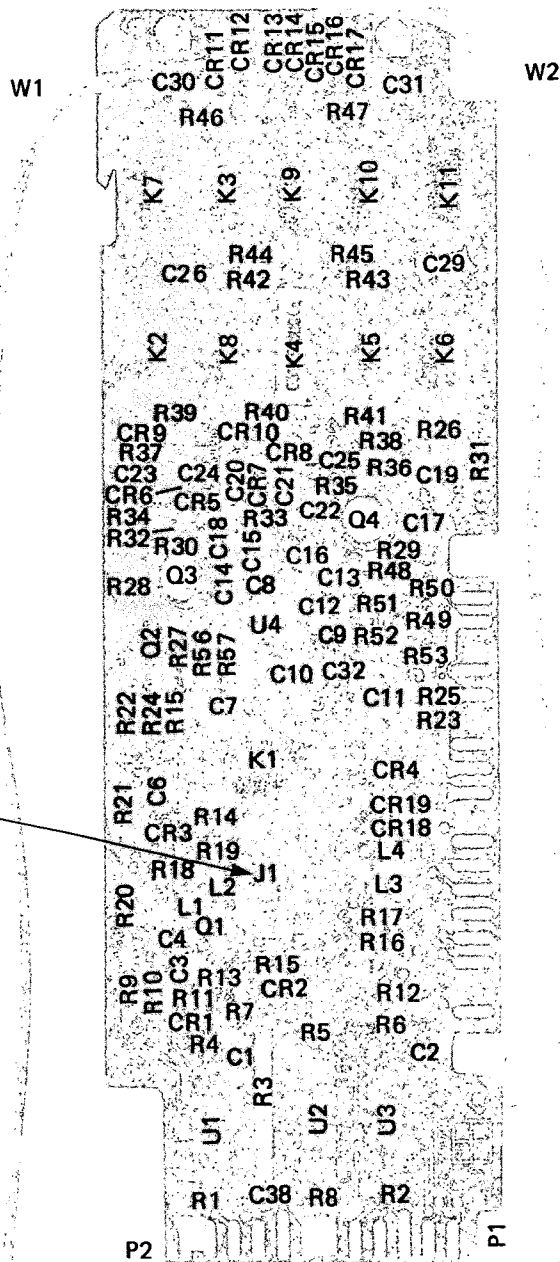
(See Page 8-95)

P/O Figure 8-BA-8. A12 Amplifier Assembly Schematic Diagram



P/O Figure 8-BA-8. A12 Amplifier Assembly Schematic Diagram

A12J1 CONNECTED TO A10J3 VIA RIBBON CABLE W4.

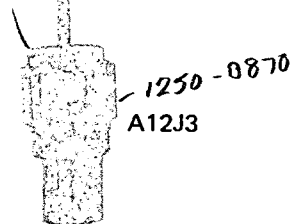


18 | 18

COMPONENT SIDE | SOLDER SIDE

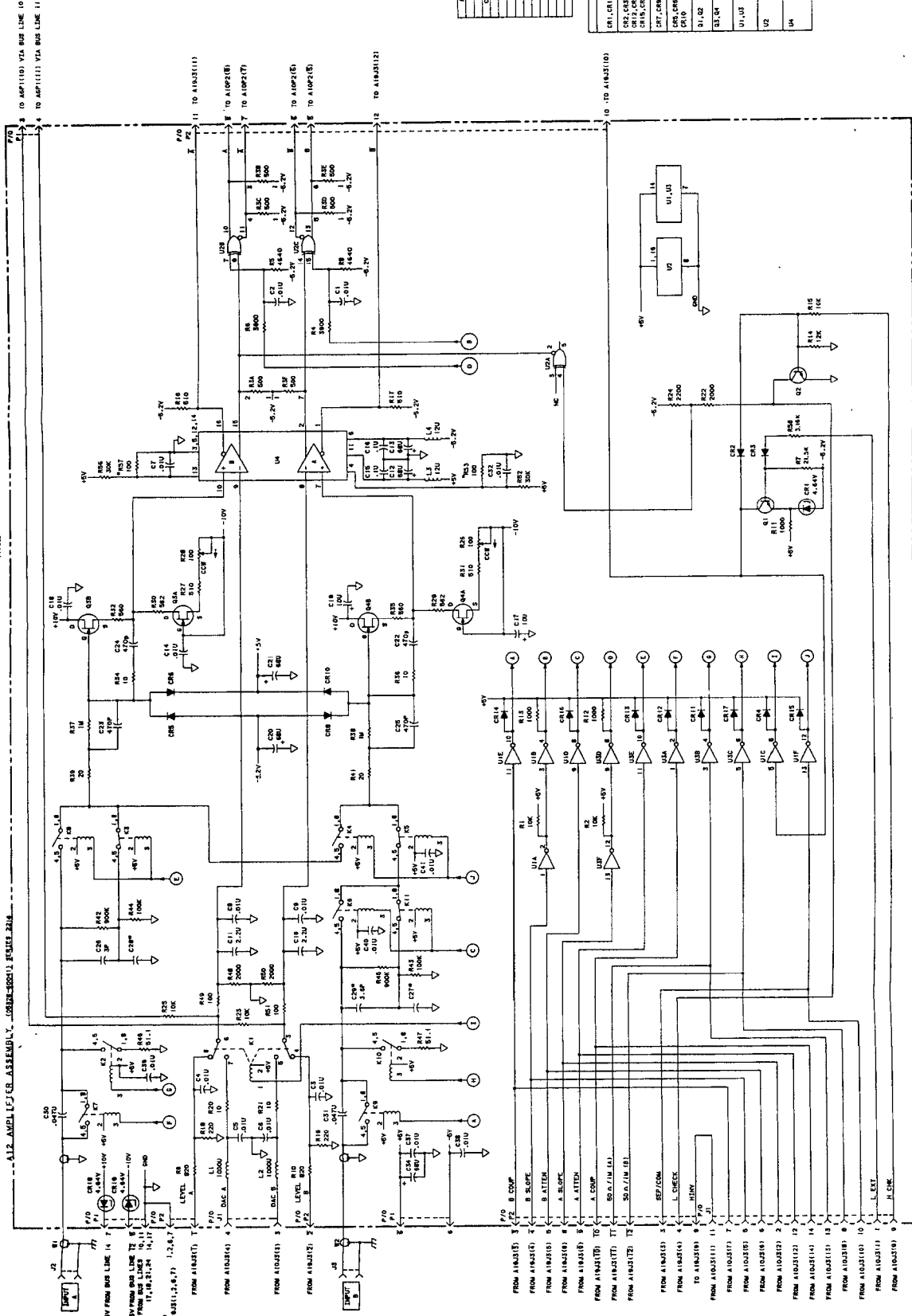
1 | 1

1 COMPONENT SIDE 10  
1 SOLDER SIDE 10



A12J2

117000



- NOTES:
1. REFERENCE DESIGNATIONS WITHIN THIS SCHEMATIC ARE TO BE USED IN CONJUNCTION WITH THE PART NUMBER AND ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.
  2. UNLESS OTHERWISE INDICATED: RESISTANCE IN OHMS; CAPACITANCE IN FARADS; INDUCTANCE IN HENRIES.
  3. ASTERISKS (\*) INDICATES SELECTED VALUE, AVERAGE VALUE, OR RANGE OF VALUES. CAPACITANCE VALUE IS SHOWN, STRAY CAPACITANCE IS USED.
  4. ALL RELAYS SHOWN IN DE-ENERGIZED STATE.

A12 REFERENCE DESIGNATIONS

C1-C24	RESISTORS
C27-C28	CAPACITORS
D1-D11	DIODES
U1-U4	OPERATIONAL AMPLIFIERS
U5-U17	COMPARATORS

A12 RELAY ELEMENTS

CR1, CR16, CR19	1002-3082
CR2, CR3, CR4, CR11, CR15, CR16, CR17	1001-3040
CR7, CR8	1002-3048
CR9, CR10, CR12	1001-3216
CR13, CR14	1001-3071
CR18, CR20, CR21, CR22, CR23	1001-3081
CR24	1001-3082
U1, U2	1001-3077
U3, U4	1001-3085
U5, U6, U7, U8, U9, U10, U11, U12, U13, U14, U15, U16, U17	1001-3086

Figure 8-BA-8. AT2 Amplifier Assembly Schematic Diagram

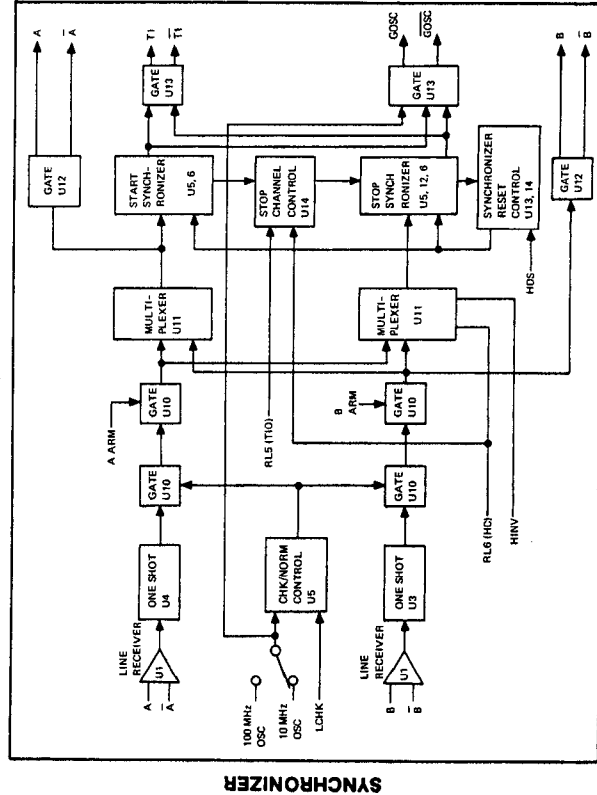
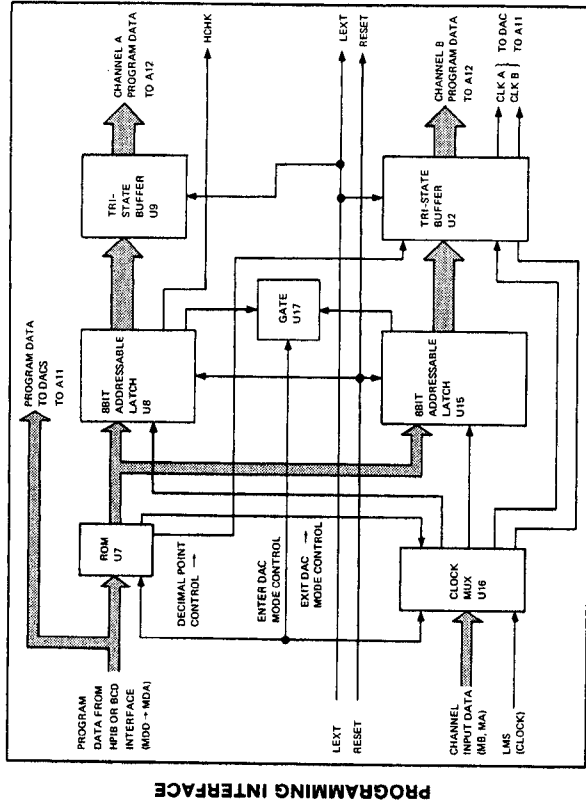


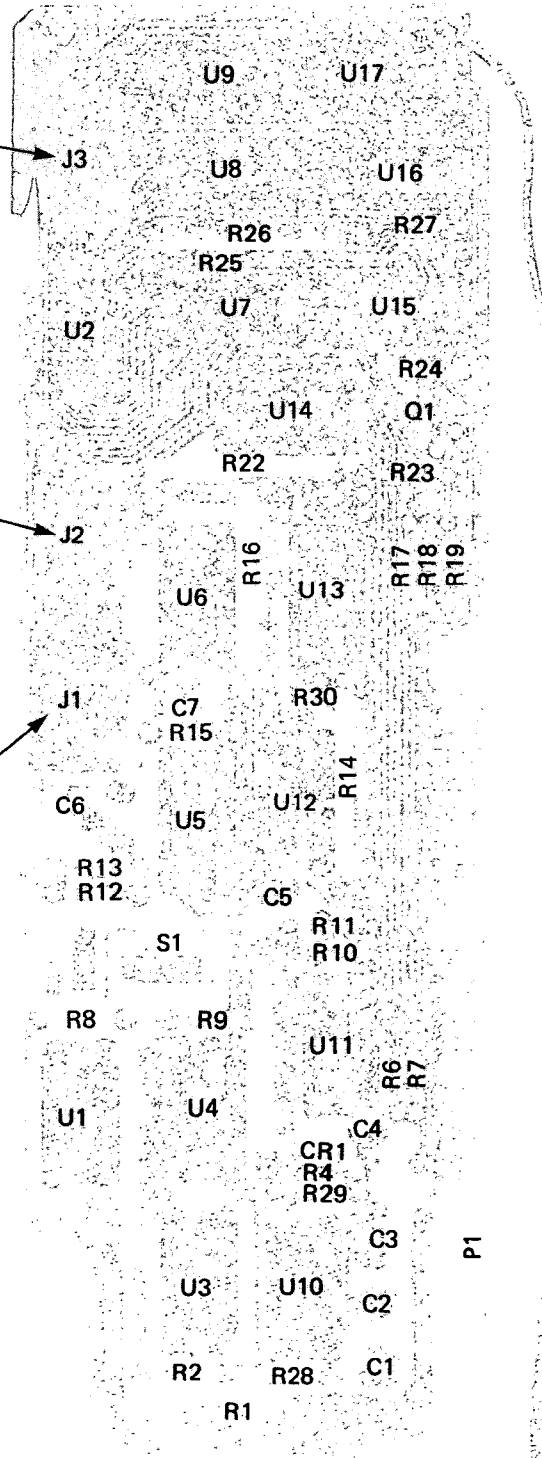
Figure 8-BA-8  
A12 AMPLIFIER ASSEMBLY (SCHEMATIC DIAGRAM)  
(See Page 8-97)

P/O Figure 8-BA-9. A10 Synchronizer Assembly Schematic

A10J3 CONNECTED  
TO A12J1 VIA  
RIBBON CABEL W4.

A10J2 CONNECTED  
TO A15J1 VIA  
RIBBON CABLE W3.

A10J1 CONNECTED  
TO A11J1 VIA  
RIBBON CABLE W5.



A10W1

18

18

COMPONENT SIDE

SOLDER SIDE

1

1

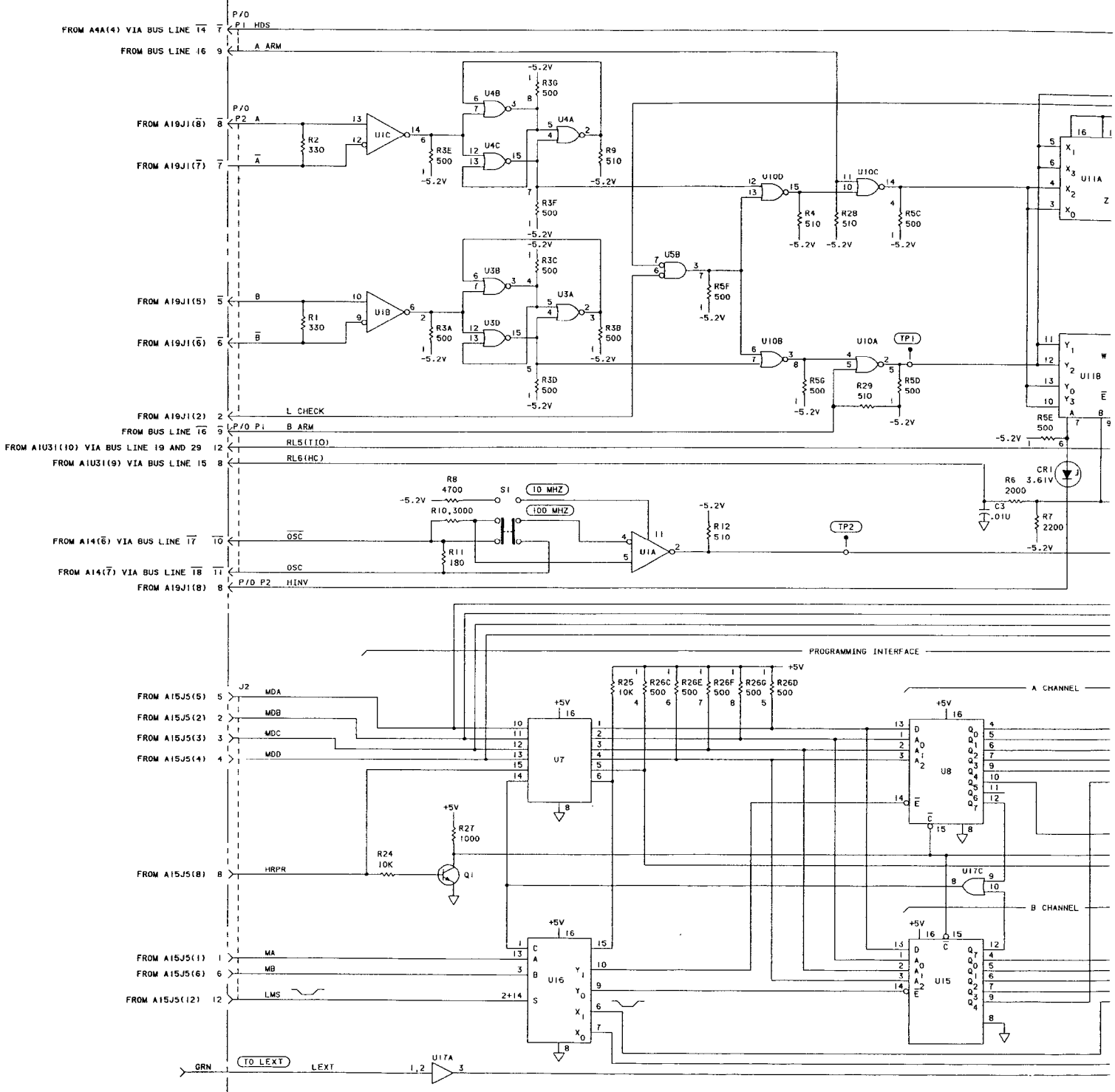
P2

1/1

10/10

COMPONENT SIDE  
SOLDER SIDE

A10 SYNCHRONIZER ASSEMBLY (05328-600201 SERIES 2211)



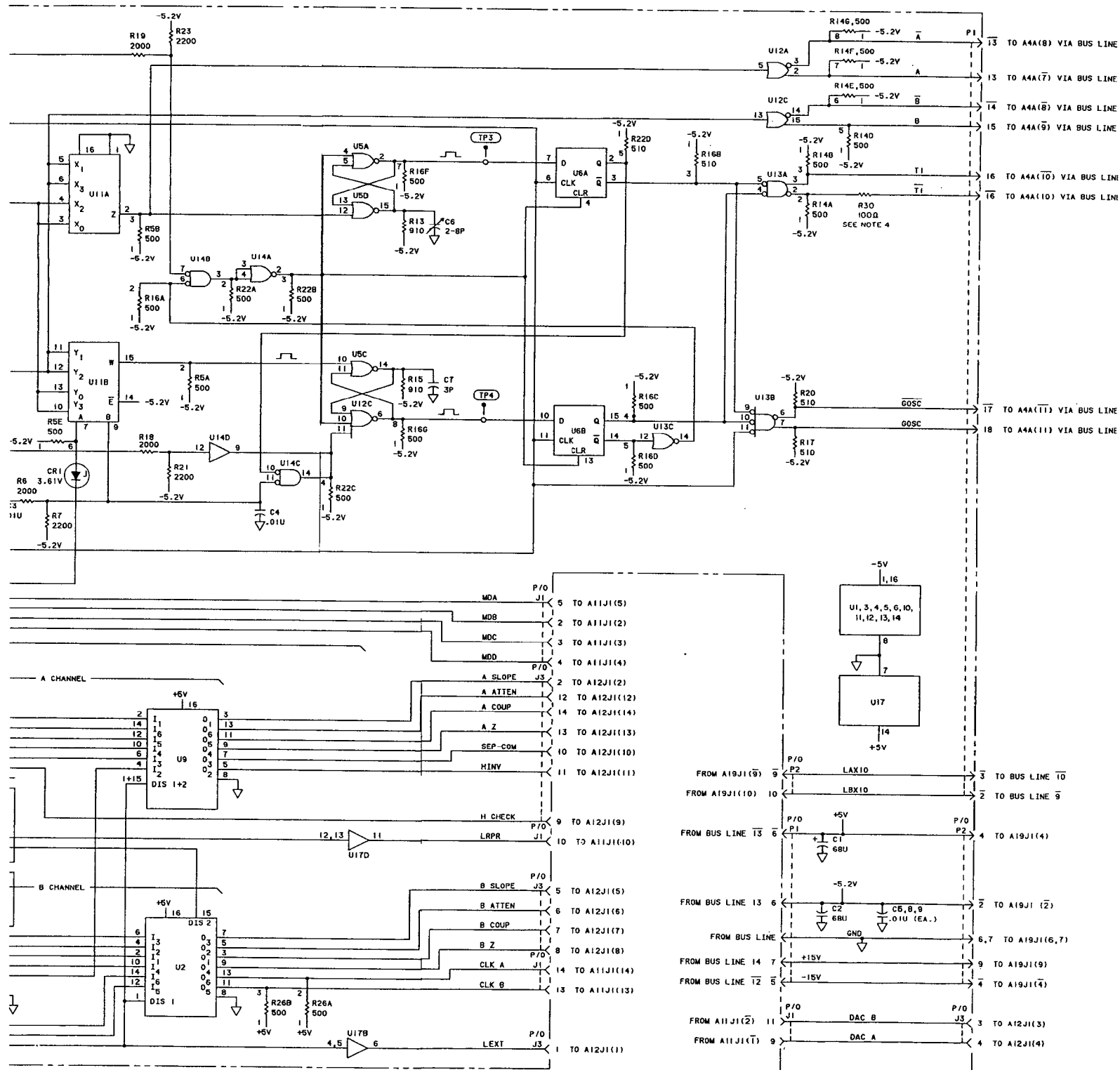
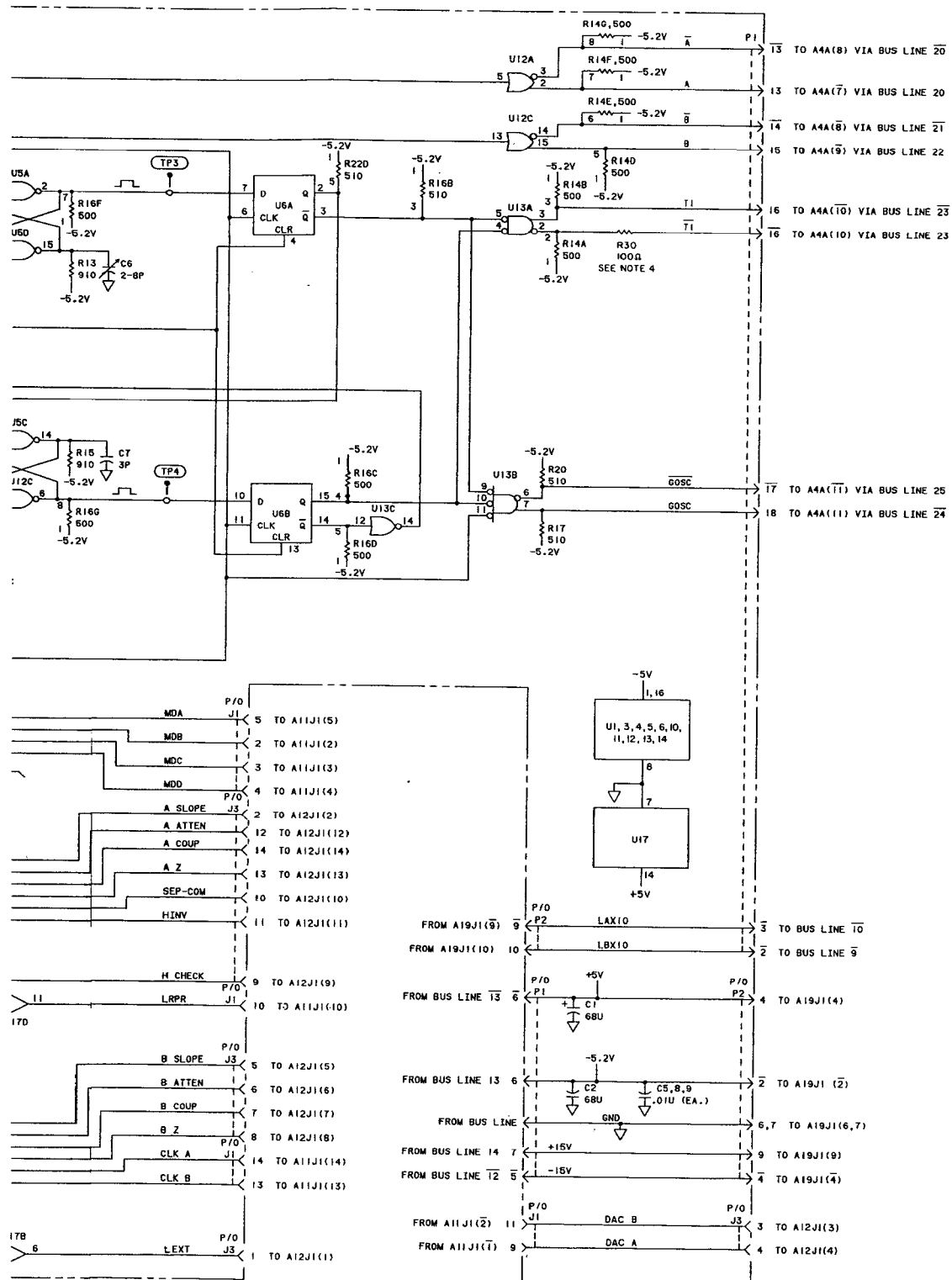


Figure 8-BA-9. A10 Synchronizer





- NOTES**
- REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.
  - UNLESS OTHERWISE INDICATED: RESISTANCE IN OHMS; CAPACITANCE IN FARADS; INDUCTANCE IN HENRIES.
  - U11 LOGIC TABLE:
- |   |   |   |   |
|---|---|---|---|
| 7 | 9 | Z | H |
| 0 | L | L | A |
| 2 | L | H | A |
| 1 | H | L | B |
| 3 | H | H | A |
- INSTRUMENTS WITH SERIAL NUMBERS 2211RS2481 THROUGH 2211RS2669 DO NOT HAVE R30.

**A10**

REFERENCE DESIGNATIONS
C1-C9
CR1
J1-J3
Q1
R1-R29
S1
TP1-TP4
U1-U17

**A10 ACTIVE ELEMENTS**

CR1	1982-3836
Q1	1854-0871 2N3391
U1	1820-1320 MC 10216
U2, U9	1820-1849 DM8097N
U3, U4, U5, U18, U14	1820-0802 MC 10162
U6	1820-0817
U7	1816-1174 OR 05328-80003
U8, U15	1820-0833
U11	1820-1359
U12, U13	1820-0803
U16	1820-1245
U17	1820-1208

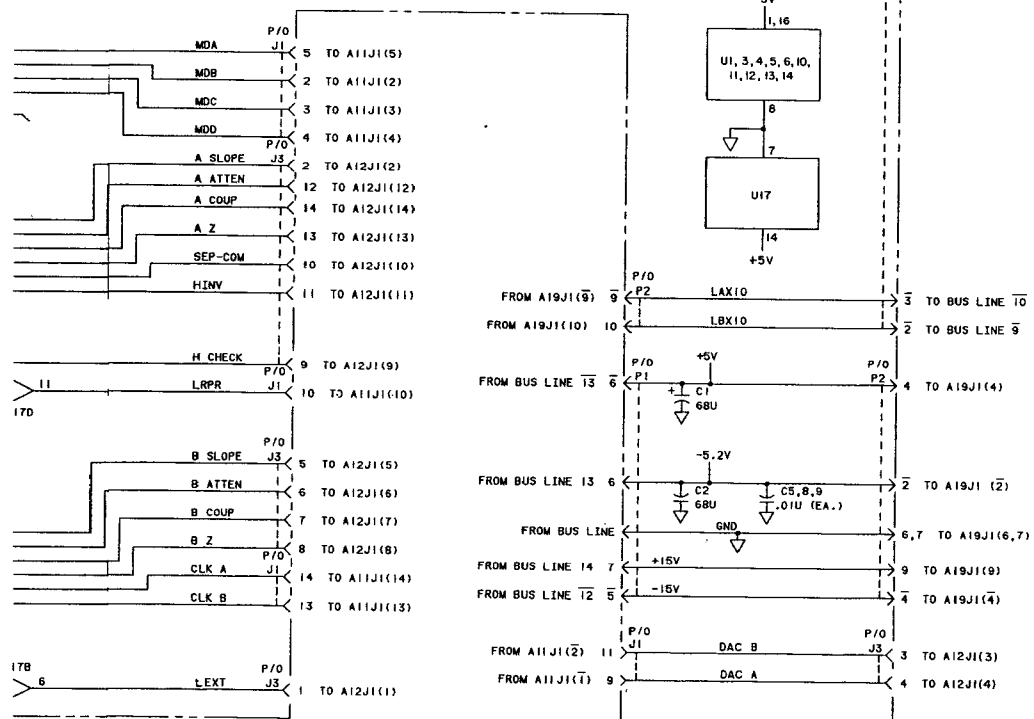
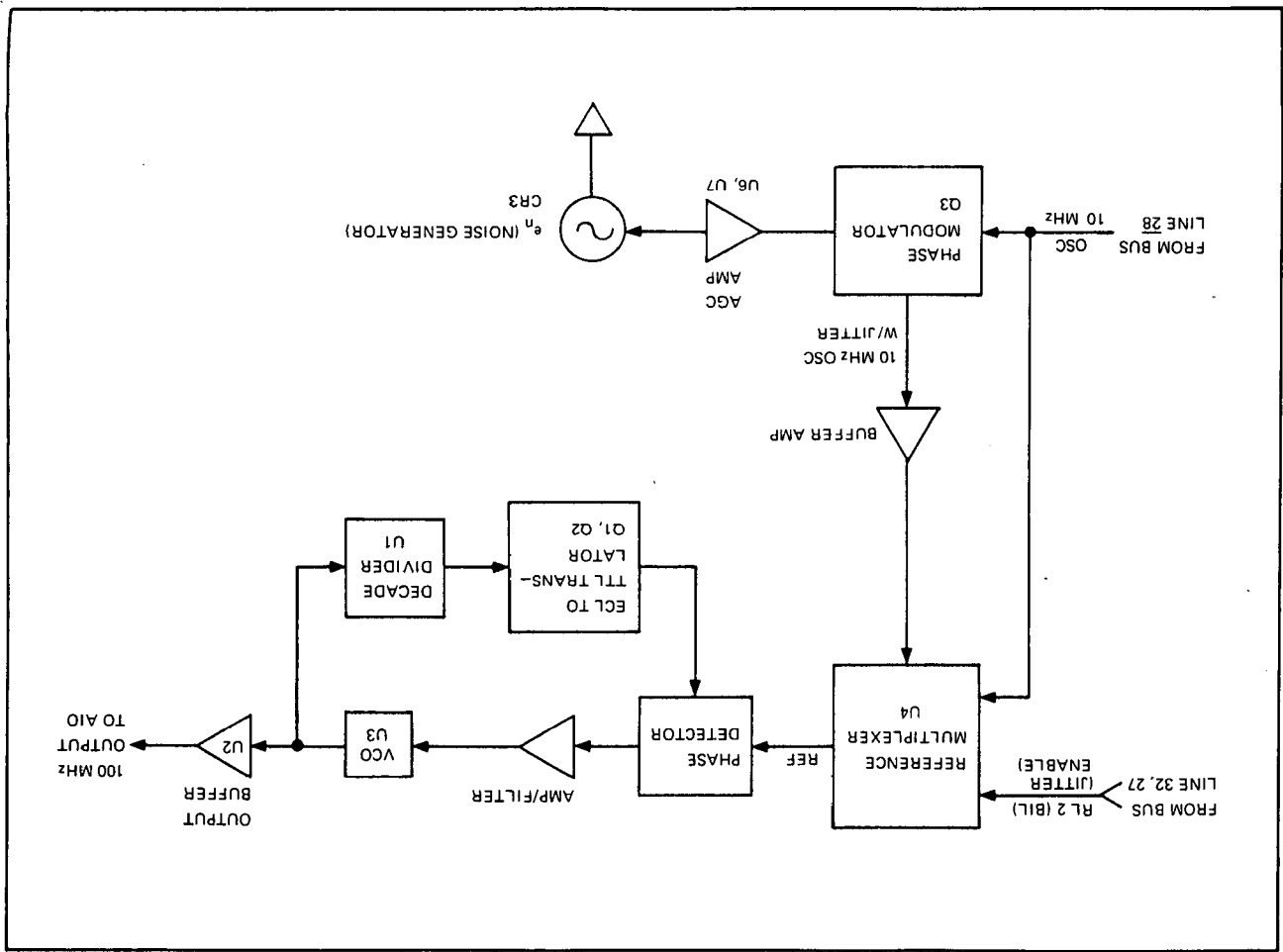
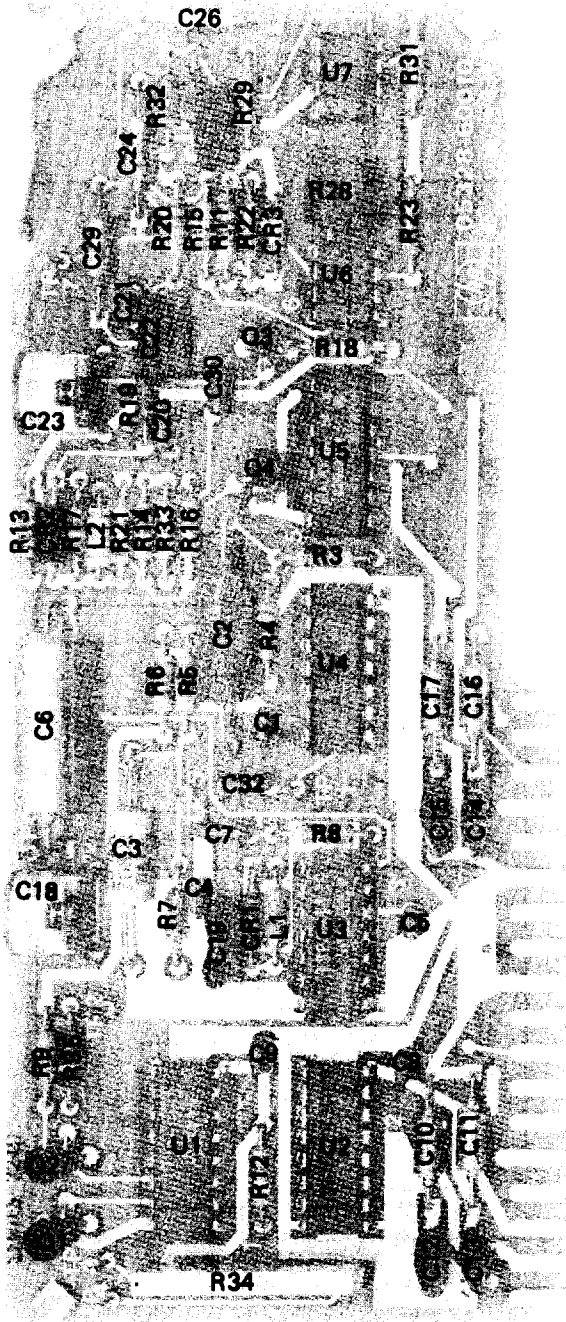


Figure 8-BA-9. A10 Synchronizer Assembly Schematic Diagram



P/O Figure 8-BA-10. A14 Multiplier Assembly

Figure 8-BA-9  
A10 SYNCHRONIZER ASSEMBLY (SCHEMATIC DIAGRAM)



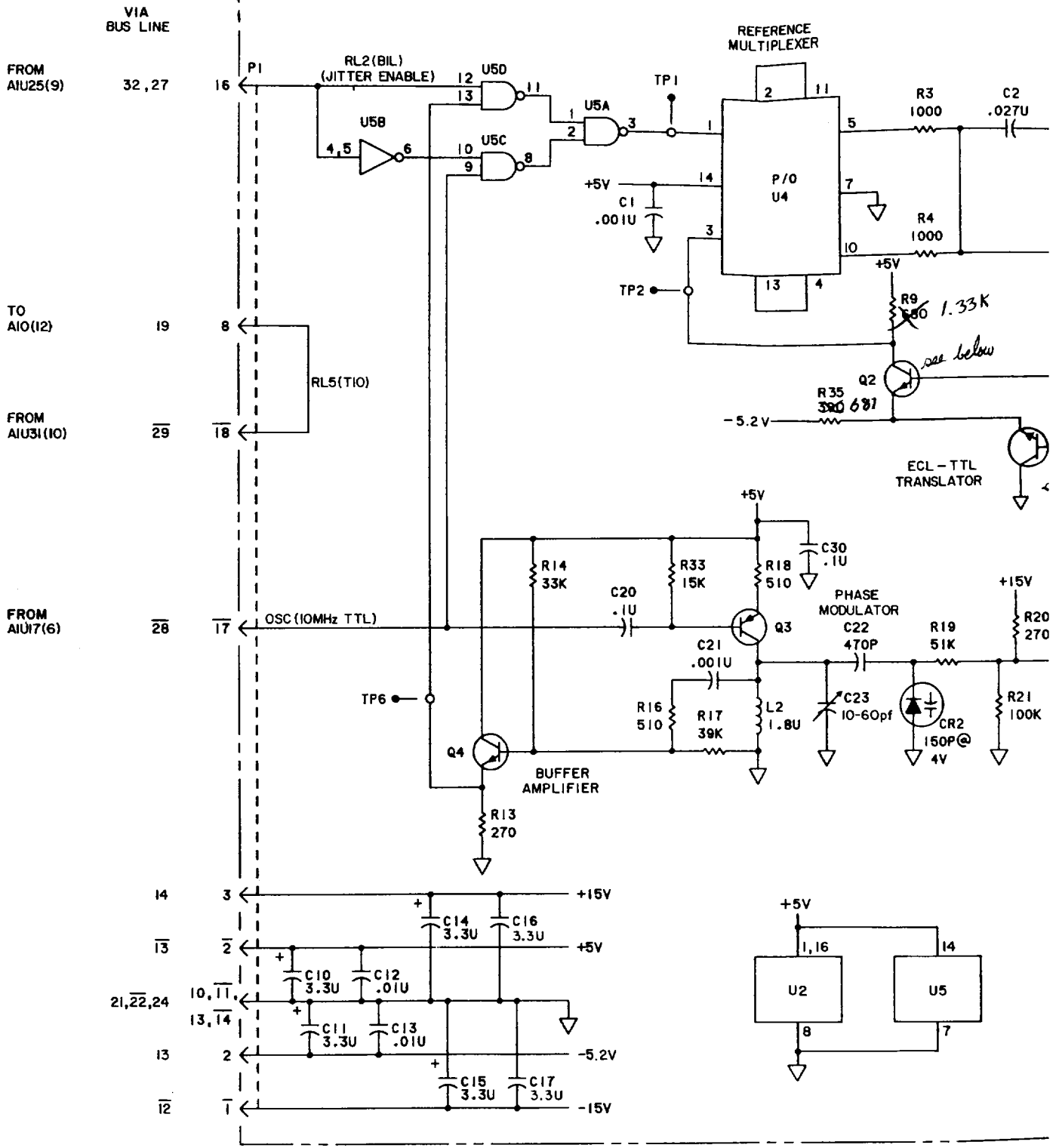
P1

1 / 1

COMPONENT SIDE  
SOLDER SIDE

18 / 18

A14 MULTIPLIER ASSEMBLY (05328-60010) SERIES 2240



*Q<sub>1</sub> + Q<sub>2</sub> change  
1854-009  
Min Miscounts  
harmonic no*

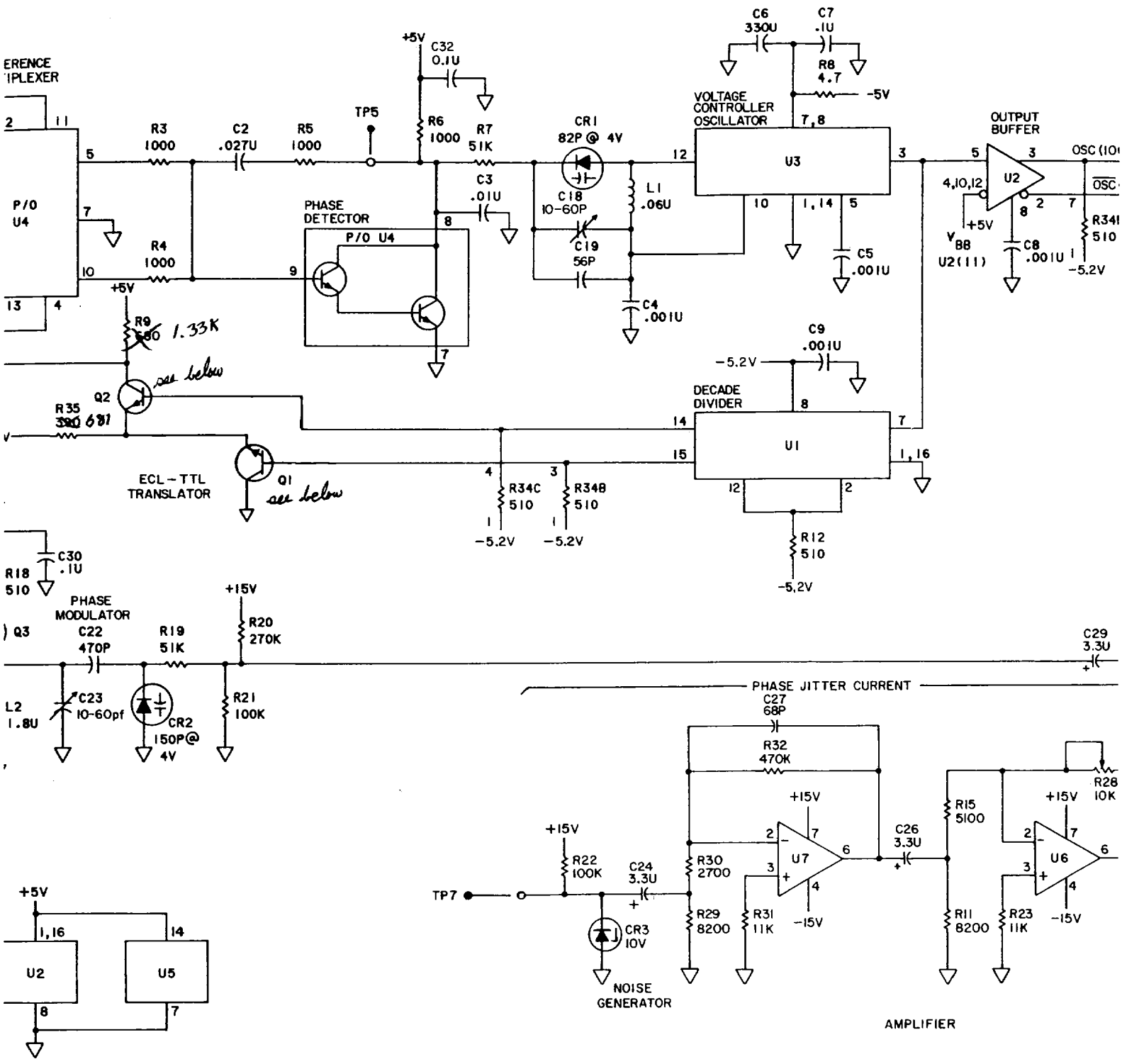
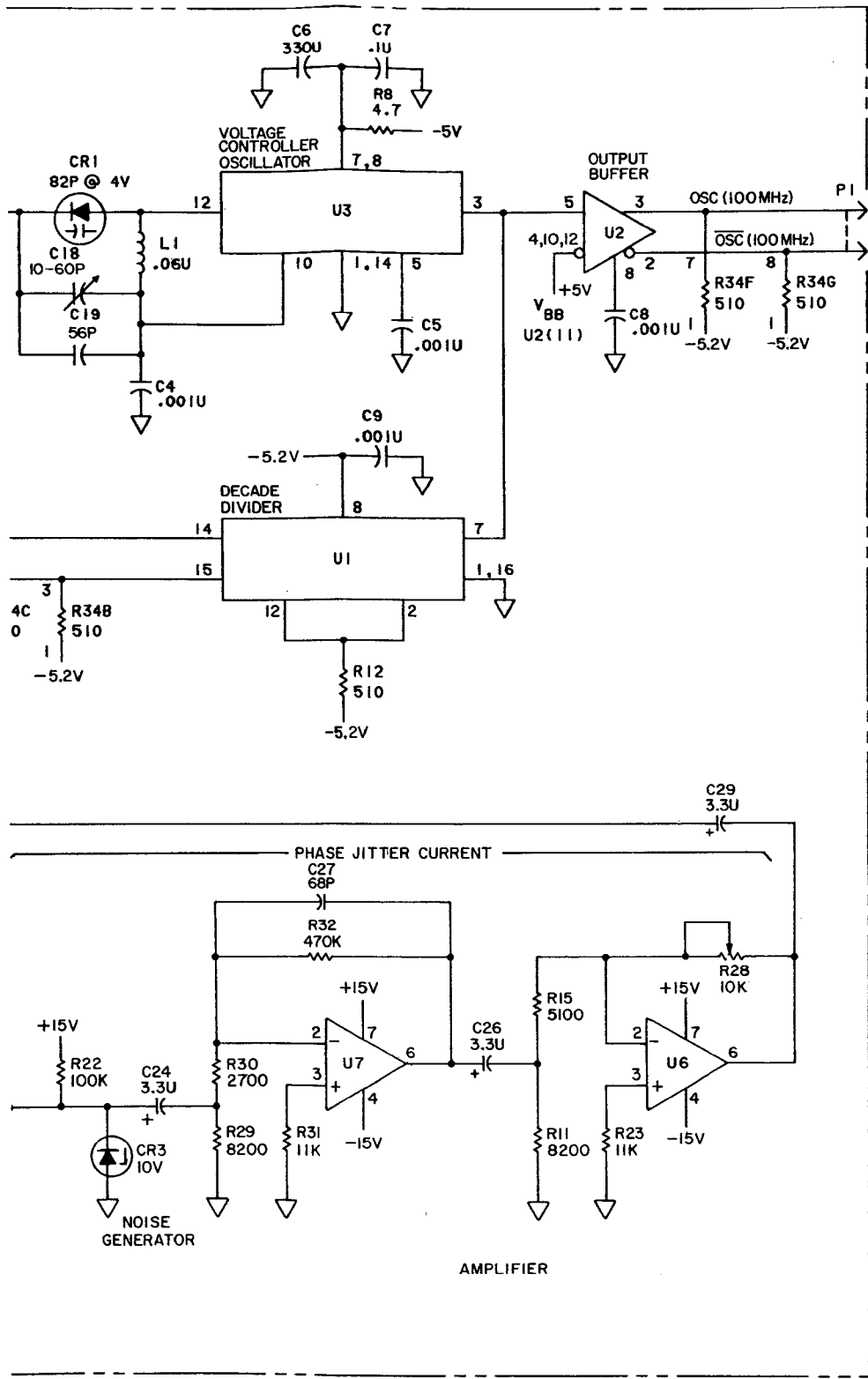


Figure 8-B



VIA  
BUS LINE

TO  
A10(I1)  
TO  
A10(I0)

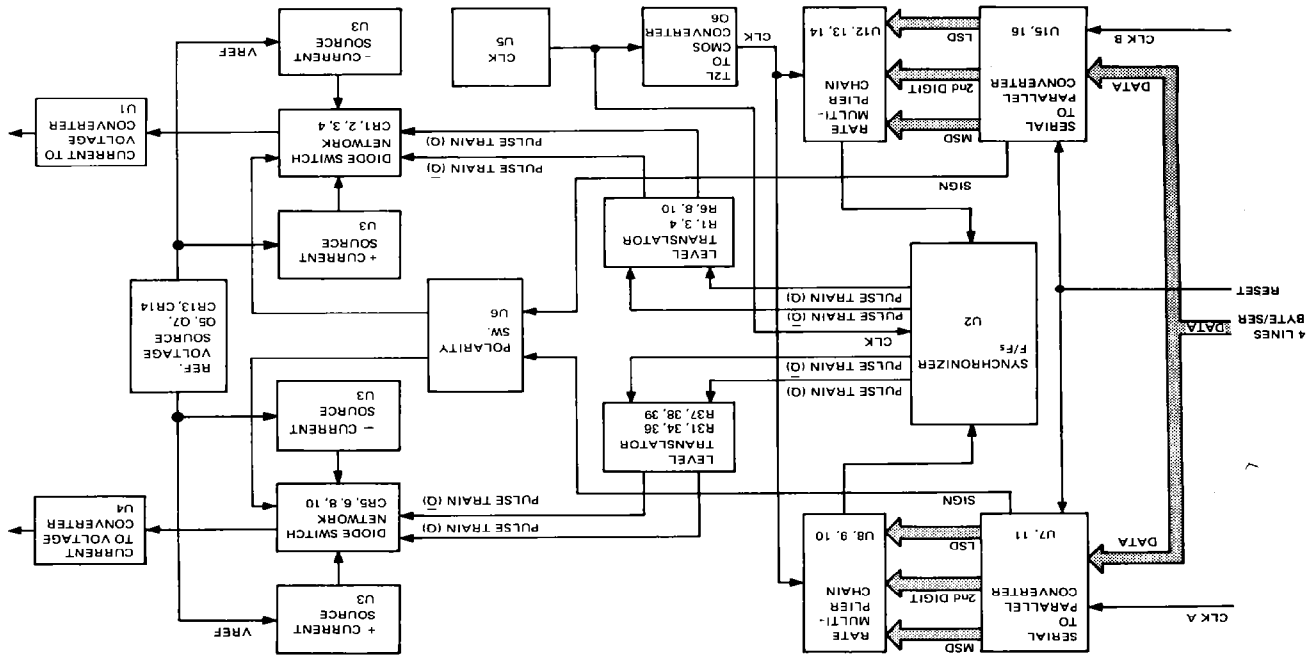
NOTES

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 FARADS  
INDUCTANCE IN HENRIES
3. ASTERISK (\*) INDICATES SELECTED COMPONENT, AVERAGE VALUES SHOWN

REFERENCE DESIGNATIONS	
A14	
C1-C24	
C25 NOT ASSIGNED	
C26, C27	
C28 NOT ASSIGNED	
C29-C32	
CR1-CR3	
L1-L2	
Q1-Q4	
R1-R2 NOT ASSIGNED	
R3-R9-	
R10 NOT ASSIGNED	
R11-R23	
R24-R27 NOT ASSIGNED	
R28-R35	
U1-U7	

A14 ACTIVE ELEMENTS	
REFERENCE DESIGNATIONS	PART NUMBERS
CR1	0122-0299
CR2	0122-0015
CR3	1902-1293
Q1, Q2	1854-0092 2N3563
Q3	1853-0016 2N3638
Q4	1854-0071
U1	1820-1383 MC10138L
U2	1820-0810 MC10116P
U3	1820-1119 MC1648L
U4	1820-0630 MC4044P
U5	1820-0054 SN7400N
U6, U7	1820-0493 LM307N

Figure 8-BA-10. A14 Multiplier Assembly Schematic Diagram

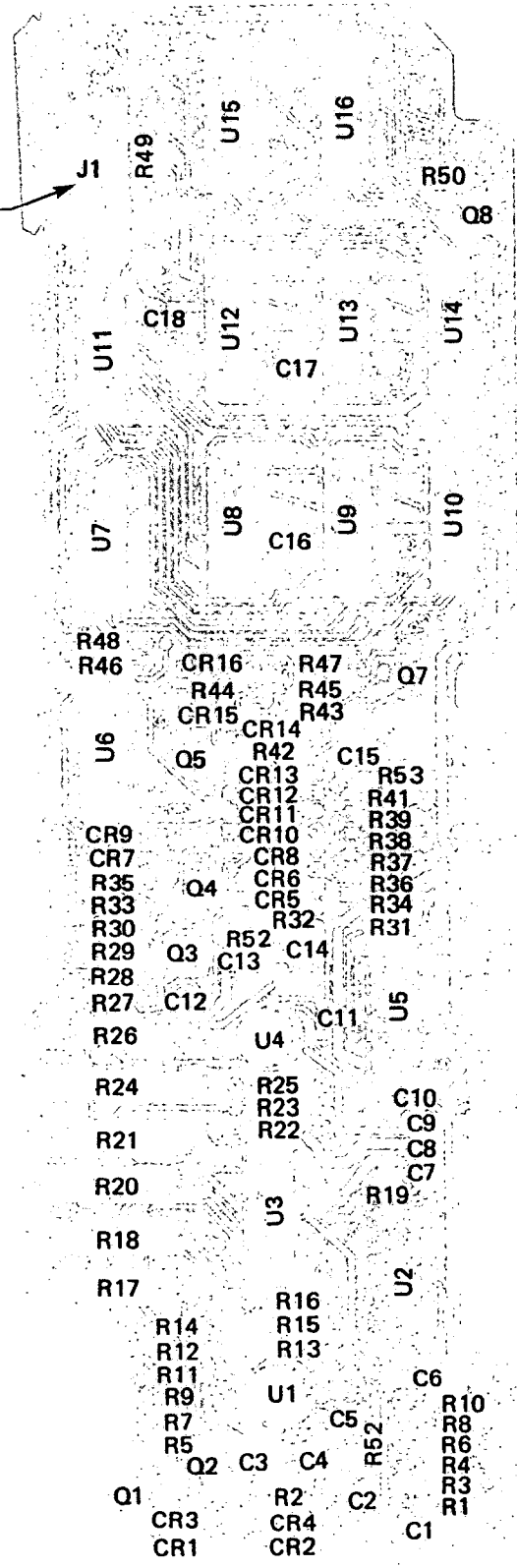


P/O Figure 8-BA-11. A14 DAC (Digital-to-Analog Converter) Assembly

Figure 8-BA-10  
A14 MULTIPLIER ASSEMBLY (SCHEMATIC DIAGRAM)

(See Page 8-101)

A11J1 CONNECTED  
TO A10J1 VIA  
RIBBON CABLE W5.



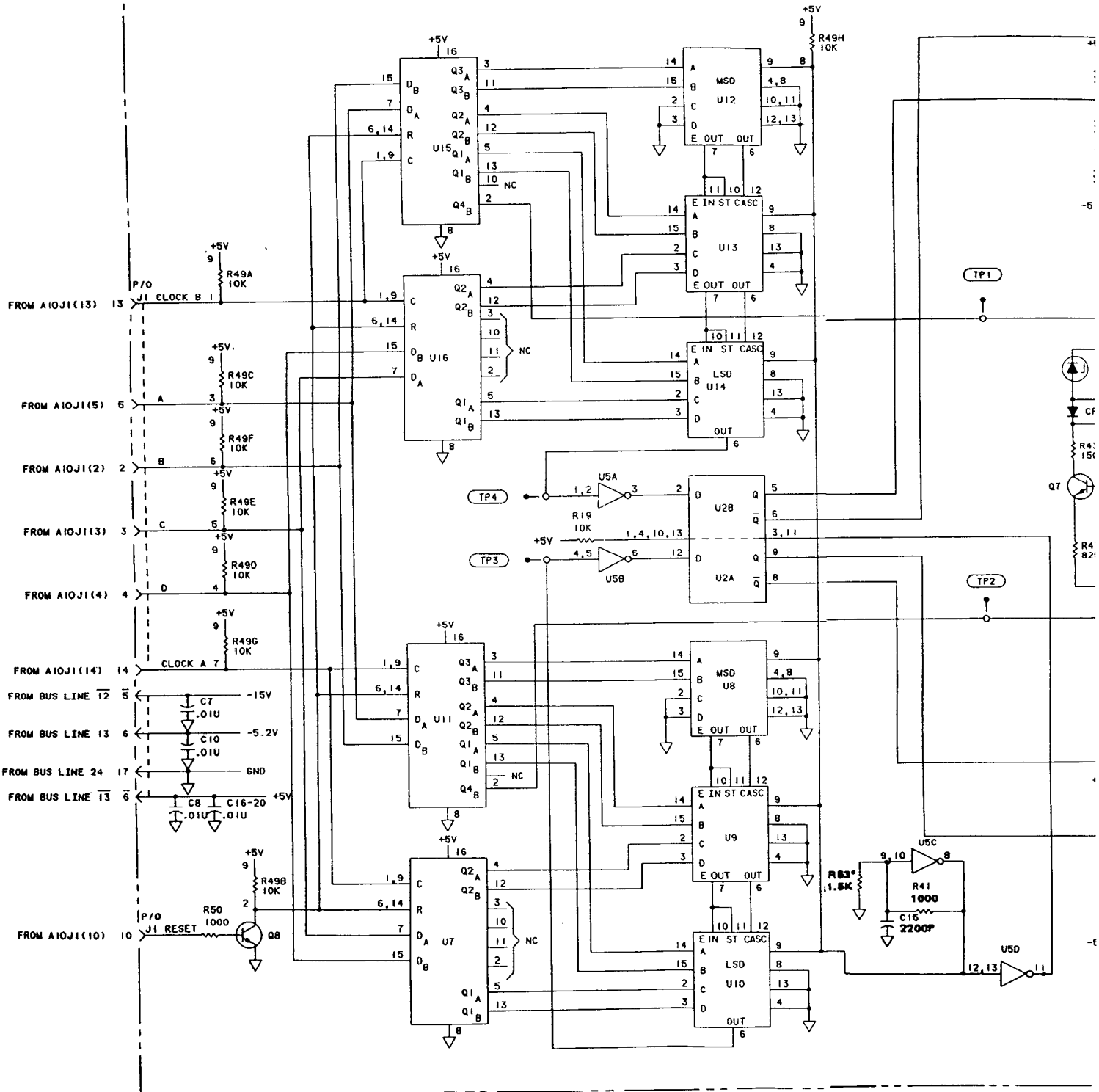
18 | 18

COMPONENT SIDE  
SOLDER SIDE

1 | 1



A11 DAC ASSEMBLY (06328-60023) SERIES 2402



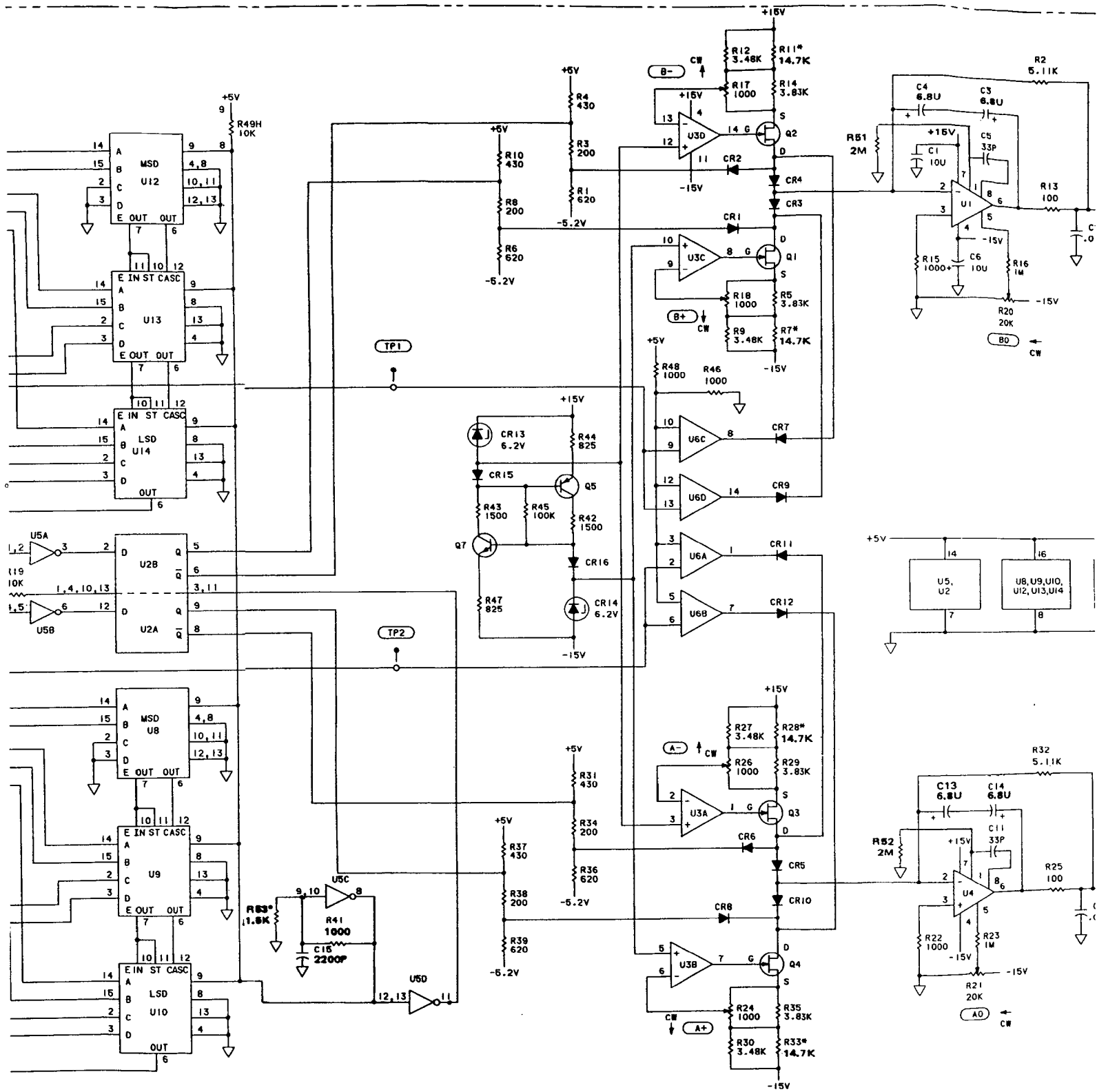
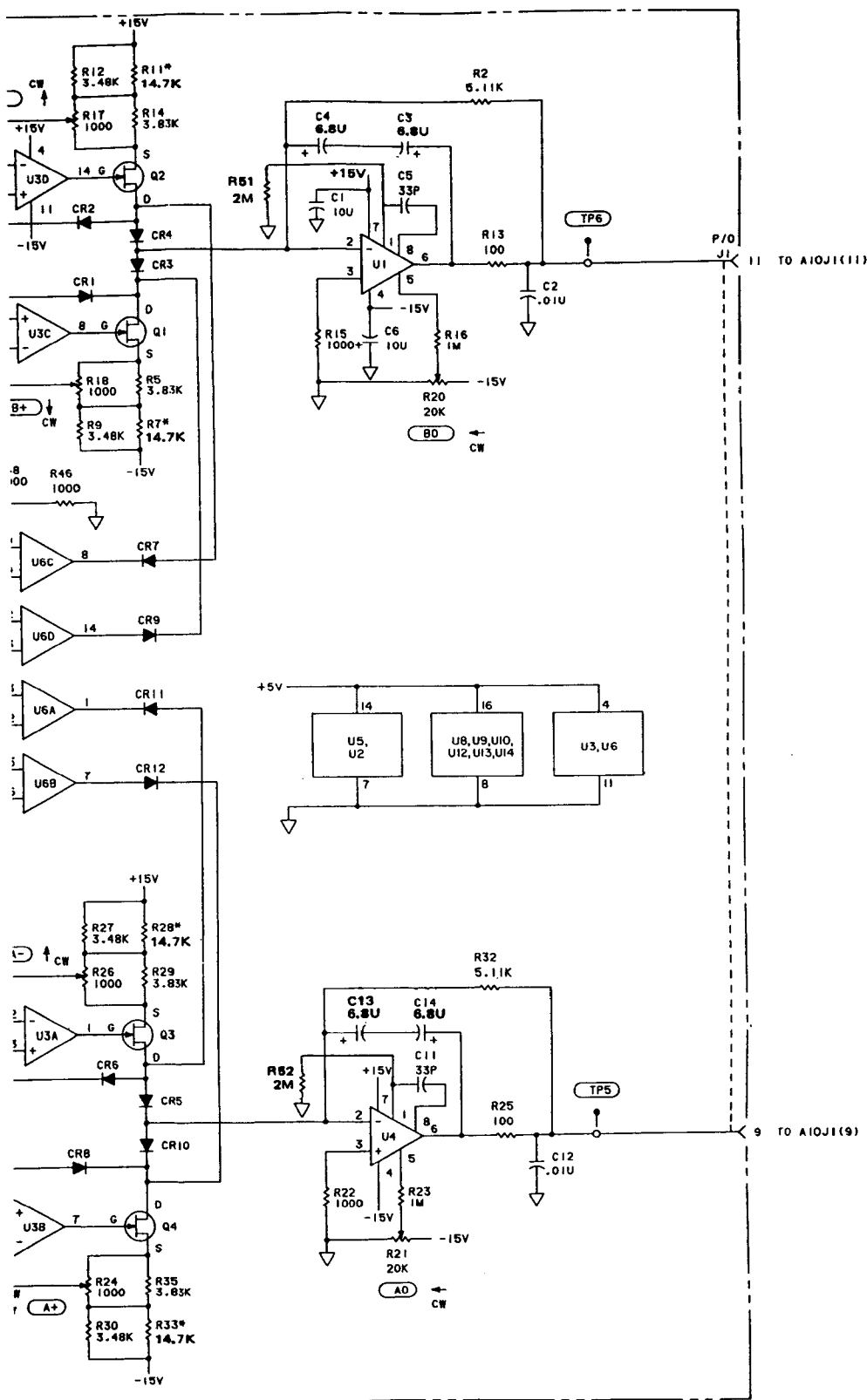


Figure 8-BA-11.



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 FARADS; INDUCTANCE IN HENRIES
3. ASTERISK (\*) INDICATES SELECTED VALUE, AVERAGE VALUE SHOWN

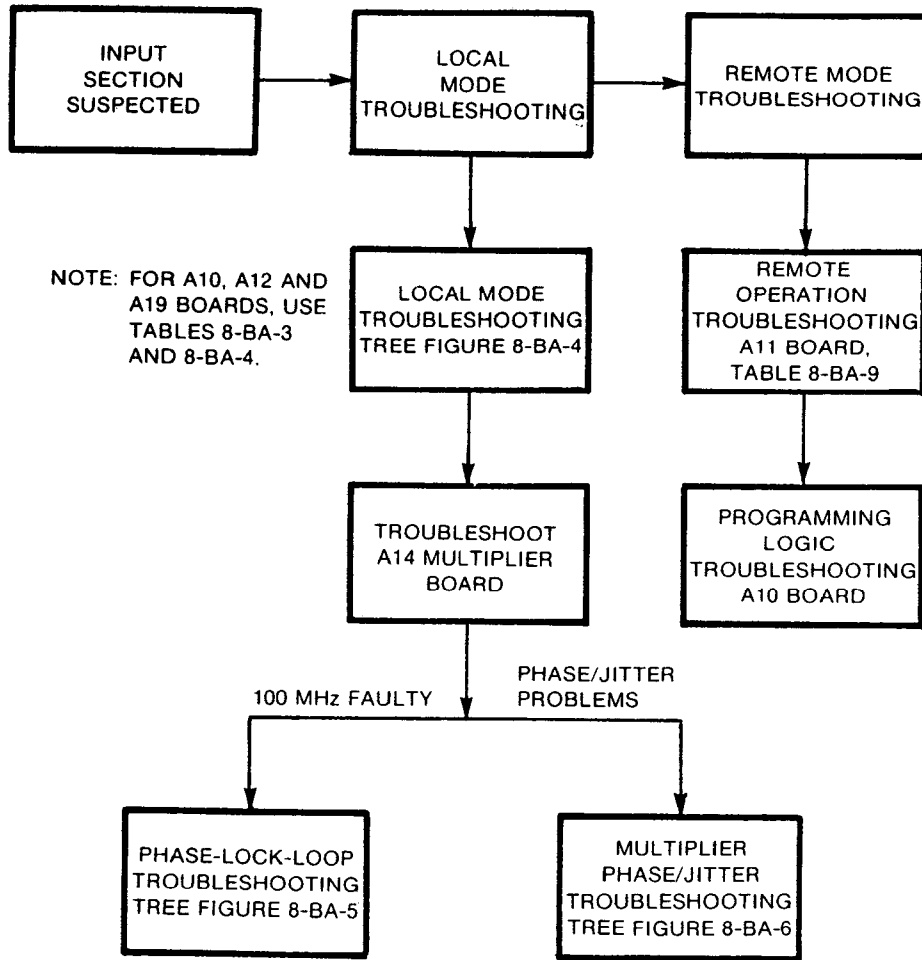
A11 REFERENCE DESIGNATIONS	
C1-C20	
CR1-CR16	
J1	
Q1-Q8	
R1-R50	
TP1-TP6	
U1-U16	

ALL ACTIVE ELEMENTS	
CR1, CR2, CR3 CR4, CR5, CR6 CR7, CR8, CR9 CR10, CR11, CR12	1901-0179
CR13, CR14	1902-0680
CR15, CR16	1901-0040
Q1, Q4	1855-0081 2N5245
Q2, Q3	1855-0416
Q7, Q8	1854-0071 2N3391
U1, U4	1826-0059 LM201A
U2	1820-0693 SN74574N
U3, U6	1826-0161 LM324
U5	1820-3475 SN74LS132
U7, U11, U15 U16	1820-0976 CD4015AE
U8, U9, U10 U12, U13, U14	1820-1265 MC1462TCP

Figure 8-BA-11. A11 DAC (Digital-to-Analog Converter) Assembly Schematic Diagram

*Figure 8-BA-11*  
**A11 DAC (DIGITAL-TO-ANALOG CONVERTER)  
ASSEMBLY (SCHEMATIC DIAGRAM)**

(See Page 8-103)



NOTE: FOR A10, A12 AND A19 BOARDS, USE TABLES 8-BA-3 AND 8-BA-4.

NOTE: EVEN IF THE PROBLEM IS IN THE REMOTE MODE, A QUICK CHECK OF THE LOCAL MODE IS RECOMMENDED BEFORE STARTING REMOTE MODE TROUBLESHOOTING.

Figure 8-BA-12. Input Section Troubleshooting

## 8-BB-1. DIGITAL VOLTMETER (OPTION 020 OR PART OF OPTION 050)

The (optional) Digital Voltmeter (DVM) Option Module allows the counter to be used to measure dc voltages. It provides a high-performance unit that has:

- 10  $\mu\text{V}$  sensitivity
- automatic or manual range control to 1000V
- 10-Megohm floating inputs
- switchable filter
- 0.03% accuracy
- capability to read triggering levels of Channel "A" and "B" inputs
- variable integration time
- high-speed acquisition (up to 300 readings per second with two-digit resolution).

The Model 5328B's (optional) Digital Voltmeter (DVM) Module uses the voltage-to-frequency conversion technique to provide an output suited to the units basic frequency measuring capabilities.

The DVM includes front-panel switches that allow it to be used to measure the triggering level of Channel "A" or Channel "B"; when either of these measurements is selected:

- the DVM's input circuitry is disconnected from its external-input banana-plug connectors, and is connected to the selected trigger-level voltage,
- the Model 5328B's front-panel FUNCTION and TIME BASE switches are disengaged
- the code "DVM" is placed on the Function Code Bus
- a 0.1 s gate time (1 mV sensitivity) is placed on the Time Base Bus

When the "READ" switch is released (i.e., in its "out" position), the Model 5328B returns to its previous state. This allows you to check trigger levels without having to change (and later change back) the FUNCTION and TIME BASE settings.

The Model 5328B's DVM provides the capability of automatic or manual selection of the DVM's range (10  $\mu\text{V}$  to 1000 V, with a basic accuracy of 0.03%). For particularly noisy environments, a switchable filter can be engaged to increase normal mode rejection to 50 dB at 50 or 60 Hz. Isolation for the DVM is accomplished through special high-speed transformers, optical isolators, and a switching dc-to-ac power supply that is part of the DVM's circuitry.

Although remote programming of the DVM's front-panel controls is not possible, remotely controlled voltage measurements can easily be done. Through the use of special range controls in the voltage-to-frequency converter, a conversion factor of 10 kHz-per-volt is maintained, regardless of the DVM's range. If the DVM has been (manually) placed in its Autorange mode, you only need to select the Model 5328B's "DVM" FUNCTION via the HP-IB to allow the DVM to measure any voltage from 10  $\mu\text{V}$  to 1000V.

The voltage-to-frequency conversion technique does result in a small problem. Suppose, for example, the voltage at the DVM's input terminals is 900V. At DVM's 10 kHz-per-volt conversion ratio, its output frequency is  $900 \times 10$  kHz, or 9 MHz. In a measurement time of one second (1s), this would provide a resolution of one part in  $9 \times 10^6$ , which is far beyond the resolution limit of the voltage-to-frequency converter. In order to prevent mis-interpretation of DVM measurement results, the DVM blanks the meaningless data, thus providing a display that contains only accurate data.

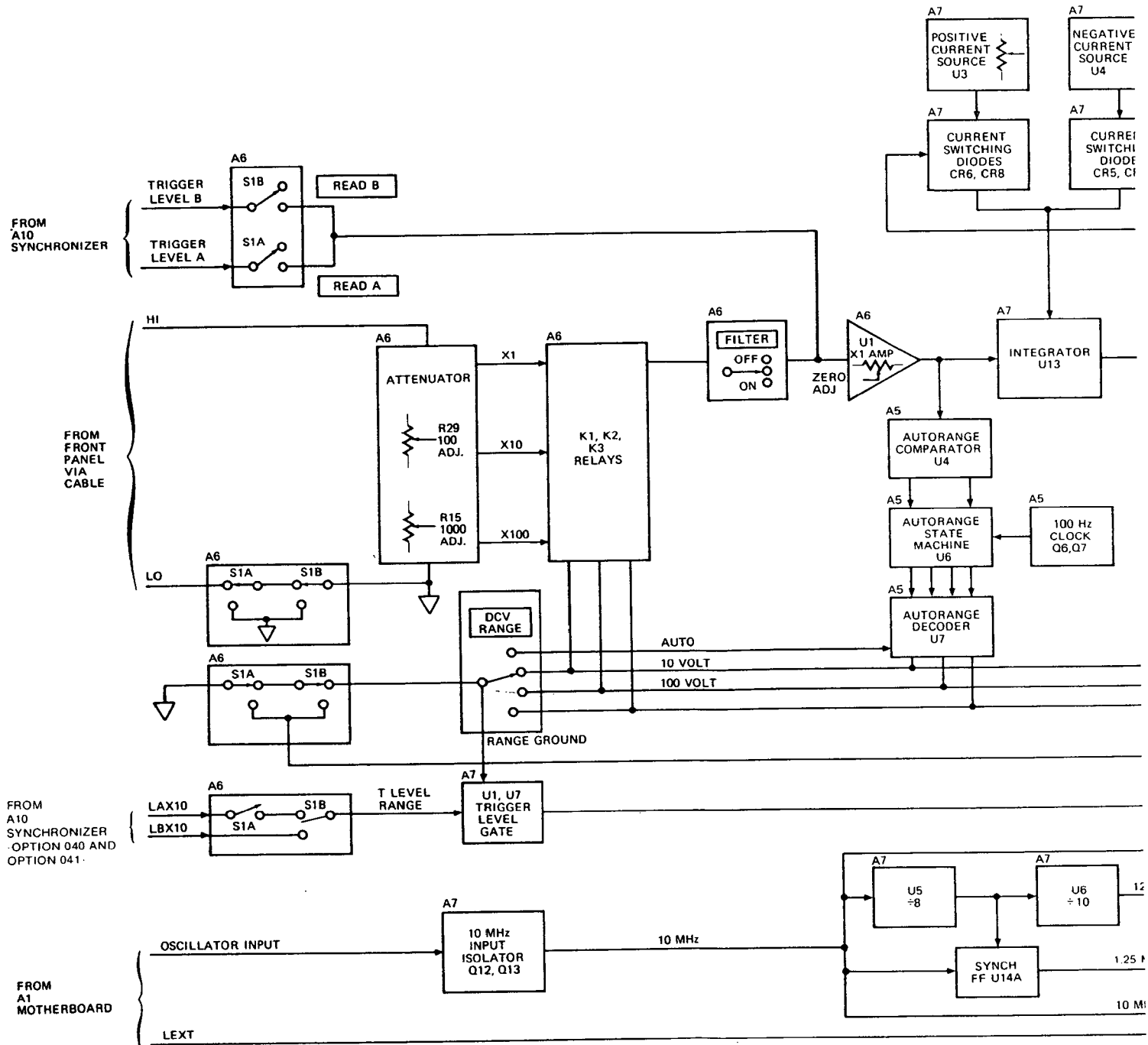
#### **8-BB-2. Principles of Operation**

The voltage at the Digital Voltmeter Module's "HI" and "LO" inputs is fed to the A6 Buffer Amplifier board through the attenuator. The attenuator's value is selected by relay K1, K2, or K3, to send the proper signal level to Buffer A6U1. The trigger level voltages from the Synchronizer (A10) enter buffer A6U1 through the "READ A" (S1A) or "READ B" (S1B) switch. When a trigger level measurement is being made, the floating ground is connected to the counter's chassis, and all of the attenuator relays are de-energized. A "zero" adjustment is connected to buffer amplifier A6U1 to provide an adjustment for 0V out when the input is zero volts.

The VF ("V-to-F" or "voltage-to-frequency") Converter Board (A7) receives the output of the Buffer Amplifier (A6) and generates a train of pulses whose frequency is proportional to the voltage at its input. The polarity of the voltage is detected by a polarity detector. Output frequency gating is provided, to change the output frequency as a function of range. An input isolator circuit and an output isolator circuit are used to couple signals between chassis ground and floating ground.

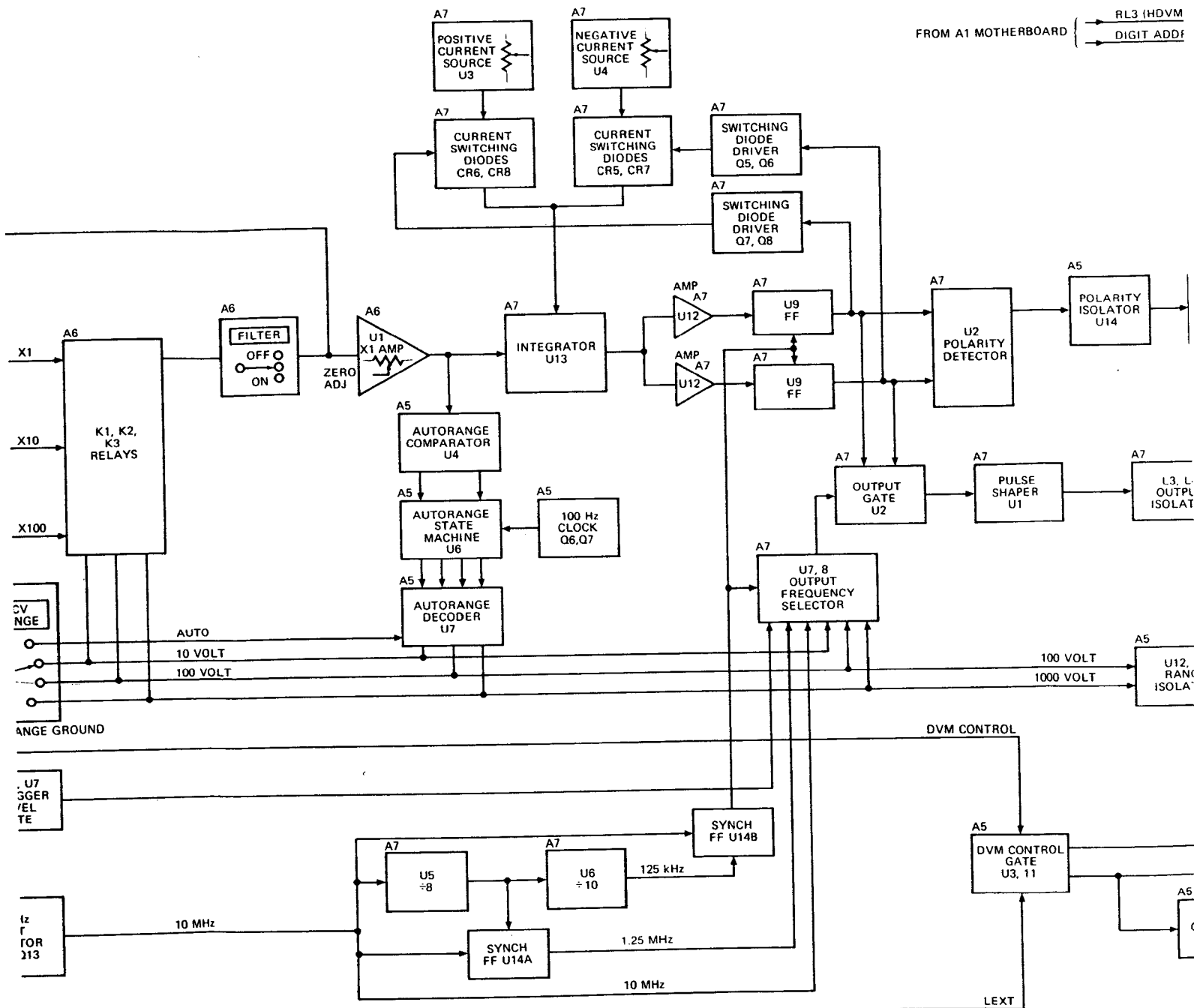
The Power Supply portion of the Auto Range Board (A5) receives +15V dc via the bus, and switches (alternates) it through a transformer. The transformer's outputs are rectified to supply all power for the "floating" portion of the DVM. The autoranging portion of the board contains four comparators (A5U4) that receive the output of Buffer Amplifier A6U1 and determine whether the DVM should range up, range down, or remain as is. The present DVM range is stored in a state machine which is decoded into one of three states. The clock for the state machine is supplied by a unijunction transistor oscillator that produces  $100 \mu\text{s}$  positive pulses at a 100 Hz rate. The remaining logic circuits on the A5 provide digit blanking and negative-sign information to the proper digits of the display.

NOTE: REFER TO TABLE 6-1 IN 5328A SERVICE MANUAL FOR DESCRIPTIONS OF SIGNAL MNEMONICS.





FROM BUS → +15 VOLTS



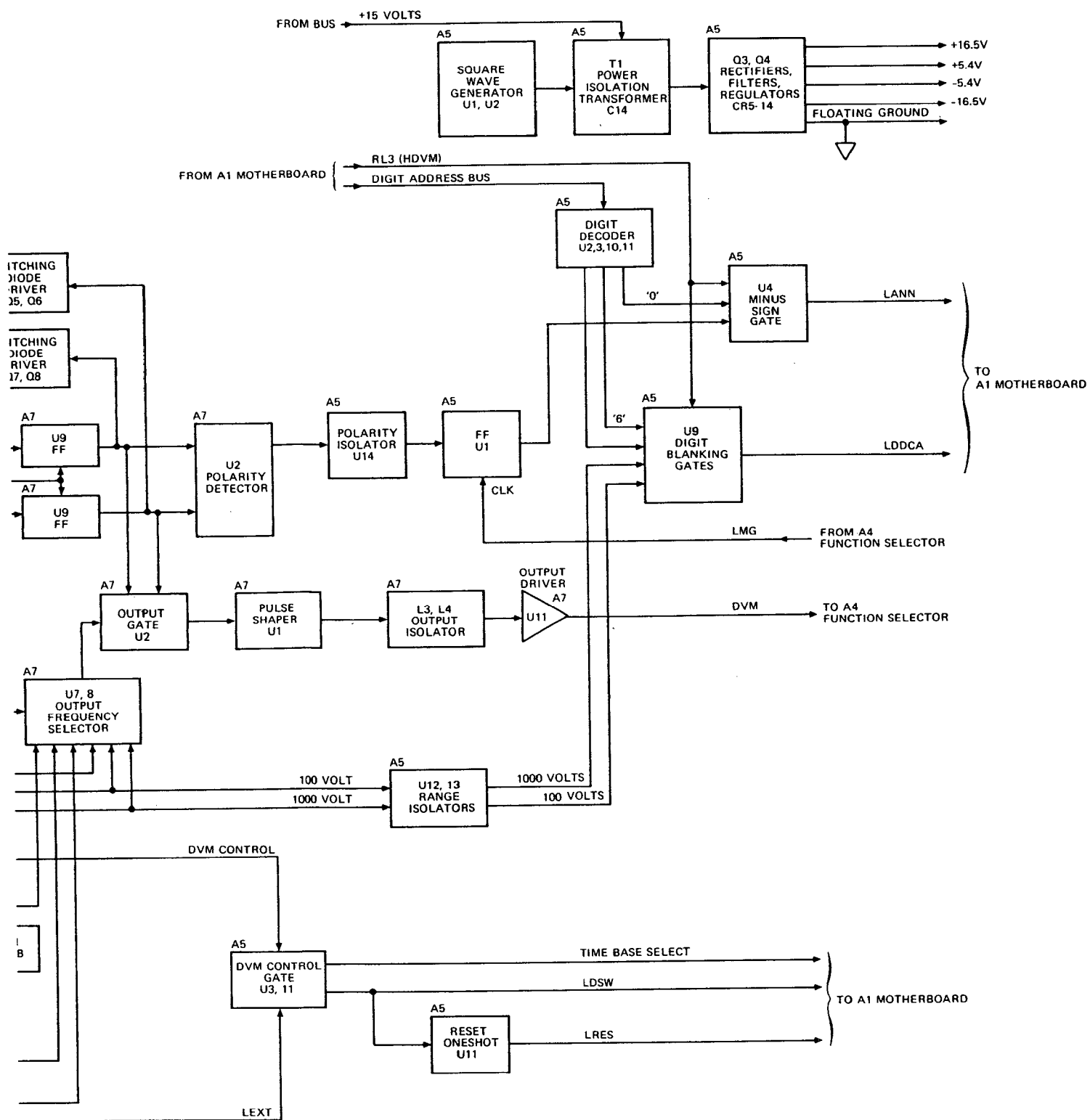


Figure 8-BB-1. Digital Voltmeter Module Block Diagram

*Figure 8-BB-1*  
**DIGITAL VOLTMETER MODULE BLOCK DIAGRAM**

(See Page 8-107)

### 8-BB-3. BUFFER AMPLIFIER BOARD — A6

The dc voltage to be measured is received from the DVM's two front-panel floating-inputs via cables W1 and W2. The input attenuator conditions the dc voltage to allow a proper level to be fed through one of three relays (K1, K2, K3) to the Buffer Amplifier (U1). The Buffer Amplifier converts the high-impedance dc level at its input to a low-impedance dc level at its output. Variable resistor R28, accessible through the front panel, allows the output to be set to "zero" for a 0V input. Switchable capacitor C1 is a low-pass filter. Diodes CR1 and CR2 protect the amplifier from over-voltage.

The READ A and READ B switches (S1A,B):

- convert the DVM's "LO" terminal to chassis ground,
- allow "RANGE GROUND" to go "high",

This de-energizes all attenuator relays.

- ground "DVM CONTROL",

This resets the counter and selects the time base code and FUNCTION code.

- select the proper range information from the Programmable Input Module,
- apply the trigger level voltage to the Buffer Amplifier's input.

### 8-BB-4. VF CONVERTER — A7

The output of the Buffer Amplifier (A6) is applied to integrator U13. The integrator slews (ramps) in the positive direction when the input is negative, and in the negative direction when the input is positive. Circuit U12 and its associated components make up two voltage comparators. When the voltage input to the integrator is positive, U12(4) goes to an ECL "low"; when the input is negative, U12(3) will go to an ECL "high". These levels are clocked into ECL "D"-type flip-flop U9. The clock is derived from a 10 MHz clock, which is divided by eight and then by ten to obtain the 125 kHz clock.

When flip-flop U9 changes state, its output is sent to one of two differential pairs of transistors — Q5 and Q6 for a negative input voltage, or Q7 and Q8 for a positive input voltage. The transistors activate and deactivate their respective switching diodes (CR7 and CR8). The polarity of the current is such that it tends to drive the output of the integrator in the opposite direction. The RS flip-flop (U2C and D) detects the polarity of the input voltage. Pulses are gated out through U2A,B during the time the current sources are "on".

The pulse rate at U2(1) is chosen by the range information; this rate is 125 kHz for the 10V range, 1.25 MHz for the 100V range, and 10 MHz for the 1000V range. When no range information is selected, as when trigger level measurements are made, the Trigger Level Range information is selected and it controls the gated output frequency.

### 8-BB-5. PS AUTORANGE BOARD — A5

Power for all floating circuitry in the DVM comes from the dc-to-dc converter on this board.

Multivibrator U2D clocks flip-flop U1B. The symmetrical output drives switching transistors Q1 and Q2 which are powered from the +15V line. Four output voltages are available at the secondary terminals of T1. Voltages supplied are rectified, filtered, and regulated +16.5V, -16.5V, +5.4V, and -1.4V.

The autorange portion of this board applies the output from the Buffer Amplifier (A6) to four comparators (U4). From the comparator's output, the "range up" and "range down" signals are generated. This range information goes to a clocked state machine (U6). The decoded "state" information energizes the proper relay on the Buffer Amplifier (A6) and selects the proper output frequency for the VF Converter (A7) when the "AUTO" RANGE is selected. Manual range selection (10V, 100V, or 1000V RANGE setting) disables the state decoder and pulls the appropriate "enable" line "low".

In order to blank non-significant digit(s) when in the 100V or 1000V range, the "range" information is passed through optically-coupled isolators U12 and U13 to chassis common. This information disables the DCA output when the digit address is "7" on the 100V range and when the digit address is "6" or "7" on the 1000V range.

Polarity information passes through a similar isolator (U14), and is then latched into a flip-flop to enable the minus sign when digit "0" is decoded.

When trigger levels are measured, the front-panel switches must be disabled and the proper time base and FUNCTION codes must be set. Also, a reset pulse must be applied when going into or out of a trigger level measurement. These signals are generated by the DVM Control line through U3A and U11. The "LEXT" line disables this function when the counter is in "external" mode.

**8-BB-6. MAINTENANCE**

When handling the Option 021 circuit boards, hold by the edges only. Do not touch the edge connectors. High impedance circuitry on the boards could develop leakage paths caused by contamination from finger prints.

**8-BB-7. IN-CABINET PERFORMANCE CHECK**

The Performance Check and Operational Verification procedures for the Model 5328B are given in Section 4 of this manual.

**8-BB-8. EXTENDER BOARD(S)**

The Digital Voltmeter Extender Board kit (HP Part Number 05328-82020) consists of the three boards listed in Table 8-BB-1. It allows circuit board assemblies to be extended from their plug-in connectors to allow signals to be monitored with the appropriate test equipment.

*Table 8-BB-1. DVM Extender Board Kit (HP Part Number 05328-82020)*

HP Part Number	Description	Use
05328-62020	One 15-pin connector and one 18-pin connector.	Extends A5
05328-62021	One 15-pin connector	Extends A6 or 7. NOTE: A5 must be placed on its extender before A6 can be extended, due to space requirements.
05328-62022	Simulates Digital Voltmeter front panel for front of A5 and A6. connectors of A5 and A6.	Cable connects this assembly to front

**WARNING**

**THE AC LINE (MAINS) (110V/120V/220V/240V) WIRES ARE EXPOSED WHEN EITHER THE TOP OR BOTTOM IS REMOVED. USE EXTREME CAUTION DURING TROUBLESHOOTING, ADJUSTMENT, OR REPAIR.**

**REDUCE THE CHANCE OF PERSONAL INJURY OR DAMAGE TO THE COUNTER BY ALWAYS DISCONNECTING THE AC POWER CORD BEFORE YOU REMOVE OR REPLACE THE COUNTER'S COVERS OR ANY ASSEMBLY OR COMPONENT WITHIN THE COUNTER.**

**8-BB-9. REMOVAL AND REPLACEMENT INSTRUCTIONS**

Removal and replacement instructions are provided for the counter's cover and the Digital Voltmeter Module (assemblies A5, A6, and A7).

**8-BB-10. Instrument Cover Removal**

To remove the Model 5328B's top or bottom cover:

- a. Disconnect the power cord from the rear of the instrument.
- b. Remove the screw at the rear of the cover that secures the cover to the counter's frame.
- c. Slide the cover toward the rear of the counter and lift it off.

To replace the Model 5328B's top or bottom cover, reverse the procedure above.

**8-BB-11. Digital Voltmeter Installation**

- a. Remove the cover as described above.
- b. Remove the plastic filler strip on the top of the front frame.
- c. Remove the 4 screws at the top and the 4 screws at the bottom of the front frame that secures the front panel section. Use a #2 posi-drive screw driver. Remove the front panel by gently pressing the front panel from the rear.
- d. Remove the Channel A and B trigger level adjust knobs and the C Channel attenuator control knob (if the C Channel is present). Use a .050 inch allen wrench. If the Option 021 is being retrofitted, remove the hex nuts from the A and B channel input controls and the Marker Output connectors so the new front panel can be installed. Use a 9/16 inch wrench or nut driver.
- e. Disconnect the coax cable from the rear of the C Channel input connector (if present). The cable connector fits a 1/4 inch wrench. Disconnect the 3 "Probe Power" wires from the A8 board with needle nose pliers.
- f. If the Option 021 is being retro-fitted, remove the hex nuts securing the C Channel input and "Probe Power" connectors to the front panel. Use 5/8 inch and 1/2 inch wrenches respectively.
- g. Install the banana plug connectors, C Channel BNC input and "Probe Power" connectors (if present) into the new front panel. Tighten the banana plug connector nuts with a 1/2 inch wrench.
- h. Install the A6 Buffer Amp board from the top of the 5328B. Insert the A6 board into the motherboard connector XA6.

- i. Route the red wire on the left side of the A6 board (as viewed from the front of the counter). Connect to the rear of the left banana plug connector labeled "HI" on the front panel. Tighten with an 8 mm wrench. (A 5/16 inch wrench, though over-size, functions satisfactorily in this low torque situation without damaging the nut.)
- j. Run the black wire on the side of the A6 board and to the banana plug connector labeled "LO". Tighten as with the red wire.
- k. From the top of the 5328B, insert the A7 VF converter board into connector XA7. Insert the A5 PS Autorange board into connector XA5.

#### NOTE

In the following steps, observe the connectors from the top (inside the front panel) to facilitate connection.

- l. From the front panel of the 5328B, carefully insert the A17 Front Board so that the small connectors mate with the small pins that extend from the front of the A5 and A6 board.
- m. Connect the C Channel coax cable and "Probe Power" wires, if they were disconnected. Use a 1/4 inch wrench to gently tighten the coax connector. The color codes for the 3 wire connections are etched on the solder side of the 3 connector pins (top, blue; middle, red; bottom, black).
- n. Position all wires and cables for clearance and insert the front panel. Secure with 4 posidrive screws at the top and 4 at the bottom of the front frame.
- o. Perform the procedures listed in the In Cabinet Performance Check in section IV of this manual.

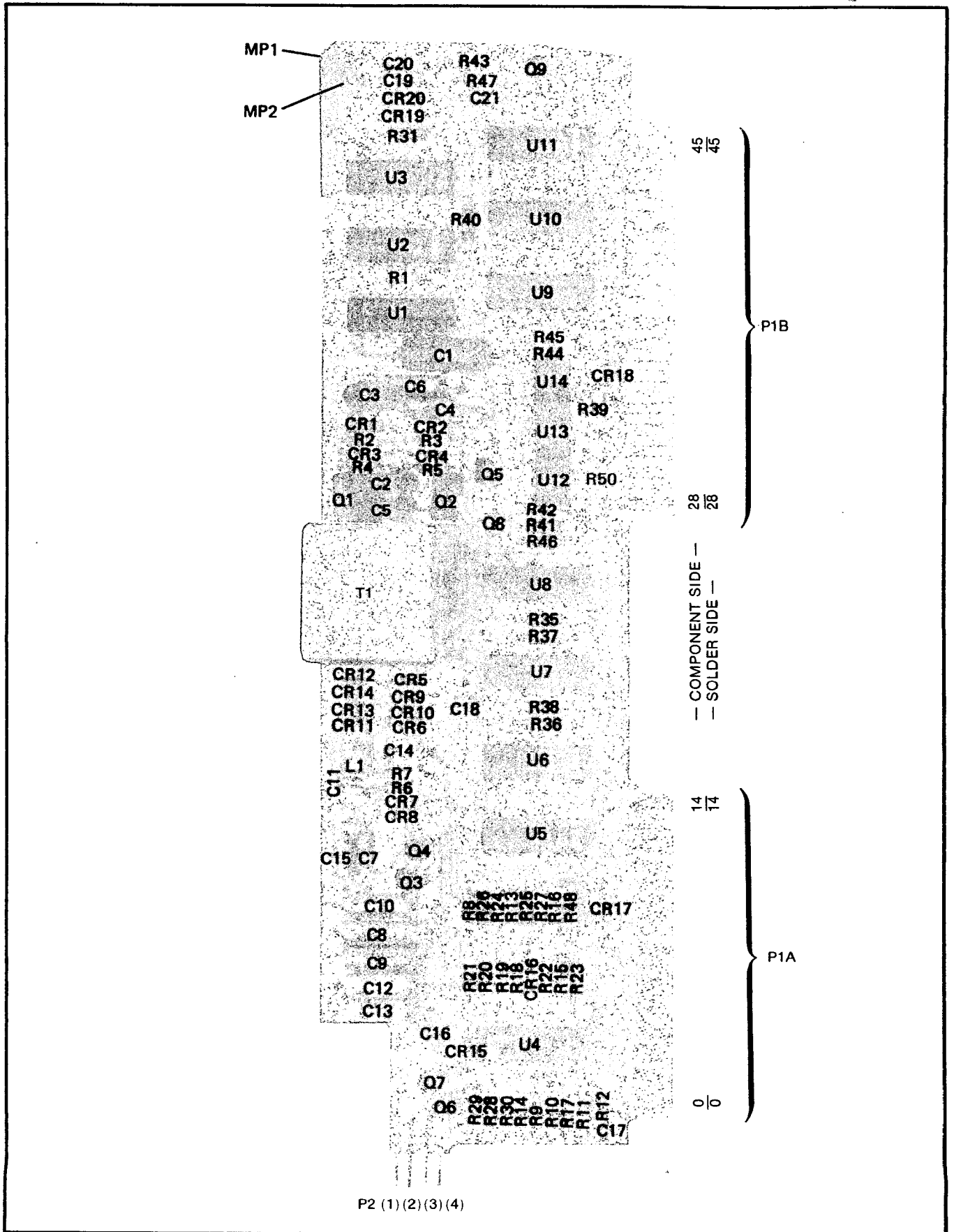
#### 8-BB-12. Digital Voltmeter Removal

To remove the Option 021 Digital Voltmeter, proceed as follows:

- a. Disconnect the power cable from the 5328B (A safety precaution)
- b. Remove the top cover from the 5328B (Use a #2 posidrive screwdriver.)
- c. Remove the plastic filler strip on the top of the front frame.
- d. Remove the 4 screws at the top and the 4 screws at the bottom of the front frame that secures the front panel section. Use a #2 posidrive screw driver. Remove the front panel by gently pressing on the panel from the rear.
- e. Disconnect the red wire and the black wire from the rear of the banana plug connectors. Loosen the nuts with an 8 mm wrench. (A 5/16 inch wrench, though over size, functions satisfactorily in this low torque situation without damaging the nut).
- f. Remove the A17 board by gently pressing forward on the rear of the board.
- g. Remove the A5 PS Autorange board.
- h. Remove the remaining A6 and A7 boards.

#### 8-BB-13. Digital Voltmeter (Option 021): Troubleshooting

Problems in this section are generally traceable through symptoms on the instrument display. A general troubleshooting flow chart, which branches to different boards in this section, is shown in Figure 8-BB-5.



P/O Figure 8-BB-2. A5 PS Autorange Assembly



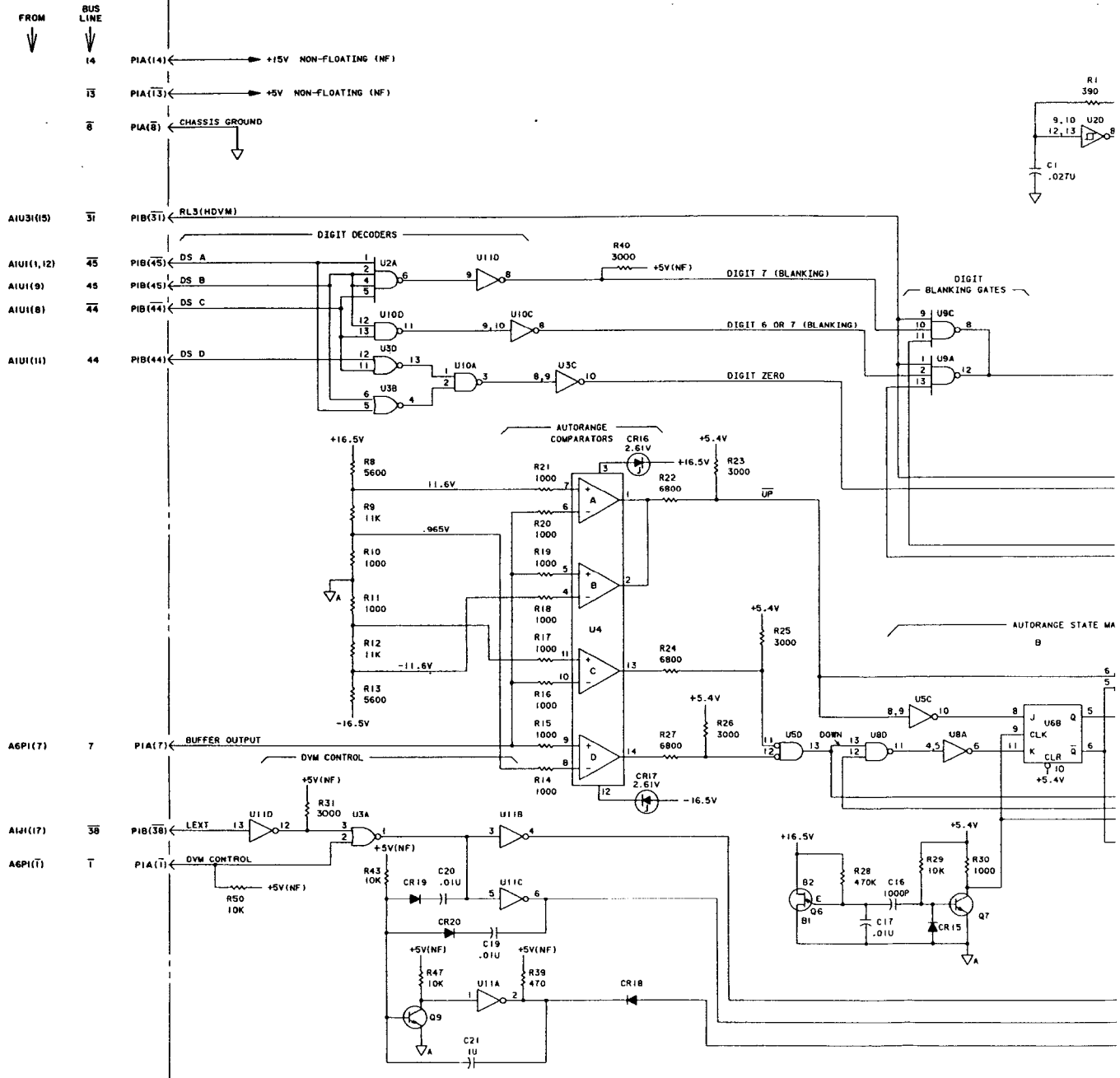
### CONNECTOR P1A

0		0	
1	Floating Ground	1	DVM Control
2	+5.4V (floating)	2	100V Enable
3	+16.5V (floating)	3	1000V Enable
4	NEGATIVE Sign	4	10V Enable
5		5	-16.5V (floating)
6		6	-5.4V (floating)
7	Buffer Output	7	
8		8	Chassis Ground
9	DVM OSC	9	
10		10	
11		11	
12		12	
13		13	+5V (Non-Floating)
14	+15V (Non-Floating)	14	
15		15	

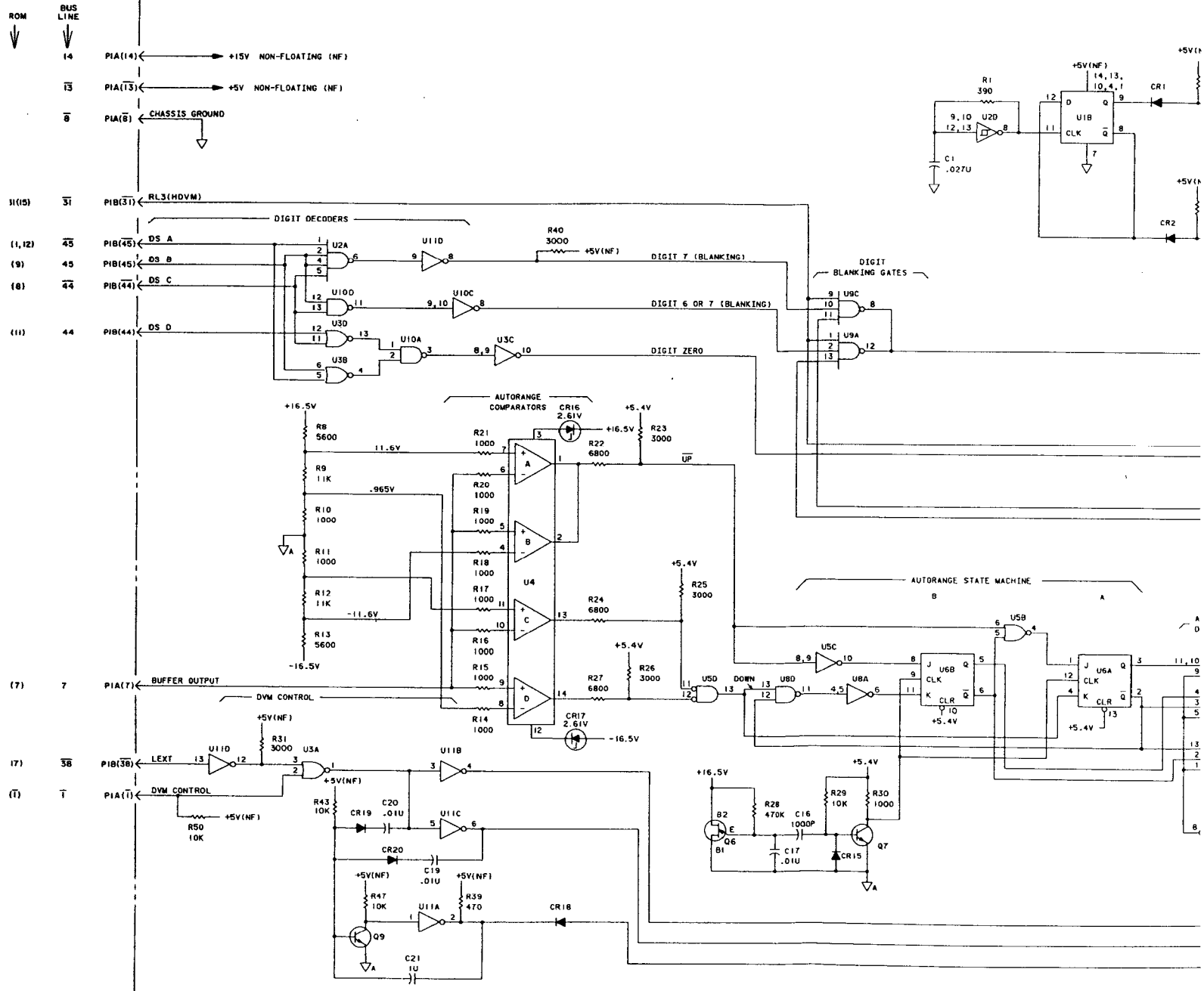
### CONNECTOR P1B

28		28	OSC
29		29	
30		30	
31		31	RL3(HDVM)
32		32	LRES
33		33	
34		34	
35	TBSB (TB code)	35	(TB code)
36		36	
37		37	
38	LMG	38	LEXT
39	LD SW	39	
40	LD DCA	40	
41		41	LANN
42		42	
43		43	
44	DS D	44	DS C
45	DS B	45	DS A

OPTION 021 A5 PS AUTO RANGE ASSEMBLY (05328-60012) SERIES 1624



OPTION Q21 A5 PS AUTO RANGE ASSEMBLY (05328-60012) SERIES 1624



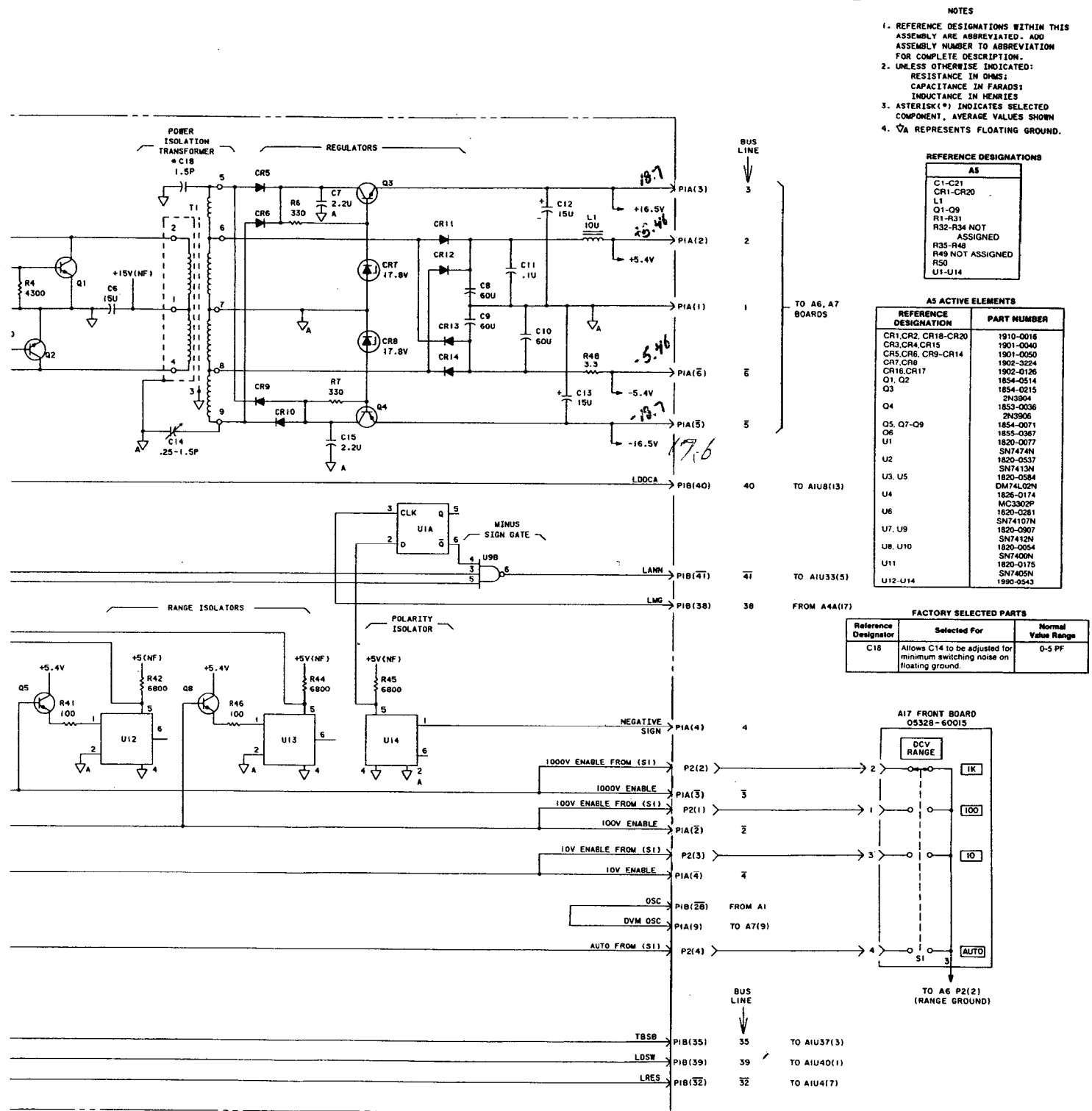
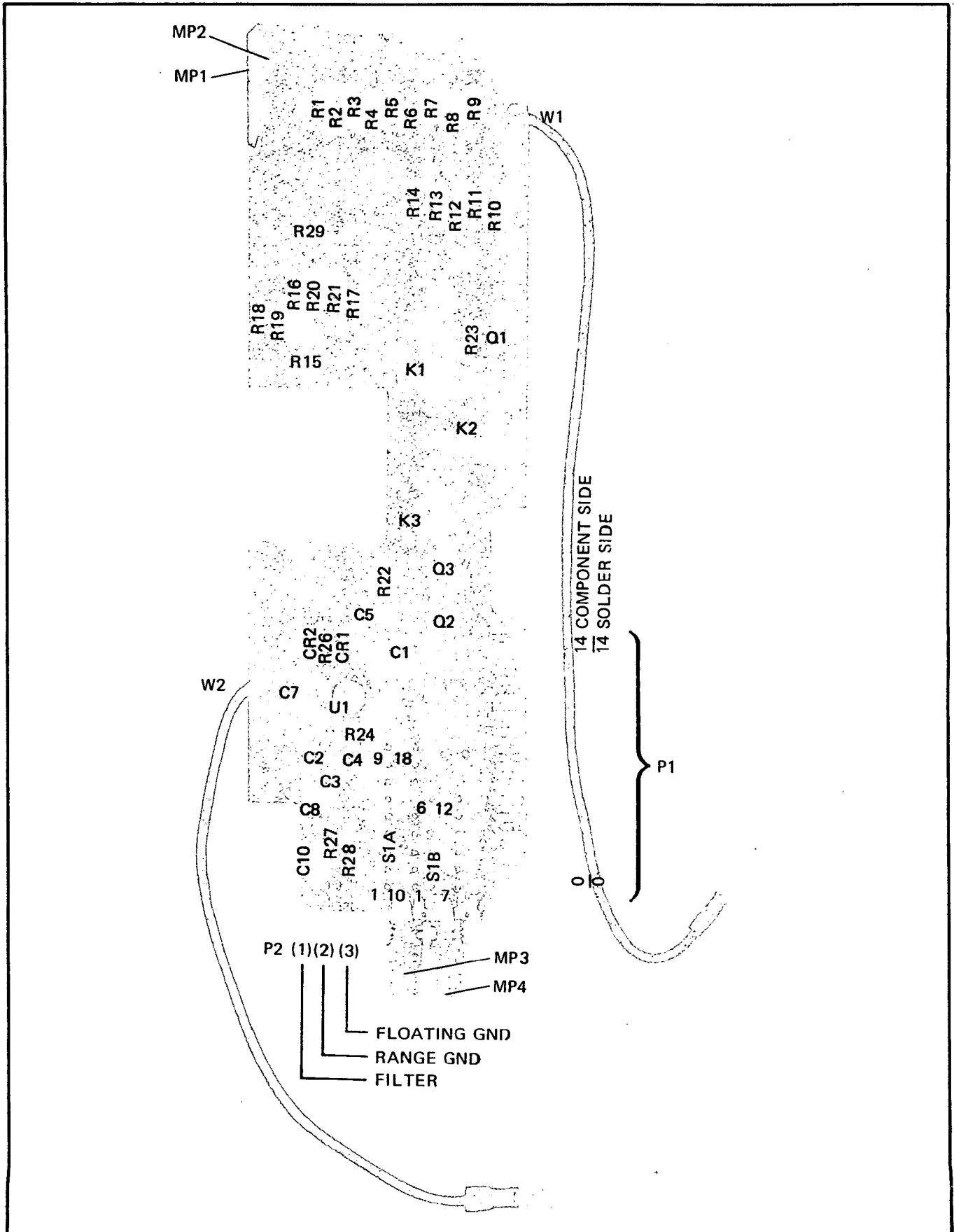


Figure 8-BB-2. A5 PS Autorange Assembly Schematic Diagram

*Figure 8-BB-2*  
**A5 PS AUTORANGE ASSEMBLY (SCHEMATIC DIAGRAM)**

(See Page 8-113)

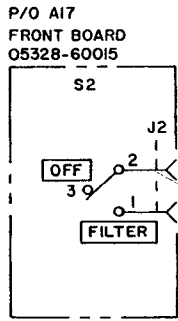
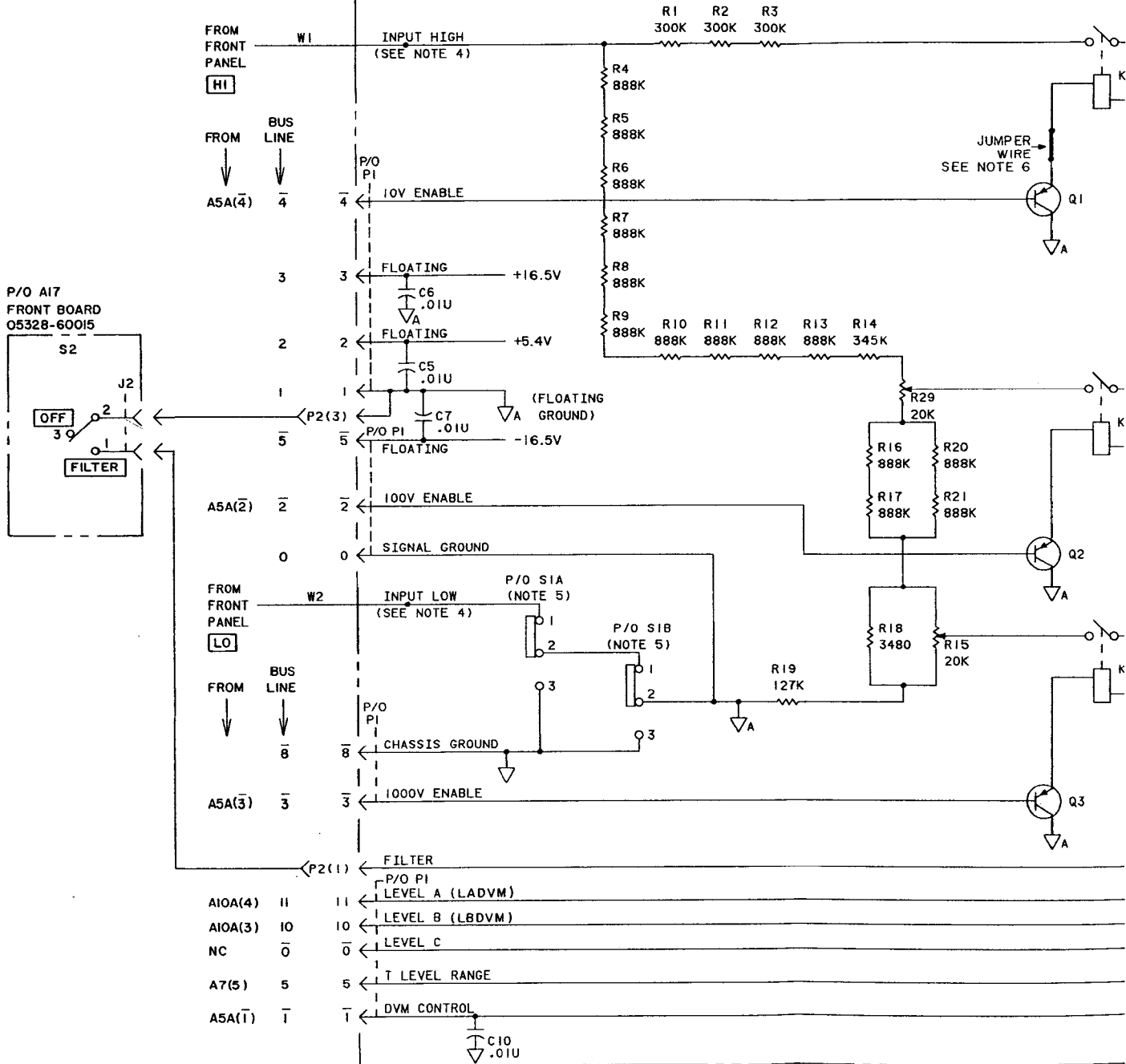


P/O Figure 8-BB-3. A6 Buffer Amplifier Assembly

### CONNECTOR P1

0	Signal Ground	0	Level C
1	Floating Ground	1	DVM Control
2	Floating (+ 5.4V)	2	100V Enable
3	Floating (+ 16.5V)	3	1000V Enable
4		4	10V Enable
5	T Level Range	5	Floating (- 16.5V)
6	Range Ground	6	
7	Buffer Output	7	
8		8	Chassis Ground
9		9	Level B RANGE (LBX10)
10	Level B (LBDVM)	10	Level A RANGE (LAX10)
11	Level A (LADVM)	11	

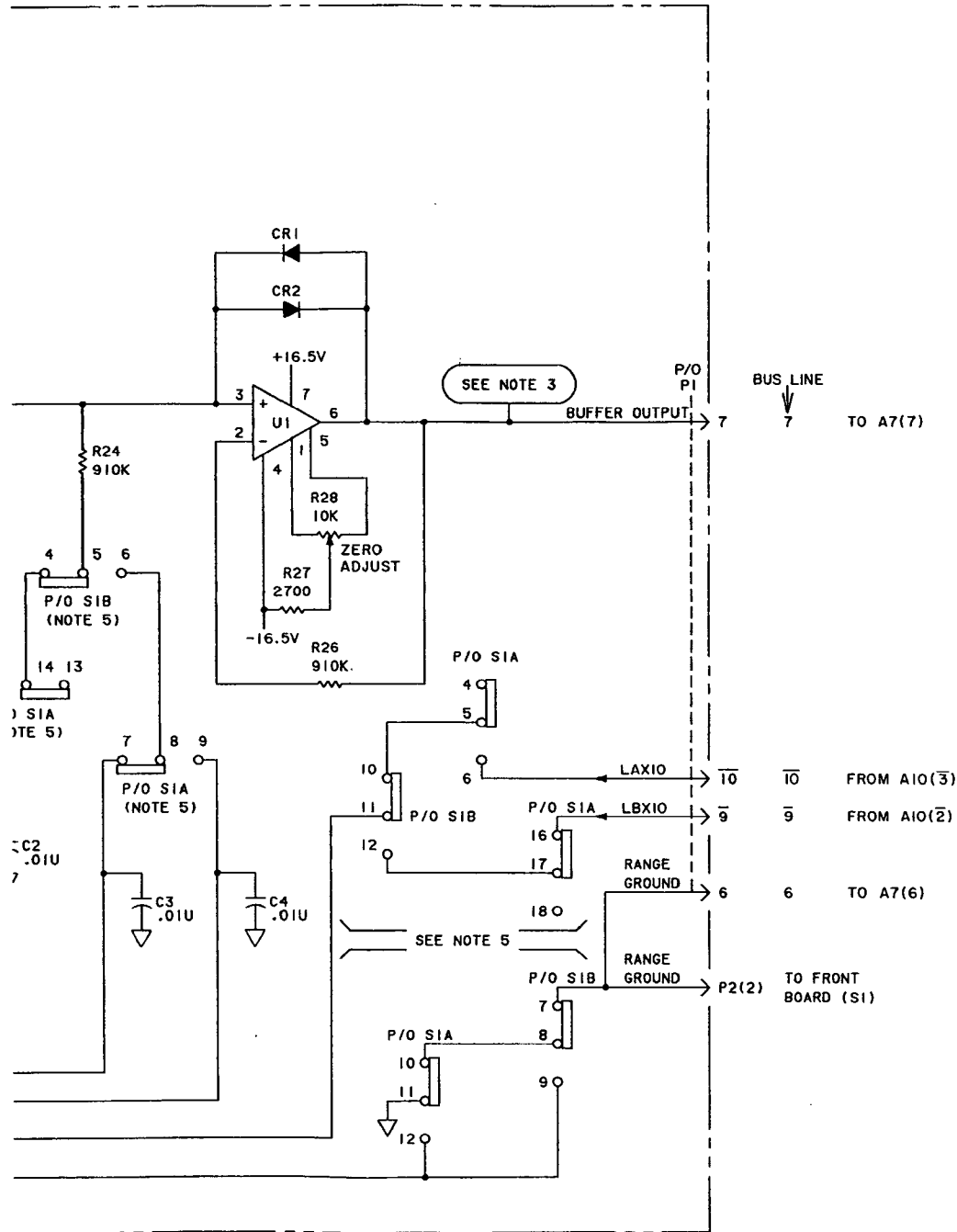
OPTION 021 A6 BUFFER AMP ASSEMBLY (05328-60013) SERIES 2004



- A10A(4) 11 11 LEVEL A (LADVM)
- A10A(3) 10 10 LEVEL B (LBDVM)
- NC 0 0 LEVEL C
- A7(5) 5 5 T LEVEL RANGE
- A5A(1) 1 1 DVM CONTROL

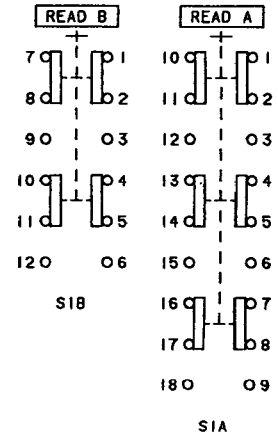






NOTES

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 FARADS.
3. GUARD TRACE CONNECTED TO THIS POINT REDUCES HIGH VOLTAGE LEAKAGE CURRENTS.
4. INPUT HIGH AND INPUT LOW CONNECT TO THE BOARD VIA CABLES W1 AND W2.
5. SWITCH S1A & S1B DIAGRAM:



6. JUMPER WIRE PART NUMBER IS 8159-0005.

REFERENCE DESIGNATIONS

A6	
C1-C8, C10	
CR1, CR2	
K1-K3	
Q1-Q3	
R1-R22, R24, R26-R29	
S1	
U1	
(R23, R25 NOT ASSIGNED)	

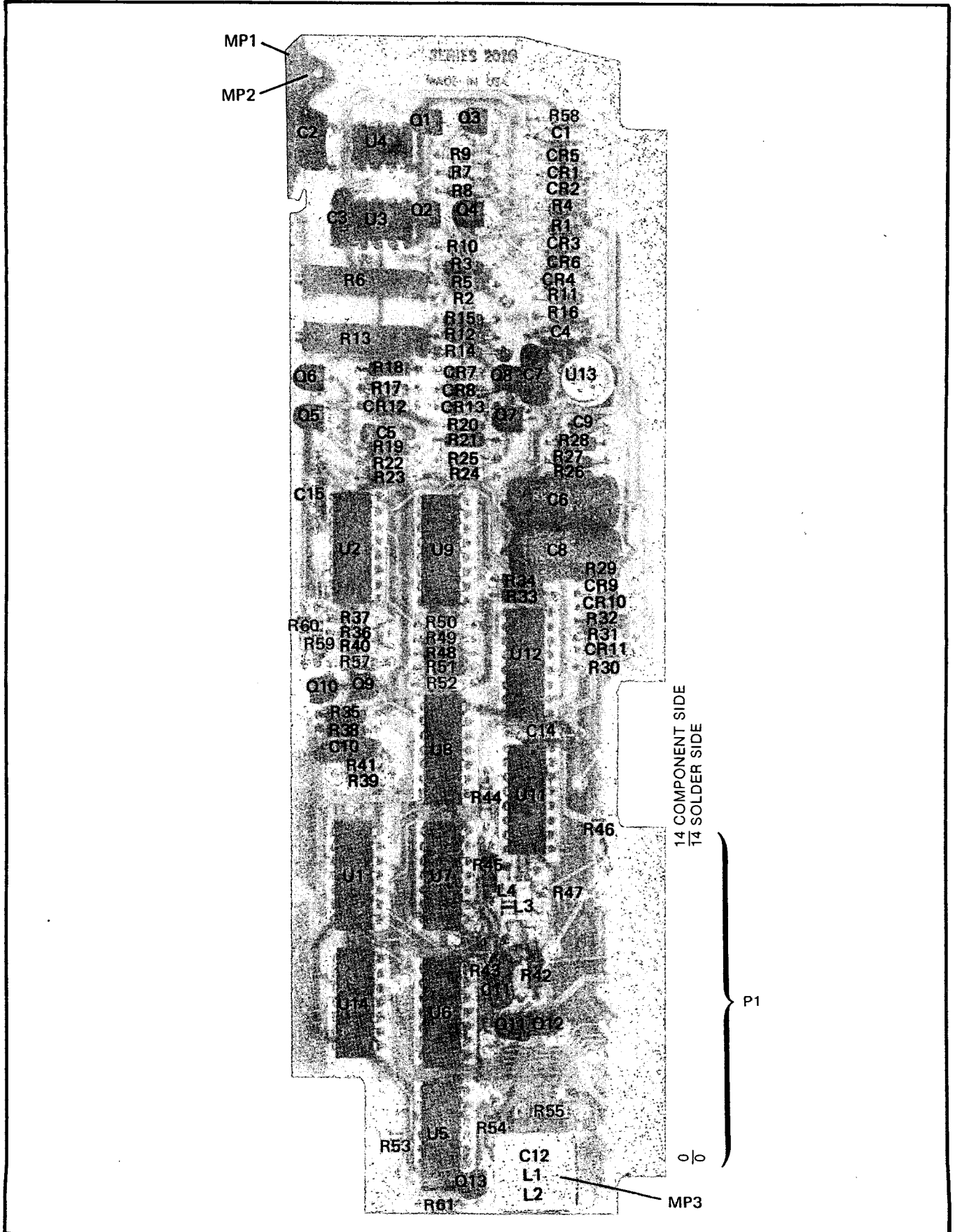
A6 ACTIVE ELEMENTS

REFERENCE DESIGNATION	PART NUMBER
CR1, CR2	1901-0376
Q1-Q3	1853-0020
U1	1826-0250
	Special LH0042CH

Figure 8-BB-3. A6 Buffer Amplifier Assembly Schematic Diagram

*Figure 8-BB-3*  
**A6 BUFFER AMPLIFIER ASSEMBLY (SCHEMATIC DIAGRAM)**

(See Page 8-115)

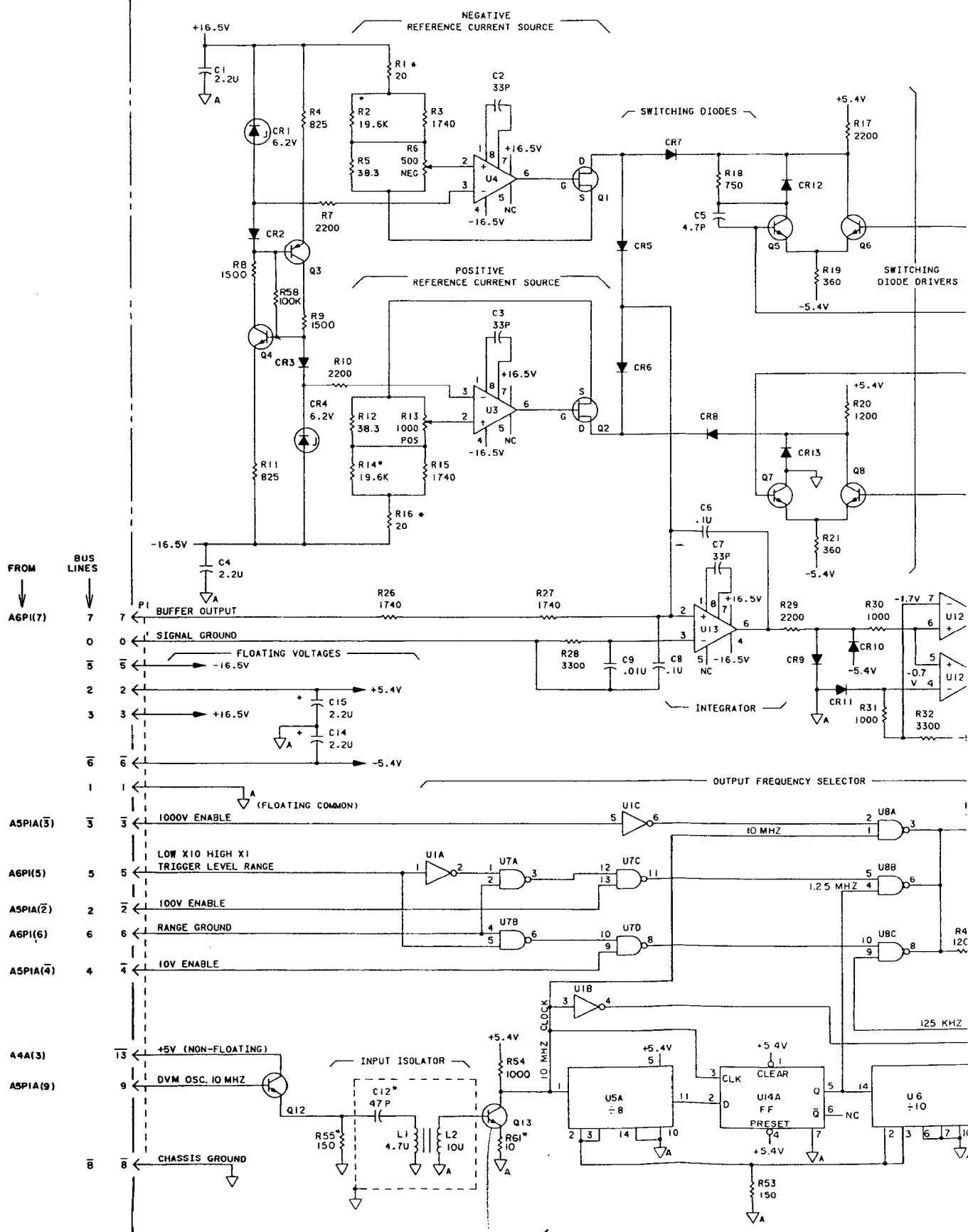


P/O Figure 8-BB-4. A7 VF Converter Assembly

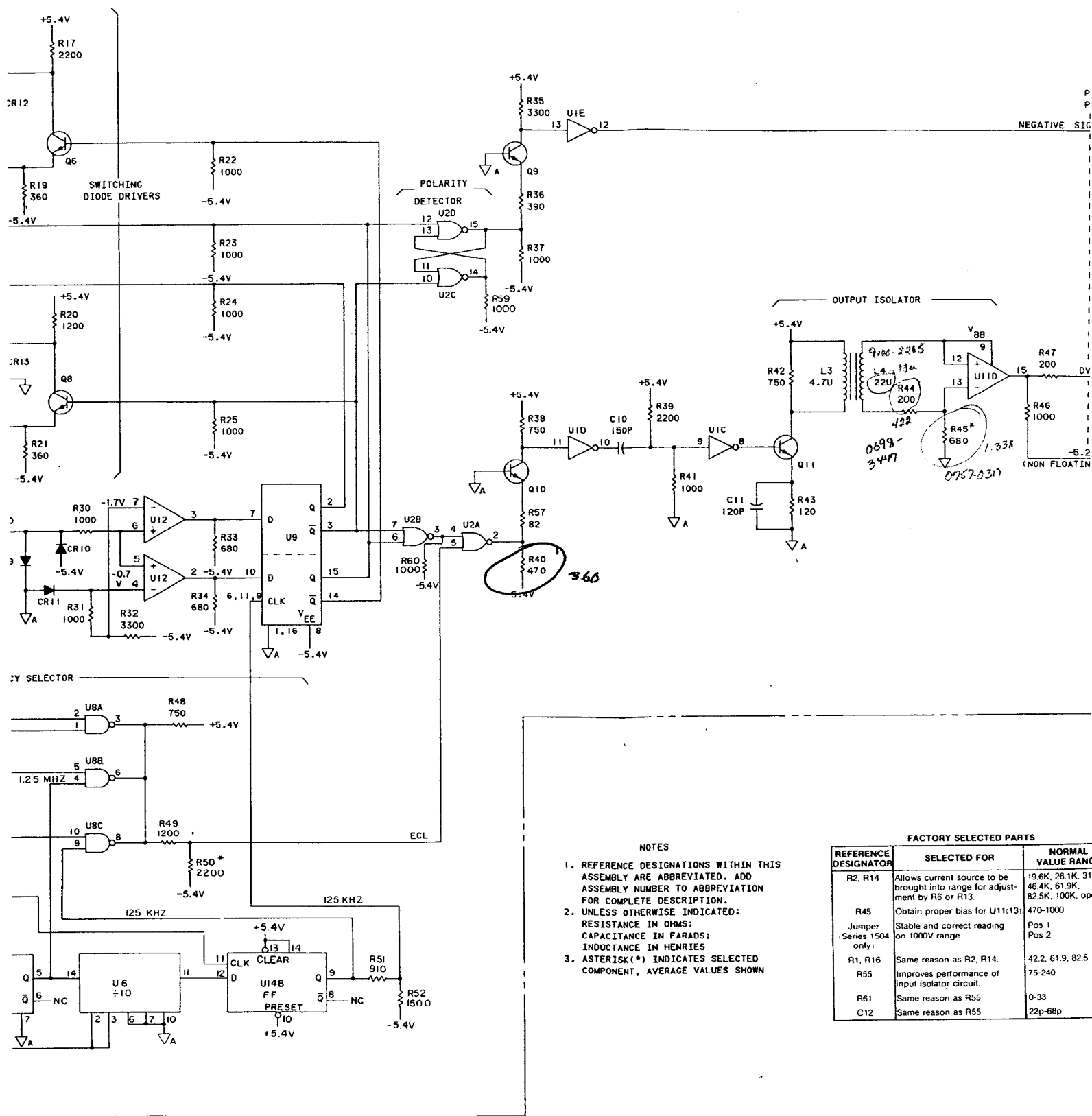
### CONNECTOR P1

0	Signal Ground	<u>0</u>	
1	Floating Ground	<u>1</u>	
2	+5.4V (from A5)	<u>2</u>	100V Enable
3	+16.5V (from A5)	<u>3</u>	1000V Enable
4	NEG Sign	<u>4</u>	10V Enable
5	T Level Range	<u>5</u>	-16.5V (from A5)
6	Range Ground	<u>6</u>	-5.4V (from A5)
7	Buffer Output	<u>7</u>	
8		<u>8</u>	Chassis Ground
9	DVM OSC	<u>9</u>	
10		<u>10</u>	
11		<u>11</u>	
12	DVM	<u>12</u>	
13	-5.2V (Non-Floating)	<u>13</u>	+5V (Non-Floating)

OPTION 021 A7 VF CONVERTER ASSEMBLY (05328-60014) SERIES 2016



1854-0215



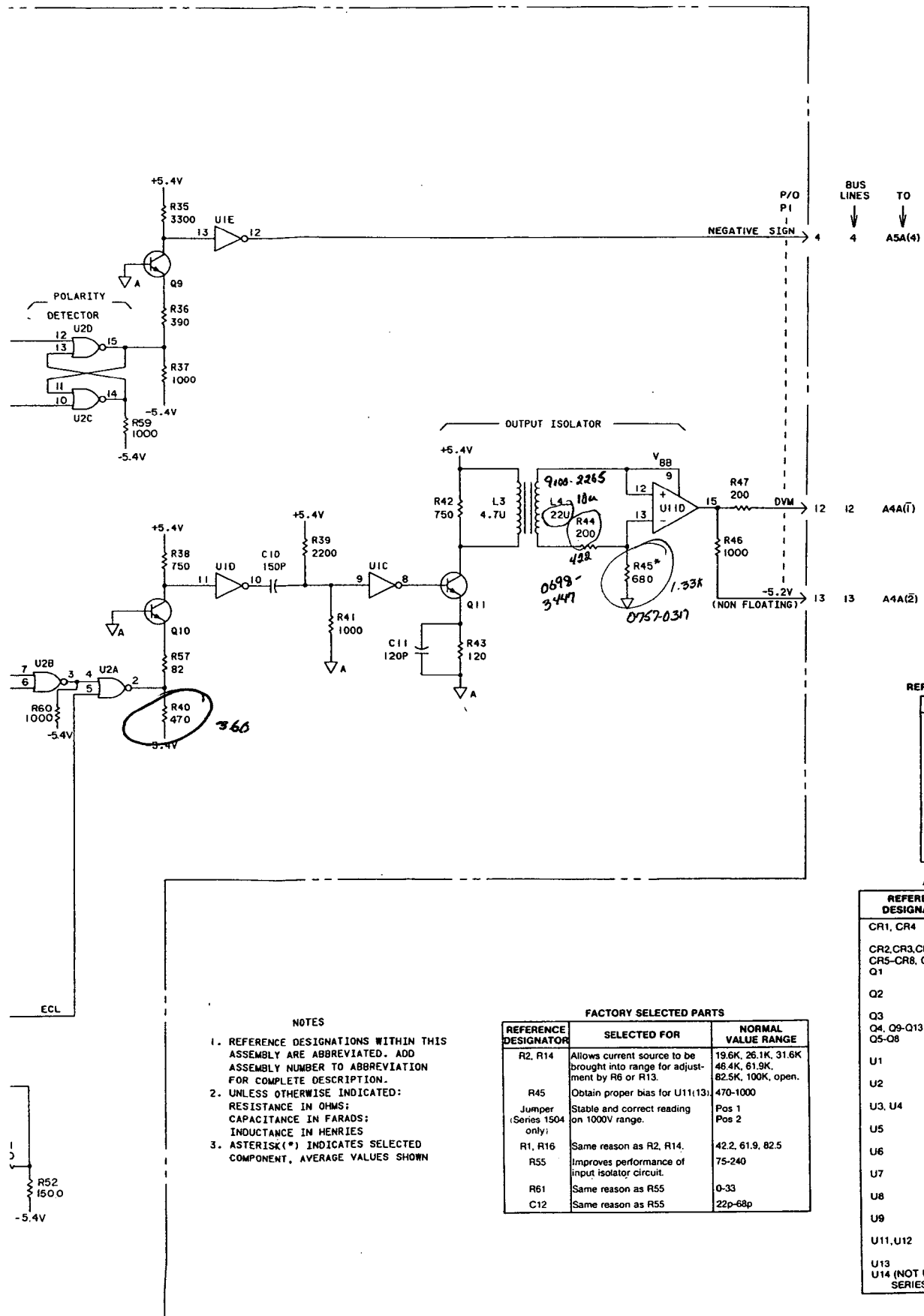
NOTES

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 FARADS; INDUCTANCE IN HENRIES
3. ASTERISK (\*) INDICATES SELECTED COMPONENT, AVERAGE VALUES SHOWN

FACTORY SELECTED PARTS

REFERENCE DESIGNATOR	SELECTED FOR	NORMAL VALUE RANGE
R2, R14	Allows current source to be brought into range for adjustment by R6 or R13.	19.6K, 26.1K, 31.4K, 46.4K, 61.9K, 82.5K, 100K, open
R45	Obtain proper bias for U11;13;	470-1000
Jumper (Series 1504 only)	Stable and correct reading on 1000V range.	Pos 1 Pos 2
R1, R16	Same reason as R2, R14.	42.2, 61.9, 82.5
R55	Improves performance of input isolator circuit.	75-240
R61	Same reason as R55	0-33
C12	Same reason as R55	22p-68p

Figure 8-BB-4. A7 VF Con



REFERENCE DESIGNATIONS

A7	
C1-C12, C14, C15	
CR1-CR13	
L1-L4	
Q1-Q13	
R1-R55	
R56 NOT ASSIGNED	
R57	
R58 (NOT USED ON SERIES 1504 & 1516)	
R58-R61	
U1-U9	
U10 NOT ASSIGNED	
U11-U14	

A7 ACTIVE ELEMENTS

REFERENCE DESIGNATION	PART NUMBER
CR1, CR4	1902-0680 1N827
CR2, CR3, CR9-CR11	1901-0040
CR5-CR8, CR12, CR13	1901-0179
Q1	1855-0066 2N4342
Q2	1855-0081 2N5245
Q3	1853-0020
Q4, Q9-Q13	1854-0071
Q5-Q8	1854-0092 2N3563 1820-0174 SN7404N
U1	1820-0902
U2	MC10102P
U3, U4	1820-0477 LM301AN
U5	1800-0099 SN7493N
U6	1820-0055 SN7490N
U7	1820-0054 SN7400N
U8	1820-0269 SN7403N
U9	1820-0817 MC10131P 1820-0809 MC10115P
U11, U12	1826-0059
U13	1820-0077
U14 (NOT USED ON SERIES 1504)	SN7474N

FACTORY SELECTED PARTS

REFERENCE DESIGNATOR	SELECTED FOR	NORMAL VALUE RANGE
R2, R14	Allows current source to be brought into range for adjustment by R6 or R13.	19.6K, 26.1K, 31.6K, 46.4K, 61.9K, 82.5K, 100K, open.
R45	Obtain proper bias for U11(1,3).	470-1000
Jumper (Series 1504 only)	Stable and correct reading on 1000V range.	Pos 1 Pos 2
R1, R16	Same reason as R2, R14.	42.2, 61.9, 82.5
R55	Improves performance of input isolator circuit.	75-240
R61	Same reason as R55	0-33
C12	Same reason as R55	22p-68p

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 FARADS; INDUCTANCE IN HENRIES
3. ASTERISK (\*) INDICATES SELECTED COMPONENT, AVERAGE VALUES SHOWN

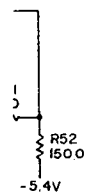


Figure 8-BB-4. A7 VF Converter Assembly Schematic Diagram



*Figure 8-BB-4*  
**A7 VF CONVERTER ASSEMBLY (SCHEMATIC DIAGRAM)**

(See Page 8-117)



*Figure 8-BB-5*  
**DIGITAL VOLTMETER TROUBLESHOOTING FLOW CHART**

(See Page 8-119)

### 8-BC-1. CHANNEL "C" INPUT (OPTION 031 OR PART OF OPTION 050)

- The Channel "C" Option (Option 031) gives the Model 5328B a wider frequency range (90 MHz to 1300 MHz). It also offers
- 20-mV sensitivity
- 50-ohm fuse-protected input
- a ninth digit in the Model 5328B's numeric display

The (optional) Channel "C" circuitry provides the Model 5328B with an input channel whose frequency range is 90 MHz to 1300 MHz. A 50-ohm fuse-protected amplifier and Schmitt trigger feed the decade divider. Latches in this circuitry strobe the ninth (least-significant) digit from the module onto the Data Bus and into the numeric Display. In any FUNCTION that does not require an input from this module, the main-controller ROM lines turn off the module's output strobing circuitry, which turns off the display's ninth digit.

### 8-BC-2. PRINCIPLES OF OPERATION

The "C" Channel circuitry is on two printed circuit boards.

The main board is installed in the Model 5328B's "A8" position. The second board, identified by reference designator "A8A1", plugs into the "A8" board and is held in place with two screws. For the discussion that follows, refer to the block diagram, Figure 8-BC-1.

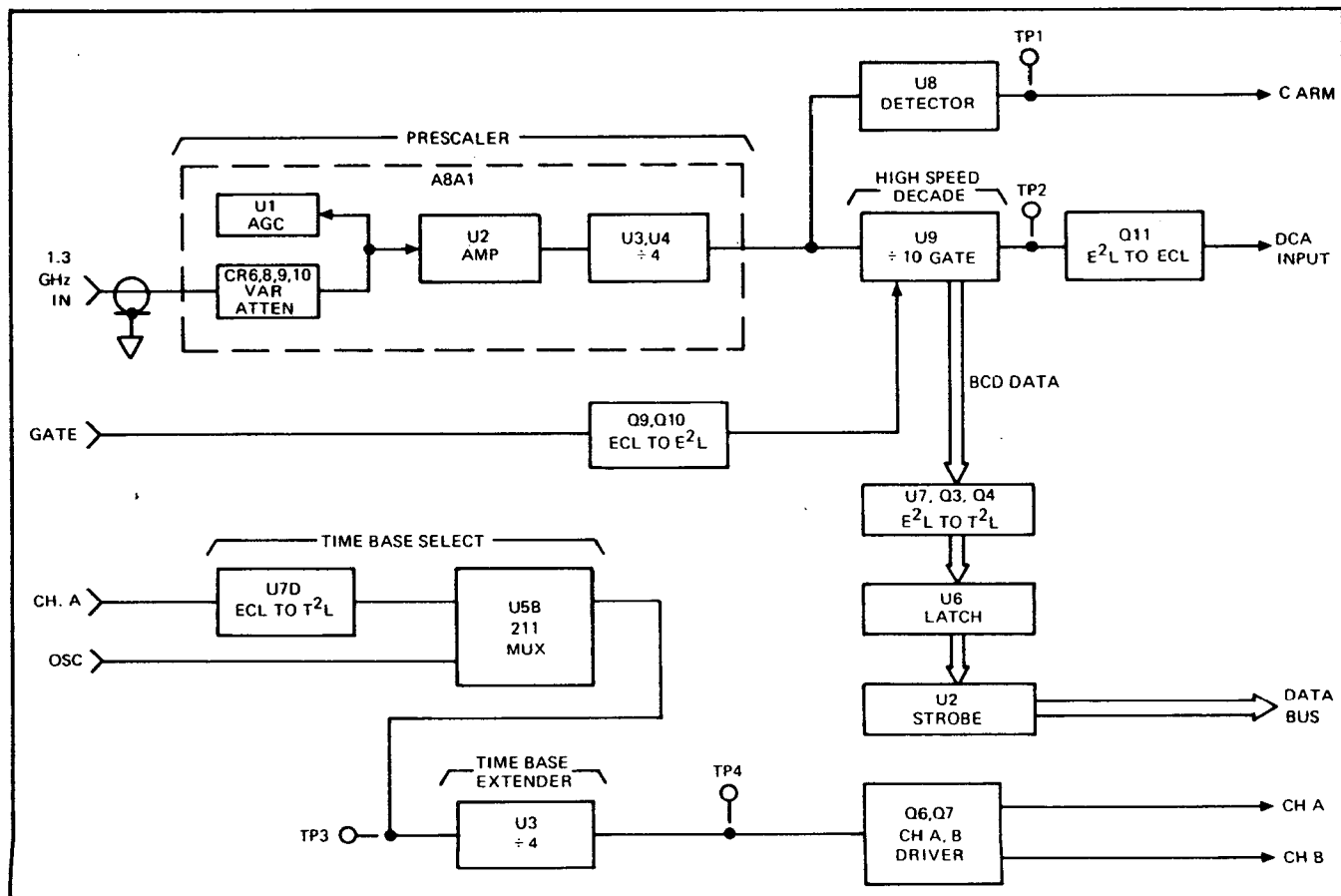


Figure 8-BC-1. "C" Channel Block Diagram

The 1300 MHz Front End Assembly (A8A1) contains circuitry that limits, amplifies, and prescales (divides) by four the input signal (which must be in the 90 to 1300 MHz range). This assembly contains an amplifier (A8A1U2) which provides approximately 20-24 dB of gain. Circuits A8A1U3 and A8A1U4 are binaries that divide the input signal frequency by four. An automatic gain control (AGC) circuit is also included in the A8A1 assembly; this circuit provides additional protection under overload conditions.

The signals sent from A8A1 to the main board (A8) have a maximum frequency of 325 MHz (1300 MHz/4). The A8 board contains a high-speed decade divider with output level conversion, latch, and strobe circuits. The board also has circuits for arming, time base select, extender, and drive. A high-speed gate, contained in U9, is driven by an ECL level from the Function Selector Board (A4).

### 8-BC-3. A8A1 1300 MHz Front End

Input signals are routed through Fuse J310F1 to the 1300 MHz Front End limiter circuitry. Diodes CR1, CR2, CR4, and CR7 form the limiter circuitry and limit the input to approximately 5V rms. A voltage-controlled attenuator composed of PIN diodes CR5, CR6, and CR8 provides variable attenuation as determined by an AGC circuit.

Signal output from the variable attenuator is supplied to U2, which provides 20-24 dB of gain. The signal from U2 is coupled by C18 to U3(3). Circuit U3 divides the signal frequency by two and routes it to U4, where it is again divided by two. Since U3 has no Schmitt trigger, it is biased for maximum sensitivity. With U3 biased for maximum sensitivity, it has a tendency to oscillate with no input signal applied. To maintain high sensitivity and prevent oscillations, R22 is adjusted to desensitize U3 when the  $\overline{\text{ARM}}$  line is "high" and produce high sensitivity when the ARM line is low. This allows the counter's readings to "snap-on" from no input signal to the exact reading when a signal is applied. The amount of "snap-on" feedback is controlled by A8R12. The greater the "snap-on" feedback, the less the possibility of partial counts, but also the lower the sensitivity.

As the input level increases, the level at U2(1) increases. This level is also connected to a bridge circuit consisting of CR11, CR12, and associated resistors including R13 which balances the bridge. Resistor R13 is adjusted to balance the bridge with a -5 dBm input signal. With small input levels, the bridge allows little dc to flow, resulting in U1(6) remaining "high". As the input exceeds -5 dBm, the rectified bridge outputs drive U1(2) positive with respect to U1(3). With the inverting input of U1 positive with respect to the non-inverting input, the output of U1 goes "low". When U1(6) goes "low", it reduces the amount of current through R9, A8R43, A8R44, L4, L1, CR6, CR8, and R11. As the current decreases, the resistance of the two PIN diodes (CR6, CR8) increases, attenuating the incoming signal. A decrease in current causes the junction of R11 and CR8 to become less positive. This allows more dc current to flow through CR9, R10, R1, R6, R7, CR5, and R2. The increased current through CR5 and CR9 decreases their resistance and allows more input signal to be routed to ground through C5 and C9.

### 8-BC-4. A8 1300 MHz "C" Channel

The output signal at A8A1(9) has a maximum frequency of 325 MHz. This signal is rectified by Hot Carrier Diode CR8 and is sent to the Arming circuit, U8. When the voltage across C14 goes above ground, U8(6) goes "high", arming the counter. The counter responds by pulling the "HDS" line (A8P1(7)) "low", thus allowing the "snap-on" effect to take place on A8A1 (see A8A1 description above). Variable resistor R12 controls the amount of "snap-on" feedback. Increasing the voltage at Q8's base causes lower sensitivity, but also provides less susceptibility to partial counts.

The signal at A8A1(9) is also sent to the input of decade U9. Circuit U8 is the least-significant-digit (LSD) decade in  $\text{FREQ C}$  and  $\text{RATIO C/A}$  functions. The signal supplied to U9 is gated, divided by ten, and differentially outputted to the A4 board on the "C" and " $\overline{\text{C}}$ " lines. The "MG" and " $\overline{\text{MG}}$ " outputs at A8P1(12) and A8P1(11) arrive from the A4 board and drive Q9 and Q10 to develop a single gate signal connected to U9(7). This signal causes gating of the input signal in U9.

LSD data from U9, converted from E<sup>2</sup>CL to TTL levels by U7A, U7B, U7C, Q3 and Q4, is supplied to the "D" input of latch U6. During transfer, LGR at A8P2(4) goes "low", causing U1(10) to go "high". This "high" latches the information at U6's inputs to its outputs.

When the inputs of U4B ("LDDCA", "HEC", and "DSD") are all "high", indicating strobing of the LSD data, U4(8) is "low", causing a "high" at U1(13). The "high" at U1(13) enables U2 and allows data latched into U6 to be transferred on the "DA" through "DD" lines.

When the Model 5328B is in **FREQ C** mode, "FB" is "high". This "high", at U5(1), connects oscillator pulses at U5(6) to U5(7). Since the input frequency is prescaled by four, oscillator pulses are routed through divide-by-four circuitry composed of U3B and U3A. With U5(1) "high", the oscillator-pulses-divided-by-four are routed from U5(3) to U5(4) and the "high" at U5(10) is supplied to U5(9). On the negative-going edge of TTL pulses at U5(4), C4 acts as a differentiator — causing emitter follower Q6 to output negative pulses on the " $\bar{A}$ " line. These pulses (on the " $\bar{A}$ " line) are sent to the A4 board, where they are used as the time base input. The "high" at U5(9) causes the " $\bar{B}$ " output to be "high". Also, with U5(1) "high", U1(4) is driven "low", causing Q1 to drive "B ARM" "low". With "A ARM" "high", any "A" channel input is disabled. A "low" on "B ARM" allows the "B" channel to function normally and arm the counter in the ARM ON mode.

In **FREQ C** and **RATIO C/A**, both "HEC" (A8P2(7)) and "FC" (A8P2(9)) lines will be "high", giving a "low" at U4(12). The "low" at U4(12) enables U5A, U5B, U5C, and U1A.

In a **RATIO C/A** function, the "FB" line is "low". This "low", at U5(1), switches the "low" at U5(14) to U5(12). With U5(12) "low", Q2 drives the "A ARM" line "low", enabling "A" channel input. The "low" at U5(12) is also coupled via CR1 to U1(5), causing U1(4) to be "high". A "high" at U1(4) causes Q1 to drive "B ARM" "high". "B ARM" being "high" disables any "B" channel input. The " $\bar{A}$ " signal, at A8P1( $\bar{13}$ ), arrives from the A10 board and is routed through one-shot U7D to appear at U5(5). With "FB" "low", the " $\bar{A}$ " signal at U5(5) is connected to U5(7). This signal, coupled to U3(11), is divided by four by U3B and U3A and applied to U5(3,11). With U5(1) "low", the " $\bar{A}$ -divided-by-four" signal is connected from U5(11) to U5(9), and the "high" at U5(2) is connected to U5(4). On the negative-going edge of TTL pulses at U5(9), C5 acts as a differentiator, causing emitter follower Q7 to output negative spikes. The output of Q7 is connected to the " $\bar{B}$ " line and sent to the A4 board where it is used as the time base input. With U5(1) "low", the "high" at U5(2) is connected to U5(4), producing a "high" at the " $\bar{A}$ " output via Q6.

When the Model 5328B includes the "C" Channel, the FUNCTION "EVENTS C, A-B" is an invalid one. Using this FUNCTION will cause a display of all zeroes and decimal points and the counter will not gate.

In summary, for **FREQ C** and **RATIO C/A** functions, input signals at the "C" input are processed identically. The operational difference between the two functions is which signal is routed to the time base and how it arrives there. In **FREQ C**, the oscillator signal is divided by four and routed via the " $\bar{A}$ " (A8P1( $\bar{13}$ )) line to the time base multiplexer on the A4 board. In **RATIO C/A**, " $\bar{A}$ " pulses, from the A10 board, are divided by four and routed via the " $\bar{B}$ " line to the time base multiplexer on the A4 board

**WARNING**

**110V/120V/220V/240V AC SUPPLY WIRES ARE EXPOSED WHEN EITHER THE TOP OR BOTTOM COVER IS REMOVED. USE EXTREME CAUTION DURING TROUBLESHOOTING, ADJUSTMENT, OR REPAIR. TO REDUCE THE CHANCE OF PERSONAL INJURY OR DAMAGE TO EQUIPMENT, DISCONNECT THE MODEL 5328B FROM ITS OPERATING AC POWER LINE BEFORE YOU REMOVE OR REPLACE ITS COVERS OR ANY OF ITS INTERNAL ASSEMBLIES OR COMPONENTS.**

### 8-BC-5. IN-CABINET PERFORMANCE CHECK

The Performance Check and Operational Verification procedures for the Model 5328B are given in Section 4 of this manual.

### 8-BC-6. EXTENDER BOARD(S)

A special extender board (HP Part Number 05328-62016) is available to make testing of certain parts of the Model 5328B either easier.

- One of these boards is required to extend the A10 or A14 Assembly.
- Two of these boards are required to extend the (optional) Frequency "C" Assembly (A8).

### 8-BC-7. REMOVAL AND REPLACEMENT INSTRUCTIONS

Removal and replacement instructions are provided for the counter's cover and the C Channel Module (A8 and A8A1).

**WARNING**

**THE AC LINE (MAINS) (110V/120V/220V/240V) WIRES ARE EXPOSED WHEN EITHER THE TOP OR BOTTOM IS REMOVED. USE EXTREME CAUTION DURING TROUBLESHOOTING, ADJUSTMENT, OR REPAIR.**

**REDUCE THE CHANCE OF PERSONAL INJURY OR DAMAGE TO THE COUNTER BY ALWAYS DISCONNECTING THE AC POWER CORD BEFORE YOU REMOVE OR REPLACE THE COUNTER'S COVERS OR ANY ASSEMBLY OR COMPONENT WITHIN THE COUNTER.**

### 8-BC-8. Instrument Cover Removal

To remove the Model 5328B's top or bottom cover:

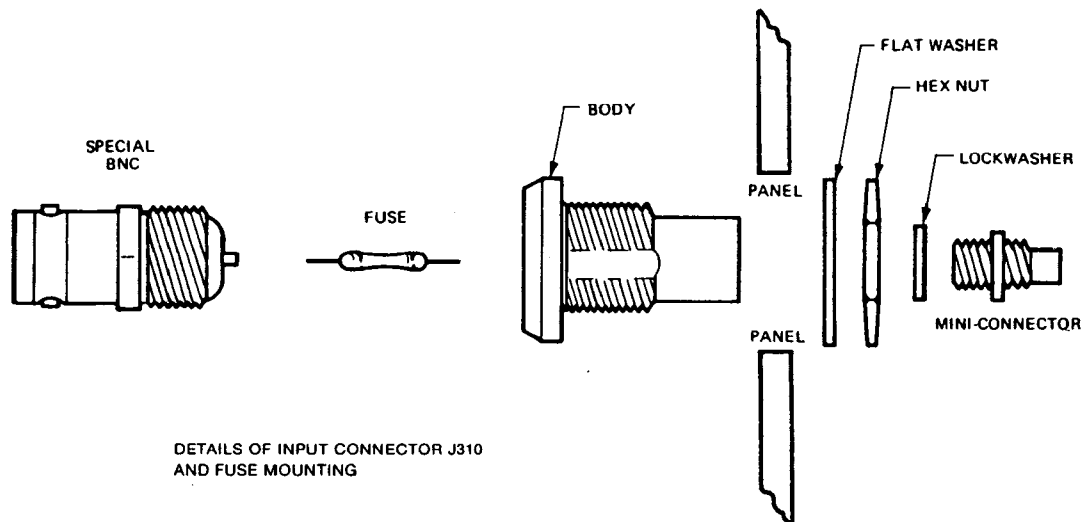
- Remove the power cord from the counter.
- Remove the screw at the rear of the cover that secures the cover to the counter's frame.
- Slide the cover toward the rear of the counter and lift it off.

To replace the Model 5328B's top or bottom cover, reverse the procedure above.

### 8-BC-9. C Channel Installation

- Remove the cover as described above.
- Remove the plastic filler strip on the top of the front.
- Remove the 4 screws at the top and the 4 screws at the bottom of the front frame that secures the front panel section. Use a #2 posi-drive screw driver. Remove the front panel by gently pressing on the front panel from the rear.
- If the Option 031 is being retrofitted, remove the Channel A and B trigger level adjust knobs. Use a .050 inch wrench. Remove the hex nuts from the A and B channel input trigger level controls and the Marker Output connectors so the new front panel can be installed. Use a 9/16 inch wrench or nut driver.

- e. Disconnect the red wire and the black wire from the rear of the banana plug connectors for the Digital Voltmeter input. (If the DVM is present.) Use an 8 mm wrench. (A 5/16 inch wrench, though oversized, functions satisfactorily in this low torque situation without damaging the nut.)
- f. If the Option 031 is being retrofitted, and the DVM is present, remove the hex nuts securing the DVM banana plug connectors so the new front panel can be installed. Use a 1/2 inch wrench.
- g. Solder 2 terminal pins in XA9 plated through holes 16 and  $\overline{16}$ .
- h. Install Option 031 C Channel board into XA8.
- i. Install the fuse holder and "Probe Power" connector assembly into the new front panel. Details of the connector assembly are shown below. Install the the SMC connector into the rear of the fuse holder. Insert the fuse and install the BNC connector into the front of the fuse holder.



- j. Connect the cable from the C Channel board to the SMC connector of the fuse holder. Connect the wires from the "Probe Power" cable to pins on the front of the A8 board (the wire colors are marked on the board).
- k. Connect the wire from the A8 board marked "A" to the terminal in XA9(16) and the wire marked "B" to the terminal in XA9(16°).
- l. Connect the banana plug connectors to the new front panel and attach the red wire and the black wire of the DVM to the banana connectors. Insert the front panel into the front frame. Secure with 4 posidrive screws at the top and bottom of the front frame.

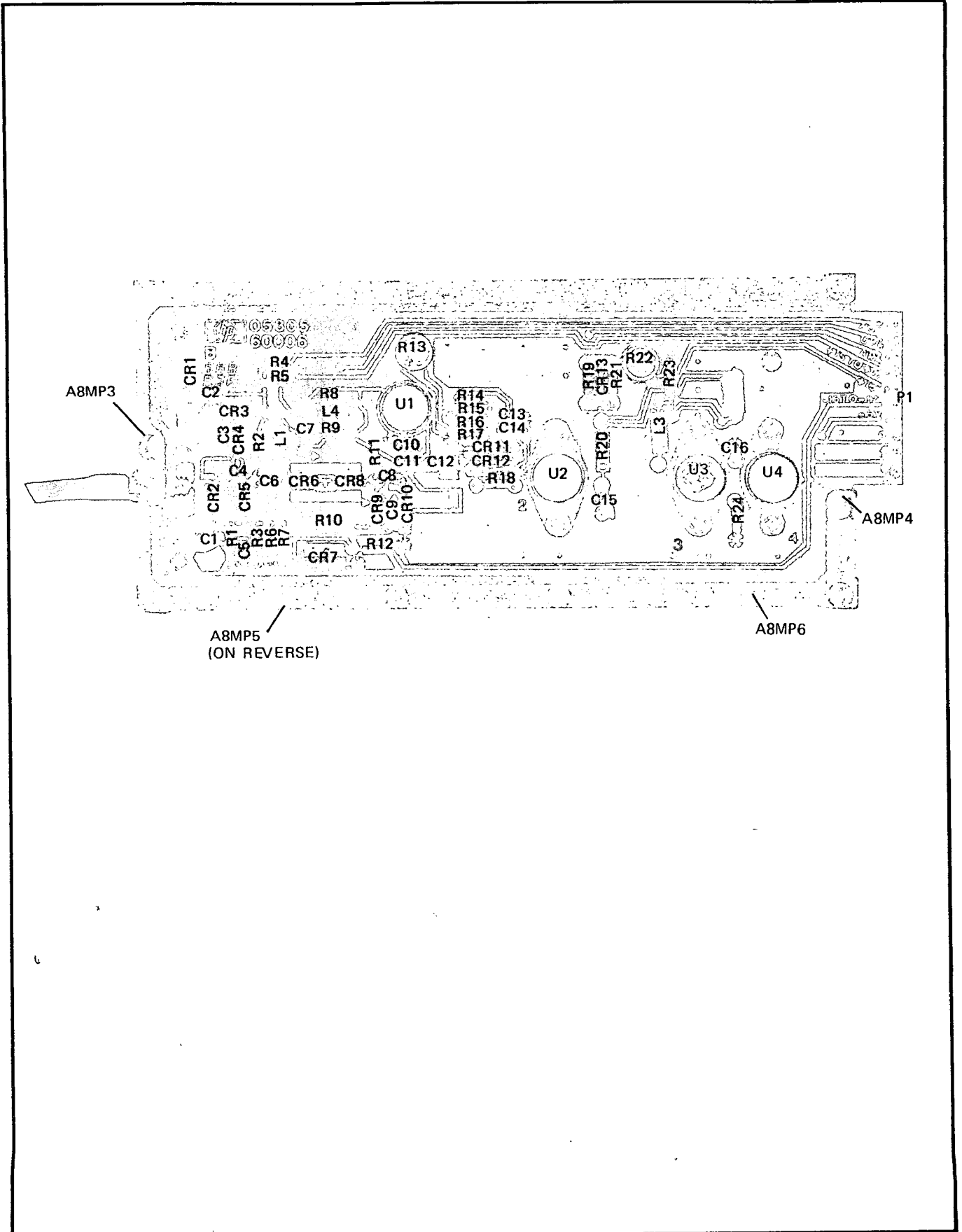
#### 8-BC-10. C Channel Removal

Removal of the Option 031 C Channel is accomplished in essentially the reverse order as described above.

#### 8-BC-11. Frequency C (Option 031): Troubleshooting

Problems in this section are easily distinguishable because they would occur only in measurements involving frequency C. If the problem occurs in other "non Frequency C" functions then the fault probably resides in some other section of the counter and should be tested before troubleshooting this section. The troubleshooting chart in Figure 8-BC-4 describes failure symptoms to faulty components on the A8 board.





P/O Figure 8-BC-2. A8A1 1300 MHz Front End Assembly

The waveforms below are included for ease of troubleshooting. Use procedure below and connect an HP 1725 Oscilloscope to location next to waveform.

**PROCEDURE:**

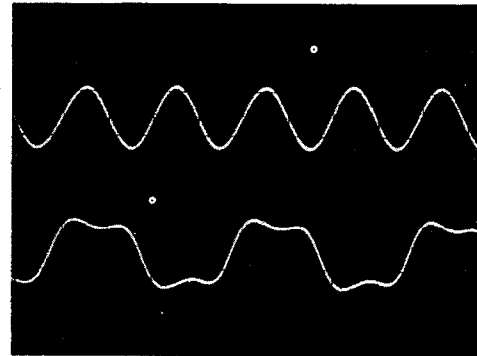
Connect HP 8660 OUTPUT, using a BNC cable to 5328B C channel INPUT.

Set 8660B to 100 MHz at 20 mV rms.

Set 5328B channel C ATTENUATOR to Min (cw).

U3(1) 0V -

U4(1) 0V -



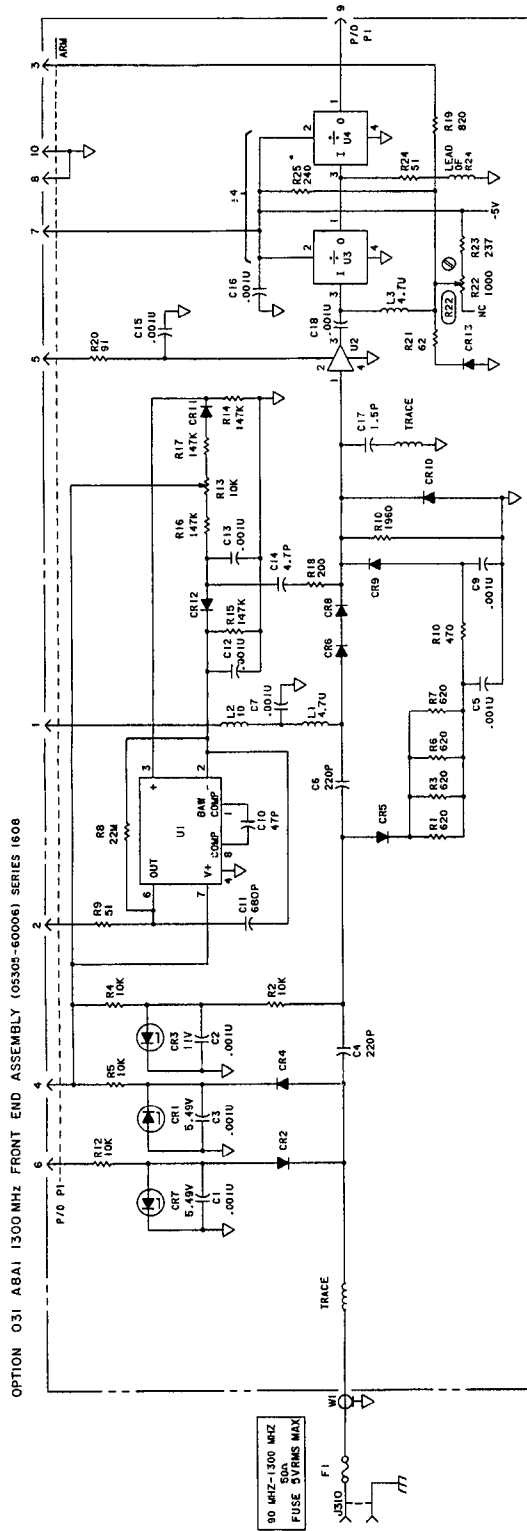
.05V/Div, .1  $\mu$ s/Div, DC 1  
ALT MAG-X10

The following table contains dc voltages for various points on the A8A1 assembly with no input signal applied.

**NOTE**

Voltages may vary depending on the adjustment of R13.

LOCATION	CHANNEL C ATTENUATOR	
	MAX (CCW)	MIN (CW)
ANODE CR5	3.1V	10.5V
CATHODE CR5	2.5V	10.2V
ANODE CR6	0V	12V
CATHODE CR6	0V	11.2V
CATHODE CR8	1.4V	10.5V
ANODE CR9	2.0V	10.2V
CATHODE CR10	.82V	.8V
CATHODE CR12	8.0V	8.0V
CATHODE CR11	8.0V	8.0V



90 MHz-1300 MHz  
50A  
FUSE 5 VRMS MAX

- NOTES
1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE TERMINATED AND ASSEMBLY NUMBER TO ABBREVIATIONS FOR COMPLETE DESCRIPTION.
  2. UNLESS OTHERWISE INDICATED: RESISTANCE IN OHMS; CAPACITANCE IN FARADS; INDUCTANCE IN HENRIES.

TABLE OF ACTIVE COMPONENTS

REFERENCE DESIGNATIONS	HP PART NUMBERS
CR1, CR7	1902-0032
CR2, CR4	1901-0050
CR3	02-0001
CR4, CR6, CR8, CR9	1901-0039
CR10, CR11, CR12	1901-0179
CR13	1901-0040
U1	850-0253
U3	1820-1811
U4	1820-1684

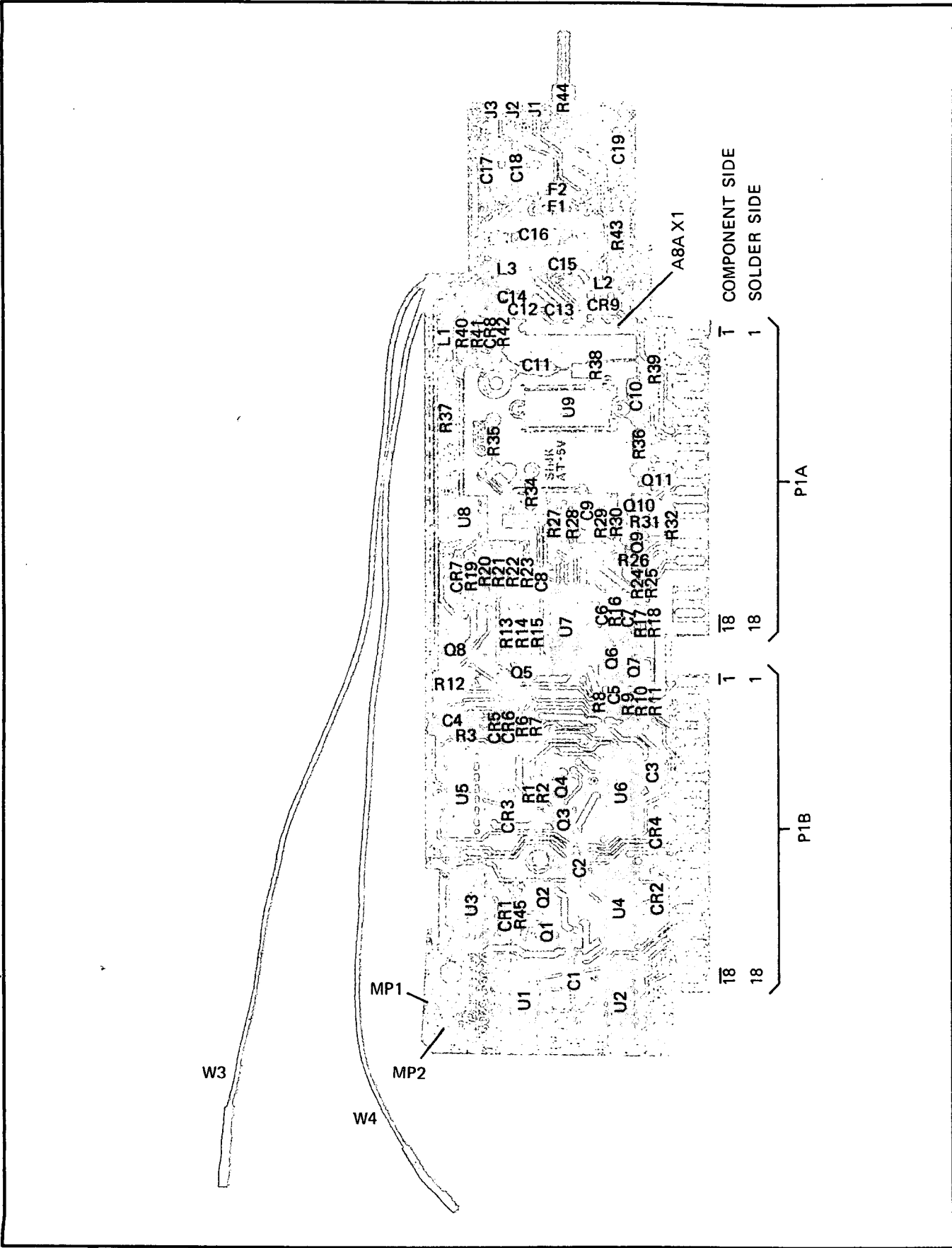
REFERENCE DESIGNATIONS

A8A1
C1-C18
CR1-CR13
L1-L3
R1-R25
U1-U4
W1

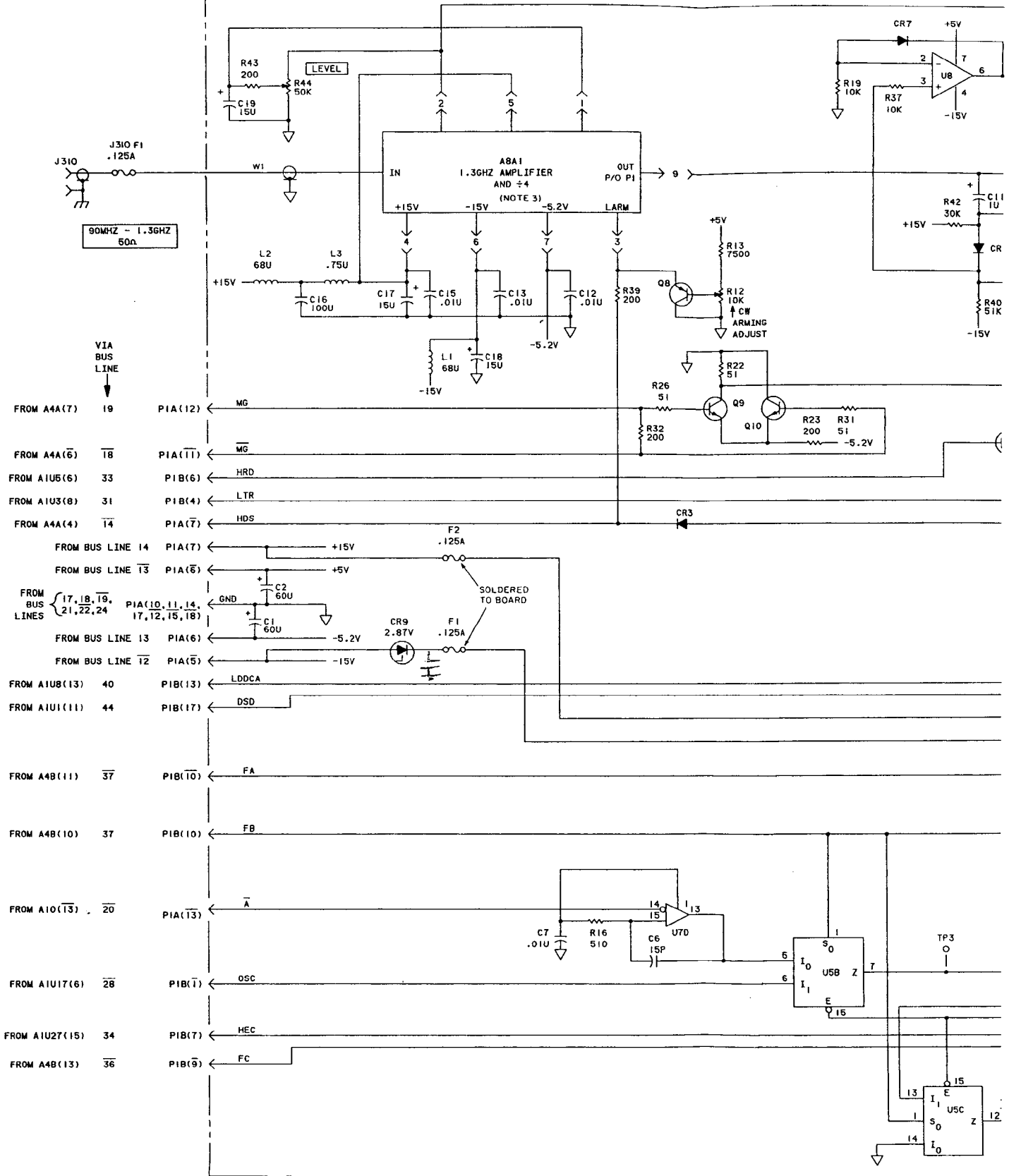
Figure 8-BC-2. A8A1 1300 MHz Front-end Assembly Schematic Diagram

*Figure 8-BC-2*  
**A8A1 1300 MHz FRONT END ASSEMBLY (SCHEMATIC DIAGRAM)**

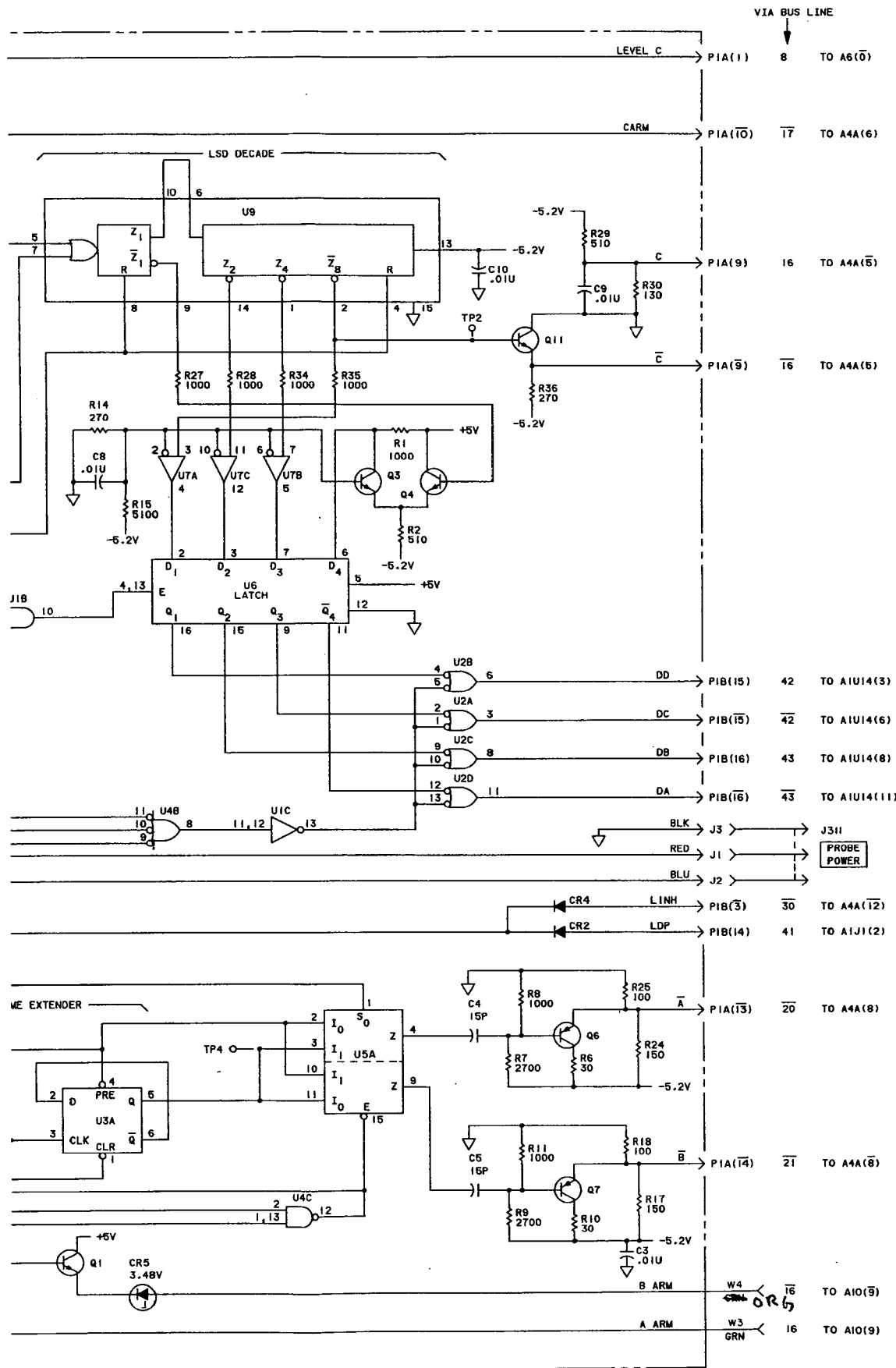
(See Page 8-127)



OPTION 031 A8 1300 MHZ C CHANNEL (05328-60025) SERIES 2024







- 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 FARADS; INDUCTANCE IN HENRIES
  3. ABA1 ALSO HAS AGC AND ATTENUATOR

TABLE OF ACTIVE COMPONENTS

REFERENCE DESIGNATIONS	HP PART NUMBERS
CR1,CR2,CR3,CR4	1910-0016
CR5,CR6	1902-3059
CR7	1901-0040
CR8	1901-0535
CR9	1902-3024
Q1,Q2,Q3,Q4,Q5, Q9,Q10,Q11	1854-0216
Q6,Q7,Q8	1853-0036
U1	1820-0328
U2	1820-0269
U3	1820-0077
U4	1820-0068
U5	1820-0616
U6	1820-0301
U7	1820-1052
U8	1820-0493
U9	1820-1019

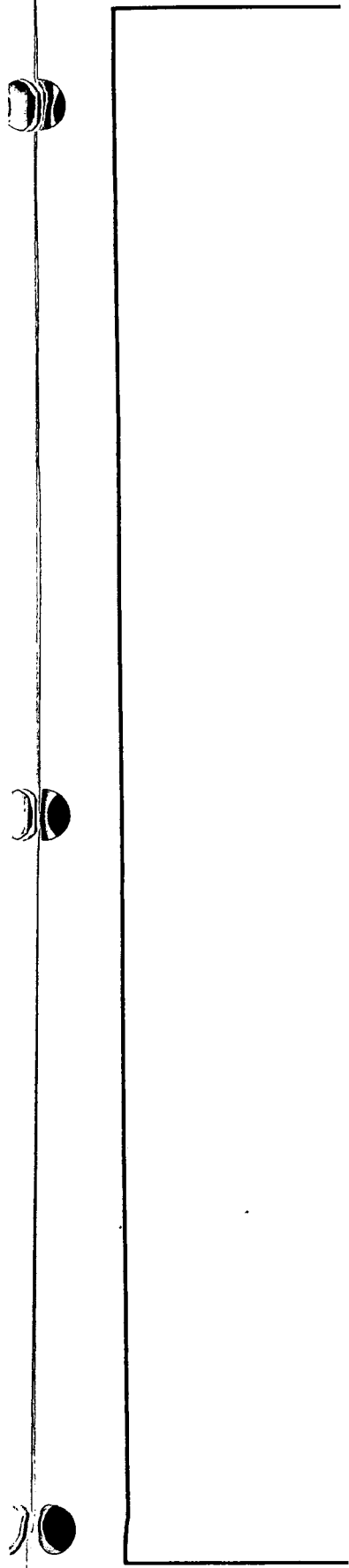
REFERENCE DESIGNATIONS

A8

A1
C1-C19
CR1-CR9
F1-F2
J1-J4
L1-L3
Q1-Q11
R1-R3
R4,R5 Not Assigned
R6-R32
R33 Not Assigned
R34-R45
TP1-TP4
U1-U9
XU9

Figure 8-BC-3. A8 1300 MHz "C" Channel Assembly Schematic Diagram





**Figure 8-BC-3**  
**AB 1300 MHz "C" CHANNEL ASSEMBLY (SCHEMATIC DIAGRAM)**

(See Page 8-129)

1. SYMPTOM:

FREQUENCY C OR RATIO C/A MEASUREMENTS INCORRECT

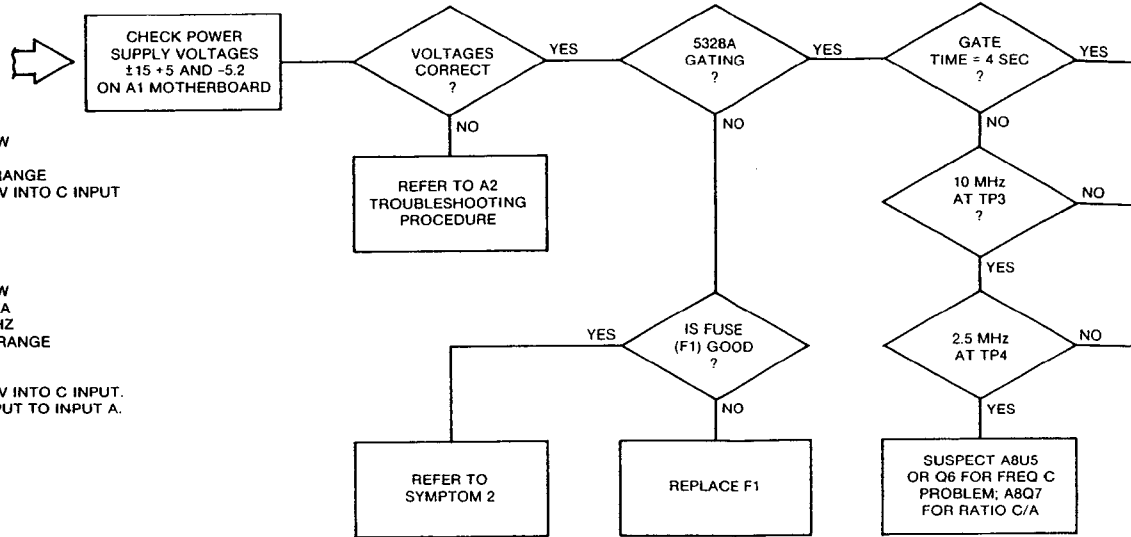
PROCEDURE:

FREQ C PROBLEMS

ATTENUATION (C CHAN) CW  
 FUNCTION ..... FREQ C  
 SAMPLE RATE ..... MID-RANGE  
 CONNECT 100 MHz AT 25 mV INTO C INPUT  
 ARM ..... OFF  
 OSC ..... INT

RATIO C/A PROBLEMS

ATTENUATION (C CHAN) CW  
 FUNCTION ..... RATIO C/A  
 RESOLUTION ..... 10%, 1 HZ  
 SAMPLE RATE ..... MID-RANGE  
 ARM ..... OFF  
 OSC ..... INT  
 CONNECT 100 MHz AT 25 mV INTO C INPUT.  
 CONNECT 5328A OSC OUTPUT TO INPUT A.

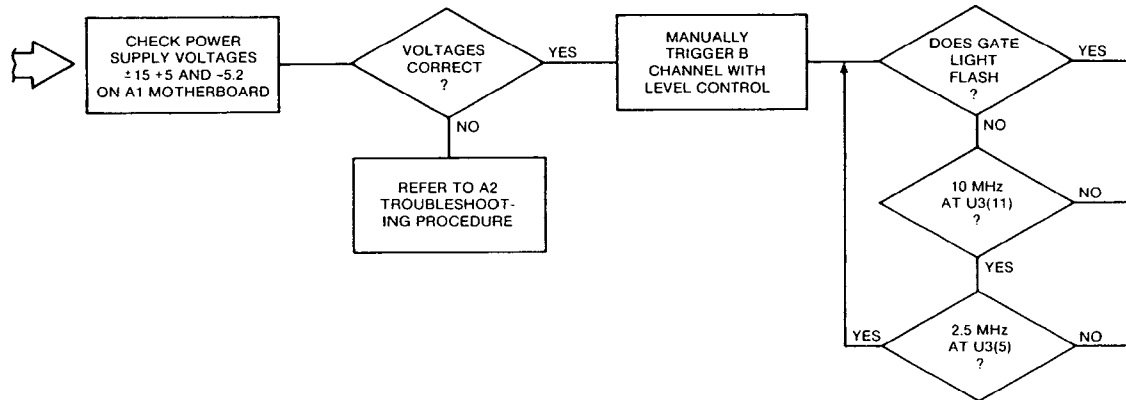


2. SYMPTOM:

GATE INOPERATIVE IN FREQ C (NORMAL ARMING)

PROCEDURE:

FUNCTION ..... FREQ C  
 ARM ..... ON  
 SAMPLE RATE ..... CCW  
 RESOLUTION ..... 0  
 SEP/COMA ..... SEP

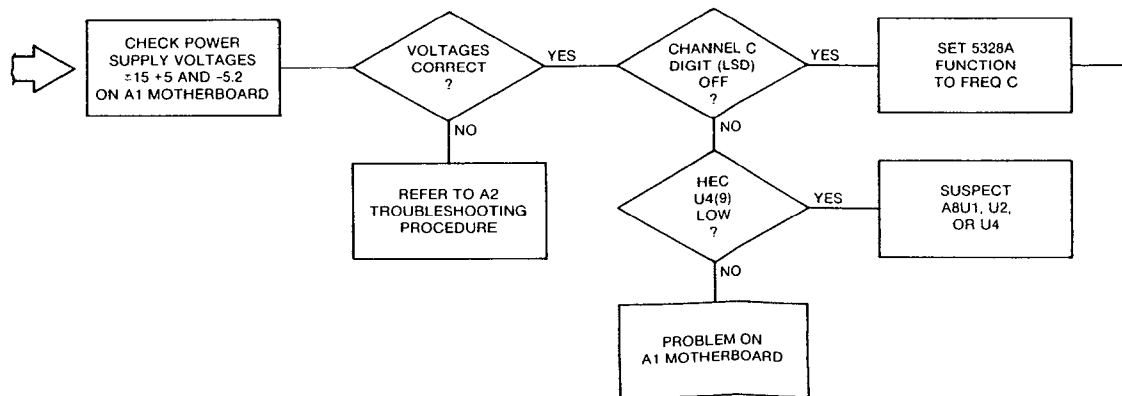


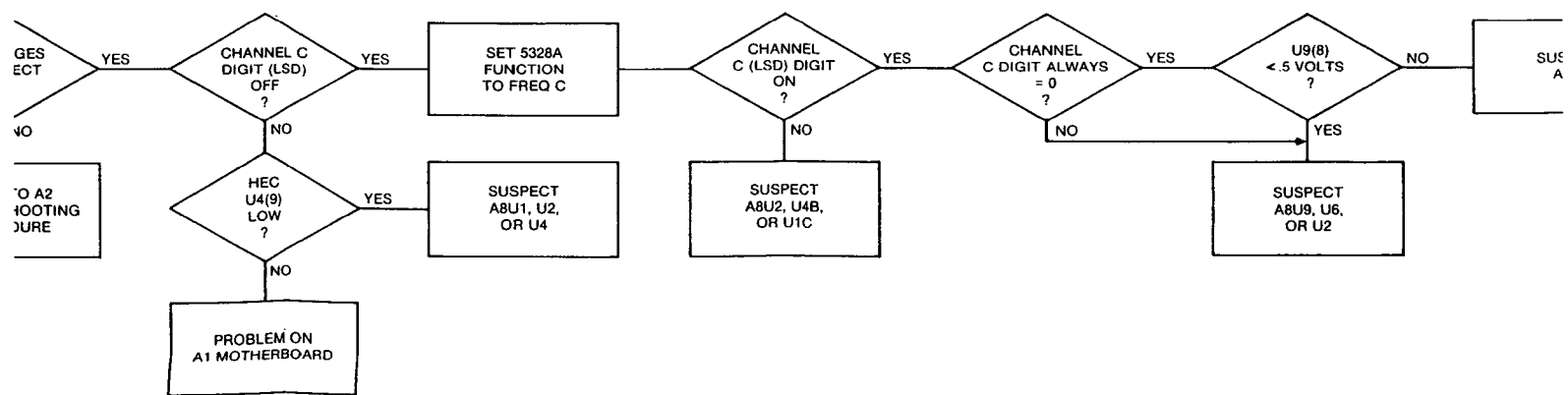
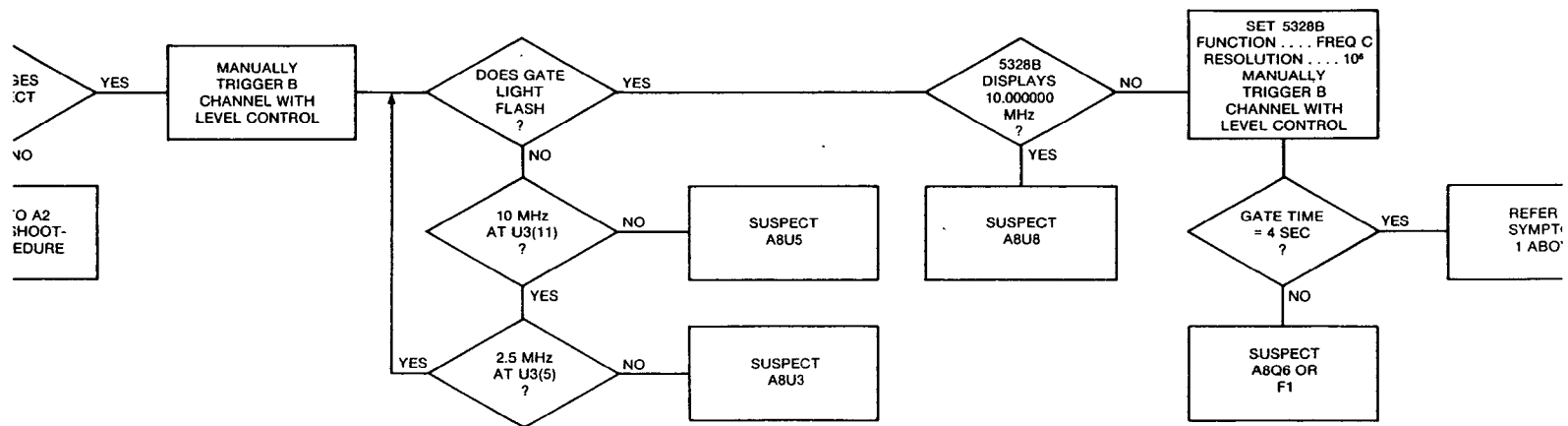
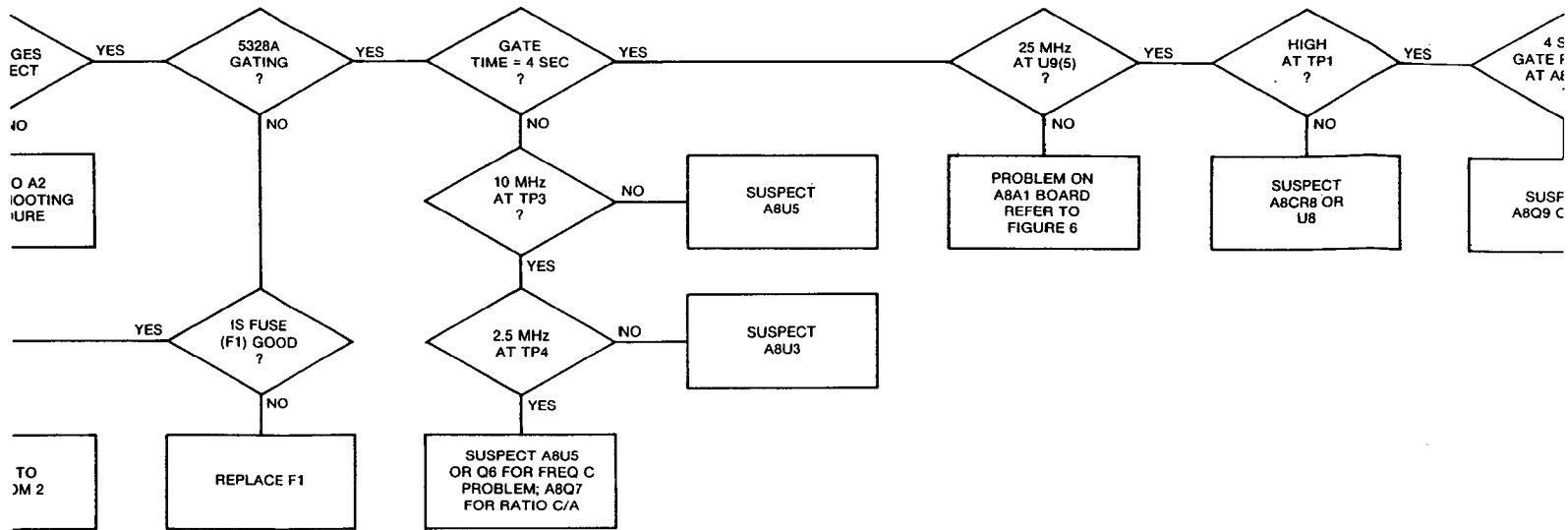
3. SYMPTOM:

LEAST SIGNIFICANT DIGIT OF DISPLAY INOPERATIVE

PROCEDURE:

FUNCTION ..... STOP





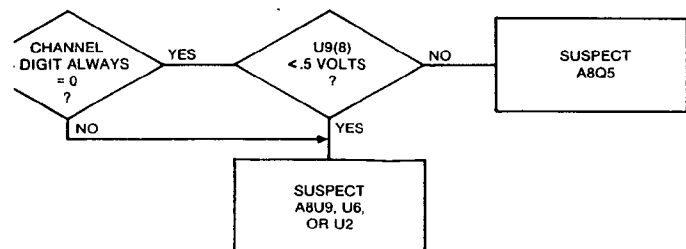
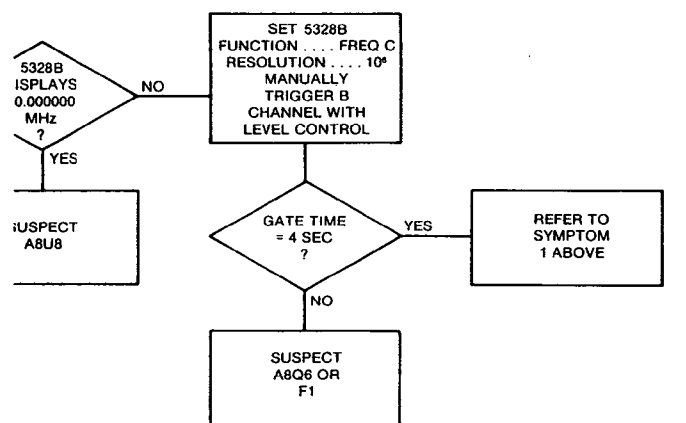
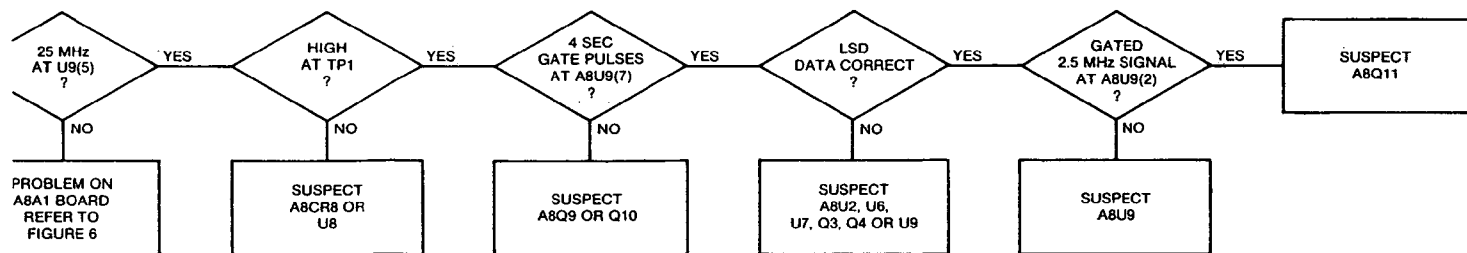


Figure 8-BC-4. "C" Channel Assembly Troubleshooting

*Figure 8-BC-4*  
**"C" CHANNEL ASSEMBLY TROUBLESHOOTING FLOWCHART**

(See Page 8-131)

### 8-C-1. HEWLETT-PACKARD INTERFACE BUS (HP-IB) SECTION

The HP-IB Assembly provides for control of the Model 5328B via the HP-IB. Plugging into the main instrument bus through a ribbon cable, the internally-mounted HP-IB board controls:

- FUNCTION
- TIME BASE
- cycle rate
- arming
- virtually all of the Model 5328B's controls, except for the DVM and the Programmable Input Module front-panel controls.

A special programming system in the HP-IB board allows any future module to be programmed through the present HP-IB system.

### 8-C-2. Principles of Operation

Operation of the Hewlett-Packard Interface Bus (HP-IB) is described in the following paragraphs.

### 8-C-3. STATE COUNTERS

Refer to the schematic diagram, Figure 8-C-2, as you read the material below.

The state of the ASM (Arithmetic State Machine) ROM (Read-Only Memory) is determined by State Counters A15U14 and A15U23, which form an eight-bit presettable binary counter.

When A15U25(1) is "low", the counters will always increment. When A15U25(1) is "high", the counters will "preset" ("jump" to another state in the program), if the output of A15U30C is "high". The preset address is supplied to the State Counter's input from the ROM.

The output of A15U30C is determined by the "not" bit from the ROM (through A15U21E) and the output of the Qualifier Flip-flop (A15U11A). The preprogrammed state of the "not" bit determines whether a "high" or "low" output of the Qualifier Flip-flop will result in a jump in the program. (This is shown in the ASM Operational Flowchart, by the of the letter "N" in a "decision diamond" symbol.) The preset (jump) is synchronous, and occurs only when:

- A15U14(9) and A15U23(9) are "low" and:
- there is a rising edge at A15U14(2) and A15U23(2).

Flip-flop A15U31A synchronizes the resetting of the State Counters to occur at the proper time.

### 8-C-4. ARITHMETIC STATE MACHINE (ASM) OSCILLATOR

Refer to the ASM Oscillator Timing Diagram, Figure 8-C-1, as you read the material below.

The ASM oscillator circuit provides three separate phases of clock outputs.

Schmitt trigger A15U18A is the fundamental oscillator element, using hysteresis to develop oscillation.

The output of A15U18A (through A15U13) strobes storage latches A15U11A and A15U11B, A15U15, A15U19, A15U24, A15U26, A15U28, A15U33, A15U31B and A15U34.

The output of A15U18A is also sent through a delay circuit (consisting of resistor A15R14 and capacitor A15C4) into A15U18B to provide another phase of the clock output that determines the state of the ASM.

In addition, the output of A15U18A is sent through A15U30A to provide a third clock phase which is applied to A15U31A. The output of A15U31A resets the 8-bit State Counter synchronously at power-up or when the IFC signal occurs. (Synchronous reset prevents loading the storage latches with erroneous data.) The IFC signal also resets A15U26 (ASM storage).

The power-up reset circuit consisting of A15U18C and A15U18D clears all storage elements.

#### **8-C-5. BUS INTERFACE**

The bus interface circuit consists of bus line termination resistors, data output drivers, and data input buffers.

Resistors A15R29 and A15R30 form the line termination networks. Integrated circuit A15U4 buffers the bus line inputs.

Integrated circuits A15U5, A15U10, and A15U16 are high-current drivers that drive the bus line output.

The "ATN" signal is sent through A15U9A and A15U29D to ensure that the gates connected to bus lines "DIO1" through "DIO7" and "DAV" do not output when "ATN" goes "true".

The DAO signal from A15U24(9) arms the DAC signal through A15U17B to ensure that DAC goes "false" within a few gate delays after "ATN" goes "true". (In some cases, the DAC response from the ROM may be too slow.) After "ATN" is "true", "DAO" is set to a "0" to allow normal operation of the DAC line.

#### **8-C-6. END OF MEASUREMENT**

When a measurement has been completed, flip-flop A15U11B is set. This flip-flop is clocked by the closing edge of the "LMG" signal.

Diode A15CR2 and transistor A15Q3 keep A15U11B from going to its "1" state when "LRES" is "low" or "HRD" is "high". (During these times, the counter is being reset, and the noise which appears on the "LMG" line, could trigger A15U11B).

#### **8-C-7. QUALIFIER MULTIPLEXERS**

Five 8-to-1 multiplexers are connected to allow 36 lines to be multiplexed into one line.

ASM ROM A15U22 controls:

- multiplexers A15U3, A15U6, A15U8, and A15U32, to select individual line qualifiers and:
- multiplexer A15U12, to select one of these multiplexers.

Additionally, A15U12 checks the output of the Auxiliary State Counter, A15U7. This counter is a four-bit binary counter that allows the same sequence of states to be repeated up to 16 times. In the output algorithm, each state represents an output character.

Qualifier flip-flop A15U11A eliminates erroneous results by ensuring that the Counters A15U14 and A15U23 are not clocked when a qualifier is changing states. This would cause a partial preset and partial increment of the State Counters.

### 8-C-8. ADDRESSING

Address Comparator A15U2 monitors the Data Input/Output (DIO) lines "2" through "5" and the address switch (S1) settings.

When the number on the "DIO" lines is the same as that set into switch S1, A15U2 sends the qualifier "ADDR" to multiplexer A15U8. The address switch's "TALK ALWAYS" section provides a way of setting A15U6 so the interface is always addressed to talk.

### 8-C-9. DATA OUTPUT

The Data Output circuit outputs characters on the bus data lines.

Storage circuit A15U24 transfers outputs from the ROM to DIO lines "5" through "7".

Integrated Circuit A15U15 selects data from either the ROM or the Model 5328B's data bus and transfers it to DIO1-DIO4. The state of the "not" bit from ROM A15U22(13) through A15U21E determines the selection made by A15U15.

A displayed digit is selected from the Model 5328B, any other character (decimal point, "E", carriage return, exponent, line feed, etc.) is selected from the ROM.

### 8-C-10. ASM STORAGE

The internal memory for the ASM is in the ASM Storage circuits (A15U19, A15U26, and A15U31B), which can set or clear 17 information bits.

One-shot A15U1, which is part of this section, outputs a 1 ms pulse ("LRST") to ensure reliable operation of the state control circuit A1U4 on the Motherboard.

Diode A15CR3 ensures that "LINH" is "low" to inhibit the counter during the time that "LRST" is "low".

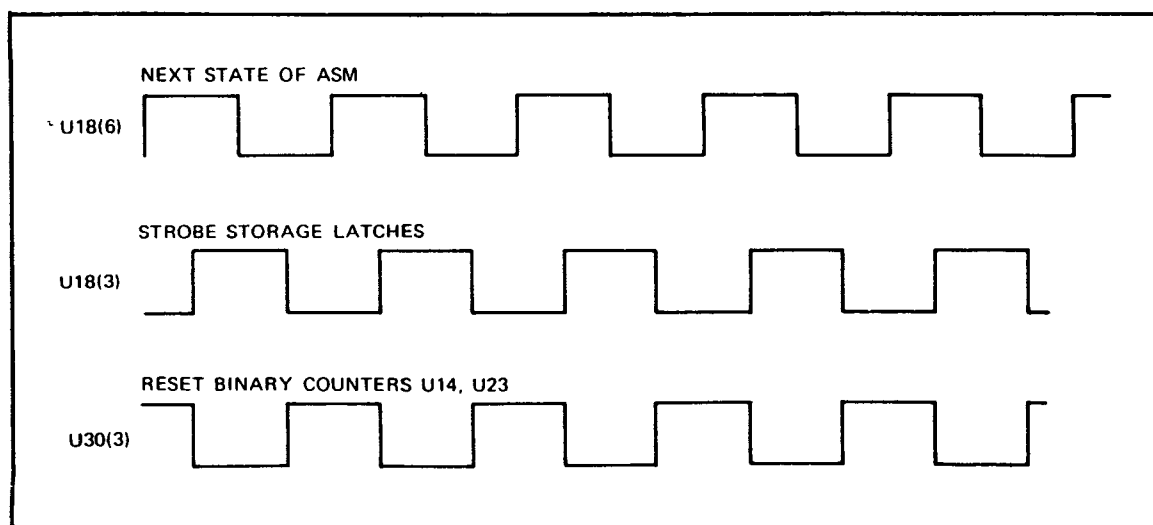


Figure 8-C-1. HP-IB Interface ASM Oscillator Timing Diagram



#### **8-C-11. STROBE ENABLE DECODER**

Decoder A15U13 is a 4-to-10-line decoder that strobes the various storage latches.

Pins "1", "14", and "15" are used to select the device to be strobed.

Pin "2" is an "enable" which determines the width of the strobe pulse.

The decoder (A15U13) is disabled when the output of A15U25C goes "high", indicating that the ASM is in its "decision state" mode.

#### **8-C-12. REMOTE PROGRAM STORAGE**

Storage circuits A15U28, A15U33, and A15U34 program instrument functions.

Integrated circuit A15U28 stores Time Base codes in three-bit bytes.

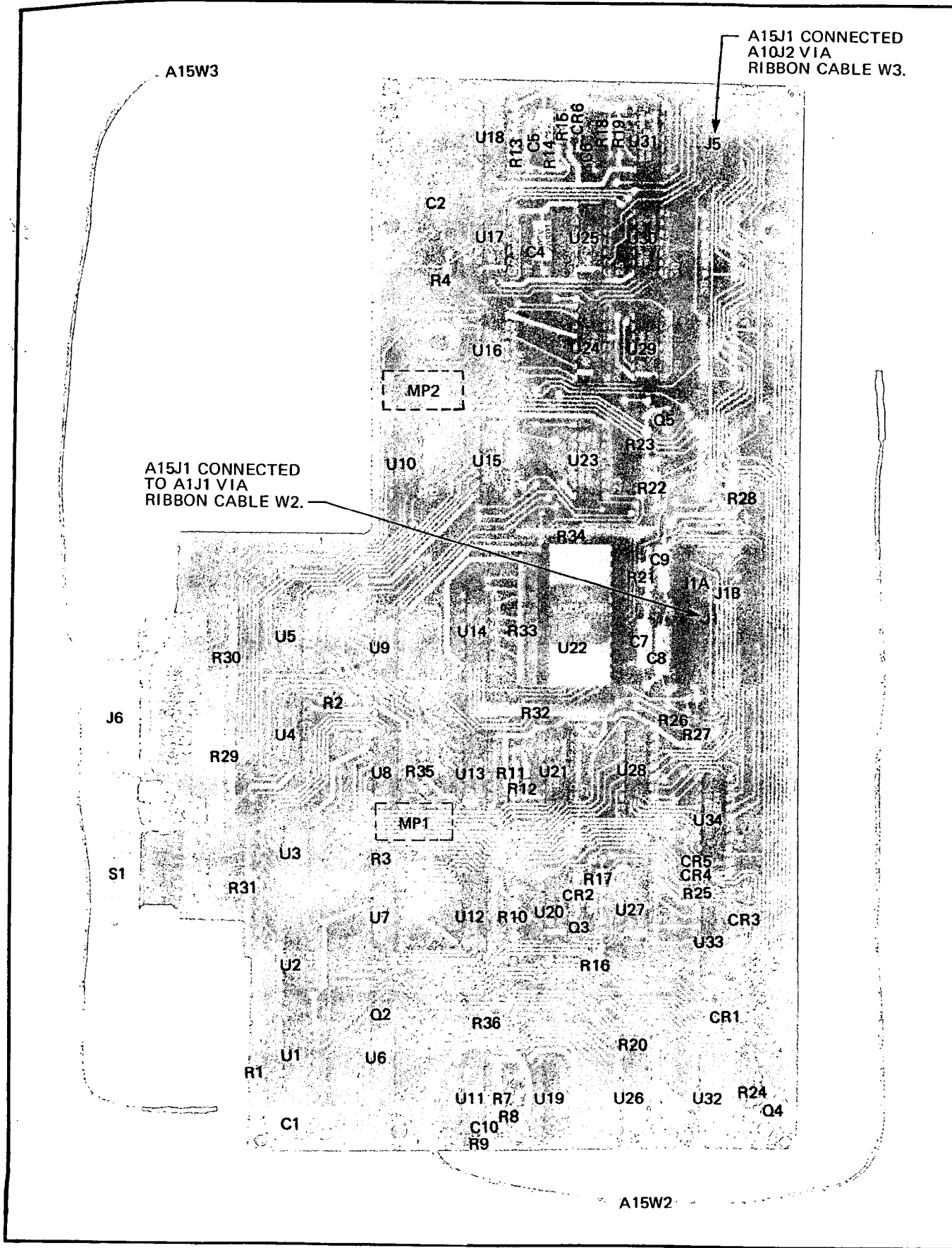
Integrated Circuit A15U34 stores Function codes in four-bit bytes.

Integrated circuit A15U33 stores eight bits of information, one bit at a time. The Sample Rate, Arming, Storage Off, and Decade Reset can be programmed by A15U33. In addition, A15U33(4, 5, and 6) control the manner in which measurements are made and output to the bus. The inputs to the remote program storage circuit are Module Data "A", "B", "C", and "D" lines from the DIO lines — "1", "2", "3", and "4", respectively.

#### **8-C-13. Troubleshooting The HP-IB Board A15**

The HP-IB board in the 5328B is a complex board with a large number of ICs and control lines. A troubleshooting kit has been set up for this board that uses the 55005A Logic Troubleshooting System. Signatures of a correctly operating HP-IB board have been characterized and provided along with a program that guides the user, pin by pin through the board. The kit also contains the 2 test cards described earlier in the Main Counter Troubleshooting. When ordering the kit use Part Number 05328-60131.

This kit is used in conjunction with a controller such as the HP 85 and the 5005B Signature Multimeter.



P/O Figure 8-C-2. A15 HP-IB Interface Assembly

Signals from A15J1 through Cable to A1J1 (Motherboard)

- 1 LDDIS → BUS (39)
- 2 LDP → BUS (41)
- 3 LOVFL → BUS (28)
- 4 FC → BUS (36) → XA16(5)
- 5 FD → BUS (36) → XA16(5)
- 6 HRD → BUS (33)
- 7 LRES → BUS (32)
- 8 LTR → BUS (31) → XA4A(12)
- 9 LINH → BUS (30)
- 10 TBSB → BUS (35) → XA16(24)
- 11 TBSA → BUS (35) → XA16(23)
- 12 FB → BUS (37) → XA16(7)
- 13 LARM → XA4B(1)
- 14 TBSC → BUS (34) → XA16(22)
- 15 FA → BUS (37) → XA16(6)
- 16 LMG → XA4(A17) → BUS (38)
- 17 LEXT → BUS (38)
- 18 LANN → BUS (41)
- 19 SRT → A1(U4) → XA16(24)
- 20 HDS → XA4A(4) → BUS (14)
- 21 +15V
- 22 DC → XA4(B15) → BUS (42)
- 23 DD → XA4(B16) → BUS (42)
- 24 +5V
- 25 DA → XA4(B17) → BUS (43)
- 26 DB → XA4(B18) → BUS (43)
- 27 GND
- 28 -5V



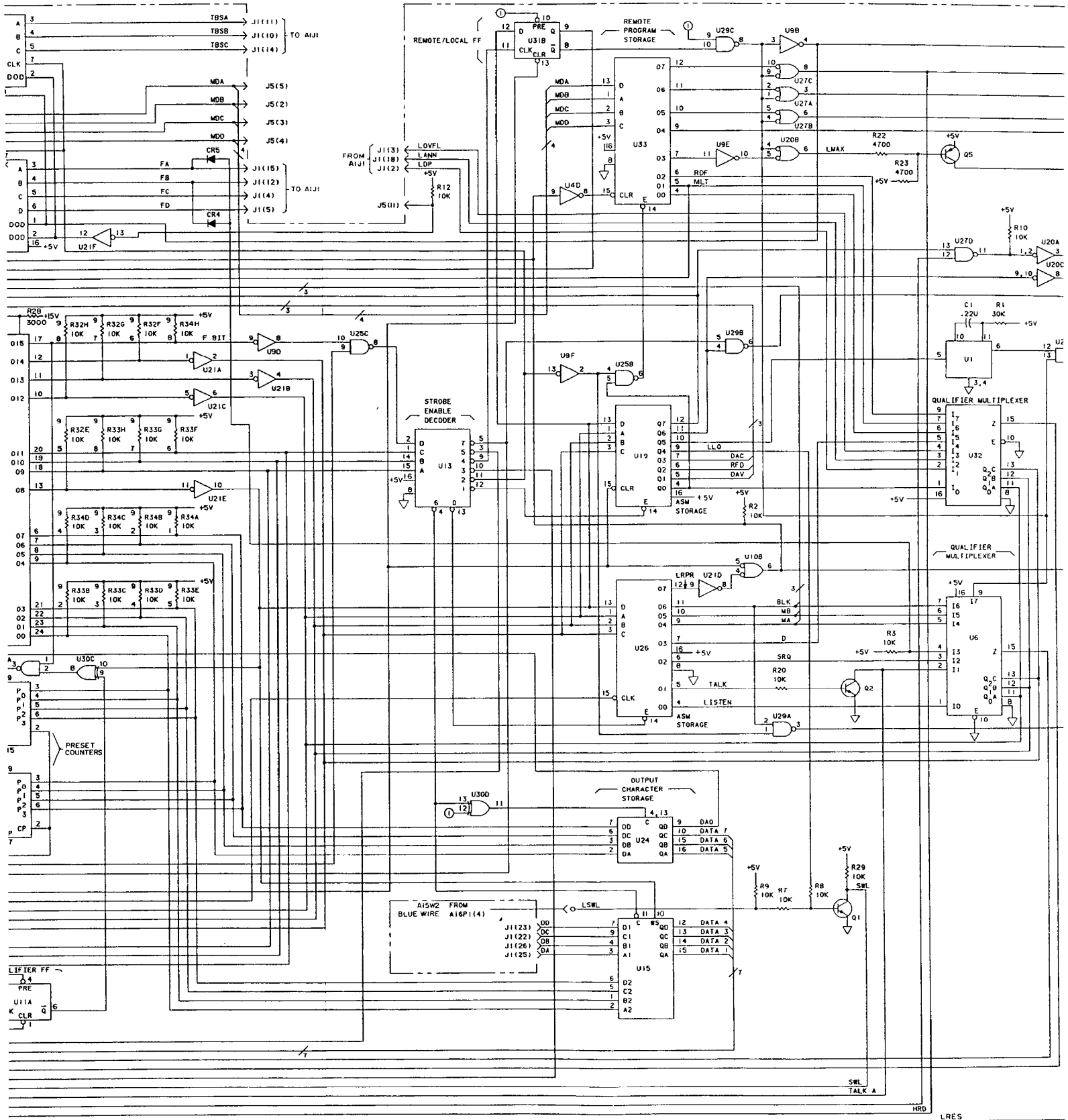
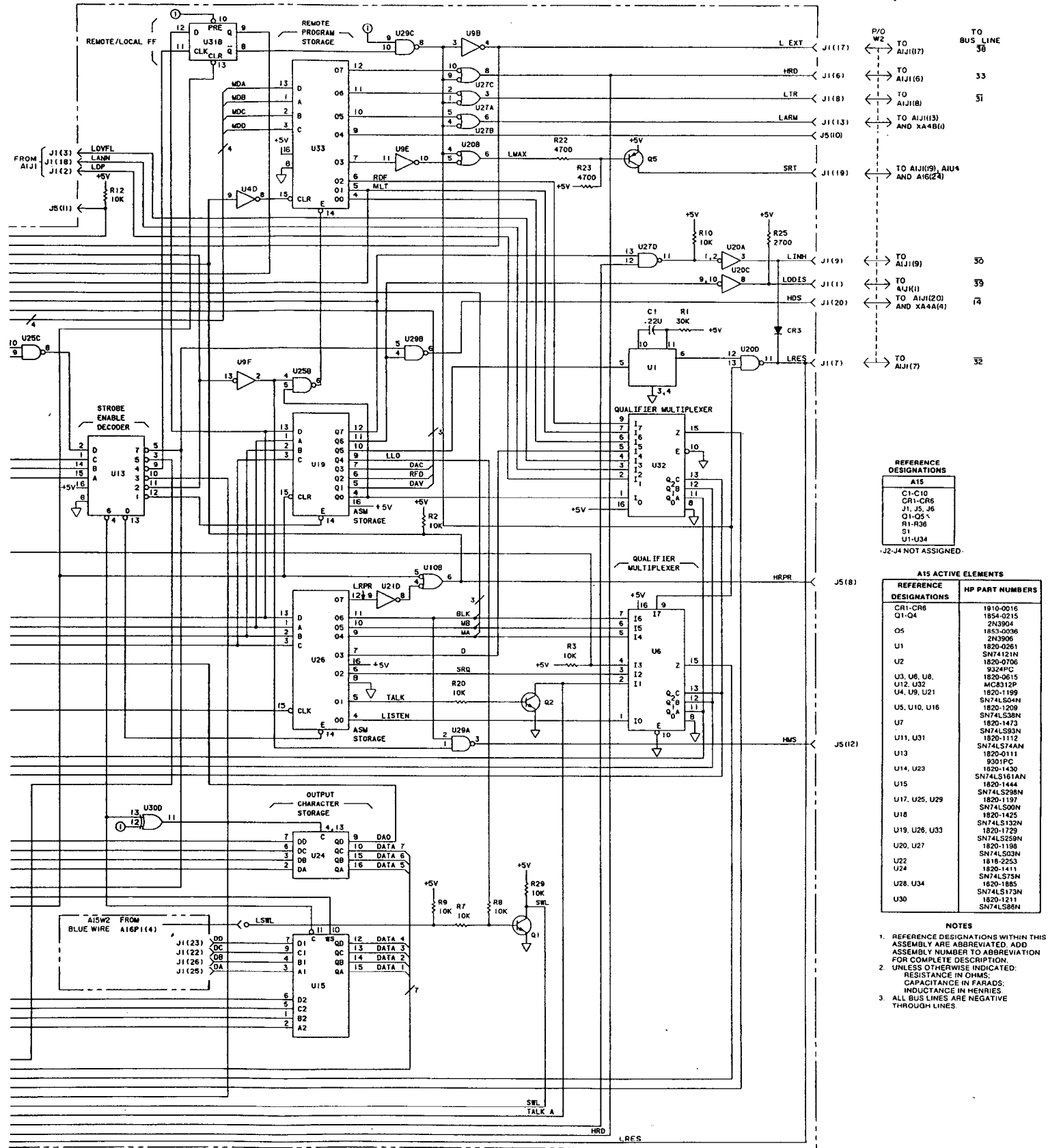


Figure 8-C-2. A15 HP-IB In



**REFERENCE DESIGNATIONS**

**A15**

C1-C10  
CR1-CR6  
J1, J5, J6  
Q1-Q5  
R1-R36  
S1  
U1-U34

J2-J4 NOT ASSIGNED.

**A15 ACTIVE ELEMENTS**

REFERENCE DESIGNATIONS	HP PART NUMBERS
CR1-CR6	1910-0016
Q1-Q4	1854-0215
	2N3904
Q5	1855-0096
	2N3906
U1	1820-0261
	SN74121A
U2	1820-0706
	9324PC
U3, U6, U8	1820-0615
U12, U32	MC8R13P
U4, U9, U21	1820-1199
U5, U10, U16	1820-1209
	SN74LS04N
	1820-1208
	SN74LS38N
U7	1820-1473
	SN74LS93N
U11, U31	1820-1112
	SN74LS74AM
U13	1820-0111
	9201PC
U14, U23	1820-1430
U15	SN74LS161AN
	1820-1444
	SN74LS298N
U17, U25, U29	1820-1197
	SN74LS90N
U18	1820-1425
	SN74LS132N
U19, U26, U33	1820-1729
	SN74LS290N
U20, U27	1820-1198
	SN74LS03N
U22	1818-2253
U24	1820-1411
	SN74LS75N
U28, U34	1820-1885
	SN74LS173N
U30	1820-1211
	SN74LS86N

- NOTES**
- REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.
  - UNLESS OTHERWISE INDICATED: RESISTANCE IN OHMS; CAPACITANCE IN FARADS; INDUCTANCE IN HENRIES.
  - ALL BUS LINES ARE NEGATIVE THROUGH LINES.

Figure 8-C-2. A15 HP-IB Interface Assembly Schematic Diagram

*Figure 8-C-2*  
**A15 HP-IB INTERFACE ASSEMBLY (SCHEMATIC DIAGRAM)**

(See Page 8-137)

## 8-D-1. POWER SUPPLY (A2)

The Model 5328B's Power Supply, shown in Figure 8-D-2, has five output voltages (all are dc): +5V, -5.2V, +15V, -15V, and +3.5V.

The +5V and -5.2V circuits are essentially the same, as are the +15V and -15V sections; therefore, only the supplies for the positive voltages will be described below.

## 8-D-2. Principles of Operation

### 8-D-3. GENERAL

The Power Supply provides regulated dc voltages for the Model 5328B's other operating sections. It has enough capacity to operate any combination of the Model 5328B's options.

The main ON/OFF switch operates only the central power supply regulator; the main ac power is not controlled by this switch, and is always "on" as long as the Model 5328B is connected to an operating ac power line. Unregulated dc is constantly fed to the (optional) oven oscillator (if installed), eliminating the need for time base warm-up. The cooling fan gets its power from the ac power line via a triac, which is controlled by an optical isolator when the Model 5328B is turned off.

### 8-D-4. +5V SUPPLY

The +5V supply is a switching regulator that is more efficient than a linear regulator having the same output.

When the "+5V" output voltage is below its nominal level, comparator U1's "+" input becomes more positive than its "-" input; this makes U1's output go positive, which turns on transistor Q5, which, in turn, turns on Q3 and Q1. The voltage at Q1's collector now goes "high" (more than +17V) and current starts to build up through L1, charging the output capacitor and increasing the output voltage. At the same time, positive feedback is provided via resistor R11 to maintain the condition until the output goes slightly above +5V. When the voltage reaches this point, the comparator's output voltage starts to fall, turning off transistors Q5, Q3, and Q1, causing the voltage at Q1's collector to fall. This provides positive feedback via resistor R11 to reinforce the charge. As a result, transistors Q5, Q3, and Q1 are turned off "hard", and the voltage at the collector of Q1 goes negative, except for diode CR3, which clamps the voltage to ground. During this part of the cycle, current flows through diode CR3 and coil L1, allowing the energy which has been stored in the field of L1 to go into the load. This goes on until the output voltage again goes "low" enough to overcome the offset at the input of Comparator U1 and turn transistor Q1 on again.

### 8-D-5. +15V SUPPLY

The +15V Supply is a linear regulator, using transistor Q7 as the pass transistor. Transistor Q9 provides level-shifting and current gain, while U3 is used as a Comparator and Gain Block.

### 8-D-6. +3.5V SUPPLY

The +3.5V Supply is a linear regulator with the Operational Amplifier section of U5 being used as a Comparator and Gain Block. Resistor R32 provides overcurrent limiting to protect against short circuits.

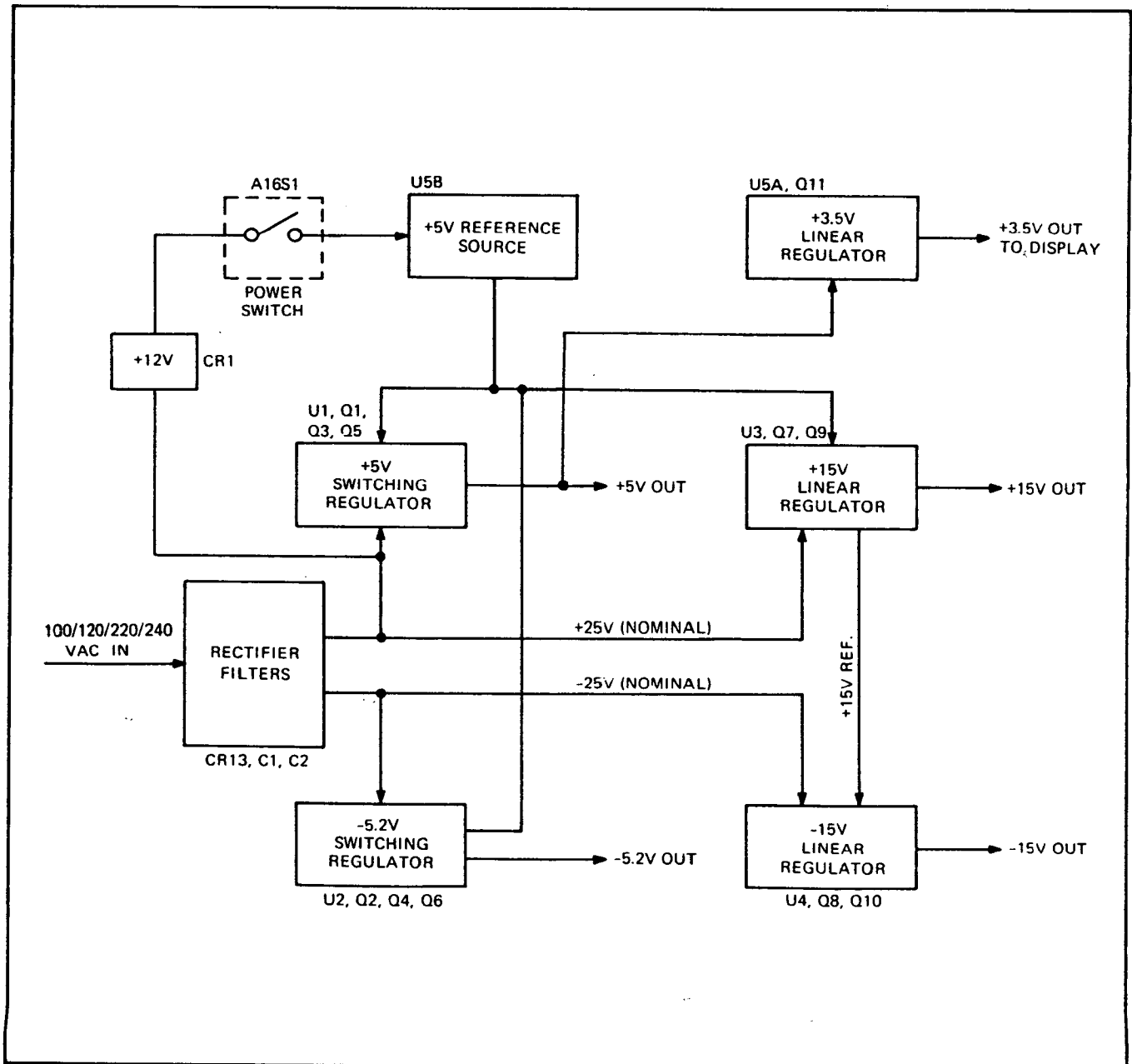
## 8-D-7. Troubleshooting

Figures 8-D-1 and 8-D-2 are provided to aid in troubleshooting the A2 Power Supply Board.



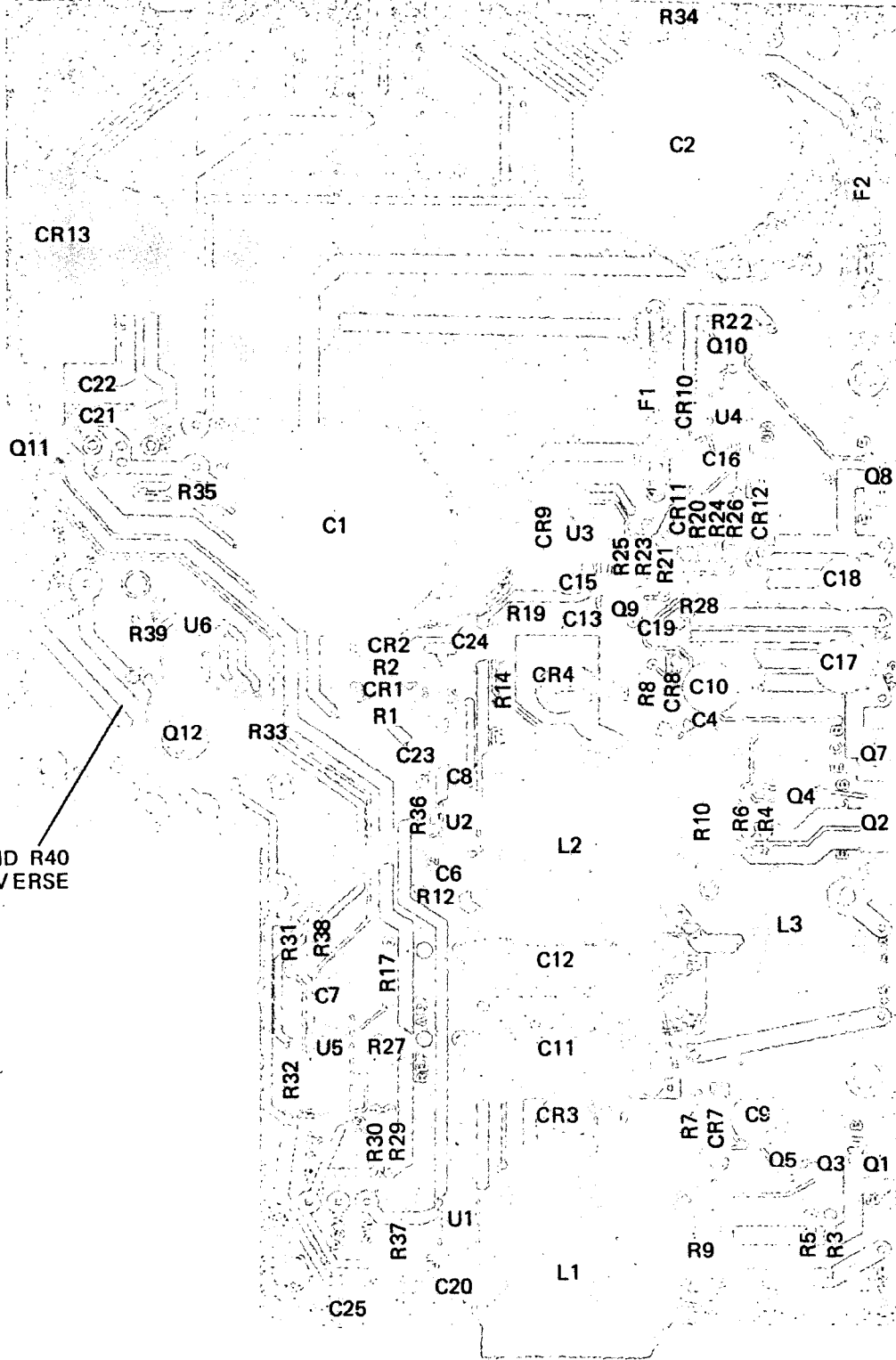
**WARNING**

110V/120V/220V/240V AC SUPPLY WIRES ARE EXPOSED WHEN EITHER THE TOP OR BOTTOM COVER IS REMOVED. USE EXTREME CAUTION DURING TROUBLESHOOTING, ADJUSTMENT, OR REPAIR. TO REDUCE THE CHANCE OF PERSONAL INJURY OR DAMAGE TO EQUIPMENT, DISCONNECT THE MODEL 5328B FROM ITS OPERATING AC POWER LINE BEFORE YOU REMOVE OR REPLACE ITS COVERS OR ANY OF ITS INTERNAL ASSEMBLIES OR COMPONENTS.



P/O Figure 8-D-2. A2 Power Supply Assembly Troubleshooting

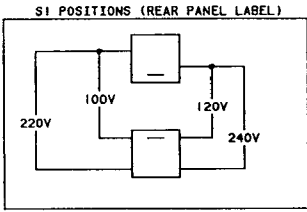
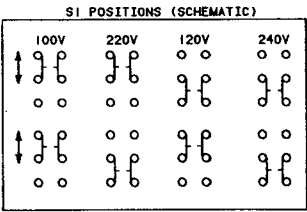
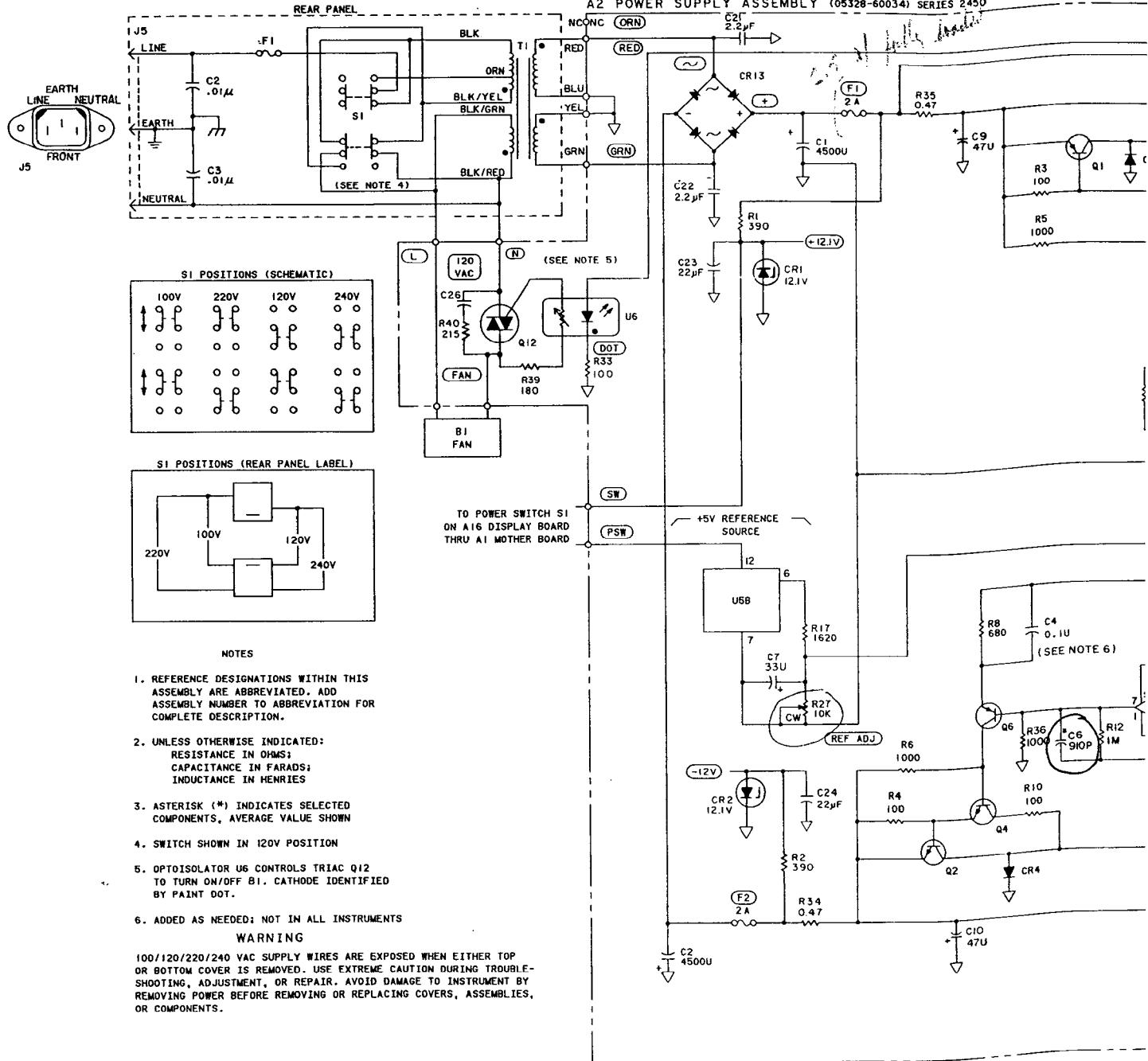
FACTORY TEST CONNECTOR



C26 AND R40  
ON REVERSE  
SIDE

55

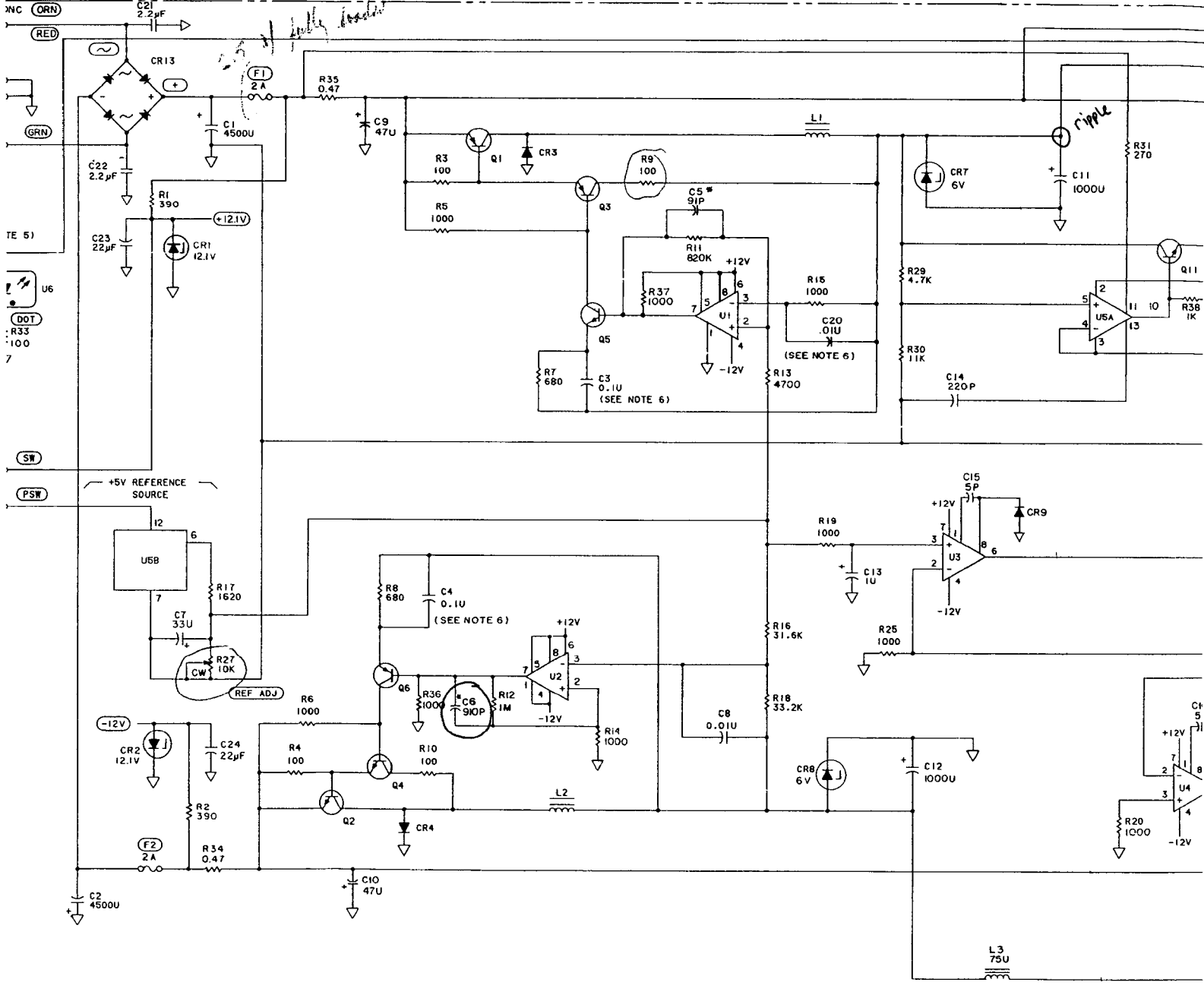
A2 POWER SUPPLY ASSEMBLY (05328-60034) SERIES 2450

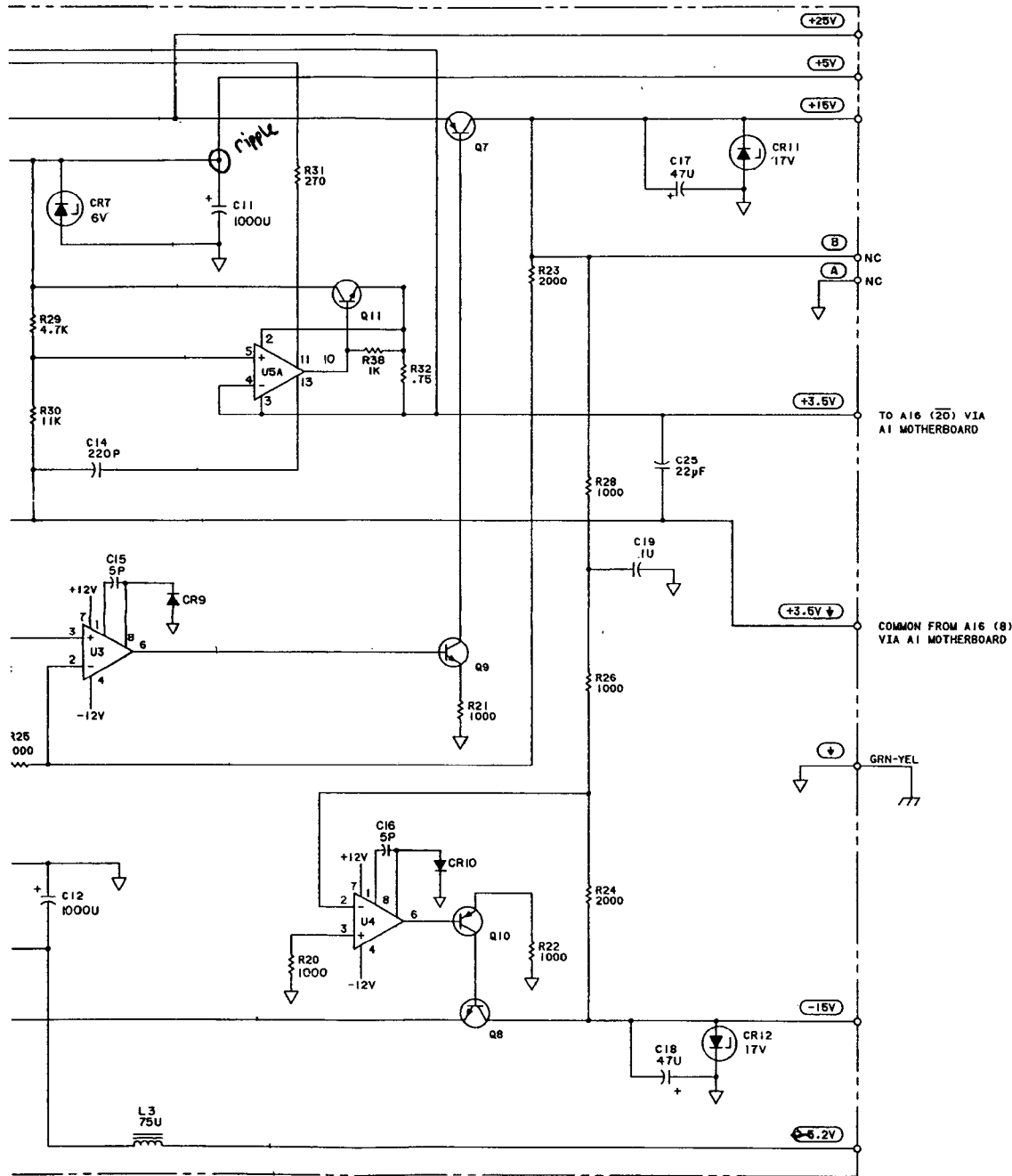


- NOTES
1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.
  2. UNLESS OTHERWISE INDICATED:  
RESISTANCE IN OHMS;  
CAPACITANCE IN FARADS;  
INDUCTANCE IN HENRIES
  3. ASTERISK (\*) INDICATES SELECTED COMPONENTS, AVERAGE VALUE SHOWN
  4. SWITCH SHOWN IN 120V POSITION
  5. OPTOISOLATOR U6 CONTROLS TRIAC Q12 TO TURN ON/OFF B1. CATHODE IDENTIFIED BY PAINT DOT.
  6. ADDED AS NEEDED; NOT IN ALL INSTRUMENTS

**WARNING**  
100/120/220/240 VAC SUPPLY WIRES ARE EXPOSED WHEN EITHER TOP OR BOTTOM COVER IS REMOVED. USE EXTREME CAUTION DURING TROUBLE-SHOOTING, ADJUSTMENT, OR REPAIR. AVOID DAMAGE TO INSTRUMENT BY REMOVING POWER BEFORE REMOVING OR REPLACING COVERS, ASSEMBLIES, OR COMPONENTS.

A2 POWER SUPPLY ASSEMBLY (05328-60034) SERIES 2450





A2	
C1 - C25	
CR1 - CR4	
CR7 - CR13	
F1, F2	
L1, L2, L3	
Q1 - Q12	
R1 - R39	
U1 - U6	
NOT ASSIGNED CR5, CR6	

A2 ACTIVE ELEMENTS	
REFERENCE DESIGNATIONS	PART NUMBERS
CR1, CR2	1902-0774
CR3, CR4	1901-1086
CR5, CR6	NOT ASSIGNED
CR7, CR8	1902-0522
CR9, CR10	1901-0040
CR11, CR12	1902-0632
CR13	1901-0638
Q1, Q7	1853-0363
Q2, Q8, Q11	1854-0635
Q3	1853-0326
Q4	1854-0634
Q5, Q9	1854-0492
Q6, Q10	1853-0016 2N3638
Q12	1894-0055
U1, U2	1826-0085 LM311N
U3, U4	1820-0477 LM301AN
U5	1820-0439 723PC
U6	1890-0845

Figure 8-D-2. A2 Power Supply Assembly Schematic