

TECHNICAL MANUAL

**OPERATOR'S, ORGANIZATIONAL, DIRECT SUPPORT,  
AND GENERAL SUPPORT MAINTENANCE MANUAL  
INCLUDING REPAIR PARTS AND SPECIAL TOOLS LIST  
FOR  
COUNTER, ELECTRONIC, DIGITAL READOUT  
AN/USM-459  
(HEWLETT-PACKARD MODEL 5328A/E42)  
(NSN 6625-01-061-8928)**

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**HEADQUARTERS, DEPARTMENT OF THE ARMY**

**MARCH 1979**



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TM 11-6625-2941-14 + P

Technical Manual

HEADQUARTERS,  
DEPARTMENT OF THE ARMY  
Washington, DC 28 March 1979

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REPORTING OF ERRORS

You can improve this manual by recommending improvements using DA Form 2028-2 located in the back of the manual. simply tear out the self-addressed form, fill it out as shown on the sample, fold it where shown, and drop it in the mail.

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In either case a reply will be furnished direct to you.

This manual is an authentication of the manufacturer's commercial literature which, through usage, has been found to cover the data required to operate and maintain this equipment. The manual was not prepared in accordance with military specifications; therefore, the format has not been structured to consider categories of maintenance.

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## **SAFETY CONSIDERATIONS**

### **GENERAL**

This is a Safety Class I instrument. This instrument has been designed and tested according to IEC Publication 348, "Safety Requirements for Electronic Measuring Apparatus."

### **OPERATION**

BEFORE APPLYING POWER verify that the power transformer primary is matched to the available line voltage and the correct fuse is installed (see Section II). Make sure that only fuses with the required rated current and of the specified type (normal blow, time delay, etc.) are used for replacement. The use of repaired fuses and the short-circuiting of fuseholders must be avoided.

### **SERVICE**

Although this instrument has been designed in accordance with international safety standards, this manual contains information, cautions, and warnings which must be followed to ensure safe operation and to retain the instrument in safe condition. Service and adjustments should be performed only by qualified service personnel.

Any adjustment, maintenance, and repair of the opened instrument under voltage should be avoided as much as possible and, when inevitable, should be carried out only by a skilled person who is aware of the hazard involved.

Capacitors inside the instrument may still be charged even if the instrument has been disconnected from its source of supply.

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

**WARNING**

IF THIS INSTRUMENT IS TO BE ENERGIZED VIA AN AUTOTRANSFORMER (FOR VOLTAGE REDUCTION] MAKE SURE THE COMMON TERMINAL IS CONNECTED TO THE EARTHED POLE OF THE POWER SOURCE.

**WARNING**

BEFORE SWITCHING ON THE INSTRUMENT, THE PROTECTIVE EARTH TERMINALS OF THE INSTRUMENT MUST BE CONNECTED TO THE PROTECTIVE CONDUCTOR OF THE (MAINS) POWER CORD. THE MAINS PLUG SHALL ONLY BE INSERTED IN A SOCKET OUTLET PROVIDED WITH A PROTECTIVE EARTH CONTACT. THE PROTECTIVE ACTION MUST NOT BE NEGATED BY THE USE OF AN EXTENSION CORD (POWER CABLE) WITHOUT A PROTECTIVE CONDUCTOR (GROUNDING).

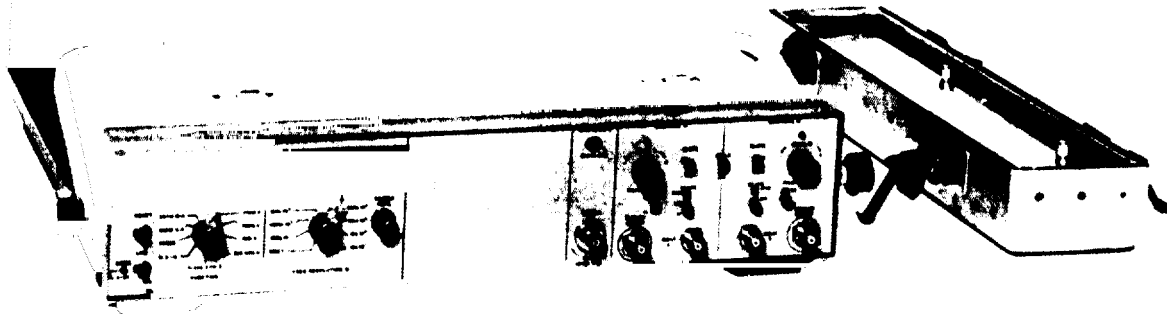
**WARNING**

THE SERVICE INFORMATION FOUND IN THIS MANUAL IS OFTEN USED WITH POWER SUPPLIED AND PROTECTIVE COVERS REMOVED FROM THE INSTRUMENT. ENERGY AVAILABLE AT MANY POINTS MAY, IF CONTACTED, RESULT IN PERSONAL INJURY.

**C A U T I O N**

BEFORE SWITCHING ON THIS INSTRUMENT:

1. MAKE SURE THE INSTRUMENT IS SET TO THE VOLTAGE OF THE POWER SOURCE.
2. ENSURE THAT ALL DEVICES CONNECTED TO THIS INSTRUMENT ARE CONNECTED TO THE PROTECTIVE (EARTH) GROUND.
3. ENSURE THAT THE LINE POWER (MAINS) PLUG IS CONNECTED TO A THREE-CONDUCTOR LINE POWER OUTLET THAT HAS A PROTECTIVE (EARTH) GROUND. (GROUNDING ONE CONDUCTOR OF A TWO-CONDUCTOR OUTLET IS NOT SUFFICIENT.)
4. MAKE SURE THAT ONLY FUSES WITH THE REQUIRED RATED CURRENT AND OF THE SPECIFIED TYPE (NORMAL BLOW, TIME DELAY, ETC.) ARE USED FOR REPLACEMENT. THE USE OF REPAIRED FUSES AND THE SHORT-CIRCUITING OF FUSE HOLDERS MUST BE AVOIDED.



*Figure 1-1. Model 5328A 500 MHz Universal Frequency Counter*

**SECTION O****INTRODUCTION****0-1. SCOPE**

This manual describes Counter, Electronic, Digital Readout AN/USM-459 and provides instructions for operation and maintenance. Throughout this manual, the AN/USM-459 is referred to as Hewlett-Packard Model 5328A Counter.

**0-2. INDEXES OF PUBLICATIONS**

a. DA Pam 310-4. Refer to the latest issue of DA Pam 310-4 to determine whether there are new editions, changes, or additional publications pertaining to the equipment.

b. DA Pam 310-7. Refer to DA Pam 310-7 to determine whether there are modification work orders (MWO's) pertaining to the equipment.

**0-3. FORMS AND RECORDS**

a. Reports of Maintenance and Unsatisfactory Equipment. Maintenance forms, records, and reports which are to be used by maintenance personnel at all maintenance levels are listed in and prescribed by TM 38-750.

b. Report of Packaging and Handling Deficiencies. Fill out and forward DD Form 6 (Packaging Improvement Report) as prescribed in AR 700-58/NAVSUPINST 4030.29/AFR 71-13/MCO P4030.29A and DLAR 4145.8.

c. Discrepancy in Shipment Report (DISREP) (SF 361). Fill out and forward Discrepancy in Shipment Report (DISREP) (SF 361) as prescribed in AR 55-38/NAVSUPINST 4610.33B/AFR 75-18/MCO P4610.19C and DLAR 4500.15.

**0-4. REPORTING EQUIPMENT IMPROVEMENT RECOMMENDATIONS (EIR)**

EIR's will be prepared using Standard Form 368 (Quality Deficiency Report). Instructions for preparing EIR's are provided in TM 38-750, The Army Maintenance Management System. EIR's should be mailed direct to Commander, US Army Communications and Electronics Materiel Readiness Command, ATTN: DRSEL-ME-MQ, Fort Monmouth, NJ 07703. A reply will be furnished direct to you.

**0-5. ADMINISTRATIVE STORAGE**

Administrative storage of equipment issued to and used by Army activities shall be in accordance with paragraph 2-26.

**0-6. DESTRUCTION OF ARMY ELECTRONICS MATERIEL**

Destruction of Army electronics materiel to prevent enemy use shall be in accordance with TM 750-244-2



## SECTION I GENERAL INFORMATION

### 1-1. SCOPE OF MANUAL

1-2. This manual provides operating and service information for the Hewlett-Packard Model 5328A/H42 500 MHz Universal Frequency Counter. (In this manual its name will be abbreviated to "5328A" or "counter".) A separate operators booklet contains condensed operator instructions.

1-3. This manual is divided into eight sections as listed and described below:

- |              |   |
|--------------|---|
| Section I    | GENERAL INFORMATION — Describes the counter, lists specifications, lists items supplied, lists items required, but not supplied, describes applications, and lists recommended maintenance and test equipment.                      |
| Section II   | INSTALLATION — Provides instructions for unpacking, inspection, preparation for use, preparation for reshipment, and preparation for storage.   |
| Section III  | OPERATION — Provides operator instructions including frequency, measurement of input signal: time period, time period average, time interval, time interval average, and ratio between frequencies of two input signals.            |
| Section IV   | THEORY OF OPERATION — Covers a. description of the general operating principles of the counter with reference to block and schematic diagrams of each assembly.   |
| Section V    | MAINTENANCE — Contains maintenance and service information, including a list of assemblies, recommended test equipment, performance checks, and adjustment. Troubleshooting procedures and flowcharts are included in this section. |
| Section VI   | REPLACEABLE PARTS — Provides a complete list of replaceable parts and parts ordering information.   |
| Section VII  | MANUAL CHANGES — Contains information on manual changes.  |
| Section VIII | CIRCUIT DIAGRAMS — Contains schematic diagrams and component locating illustrations.  |

### 1-4. DESCRIPTION

1-5. The 5328A counter can be used to measure frequency, period, period average, time interval, time interval average, and ratio. The 5328A provides a 9-digit LED display, display storage, and leading zero blanking. Decimal point and unit readouts are displayed automatically. Two independent selectable input channels are provided for time interval measurements. Each input channel has an attenuator, trigger slope selector, level control, ac or dc coupling, and an oscilloscope marker output. Rear panel connectors provide a gate output, one- and 10-megahertz output, and an input for an external frequency standard. An ARM switch on the rear panel allows arming by the signal being measured (switch OFF) or by another input signal (switch ON).

### 1-6. INSTRUMENT IDENTIFICATION

1-7. Hewlett-Packard instruments have a 2-section, 10-character serial number (0000A00000), which is located on the rear panel. The 4-digit serial prefix identifies instrument changes. If the serial prefix of your instrument differs from that listed on the title page of this manual, there are differences between this manual and your instrument. Instruments having higher serial prefixes are covered with a "Manual Changes" sheet included with this manual.

**1-8. APPLICATIONS**

1-9. Specific applications information is provided in Section III of this manual. The general application features of the 5328A are described in the following paragraphs.

1-10. The high sensitivity, frequency range, and signal conditioning controls (see Table 7-3) make the 5328A suited for a wide range of applications.

1-11. The rear panel controlled "ARM" feature of the 5328A is useful in applications such as burst frequency measurements, and pulse amplitude measurements.

1-12. The 5328A single-shot resolution of 100 ns meets the requirements for applications such as mechanical and electromechanical device (relays) timing, time of flight measurements (ballistics), sonar ranging, radio ranging, and navigation.

1-13. Using time interval averaging, time intervals as short as 100 picosecond, with resolution to 10 picosecond may be measured. Applications include coaxial cable length measurements, phase measurements, logic timing measurements, and integrated circuit propagation delay measurement.

1-14. Full bandwidth, sensitivity, and signal conditioning of the Channel A, B, and C input amplifiers is provided for ratio and totalizing measurements.

1-15. The 5328A HP-IB Interface is able to output measurement data and be controlled (fully programmed) via the Hewlett-Packard Interface Bus (HP-16). The 5328A may be interfaced to HP-IB compatible instruments, calculators, or computers by interconnecting with an HP-IB cable.

**1-16. EQUIPMENT SUPPLIED AND ACCESSORIES AVAILABLE**

1-17. Table 7-7 lists equipment supplied with the 5328A and Table 7-2 lists accessories available. The Service Kits listed in Table 1-2 are described in Section III.

**Table 1-1. Equipment Supplied**

| DESCRIPTION                                | HP PART NUMBER |
|--|----------------|
| Detachable Power Cord 231 cm (7½ ft.) long | 8120-1348      |
| Extender Board, 18 pin                     | 05328-62016    |

**Table 1-2. Accessories Available**

| DESCRIPTION  | HP PART NUMBER  |
|--|---|
| HP Interface Bus Interconnect Cable                                      | 10631A, 914 mm (3 ft. long)<br>10631B, 1828 mm (6 ft. long)<br>10631C, 3656 mm (12 ft. long)<br>10631D, 0.5 m (1½ ft. long) |
| Front Handle Kit   | 5061-0088   |
| Rack Flange Kit (for instruments without handles)                        | 5061-0076   |
| Rack and Handle Kit (installation instructions included with above kits) | 5061-0082   |
| <b>Service Kit:</b><br>Function Selector and ROM Kit                     | 05328-82004   |

**1-18. SPECIFICATIONS**

1-19. Table 1-3 lists detailed specifications for the 5328AF/096.



Table 1-3. 5328A Counter Specifications

|  |   |
|--|---|
| <b>GENERAL</b>   |   |
| <p><b>Power Requirements:</b> 115 or 230 volts 60 or 400 Hz ac.<br/> <b>Display:</b> Nine-digit LED.<br/> <b>Sample Rate:</b> Variable from less than 2 milliseconds to HOLD.<br/> <b>Arming:</b> Rear panel ARM (ON-OFF) switch. Refer to operation for details.<br/> <b>Blanking:</b> Unwanted zeros to left of most-significant-digit are suppressed.<br/> <b>Hold:</b> HOLDS count between samples.<br/> <b>Trigger Light:</b> Indicates input is above trigger level.</p>   | <p><b>Period Measurements</b><br/> <b>Period A</b><br/> <b>Range:</b> 0—10 MHz<br/> <b>Resolution:</b> 10 ns to 0.1s in decade steps.<br/> <b>Accuracy:</b> <math>\pm 1</math> count <math>\pm</math> time base error <math>\pm</math> trigger error*<br/> <b>Display:</b> ns, <math>\mu</math>s, ms.<br/> <b>Period Average A</b><br/> <b>Range:</b> 0—10 MHz<br/> <b>Resolution:</b> 100 ns—.01 ps in decade steps.<br/> <b>Accuracy:</b> <math>\pm 1</math> count displayed <math>\pm</math> time base error <math>\pm</math> trigger error*<br/> <math display="block">\pm \frac{\text{no. of periods averaged}}{\text{no. of periods averaged}}</math> <b>Display:</b> <math>\mu</math>s, ns</p> |
| <b>PROGRAMMABLE OPERATION (CHANNELS A AND B)</b>   |   |
| <p>Includes independent selection of coupling, trigger slope, trigger level, and attenuator for each channel. Separate/Common A switch is programmable. Also, an invert feature switches Channels A and B; useful in all functions except Ratio B/A.<br/>         Trigger level is programmable in 10 mV steps in X1; 100 mV in X10; 1V in X100.<br/>         Trigger level accuracy under remote control:<br/>         X1: <math>\pm 35</math> mV<br/>         X10: <math>\pm 350</math> mV +2% of trigger level<br/>         X100: <math>\pm 3.5</math>V +2% of trigger level</p>  |   |
| <b>Input Characteristics</b>   |   |
| <p><b>Sensitivity:</b> 15 mV rms, 0—35 MHz (decoupled 20 Hz—35 MHz (ac coupled)<br/>         50 mV rms, 35 MHz—100 MHz<br/>         Minimum pulse width 5 ns, 140 mV p-p.<br/> <b>Coupling:</b> ac or dc switch selectable.<br/> <b>Impedance:</b> 1 M<math>\Omega</math>    &lt;70 pF.<br/> <b>Trigger Level:</b> Variable over <math>\pm 2.5</math> volts times attenuator setting with 0 volt preset position.<br/> <b>Trigger Slope:</b> Independent selection of + or - slope.<br/> <b>Attenuators:</b> X1, X10, X100.<br/> <b>Dynamic Range:</b> 25 mV to 1V rms times attenuator setting, 0—35 MHz; 50 mV rms times attenuator setting, 35 MHz to 100 MHz<br/> <b>Maximum Input:</b><br/> <b>dc coupled, X1:</b> 250V rms, dc — 50 kHz<br/> <math>1.25 \times 10^4</math> V rms/freq., 50 kHz—2.5 MHz<br/>         5V rms, 2.5 MHz—100 MHz.<br/> <b>dc coupled, X10 and X100:</b> 250V rms, dc 5 MHz<br/> <math>1.25 \times 10^9</math> V rms/freq., 5—100 MHz<br/> <b>ac coupled:</b> 200V (peak ac + dc), 0-20 Hz; same as dc coupled above 20 Hz.<br/> <b>Channel Input:</b> Separate or Common A.<br/> <b>Marker Outputs:</b> A and B channel Schmidt trigger outputs available on front panel; 0 to 300 mV levels into 50<math>\Omega</math>; &lt;20 ns delay.</p> |   |
| <b>Frequency Measurements</b>  |   |
| <p><b>Frequency A</b><br/> <b>Range:</b> 0—100 MHz direct count.<br/> <b>Resolution:</b> 1 MHz to 0.1 Hz in decade steps.<br/> <b>Accuracy:</b> <math>\pm 1</math> count <math>\pm</math> time base error.<br/> <b>Display:</b> Hz, kHz, MHz.</p>  |   |
| <b>Time Interval Measurements</b>  |   |
| <p><b>Time Interval A to B</b><br/> <b>Range:</b> 100 ns to 10<sup>8</sup> seconds<br/> <b>Resolution:</b> 100 ns to 1-second in decade steps.<br/> <b>Accuracy:</b> <math>\pm 1</math> count <math>\pm</math> time base error <math>\pm</math> trigger error*<br/> <b>Display:</b> <math>\mu</math>s, ms, s.<br/> <b>Time Interval Average A to B</b><br/> <b>Range:</b> 0.1 ns to 10 seconds<br/> <b>Resolution:</b><br/> <math display="block">\pm \frac{100 \text{ ns}}{\sqrt{\text{no. of intervals averaged}}} \pm 10 \text{ ps}</math> <b>Accuracy:</b><br/> <math display="block">\pm 100 \text{ ns} + \text{trigger error}^* \pm 2 \text{ ns} \pm \text{time base error}</math> <math display="block">\pm \frac{\text{no. intervals averaged}}{\sqrt{\text{no. intervals averaged}}}</math> <b>Minimum Dead Time:</b> 150 ns from one STOP to next START<br/> <b>Maximum Repetition Rate:</b> 10 MHz.<br/> <b>Display:</b> <math>\mu</math>s, ns.</p>   |   |
| <b>Ratio Measurement</b>   |   |
| <p><b>Ratio B/A, or C/A</b><br/> <b>Range:</b> A: 0—10 MHz<br/>         Range: B: 0—100 MHz<br/>         Range: C: 30—500 MHz<br/> <b>Resolution:</b> 1 part in <math>\frac{B}{A} \times N</math><br/> <b>Accuracy:</b> <math>\pm 1</math> count of B or C <math>\pm</math> trigger error* of A times frequency of B or C (N&gt;1)<br/>         For N=1, add 12 ns times frequency of B or C.</p>  |   |
| <p>* Trigger error is &lt;0.3% of one period for sine waves of 40 dB S/N or better and amplitude equal to sensitivity of counter. For any wave shape, trigger error is than then:<br/> <math display="block">\frac{\pm 2 \times \text{peak noise voltage}}{\text{signal slope}}</math>         (or <math>\frac{\pm .0025 \mu\text{s}}{\text{signal slope in V}/\mu\text{s}}</math> for 40 dB S/N)</p>  |   |

*Table 7-3. 5328A Counter Specifications (Continued)*

| CHANNEL C   | TIME BASE   |
|---|---|
| <p><b>Input Characteristics</b><br/><b>Range:</b> 30 MHz to 500 MHz direct count<br/><b>Sensitivity:</b> 15 mV rms, 30 MHz—500 MHz<br/><b>Trigger level:</b> 0 volts<br/><b>Impedance:</b> 50<math>\Omega</math> nominal<br/><b>Maximum Input:</b> 5 volts rms<br/><b>Input protection:</b> Input BNC fused; accessible from front panel. protected to 200 volts peak.<br/><b>overload Indicator:</b> flashing indicator warns of potential overload conditions.<br/><b>Resolution:</b> 1 MHz to 0.1 Hz in decade steps<br/><b>Accuracy:</b> <math>\pm 1</math> count <math>\pm</math> time base error<br/><b>Display:</b> Hz, kHz, MHz</p> | <p><b>Outputs:</b> 1 MHz and 10 MHz available at rear panel BNC in standby and operate modes<br/><b>Output level:</b> 1 volts rms into 50<math>\Omega</math><br/><b>External Input:</b> Operates from 1, 2.5, 5, and 10 MHz inputs at 1V rms.<br/>Input impedance 1 k<math>\Omega</math>   &lt;30 pF<br/>Counter automatically switches to external mode when external input is present.<br/><b>Oscillator Aging Rate:</b> <math>&lt;5 \times 10^{-10}</math>/day after 24-hour warmup. Oscillator oven is energized when power cable is connected to line voltage.</p> |

## SECTION II INSTALLATION

### 2-1. INTRODUCTION

2-2. This section provides instructions for unpacking, inspection, preparation for use, shipment, and storage.

### 2-3. UNPACKING AND INSPECTION

2-4. If the shipping carton is damaged, inspect the counter for visible damage (scratches, dents, etc.). If the counter is damaged, notify the carrier and the nearest Hewlett-Packard Sales and Service Office immediately (offices are listed at the back of this manual). Keep the shipping carton and packing material for the carrier's inspection.

### 2-5. PREPARATION FOR USE

#### CAUTION

**Before connecting this instrument to an ac power line, be sure that the 115—230-volt line selector switch on the rear panel is set to the proper position and proper line fuse is installed (see below).**

### 2-6. Power Requirements

2-7. This instrument can be operated on single phase 115 or 230 (-10%. +5%) volts ac. Power required is approximately 100 VA maximum. To avoid instrument damage, the rear panel line selector switch must be set to the correct position and the correct fuse (as labeled on the rear panel) must be installed. See Section III for rear panel features photograph. When shipped, the switch is set to 115-volt ac operation.

### 2-8. Fuse Replacement and Installation

2-9. Two fuses are supplied with the instrument. The instrument is shipped with a 2.0 ampere fuse installed for 115- volt operation. To change the instrument for 230-volt operation disconnect the ac power cable, set the line selector switch and install the 1.0 ampere fuse.

### 2-10. Power Cables

#### WARNING

**TO PROTECT OPERATING AND SERVICING PERSONNEL, THIS INSTRUMENT IS EQUIPPED WITH A THREE-PIN POWER RECEPTACLE. THE CENTER PIN OF THE RECEPTACLE CONNECTS THE INSTRUMENT 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 EQUIPMENTS.**

## Model 5328A Installation

2-11. To accommodate the different power receptacles used throughout the world, this instrument is supplied with one of the power cables shown in Figure 2-7. The cable supplied for use in the United States meets the specifications established by the International Electrotechnical Commission (IEC). The male connector of this cable is a NEMA type and the female connector is a C.E.E. type.

2-12. Connect the power cable to a power source receptacle that has a grounded third conductor. If the line power receptacle is a two-pin type instead of a three-pin receptacle, use a two- to three-pin adapter (HP Part No. 1251-0048 for USA applications) and connect the green lead on the adapter to earth ground. See warning above. If counter is to be operated with 230V ac line power, an Underwriters Laboratories listed connector should be used to connect power.

### 2-13. Operating Environment

2-14. Maximum and minimum allowable operating temperatures are listed in Table 1-3. If these limits are exceeded at the installation site, auxiliary cooling or heating should be used to keep the environment within limits. A 1-inch space above the counter should be clear to allow cooling air circulation. The cooling fan exhaust port at rear is to be kept clear.

### 2-15. Bench Operation

2-16. The instrument cabinet has plastic feet and the large tilt carrying handle will fold under for convenient bench operation. The tilt handle permits inclining the instrument for ease in using front-panel controls and indicators.

#### NOTE

The tilt carrying handle may be secured in any position by tightening the knurled side screws.

### 2-17. Rack Mounting

2-18. The counter is ready for bench operation as shipped from the factory. To mount the counter in a rack, it is necessary to order and install the rack flange kit listed in Table 7-2.

#### CAUTION

**Ambient temperature in rack during operation should not exceed 112°F (50°C). Be sure instrument position in rack permits adequate air circulation and that nearby equipment does not discharge hot air directly on the instrument.**

### 2-19. PACKAGING FOR RESHIPMENT

#### 2-20. Original Packaging

2-21. The same containers and materials used in factory packaging can be obtained through the Hewlett-Packard Sales and Service Offices listed at the rear of this manual.

2-22. If the counter is being returned to Hewlett-Packard for service, attach a tag indicating the type of service required, return address, model number, and full serial number. Mark the container FRAGILE to assure careful handling.

2-23. In any correspondence refer to the counter by model number and full serial number.

## **2-24. Other Packaging Methods**

2-25. If factory packaging is not available, good commercial packing should be used. Contract packaging companies in many cities can provide dependable custom packaging on short notice. The following general instructions should be followed when repackaging with commercially available materials.

- a. If shipping to a Hewlett-Packard Service Office or Service Center, attach a tag indicating the type of service required, return address, model number, and full serial number.
- b. Wrap the counter in heavy paper or plastic.
- c. Use a strong shipping container. A double-wall carton made of 350-pound test material is normally adequate for shipments inside the U.S.
- d. Use enough shock-absorbing material (3-to 4-inch layer) around all sides of the counter to provide a firm cushion and prevent movement inside the container. Protect the control panel with cardboard.
- e. Seal the shipping container securely.

## **2-26. STORAGE**

2-27. If the counter is to be stored for an extended period of time, it should be enclosed in a clean, dry, sealed container. See specifications in Section I for storage environmental limitations.



**SECTION III  
OPERATION  
(OPERATORS INSTRUCTIONS)**

**3-1. INTRODUCTION**

3-2. This section contains information necessary to understand how to control and use the counter. Specific details and examples are provided for making measurements of frequency, period, period average, time interval and time interval average, and ratio. How to use the external frequency standard input is described. Programming information for use with the HP-IB Interface and the Programmable Input Module is provided. Front and rear panel controls, connectors, and indicators are described.

**3-3. FREQUENCY MEASUREMENTS**

3-4. To make a frequency measurement on a CW signal below 100 MHz, select **FREQ A** function, select the appropriate input signal conditioning, and apply the signal to **A** input. The **RESOLUTION** switch determines the resolution of the measurement. Since the 5328A is a conventional counter, 1 Hz resolution is obtained in 1-second of measurement time (e.g., .1Hz 10 seconds). The .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.

3-5. To make a frequency measurement on a CW signal in the range of 30 to 500 MHz, select **FREQ C** function and apply the signal to the **Channel C** input. Make sure that the amplitude does not exceed 5V rms. The trigger level for the **Channel C** is fixed at 0V dc. If pulse waveforms are being measured, they must cross through 0 volts dc by at least 25 mV. Pulse widths down to 1 ns can be counted.

**CAUTION**

**DO NOT exceed 5 volts rms at "C" channel input. Circuits in this channel may be damaged by higher voltages.**

3-6. The **A**, **B**, and **C** input modules are direct count modules. Direct count 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).

3-7. When the 5328A is in **FREQ A** or **FREQ C** function and the rear panel **ARM** switch is **OFF**, a measurement cycle is initiated (i.e., arms the counter) upon the first trigger level crossing at the **A** (or **C**) input. This means that pulsed signals are measured as easily as CW if the measurement time (determined by the **RESOLUTION** switch) is less than the width of the pulse.

3-8. With the **ARM** switch **ON**, **FREQ A** and **FREQ C** are armed by a trigger event at the **B** input. This mode is useful whenever it is desired 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 and the corresponding frequency measurements made at those levels, the linearity of the generator may be determined.

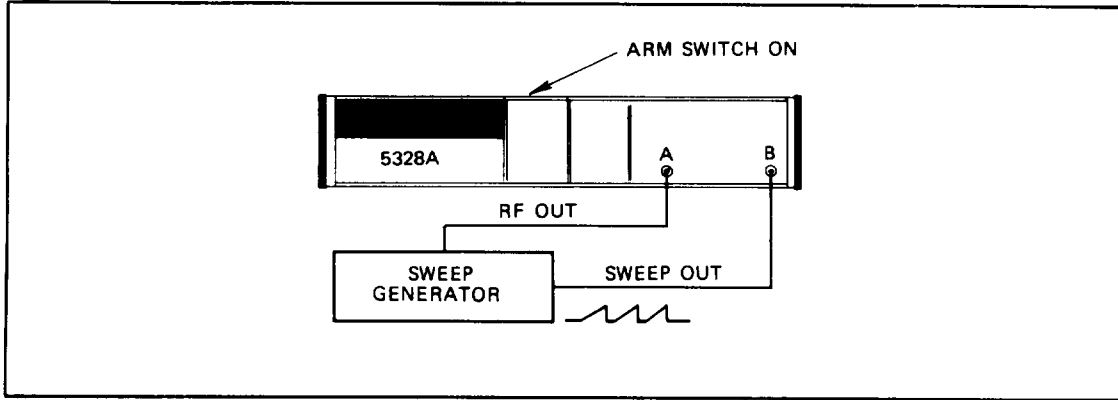


Figure 3-1. Measuring Linearity

### 3-9. PERIOD MEASUREMENTS

3-10. The PERIOD and PERIOD AVG functions allow single period measurement or multiple period averages to be made on input signals into Channel A for frequencies up to 10 MHz. These modes are useful for making low frequency measurements where maximum resolution is desired.

3-11. To make a PERIOD or PERIOD AVG measurement, select the desired function, select appropriate input signal conditioning, and apply the signal to the 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 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 =  $\frac{100 \text{ ns}}{N}$ ). The measurement time is equal to the period times N.

3-12. 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 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 3-2. Select N equal to or less than the number of periods in the tone burst and adjust Channel B trigger level to trigger on the first cycle of the input signal.

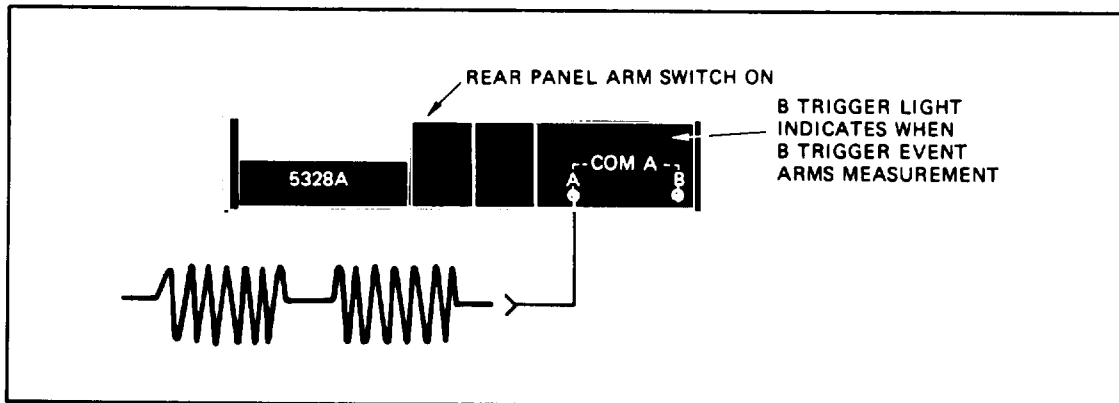


Figure 3-2. Tone Burst Measurement

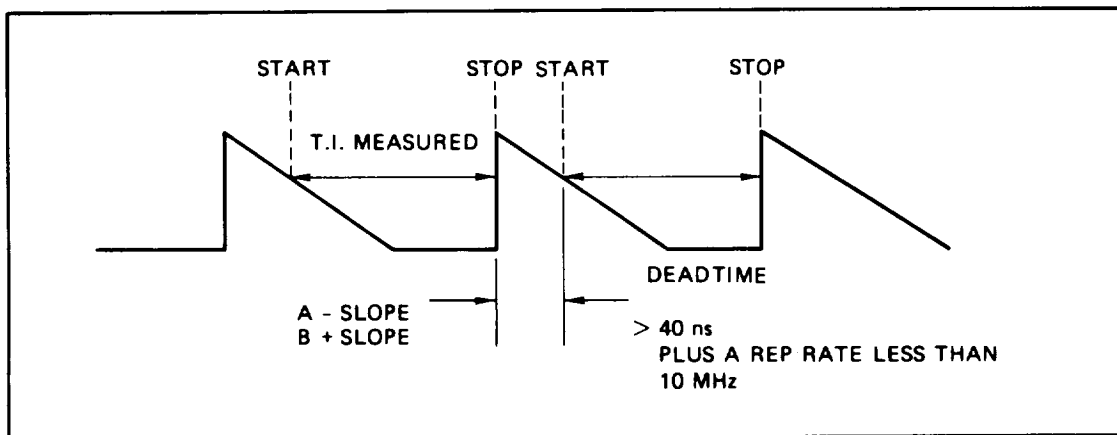


### 3-13. TIME INTERVAL MEASUREMENTS

3-14. 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 STOP signal at the Channel B input. If both the START and the STOP signals are derived from the same signal, place the COM A-SEP in COM A position. Separate slope and level controls for each channel allow variable triggering on either positive or negative going slope.

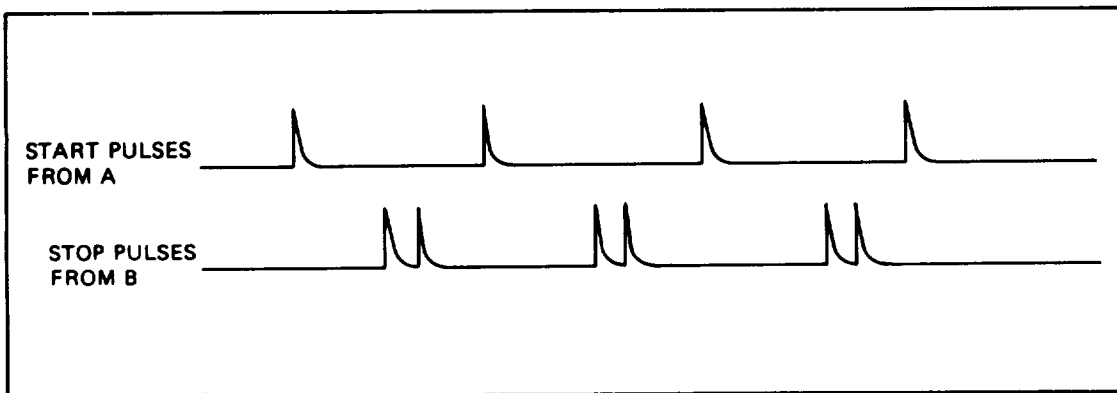
3-15. In single-shot time interval measurements, Channel A opens the main gate and Channel B closes the main gate. While the main gate is open, 10 MHz is divided by the setting of the RESOLUTION switch and totalized by the counter. For optimum resolution, select N=1. Other N values may be chosen to prevent 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 5328A 10 MHz clock is totalized only during the individual time intervals. The resolution of the measurement is improved by the  $\sqrt{N}$ .

3-16. In order to allow the synchronizers time to reset during time interval averaging, there must be at least 40 ns deadtime (and the additional constraint that the repetition rate be less than 10 MHz). Deadtime is the time between the preceding time interval stop event and the current time interval start event as shown in *Figure 3-3*.



*Figure 3-3. Deadtime*

3-17. During a time interval average, there must be only one stop pulse for each start pulse. Extraneous stop pulses which occur before the next start pulse are accumulated and give erroneous readings. For example, the case illustrated in *Figure 3-4* would result in a reading equal to one-half of the desired time interval.



*Figure 3-4. Multiple STOP Pulses*

## Model 5328A Operation

3-18. To set up a time interval measurement, the marker outputs may be monitored on an oscilloscope (see Figure 3-5) to indicate where the channels are triggering with relation to the time interval of interest. The GATE/MARKER OUT is high during the time interval being measured.

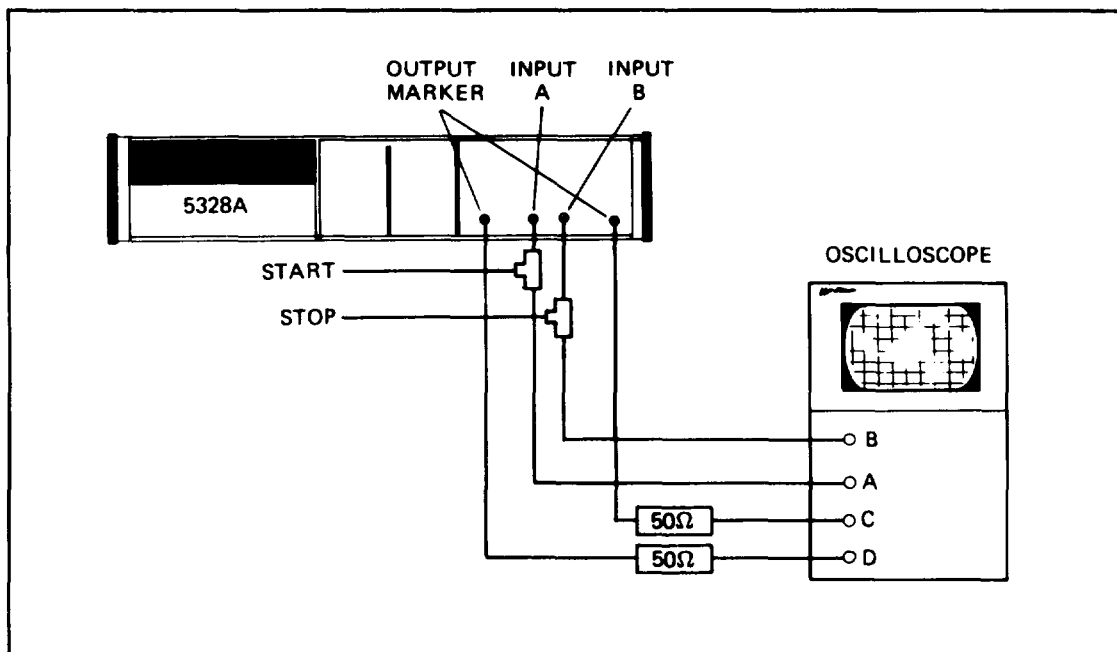


Figure 3-5. Monitoring Marker Outputs

3-19. 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 C input. For T.I. **AVG A→B**, only one arming signal is required per average measurement (i.e., the counter doesn't need to be armed prior to each individual time interval in the time interval measurement).

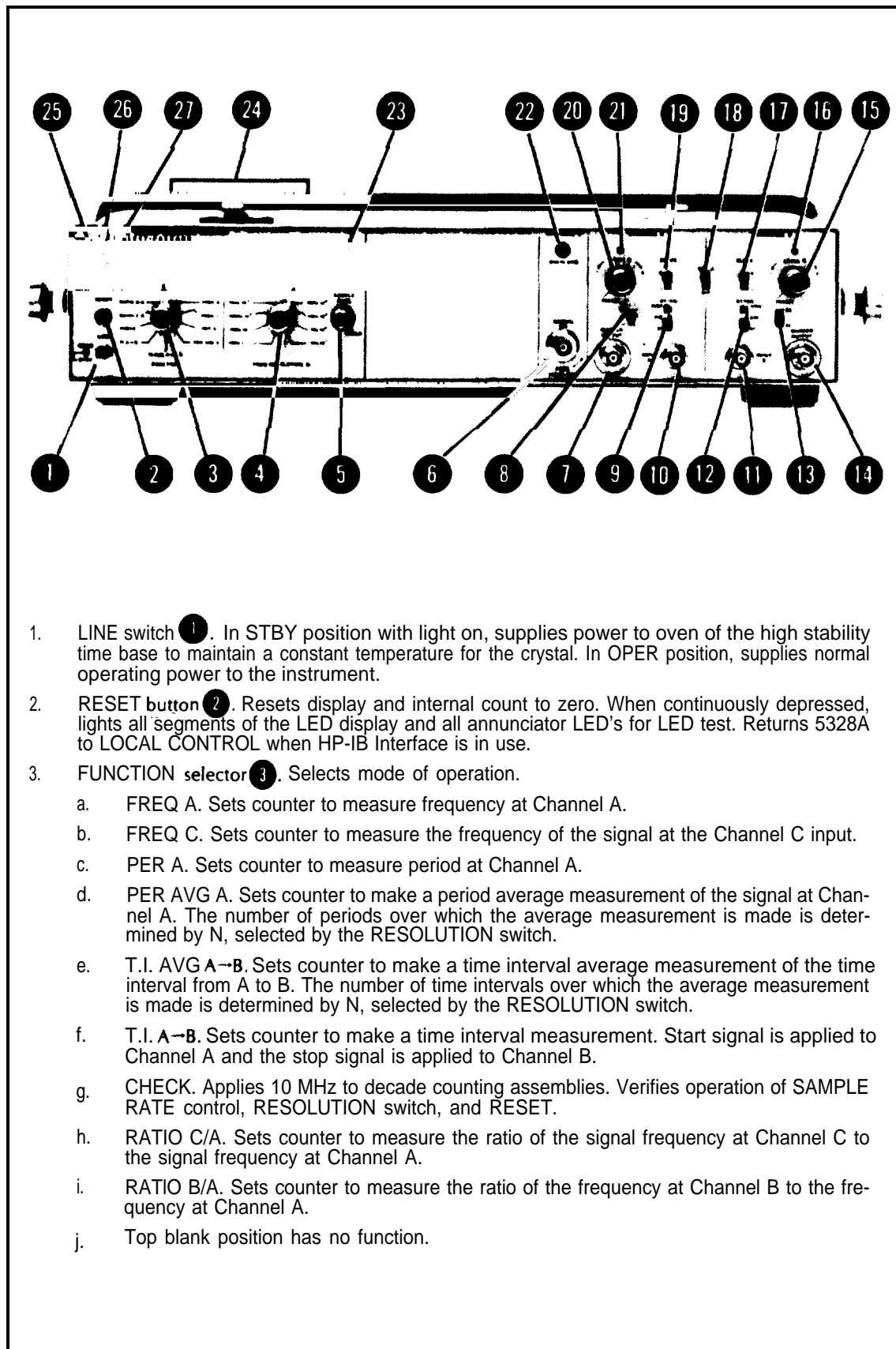
### 3-20. RATIO MEASUREMENTS

3-21. For ratio measurements, the 5328A has wide bandwidth, good sensitivity, and complete signal conditioning of the Channel A, B, and C input amplifiers.

3-22. Two ratio functions are available: **B/A** and **C/A**. The ratio of the frequency at B (or C) to the frequency at A is measured for N counts of A where N is selected by the RESOLUTION switch. The resolution of the measurement improves with increasing N and is given by 1 part in  $B/A \times N$  (or  $C/A \times N$ ). Since the range of A is 0-10 MHz while B is 0-100 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 may be measured). If B/A is greater than 1, the measurement resolution is better than switching the inputs for a ratio  $<1$ , provided the value of N remains the same.

### 3-23. OPERATING CONTROLS

3-24. All of the front and rear panel operating controls are shown and described in Figures 3-6 and 3-7.



1. LINE switch **1**. In STBY position with light on, supplies power to oven of the high stability time base to maintain a constant temperature for the crystal. In OPER position, supplies normal operating power to the instrument.
2. RESET button **2**. 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 5328A to LOCAL CONTROL when HP-IB Interface is in use.
3. FUNCTION selector **3**. Selects mode of operation.
  - a. FREQ A. Sets counter to measure frequency at Channel A.
  - b. FREQ C. Sets counter to measure the frequency of the signal at the Channel C input.
  - c. PER A. Sets counter to measure period at Channel A.
  - d. 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.
  - e. 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.
  - f. 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.
  - g. CHECK. Applies 10 MHz to decade counting assemblies. Verifies operation of SAMPLE RATE control, RESOLUTION switch, and RESET.
  - h. RATIO C/A. Sets counter to measure the ratio of the signal frequency at Channel C to the signal frequency at Channel A.
  - i. RATIO B/A. Sets counter to measure the ratio of the frequency at Channel B to the frequency at Channel A.
  - j. Top blank position has no function.

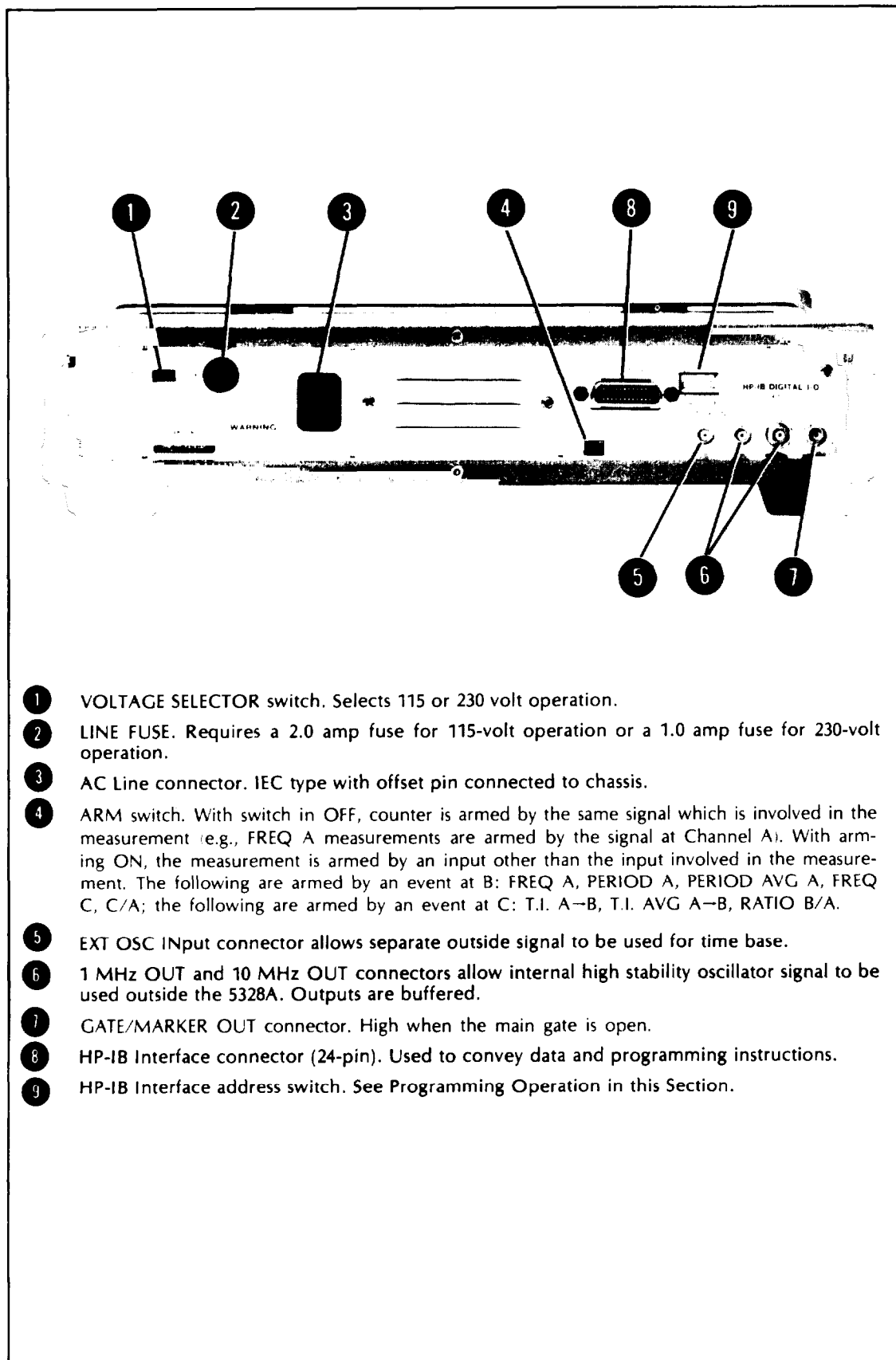
Figure 3-6. 5328A Front Panel Operation Summary

4. **FREQ RESOLUTION, N selection switch 1**. Selects resolution in frequency measurements and N for totalizing and averaging measurements. Determines how long the main gate is open for frequency measurements:

| N      | GATE TIME<br>(Seconds) | RESOLUTION<br>(Hz) |
|--------|------------------------|--------------------|
| 1      | $1 \times 10^{-6}$     | 1 M                |
| 10     | $10 \times 10^{-6}$    | 100 k              |
| $10^2$ | $100 \times 10^{-6}$   | 10 k               |
| $10^3$ | $1 \times 10^{-3}$     | 1 k                |
| $10^4$ | .01                    | 100                |
| $10^5$ | .1                     | 10                 |
| $10^6$ | 1                      | 1                  |
| $10^7$ | 10                     | .1                 |

5. **SAMPLE RATE control 5**. Varies time between measurements continuously from approximately 2 milliseconds to HOLD (which holds display indefinitely).
6. **500 MHz, 50Ω 6**, Channel C input BNC connector. Input for "FREQ C" channel. Refer to specification in Section I.
7. **OUTPUT MARKERS 7, 14**. Channel A and B Schmitt trigger outputs indicate when a channel is triggered; 0 to 300 mV levels into 50Ω with less than 20 ns delay.
8. **Coupling switch AC-DC 8, 13**. Selects ac or dc coupling for input signal. When input amplifier control switch 18 is in COM A, Channel B coupling is determined by setting of Channel A coupling switch.
9. **ATTEN switches 9, 12**. Selects attenuation of input signal. Signal amplitude is reduced by 10 in X10 and by 100 in X100. When input amplifier control switch 18 is in COM A, Channel B attenuation is determined by setting of Channel A attenuation switch 9.
10. **Channel inputs 10, 11**. Input channels A and B. (Table 1-2 lists the type of coaxial cable used with these inputs.)
11. **COM A/SEP input amplifier control switch 18**. Selects independent operation of Channels A and B in SEP (separate) position. In COM A (Common A) position, the signal at A is also applied to Channel B. (The B input is disconnected from the input circuitry; Channel B coupling and attenuation are determined by the Channel A settings.)
12. **Trigger lights 16, 21**. 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.
13. **LEVEL A/B controls 15, 20**. Used in conjunction with ATTEN switch to select voltage at which triggering occurs. With X1 attenuator, level is variable  $\pm 2.5$  volts. In X10,  $\pm 25$  volts. In X100,  $\pm 250$  volts.
14. **SLOPE switches 17, 19**. Select triggering on either positive or negative slope of input signal.
15. **OVERLOAD annunciator 22** indicates (flashes on-off) if more than 5 volts is applied to Channel C input connector 6.
16. **OVFL (overflow) annunciator 23**. Indicates that one or more of the most-significant digits (digits left-most from the decimal point) are not displayed.
17. **RMT (remote) annunciator 26**. For counters with HP-IB only. Lights when 5328A is in remote operation.
18. **GATE annunciator 27**. Indicates when the counter's main gate is open and a measurement is in progress.
19. **K,S,M,μ,n, and Hz annunciators 28**. Indicates the units multiplier of the measurement.
20. **Nine-digit LED display 24** shows all measurements.

Figure 3-6. 5328A Front Panel Operation Summary (Continued)



- 1 VOLTAGE SELECTOR switch. Selects 115 or 230 volt operation.
- 2 LINE FUSE. Requires a 2.0 amp fuse for 115-volt operation or a 1.0 amp fuse for 230-volt operation.
- 3 AC Line connector. IEC type with offset pin connected to chassis.
- 4 ARM switch. With switch in OFF, counter is armed by the same signal which is involved in the measurement (e.g., FREQ A measurements are armed by the signal at Channel A). 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, C/A; the following are armed by an event at C: T.I. A-B, T.I. AVG A-B, RATIO B/A.
- 5 EXT OSC Input connector allows separate outside signal to be used for time base.
- 6 1 MHz OUT and 10 MHz OUT connectors allow internal high stability oscillator signal to be used outside the 5328A. Outputs are buffered.
- 7 GATE/MARKER OUT connector. High when the main gate is open.
- 8 HP-IB Interface connector (24-pin). Used to convey data and programming instructions.
- 9 HP-IB Interface address switch. See Programming Operation in this Section.

Figure 3-7. 5328A Rear Panel Controls and Connectors

### 3-25. FUNCTION OF CONTROLS, INDICATORS, INPUTS, AND OUTPUTS

3-26. The following paragraphs provide a detailed description of the function of controls, indicators, and connectors.

#### 3-27. Display

3-28. The 5328A counter display consists of nine-digit, seven-segment LED display and annunciators for indicating the measurement units of Hz, s, as well as multiplier indicators (K, m,  $\mu$ , n). These display units and multipliers are automatically displayed along with the correct decimal point location. Overflow (OVFL) indicates that left-most-significant digits have overflowed the display. Remote (RMT) indicates that the counter (HP-IB interface) is under remote program control. A GATE lamp indicates that the counter has been armed and that a measurement is in process.

#### 3-29. Power (Line)

3-30. The LINE switch puts the counter in OPER (operate) or STBY (standby). The STBY position with STBY light on turns off some but not all the power supply voltages. This circuit arrangement allows the high stability oscillator to operate continuously. Therefore, the input to main power transformer (T1) plus the unregulated dc voltage to the oscillator oven is always energized whenever power is connected even with the line switch in STBY.

#### 3-31. Reset

3-32. 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. The HP-IB interface, provides remote control capability, pushing the RESET button restores the counter to local control (when not remotely locked out by the HP-IB Local Lockout universal command). Refer to programming in this section.

#### 3-33. Sample Rate Control

3-34. The SAMPLE RATE control sets the minimum time between samples. The time is continuously variable from less than 2 milliseconds between measurements to HOLD, which holds the display indefinitely.

#### NOTE

The counter will internally (self) arm (via the SAMPLE RATE control) only when ARMING is OFF and the FUNCTION selected is at other than FREQ A, FREQ C, and RATIO C/A.

#### 3-35. Arming

3-36. 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 3-7 is an arming status table. A rear panel switch turns ARMING either ON or OFF. The counter is armed within 1  $\mu$ s after the event at the B arming input and is armed within 10  $\mu$ s after the event of the C arming input.

Table 3-1. Arming Status

| FUNCTION        | ARMING OFF           | ARMING ON        |
|-----------------|----------------------|------------------|
| FREQ A          | Armed by A input     | Armed by B input |
| PERIOD A        | Armed by SAMPLE RATE | Armed by B input |
| PERIOD AVG A    | Armed by SAMPLE RATE | Armed by B input |
| T.I. A to B     | Armed by SAMPLE RATE | Armed by C input |
| T.I. AVG A to B | Armed by SAMPLE RATE | Armed by C input |
| FREQ C          | Armed by C input     | Armed by B input |
| RATIO B/A       | Armed by SAMPLE RATE | Armed by C input |
| RATIO C/A       | Armed by C input     | Armed by B input |

### 3-37. Frequency Resolution, N Switch

3-38. The FREQUENCY RESOLUTION, N switch determines the amount of time that the counter's main gate is open for a particular measurement when the Main Gate FF (refer to Section IV) determines the gate time. Depending on the measurement, this time results in a certain measurement resolution (e.g., frequency measurements), a number of intervals averaged (e.g., T.1. AVG measurements), or a scaling factor by which the time base is divided (e.g., period measurements). Table 3-2 shows the setting of the RESOLUTION switch and the corresponding time the main gate is open.

Table 3-2. Frequency Resolution, N Switch Settings and Gate Times

| RESOLUTION | N      | GATE TIME   |
|------------|--------|-------------|
| 1 Hz       | $10^7$ | 10 s        |
| 1 Hz       | $10^6$ | 1 s         |
| 10 Hz      | $10^5$ | .1 s        |
| 100 Hz     | $10^4$ | 10 ms       |
| 1 kHz      | $10^3$ | 1 ms        |
| 10 kHz     | $10^2$ | 100 $\mu$ s |
| 100 kHz    | 10     | 10 $\mu$ s  |
| 1 MHz      | 1      | 1 $\mu$ s   |

3-39. Table 3-3 summarizes the FUNCTIONS and the corresponding interpretation of the FREQUENCY RESOLUTION, N switch setting.

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,<br>T.I. AVG A to B | Indicates number of time intervals or periods over which the average measurement is made.                                      |
| RATIO B/A, RATIO C/A             | Indicates the number of counts at the A input over which the ratio measurement is made. Resolution improves with increasing N. |

### 3-40. Input Channel Section

3-41. Two separate inputs are provided on the right side of the panel. The A and B inputs are identical in specification and identical controls are provided for each input to allow maximum versatility and accuracy.

3-42. HP-IB PROGRAMMABLE INPUT CONTROLS. In 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 3-8. In COM A the Channel B AC-DC, X1, X10, X100 Attenuator relays are disabled. The Channel A AC-DC, X1, X10, X100 Attenuator determine the coupling for the Channel B amplifier.

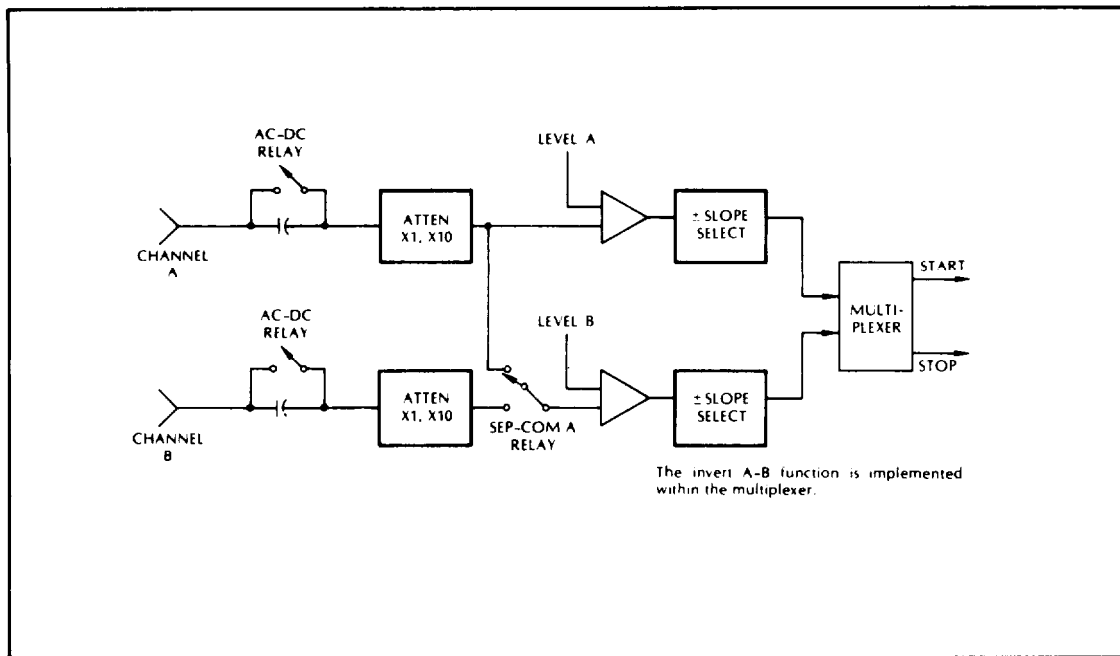


Figure 3-8. Programmable Input Switch Configuration for COM A

3-43. The A and B input amplifiers have independent LEVEL and SLOPE controls regardless of the mode of operation (SEP or COM A).

### 3-44. A and B Channel Signal Conditioning

3-45. 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 advantage of AC coupling is to provide a DC block for signals with a DC component. DC has the disadvantage of being unable to pass low frequency 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.

3-46. ATTENUATOR. The attenuator (ATTEN) connects the input signal directly to the amplifier (in X1) or through a 10:1 attenuator (X10) or a 100:1 attenuator (X100) to increase the voltage range by 10 or 100 times to allow measurement of high level signals that would otherwise be impossible without external attenuation.



3-47. 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, (Figure 3-9) if the pulse width of a positive pulse is to be measured, the A channel slope switch would be set to "+" and the B channel would be set to "-" (for time interval measurements the A channel always begins the measurement and the B channel ends the measurement).

**NOTE**

A simple pulse width measurement is achieved with the use of the +SLOPE setting for Channel A and the -SLOPE setting for Channel B.

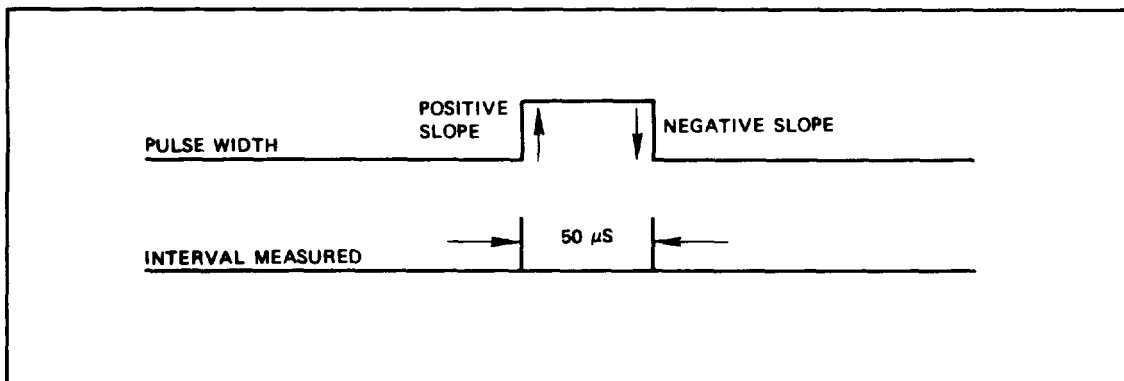


Figure 3-9. Slope Switch Settings

3-48. LEVEL CONTROL. The LEVEL control for each channel is adjustable over the range of  $\pm 2.5$ V dc with the attenuator for that channel in the X1 position. A typical use of the LEVEL controls is shown in Figure 3-10.

**NOTE**

Simple measurement of a time interval, the LEVEL control of the A and B input channels were used to set the trigger LEVEL of A and B.

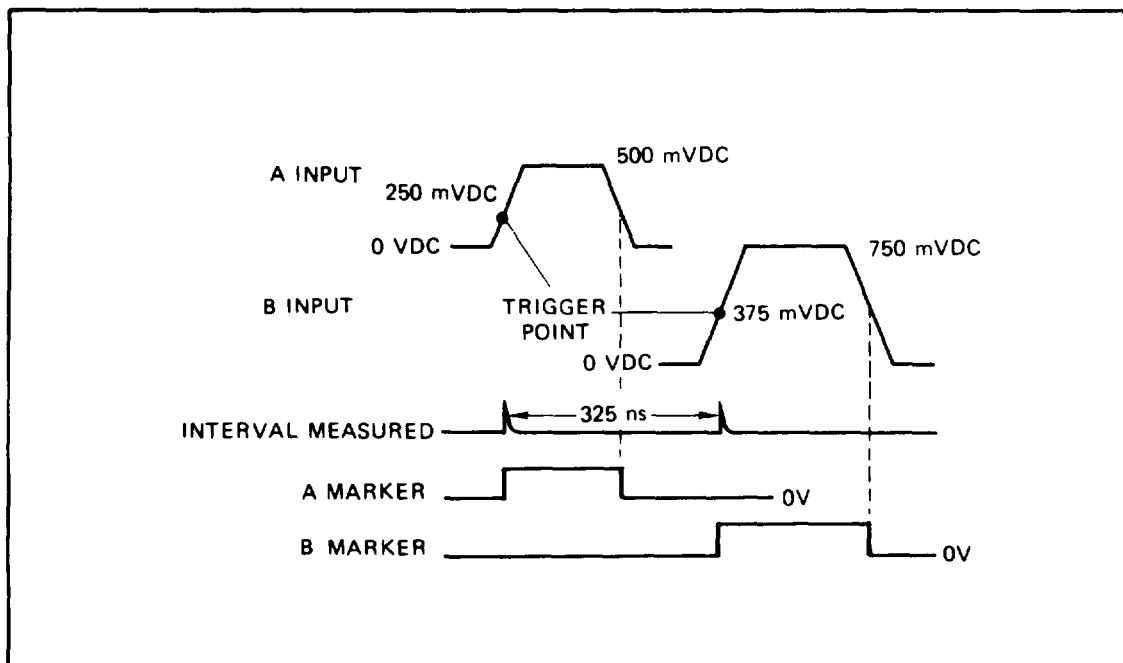


Figure 3-10. Level Control Settings

### 3-49. Channel C Input

3-50. The CHANNEL C 500 MHz 50 $\Omega$  input is useful for higher frequency signals out of the A and B input channel range (0 to 100 MHz).

#### CAUTION

The "C" channel input signal should be limited to 5 volts maximum. If this limit is exceeded the inline fuse may open (blow).

### 3-51. "C" Channel Overload Indicator

3-52. The OVERLOAD (CHANNEL C) indicator will flash on and off if the voltage maximum is exceeded at the "C" channel input.

### 3-53. Hysteresis Band of Trigger Levels

3-54. The width of the trigger level hysteresis band, shown in Figure 3-77 is determined by the sensitivity of the counter. 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 MHz 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.

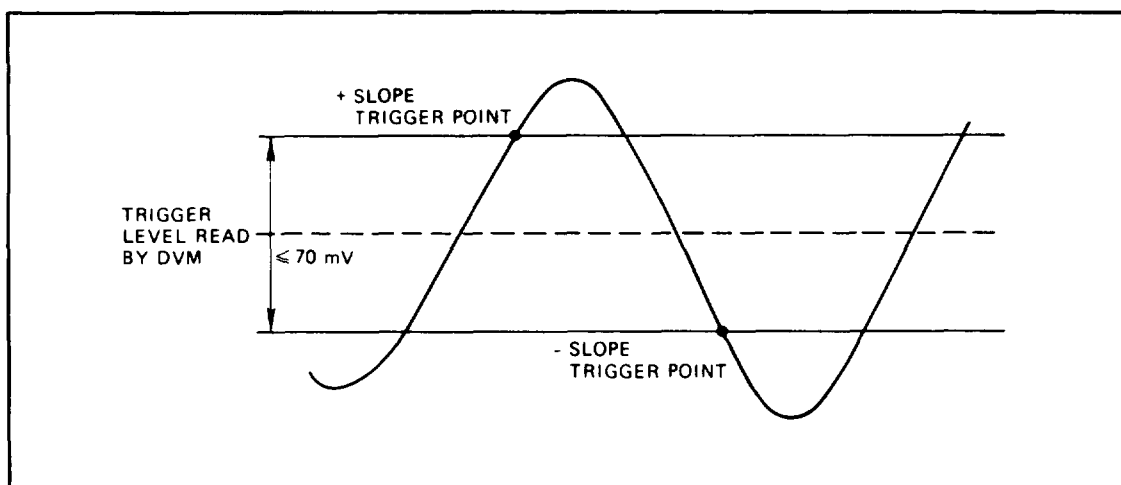


Figure 3-11 Hysteresis Band

3-55. Since trigger level measurements indicate the center of the hysteresis band, 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 30 mv peak-to-peak.

3-56 The value to use for the hysteresis band depends on the frequency; or, for pulses, it depends on the rise time.

### 3-57. External Frequency Standard Input

3-58. The rear panel external frequency standard (EXT OSC IN) input is useful for locking the counter to a high stability external frequency standard. This external standard must be 1, 2.5, 5, or 10 MHz, with an amplitude of >1V rms into 1 k $\Omega$  (maximum input of 5 volts peak-to-peak).

### 3-59. Marker Outputs

3-60. Two marker output connectors are mounted on the front panel. These outputs represent the Channel A and Channel B Schmitt triggers. The outputs provide 0 to 300 mV levels into  $50\Omega$  delayed by less than 20 ns. These outputs are useful for oscilloscope monitoring, Time interval measurement setups are simplified if the time interval of interest and the marker outputs can be simultaneously displayed on oscilloscope traces. Frequency measurements on noisy signals can be made with more confidence since the markers can indicate the presence of noise triggering. These outputs are protected from inadvertently applied voltage to  $\pm 5V$  dc.

### 3-61. Gate/Marker Out

3-62. the GATE/MARKER OUT rear panel connector 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 on an oscilloscope can provide this information for applications where the markers do not give the desired information.

### 3-63. 1 MHz and 10 MHz Frequency Standard Outputs

3-64. The 1 MHz OUT and 10 MHz OUT connectors are on the rear panel. When terminated in 50 ohms, the output is a square wave of approximately 1-volt amplitude.

### 3-65. Trigger Lights

3-66. A trigger light is provided for each (A and B) input channel to enable the user to know not only if the channel is triggering, but also in which direction the trigger level must be adjusted to cause triggering. The light is ON when input is above the trigger level; OFF when input is below the trigger level; BLINKING when channel is triggering. The trigger lights are operative over the full frequency range of dc to 100 MHz.

3-67. The trigger lights can be used with a 10:1 oscilloscope probe to provide a logic probe function. By adjusting the trigger level to one-tenth (since using 10:1 divider probes) of the threshold voltage for the logic family under investigation (e.g., .14 volts for TTL), the light indicates the logic state of circuit points which are contacted with the probe. When the trigger level light is ON, the circuit node is a high (i.e., above the threshold voltage). If the light is OFF, the node is a logical low. If the light blinks, then pulses (up to 100 MHz rep rate) are present at the node. The trigger lights can also detect 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.

### 3-68. PROGRAMMING OPERATION

3-69. The 5328AF/096/H42 Universal Counter is fully compatible with the Hewlett-Packard Interface Bus (HP-1B) IEEE Standard 488-1975 Appendix C.

3-70. Procedures for verification of proper operation of the 5328AF/096/H42 in the remote mode are contained in paragraphs 5-37 through 5-42.

### 3-71. SETTING ADDRESS SWITCHES

3-72 To use the 5328A 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 results to another device on the bus such as a printer or D/A converter.

3-73. The five right-hand switches, AS through A1, set the talk and listen addresses to the 5328A 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.

**Table 3-4. Addressing**

| ASCII ADDRESS CODES |                |                |                |                | ASCII LISTEN ADDRESS | ASCII TALK ADDRESS |
|---------------------|----------------|----------------|----------------|----------------|----------------------|--------------------|
| A <sub>5</sub>      | A <sub>4</sub> | A <sub>3</sub> | A <sub>2</sub> | A <sub>1</sub> |                      |                    |
| 0                   | 0              | 0              | 0              | 0              | SP                   | @                  |
| 0                   | 0              | 0              | 0              | 1              | !                    | A                  |
| 0                   | 0              | 0              | 1              | 0              | "                    | B                  |
| 0                   | 0              | 0              | 1              | 1              | #                    | C                  |
| 0                   | 0              | 1              | 0              | 0              | \$                   | D                  |
| 0                   | 0              | 1              | 0              | 1              | %                    | E                  |
| 0                   | 0              | 1              | 1              | 0              | &                    | F                  |
| 0                   | 0              | 1              | 1              | 1              | '                    | G                  |
| 0                   | 1              | 0              | 0              | 0              | (                    | H                  |
| 0                   | 1              | 0              | 0              | 1              | )                    | I                  |
| 0                   | 1              | 0              | 1              | 0              | *                    | J                  |
| 0                   | 1              | 0              | 1              | 1              | +                    | K                  |
| 0                   | 1              | 1              | 0              | 0              | ,                    | L                  |
| 0                   | 1              | 1              | 0              | 1              | -                    | M                  |
| 0                   | 1              | 1              | 1              | 0              | .                    | N                  |
| 0                   | 1              | 1              | 1              | 1              | /                    | O                  |
| 1                   | 0              | 0              | 0              | 0              | 0                    | P                  |
| 1                   | 0              | 0              | 0              | 1              | 1                    | Q                  |
| 1                   | 0              | 0              | 1              | 0              | 2                    | R                  |
| 1                   | 0              | 0              | 1              | 1              | 3                    | S                  |
| 1                   | 0              | 1              | 0              | 0              | 4                    | T                  |
| 1                   | 0              | 1              | 0              | 1              | 5                    | U                  |
| 1                   | 0              | 1              | 1              | 0              | 6                    | V                  |
| 1                   | 0              | 1              | 1              | 1              | 7                    | W                  |
| 1                   | 1              | 0              | 0              | 0              | 8                    | X                  |
| 1                   | 1              | 0              | 0              | 1              | 9                    | Y                  |
| 1                   | 1              | 0              | 1              | 0              | :                    | Z                  |
| 1                   | 1              | 0              | 1              | 1              | ;                    | [                  |
| 1                   | 1              | 1              | 0              | 0              | <                    | \                  |
| 1                   | 1              | 1              | 0              | 1              | =                    | ]                  |
| 1                   | 1              | 1              | 1              | 0              | >                    | (                  |

3-74. Table 3-5 gives the program code set for the 5328AF/096\H42. All Function, Frequency Resolution, N and Channel A/B Signal Conditioning are analogous to the corresponding front-panel operations described previously.

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
  - F4 Freq. A
  - F6 Period A
  - F7 Per. Avg. A
  - F8 T.I. A-B
  - F9 B/A
  - F: T.I. Avg. A-B
  - F< Check
  - F= C/A
  - F> Freq. C
3. Time Base
 

| Code      | Freq Res | Multiplier      | Time Res (Std) |
|-----------|----------|-----------------|----------------|
| <b>G0</b> | 1 MHz    | 1               | 100 ns         |
| G1        | 100 kHz  | 10              | 1 μs           |
| G2        | 10 kHz   | 10 <sup>2</sup> | 10 μs          |
| G3        | 1 kHz    | 10 <sup>3</sup> | 100 μs         |
| G4        | 100 Hz   | 10 <sup>4</sup> | 1 ms           |
| G5        | 10 Hz    | 10 <sup>5</sup> | 10 ms          |
| G6        | 1 Hz     | 10 <sup>6</sup> | 100 ms         |
| G7        | 0.1 Hz   | 10 <sup>7</sup> | 1 s            |
4. Single-Multiple Measurement
  - S0** Single Measurement
  - S1 Multiple Measurement
5. Measurement Cycle
  - S2** Wait to output; Service Request at end of measurement
  - S3 Continue cycle; no Service Request
6. Output Mode
  - S4** Output at end of measurement
  - S5 Output when addressed (on-the-fly)
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)
12. Channel A Signal Conditioning
  - a. Coupling
    - A2** AC
    - A3 AC
  - b. Slope
    - A4** +slope
    - A5 -slope
  - c. Attenuator
    - A1 X100
    - A6** X10
    - A7 X1
13. Separate - Common
  - A8** Separate
  - A9 Common A
14. Trigger level A
  - volts
  - tenths of volts
  - hundredths of volts
  - A ± d<sub>1</sub> d<sub>2</sub> d<sub>3</sub> \*
  - 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
15. Channel B Signal Conditioning
  - a. Coupling
    - B2** AC
    - B3 DC
  - b. Slope
    - B4** +slope
    - B5 -slope
  - c. Attenuator
    - B1 X100
    - B6** X10
    - B7 X1
16. Trigger Level B
  - B ± d<sub>1</sub> d<sub>2</sub> d<sub>3</sub> \***
  - See Group 15, Trigger Level A, for details.
17. Channel Invert
  - B8** Normal
  - B9 Invert A and B inputs
18. Reset; Trigger
  - (Also see Bus Command GET)
  - R** Reset, no trigger
  - T Reset and trigger

### 3-75. MEASUREMENT OUTPUT FORMAT

3-76. The 5328AF/096/H42 transmits the following string of characters to output a measurement:

|           |        |       |                                     |    |       |    |    |    |
|-----------|--------|-------|-------------------------------------|----|-------|----|----|----|
| Position  | 1      | 2     | 3 thru 12                           | 13 | 14    | 15 | 16 | 17 |
| Character | { O }  | { + } | { 9 digits and<br>decimal point . } | E  | { + } | d  | CR | LF |
|           | { SP } | { - } |                                     |    | { - } |    |    |    |

*“O” 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. The decimal point may appear at positions 4 to 12. The output string is always 17 characters long. Typical character output strings are:*

|          |          |          |          |          |          |          |          |          |           |           |           |           |           |           |           |           |
|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| <b>1</b> | <b>2</b> | <b>3</b> | <b>4</b> | <b>5</b> | <b>6</b> | <b>7</b> | <b>7</b> | <b>9</b> | <b>10</b> | <b>11</b> | <b>12</b> | <b>13</b> | <b>14</b> | <b>15</b> | <b>16</b> | <b>17</b> |
| 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 5328AF/096/H42 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 a constant 17 characters.*

### 3-77. BUS COMMANDS

3-78. The 5328AF/096/H42 obeys the following HP-1 B Universal Commands and Addressed Commands (ASCII codes shown in parenthesis and in Table 3-6).

a. Universal Commands:

LLO Local Lockout (ASCII DC1)

Disables all programmable front panel controls 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 5328A produces a status byte to indicate its condition. If the counter has completed a measurement and it requesting service, the status byte contains a “1” in bit 7 (decimal value 64). If the counter has not requested service, the status byte will be “0” in all bits. When addressed to talk in the serial poll mode, the counter will immediately stop requesting service.

SPD Serial Poll Disable (ASCII EM)

Terminates the serial poll mode. The 5328A can resume its normal data output mode.

b. Addressed Commands:

GTL Go To Local (ASCII SOH)

Returns the 5328A to local (manual) control from remote control.

SDC Selected Device Clear (ASCII EOT)

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

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

UNIVERSAL ADDRESS COMMANDS      LISTEN ADDRESSES      UNLISTEN COMMAND      TALK ADDRESSES      UNTALK COMMAND

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

### 3-79. PROGRAM EXAMPLES

3-80. The following examples illustrate the programming capability of the 5328AF/096/H42, using the HP9825A Desktop Computer as a computing controller.

3-81. Example 1

3-82. This program sets the 5328AFA/096/H42 into its CHECK mode, with 1 Hz resolution. The program takes a measurement (trg 701) and reads it into the A register of the HP9825A. After waiting 500 ms, the program loops back to line 1 for the next trigger.

```
0: wrt 701, "PF<G  
6R"  
1: trg 701;rd  
701.A;dsr A;  
prt A  
2: wait 500;sto  
1  
3: end  
*9943
```

```
10000000.00  
10000000.00  
10000000.00  
10000000.00  
10000000.00  
10000000.00  
10000000.00  
10000000.00  
10000000.00
```



3-83. Example 2

3-84. This program sets the 5328AF/096/H42 into its Frequency mode with 1Hz resolution. The program takes a frequency measurement, reads it into the A register of the HP9825A, and prints the results. The calculator computes the period from the frequency measurement and prints the calculated period. The program then sets the 5328AF/096/H42 into its PERIOD mode with 10  $\mu$ s resolution. A period measurement is made, read into the C register of the HP9825A and printed. After waiting 2 sec, the program loops back to line 0 for the next trigger.

```

0: wrt 701,"PF4G      MEASURED FREQ=
  6813R"              9.73e 05
1: rcd 701,A          HZ
2: prt "MEASURED     CALC PERIOD=
  FREQ=",A,"         1.03e-06
                    HZ"
                    sec
3: 1/A*B:flt 2       MEASURED PERIOD=
4: prt "CALC        1.03e-06
  PERIOD=",B,"      sec
                    sec"
5: wrt 701,"PF7G
  2813R"
6: rcd 701,C          MEASURED FREQ=
7: prt "MEASURED     9.73e 05
  PERIOD=",C,"      HZ
                    sec"
8: prt "-----
  -----" ;sec
  2;wait 2000        MEASURED PERIOD=
9: go 0              1.03e-06
10: end              sec
*31082
-----

```



## SECTION IV THEORY OF OPERATION

### 4-1. INTRODUCTION

4-2. This section contains a description of the operating principles of the counter in reference to an overall block diagram in this section and to individual block and schematic diagrams in Section VIII.

### 4-3. OVERALL DESCRIPTION

4-4. The 5328A is a 500 MHz universal frequency counter with the following capabilities.

- Frequency — 100 and 500 MHz direct count
- Period — 100 ns resolution
- Period Average — 10 MHz clock
- Time Interval — 100 ns single-shot resolution
- Time Interval Average
- Ratio — 100 MHz/10 MHz
- Check

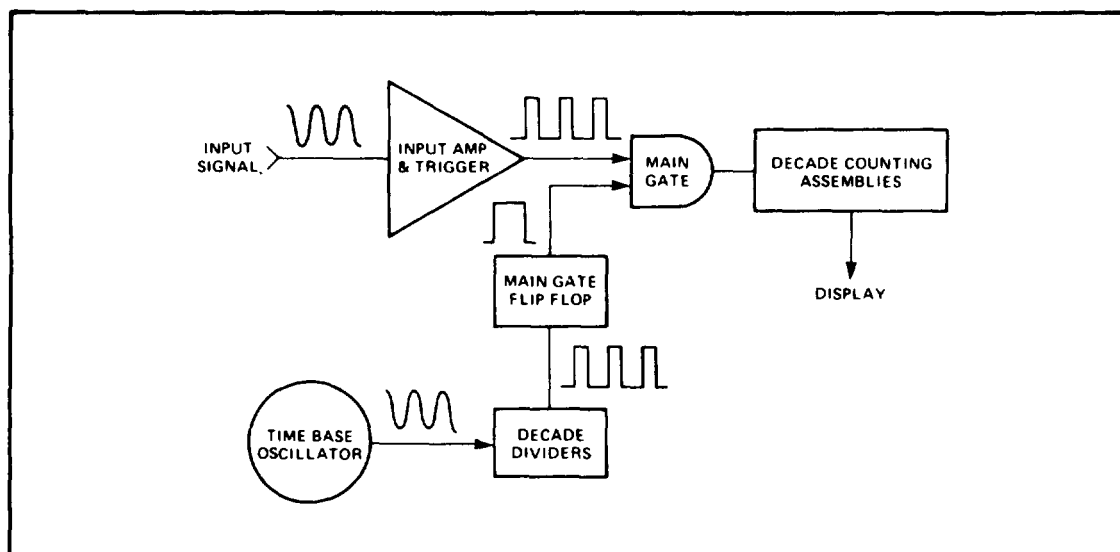
### 4-5. BASIC COUNTER OPERATION

4-6. The operation of the frequency counter is best understood by describing how the counter performs a frequency measurement. If  $n$  is the number of cycles of a signal that occurs in a time period,  $t$ , the average frequency,  $f$ , of that signal over the time period,  $t$ , is given by

$$f = \frac{n}{t} \tag{1}$$

### 4-7. Frequency

4-8. The counter measures the frequency,  $f$ , by accumulating the number of cycles,  $n$ , of the input signal that occurs over the time period,  $t$ . The basic counter elements necessary to perform this measurement are shown in Figure 4-1.



*Figure 4-1. Basic Elements of the Frequency Counter*

4-9. INPUT AMPLIFIER AND TRIGGER — essentially conditions the input signal to a form that is compatible with the internal circuitry of the counter. As Figure 4-7 indicates, the output of the amplifier/trigger is a pulse train where each pulse corresponds to one cycle or event of the input signal.

4-10. TIME BASE OSCILLATOR — is that element of the counter from which the time,  $t$ , of equation (1) is derived. From equation (1) it may be seen that the accuracy with which  $t$  is determined has a significant effect on the measurement accuracy of the frequency,  $f$ . The 5328A employs a 10 MHz temperature-controlled (oven-regulated) precision, crystal oscillator as the time base element.

4-11. DECADE DIVIDERS — take the time base oscillator signal as the input and provide as an output a pulse train whose frequency is variable in decade steps. The operator can control this frequency with the FREQ RESOLUTION,  $N$  switch. The time,  $t$ , of equation (1) is determined by the period of this pulse train.

4-12. MAIN GATE — is the heart of the counter. When this gate is opened, pulses from the amplifier/trigger are allowed to pass through. The opening and closing of the main gate is controlled by the decade divider output to the main gate flip-flop.

4-13. DECADE COUNTING ASSEMBLIES — totalizes the output pulses from the main gate and displays this total after the gate is closed. If, for example, the gate is open for precisely 1 second, the decade counting assemblies (DCA's) display the frequency, in Hertz, of the input signal.

4-14. Other basic measurements the counter can perform are described in the following paragraphs.

#### 4-15. Period

4-16. Period, the inverse of frequency, can be measured with the counter by reversing the inputs to the main gate. Now the input signal controls the duration over which the main gate is open and the decade divider output is counted by the DCA's. The duration of the count is, of course, one cycle or period of the input signal (see Figure 4-2).

4-17. Unused decades in the decade divider chain can be used to divide the amplifier/trigger output so that the gate remains open for decade steps of the input period rather than a single period. This is the basis for multiple period averaging. Period and period averaging techniques are used to increase measurement accuracy on low frequency measurements.

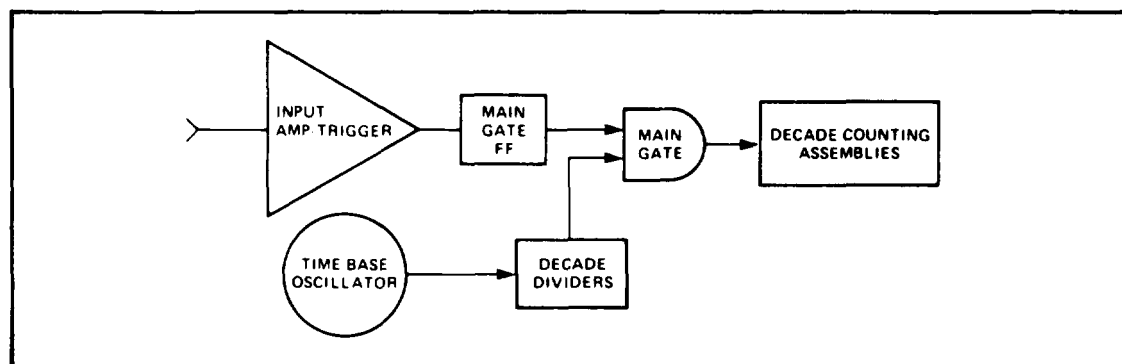


Figure 4-2. Measuring Period

#### NOTE

The roles of the amplifier/trigger and decade divider outputs are reversed in measuring the period. This same configuration also serves for ratio measurements with the second input replacing the time base oscillator.

**4-18. Ratio**

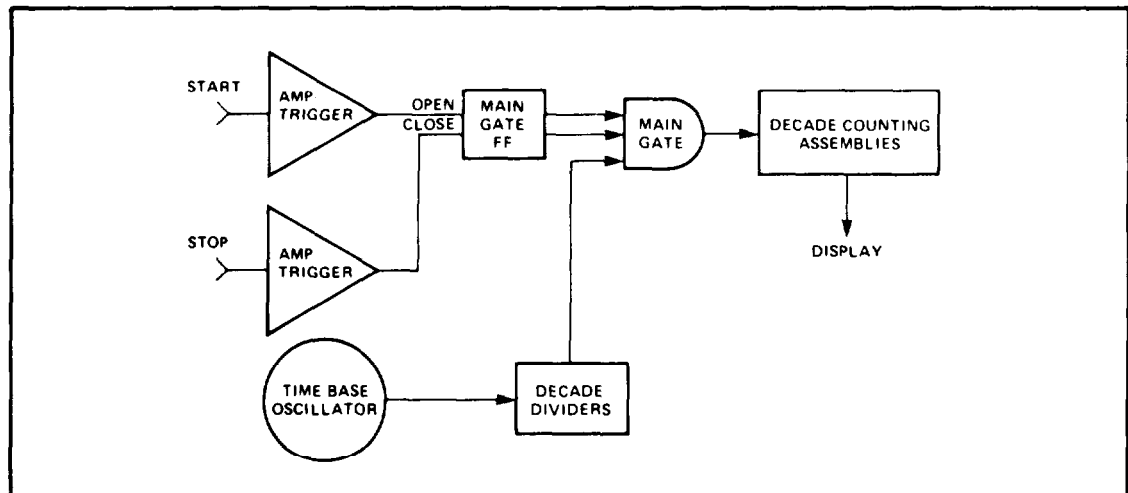
4-19. By replacing the time base with a second input of frequency,  $f_2$ ; the same configuration as in Figure 4-2 can be used to measure the ratio  $f_2/f_1$ . For higher resolution the signal at frequency  $f_1$  can be divided in decade steps in a manner identical to multiple period averaging.

**4-20. Time Interval**

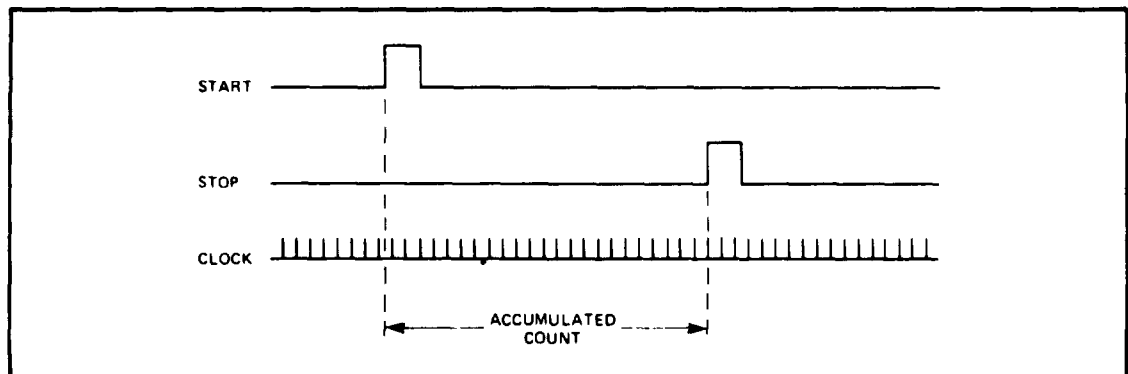
4-21. Figure 4-3 shows the configuration for the measurement of time between two events or time interval. The main gate is now opened by the START input and closed by the STOP. The decade divider output is again counted and the display shows the elapsed time between START and STOP signals. The measurement of time interval is considered in more detail in paragraph 4-22.

**4-22. TIME INTERVAL, RESOLUTION, AND AVERAGING TECHNIQUES**

4-23. Time interval, the measurement of the time between two events, is shown in the block diagram shown in Figure 4-3. The main gate is now controlled by two independent inputs, the START input opening the gate and the STOP input closing it. Clock pulses are accumulated for START and STOP. This is shown in Figure 4-4.



*Figure 4-3. Basic Elements of a Time Interval Counter*



*Figure 4-4. Clock Pulses*

**NOTE**

In a time interval measurement, clock pulses are accumulated for the duration the main gate is open. The gate is opened by one event, START and closed by the other, STOP.

#### 4-24. Resolution

4-25. The resolution of the measurement is determined by the frequency of the counted clock (e.g., a 10 MHz clock provides 100 ns resolution). The elements within the time interval counter (input amplifier, main gate, DCA's) must operate at speeds consistent with the clock frequency, otherwise the instrument's resolution would be meaningless. The 5328A counts a 10 MHz clock.

4-26. Clock frequencies of 1, 10, 100 MHz, and other 10<sup>n</sup> frequencies, are preferred since the accumulated count, with the appropriate placement of decimal point, gives a direct readout of time interval. This explains why the conventional time interval counter is at present limited to 10 nanoseconds, a clock frequency of 100 MHz. 1 GHz is beyond reach and a clock frequency of 200 MHz would require some arithmetic processing of the accumulated count in the DCA's to enable time to be displayed directly.

#### 4-27. Time Interval Averaging

4-28. This technique is based on the fact that if the  $\pm 1$  count error is truly random it can be reduced by averaging a number of measurements. The words "truly random" are significant. For time interval averaging to work, the time interval must (1) be repetitive, and (2) have a repetition frequency which is synchronous to the instrument's clock. Under these conditions the resolution of the measurement is:

$$\text{Resolution} = \frac{\pm 1 \text{ count}}{\sqrt{N}}$$

where N = number of time intervals averaged

4-29. With averaging, resolution of a time interval measurement is limited only by the noise inherent in the instrument. Ten picosecond resolution can be obtained with the 5328A. Most time interval averaging suffers one severe limitation; the minimum measurable time interval is limited to the period of the clock. This limitation is removed by circuits known as synchronizers which are used in the 5328A to measure intervals as short as 100 picosecond.

4-30. The 5328A synchronizers operate as shown in Figure 4-5. The top waveshape shows a repetitive time interval which is asynchronous to the square wave clock. When these signals are applied to the main gate, an output similar to the third waveform results (no synchronizers). Note that much of this output results in transitions of shorter duration than the clock pulses. DCA's designed to count at the clock frequency are unable to accept pulses of shorter duration than the clock. The counts accumulated in the DCA's will therefore approximate those shown in the fourth trace — the exact number of counts is indeterminate since the number of short duration pulses actually counted by the DCA's cannot be known. Since the time interval to be measured is slightly greater than the clock period, the fourth waveshape shows that the average answer will be in error, having been biased, usually low, because of the DCA's requirement of having a full clock pulse to be counted.

4-31. This problem is alleviated by the synchronizers which are designed to detect leading edges of the clock pulses that occur while the gate is open. The waveshape applied to the DCA's, when synchronizers are used, is shown by the fifth waveform. The leading edges are detected and reconstructed, such that the pulses applied to the DCA's are of the same duration as the clock.

4-32. Synchronizers are a necessary part of time interval averaging; without them the averaged answer is biased. In addition, it may easily be seen that with synchronizers involved, time intervals of much less than the period of the clock can be measured. This technique is only as good as the synchronizers, however. The 5328A high-speed synchronizers enable intervals as small as 100 picosecond to be measured.

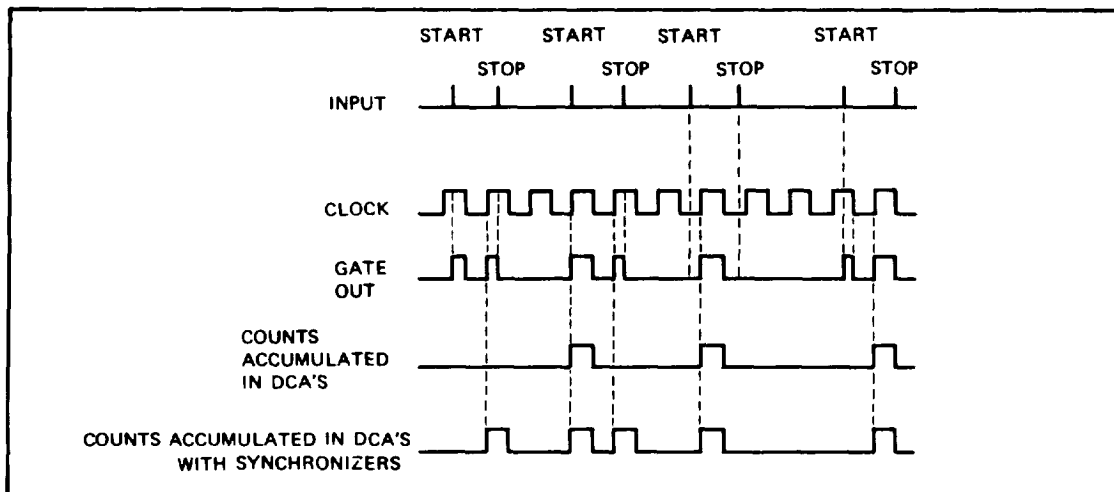


Figure 4-5, Synchronizer Operation with Time Interval Averaging

4-33. There are occasional situations where time interval averaging cannot be performed on a periodic signal. This problem occurs when the input time interval repetition rate is synchronous with the internal clock.

#### 4-34. SOURCES OF MEASUREMENT ERROR

4-35. The major sources of measurement error are the  $\pm 1$  count ambiguity, the time base error and trigger error. These are discussed in the following paragraphs.

#### 4-36. $\pm 1$ Count Ambiguity

4-37. Since the signal input to the main gate of the counter and the clock input are not coherent, an inherent  $\pm 1$  count ambiguity exists in the count accumulated in the decade counting assemblies. This is illustrated by Figure 4-6.

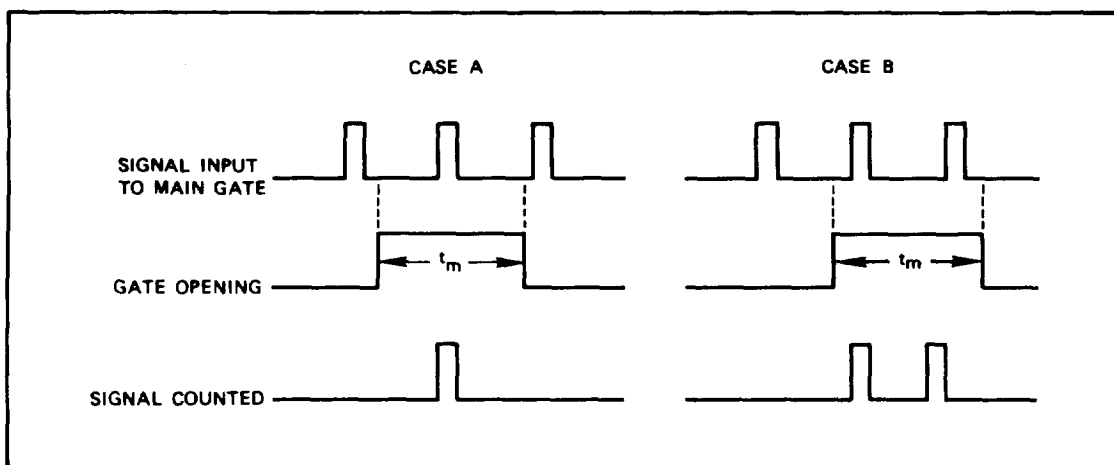


Figure 4-6.  $\pm 1$  Count Ambiguity

#### NOTE

The main gate is open for the same time,  $t_m$ , in both cases. incoherence between the clock and the input signal can result in two different counts which for this example is one for case A and two for case B.

4-38. FREQUENCY MEASUREMENT ERROR. The error caused by the ambiguity is in absolute terms,  $\pm 1$  of the accumulated count. For a frequency measurement the signal counted is the input signal of frequency,  $f_{in}$ . Thus the relative error is given by:

$\pm 1$  count error, relative frequency measurement error

$$\frac{\Delta f}{f} = \frac{\pm 1}{f_{in}} \quad (2)$$

4-39. PERIOD MEASUREMENT ERROR. For period measurement, the signal counted is the internal time base clock of period  $t_c$ . Hence the relative error becomes:

$\pm 1$  count error; relative period measurement error

$$\frac{\Delta T}{T} = \frac{\pm t_c}{T_{in}} \quad (3)$$

4-40. MAIN GATE REQUIREMENTS. The  $\pm 1$  count error described above assumes the main gate itself does not contribute any error. As with any gate, however, the main gate does exhibit propagation delays and takes finite times to both switch on and off. Any differential between the times taken for the main gate to switch on and off show up as uncertainties in the length of time the gate is open. This uncertainty in turn translates into a measurement error that increase the  $\pm 1$  count. However, the uncertainty in the main gate of the 5328A is substantially less than the period of the highest frequency counted, so this error is not appreciable.

#### 4-41. Time Base Error

4-42. Any error in the time base oscillator directly translates itself into a measurement error. Thus, if the total of all the oscillator errors amount to  $1 \times 10^{-6}$ , the total error contributed by the time base in the measurement of a 10 MHz signal is  $1 \times 10^{-6} \times 10^7 = 10$  Hz. Similarly, for the measurement of a 100-millisecond period, the error would be  $1 \times 10^{-6} \times 10^5 = 1 \times 10^{-1}$  or 100 nanoseconds.

#### 4-43. Trigger Error

4-44. Noise on the input signal will cause uncertainties in the point at which the Schmitt trigger switches. Provided the noise is not large enough to cause false triggering (i.e., cross both limits of the hysteresis band which would produce more pulses out of the Schmitt trigger than input cycles to it) no significant error is introduced in a frequency measurement.

4-45. For period measurements, however, this uncertainty produces like error in the time the gate is open, since it is this signal that controls the gate. It can be shown that with essentially low frequency noise and a signal-to-noise ratio of 40 dB, the resultant worst case trigger error is .32% of the period. Thus, the trigger error in the measurement of the period of a 1 kHz signal is  $3.2 \times 10^{-3} \times 10^{-3} = 3.2$  microseconds, worst case. For 60 dB signal-to-noise ratio, worst case error is .032%; while for a 20 dB signal-to-noise ratio signal it is 3.2%.

4-46. For an arbitrary wave shape (but constant slew rate through the hysteresis band), the trigger error takes on a different expression. In Figure 4-7, it is shown that for this case, the trigger error is:

$$\frac{\pm 2 \text{ peak noise voltage}}{\text{signal slew rate}}$$

for a 40 dB S/N, this translates to:

$$\frac{\pm .0025 \mu\text{s}}{\text{signal slew rate (V}/\mu\text{s)}}$$



4--47. For time interval measurements, trigger error is generally negligible when compared to the systematic error introduced by the uncertainty in the setting of trigger levels. For an uncertainty in trigger level of  $\pm 10$  millivolt and a peak noise voltage of one millivolt, trigger error is a factor of five less than the error caused by trigger level uncertainty, regardless of signal slew rate. For example, trigger level uncertainty of  $\pm 10$  millivolt on a 100 millivolt/nanosecond signal introduces an error in the time interval measurement of  $\pm 0.1$  nanosecond. The trigger error for such a signal, with 1 millivolt peak noise, is less than  $\pm 0.02$  nanosecond, a factor of five less. Averaging reduces the trigger error still further (but not the trigger level uncertainty error). The error is reduced by  $\sqrt{N}$  for time interval averaging and by  $N$  for period averaging.

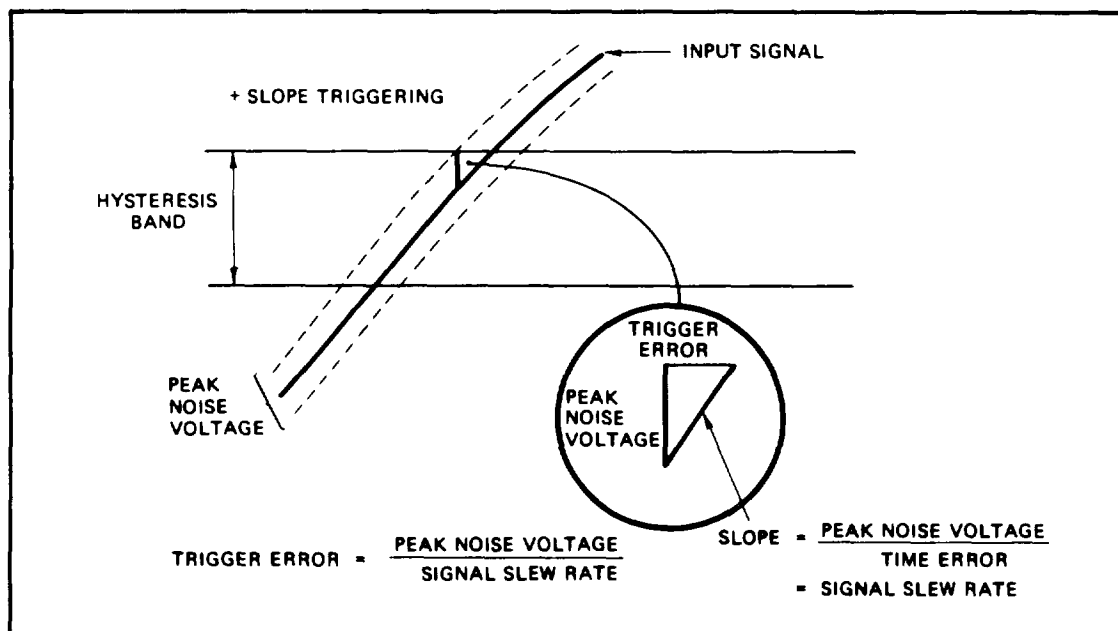


Figure 4-7. Trigger Error

#### 4-48. 5328A PRINCIPLES OF OPERATION

4-49. The 5328A is organized into four main operating sections (refer to Figure 4-8):

- The main counter section
- The input section
- The power supply section
- The Hewlett-Packard Interface Bus (HP-IB) section

4-50. Each section operates relatively independently and communicates to the other through an internal bus system. The two-way bus consists of 90 lines.

4-51. The power supply provides regulated dc voltage for the other operating sections of the instrument. The main on-off switch of the instrument operates only the central power supply regulator; the main ac power line is never broken. Unregulated dc is constantly fed to the oven oscillator eliminating the need for time base warmup. The fan is dc powered.

#### 4-52. Main Counter Section

4-53. The main counter section on A1 Motherboard contains all of the functional subunits of a standard counter with the exception of input signal conditioning and special logic, which are contained in the input section. The decade counting assembly contains eight decades of BCD counting logic, latches, and output multiplexing logic. The time base assembly contains eight

Model 5328A  
Theory of Operation

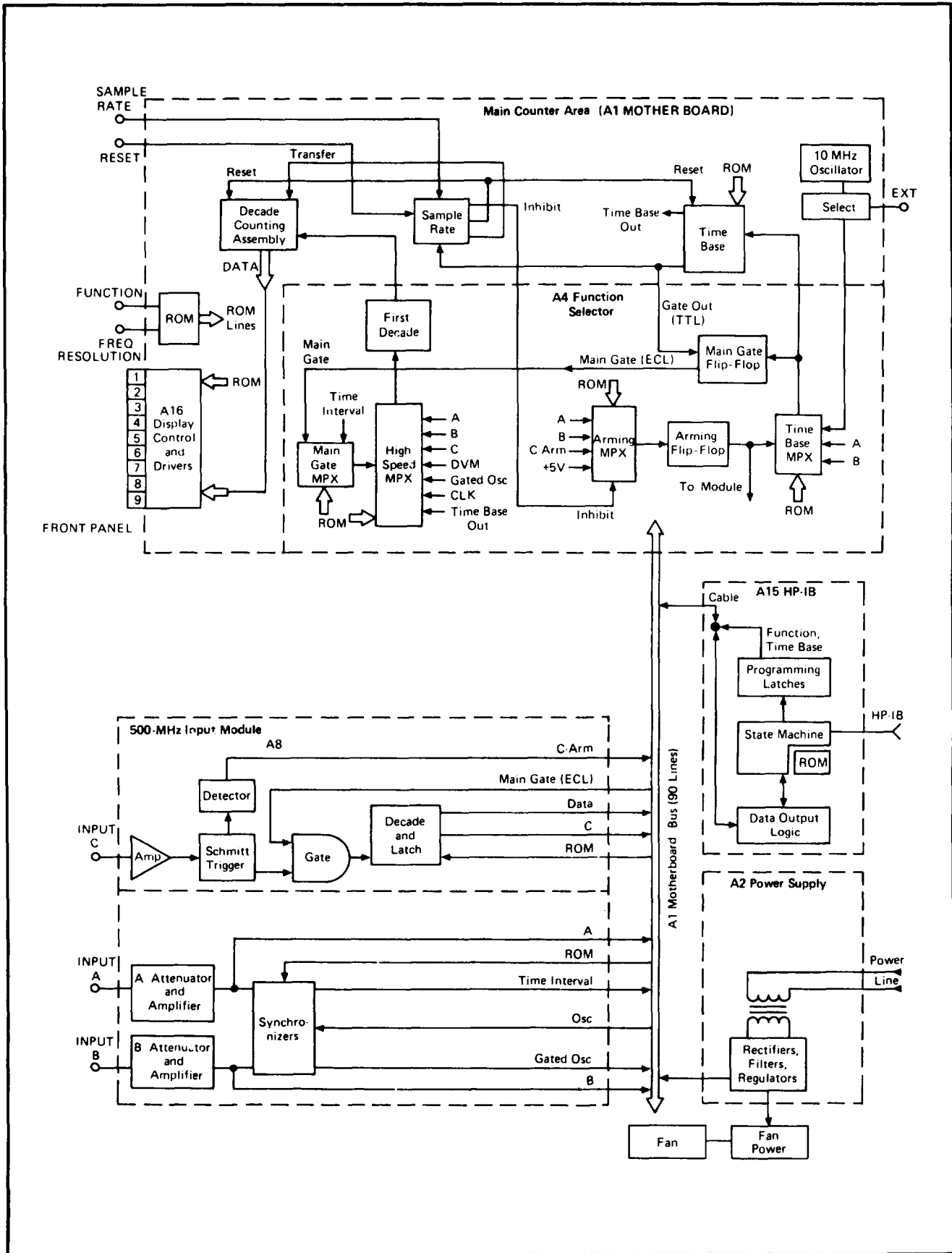


Figure 4-8. Block Diagram

counting decades, output multiplexing logic, and synchronizers to generate precise timing signals for the main gate. The oscillator section contains the input/output logic to accept an external signal via the rear panel or an internal signal from the oven-regulated crystal oscillator.

**4-54.** The sample rate circuit controls the instrument display cycle. Inhibit, reset, main gate, transfer, and sample rate signals are generated in this circuit, as is the BCD digit address code for the strobed display. Generation of decimal point and annunciators and decoding of BCD data are accomplished by the display control circuits. Data out of the decade counting assembly or the input modules is decoded and displayed on the nine-digit LED display.

**4-55.** The A4 Function Selector serves as the main signal switch of the instrument. It routes input signals through multiplexer to the decade counting assembly and/or the time base. At the same time, it interacts with the display control circuits to determine the beginning and end of the display cycle. The precision main gate signal is created on the function selector through interaction with the time base assembly. The function selector also has extensive interaction with the input modules. It is the main receiver of the high-speed data from the modules and the originator and receiver of module arming pulses.

**4-56.** The flexibility of the 5328A comes from the ability of all these operating subsections to accept diverse data from input modules. This is accomplished through the use of a 4000-bit read-only memory (ROM) as the master control of the instrument. Located in the main counter section of the instrument, the ROM accepts the four-bit function code and the three-bit time base code from the front-panel switches or the HP-IB remote programming board. The ROM generates 32 bits of output data which are transmitted throughout the instrument to set-up each subsection for the particular measurement situation.

#### **4-57. Input Section**

**4-58.** The input modules are the main interface between the instrument and the outside electronic environment. They accept input signals and convert them into the proper form to be handled by the main counter circuits.

**4-59.** The middle area of the input module section provides the 5328A with extended frequency capability (Channel C). A  $50\Omega$  fuse-protected 500 MHz amplifier and Schmitt trigger feed the 500 MHz decade. Latches in this section strobe the ninth (least-significant) digit from the module onto the data bus and into the display. In functions not requiring an input from this module, ROM lines deactivate the output strobing circuitry and the ninth digit on the display goes blank.

#### **4-60. Hewlett-Packard Interface Bus (HP-US) Section**

**4-61.** The fourth section of the instrument, the HP-IB assembly provides for control of the counter by the HP-IB. Connected to the main instrument bus through a ribbon cable, the internally-mounted HP-IB board controls function, time base, cycle rate, arming, and other controls in the instrument.

#### **4-62. A1 MOTHERBOARD**

**4-63.** The A1 Motherboard consists of five sections, as follows:

- a. Display control.
- b. State control.
- c. Oscillator.
- d. Decade Counting Assembly.
- e. Time Base.

#### **4-64. Display Control**

**4-65.** The display control section on A1 Motherboard acts as an interface between the A16 Display board and the other circuits of the counter.

**4-66.** The outputs of the A16 Display Board FUNCTION and RESOLUTION switches go to the ROM (A1U37). The outputs of the ROM position the decimal point and annunciators in the display and provide control functions for other circuits of the counter. Data from the data bus is translated from BCD to seven-segment form in decoder U41 and sent to the display which is strobed by U39. U39 decodes the digit address code from BCD to one of 10 forms. Leading zero blanking is provided by the latch comprised of U32B and U40B. Latches U25, U26, U27, and U31 provide outputs related to function and time base codes for use in other sections of the instrument.

#### **4-67. State Control**

**4-68.** The state control section is comprised of circuits U1, U2, U3, U4, and US. Decade Counter U1 generates the digit select strobe code for the display. Circuit U4 receives the Sample Rate signal and generates the main Reset, Transfer, and Inhibit signals.

#### **4-69. A3 OSCILLATOR SUPPORT**

**4-70.** An oven-temperature-regulated crystal oscillator (A3A1) supplies the precision 10 MHz time base signal in the 5328A. The A3A1 crystal oscillator (also designated HP Model 10544A) is in rectangular metal enclosure which plugs into the A3 Oscillator Support. The A3 Oscillator Support in turn plugs in the A1 Motherboard.

#### **4-71. A3 Oscillator Support**

**4-72.** On the A3 Oscillator Support five separate functional circuits are provided: a voltage regulator, an external signal detector, and amplifier-multiplier, a multiplexer, and a 10:1 divider. Integrated circuit U3 is a voltage regulator which regulates the 25-volt power at about 13 volts for the oscillator. External signal detector U4C will detect if an external signal (1, 5, or 10 MHz) is applied to the 5328A rear panel EXT OSC IN connector and send a signal, U4C(13), to control the U2 multiplexer. If an external oscillator signal is applied, the multiplexer selects the external signal for the 5328A time base. If only the A3A1 10 MHz signal is available, it is used for the time base. U4A and B produce a 10 MHz output, U4B(5), with either 1, 5, or 10 MHz input. The A3A1 10 MHz is divided to 1 MHz by U1 for the rear panel 1 MHz OUT connector.

#### **NOTE**

The rear panel 10 MHz OUT and 1 MHz OUT are both always derived from the 10544A, A3A1 Oscillator.

#### **4-73. A3A1 Oscillator (HP 10544A)**

**4-74.** The oscillator specifications are given in *Table 7-3*. This oscillator is a factory-serviced assembly. No circuit description is given here.

#### **4-75. DECADE COUNTING ASSEMBLY (DCA)**

**4-76.** The 5328A DCA is comprised of Decade Counter/Latches (U10 and U12) on the A1 Motherboard and U1A, U3, and U4B on A4 Function Selector Board. The Motherboard contains output enable circuitry (U6, U7, and U9) for controlling the counters output data, signal overflow indication, and circuitry for strobing data into the display (U41). The data output of each Decade Counter in the DCA corresponds to a digit on the display. The first Decade Counter in the sequence of operation corresponds to the least-significant-digit and the last to the most-significant-digit. Digits 0 through 5 are processed by U12, digit 6 by U10, and digit 7 by U11.

**4-77.** All measurements performed by the 5328A result in pulses being counted in the DCA. Pulses are admitted to the DCA by way of the Main Gate FF on A4 which is either controlled by a Gate Out signal from the Time Base (A1U19) or held open by the HOPN signal from A1U25.

**4-78.** Data strobe signals, transfer pulses, reset pulses, and an output disabling signal are routed to the DCA via the 5328A 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.

#### **4-79. TIME BASE**

**4-80.** The 5328A Time Base circuit is comprised of an 8-decade divider U21, shaping flip-flop U19A, and Synchronization flip-flop U19B. The Time Base input, depending on the particular measurement being made, is either the 10 MHz system clock or the Channel A or B input signal. These signals are routed to the Time Base input via the ROM-controlled Time Base Multiplexer, U10 on the A4 Function Selector board.

**4-81.** The Time Base circuit has two modes of operation consistent with the two types of measurements performed by the 5328A. For frequency and time interval type measurements, the Time Base circuit generates a gate during which either oscillator or input pulses are counted. For totalize type measurements, the Time Base circuit divides its input by N as set on the RESOLUTION, N switch on the front panel and outputs the divided signal to be counted in the DCA. The outputs of the Time Base circuit, corresponding to both operating modes, are generated simultaneously. Regardless of the type of measurement being performed, these outputs are made available to the A4 Function Selector which selects the proper signal to perform the function.

**4-82.** The length of the gate time generated by the Time Base circuit and the scale factor of the Time Base Input is determined by the Time Base code. The 5328A 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 measurement resolution and scale factor agree with the information in the various (RESOLUTION, N) switch positions.

#### **4-83. A2 POWER SUPPLY**

**4-84.** The power supply has five output voltages: +5, -5.2, +15, -15, and +3.5 volts, dc. The +5V and -5.2V circuits are essentially the same as are the +15V and -15V sections, so only the positive voltage sections will be described.

#### **4-85. +5V Supply**

**4-86.** The +5V supply is a switching regulator that has greater efficiency than a linear regulator of the same output. When the output voltage is below its nominal level, comparator U1 sees its + input being above its - input and hence its output goes positive turning on transistor Q5 which in turn turns on Q3 and Q1. The voltage at the collector of Q1 now goes high (greater 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 situation until the output goes slightly above +5V. When the voltage reaches this point the comparator output voltage starts to fall turning off transistors Q5, Q3, and Q1 causing the voltage at the collector of Q1 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.

**4-87. +15V FAN POWER.** The +15V supply is a simple linear regulator using transistor Q7 as the pass transistor. Transistor Q2 provides level shifting and current gain while U3 is used as comparator and gain block. The 5328A cooling fan motor receives power from A20. A20 is a sealed unit which produces an alternating current from +15 volts input.

**4-88.** The +3.5V supply is also a simple 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 shorts.

#### **4-89. A4 FUNCTION SELECTOR**

**4-90.** The A4 Function Selector serves as the main high-speed switching module of the 5328A. 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. In addition, the Main Gate FF, the Arming Multiplexer and Arming FF, and the First Decade of the DCA are on the A4 Function Selector assembly.

#### **NOTE**

Refer to Table 8-7 for definitions of mnemonics.

#### **4-91. High Speed Multiplexer, Main Gate, and 1st Decade**

**4-92.** High speed multiplexer U6 serves as the main multiplexer and routes the following signals to the 1st decade of the DCA: A, B, GATES OSC (GOSC), C, DVM, TIME BASE OUT (TBO), and OSCILLATOR (OSC). ROM lines IA, IB, and IC control the active address of the multiplexer. Pin 2 (enable) of the multiplexer serves as the Main Gate. The Low Time Interval (LTIF), Low Main Gate FF (LMGF), or (LTOTŽLST), signal operating through U8 and enabled by ROM lines LMGF, LTIF, (LTOTŽLST), respectively control the Main Gate. In addition, ROM line HOPN can override LTIF or LMGF and lock open Main Gate U6(2) through U8C. Main Gate status is detected and sent off the A4 Function Selector by ECL-to-TTL translator U2D. Capacitor C11 and resistor R35 serve to stretch any ECL gate signal present at U2(10) so that the slower TTL control chip A1U4 and gate light one-shot (Q6, U36B, E) can see the pulses and properly react. U8D differentially drives bus lines MG and M to operate the remote Main Gate of Channel C.

**4-93.** The output of the main multiplexer U6(15) feeds into first binary U1 of the main DCA. U1A is an ECL High-Speed binary the output of which couples to pins 14 and 15 of ECL-to-TTL translator U2. The TTL output of U2(13) clocks Schottky quinary U4 and U3. The outputs of the first decade U3(9), U4(9), U3(5), and U2(13) travel off the A4 Function Selector board to the DCA on the AI Motherboard where they are latched and the carry feeds into the next decade of the DCA.

#### **4-94. Arming Multiplexer and Arming FF**

**4-95.** The Arming FF, the second half of U4, serves to inhibit various measurements by enabling or disabling Time Base Multiplexer U10 and the synchronizers in the Universal Module. This action occurs via the High Disables Synchronizers (HDS) signal from U4(6). The signal which sets or enables U4 comes from Arming Multiplexer U5(6). ROM lines control U5(10, 11) while the remaining address line (pin 9) is controlled by the Low Arm (L ARM) signal from the rear panel ARM switch. US thus selects either C-ARM, B, B, or free run (+5V) as the signal to send to U4 as the Arming signal. The A and B signals are derived from ECL-to-TTL translator U2A and U2B, respectively. Capacitors C4 and C5 and resistors R17 and R18 serve as pulse stretcher timing elements to enable the narrow ECL pulses on lines **A** and **B** to be seen by the TTL Arming FF U4.

#### 4-96. Time Base Multiplexer and Main Gate FF

**4-97.** Time Base Multiplexer U10 select either A, B, or OSC to send the Time Base Input (TBI) signal via pin 8 to the Time Base. This same signal is also sent to U1, the Main Gate FF, as a desynchronizing signal. ROM lines R(HTBA), R(HTBO), and R(HTBB) control the selection of the Time Base Input signal. The HDS signal to U10(3) or ROM line LTOT to U10(1) serve to enable or disable U10.

**4-98.** U1B is a high-speed ECL FF used to generate precise stable gate times for the Main Gate Multiplexer U8 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 U1 via the line Main Gate Synchronizer on the Motherboard. Resistors R14 and R43B translate this TTL signal down to ECL levels at U1(10). The output of Time Base Multiplexer U10 via resistors R42 and R43D and capacitor C16 clocks U1(11) yielding a synchronized fast rise and fall time Main Gate signal on U1(14).

#### 4-99. An Example of Operation

**4-100.** To show how the above mentioned function selector circuits operate together an example of the measurement of frequency A is given in the following paragraphs.

**4-101.** Assume 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 U1 and U4 and High Reset Decade (HRD) has momentarily gone high resetting First Decade U1, U4, and U4. The control chip on the Motherboard releases LINH to go high. U9(13) goes low enabling Arming Multiplexer US. Assuming that self arm has been selected, A will have been detected by the ROM, on pins 9, 10, and 11 of U5. When the first A pulse occurs U4(4) goes low setting U4. U4(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 on pin 2 of U10 to be sent into the Time Base. Shortly after the Time Base returns, a high signal on Main Gate Synchronizer drives U1(10) high. On the next Oscillator signal (through U10) U10(11) gets clocked causing U1(14) to go low. This low signal propagates through U8(B and C) to U6(2) opening the Main Gate and initiating the count, Signal A has been selected on U6 by ROM lines R22, 23, and 24 thus each A event is counted into 1st decade U1A, U4A, and U3.

**4-102.** 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 FF U1 closed. U2(10) detects the closing of the Main Gate and sends a TTL signal (LMGF) to U4 in the State Control section of the AI Motherboard which initiates a new display cycle.

#### 4-103. A16 DISPLAY ASSEMBLY

**4-104.** The Display Assembly contains the display, as shown in the block diagram in Section VIII, in addition to switches S1 (POWER), S2 (RESET), S3 (FUNCTION), S4 (FREQ RESOLUTION, N) and SAMPLE RATE control R6 as shown in the schematic diagram in Section VIII.

**4-105.** The display consists of a nine-digit seven-segment LED numeric display (DS1-DS9) and annunciators for indicating measurement units (DS10-DS16) in addition to overflow (DS17), remote (DS18), and gate (DS19). The display digits and annunciators are automatically displayed with the correct decimal point.

**4-106.** 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 Q13-Q20. The gate (DS19), remote (DS18), and overflow (DS17) LED's receive signals from the Motherboard through transistors Q10, Q11, and Q12, respectively.

**4-107. REMOTE CONTROLLABLE (PROGRAMMABLE) INPUT BLOCK DIAGRAM DESCRIPTION**

**4-108.** In the local mode, the A19 Switch Control board generates TTL levels that control the A12 signal conditioning relays. These levels allow front panel control of A and B channel input signal conditioning. The A19 board accepts inverted A and B channel signals from the A12 board. These signals are routed through pulse stretcher and driver circuits to the A and B channel trigger LEDs located on the A19 board. The inverted signals are also translated from ECL to TTL levels and supplied to the A and B marker outputs.

**4-109.** Input circuitry for the A and B channels is on the A12 Amplifier board and part of the A10 Synchronizer board. The A12 board contains the 100 MHz A and B channels with signal conditioning SLOPE, AC/DC, ATTENUATORS, SEP/COM, amplifiers, and Schmitt triggers. Signal conditioning circuitry is controlled by relays K1 through K12 synchronizing circuitry for period and time interval type measurements. The A,  $\bar{A}$ , B,  $\bar{B}$ , TI,  $\bar{TI}$ , GOSC, and GOSC outputs, from the A10 board, are routed to the A4 Function Selector.

**4-110.** The programming interface section of A10 board is used to allow remote control of all input signal conditioning relays. The A11 DAC board contains two identical DACs, A and B channel, that allow remote control of trigger levels. The outputs of these DACs are supplied to a relay on the A12 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 DAC control modes.

**4-111.** When the 5328A goes into remote, 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 decode serial data bytes, stores the information in latches, and control signal conditioning via the latched outputs.

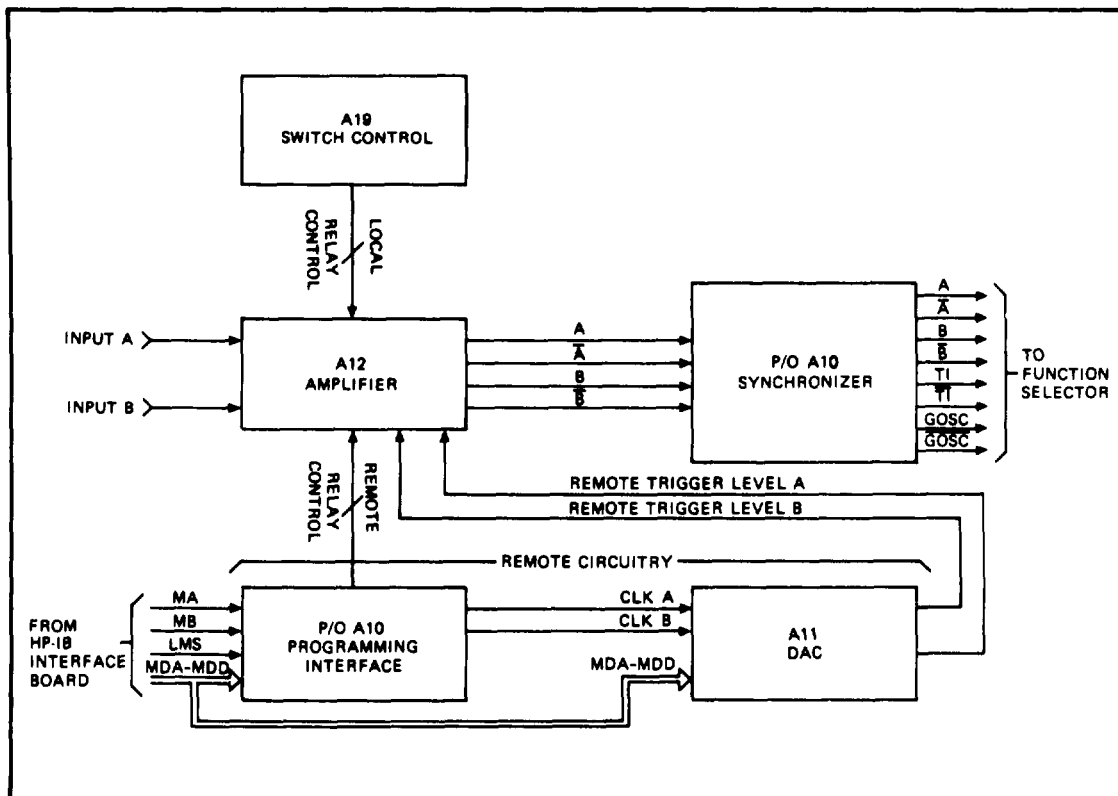


Figure 4-9. Remote Controllable (Programmable) Input Block Diagram



**4-112.** 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 input. Simultaneously, the information, on the input data lines (MDA-MDD) is accepted by the A11 DAC board.

**4-113.** The A11 DAC board shifts the polarity indicator and 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 4-7 for proper format). The asterisk causes the programming interface to revert back to the non-DAC control mode. In this mode, the All board stops accepting data, and the programming interface latches again accept the input data.

**Table 4-1. 5328A Input Circuit Program Code Set**

|   |                      |                   |
|---|----------------------|-------------------|
| <p>Programming is accomplished as detailed in Section III with the additions below. Codes shown underlined are start up conditions. These conditions are set by the code "P", Remote Programm Initialize, or by the bus commands Device Clear, or Selected Device Clear.</p> <p>Commands to A channel are preceded by A<br/>         Commands to B channel are preceded by B</p> <p>Trigger levels are programmed using the following format</p> <p style="text-align: center;"><math>\pm X.Y Z^*</math></p> <p>Where X is volts<br/>         Y is 100 s of mV<br/>         Z is 10 x of mV<br/>         * is used to terminate inputs to the DAC's</p> |                      |                   |
| <b>Control</b>  | <b>Function</b>      | <b>Code</b>       |
| Coupling  | AC                   | 2                 |
|   | DC                   | 3                 |
| Slope   | +                    | 4                 |
|   |                      | 5                 |
| Atten   | X100                 | 1                 |
|   | X10                  | 6                 |
|   | x1                   | 7                 |
| Separate/Corn   | Separate             | A8                |
|   | Common A             | A9                |
| <b>NOTE</b>   |                      |                   |
| Underlined codes are default conditions.  |                      |                   |
| Invert  | Normal               | B8                |
|   | A&B Inverted         | B9                |
| <p>The check function overrides all other programming commands for A&amp;B channels.</p> <p>EXAMPLES:</p> <p>The instruction:</p> <p>CMD "?U9", "PF:G5S137A3579-1.25*B37+1.65*R"</p> <p>Input circuits related programming information</p> <p>Will program a 5328A with listen address of 9 to:</p>   |                      |                   |
| <b>Function</b>   | <b>Channel A</b>     | <b>Channel B</b>  |
| Time Interval Avg A to B  | DC Coupled           | DC Coupled        |
| Multiplier <u>10<sup>5</sup></u>  | -Slope               | X1 Atten          |
| Multiple measurement  | X1 Atten             | Trig Level +1.65V |
| Continuous Cycle  | Common A             | +Slope            |
| Manual sample rate control  | Trigger Level -1.25V |                   |

**4-114.** The A11 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.

#### **4-115. REMOTE CONTROLLABLE (PROGRAMMABLE) INPUT SCHEMATIC THEORY**

**4-116.** Theory of operation for the programmable input section is given in the following paragraphs.

#### **4-117. A19 Switch Control Board**

**4-118.** In local mode, -0.7 volts is applied to switches S1-S8. This potential allows the switches to control their respective functions by supplying an active low available at each switch. In a closed switch position, the -0.7 volts will forward-bias the associated diode, pull the anode low, and cause a low to be sent to the amplifier board through J3.

**4-119.** In remote mode, the -0.7 volts switches to +5 volts, only allowing the output lines, transmitted through J3, to be high. When a switch is open, the pull-up resistor on the line causes it to go high. When the switch is closed, the associated diode is reverse biased and the line remains high,

**4-120.** 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 U1. Feedback capacitors C8 and C9 stretch the 5 nanosecond ECL pulse to approximately a 25 millisecond TTL output pulse. This 25 millisecond pulse is of long enough duration to be seen, and is used to drive the trigger LEDs. Since this pulse stretcher is decoupled to the Schmitt trigger, it functions like a logic probe with adjustable threshold voltage. When Channel A input is higher than the trigger level setting, the trigger LED is ON. When the input is lower, the LED is OFF, and whenever it passes through the trigger threshold, the LED flashes on or off depending on the polarity of the input signal.

**4-121.** The 5 nanosecond inverted A and B outputs are also applied to pins 2 and 6 respectively of U1. The signals are translated from ECL to TTL levels and connected to the marker outputs.

#### **4-122. A12 Amplifier Board**

**4-123,** Since both A and B channel circuitry are identical only the A channel will be discussed.

**4-124.** Input signal A enters A12 through J2 and depending on relay K7 is either ac coupled through capacitor c30 or dc coupled across relay K7. The signal then enters the three position attenuator (X1, X10, X100) and is passed from the selected attenuation node through either K2, K3, or K8 to the input of the FET impedance converter stage. Diodes CR5 and CR6, resistors R39, R37, and R34, and capacitors C23 and C24 form an overvoltage protection network to limit the signal sent to FET transistor Q3 and successive circuits to  $\pm 2.61$  volts maximum, The signal at the node between resistors R30 and R32 follows closely the signal at the gate of Q3A. A potentiometer is used to adjust any initial offset voltage.

**4-125.** SEP/COM A relays, K4 and K5, connect the input of the B channel attenuator to either the A or B channel inputs. The signal then passes through U4, a dual Schmitt trigger, Trigger U4B compares the signal at pin 9 to a dc reference between  $\pm 2.5$  volts on pin 10. This dc reference is selected by K1 and is supplied by either the A11 DAC board or by the A19Switch Control board. The output of U4 changes state whenever the input crosses the reference voltage on U4(11). The output is ECL ( $= -0.8$  to  $-1.6V$ ) and drives both the A trigger LED circuit on the A19 board

and the exclusive OR gate U2. Schmitt trigger U4 has approximately 15 mV peak-to-peak hysteresis at its input. Exclusive OR gate U2 is used to select the desired slope of the input waveform. When pin 7 of U2 is held to an ECL high level (SLOPE switch in + position), U2 acts as an inverter. When pin 7 goes low (SLOPE switch in the - position), U2 does not invert the signal passing through it.

**4-126.** Input signal conditioning control is accomplished by inverters U1 and U3 and relays K1-K12. This control is supplied from either the A10Synchronizer board or the A19Switch Control board. When the 5328A is in remote, relay control is received through J1 from the A10 board. In the local mode, relay control arrives via P2 from the A19 board. Since all of the relay control lines contain inverters, relay activation is caused by a high at the input.

#### 4-127. A10 Synchronizer Board

**4-128.** The differential A channel outputs from A12U2 feedthrough connector P2 pins 7 and 8 respectively to U1. Circuit U4 is a one-shot that only triggers on a negative edge, and therefore, passes only trigger events that occur on the slope selected by A12U2. The output of U4 pin 15 is an ECL pulse of approximately 5-10 nanoseconds width. In the FREQ A check mode, the oscillator signal from U1(2), (either 10 MHz or 100 MHz as selected by S1) is injected via U5B to U10(13). The normal A input entering U10(12) is disabled at A12U4 by LCHK being low. The oscillator signal at U10(13) is passed through U10C and U10D to U11 a dual 4 to 1 multiplexer. In a noninverting mode, multiplexer U11 always routes the A channel signal to the start synchronizer U6A. In a period function, U11 routes the A channel signal to the stop synchronizer U6B. For time interval measurements, the B channel signal is supplied to stop synchronizer U6B. ROM line R6 controls the stop synchronizer input switching. In remote, HINV, from U11(7) allows the A and B channel outputs of U11 to be inverted. The outputs of U11A feed U12A which drives the A and A outputs to the A4 Function Selector.

**4-129.** In TI, TI AVG, PER, and PER AVG functions, U5, U6, U12, and U13 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 FFs U5 and U12 and D FFs U6A and U6B are reset. At the same time, the  $\overline{\text{TI}}$  and  $\overline{\text{GOSC}}$  outputs are at an ECL high. When a start event enters U5D pin 12, it sets the U5A output to U6A pin 7 high. The next clock pulse to U6(6) will cause U6A pin 3 to go low. This pulls the  $\overline{\text{TI}}$  output low, signaling to the function selector that the time interval has started. When TI goes low, GOSC (U13B) starts to output oscillator pulses. When a stop event occurs at U5(10), the output of U12C goes high. This, synchronous to the next clock pulse, sets U16(15) high. When U16(15) goes high, the TI and GOSC outputs go high stopping the time interval measurement. The Q output of U6B through U13C, U14B, and U14A resets all FFs and thus prepares them for the next measurement.

**4-130.** ROM line RL6(HC), connected to U14(11) by R6, is used in period measurements. This line is set low in period, and holds the stop FF (U5C and U12C) off until the start synchronizer U6A clocks a high to its Q output.

**4-131.** 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 R18 and R21, and applied through U14D to U12(1)). This causes the stop synchronizer flip-flop (U5C and U12C) to remain in a reset condition.

**4-132.** The programming interface has two operational modes, the non-DAC and DAC control modes. 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.

## Model 5328A Theory of Operation

**4-133.** When the 5328A goes into remote, LEXT goes low. The low, on LEXT, causes the output of A1 Motherboard switch control circuit to go from -0.7 volts to +5 volts. This change, disables front panel switch control on the A16 and the A19 boards. When LEXT is low, U17(4) connected to tri-state buffers U2 pin 1 and U9 pines 1 and 15 is also low. This low, returns the outputs of tri-state buffers, U2 and U9, to their active state. With the outputs of U2 and U9 enabled, the outputs of addressable latches, U8 and U15, control the A12 signal conditioning relays.

**4-134.** The interface is reset by a high on the HRPR line. This high is generated by the A15 HP-IB Interface Board when it receives an ASCII "P".

**4-135.** When the interface is reset it defaults to the non-DAC control mode. The reset causes the latched outputs of U8 and U15 to go low. This sets U17 pins 9 and 10 low, giving a low at U17(8). The low at U17(8) is connected to U7(14), where it causes the interface to be in the non-DAC mode. The low at U17(8) is also connected to clock multiplexer U16(1) where it causes U16 to route clock (LMS) pulses to only U8 or U15.

**4-136.** Clock multiplexer U16 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 U8(14) for A channel information, or to U15(14) for B channel information. The clock pulse, latches the information into the intended latch.

**4-137.** After reset, the interface defaults to all of the underlined functions in *Table 3-5 Program Code Set*. To change one of the signal conditioning controls it is necessary to program that function.

**4-138.** 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 5328A. When the "A" is decoded by the A15 HP-IB interface, it causes the MA line to be high and the MB line to be low. The MA and MB lines are decoded by U6 and it routes the following clock pulses to U8.

**4-139.** When the "7" is sent, 1110 appears at the input of ROM U7 on MDA-MDD respectively. As shown in *Table 5-28*, the 1110 at the input causes an output of 000011 on U7 pins 1-6.

**4-140.** The clock pulse arrives at U8(14) and latches the high on U8(13) to U8(5). The high on U8(5) is buffered by U9 and appears at pin 13 of its output. The high at U9(13) is inverted on the same function as Channel A.

**4-141.** All non-DAC information is latched in the same manner. B channel information is latched into the outputs of U15. it has the same code into U7, and thus the same code out of U7, for the same function as Channel A.

**4-142.** Refer to *Table 3-5 Program Code Set* for the proper format to program a trigger level. The proper format is  $\pm X.YZ^*$ , and follows an A and B which indicates to which channel it applies.

**4-143.** For the following discussion, assume 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. U16 decodes the MA and MB lines, in the non-DAC mode, and clocks the A channel latch U8.

**4-144.** When a + or - appears on the MDA-MDD lines, a high is latched into U8(12). Latching occurs on the positive clock pulse transition from U16. The high at U8(12), will cause U17(8) to go high. U17(8) is connected to U7(14), where the high changes the input address to ROM U7, and locks the interface into the DAC control mode. The high at U17(8) is also connected to U16(1). A high at U16(1) causes U16 to supply clock pulses to either the A or B channel DAC.

Since the condition of the MA and 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 U11.

4-145. Following the format, the next data byte on MDA-MDD will be a number. The MDA-MDD lines supplied to U7 are also connected to the A11 DAC board shift registers. Since the interface is in the DAC mode, neither U8 or U15 are 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 U7. When U7 decodes the decimal, it sends U7(5) high. This high, applied to U2(15), causes U2 to block the clock pulse associated with the decimal data byte. In this manner, the DAC disregards the decimal.

4-146. Following the format, two more numbers are input, serially, and each clocked into the A channel DAC shift registers. The final character in the string, an asterisk (\*), appears on the input data lines to U7. When U7 decodes the asterisk, U7(5) goes high, again blocking the positive clock pulse transition to the A channel DAC. This causes the A channel DAC to disregard the \*. Simultaneously U7(6) goes low, allowing the negative transition of the clock pulse to latch the low at U8(13) into U8(12). The low at U8(12) causes U17(8) to go low, returning the interface to the non-DAC control mode.

#### **4-147. A11 DAC Board**

4-148. Since the DAC board contains two identical DACs only the Channel A DAC will be discussed. For the following description assume the Channel A DAC is programmed for a +2.22V trigger level. Refer to Program Code Set, Table 3-5, for an explanation of the format.

4-149. The first data byte, a +, appears on the input data lines MDA-MDD. This data byte is supplied to the inputs of shift registers U7 and U11. An LMS clock pulse routed through A10U6, applied to U7 pin 1, shifts the + into U7 and U11. The next three data bytes, all two's, are shifted into U7 and U11 in the same manner.

4-150. With the + and the three numerals shifted into U7 and U11, the shift registers provide a parallel BCD output. This parallel output is static until the A channel DAC is reprogrammed. The parallel output is supplied to the input of rate multiplier chain U8, U9, and U10.

4-151. Circuit USC and related components are configured as an oscillator. The oscillator output is coupled through Q7 to the clock input of rate multipliers U8, U9, and U10. The clock signal is also supplied through inverter U5D to D-FF U2A, which is used as a synchronizer and wave shaper.

4-152. With 1000 pulses entering pin 9 of each rate multiplier, the output at U10(6) will be 222 pulses. These pulses are supplied through level shifter and inverter U5B to U2(12). The input pulses are synchronized and shaped by U2A. The Q and Q outputs, from U2A, supply level shifter networks composed of resistors R31, R34, and R36, R38, and R39. The pulse outputs from the level shifter networks arrive at the cathode of CR6 and the anode of CR8.

4-153. The + shifted into U11, causes U6 pins 2 and 6 to go high. The highs, on pins 2 and 6, cause pins 1 and 7 to go low. The low at U6(1), causes CR11 to be forward biased. Forward biasing CR11 causes U6A to sink all of the current from the positive current source. This disables the positive current source U3A and Q3. With U6(7) low, CR12 is reverse biased enabling the negative current source U3B and Q4.

4-154. The signal at the anode of CR8 is the inverted output from the rate multipliers. When the anode of CR8 is low, CR8 is reverse biased, and current flows through CR10 into U4(2). When the anode of CR8 is high, CR8 is forward biased and current flows from Q4 through CR8

4-155. Averager U4 converts the current pulses supplied via CR10 into a dc output voltage. The averager generates the output voltage proportional to the duty cycle of the input current pulses.

#### **4-156. A8 Channel C Input**

4-157, The A8 board contains circuitry to amplify and detect input signals up to 500 MHz, a divide-by-10 counting chain, a high-speed gate, and circuitry to drive the least-significant-digit in the display.

4-158, The input signal enters J1 and continues through a fuse (F1) into a limiter circuit composed of diodes CR2-5 and a 50-ohm termination. Diodes CR2-5 have 70V reverse breakdown voltage and limit the signals below that value to approximately  $\pm 600$  mV to protect amplifier U1. Fuse (F1) is rated at 125 mA and blows when the input voltage reaches about  $\approx 7$  volts. The signal passes through amplifier U1 (with a single ended gain of  $\approx 4$ ) and drives U2 (a combination amplifier/Schmitt trigger) differentially. The Schmitt trigger output (U2 pin 13) is a logic level from 0 volts to approximately -600 mV. The now digital (square wave) signal passes through U3 where it branches to drive a binary (U4) and a detector. The detector circuit senses the presence of an input signal and sends a TTL "C ARM" command to the A4 Function Selector, as described in the following paragraph.

4-159. During normal operation (in the frequency C function) U4 is originally disabled by a High logic level at U4 pin 14 (0 volts). When the counter is ready to make a measurement and it senses that an input signal is present via the "C ARM" line, the main gate opens. Pin 14 on U4 then goes "low" (to -600 mV) and the input signal passes through U4 ( $\approx 5$ ) where it is translated to ECL levels. A 50-40% duty cycle (for sine wave inputs) signal is sent to the A4 Function Selector on "C" and " $\overline{C}$ " bus lines, after the time base counts out, the main gate closes, U4 pin 14 goes high and U4 and U5 stop in their present states. Circuit U6 translates the information in U4–U5 to TTL level and it is shifted into a quad latch (U7) where it is stored for strobing into the display.

4-160. Circuit U10, Q1, Q2, and various resistors constitute a current source to properly bias U1 and U2. The circuit draws approximately 16 mA out of pin 3 on each IC and adjusts the current out of pin 6 between 28 and 56 mA until the voltage on pin 3 is approximately +600 to +900 mV on each IC.

4-161. Resistors R1, R2, R4, and R82 and U9A comprise the offset voltage adjustment circuit. This circuit also compensates for changes in input bias current into U1 to minimize drift in offset voltage.

#### **4-162. HP INTERFACE BUS THEORY**

4-163. The HP Interface Bus 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.

4-164. Eight of the lines (DIO1—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, NDAC). The other five lines are for control of bus activity,

4-165. 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—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 PC 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.

4-166. Several listeners can be active simultaneously but only one 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.

4-167. 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.

4-168. The ATN line is one of the five control lines. When ATN is low, addresses and universal commands are transmitted on seven of the data lines using the ASCII (American Standard Code for Information Interchange) code. When ATN is high, any code of 8 bits or less understood by both talker and listener(s) may be used.

4-169. 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.

4-170. Any active device can set the SRQ (service request) line low. This indicates to the controller that some device on the bus wants attention, say a counter that has just completed a time-interval measurement and wants to transmit the reading to a printer.

4-171. 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.

4-172. 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.

#### **4-173. HP-IB A15 INTERFACE OPERATION**

4-174. The 5328A HP-IB Interface is used to remotely program the 5328A and deliver the measurement results to the bus. Thus, the board operates both as a listener and as a talker.

4-175. As a listener, the interface is capable of programming most of the controls in the mainframe and all programmable modules that may be installed. 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.

4-176. As a talker, the interface is capable of outputting the measurement data in exponential format with a mantissa of nine digits (leading zeros are output as spaces) and an exponent of one digit. Overflow and signal information is also contained along with a carriage return (CR), linefeed (LF) termination to make it compatible with the standard HP-IB serial data format.

4-177. In addition to being a talker and listener, the HP-IB Interface follows a set of HP-1 B commands. This includes complete service request capability. The ASCII codes used for addressing and for data are shown in Table 3-7. Address switch information is shown in Table 3-4. The program code set is shown in Table 3-5.

#### **4-178. Overall Operation**

4-179. The heart of the HP-IB Interface is a 256 state algorithmic state machine (ASM) controlled by a 256x16 ROM (U22) as shown in the block diagram. This state machine has two different format states determined by the format (F) bit from U22. One state (F=0) is an output mode state where the machine will proceed sequentially to the next state (address) after storing or outputting information. The other state (F=1) is a mode where the machine can either proceed to the next line or perform a conditional jump to a different line in the program. The decision as to which state is chosen is made on the basis of where the qualifier bit from U11A is low or high. Preset counters U14 and U23 provide presetting to a jump state when F=1 and the qualifier is low. These counters increment their count in all other cases. Altogether, there are 52 different bits that may be selected as the qualifier for a particular state.

4-180. Qualifier negate circuit U30C can invert the qualifier bit for any given state so that the machine can branch on the qualifier being low or being high. U7 is added for pseudo sub-routine capability. In the output mode, the ASM goes through the same group of states once for every character being outputted on the bus. U7 is incremented every time so that the ASM can tell which character it is to output.

#### **4-181. Bus Command Mode**

4-182. In this mode (ATN low), the ASM accepts parallel bytes of information and decodes them into bus commands. This usually requires setting or clearing bits of storage in U19 or U26.

#### **4-183. Listen Mode**

8-184. In the listen mode, the listen qualifier of U26 must be low and ATN high. The interface will then accept 8-bit parallel bytes continuously. When receiving the ASCII characters P, Q, U, R, or T the counter will act upon the byte immediately (refer to programming in Section III). When receiving the letters F, G, A, B, C, D, or S the interface will then route any ASCII number or numbers following these letters into particular storage registers. These registers are U28, U33, and U34 along with any that are contained in any of the optional modules installed in the mainframe.

#### **4-185. Talk Mode**

4-186. The HP-IB Interface will go into the talk mode if the talk qualifier of U26 is low or the talk always switch is set to talk always and ATN high for both cases. There will be no output in normal operation unless a completed measurement is present and has not been outputted. The information to be put on the bus is latched into latches U15 and U24. These drive the high current buffers U5, U10, and U16. Counter U7 is used as a pointer for the ASM to recognize which character in the serial output string the interface is to output.

#### **4-187. A15 Circuit Operation**

4-188. The following paragraphs describe the circuit operation of the HP-IB Interface.

4-189. STATE COUNTERS. The state of the ASM ROM (current state and next state) is determined by State Counters U14 and U23. These counters form an 8-bit presettable binary counter. When pin 1 of U25 is low, the counters will always increment. When pin 1 of U25 is high, the counters will preset (jump to another state in the program) if the output of U30C is high. The preset address is supplied to the State Counters input from the ROM. The program is shown in the operational flowchart, *Figures 5-4, 5-5, and 5-6*. The output of U30C is determined by the "not" bit from the ROM (through U21E) and the output of the Qualifier FF U11A. The pre-programmed state of the "not" bit determines whether a high or low output of the qualifier FF will result in a jump in the program. (This is shown in the ASM Operational Flowchart, by



the use of the letter “N” in a decision diamond symbol. ) The preset (jump) is synchronous and only occurs when pin 9 of U14 and U23 is low and when there is a rising edge at pin 2 of U14 and U23. FF U31A synchronizes the reset of the State Counters to occur at the proper time.

4-190. ASM OSCILLATOR. As shown in the ASM Oscillator Timing Diagram, Figure 4-70, the ASM oscillator circuit provides three separate phases of clock outputs. Schmitt trigger U18A is the fundamental oscillator element which uses hysteresis to develop oscillation, The output of U18A (through U13) strobes storage latches U11A and B, U15, U19, U24, U26, U28, U33, U31B, and U34. The output of U18A is also sent through a delay circuit consisting of resistor R14 and capacitor C4 into U18B to provide another phase of the clock output that determines the next state of the ASM. In addition, the output of U18A is sent through U30A to provide a third clock phase which is applied to U31A. The output of U31A 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 U26 (ASM storage). The power up reset circuit U18C and U18D clears all storage elements.

4-191. BUS INTERFACE. The bus interface circuit consists of bus line termination resistors, data output drivers and data input buffers. Resistors R29 and R30 form the line termination networks, U4 is used to buffer the bus line inputs and U5, U10, and U16 are high current drivers that drive the bus lines output. The ATN signal is sent through U9A and U29D to ensure that the gates connected to bus lines DIO1—DIO7 and DAV do not output when ATN goes true. The DAO signal from U24(9) arms the DAC signal through U17B 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.

4-192. END OF MEASUREMENT. When a measurement has been completed, FF U11B is set. This FF is clocked by the closing edge of the LMG signal. Diode CR2 and transistor Q3 keep U11B from going to the “1” state when LRES is low or HRD is high, (During these times the counter is being reset and noise appears on the LMG line which could trigger UIIB.)

4-193. QUALIFIER MULTIPLEXER. Five 8-to-1 multiplexer are connected to allow 36 lines to be multiplexed into 1 line. ASM ROM U22 controls multiplexer U3, U6, U8, and U32 to select individual line qualifiers and U12 to select one of these multiplexer. In addition, U12 checks the output of auxiliary State Counter U7, a 4-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 FF U11A eliminates erroneous results by ensuring that the State Counters U14 and U23 are not clocked when a qualifier is changing states. This would cause a partial preset and partial increment of the State Counters,

4-194. ADDRESSING. Address Comparator U2 monitors the Data Input/Output (DIO) lines 2 through 5 and the address switch (S1) settings. When a comparison occurs between the state of these DIO lines and the address switch settings, U2 sends qualifier ADDR to multiplexer U8. The TALK ALWAYS section of the address switch provides a means of setting U6 so that interface is always addressed to talk.

4-195. DATA OUTPUT. The Data Output circuit outputs characters on the bus data lines. Storage circuit U24 transfers outputs from the ROM to DIO lines 5 through 7. U15 selects data from either the ROM or the 5328A data bus and transfers it to DIO1—DIO4. The state of the “not” bit from ROM U22(13) through U21E determines the selection made by U15. A displayed digit is selected from the 5328A, any other characters (decimal point, “E”, carriage return, exponent, linefeed, etc.) are selected from the ROM.

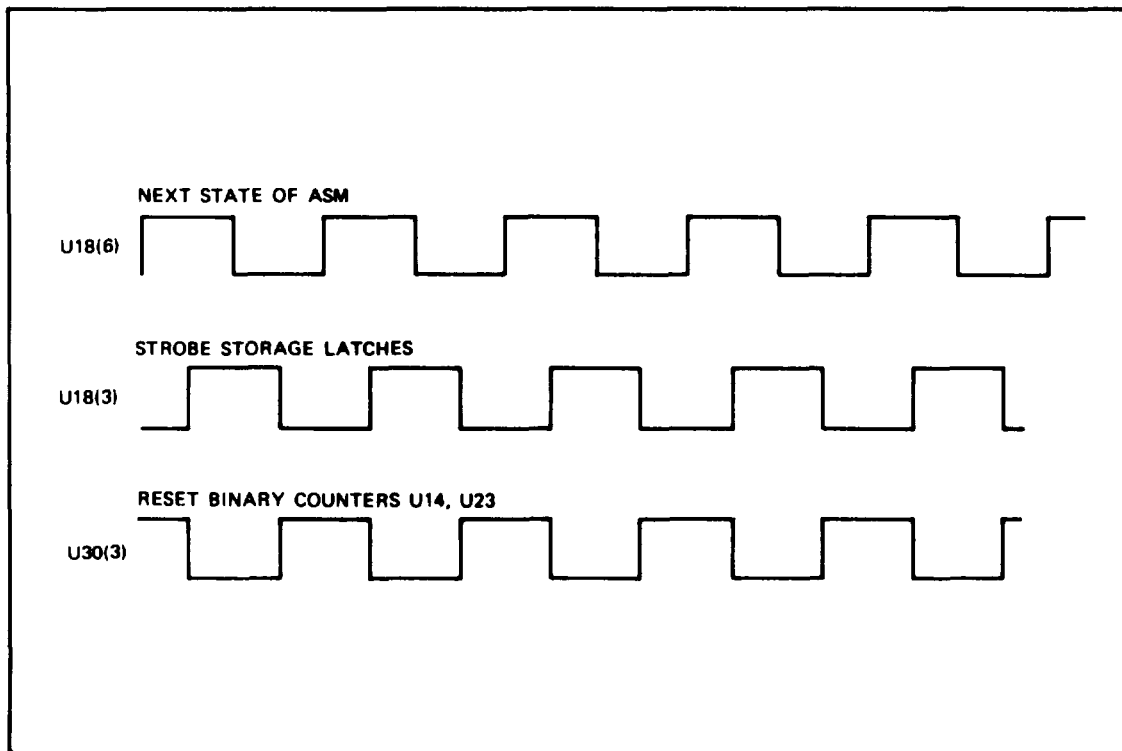
4-196. ASM STORAGE. The internal memory for the ASM operation is in ASM Storage circuits U19, U26, and U31B. There are 17 information bits that can be set or cleared by these circuits. This section also includes one-shot U1 which outputs a 2 ms pulse (LRST) to ensure reliable

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**Theory of Operation**

operation of the state control circuit U4 on the motherboard. Diode CR3 ensures that LINH is low to inhibit the counter during the time that LRST is low.

4-197. STROBE ENABLE DECODER. Decoder U13 is a 4- to lo-line decoder used to strobe the various storage latches. Pins 1, 14, and 15 are used to select the device to be strobed and pin 2 is an enable which determines the width of the strobe pulse. The output of U25C disables U13 when the ASM is in the decision state mode. In the decision state mode, the format bit U22(17) goes high which disables U13.

4-198. REMOTE PROGRAM STORAGE. Storage circuits U28, U33, and U34 are used to program instrument functions. U28 stores Time Base codes in 3-bit bytes and U34 stores Function codes in 4-bit bytes. U33 stores 8 bits of information, one-bit at a time. The Sample Rate, Arming, Storage Off, and Decade Reset can be programmed by U33. In addition, U33(4,5, and 6) control the manner in which measurements are made and output to the bus. The inputs to the remote program storage circuits are the Module Data A, B, C, and D lines from DIO lines, 1,2,3, and 4, respectively.



*Figure 4-10. ASM Oscillator Timing Diagram*

**SECTION V  
MAINTENANCE**

**5-1. INTRODUCTION**

5-2. This section gives maintenance and service information. Included is a table of assemblies, recommended test equipment, a performance test, (which may be used to verify proper counter operations) and adjustments.

**5-3. ASSEMBLY DESIGNATIONS**

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

**5-5. TEST EQUIPMENT**

5-6. Test equipment recommended for maintaining and checking performance is listed in Table 5-2. Test equipment having equivalent characteristics may be substituted for the equipment listed. Required test equipment is listed in Appendix D, Maintenance Allocation.

**5-7. ASSEMBLY CONNECTION IDENTIFICATION**

5-8. Throughout the manual, connections to printed-circuit assemblies are referred to in abbreviated form. For example, connection to A4 pin 10 is A4(10).

Table 5-1. 5328A Assembly Identification

| <b>"A" Number</b> | <b>Description</b>                           | <b>HP Part No.</b> |
|-------------------|--|--------------------|
| A1                | Main (Motherboard)                           | 05328-60028        |
| A2                | Power Supply                                 | 05328-60035        |
| A3                | Oscillator Support (Holds 10544A Oscillator) | 05328-60027        |
| A3A1              | Oscillator 10544A                            | 10544-60011        |
| A4                | Function Selector                            | 05328-60005        |
| A5                | Not used                                     |                    |
| A6                | Not used                                     |                    |
| A7                | Not used                                     |                    |
| A8                | "C" Channel Input                            | 05328-60032        |
| A9                | Not used                                     |                    |
| A10               | Synchronizer                                 | 05328-60020        |
| A11               | Digital-to-Analog Converter                  | 05328-60023        |
| A12               | "A-B" Channel Input                          | 05328-60031        |
| A13               | Not used                                     |                    |
| A14               | Not used                                     |                    |
| A15               | HP-IB Interface                              | 05328-60019        |
| A16               | Display                                      | 05328-60026        |
| A17               | Not used                                     |                    |
| A18               | Not used                                     |                    |
| A19               | Switch (Attenuator)                          | 05328-60030        |

Table 5-2. Recommended Test Equipment

| Instrument Type            | Required Characteristics            | Recommended Type      |
|----------------------------|-------------------------------------|-----------------------|
| Frequency Standard         | 1 MHz Output                        | HP 107AR              |
| Oscilloscope               | 50 MHz Bandwidth                    | HP 180A               |
| Vertical Plug-In           | 50 mV/cm Sensitivity                | HP 1801A              |
| Time Base Plug-In          | 50 MHz Bandwidth                    | HP 1820A              |
| 1 GHz Sampler              | 1 GHz Bandwidth                     | HP 1810A              |
| Test Oscillator            | 10 Hz to 10 MHz at 5V p-p           | HP 651B               |
| VHF Signal Generator       | 10 MHz to 480 MHz                   | HP 608E               |
| Frequency Counter          | 10 to 80 MHz Frequency Measurements | HP 5381A              |
| Digital Multimeter         | 10V Range .01% Accuracy             | HP 3490               |
| DC Voltmeter               | 0 to 200V dc, 1% Accuracy           | HP 970A               |
| AC VTVM                    | 0 to 250V ac                        | HP 400F               |
| RF Voltmeter               | 1 mV to 3V                          | HP 3406A              |
| Logic Probe                | Logic State Test                    | HP 10525T             |
| Logic Pulser               | State Activator                     | HP 10526T             |
| Logic Comparator           | IC Test                             | HP 10529A             |
| Calculator                 | HP-IB Compatible                    | HP 9830A or 9820A     |
| HP-IB Calculator Interface | Connects 9830A to HP-IB             | HP 59405A, Option 030 |
| Printer                    | Compatible with 9830A               | HP 9866A              |
| Pulser Generator           | 0.5 Hz to 25 MHz at 1V              | HP 8008A              |
| DC Power Supply            | 0—10V Stable to $\pm 1$ mV          | HP 6213A              |
| RMS Voltmeter              | RMS ac Voltage 0—10V Range          | HP 3400A              |

### 5-9. PREVENTIVE MAINTENANCE

5-10. Preventive maintenance consists of periodic inspection, cleaning, performance checks, and oscillator calibration. Table 5-3 lists the recommended schedule of preventive maintenance routines.

Table 5-3. Preventive Maintenance

| Routine                | Schedule    |
|------------------------|-------------|
| Inspection             | Weekly      |
| Cleaning               | Monthly     |
| Performance Test       | As required |
| Oscillator Calibration | Quarterly   |

### 5-11. Inspection

5-12. The 5328A 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.

### 5-13. Cleaning

5-14. The instrument should be kept free of dust, moisture, grease, and foreign matter to ensure trouble-free operation. A dry clean cloth, a soft bristled brush, or a cloth saturated with cleaning compound may be used.

#### WARNING

**100/120/220/240 VAC SUPPLY WIRES ARE EXPOSED WHEN EITHER TOP OR BOTTOM COVER IS REMOVED. USE EXTREME CAUTION DURING TROUBLESHOOTING, ADJUSTMENT, OR REPAIR. AVOID DAMAGE TO INSTRUMENT BY REMOVING POWER BEFORE REMOVING OR REPLACING COVERS, ASSEMBLIES, OR COMPONENTS.**

### 5-15. Performance Test

5-16. GENERAL. The performance test (Table 5-4) and test card sheets that follow the test can be used to verify and record proper operation of all circuits of the counter and may also be used:

- a. As part of an incoming inspection check of instrument specifications.
- b. Periodically, for instruments used in systems where maximum reliability is important.
- c. As part of a procedure to locate defective circuits.
- d. After any repairs or adjustments and before returning instrument to regular service.
- e. As a permanent record of instrument maintenance performed, because the test record pages may be removed.

### 5-17. REPAIR

#### 5-18. Printed Circuit Component Replacement

5-19. Component lead holes in the circuit boards have plated-through walls to ensure good electrical contact between conductors on opposite sides of the board. To prevent damage to the plating and the replacement component, apply heat sparingly, and work carefully.

#### 5-20. Replacing Integrated Circuits

5-21. Following are two recommended methods of replacing integrated circuits:

- a. **SOLDER GOBBLER.** This is the best method. Solder is removed from board by a soldering iron with a hollow tip connected to a vacuum source,
- b. **CLIP-OUT.** This method should be used as a last resort only. Clip the leads as close to the base as possible. With a soldering iron and long nose pliers, carefully remove the wires from each hole. Then clean the holes.

Table 5-4. Performance Test

### 1. SENSITIVITY - Channel A

**Specification:**

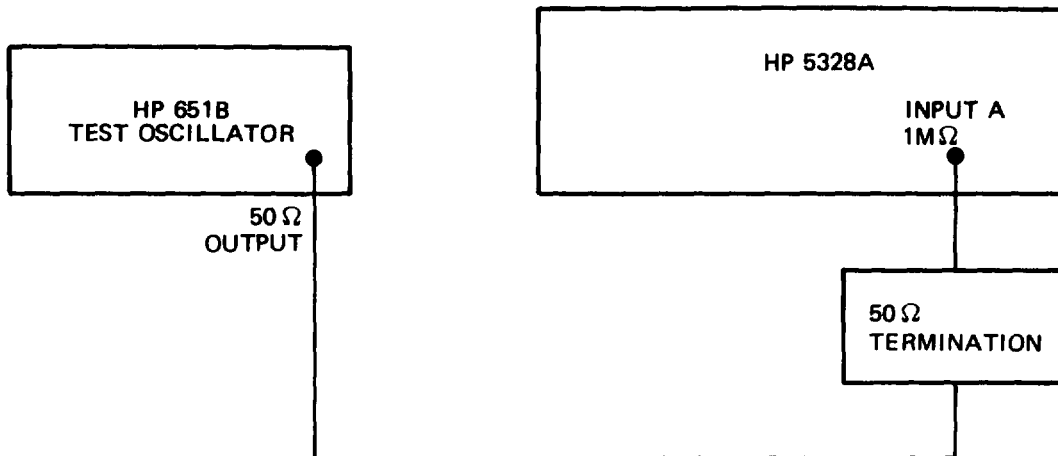
15 mV rms, 0-35 MHz (dc coupled)  
20 Hz-35 MHz (ac coupled)

50 mV rms, 35 MHz-100 MHz

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

- a. 10 Hz to 10 MHz

**Setup:**



(1) DC coupled 10 Hz to 10 MHz

- Set the 5328A to FREQ A, 1 Hz RESOLUTION, SAMPLE RATE fully ccw, Level A to PRESET, DC COUPLING, ATTEN X1, SEP. Rear panel ARM switch should be set to OFF.
- Set the 651B for 15 mV rms. Vary the 651B's frequency from 10 Hz to 10 MHz and verify that the 5328A displays the proper frequency. Adjust the 5328 LEVEL A control as necessary to achieve a stable display. Mark results on performance test record at the end of these procedures.

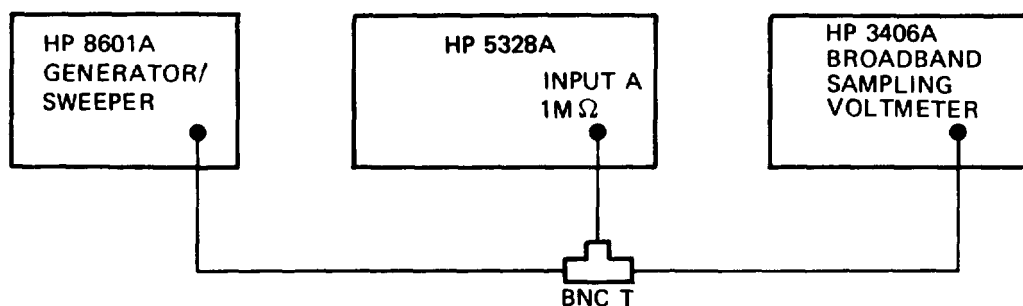
(2) AC coupled 20 Hz to 10MHz

- Set the 5328 to AC coupling.
- Set the 651B for 15 mV rms. Vary the 651B's frequency from 20 Hz to 10 MHz and verify that the counter displays the proper frequency. Adjust the 5328 LEVEL A control as necessary to achieve a stable display. Mark results on performance test record at the end of these procedures.

Table 5-4. Performance Test (Continued)

b. 10 MHz to 100 MHz

**Setup:**



(1) DC coupled 10 MHz to 100 MHz

- Set the 5328A to DC COUPLING.
- Set the 8601A for an output level of 15 mV rms as measured on the 3436A RF voltmeter. Vary the 8601A's frequency from 10 MHz to 35 MHz and verify that the counter displays correct frequency readings. Increase the 8601A output level to 50 mV rms and vary the frequency from 35 MHz to 100 MHz. Verify that the counter displays correct frequency readings. Adjust 5328A LEVEL A control as necessary to obtain stable display. Mark results on performance test record.

(2) AC coupled 10 MHz to 100 MHz

- Set the 5328A to AC coupling.
- Set the 8601A for an output level of 15 mV rms and repeat part 2 of step (1.) above.

**2. SENSITIVITY - Channel B**

**Specification:**

15 mV rms, 0-35MHz (dc coupled)  
20 Hz-35 MHz (ac coupled)

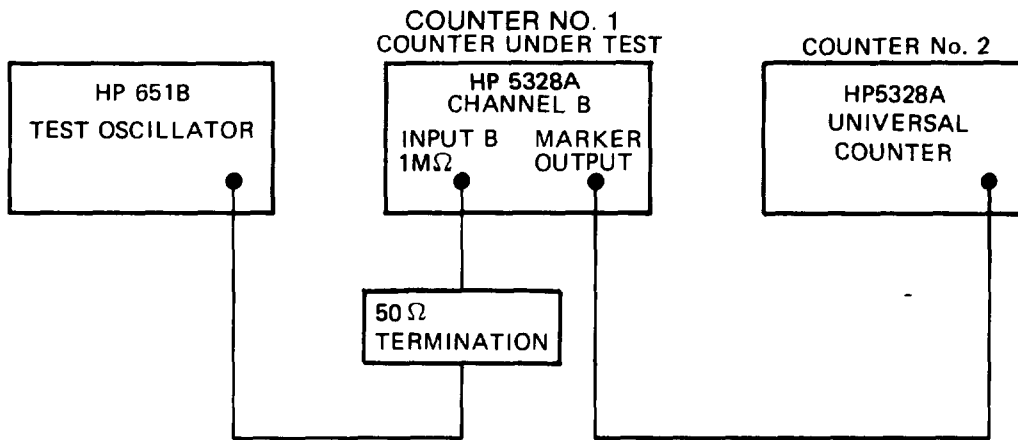
50 mV rms, 35 MHz-100MHz

**Description:** A generator with calibrated output drives the B channel of the 5328A under test. The frequency of the B channel MARKER OUTPUT is measured by a second frequency counter. The generator is set to the specified 5328A signal sensitivity level and varied over the specified frequency range. The second counter must display the correct frequency. Adjustments of the 5328A LEVEL B control may be necessary to achieve a stable count.

Table 5-4. Performance Test (Continued)

a. 10 Hz to 10 MHz

Setup:



(1) DC coupled 10 Hz to 10 MHz

- Set counter No. 1 (HP 5328A) to SEP, LEVEL B to PRESET, ATTEN X1 (B channel), DC coupling (B channel).
- Set the 651B to 15 mV rms. Vary the 651B's frequency from 10 Hz to 10 MHz and verify that the 5328A Channel B MARKER OUTPUT is the correct frequency as read by counter No. 2. Adjust the 5328A LEVEL B control as necessary to achieve a stable display. Mark results on performance test record.

(2) AC coupled 20 Hz to 10 MHz

- Set Counter No. 1 (HP 5328A) to AC coupling (B channel).
- With the 651B set to 15 mV rms, vary the frequency from 20 Hz to 10 MHz and verify that the 5328A Channel B MARKER OUTPUT is the correct frequency as read by counter No. 2. Adjust the 5328A LEVEL B control as necessary to achieve a stable display. Mark results on performance test record.

b. 10 MHz to 100 MHz

Setup:

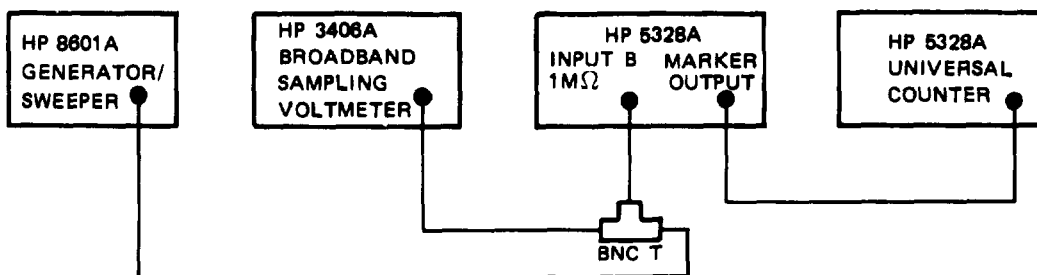




Table 5-4. Performance Test (Continued)

(1) DC coupled 10 MHz to 100 MHz

- Set Counter No. 1 (HP 5328A) to DC coupling (B channel).
- Set the 8601A for an output level of 15 mV rms as measured on the 3406A RF voltmeter. Vary the 8601A's frequency from 10 MHz to 35 MHz and verify that the 5328A Channel B MARKER OUTPUT is the correct frequency as read by counter No. 2. Increase the 8601A output level to 50 mV rms and vary the frequency from 35 MHz to 100 MHz. Counter No. 2 must continue displaying the correct input frequency. Adjust the 5328A LEVEL B control as necessary to achieve a stable display. Mark results on performance test record.

(2) AC coupled 10 MHz to 100 MHz

- Set Counter No. 1 (HP 5328A) to DC coupling (B channel).
- Set the 8601A for an output level of 15 mV and repeat part 2 of step (1) above.

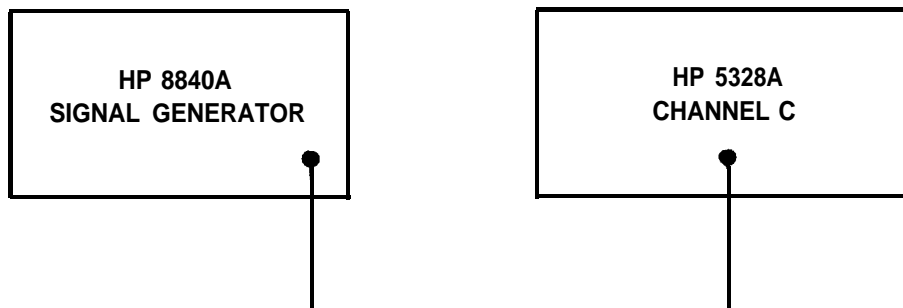
**3. SENSITIVITY-Channel C**

**Specification:**

15 mV rms, 30 MHz-500MHz

**Description:** A signal generator covering the frequency range from 30 MHz to 500 MHz is set to the specified channel C 5328A signal sensitivity level and varied over the specified frequency range. The counter must display the correct frequency.

**Setup:**



- Set the 5328A to FREQ C, 1 kHz, 10<sup>3</sup> Resolution, SAMPLE RATE midrange.
- Set the signal generator for an output of 15 mV rms (-24 dBm for 50Ω). Vary the frequency from 30 MHz to 500 MHz and verify that the counter displays the proper frequency.

Table 5-4. Performance Test (Continued)

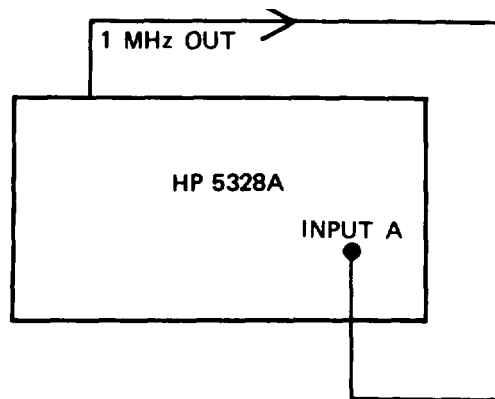
#### 4. PERIOD AND PERIOD AVERAGE

**Specification:**

PER A - counter will measure periods of signals to 10 MHz with resolutions from 10 ns to 0.1s in decade steps.

PER AVG A - counter will measure periods of signals to 10 MHz with resolutions from 100 ns to 0.01 ps in decade steps. The number of periods over which the period average measurement is made can be selected by the FREQ RESOLUTION, N switch.

**Description:** The 1 MHz time base output from the rear panel of the 5328A drives the A channel input of the counter.



- Set 5328A Function switch to PER A; Freq Resolution, N switch to 1 MHz, 1; Level A to PRESET; AC coupling; X10 ATTEN; SEP. Verify that the counter displays 1.0μsec. Mark results on performance test record.
- Set the 5328A Function switch to PER AVG A and the Freq Resolution, N switch to 1 Hz, 10<sup>6</sup>. Verify that the counter displays approximately 999,9XXXX nsec with 0.1 psec resolution. Mark results on performance test record.

#### 5. RATIO B/A, or C/A

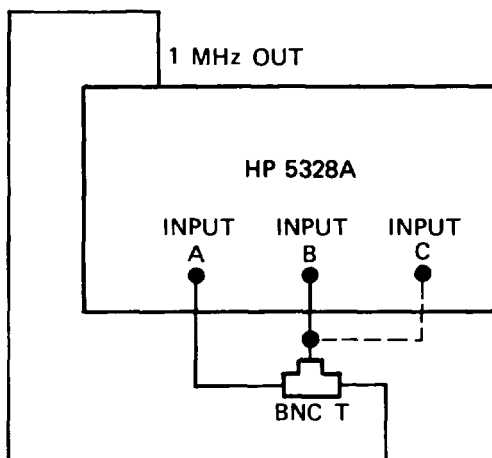
**Specification:**

RATIO B/A, RATIO C/A-Counter will measure the ratio of the frequency at B (0 to 100 MHz) or C (30 to 500 MHz) to the frequency at A (0 to 10 MHz) for N counts of A.

**Description:** The 1 MHz time base output from the rear panel of the 5328A drives the A, B or C input channels of the counter.

Table 5-4. Performance Test (Continued)

Setup:



- Set the 5328A Function switch to RATIO B/A: Freq Resolution. N switch to 1 kHz, 103; Level A and B to PRESET; AC coupling on both channels; X10 ATTEN on both channels; COM A. Verify that the counter displays 1.000. Mark results on performance test record.
- Set the 5328A Function switch to RATIO C/A; SEP. Disconnect the channel B input and reconnect it to channel C. Verify that the counter displays 1.000.

6. TIME INTERVAL AND TIME INTERVAL AVERAGE

Specification:

T.I. A-B - counter measures time intervals (100 ns to  $10^8$  see) between a start signal at the channel A input and a stop signal at the channel B input.

T.I. AVG A-B - counter measures time intervals (0.1 ns to 10 see) 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 average measurement is made can be selected by the FREQ RESOLUTION, N switch.

Description: A 1 MHz signal drives the A and B channel inputs of the 5328A counter.

Setup:

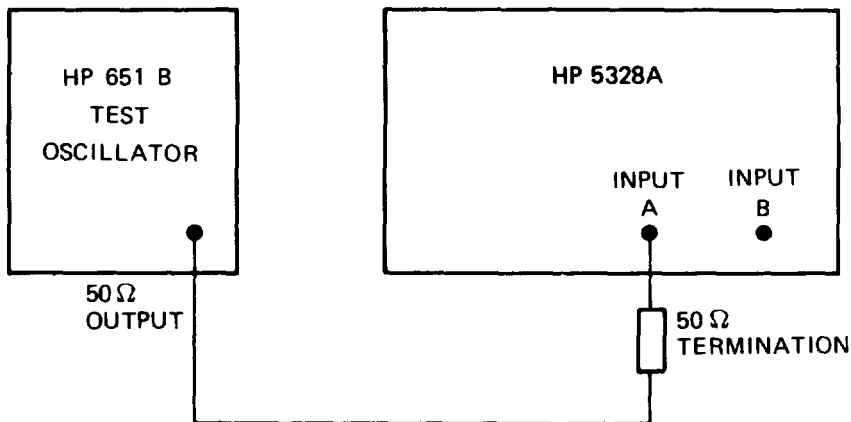
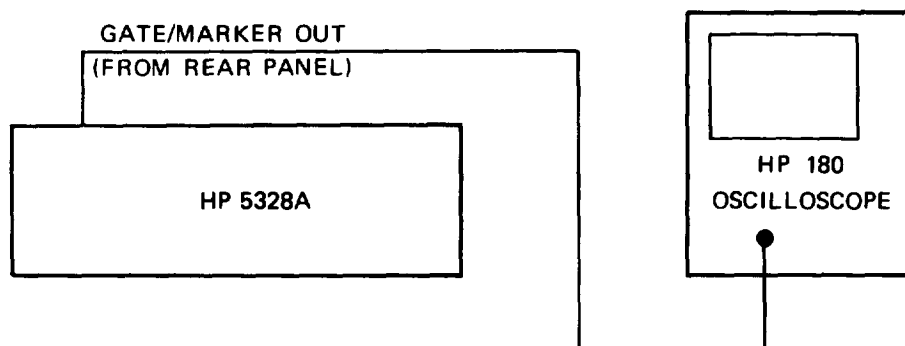


Table 5-4. Performance Test (Continued)

- Set the 651B to 1.0 MHz and 500 mV rms.
- Set the 5328A Function switch to T.I. A-B; Freq Resolution, N switch to 1 MHz, 1; Level A and B to PRESET; AC coupling on both channels, X1 ATTEN on both channels, COM A.
- Set the Channel A SLOPE to (+) and the Channel B SLOPE to (-). Verify that the counter displays  $0.5 \mu\text{s} \pm 0.25 \mu\text{s}$ . Mark results on performance test record.
- Set 5328A Function switch to T.I. AVG A→B and Freq Resolution, N switch to 1 Hz,  $10^6$ . Verify that the counter displays 500.XXXX ns. Mark results on performance test record.
- Change Channel A SLOPE to (-) and Channel B SLOPE to (+). Verify that the counter displays 500.XXXX ns. Mark results on performance test record.

## 7. GATE/MARKER OUT AND SAMPLE RATE

Setup:

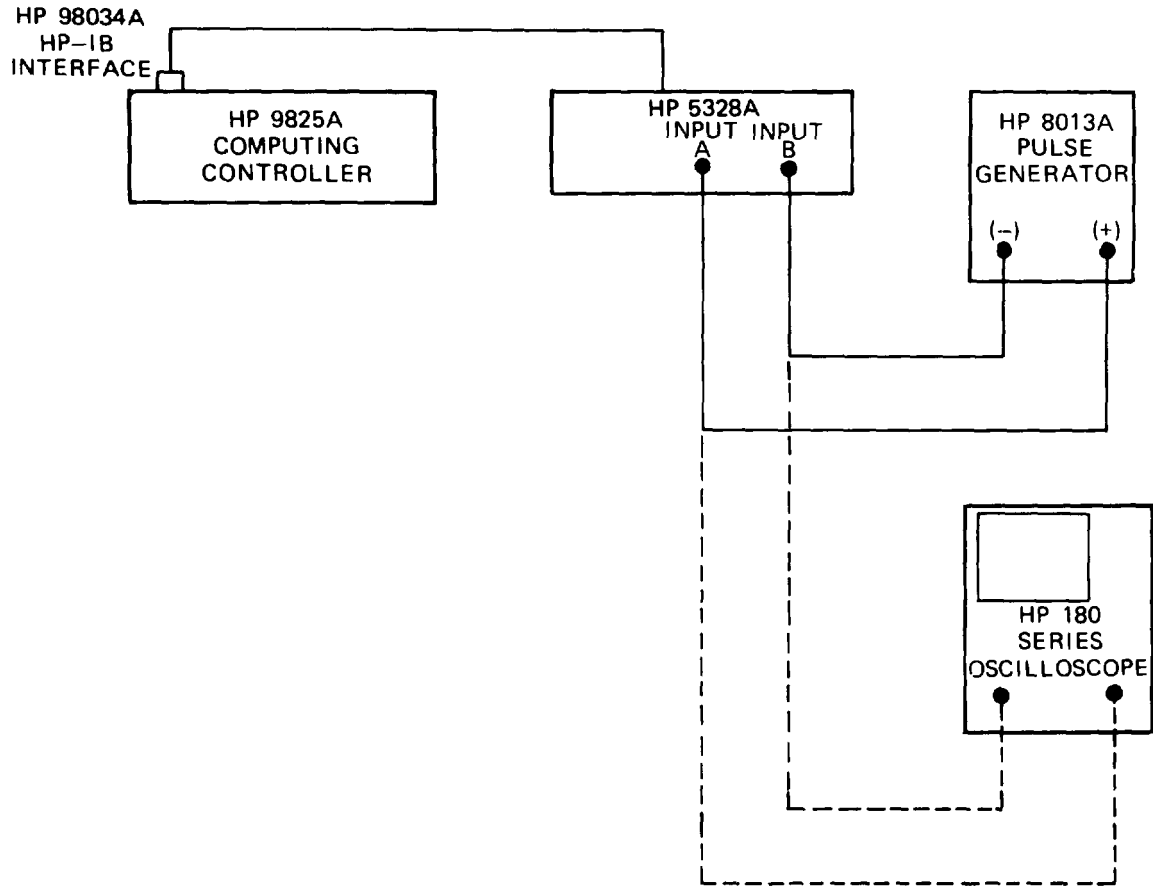


- Set the 5328A to CHECK, 1 kHz,  $10^3$  Resolution.
- Observe the GATE/MARKER OUT signal from the counter. Vary the SAMPLE RATE control to full ccw. The GATE/MARKER OUT signal must be greater than 2.4 Vdc and the sample delay (time during which GATE/MARKER OUT is Low) must be less than 2 msec. Mark results on performance test record.

Table 5-4. Performance Test (Continued)

8. REMOTE PROGRAMMING TEST

Setup:



- Set the 5328A rear panel address switches as follows:

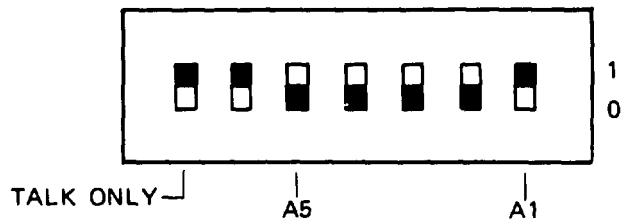
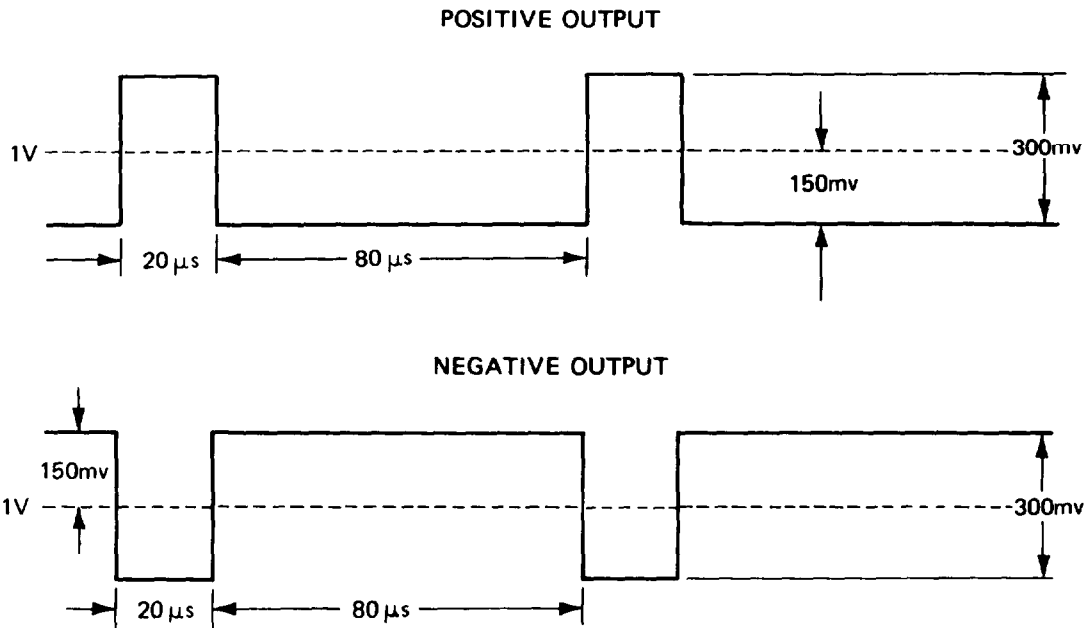


Table 5-4. Performance Test (Continued)

- Set the pulse generator for the following output:

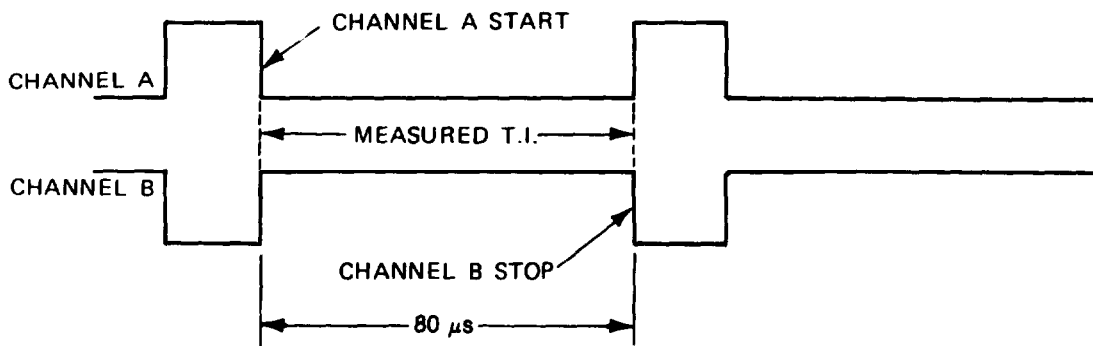


a. (-) SLOPE TEST

Execute the following from the 9825A keyboard:

wrt 701, "PF8G1S13A57+000\*B57+000\*R"

Counter should display  $20 \mu\text{s} \pm 10 \mu\text{s}$ . Mark results on performance test record.



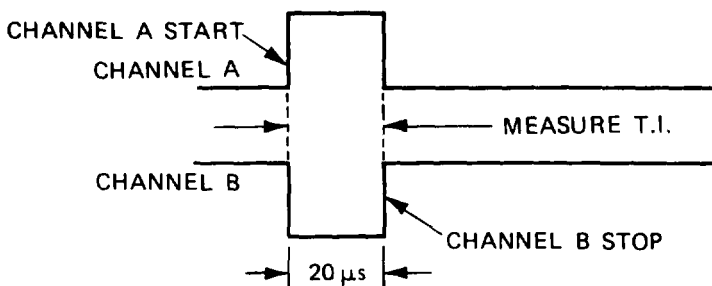
b. (+) SLOPE TEST

- Press RESET button on HP 5328A. Set Channels A and B slope switches to (-).
- Execute the following from the 9825A keyboard.

wrt 701, "PF8G1S13A7+000\*B7+000\*R"

Table 5-4. Performance Test (Continued)

- Counter should display  $20 \mu\text{s} \pm 10 \mu\text{s}$ . Mark results on performance test record.



c. AC/DC TEST

- Press RESET button on 5328A and set both channels A and B to AC coupling.
- Execute the following from the 9825A keyboard:

wrt 701, "PF8G1S13A37+000\*B37+000\*R"

- Counter should display  $0. \mu\text{s}$  and the GATE light should be off. Both A and B channel trigger lights should be lighted (but NOT blinking). Mark results on performance test record,

d. SEP/COM A TEST

- Press RESET on 5328A.
- Execute the following from the 9825A keyboard:

wrt 701, "PF8G1S13A79+000\*B7+000\*R"

- Counter should display  $0. \mu\text{s}$  and the GATE light should be flashing. Both A and B channel trigger lights should be blinking. Mark results on performance test record.

e. INVERT TEST

- Execute the following from the 9825A keyboard:

- Counter should display  $80. \mu\text{s} \pm 40 \mu\text{s}$ .

- Execute:

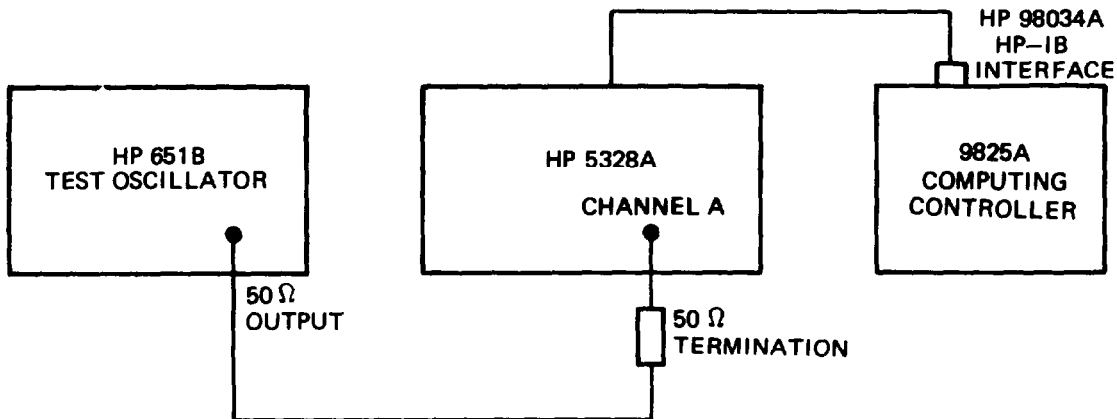
wrt 701, "B9R"

- Counter should display  $20. \mu\text{s} \pm 10 \mu\text{s}$ . Mark results on performance test record.

Table 5-4. Performance Test (Continued)

f. ATTEN X1, X10, X100 TEST

Setup:



- Set the 651B to 1 kHz at an output level of 25 mV rms.

(1) ATTEN X1 TEST

- Execute the following from the 9825A keyboard:

wrt 701, "PF4G5S13A379+000\*B37+000\*R"

- Observe that both channel A and B trigger lights are blinking.

(2) ATTEN X10 TEST

- Execute the following from the 9825A keyboard:

wrt 701, "PF4G5S13A3+000\*B3+000\*R"

- Observe that both channel A and B trigger lights are off. Mark results on performance test record.

(3) ATTEN X100 TEST

- Execute the following from the 9825A keyboard:

wrt 701, "PF4G5S13A319+000\*B31+000\*R"

- Observe that both channel A and B trigger lights are off. Mark results on performance test record.



Table 5-4. Performance Test (Continued)

### 9. REMOTE TRIGGER LEVEL TEST

Setup:

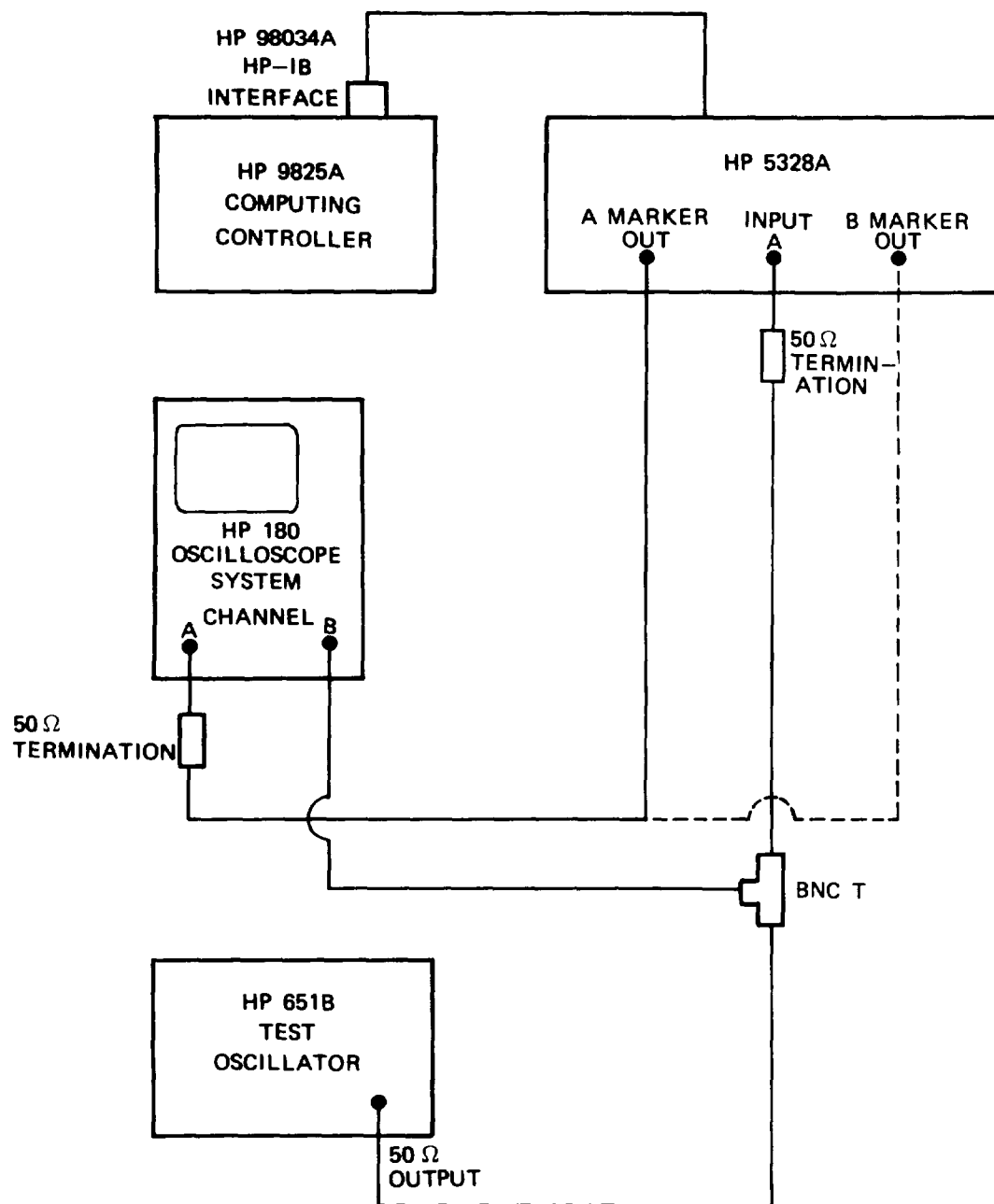
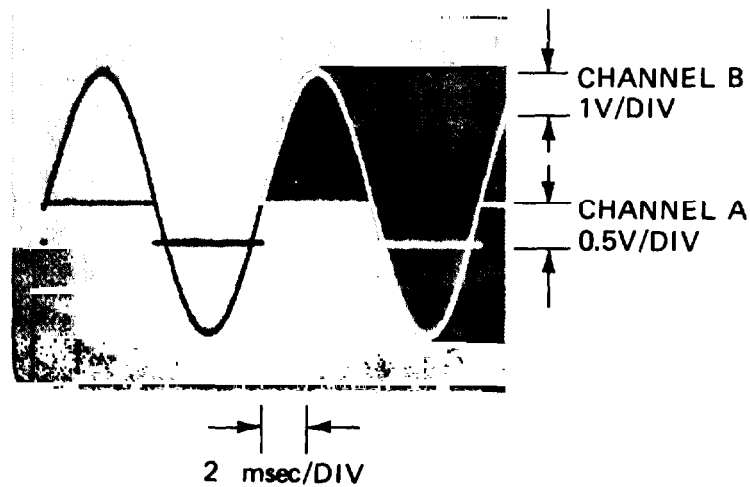


Table 5-4. Performance Test (Continued)

- Set channels A and B of the 5328A to DC coupling, COM A, X1 ATTEN, and FREQ A.
- Set the 6516 Test Oscillator for an output of 100 Hz at 6 volts peak-to-peak. Center the signal on the oscilloscope B channel display.
- Execute the following from the 9825A keyboard:

wrt 701, "PF4G6S13A379+000\*B37+000\*R"

- Adjust the display of the A channel marker output (on channel A of the oscilloscope) such that the top of marker waveform just barely intersects the positive slope and negative slope of the 100 Hz sine wave. Verify that this occurs at 0 volts on the 100 Hz sine wave.

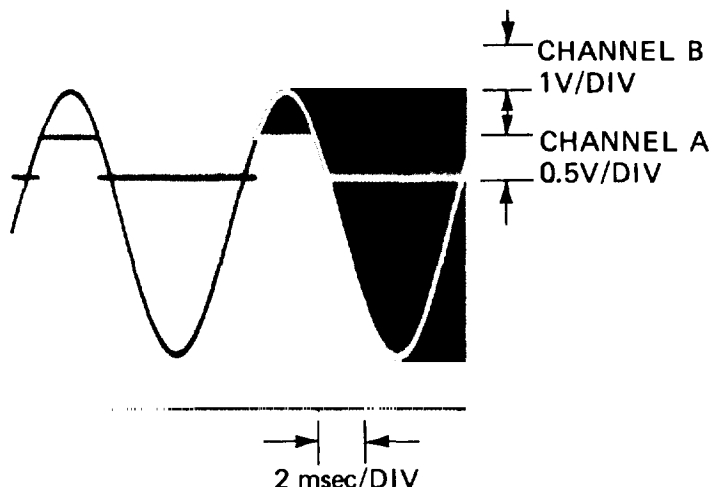


- Connect the counter's B Marker Output to the A channel of the oscilloscope. Verify that the top of the marker intersects the 100 Hz sinewave at 0 volts.
- Execute the following from the 9825A keyboard:

wrt 701, "PF4G6S13A379+200\*B37+200\*R"

- Adjust the display of the B channel marker output such that the top of the marker just barely intersects both positive and negative slopes of the 100 Hz waveform. Verify that this occurs at +2 volts on the 100 Hz waveform as shown.

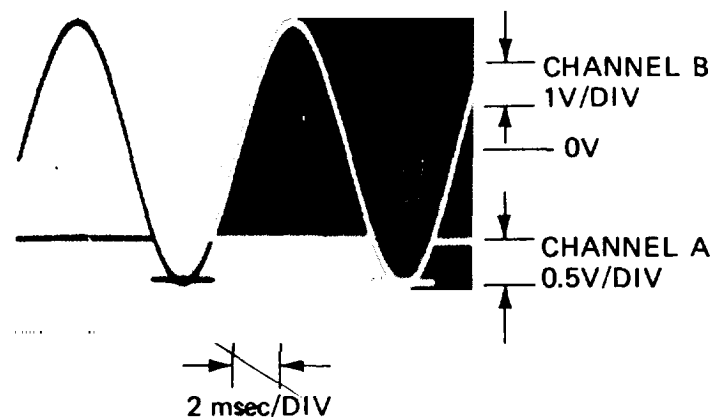
Table 5-4. Performance Test (Continued)



- Connect the 5328A A MARKER output to the A channel of the oscilloscope. Adjust the position of the A MARKER as described above and verify that it intersects the 100 Hz sine wave at +2 volts.
- Execute the following from the 9825A keyboard:

wrt 701, "PF4G6S13A379-200\*B37-200\*R"

- Adjust the display of the A channel marker output such that the top of the waveform just barely intersects both positive and negative slopes of the 100 Hz waveform. Verify that this occurs at -2 volts on the 100 Hz waveform.



Connect the 5328A B marker output to the A channel of the oscilloscope. Adjust the position of the B marker as described and verify that it intersects the 100 Hz waveform at -2 volts.

- Mark results on performance test record.



PERFORMANCE CHECK TEST CARD

5328A \_\_\_\_\_

Date \_\_\_\_\_

| TEST | DESCRIPTION  | RESULTS |       |
|------|--|---------|-------|
|      |  | PASS    | FAIL  |
| 1    | a. Sensitivity, Channel A  |         |       |
|      | (1) 10 Hz-10 MHz, dc   | _____   | _____ |
|      | (2) 20 Hz-10 MHz, ac   | _____   | _____ |
|      | b. Sensitivity, Channel A  |         |       |
|      | (1) 10 MHz-100 MHz, dc   | _____   | _____ |
|      | (2) 10 MHz-100 MHz, ac   | _____   | _____ |
| 2    | a. Sensitivity, Channel A  |         |       |
|      | (1) 10 Hz-10 MHz, dc   | _____   | _____ |
|      | (2) 20 Hz-10 MHz, ac   | _____   | _____ |
|      | b. Sensitivity, Channel B  |         |       |
|      | (1) 10 MHz-100 MHz, dc   | _____   | _____ |
|      | (2) 10 MHz-100 MHz, ac   | _____   | _____ |
| 3    | Sensitivity, Channel C . . . . .<br>30 MHz-500 MHz                 | _____   | _____ |
| 4    | period and period Average  |         |       |
|      | 1.0 $\mu$ sec display  | _____   | _____ |
|      | Approximately 999.9XXX nsec<br>display with 0.1 psec<br>resolution | _____   | _____ |



PERFORMANCE CHECK TEST CARD

5328A \_\_\_\_\_

Date \_\_\_\_\_

| TEST                  | DESCRIPTION                                      | RESULTS |       |
|-----------------------|--|---------|-------|
|                       |  | PASS    | FAIL  |
| 5                     | RATIO B/A  |         |       |
|                       | 1.000 display                                    | _____   | _____ |
|                       | RATIO C/A  |         |       |
|                       | 1.000 display                                    | _____   | _____ |
| 6                     | TIME INTERVAL AND TIME<br>INTERVAL AVERAGE       |         |       |
|                       | TI A-B -0.5 $\mu$ sec display                    | _____   | _____ |
|                       | TI AVG A-B, (+) to (-),<br>500.XXXX nsec display | _____   | _____ |
|                       | TI AVG A-B, (-) to (+),<br>500.XXXX nsec display | _____   | _____ |
| 7                     | GATE/MARKER OUT<br>AND SAMPLE RATE               | _____   | _____ |
| 8                     | REMOTE PROGRAMMING                               |         |       |
|                       | a. (-) SLOPE TEST                                | _____   | _____ |
|                       | b. (+) SLOPE TEST                                | _____   | _____ |
|                       | c. AC/DC TEST                                    | _____   | _____ |
|                       | d. SEP/COM A TEST                                | _____   | _____ |
|                       | e. INVERT TEST                                   | _____   | _____ |
|                       | f. ATTEN TEST                                    |         |       |
|                       | (1) ATTEN X1 Test                                | _____   | _____ |
|                       | (2) ATTEN X10 Test                               | _____   | _____ |
|                       | (3) ATTEN X100 Test                              | _____   | _____ |
| g. Trigger Level Test | _____  | _____   |       |





## 5-22. ADJUSTMENTS

5-23. Adjustment procedures are provided for the oscillator and for the time interval unit (sensitivity). The adjustments should not be done unless:

- a. A trouble has been repaired which would affect these values.
- b. The instrument does not meet all specifications while performing the check in Table 5-4 (Performance Test), or during periodic calibration.

5-24. OSCILLATOR ADJUSTMENT. Periodically, the oscillator should be checked against a house standard. When adjustment is required, use the oscilloscope method shown in *Figure 5-2*. Using the appropriate sweep speed, adjust the oscillator until the movement of the pattern is stopped or nearly stopped.

### NOTE

When adjusting the 5328A oscillator, adjust **FREQ ADJ** on the 10544A crystal oscillator unit, and the fine tuning adjustment **A3R14**.

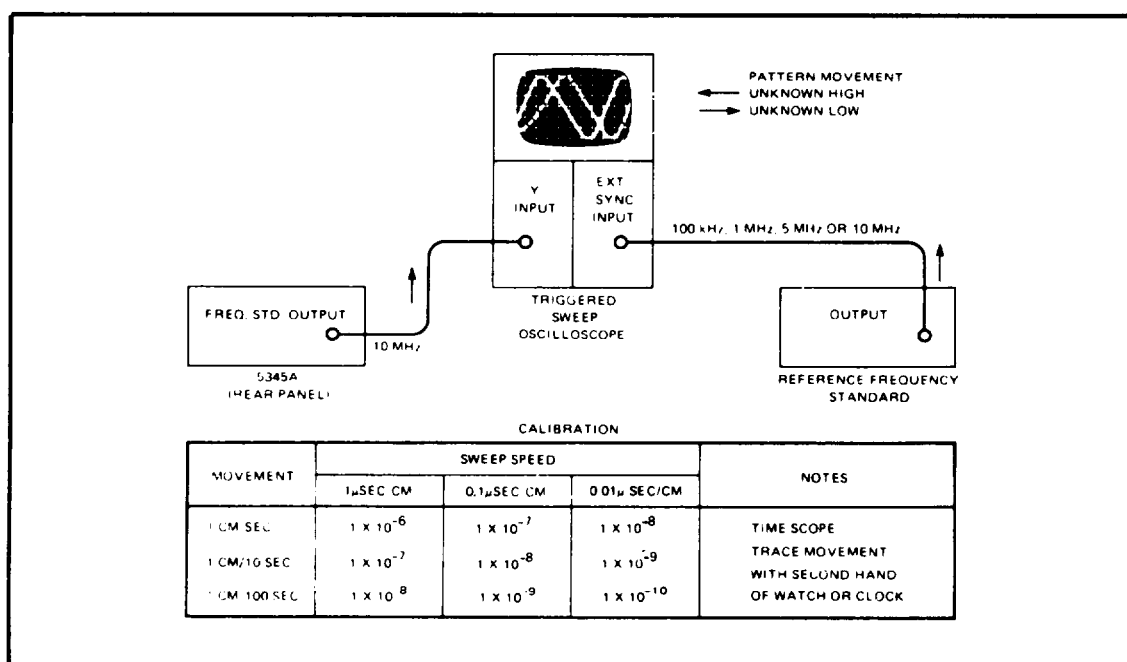


Figure 5-1. 10 MHz Oscillator Frequency Check

## 5-25. Sensitivity Adjustments

1. Adjust the channels A and B sensitivity as follows:
  - a. Remove top cover of 5328A to gain access to variable resistors R28 and R26 on the A12 Amplifier Assembly (see location photo in Section VIII),
  - b. Set 5328A 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  
SEP-COM A ..... SEP  
SAMPLE RATE ..... MIDRANGE

- c. Set 5328A rear panel control as follows:  
ARM . . . . . OFF
  - d. Connect HP 608E Signal Generator (or equivalent) to INPUT A. Set signal generator to 35 MHz at 50 mV rms (140 mV p-p).
  - e. Slowly decrease the signal generators output level to 15 mV rms (42 mV p-p), while adjusting variable resistor R26, to obtain a stable correct display, on the counter.
  - f. To set Channel B sensitivity change 5328A front panel controls as follows:  
FUNCTION . . . . . RATIO B/A  
RESOLUTION . . . . .  $10^3$  10 kHz  
SEP-COM A . . . . . SEP  
LEVEL B . . . . . PRESET
  - g. With HP 651B Test Oscillator (set to 10 MHz at 100 mV rms) connected to INPUT A, connect a second signal generator (set to 40 MHz at 50 mV rms) to INPUT B.
  - h. Repeat step e adjusting variable resistor R28 instead of R26.
2. Channel C Sensitivity adjustments:
- a. Remove the top cover from the 5328A.
  - b. Set signal to 100 MHz and reduce level until no stable reading in counter display. Adjust A8R82 for stable reading.
  - c. Repeat step b. until best sensitivity is obtained.
  - d. Repeat step b. to ensure that the counter still meets the requirement.
3. High Frequency Offset adjustments:
- a. Remove top cover.
  - b. Set signal generator to 500 MHz and reduce signal level until display reading is no longer stable. Adjust A8R85 until display is stable.
  - c. Repeat step b. until best balance is obtained.

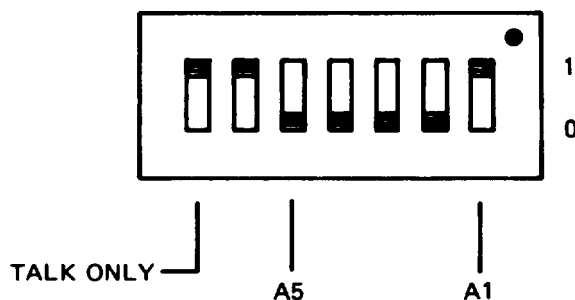
4. D-to-A Converter Adjustment procedure:

The following adjustment procedure adjusts the All D-to-A Converter outputs for accurate programmed trigger levels. Measuring the DAC outputs with a DVM is NOT an equivalent procedure. Since the gain through the 5328A 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 gain 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 volts 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 takes into account the fact that the input amplifier gain is less than 1.0.

The procedure offsets an input signal to the 5328A by 0, +2, and -2 volts and programs the A and B channel trigger levels for 0, +2, and -2 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 input to the A12U4 comparator.

It is very important that the DAC adjustments be performed after the A and B channels sensitivity adjustment. In this adjustment, follow the procedure outlined on page 12 of the Option 041 Manual but adjust for optimum sensitivity by continuing to decrease the signal generator level below 25 mV rms and adjusting the A12R26, R28 for stable counter displays.

- a. Set up the equipment as in Figure 5-2. Set the rear panel address switches on the 5328A to:



Set the 651B test oscillator to 20kHz at a level of 25 mV rms (70mV p-p). Set the 180A oscilloscope A channel for ac coupling and 50 mV per division. Verify that the 20 kHz signal into the counter is 70 mV p-p.

- b. Disconnect the dc supply for a 0.0-volt dc offset on the input signal. Execute from the keyboard of the 9825A the following:

wrt **701**, "PF4G5S1S3A379+000\*B37+000\*R"

Monitoring the 5328A Marker A output on the oscilloscope, adjust A11R21 for a 50% duty cycle in the Marker A signal as shown:

- c. Connect the 5328A B Marker 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 COMA.)
- d. Connect power supply as in the figure and adjust for a dc level of 2.00 volts ( $\pm 2$  mV) as read on the DVM.
- e. Execute the following from the keyboard of the 9825A:

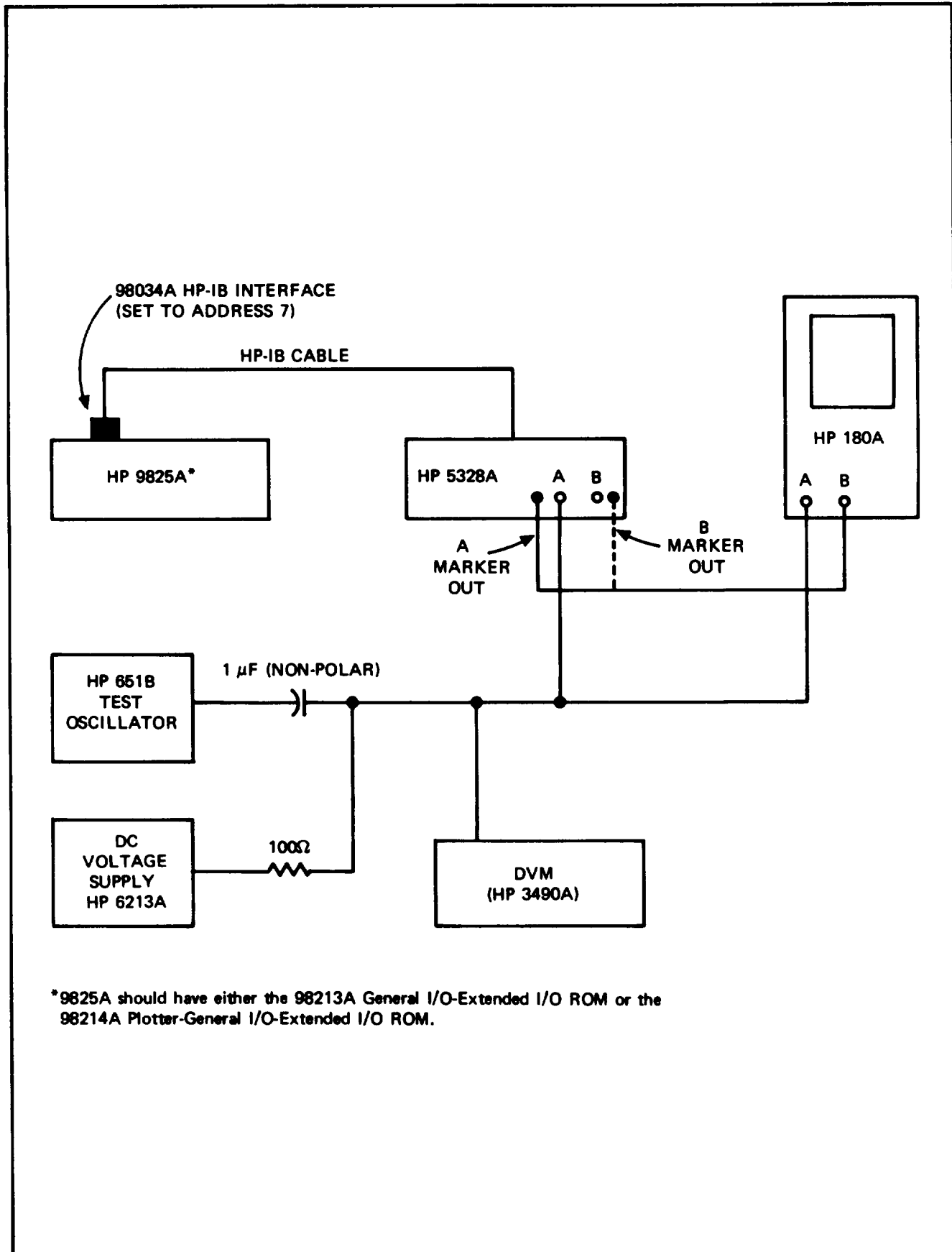
wrt **701**, "PF4G5S1S3A379+200\*B37+200\*R"

(press RECALL on 9825A and simply change DAC voltages as required.)

Adjust A11R18 for a 50% duty cycle on the 5328A B Marker output signal.

Connect the 5328A marker output signal to channel B of the oscilloscope. Adjust A11R24 for a 50% duty cycle on the A Marker output signal.

- h. Reconfigure dc power supply for negative voltages and set the voltage for -2.00 volts ( $\pm 2$  mv).
- i. Execute the following from the keyboard of the 9825A:
- wrt **701**, "PF4C5S1S3A379-200\*B37-200\*R"
- j. Adjust All R26 for a 50% duty cycle on the A Marker output signal.
- k. Connect the 5328A B Marker output to the B channel of the oscilloscope. Adjust A11R17 for a 50% duty cycle on the B Marker output signal.



\*9825A should have either the 98213A General I/O-Extended I/O ROM or the 98214A Plotter-General I/O-Extended I/O ROM.

Figure 5-2. DAC Adjustment Equipment Connections

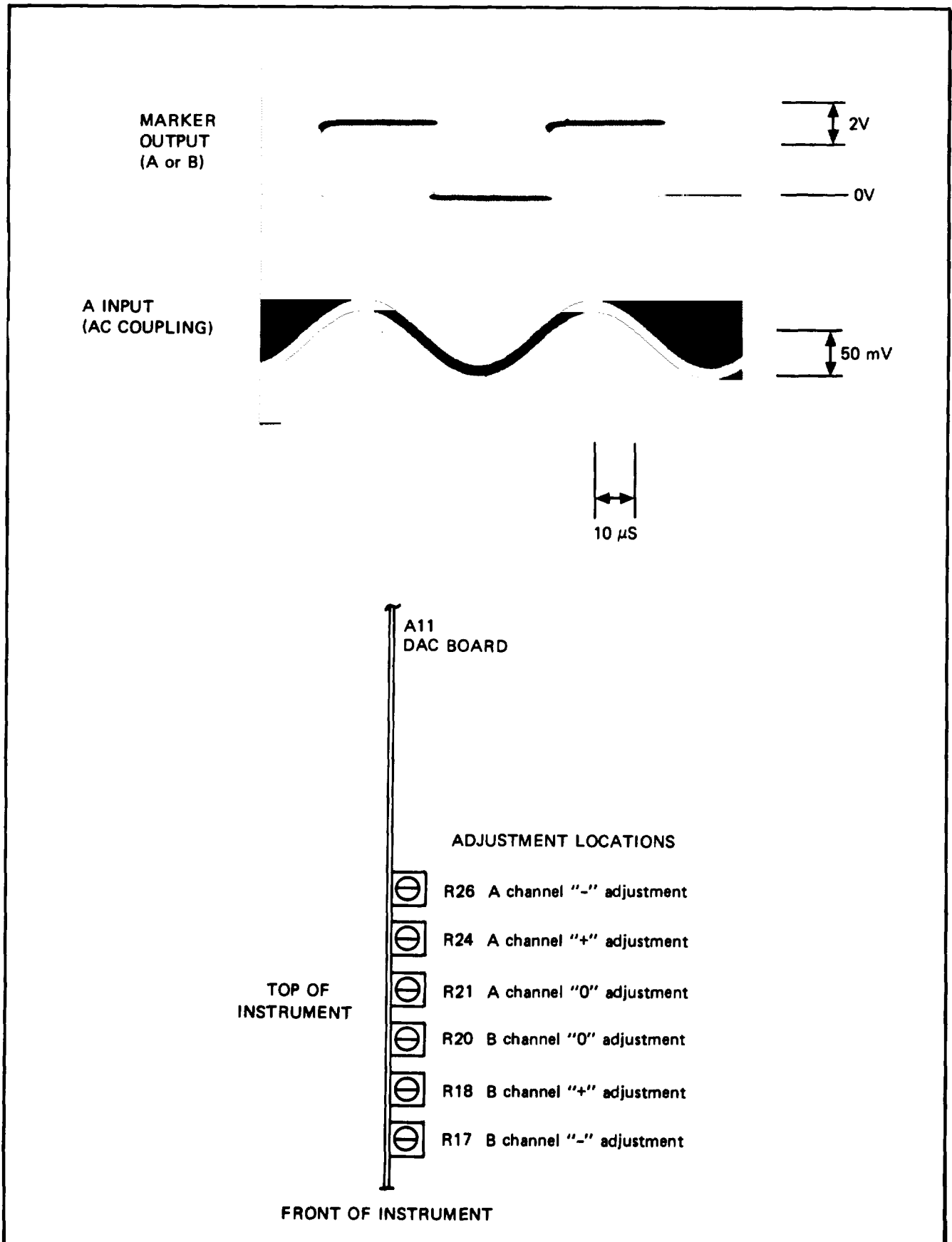


Figure 5-3. DAC Adjustment oscilloscope readout and adjustment locations

### 5-26. Adjustment of A3 Oscillator Support

1. Connect 5328A, HP 8640, and HP 180 as shown in Figure 5-4.

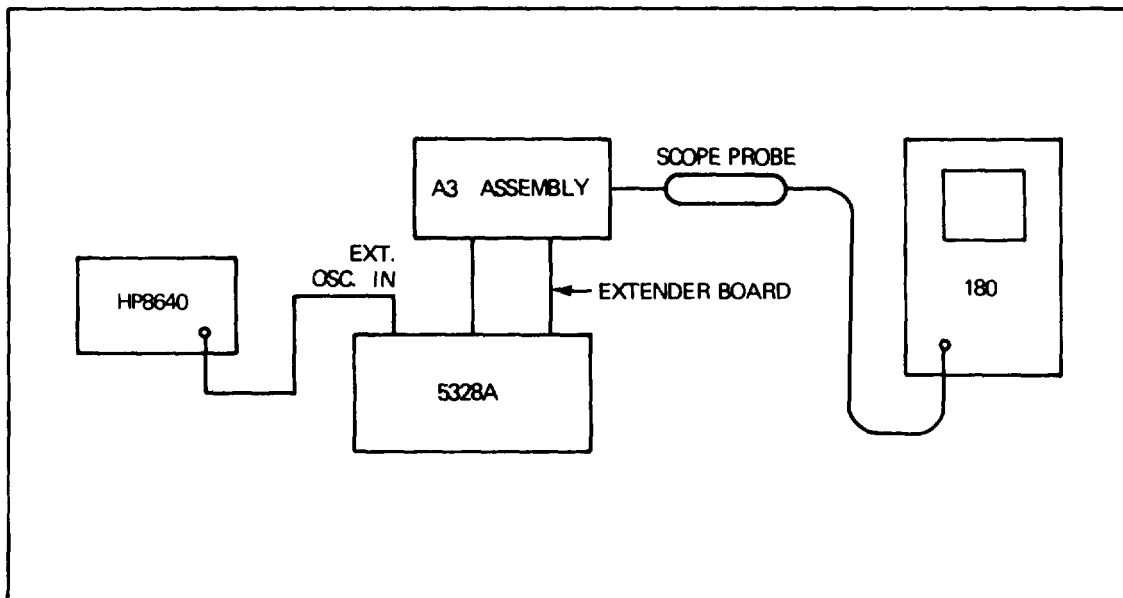


Figure 5-4. Hookup For A3 Oscillator Support Adjustment

2. Place A3 on an extender board,
3. Apply a 1 MHz signal at a level greater than 1V rms to the 5328A rear-panel EXT OSC IN.
4. With scope probe, monitor A3U2 (6) non-component side of A3 circuit board.
5. Adjust A3C15 and A3C12 to minimize side-jitter in trace, as shown in Figure 5--5.
6. Put the scope in X10 and fine-tune the adjustments for minimum jitter.

### 5-27. TROUBLESHOOTING

5-28. Trouble isolation can best be accomplished by obtaining all possible information from the controls, connectors, and indicators on the 5328A. This information should then be analyzed by conducting the Performance Test (Table 5-4) to aid in determining symptoms of the trouble. Troubleshooting aids are described in the following paragraphs,

### 5-29. TROUBLESHOOTING AIDS

5-30. Troubleshooting flowcharts for each assembly of the 5328A are provided at the back of this section. Extender boards and test cards are available as service kits. This section contains a table for analysis of functional signals and a table for IC troubleshooting.

### 5-31. Extender Board (05328-62016)

5-32. Two of these extender boards are supplied with the 5328A to extend the A4 Function Selector Assembly or the A8 Frequency C Assembly. One of these extender boards is required to extend the A10 assembly for the standard 5328A.

A3 Out of Adjustment



Figure 5-5A

C15, C12 Adjusted for Minimum Jitter

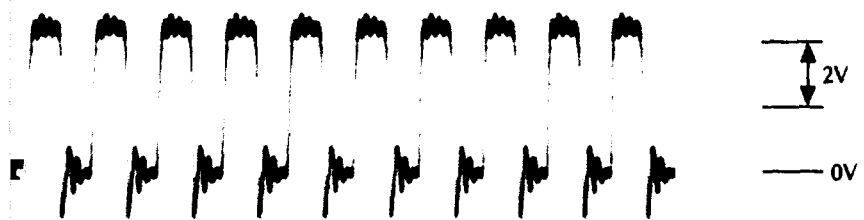


Figure 5-5B

Figure 5-5. A3 Jitter Adjustment

### **5-33. IC Troubleshooting**

5-34. To troubleshoot the IC's on the A1 Motherboard, proceed as follows:

- a. Set the FUNCTION switch to CHECK.
- b. Set the FREQ RESOLUTION, N switch to 1 MHz, 1.
- c. Remove top cover and remove A4 Function Selector Assembly.
- d. Apply power and check for the logic states as shown in Table 5-5, using an HP Model 10528A Logic Clip or a Model 10525T Logic Probe. A dark pattern indicates a logic high.

### **5-35. Function Signals**

5-36. *Table 5-6* lists the functional signals at pertinent points for each position of the FUNCTION switch. This information can be used to isolate problems that may occur in any of the various modes of operation.

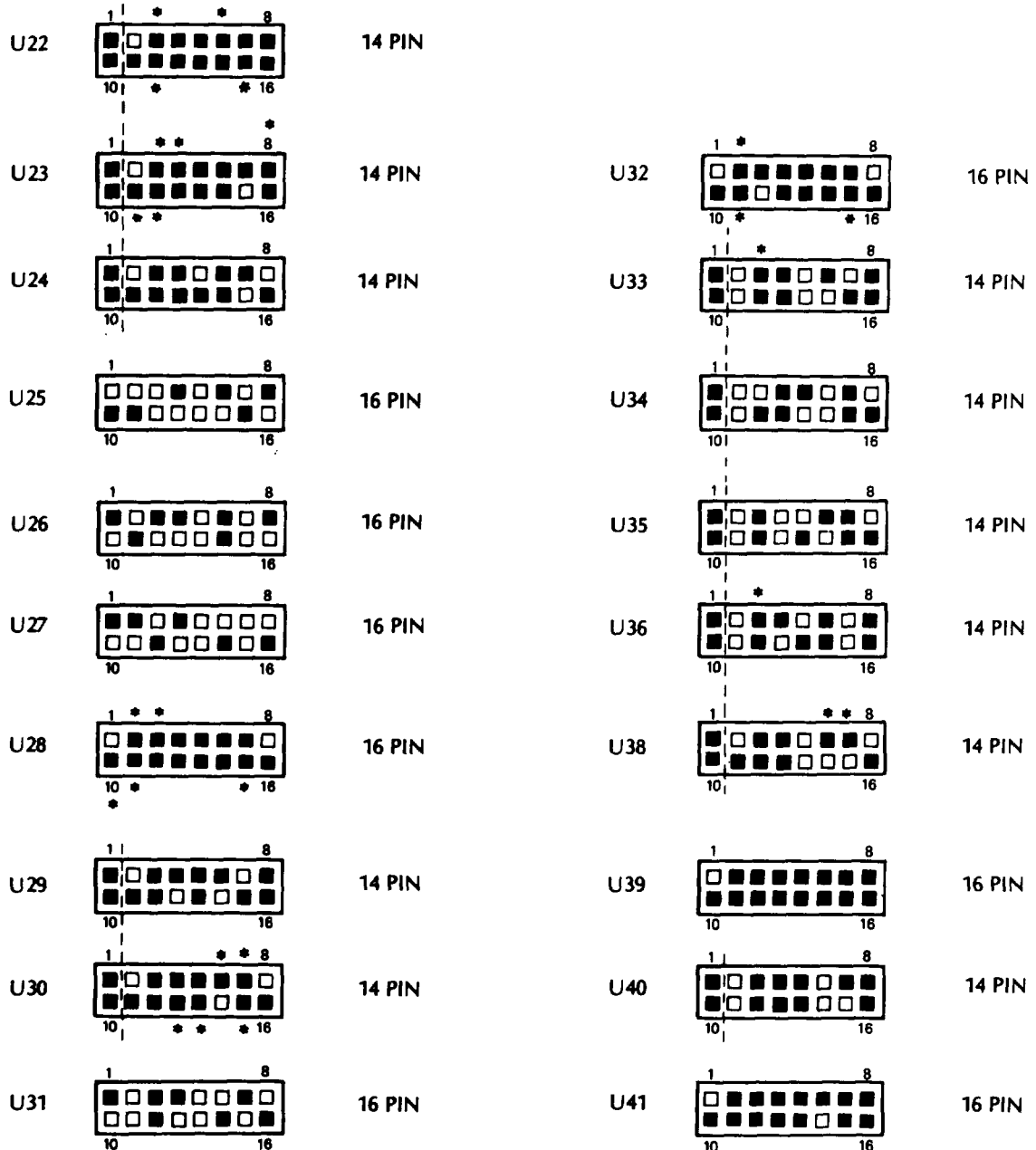


Table 5-5 IC Troubleshooting, A1 Motherboard

5328A Display:   
(See preceding initial conditions)

**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

Table 5-5. IC Troubleshooting, A1 Motherboard (Continued)

| PINS U25 |    | FUNCTION |        |        |       |           |           |        |            |           |
|----------|----|----------|--------|--------|-------|-----------|-----------|--------|------------|-----------|
|          |    | CHECK    | FREQ C | FREQ C | PER A | PER AVG A | RATIO B/A | TI A-B | TI AVG A-B | RATIO C/A |
| INPUTS   | 2  | L        | L      | L      | H     | H         | H         | H      | H          | H         |
|          | 3  | H        | H      | H      | L     | L         | L         | L      | L          | L         |
|          | 6  | H        | L      | H      | H     | H         | H         | H      | H          | L         |
|          | 7  | H        | L      | H      | L     | L         | H         | L      | L          | L         |
| OUTPUTS  | 9  | H        | L      | L      | L     | L         | L         | L      | L          | L         |
|          | 10 | H        | H      | H      | H     | H         | H         | H      | H          | H         |
|          | 15 | L        | L      | L      | L     | L         | L         | L      | L          | L         |
|          | 16 | L        | H      | L      | H     | H         | L         | H      | H          | H         |
| U26      |    |          |        |        |       |           |           |        |            |           |
| INPUTS   | 2  | L        | H      | L      | L     | L         | L         | L      | L          | H         |
|          | 3  | H        | L      | H      | H     | H         | H         | H      | H          | L         |
|          | 6  | H        | L      | H      | L     | L         | L         | L      | L          | L         |
|          | 7  | L        | H      | H      | H     | H         | L         | L      | L          | H         |
| OUTPUTS  | 9  | L        | L      | L      | L     | L         | L         | L      | H          | L         |
|          | 10 | H        | L      | L      | H     | H         | H         | H      | H          | L         |
|          | 15 | L        | L      | L      | L     | L         | L         | L      | L          | L         |
|          | 16 | L        | L      | L      | L     | L         | L         | L      | L          | L         |
| U27      |    |          |        |        |       |           |           |        |            |           |
| INPUTS   | 2  | L        | L      | L      | L     | L         | L         | L      | L          | L         |
|          | 3  | L        | L      | L      | H     | H         | H         | H      | H          | H         |
|          | 6  | L        | L      | L      | L     | L         | H         | L      | L          | H         |
|          | 7  | H        | H      | H      | H     | H         | H         | H      | H          | H         |
| OUTPUTS  | 9  | L        | L      | L      | H     | H         | H         | H      | H          | H         |
|          | 10 | L        | L      | H      | H     | H         | L         | H      | H          | L         |
|          | 15 | L        | H      | L      | L     | L         | L         | L      | L          | H         |
|          | 16 | L        | L      | L      | L     | L         | L         | L      | L          | L         |
| U31      |    |          |        |        |       |           |           |        |            |           |
| INPUTS   | 2  | H        | H      | H      | L     | L         | L         | L      | L          | L         |
|          | 3  | L        | L      | L      | L     | L         | L         | L      | L          | L         |
|          | 6  | H        | H      | H      | L     | L         | H         | L      | L          | H         |
|          | 7  | L        | L      | L      | L     | L         | H         | L      | L          | H         |
| OUTPUTS  | 9  | L        | L      | L      | L     | L         | L         | H      | H          | L         |
|          | 10 | L        | L      | L      | L     | L         | L         | L      | L          | L         |
|          | 15 | L        | L      | H      | L     | L         | L         | L      | L          | L         |
|          | 16 | H        | H      | H      | L     | L         | L         | L      | L          | L         |

Table 5-5. IC Troubleshooting, A1 Motherboard (Continued)

| 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         | H                      | 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 5-5. IC Troubleshooting, A1 Motherboard (Continued)

| U37<br>(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 |

Table 5-6. 5328A Functional Signals

| NOTE<br>N=0-7 (Exponent of 10 on FREQ RESOLUTION, N Switch.<br>N=0 is position 1 on switch. All other positions N≠0).<br>CLK = 10 MHz<br>* = Don't care |   |                                |        |                                       |      |                         |       |                           |        |                                    |                          |
|---|---|--------------------------------|--------|---------------------------------------|------|-------------------------|-------|---------------------------|--------|------------------------------------|--------------------------|
| Function Switch   | Displayed Number<br>FREQ • TIME<br>(Hz) (Seconds) | Signal to TB<br>(Output A4U10) |        | Signal to 1st Decade<br>(Output A4U6) |      | Arming<br>(Output A4U5) |       | Main Gate<br>(Input A4U6) |        | Gate<br>(Opt. 030)<br>(Input A8U4) |                          |
|   |   | IF N=0                         | IF N≠0 | IF N=0                                | N≠0  | Norm                    | Armed | IF N=0                    | IF N≠0 |                                    |                          |
| 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 AVG A   | $CLK \cdot 10^N PER A$                            | *                              | A      | GOSC                                  | CLK  | Free                    | B     | Open                      | MGFF   |                                    | *                        |
| TI A-B  | $\frac{CLK}{10^N} \cdot TO A-B$                   | *                              | CLK    | GOSC                                  | TBO  | Free                    | CA    | Open                      | TI     |                                    | *                        |
| TI AVG A-B  | $(CLK \cdot 10^N) \cdot TI A-B$                   | *                              | B      | GOSC                                  | GOSC | Free                    | CA    | Open                      | MGFF   |                                    | *                        |
| FREQ C<br>(Option 030)  | $C \cdot \frac{10^{(N+1)}}{CLK}$                  | CLK                            | CLK    | C                                     | C    | CA                      | B     | Open                      | Open   |                                    | MGFF                     |
| RATIO B/A   | $B \cdot \frac{10^N}{A}$                          | †*                             | A      | B                                     | B    | Free                    | CA    | TI                        | MGFF   |                                    | *                        |
| RATIO C/A   | $C \cdot \frac{10^N}{A}$                          | *                              | A      | C                                     | C    | Free                    | B     | Open                      | Open   |                                    | TI IF N=0<br>MGFF IF N≠0 |
| CHECK   | $CLK \cdot \frac{10^{(N+1)}}{CLK}$                | CLK                            | CLK    | CLK                                   | CLK  | Free                    | B     | MGFF                      | MGFF   |                                    | *                        |
| <p>NOTES<br/>† = ROM makes "A" into period = gate time<br/>CA = CARM</p>  |   |                                |        |                                       |      |                         |       |                           |        |                                    |                          |

5-37. HP-IB VERIFICATION USING THE HP9825A

5-38. The following program checks the 5328AF/096/H42 for proper operation on the HP-IB. The program is designed to operate with the 5328AF/096/H42 connected to a HP9825A Desktop Computer as a controller.

5-39. To perform the verification, connect the 5328AF/096/H42 as shown in Figure 5-6, and set the rear panel address switches to decimal equivalent one.

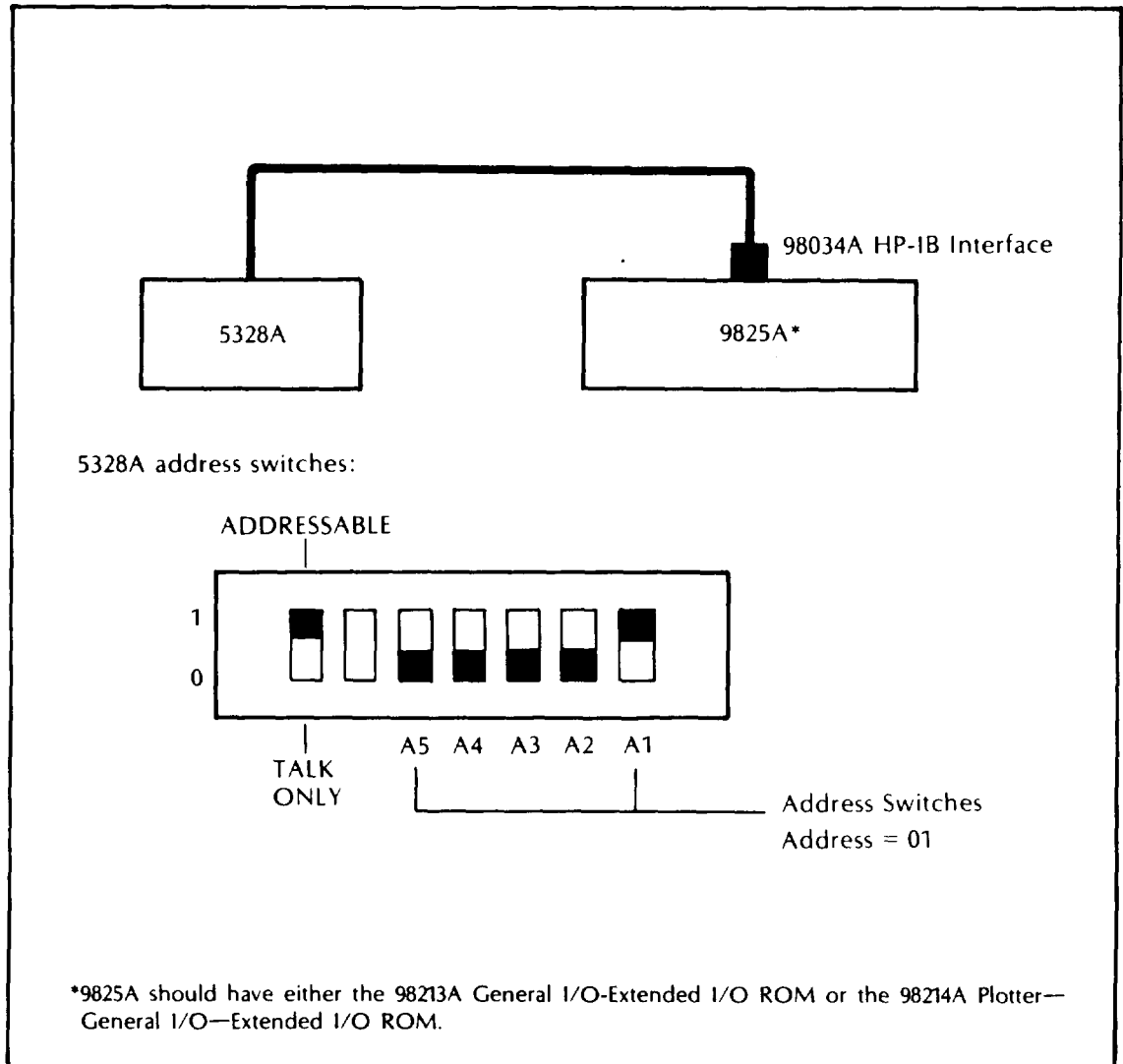


Figure 5-6. System Configuration

5-40. The program listed in Table 5-7 may be keyed into the 9825A or may be loaded from an HP-IB Verification cassette, HP P/N 59300-10001, (Revision E or later) which also contains HP-IB verification programs for the 59300 series of instruments. To run the program on the cassette, insert the cassette into the 9825A, Load file 0, and press RUN. Enter "5328" when the instrument model number is requested. The 9825A will then load into memory the 5328A verification program.

5-41. The 5328A HP-IB Verification Program goes through 17 check points. The information in Table 5-8A, B, C tells what occurs during each test and what should be observed by the operator if the test has been successfully completed. At the conclusion of each test, the program stops and displays the current check point. To advance to the next test, simply press **CONTINUE**. If it is desired to repeat a test, set the variable L to 1 via the 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**.

5328AF/096 OR  
5328A/H42

HP-IB TESTS

-----  
CHECK POINT 1  
\*REMOTE

-----  
CHECK POINT 2  
\*CHECK=  
+ 10.0000E+6

-----  
CHECK POINT 3  
RESOLUTION  
+ 10.00E+6  
+ 10.000E+6  
+ 10.0000E+6  
+ 10.00000E+6  
+10.0000000E+6  
0+0.00000000E+6

-----  
CHECK POINT 4  
\*FREQ A

-----  
CHECK POINT 5  
\*RATIO B/A

-----  
CHECK POINT 6  
\*PERIOD A

CHECK POINT 7  
\*PER.AVG.A

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

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

-----  
CHECK POINT 10  
FREQ C

-----  
CHECK POINT 11  
RATIO C/A

-----  
CHECK POINT 12  
\*SAMPLE RATE  
\*SINGLE/MULTIPLE  
MEASMT

-----  
CHECK POINT 13  
\*ATTENUATOR

-----  
CHECK POINT 14  
\*SEPARATE/COMMON  
\*NORMAL/INVERTED

CHECK POINT 15  
\*COUPLING

-----  
CHECK POINT 16  
\*TRIGGER LEVELS  
CHNL B,+SLOPE  
CHNL B,-SLOPE  
CHNL A,+SLOPE  
CHNL A,-SLOPE

-----  
CHECK POINT 17  
BUS COMMANDS:  
\*LOCAL LOCKOUT  
\*DEVICE CLEAR  
\*SELECTED DEVICE  
CLEAR  
\*GROUP EXECUTE  
TRIGGER  
\*SERIAL POLL  
STATUS BYTE=  
6.40e 01  
\*GO TO LOCAL

END OF TEST

Figure 5-7. Sample Printout

Table 5-7. Program Listing

```

0: dim C$(40); dsp "MODEL5328AF/095/H42 FREQ COUNTER"
1: prt "5328AF/095 OR"
2: prt "5328A/H42"; spc 1
3: prt " HP-IB TESTS"; spc 1
4: "1": prt "-----", "CHECK POINT 1"
5: rem 701
6: prt "*REMOTE"; beep; spc 2
7: dsp "CHECK POINT 1--PRESS CONTINUE"; stp
8: if L=1; gto -6
9: prt "-----", "CHECK POINT 2"
10: wrt 701, "PF<G3S13R"
11: red 701, C$; prt "*CHECK=", C$; beep; spc 2
12: dsp "CHECK POINT 2--PRESS CONTINUE"; stp
13: if L=1; gto -4
14: prt "-----", "CHECK POINT 3", "RESOLUTION"
15: l+x
16: "LOOP": fmt 2, "G", f.0, "R"
17: wrt 701.2, X
18: red 701, C$; prt C$
19: X+l+x
20: if X=8; gto +2
21: gto "LOOP"
22: dsp "CHECK POINT 3--PRESS CONTINUE"; beep; stp
23: if L=1; gto -9
24: prt "-----", "CHECK POINT 4"
25: wrt 701, "F4R"
26: prt "*FREQ A"; beep; spc 2
27: dsp "CHECK POINT 4--PRESS CONTINUE"; stp
28: if L=1; gto -4
29: prt "-----", "CHECK POINT 5"
30: wrt 701, "F9R"
31: prt "*RATIO B/A"; beep; spc 2
32: dsp "CHECK POINT 5--PRESS CONTINUE"; stp
33: if L=1; gto -4
34: prt "-----", "CHECK POINT 6"
35: wrt 701, "F6R"
36: prt "*PERIOD A"; beep; spc 2
37: dsp "CHECK POINT 6--PRESS CONTINUE"; stp
38: if L=1; gto -4
39: prt "-----", "CHECK POINT 7"
40: wrt 701, "F7R"
41: prt "*PER.AVG.A"; beep; spc 2
42: dsp "CHECK POINT 7--PRESS CONTINUE"; stp
43: if L=1; gto -4
44: prt "-----", "CHECK POINT 8"
45: wrt 701, "F8R"
46: prt "*T.I.A+B"; beep; spc 2
47: dsp "CHECK POINT 8--PRESS CONTINUE"; stp
48: if L=1; gto -4
49: prt "-----", "CHECK POINT 9"
50: wrt 701, "F:R"

```

Table 5-7. Program Listing (Continued)

```
51: prt  "*T.I.AVG.A+B";beep;spc 2
52: dsp  "CHECK POINT 9--PRESS CONTINUE";stp
53: if L=1;gto -4
54: prt  "-----", "CHECK POINT 10"
55: wrt  701,"F>R"
56: prt  "FREQ C";beep;spc 2
57: dsp  "CHECK POINT 10--PRESS CONTINUE";stp
58: if L=1;gto -4
59: prt  "-----", "CHECK POINT 11"
60: wrt  701,"F=R"
61: prt  "RATIO C/A";beep;spc 2
62: dsp  "CHECK POINT 11--PRESS CONTINUE";stp
63: if L=1;gto -4
64: prt  "-----", "CHECK POINT 12"
65: wrt  701,"F<G1S137R"
66: dsp  "MANUAL OK?--PRESS CONTINUE";stp
67: prt  "*SAMPLE RATE"
68: wrt  701,"S60R"
69: dsp  "GATE LIGHT OFF?--PRESS CONTINUE";stp
70: prt  "*SINGLE/MULTIPLE MEASMNT";beep;spc 2
71: dsp  "CHECK POINT 12--PRESS CONTINUE";stp
72: if L=1;gto -8
73: "13":prt "-----", "CHECK POINT 13"
74: wrt  701,"PF4G4S13A379B37R"
75: dsp  "STEPS 1,2--PRESS CONTINUE";stp
76: wrt  701,"PF4G4S13A139B13R";wait 1000
77: prt  "*ATTENUATOR";beep;spc 2
78: dsp  "CHECK POINT 13--PRESS CONTINUE";stp
79: if L=1;gto -6
80: "14":prt "-----", "CHECK POINT 14"
81: dsp  "STEP 3--PRESS CONTINUE";stp
82: wrt  701,"PF9G3S13A79B7R"
83: wait 2000
84: dsp  "STEP 4--PRESS CONTINUE";stp
85: wrt  701,"PF4C5S13B79R";wait 2000
86: prt  "*SEPARATE/COMMON","*NORMAL/INVERTED";beep;spc 2
87: dsp  "CHECK POINT 14--PRESS CONTINUE";stp
88: if L=1;gto -8
89: "15":prt "-----", "CHECK POINT 15"
90: wrt  701,"PF4G4S13A79B7R"
91: dsp  "STEPS 5,6--PRESS CONTINUE";stp
92: wrt  701,"PF4G4S13A379B37R"
93: prt  "*COUPLING";beep;spc 2
94: dsp  "CHECK POINT 15--PRESS CONTINUE";stp
95: "15":prt "-----", "CHECK POINT 15"
96: wrt  701,"PF4G6S136A379+000*B37+000*R"
97: dsp  "STEPS 7,3--PRESS CONTINUE";stp
98: wrt  701,"PF4C6S136A379+040*B37+040*R"
99: prt  "*TRIGGER LEVELS"
100: dsp  "TRIGGER LVLS--PRESS CONTINUE";stp
```



Table 5-7. Program Listing (Continued)

```

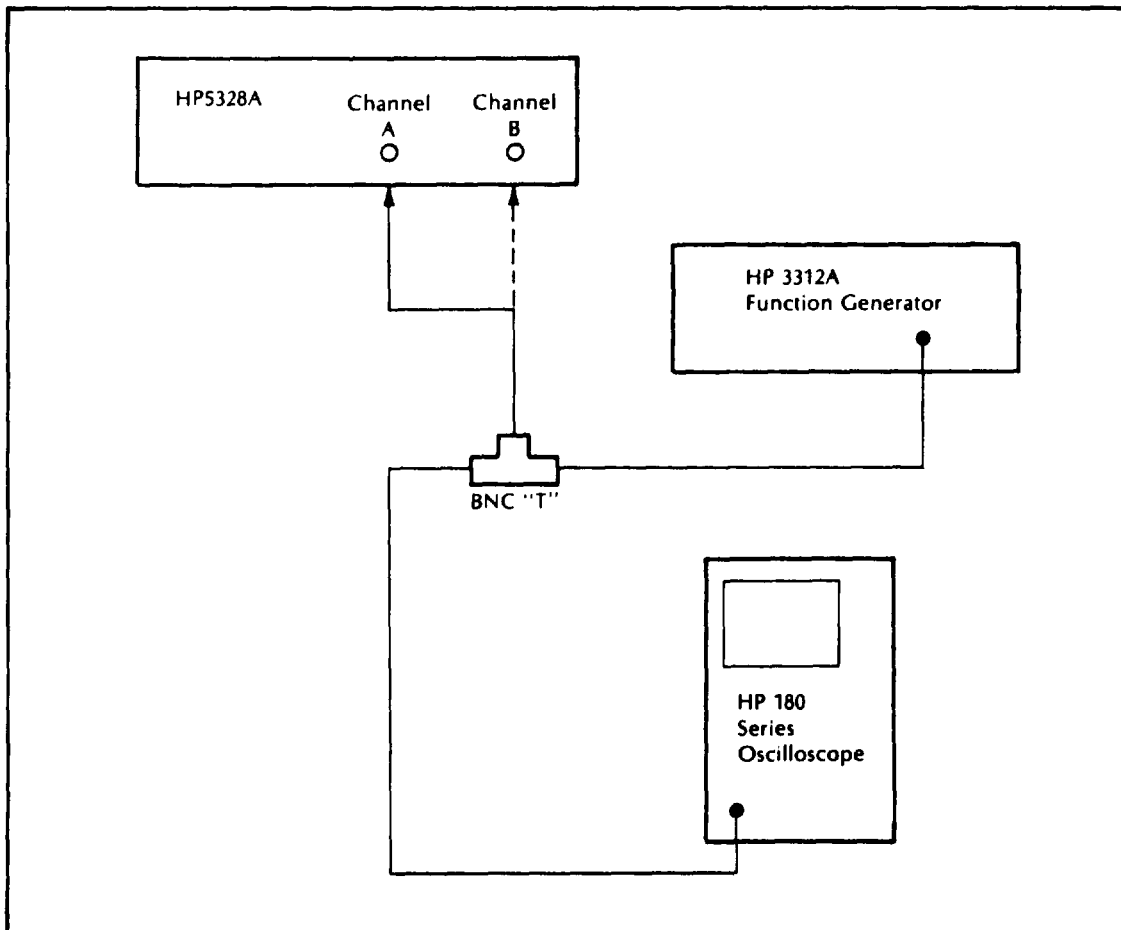
101: dsp "STEPS 9,10,11,12-PRESS CONTINUE";stp
102: wrt 701,"PF:S137A379+040*B37+050*R"
103: prt "CHNL B,+SLOPE"
104: dsp "CHANNEL B,+SLOPE--PRESS CONTINUE";stp
105: wrt 701,"PF:S137A379+040*B375+050*R"
106: prt "CHNL B,-SLOPE"
107: dsp "CHNL B,-SLOPE--PRESS CONTINUE";stp
108: wrt 701,"PF:S137A379+050*B375+040*R"
109: prt "CHNL A,+SLOPE"
110: dsp "CHNL A,+SLOPE-PRESS CONTINUE";stp
111: wrt 701,"PF:S137A3795+050*B375+040*R"
112: prt "CHNL A,-SLOPE";spc 2
113: dsp "CHNL A,-SLOPE-PRESS CONTINUE";stp
114: dsp "CHECK POINT 16-PRESS CONTINUE";stp
115: if L=1;gto "16"
116: "17":prt "-----","CHECK POINT 17"
117: prt "BUS COMMANDS:"
118: rem 701;dsp "REMOTE?-PRESS CONTINUE";stp
119: llo 7;dsp "LOCAL LOCKOUT?-PRESS CONTINUE";stp
120: prt "*LOCAL LOCKOUT"
121: wrt 701,"PF<S13G3R"
122: dsp "10.000MHz?-PRESS CONTINUE";stp
123: clr 7;prt "*DEVICE CLEAR";beep
124: dsp "DCL-PRESS CONTINUE";stp
125: wrt 701,"PF<S13G3R"
126: dsp "10.000MHz?-PRESS CONTINUE";stp
127: clr 701;prt "*SELECTED DEVICE CLEAR";beep
128: dsp "DCL-PRESS CONTINUE";stp
129: wrt 701,"PF<03B03R"
130: dsp "IN HOLD?-PRESS CONTINUE";stp
131: wait 1000;try 7;beep;wait 2000;try 701;beep;wait 1000
132: prt "*GROUP EXECUTE TRIGGER"
133: dsp "GET-PRESS CONTINUE";stp
134: wrt 701,"PF<G7S12R"
135: rds(701)+A;dsp A
136: if A=0;gto -1
137: prt "*SERIAL POLL"," STATUS BYTE=",A
138: dsp "SERIAL POLL-PRESS CONTINUE";stp
139: lcl 7;dsp "COUNTER IN LOCAL?-PRESS CONTINUE";stp
140: prt "*GO TO LOCAL";spc 2
141: rem 701
142: dsp "CHECK POINT 17-PRESS CONTINUE";stp
143: if L=1;gto "17"
144: "END":dsp "END OF TEST"
145: prt "END OF TEST";beep;spc 5
146: end
*17327

```

**Table 5-8A. Program Description**

| Check Point | Test  | Observe on 5328A   |
|-------------|---|--|
| 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 0.1 Hz to 1.0 MHz.  |
| 4           | FREQ A  | Counter display should read 0.0000 KHz.  |
| 5           | RATIO B/A                                     | Counter display should read 0.0000000  |
| 6           | PERIOD A                                      | Counter display should read 0. s   |
| 7           | PER. AVE. A                                   | Counter display should read 0.00000 ns   |
| 8           | T.I. A-B                                      | Counter display should read 0. s   |
| 9           | T.I. AVG. A-B                                 | Counter display should read 0.00000 ns   |
| 10          | FREQ C  | Counter display should read 0.0000 KHz   |
| 11          | RATIO C/A                                     | Counter display should read 0.0000000  |
| 12          | SAMPLE RATE<br>SINGLE/<br>MULTIPLE<br>MEASMNT | When calculator displays MANUAL OK?, verify that front panel SAMPLE RATE control can be manually adjusted as seen from GATE LIGHT flashing rate.<br>When calculator displays GATE LIGHT OFF?, verify that Gate Light is truly off. |

5-42. Connect a function generator to the 5328 input channels and monitor the signal with an oscilloscope as shown in *Figure 5-8*.



**Figure 5-8. Hookup for tests described in Table 5-8B & C**

Table 5-8B. Program Description

| Check Point | Step | Test                                       | Counter Display Readout  |
|-------------|------|--|--|
| 13          | 1    | ATTENUATOR                                 | Set the function generator to an output of 1 kHz, 100 mV p-p sinewave centered at 0 vdc 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. HP5328AF/096/H42 trigger lights should be blinking. |
|             | 2    |  | When the 9825A <b>CONTINUE</b> key is pressed, verify that the counter trigger lights stop blinking.   |
| 14          | 3    | SEPARATE/<br>COMMON<br>NORMAL/<br>INVERTED | With function generator connected to Channel A of counter, when <b>CONTINUE</b> key of 9825A is pressed, verify counter readout as 1.000.  |
|             | 4    |  | With function generator connected to Channel B of counter, when <b>CONTINUE</b> key of 9325A is pressed, counter should display approximately 1.00 kHz (frequency of function generator).  |
| 15          | 5    | COUPLING                                   | Set the function generator to a triangular pulse output of 1 kHz at 300 mV p-p with a +0.4 vdc offset ( <i>Figure 5-9</i> ). Connect signal to counter's Channel A input. Counter's Channel A and B trigger lights should be blinking.   |
|             | 6    |  | When the 9825A <b>CONTINUE</b> key is pressed, observe the counter's trigger lights stop blinking.   |
| 16          | 7    | SLOPE/<br>TRIGGER<br>LEVEL                 | Set the function generator to a triangular pulse output of 1 kHz at 300 mV p-p with a +0.4 vdc offset ( <i>Figure 5-9</i> ). Connect the function generator's output to Channel A of the counter. Set the counter's LEVEL A and B to PRESET.   |
|             | 8    |  | When the 9825A <b>CONTINUE</b> key is pressed, observe Channel A and B trigger lights commence blinking.   |
|             | 9    | Channel B<br>+ SLOPE                       | When the 9825A <b>CONTINUE</b> key is pressed, counter should display approximately 150µsec±75µsec (wide tolerance).   |
|             | 10   | Channel B<br>- SLOPE                       | When the 9825A <b>CONTINUE</b> key is pressed, counter should display approximately 400µsec±100µsec (wide tolerance).  |
|             | 11   | Channel A<br>+ SLOPE                       | When the 9825A <b>CONTINUE</b> key is pressed, counter should display approximately 400µsec±100µsec (wide tolerance).  |
|             | 12   | Channel A<br>- SLOPE                       | When the 9825A <b>CONTINUE</b> key is pressed, counter should display approximately 150µsec±75µsec (wide tolerance).   |

Table 5-8C. HP-IR Bus Commands

| Check Point | Test  |   |
|-------------|---|---|
| 17          | LOCAL LOCKOUT (LLO)<br><br>DEVICE CLEAR (DCL)<br><br>SELECTED DEVICE CLEAR (SDC)<br>GROUP EXECUTE TRIGGER (GET)<br>SERIAL POLL (SPE/SPD)<br><br>GO TO LOCAL (GTL) | <p>When the 9825A CONTINUE key is pressed, verify that counter (RMT) annunciator is on.</p> <p>When the 9825A CONTINUE 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).</p> <p>When the 9825A CONTINUE key is pressed, verify that counter displays 10.000 MHz. When the 9825A CONTINUE key is again pressed, counter will reset to its Remote Program Initialize mode and display (O.).</p> <p>When the 9825A CONTINUE key is pressed, verify that counter displays 10.000 MHz. When the 9825A CONTINUE key is again pressed, counter will reset to its Remote Program Initialize mode and display (O.).</p> <p>When the 9825A CONTINUE key is pressed, verify that counter is in Hold (Gate Light off). When the 9825A CONTINUE key is pressed, Gate Light should flash twice and counter should display 10.000 MHz.</p> <p>When the 9825A CONTINUE key is pressed, counter should display (0.0000000 MHz) and GATE Light should go off. Calculator should print (STATUS BYTE = 64.00).</p> <p>When the 9825A CONTINUE key is pressed, verify that counter is in Local (RMT annunciator off). When 9825A CONTINUE key is again pressed, counter will go into remote.</p> <p>END OF TEST</p> |

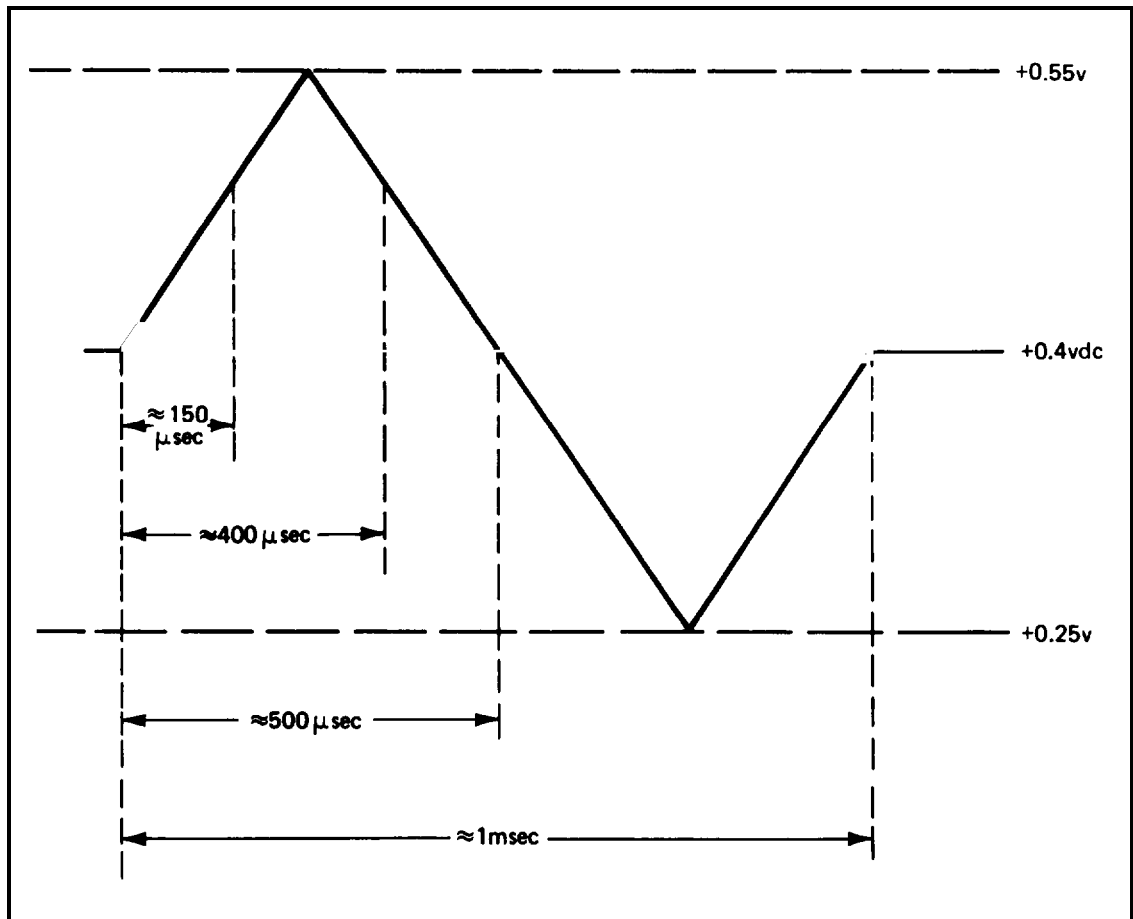


Figure 5-9. Triangular Pulse Observed in Steps 5 and 7, Table 5-8B

Table 5-9. 5328A A15 Qualifiers and Signal Mnemonics

| QUALIFIERS |        |  |
|------------|--------|--|
| Signal     | Source | Description  |
| ADDR       | U26(4) | H = My Listen Address  |
| ANN        | U32(3) | L = Annunciator On   |
| ATN        | U8(5)  | L = Attention  |
| B0         | U12(5) | 16 State Sequence Count for Output of ASCII Code                                     |
| B1         | U12(6) | 16 State Sequence Count for Output of ASCII Code                                     |
| B2         | U12(7) | 16 State Sequence Count for Output of ASCII Code                                     |
| B3         | U12(9) | 16 State Sequence Count for Output of ASCII Code                                     |
| BLK        | U6(7)  |  |
| D          | U32(5) | H = Decimal Point has been Outputted   |
| DAC        | U8(7)  | H = Data Accepted  |
| DAV        | U3(1)  | L = Data is Valid  |
| DIO1       | U3(2)  | HP-IB Data Bit 1   |
| DIO2       | U3(3)  | HP-IB Data Bit 2   |
| DIO3       | U3(4)  | HP-IB Data Bit 3   |
| DIO4       | U3(5)  | HP-IB Data Bit 4   |
| DIO5       | U3(6)  | HP-IB Data Bit 5   |
| DIO6       | U3(7)  | HP-IB Data Bit 6   |
| DIO7       | U3(9)  | HP-IB Data Bit 7   |
| EOM        | U8(1)  | H = End of Measurement   |
| J          | U8(2)  | Always HIGH, used for unconditional jump   |
| LDP        | U32(2) | L = Decimal Point On   |
| LIS        | U6(1)  | H = Address to Listen  |
| LLO        | U19(9) | H = Local Lockout On   |
| MA         | U6(5)  | L = Enable Strobe to Function Select Latch U34 and Select Bit on Module Strobe Code  |
| MB         | U6(6)  | L = Enable Strobe to Time Base Select Latch U28 and Select Bit on Module Strobe Code |
| MLT        | U32(6) | H = Make Multiple Measurements   |
| MS         | U29(3) | H = Module Strobe L = FC & TB Strobe   |
| OVFL       | U32(4) | L = Overflow   |
| ODV        | U32(7) | L = Wait until Addressed   |
| RDF        | U32(9) | H = Read Data on the fly   |
| REN        | U8(4)  | L = Remote Enabled   |
| RFD        | U8(9)  | H = Ready for Data   |
| RMT        |        | H = Option 011 in Remote   |
| S          | U32(1) | H = Measurement has dimension of time  |
| SP         | U32(1) | H = Serial Pole Active   |
| SRQ        | U6(3)  | L = Service Request  |
| SWL        | U8(6)  | H = Switch to Local  |
| TALK A     | U6(2)  | L = Talk Always  |
| TLK        | U26(5) | H = Address to Talk  |

Table 5-9. 5328A A15 Qualifiers and Signal Mnemonics (Continued)

| OUTPUTS |        |  |
|---------|--------|--|
| Signal  | Source | 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 use 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 for Data  |
| LDAC    |        | 5328A says Data not Accepted   |
| HDAC    |        | 5328A says Data Accepted   |
| LLO     |        | Local Lockout Off  |
| HLLO    |        | 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 HDDIS  |
| 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<br>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  |
| AØ      |        | ASCII Ø  |
| 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   |

### 5-43. TROUBLESHOOTING INPUT CHANNELS

5-44. The main function of the input channels is to perform input signal conditioning via either local or remote control. Therefore, effective problem diagnosis is divided into two sections, local and remote. It is most efficient to assure proper local operation before remote section troubleshooting is performed. Use of the Performance Test (*Table 5-4*) will aid in determining which troubleshooting section to use.

### 5-45. Local Mode Troubleshooting

5-46. Local Mode Troubleshooting consists of the troubleshooting flowchart in Figure 5-5. These flowcharts are intended to help isolate local operation problems.

5-47. The flowchart in Figure 5-5 is intended for overall local operation troubleshooting. Table 5-10 Relay Operation shows required levels, control lines, and the relay involved for any function. *Table 5-11* Relay Control Logic shows the output line and level required for proper relay operation in a function. These tables, 5-10 and 5-11, are to be used with the Local Mode Troubleshooting Flowchart (*Figure 5-5*).

5-48. The programming interface section of the A10 Synchronizer board is used only when the 5328A is in remote. The interface is used in conjunction with the All board to control A and B channel signal conditioning. When the 5328A is in remote, addressable latches, U8 and U15, control all of the signal conditioning relays. The A11 DAC board is also used in remote to allow programming of the A and B channel trigger levels.

**Table 5-10. A12 Relay Operation**

| J-1 Pin # | Function           | J-1 PIN |     | Relay Controlled |
|-----------|--------------------|---------|-----|------------------|
|           |                    | HI      | LO  |                  |
| 2         | Channel A Slope    | —       | +   | —                |
| 5         | Channel B Slope    | —       | +   | —                |
| 6         | Channel B Atten    | X1      | X10 | K6, K11, K10     |
| 7         | Channel B Coupling | DC      | AC  | K9               |
| 10        | SEP/COM            | COM     | SEP | K4, K5           |
| 12        | Channel A Atten    | X1      | X10 | K2, K3, K8       |
| 14        | Channel A Coupling | DC      | AC  | K7               |

NOTE: Nongrounded pins on J-1 should float to TTL high.

**Table 5-11. Relay Control Logic**

| Function               | Channel A  | Channel B   |
|------------------------|--|---|
| Slope *                | A10J3 Pin 2 Low<br>A10 J3 Pin 2 High                       | A10J3 Pin 5 Low<br>A10J3 Pin 5 High                     |
| X1<br>Attn X10<br>X100 | A10J3 Pin 12 High<br>A10J3 Pin 12 Low<br>A10J3 Pin 13 High | A10J3 Pin 6 High<br>A10J3 Pin 6 Low<br>A10J3 Pin 8 High |
| Coupling AC<br>DC      | A10J3 Pin 14 Low<br>A10J3 Pin 14 High                      | A10J3 Pin 7 Low<br>A10J3 Pin 7 High                     |
| SEP, COM A             | SEP A10J3 Pin 10 Low<br>COM A A10J3 Pin 10 High            |   |

### 5-49. Remote Mode Troubleshooting

5-50. The following information includes Programming Logic Troubleshooting and DAC Troubleshooting. These areas will help isolate remote operation problems where A and B input channels operate correctly in local control.

5-51. Programming Logic Troubleshooting includes Tables 5-12 and 5-13. Table 5-12 Program Interface Operation shows the necessary levels that the A10 must generate in any function. Input and Output codes for ROM (A10U7) are contained in Table 5-13.

5-52. DAC Troubleshooting includes a checkout procedure that does not require a programming source. Table 5-14 DAC Logic Levels gives the required logic output levels for proper operation. The information in Table 5-15 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 bad.

**5-53. DAC TROUBLESHOOTING.** To perform DAC troubleshooting proceed as follows:

- a. Check +5, -5.2, +15, and -15 volts on the A1 Motherboard (refer to A1 troubleshooting procedure for repair).
- b. Check for clock signal on U5 pins 8 and 11 and on collector of Q7. If incorrect, suspect U5, Q7, or C12.
- c. Perform the following setup procedure:
  1. Turn 5328A power off and unplug 14-conductor cable from A11J1.
  2. Remove DAC board A11 from 5328A and install jumpers in J1 from pins 8 to 10, 5 to 6, 4 to 7, and 3 to 12. Reinstall All board using an extender board (05328-62016) into XA11.

**NOTE**

Ensure jumper from pin 8 to 10 does not short to any of the other jumpers.

3. Apply power to an HP 10526T Logic Pulser.
  4. Connect HP 3490A Voltmeter between A11TP5 and 5328A chassis (used to monitor Channel A DAC output).
  5. Turn 5328A power switch to ON.
- d. Pulse A11U11 (14) with the logic pulser. This resets the DAC storage registers. HP 3490 Voltmeter should display  $OV \pm 50$  mV. If so, perform step 5. If not, refer to Table 5-14 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 5-14.
  - f. Pulse A11J1(14) three more times, stopping after each pulse to verify the next line of Table 5-14.
  - g. Steps a through f have checked the A channel DAC. To check the B channel DAC change the voltmeter connection to A11TP6 and 5328A chassis. Repeat steps d through f, pulsing A11J1 pin 13 instead of pin 14. The parentheses in Table 5-14 refer to B channel DAC circuit locations.
  - h. If the A and B channel DAC output voltages were the same as in Table 5-74 the board is functioning correctly. If a digital output from Table 5-74 is incorrect, suspect the integrated circuit generating the level. If the digital outputs are correct and the analog output is incorrect continue with step i.
  - i. Reset storage registers (U16, U15, U11, U10) by pulsing A11U10(14) with a logic pulser. Using an oscilloscope check signals listed in line 1 of Table 5-15.
  - j. Pulse A11J1(14) and again using the oscilloscope check for signals in line 2 of Table 5-15.
  - k. Pulse A11J1 (14) three more times, stopping after each pulse to verify the next line in Table 5-15 with the oscilloscope.
  - l. Sets i through k have checked the A channel DAC signal path. To check Channel B DAC, follow steps i through k above, pulsing A11J1 pin 13 instead of 14. Stop after each pulse to verify the locations in parentheses of Table 5-15.
  - m. Refer to Table 5-16 match the symptom received with the probable cause of trouble.



Table 5-12. Program Interface Operation

| Code   | Function    | A10U7 Pins  | A10U8 Pins      | A10U15 Pins  | A10J3 Pins                 | A10U17<br>8 |
|--------|-------------|-------------|-----------------|--------------|----------------------------|-------------|
|        |             | 1 2 3 4 5 6 | 4 5 6 7 9 10 12 | 4 5 6 7 9 12 | 2 5 6 7 8 9 10 11 12 13 14 |             |
| A0B0   | 1 Meg       | 0 1 1 0 0 0 | 0               | 0            |                            |             |
| A3B3   | DC          | 1 0 1 0 0 0 | 1               | 1            | 1                          | 1           |
| A2B2   | AC          | 0 0 1 0 0 0 | 0               | 0            |                            |             |
| A5B5   | —           | 1 0 0 0 0 0 | 1               | 1            | 1 1                        |             |
| A4B4   | +           | 0 0 0 0 0 0 | 0               | 0            |                            |             |
| A7B7   | X1          | 1 1 0 0 0 0 | 1               | 1            | 1                          | 1           |
| A6B6   | X10         | 0 1 0 0 0 0 | 0               | 0            |                            |             |
| A1B1   | X100        | 1 1 1 0 0 0 | 1               | 1            | 1                          | 1           |
| A9B9   | Com A, Inv. | 1 0 0 1 0 0 | 1               | 1            | 1                          | 1           |
| A8B8   | Sep, Norm   | 0 0 0 1 0 0 | 0               | 0            |                            |             |
| A+1B+1 | DAC         | 1 1 1 1 0 1 | 1               | 1            |                            | 1           |
| A*B*   | NORM        | 0 1 1 1 1 0 | 0               | 0            |                            | 0           |

**NOTE**

If U7 is good and U8 is bad, check for pulse one pins 9 and 10 of U16 for all commands and pins 6 and 7 for DAC command only. Pulse will occur during execution of command.

Table 5-13. ROM (A10U7) Input/Output Code

| 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 | 0 | 1 | 1 | 0 |
| 0          | 0  | 0  | 0  | 1  | 0           | 0 | 0 | 0 | 1 | 1 | 1 |
| 0          | 0  | 0  | 1  | 0  | 0           | 0 | 0 | 0 | 1 | 0 | 0 |
| 0          | 0  | 0  | 1  | 1  | 0           | 0 | 0 | 0 | 1 | 0 | 1 |
| 0          | 0  | 1  | 0  | 0  | 0           | 0 | 0 | 0 | 0 | 0 | 0 |
| 0          | 0  | 1  | 0  | 1  | 0           | 0 | 0 | 0 | 0 | 0 | 1 |
| 0          | 0  | 1  | 1  | 0  | 0           | 0 | 0 | 0 | 0 | 1 | 0 |
| 0          | 0  | 1  | 1  | 1  | 0           | 0 | 0 | 0 | 0 | 1 | 1 |
| 0          | 1  | 0  | 0  | 0  | 0           | 0 | 0 | 1 | 0 | 0 | 0 |
| 0          | 1  | 0  | 0  | 1  | 0           | 0 | 0 | 1 | 0 | 0 | 1 |
| 0          | 1  | 0  | 1  | 0  | 0           | 0 | 1 | 1 | 1 | 1 | 0 |
| 0          | 1  | 0  | 1  | 1  | 0           | 0 | 0 | 1 | 1 | 1 | 1 |
| 0          | 1  | 1  | 0  | 0  | 0           | 0 | 0 | 1 | 0 | 1 | 0 |
| 0          | 1  | 1  | 1  | 0  | 0           | 1 | 1 | 0 | 0 | 0 | 0 |
| 0          | 1  | 1  | 1  | 1  | 0           | 0 | 0 | 1 | 0 | 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           | 1 | 0 | 0 | 0 | 0 | 0 |
| 1          | 1  | 0  | 1  | 1  | 0           | 1 | 0 | 0 | 0 | 1 | 0 |
| 1          | 1  | 1  | 0  | 0  | 0           | 1 | 0 | 0 | 0 | 1 | 1 |
| 1          | 1  | 1  | 0  | 1  | 0           | 1 | 0 | 1 | 1 | 1 | 1 |
| 1          | 1  | 1  | 1  | 0  | 0           | 1 | 0 | 1 | 0 | 1 | 0 |
| 1          | 1  | 1  | 1  | 0  | 1           | 1 | 0 | 1 | 1 | 1 | 1 |
| 1          | 1  | 1  | 1  | 1  | 0           | 1 | 1 | 0 | 0 | 0 | 0 |
| 1          | 1  | 1  | 1  | 1  | 1           | 0 | 0 | 1 | 0 | 1 | 1 |

Table 5-14. 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±.050 VDC  |
| 1 Pulse J1 Pin 14(13)  | 0                               | 1  | 0 | 0 | 0      | 0  | 0 | 0 | 0                             | 0  | 0           | -0.020±.050 VDC |
| 2 Pulses J1 Pin 14(13) | 0                               | 1  | 0 | 0 | 0      | 1  | 0 | 0 | 0                             | 0  | 0           | -0.220±.070 VDC |
| 3 Pulses J1 Pin 14(13) | 0                               | 1  | 0 | 0 | 0      | 1  | 0 | 0 | 0                             | 1  | 0           | -2.220±.070 VDC |
| 4 Pulses J1 Pin 14(13) | 0                               | 1  | 0 | 0 | 0      | 1  | 0 | 0 | 0                             | 1  | 1           | +2.22±.070 VDC  |

**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 5-15. A 11 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±0.05 VDC  |
| 1 Pulse J1 Pin 14(13)  | 10msec±4msec period pulses   | 10msec±4msec period pulses   | 10msec±4msec period pulses   | ≈+13 VDC                     | -0.02±0.05 VDC |
| 2 Pulses J1 Pin 14(13) | 1msec±0.4msec period pulses  | 1msec±0.4msec period pulses  | 1msec±0.4msec period pulses  | ≈+13 VDC                     | -0.22±0.07 VDC |
| 3 Pulses J1 Pin 14(13) | 100µsec±40µsec period pulses | 100µsec±40µsec period pulses | 100µsec±40µsec period pulses | ≈+13 VDC                     | -2.22±0.07 VDC |
| 4 Pulses J1 Pin 14(13) | 100µsec±40µsec period pulses | 100µsec±40µsec period pulses | ≈-13 VDC                     | 100µsec±40µsec period pulses | +2.22±0.07 VDC |

**NOTE**

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.

Table 5-16. 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<br>U1 for Channel B |

## 5-54. REMOVAL AND REPLACEMENT INSTRUCTIONS

5-55. Removal and replacement instructions are provided for the instrument cover, the time interval module (assemblies A10 and A19) and A16 Display Assembly.

### 5-56. Instrument Cover Removal

5-57. To remove top or bottom cover, remove the screw at the rear edge that secures cover to instrument. Slide cover toward rear of instrument and lift off. To replace cover, reverse procedure.

#### WARNING

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

### 5-58. Time Interval Module (Assemblies A10 and A19) Removal Replacement

5-59. To remove and replace the time interval module, proceed as follows:

- a. Disconnect the power cable from the 5328A (Safety Precaution).
- b. Remove rear feet and the top cover from the 5328A.
- c. Using a suitable flat-blade screwdriver as a prying tool, gently remove the plastic filler strip from the top of the 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 5328A on its side and remove the two machine screws that secure 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. Remove front panel nuts from A and B channel input connectors.
- h. Remove the A19 Switch Board with front panel attached, by gently pushing the assembly from the rear. Note that the A19 board is separate from the A10 Synchronizer Assembly during this operation.
- i. Remove the front panel from A19 by removing the MARKER OUTPUT connector nuts and removing the LEVEL A and B control knobs.
- j. Remove the A10 Synchronizer Assembly by pulling the assembly upward.
- k. Replacement is essentially the reverse of removal.

### 5-60 Display Assembly Removal and Replacement

5-61. To remove and replace the A16 Display Assembly, proceed as follows:

- a. Disconnect the power cable from the 5328A (Safety Precaution).
- b. Remove the top cover from the 5328A.
- c. Using a suitable flat-blade screwdriver as a prying tool, gently remove the plastic filler strip from the top of the 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 5328A on its side and remove the two machine screws that secure 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 module front panel.
- g. Remove the A16 Display Assembly, with front panel attached, by gently pushing the assembly from the rear. Note that the display assembly is separated from the A1 Motherboard during the operation.
- h. Using a suitable allen wrench, remove the SAMPLE RATE control knob from the module.
- i. Remove the nuts that attach the SAMPLE RATE and RESET switches and separate the front panel from the display assembly.

**NOTE**

If the FUNCTION or FREQUENCY 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 following paragraph.

- j. To realign the display switches with the proper knob positions, set the rear ceramic wafers with the slots down. Set the knob of the FUNCTION switch to FREQUENCY A and set the knob of the FREQUENCY RESOLUTION switch to  $10^2$  (10 kHz) .1 kHz position and tighten the two set screws on each knob with a suitable allen wrench.





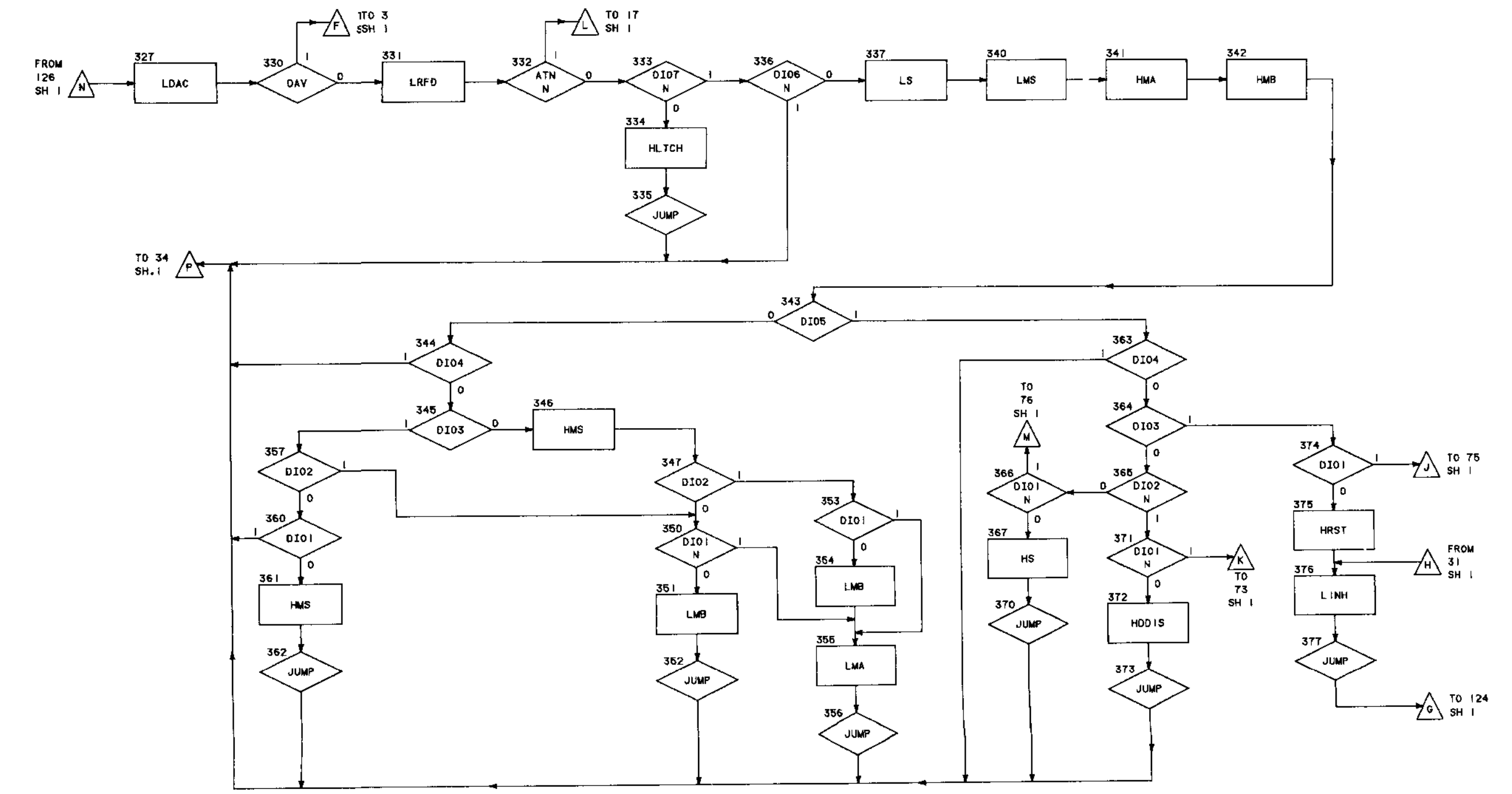
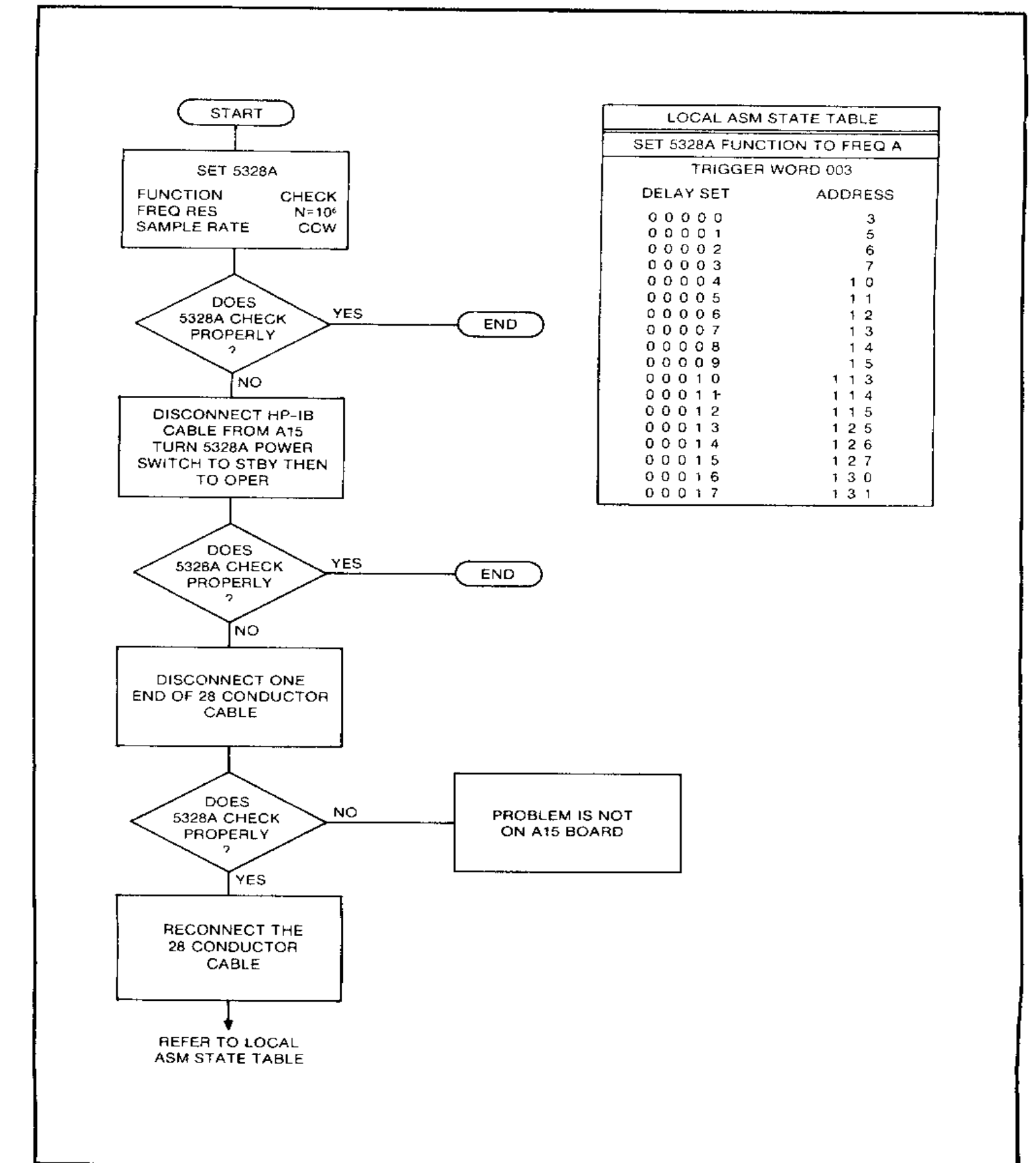


Figure 5-10. Assembly Flowchart (Sheet 3 of 3)



| LOCAL ASM STATE TABLE        |         |
|------------------------------|---------|
| SET 5328A FUNCTION TO FREQ A |         |
| TRIGGER WORD 003             |         |
| DELAY SET                    | ADDRESS |
| 0 0 0 0 0                    | 3       |
| 0 0 0 0 1                    | 5       |
| 0 0 0 0 2                    | 6       |
| 0 0 0 0 3                    | 7       |
| 0 0 0 0 4                    | 1 0     |
| 0 0 0 0 5                    | 1 1     |
| 0 0 0 0 6                    | 1 2     |
| 0 0 0 0 7                    | 1 3     |
| 0 0 0 0 8                    | 1 4     |
| 0 0 0 0 9                    | 1 5     |
| 0 0 0 1 0                    | 1 1 3   |
| 0 0 0 1 1                    | 1 1 4   |
| 0 0 0 1 2                    | 1 1 5   |
| 0 0 0 1 3                    | 1 2 5   |
| 0 0 0 1 4                    | 1 2 6   |
| 0 0 0 1 5                    | 1 2 7   |
| 0 0 0 1 6                    | 1 3 0   |
| 0 0 0 1 7                    | 1 3 1   |



OPTION 030 FREQUENCY C TROUBLESHOOTING FLOWCHART

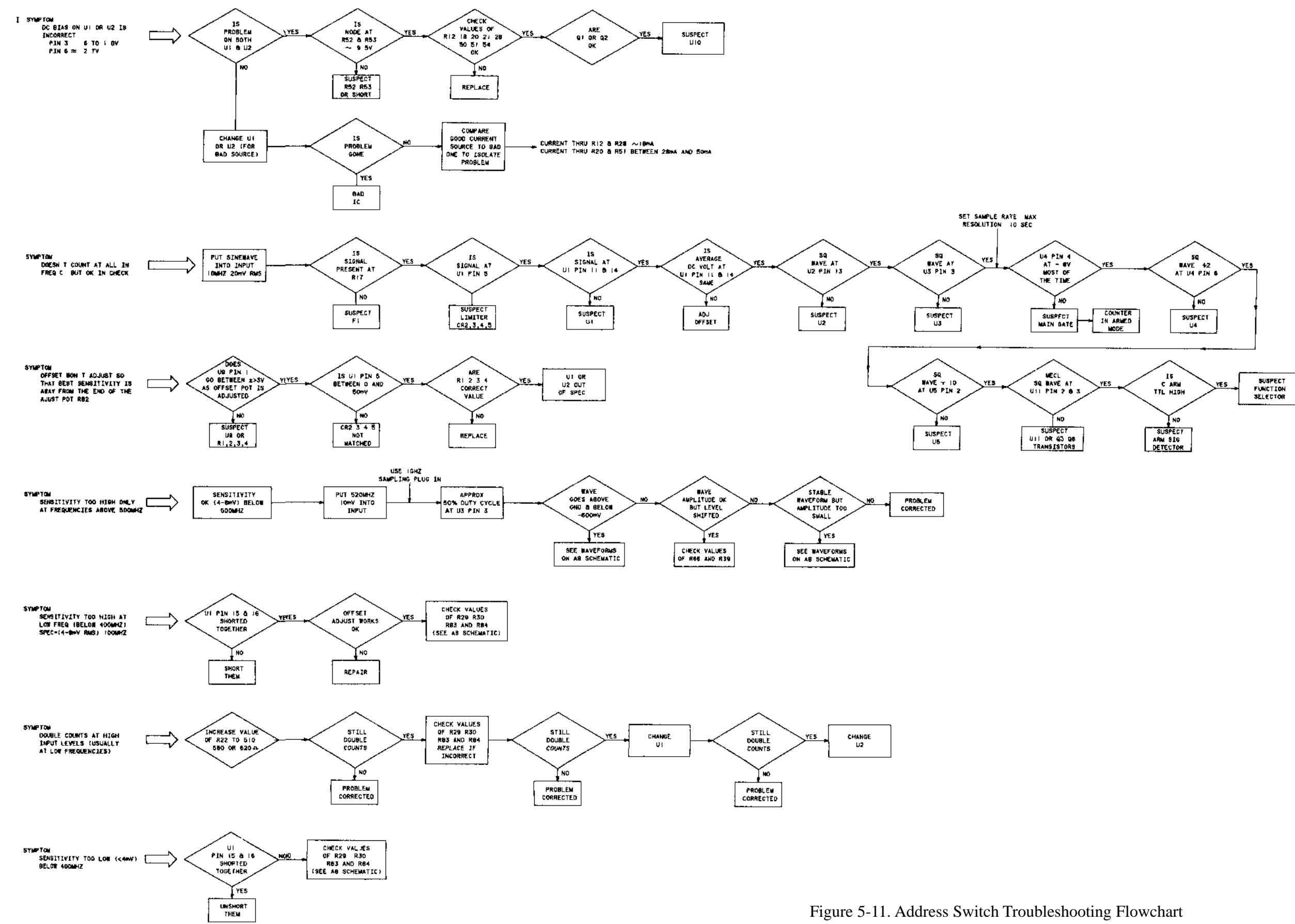
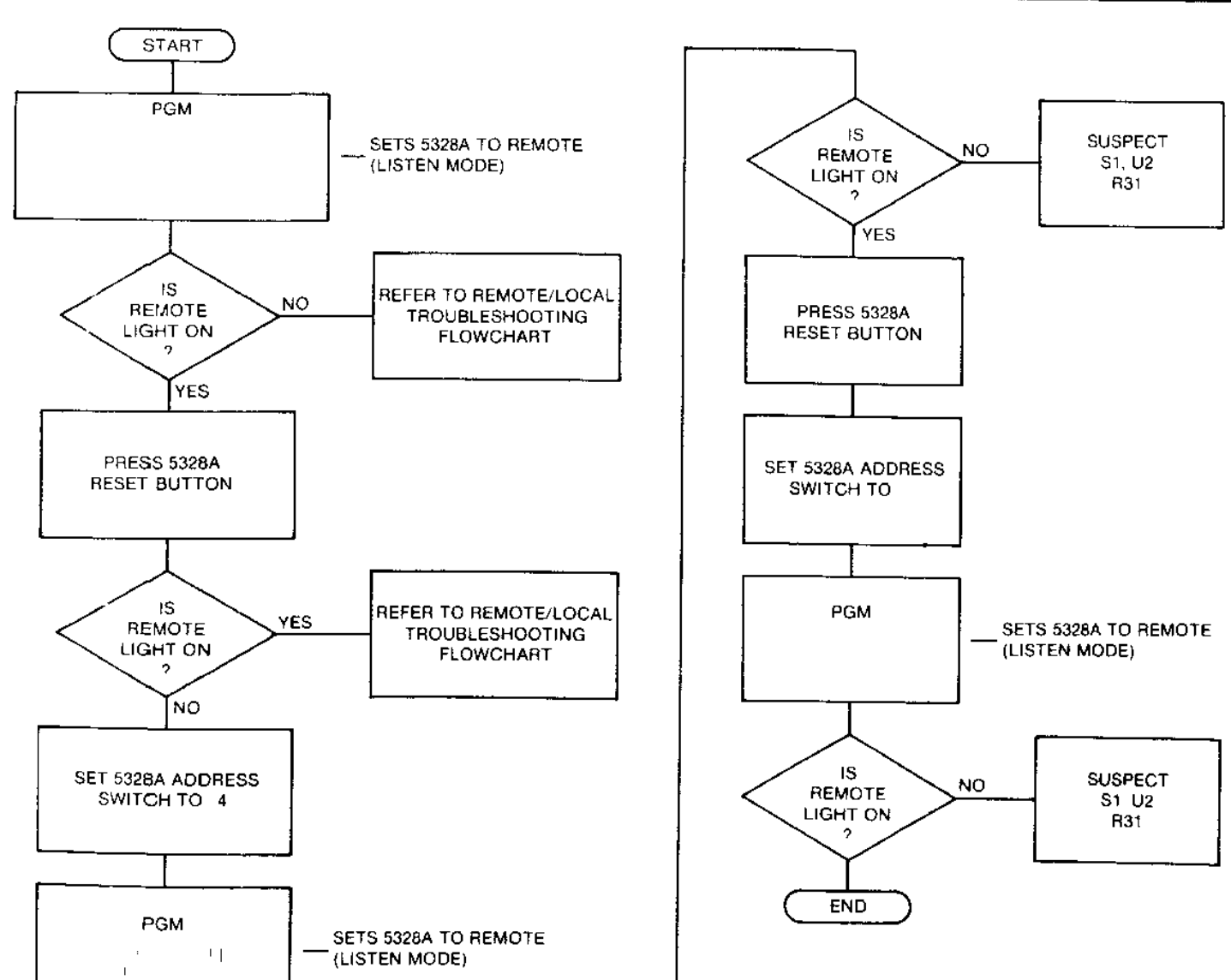


Figure 5-11. Address Switch Troubleshooting Flowchart



5-54 Figure 5-12. ADDRESS SWITCH Troubleshooting Flowchart

## SECTION VI REPLACEABLE PARTS

### 6-1. INTRODUCTION

6-2. This section contains information for ordering replacement parts. Table 6-7 lists parts in alphanumerical order of their reference designators and indicates the description and HP PART Number of each part, together with any applicable notes. The table includes the following information.

- a. Description of part (see abbreviations below).
- b. Typical manufacturer of the part in a five-digit code; see list of manufacturers Table 6-2.
- c. Manufacturer's part number.
- d. Total quantity used in the instrument (Qty column).

### 6-3. ORDERING INFORMATION

6-4. To obtain replacement parts, address order of inquiry to your local Hewlett-Packard Sales and Service Office (see lists at rear of this manual for addresses). Identify parts by their Hewlett-Packard part numbers.

- a. Instrument model number.
- b. Instrument serial number.
- c. Description of the part.
- d. Function and location of the part.

| REFERENCE DESIGNATIONS  |  |  |  |   |  |
|---|--|--|--|---|--|
| <b>A</b> = assembly<br><b>AT</b> = attenuator, isolator termination<br><b>B</b> = fan motor<br><b>BT</b> = battery<br><b>C</b> = capacitor<br><b>CP</b> = coupler<br><b>CR</b> = diode, diode thyristor, varactor<br><b>DC</b> = directional coupler<br><b>DL</b> = delay line<br><b>DS</b> = annunciator, signaling device (audible or visual), lamp, LED  | <b>E</b> = miscellaneous electrical part<br><b>F</b> = fuse<br><b>FL</b> = filter<br><b>H</b> = hardware<br><b>HY</b> = hybrid<br><b>J</b> = electrical connector (stationary portion), jack<br><b>K</b> = relay<br><b>L</b> = coil, inductor<br><b>M</b> = meter<br><b>MP</b> = miscellaneous mechanical part   | <b>O</b> = transistor, SCR, triode thyristor<br><b>R</b> = resistor<br><b>RT</b> = thermistor<br><b>S</b> = switch<br><b>T</b> = transformer<br><b>TB</b> = terminal board<br><b>TC</b> = thermocouple<br><b>TP</b> = test point<br><b>U</b> = integrated circuit, microcircuit  | <b>P</b> = electrical connector (movable portion), plug<br><b>Q</b> = transistor, SCR, triode thyristor<br><b>R</b> = resistor<br><b>RT</b> = thermistor<br><b>S</b> = switch<br><b>T</b> = transformer<br><b>TB</b> = terminal board<br><b>TC</b> = thermocouple<br><b>TP</b> = test point<br><b>U</b> = integrated circuit, microcircuit   | <b>V</b> = electron tube<br><b>VR</b> = voltage regulator, breakdown diode<br><b>W</b> = cable, transmission path, wire<br><b>X</b> = socket<br><b>Y</b> = crystal unit, piezo-electric<br><b>Z</b> = tuned cavity, tuned circuit |  |
| ABBREVIATIONS   |  |  |  |   |  |
| <b>A</b> = ampere<br><b>ac</b> = alternating current<br><b>ACCESS</b> = accessory<br><b>ADJ</b> = adjustment<br><b>A/D</b> = analog-to-digital<br><b>AF</b> = audio frequency<br><b>AFC</b> = automatic frequency control<br><b>AGC</b> = automatic gain control<br><b>AL</b> = aluminum<br><b>ALC</b> = automatic level control<br><b>AM</b> = amplitude modulation<br><b>AMPL</b> = amplifier<br><b>APC</b> = automatic phase control<br><b>ASSY</b> = assembly<br><b>AUX</b> = auxiliary<br><b>avg</b> = average<br><b>AWG</b> = american wire gauge | <b>BAL</b> = balance<br><b>BCD</b> = binary coded decimal<br><b>BD</b> = board<br><b>BE CU</b> = beryllium copper<br><b>BFO</b> = beat frequency oscillator<br><b>BH</b> = binder head<br><b>BKDN</b> = breakdown<br><b>BP</b> = bandpass<br><b>BPF</b> = bandpass filter<br><b>BRS</b> = brass<br><b>BWO</b> = backward-wave oscillator<br><b>CAL</b> = calibrate<br><b>ccw</b> = counterclockwise<br><b>CER</b> = ceramic<br><b>CHAN</b> = channel<br><b>cm</b> = centimeter<br><b>CMO</b> = coaxial | <b>COEF</b> = coefficient<br><b>COM</b> = common<br><b>COMP</b> = composition<br><b>COMPL</b> = complete<br><b>CONN</b> = connector<br><b>CP</b> = cadmium plate<br><b>CRT</b> = cathode-ray tube<br><b>CTL</b> = complementary transistor logic<br><b>CW</b> = continuous wave<br><b>cw</b> = clockwise<br><b>D/A</b> = digital-to-analog<br><b>dB</b> = decibel<br><b>dBm</b> = decibel referred to 1 mW<br><b>dc</b> = direct current<br><b>deg</b> = degree (temperature interval or difference) | <b>°C</b> = degree Celsius (centigrade)<br><b>°F</b> = degree Fahrenheit<br><b>*K</b> = degree Kelvin<br><b>DEPC</b> = deposited carbon<br><b>DET</b> = detector<br><b>diam</b> = diameter<br><b>DIA</b> = diameter (used in parts list)<br><b>DIFF</b> = differential amplifier<br><b>AMPL</b> = differential amplifier<br><b>div</b> = division<br><b>DPDT</b> = double-pole, double-throw<br><b>DR</b> = drive<br><b>DSB</b> = double sideband<br><b>DTL</b> = diode transistor logic<br><b>DVM</b> = digital voltmeter<br><b>ECL</b> = emitter coupled logic |   |  |

**ABBREVIATIONS (CONTINUED)**

|         |   |         |   |         |  |       |  |
|---------|---|---------|---|---------|--|-------|--|
| EMF     | = electromotive force                               | mH      | = millihenry  | PIN     | = positive-intrinsic-negative                | TERM  | = terminal                                       |
| EDP     | = electronic data processing                        | mho     | = mho   | PIV     | = peak inverse voltage                       | TFT   | = thin-film transistor                           |
| ELECT   | = electrolytic                                      | MIN     | = minimum   | pk      | = peak                                       | TGL   | = toggle   |
| ENCAP   | = encapsulated                                      | min     | = minute (time)   | PL      | = phase lock                                 | THD   | = thread   |
| EXT     | = external  | ...     | = minute (plane angle)                                  | PLO     | = phase lock oscillator                      | THRU  | = through  |
| F       | = farad   | MINAT   | = miniature   | PM      | = phase modulation                           | TI    | = titanium                                       |
| FET     | = field-effect transistor                           | mm      | = millimeter  | PNP     | = positive-negative-positive                 | TOL   | = tolerance                                      |
| F/F     | = flip-flop   | MOD     | = modulator   | P/O     | = part of                                    | TRIM  | = trimmer  |
| FH      | = flat head   | MOM     | = momentary   | POLY    | = polystyrene                                | TSTR  | = transistor                                     |
| FOL H   | = fillister head                                    | MOS     | = metal-oxide semiconductor                             | PORC    | = porcelain                                  | TTL   | = transistor-transistor logic                    |
| FM      | = frequency modulation                              | ms      | = millisecond   | POS     | = positive; position(s) (used in parts list) | TV    | = television                                     |
| FP      | = front panel                                       | MTG     | = mounting  | POSN    | = position                                   | TVI   | = television interference                        |
| FREQ    | = frequency   | MTR     | = meter (indicating device)                             | POT     | = potentiometer                              | TWT   | = traveling wave tube                            |
| FXD     | = fixed   | mV      | = millivolt   | p-p     | = peak-to-peak                               | U     | = micro (10 <sup>-6</sup> ) (used in parts list) |
| g       | = gram  | mVac    | = millivolt, ac   | PP      | = peak-to-peak (used in parts list)          | UF    | = microfarad (used in parts list)                |
| GE      | = germanium   | mVdc    | = millivolt, dc   | PPM     | = pulse-position modulation                  | UHF   | = ultrahigh frequency                            |
| GHz     | = gigahertz   | mVpk    | = millivolt, peak                                       | PREAMPL | = preamplifier                               | UNREG | = unregulated                                    |
| GL      | = glass   | mVp-p   | = millivolt, peak-to-peak                               | PRF     | = pulse-repetition frequency                 | V     | = volt   |
| GND     | = ground(ed)  | mVrms   | = millivolt, rms  | PRR     | = pulse repetition rate                      | VA    | = voltampere                                     |
| H       | = henry   | mW      | = milliwatt   | ps      | = picosecond                                 | Vac   | = volts ac                                       |
| h       | = hour  | MUX     | = multiplex   | PT      | = point                                      | VAR   | = variable                                       |
| HET     | = heterodyne  | MY      | = mylar   | PTM     | = pulse-time modulation                      | VCO   | = voltage-controlled oscillator                  |
| HEX     | = hexagonal   | μA      | = microampere   | PWM     | = pulse-width modulation                     | Vdc   | = volts dc                                       |
| HD      | = head  | μF      | = microfarad  | PWV     | = peak working voltage                       | VDCW  | = volts dc, working (used in parts list)         |
| HDW     | = hardware  | μH      | = microhenry  | RC      | = resistance capacitance                     | V(F)  | = volts, filtered                                |
| HF      | = high frequency                                    | μH      | = microhenry  | RECT    | = rectifier                                  | VFO   | = variable-frequency oscillator                  |
| HG      | = mercury   | μmho    | = micromho  | REF     | = reference                                  | VHF   | = very-high frequency                            |
| HI      | = high  | μs      | = microsecond   | REG     | = regulated                                  | Vpk   | = volts peak                                     |
| HP      | = Hewlett-Packard                                   | μV      | = microvolt   | REPL    | = replaceable                                | Vp-p  | = Volts peak-to-peak                             |
| HPF     | = high pass filter                                  | μVac    | = microvolt, ac   | RF      | = radio frequency                            | Vrms  | = volts rms                                      |
| HR      | = hour (used in parts list)                         | μVdc    | = microvolt, dc   | RFI     | = radio frequency interference               | VSWR  | = voltage standing wave ratio                    |
| HV      | = high voltage                                      | μVpk    | = microvolt, peak                                       | RH      | = round head; right hand                     | VTO   | = voltage-tuned oscillator                       |
| Hz      | = Hertz   | μVp-p   | = microvolt, peak-to-peak                               | RLC     | = resistance-inductance-capacitance          | VTVM  | = vacuum-tube voltmeter                          |
| IC      | = integrated circuit                                | μVrms   | = microvolt, rms  | RMO     | = rack mount only                            | V(X)  | = volts, switched                                |
| ID      | = inside diameter                                   | μW      | = microwatt   | rms     | = root-mean-square                           | W     | = watt   |
| IF      | = intermediate frequency                            | nA      | = nanoampere  | RND     | = round                                      | W/    | = with   |
| IMPG    | = impregnated                                       | NC      | = no connection   | ROM     | = read-only memory                           | WIV   | = working inverse voltage                        |
| in      | = inch  | N/C     | = normally closed                                       | R&P     | = rack and panel                             | WW    | = wirewound                                      |
| INCD    | = incandescent                                      | NE      | = neon  | RWV     | = reverse working voltage                    | W/O   | = without  |
| INCL    | = include(s)  | NEG     | = negative  | S       | = scattering parameter                       | YIG   | = yttrium-iron-garnet                            |
| INP     | = input   | nF      | = nanofarad   | s       | = second (time)                              | Zo    | = characteristic impedance                       |
| INS     | = insulation  | NI PL   | = nickel plate  | ...     | = second (plane angle)                       |       |  |
| INT     | = internal  | N/O     | = normally open   | S-B     | = slow-blow (fuse (used in parts list)       |       |  |
| kg      | = kilogram  | NOM     | = nominal   | SCR     | = silicon controlled rectifier, screw        |       |  |
| kHz     | = kilohertz   | NORM    | = normal  | SE      | = selenium                                   |       |  |
| kΩ      | = kilohm  | NPN     | = negative-positive-negative                            | SECT    | = sections                                   |       |  |
| kV      | = kilovolt  | NPO     | = negative-positive zero (zero temperature coefficient) | SEMICON | = semiconductor                              |       |  |
| lb      | = pound   | NRFR    | = not recommended for field replacement                 | SHF     | = superhigh frequency                        |       |  |
| LC      | = inductance-capacitance                            | NSR     | = not separately replaceable                            | SI      | = silicon                                    |       |  |
| LED     | = light-emitting diode                              | ns      | = nanosecond  | SIL     | = silver                                     |       |  |
| LF      | = low frequency                                     | nW      | = nanowatt  | SL      | = slide                                      |       |  |
| LG      | = long  | OBD     | = order by description                                  | SNR     | = signal-to-noise ratio                      |       |  |
| LH      | = left hand   | OD      | = outside diameter                                      | SPDT    | = single-pole, double-throw                  |       |  |
| LIM     | = limit   | OH      | = oval head   | SPG     | = spring                                     |       |  |
| LIN     | = linear taper (used in parts list)                 | OP AMPL | = operational amplifier                                 | SR      | = split ring                                 |       |  |
| lin     | = linear  | OPT     | = option  | SPST    | = single-pole, single-throw                  |       |  |
| LK WASH | = lockwasher  | OSC     | = oscillator  | SSB     | = single sideband                            |       |  |
| LO      | = low, local oscillator                             | OX      | = oxide   | STL     | = stainless steel                            |       |  |
| LOG     | = logarithmic taper (used in parts list)            | oz      | = ounce   | SQ      | = square                                     |       |  |
| log     | = logarithm(ic)                                     | Ω       | = ohm   | SWR     | = standing-wave ratio                        |       |  |
| LPF     | = low pass filter                                   | P       | = peak (used in parts list)                             | SYNC    | = synchronize                                |       |  |
| LV      | = low voltage                                       | PAM     | = pulse-amplitude modulation                            | T       | = timed (slow-blow fuse)                     |       |  |
| m       | = meter (distance)                                  | PC      | = printed circuit                                       | TA      | = tantalum                                   |       |  |
| mA      | = milliampere                                       | PCM     | = pulse-code modulation, pulse-count modulation         | TC      | = temperature compensating                   |       |  |
| MAX     | = maximum   | PDM     | = pulse-duration modulation                             | TD      | = time delay                                 |       |  |
| MΩ      | = megohm  | pF      | = picofarad   |         |  |       |  |
| MEG     | = meg (10 <sup>6</sup> ) (used in parts list)       | PH BRZ  | = phosphor bronze                                       |         |  |       |  |
| MET FLM | = metal film  | PHL     | = Phillips  |         |  |       |  |
| MET OX  | = metal oxide                                       |         |   |         |  |       |  |
| MF      | = medium frequency, microfarad (used in parts list) |         |   |         |  |       |  |
| MFR     | = manufacturer                                      |         |   |         |  |       |  |
| mg      | = milligram   |         |   |         |  |       |  |
| MHz     | = megahertz   |         |   |         |  |       |  |

**NOTE**

All abbreviations in the parts list will be in upper case

**MULTIPLIERS**

| Abbreviation | Prefix | Multiple          |
|--------------|--------|-------------------|
| T            | tera   | 10 <sup>12</sup>  |
| G            | giga   | 10 <sup>9</sup>   |
| M            | mega   | 10 <sup>6</sup>   |
| k            | kilo   | 10 <sup>3</sup>   |
| da           | deka   | 10                |
| d            | deci   | 10 <sup>-1</sup>  |
| c            | centi  | 10 <sup>-2</sup>  |
| m            | milli  | 10 <sup>-3</sup>  |
| μ            | micro  | 10 <sup>-6</sup>  |
| n            | nano   | 10 <sup>-9</sup>  |
| p            | pico   | 10 <sup>-12</sup> |
| f            | femto  | 10 <sup>-15</sup> |
| a            | atto   | 10 <sup>-18</sup> |

## 6-5. HP PART NUMBER ORGANIZATION

6-6. Following is a general description of the HP part number system.

### 6-7. Component Parts and Materials

6-8. Generally, the prefix of HP part numbers identifies the type of device. Eight digit part numbers are used, where the four-digit prefix identifies the type of component, part, or material and the four-digit suffix indicates the specific type. Following is a list of some of the more commonly used prefixes for component parts. The list includes HP manufactured parts and purchased parts.

| Prefix           | Component/Part/Material                                |
|------------------|--|
| 0121-            | Capacitors, Variable (mechanical)                      |
| 0122-            | Capacitors, Voltage Variable (semiconductor)           |
| 0140-            | Capacitors, Fixed                                      |
| 0150-            | Capacitors, Fixed Non-Electrolytic                     |
| 0160-            | Capacitors, Fixed                                      |
| 0180-            | Capacitors, Fixed Electrolytic                         |
| 0330-            | Insulating Materials                                   |
| 0340-            | Insulators, Formed                                     |
| 0370-            | Knobs, Control   |
| 0380-            | Spacers and Standoffs                                  |
| 0410-            | Crystals   |
| 0470-            | Adhesives  |
| 0490-            | Relays   |
| 0510-            | Fasteners  |
| 0674- thru 0778- | Resistors, Fixed (non wire wound)                      |
| 0811- thru 0831- | Resistors (wire wound)                                 |
| 1200-            | Sockets for components                                 |
| 1205-            | Heat Sinks   |
| 1250-            | Connectors (RF and related parts)                      |
| 1251-            | Connectors (non RF and related parts)                  |
| 1410-            | Bearings and Bushings                                  |
| 1420-            | Batteries  |
| 1820-            | Monolithic Digital Integrated Circuits                 |
| 1826-            | Monolithic Linear Integrated Circuits                  |
| 1850-            | Transistors, Germanium PNP                             |
| 1851-            | Transistors, Germanium NPN                             |
| 1853-            | Transistors, Silicon PNP                               |
| 1854-            | Transistors, Silicon NPN                               |
| 1855-            | Field-Effect-Transistors                               |
| 1900- thru 1912- | Diodes   |
| 1920- thru 1952- | Vacuum Tubes   |
| 1990-            | Semiconductor Photosensitive and Light-Emitting Diodes |
| 3100- thru 3106- | Switches   |
| 8120-            | Cables   |
| 9100             | Transformers, Coils, Chokes, Inductors, and Filters    |

6-9. For example, 1854-0037, 1854-0221, and 1851-0192 are all NPN transistors. The first two are silicon and the last is germanium.

### **6-10. General Usage Parts**

6-11. The following list gives the prefixes for HP manufactured parts used in several instruments, e.g., side frames, feet, top and bottom covers, etc. These are eight-digit part numbers with the four-digit prefix identifying the type of parts as shown below:

| <b>Type of Part</b> | <b>Prefix</b>  |
|---------------------|----------------|
| Sheet Metal         | 5000- to 5019- |
| Machined            | 5020- to 5039- |
| Molded              | 5040- to 5059- |
| Assemblies          | 5060- to 5079- |
| Components          | 5080- to 5099- |

### **6-12. Specific Instrument Parts**

6-13. These are HP manufactured parts for use in individual instruments or series of instruments. For these parts, the prefix indicates the instrument and the suffix indicates the type of parts. For example, 05328-60001 is an assembly used in the 5328A. Following is a list of suffixes commonly used.

| <b>Type of Part</b> | <b>P/N Suffix</b> |
|---------------------|-------------------|
| Sheet Metal         | -00000 to -00499  |
| Machined            | -20000 to -20499  |
| Molded              | -40000 to -40499  |
| Assemblies          | -60000 to -60499  |
| Components          | -80000 to -80299  |
| Documentation       | -90000 to -90249  |

### **6-14. FACTORY SELECTED PARTS**

6-15. Some of the values in the parts lists are selected during manufacture to meet circuit requirements. These parts are marked with an asterisk (\*) in the parts list and schematic diagrams, with average values shown.

### **6-16. PART NUMBER TO NATIONAL STOCK NUMBER CROSS REFERENCE INDEX**

6-17. Refer to Table 6-3 to cross reference part numbers to National Stock Numbers.

MODEL 5328A  
REPLACEABLE PARTS

TABLE 6-1. REPLACEABLE PARTS

| REFERENCE DESIGNATION | HP PART NUMBER | QTY | DESCRIPTION | MFR CODE   | MFR PART NUMBER          |
|-----------------------|----------------|-----|-------------|--|--------------------------|
| A1                    | 05328-60028    | 9   | 1           | MOTHER (MAIN) BOARD, SERIES 1804                                 | 28480 05328-60028        |
| A1C1                  |                |     |             | NOT ASSIGNED   |                          |
| A1C2                  |                |     |             | NOT ASSIGNED   |                          |
| A1C3                  | 0180-1735      | 2   | 1           | CAPACITOR-FXD .22UF+-10% 35VDC TA                                | 56389 150D224X9035A2     |
| A1C4                  | 0160-0161      | 4   | 1           | CAPACITOR-FXD .01UF +-10% 200VDC POLYE                           | 28480 0160-0161          |
| A1C5*                 | 0180-0106      | 9   | 2           | CAPACITOR-FXD 60UF+-20% 6VDC TA<br>*FACTORY SELECTED PART        | 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                  | 0180-0230      | 0   | 3           | CAPACITOR-FXD 1UF+-20% 50VDC TA                                  | 56289 150D105X0050A2     |
| A1C10                 | 0160-0314      | 9   | 1           | CAPACITOR-FXD .01UF +-5% 100VDC POLYE                            | 84411 663UW10354W2       |
| A1C29                 | 0180-0230      | 0   |             | CAPACITOR-FXD 1UF+-20% 50VDC TA                                  | 56289 150D105X0050A2     |
| A1C30                 | 0160-0153      | 4   | 2           | CAPACITOR-FXD 1000PF +-10% 200VDC POLYE                          | 28480 0160-0153          |
| A1C31                 | 0180-0230      | 0   |             | CAPACITOR-FXD 1UF+-20% 50VDC TA                                  | 56289 150D105X0050A2     |
| A1C32                 | 0180-0106      | 9   |             | CAPACITOR-FXD 6UF+-20% 6VDC TA                                   | 56289 150D606X0006B2     |
| A1C33                 | 0160-2055      | 9   | 17          | CAPACITOR-FXD .01UF +80-20% 100VDC CER                           | 28480 0160-2055          |
| A1C34                 | 0180-0210      | 6   | 6           | CAPACITOR-FXD 3.3UF+-20% 15VDC TA                                | 56289 150D335X0015A2     |
| A1C35                 | 0160-2055      | 9   |             | CAPACITOR-FXD .01UF +80-20% 100VDC CER                           | 28480 0160-2055          |
| A1C36                 | 0180-0210      | 6   |             | CAPACITOR-FXD 3.3UF+-20% 15VDC TA                                | 56289 150D335X0015A2     |
| A1C37                 | 0160-2055      | 9   |             | CAPACITOR-FXD .01UF +80-20% 100VDC CER                           | 28480 0160-2055          |
| A1C39                 | 0160-2055      | 9   |             | CAPACITOR-FXD .01UF +80-20% 100VDC CER                           | 28480 0160-2055          |
| A1C40                 | 0180-0155      | 8   | 6           | CAPACITOR-FXD 2.2UF+-20% 20VDC TA                                | 56289 150D225X0020A2     |
| A1C41                 | 0160-2055      | 9   |             | CAPACITOR-FXD .01UF +80-20% 100VDC CER                           | 28480 0160-2055          |
| A1C42                 | 0180-0155      | 8   |             | CAPACITOR-FXD 2.2UF+-20% 20VDC TA                                | 56289 150D225X0020A2     |
| A1C43                 | 0160-2055      | 9   |             | CAPACITOR-FXD .01UF +80-20% 100VDC CER                           | 28480 0160-2055          |
| A1C44                 | 0160-2055      | 9   |             | CAPACITOR-FXD .01UF +80-20% 100VDC CER                           | 28480 0160-2055          |
| 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                 |                |     |             | NOT ASSIGNED   |                          |
| 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                 |                |     |             | NOT ASSIGNED   |                          |
| A1C51                 |                |     |             | NOT ASSIGNED   |                          |
| 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   | 13          | DIODE-SWITCHING 30V 50MA 2NS DO-35                               | 28480 1901-0040          |
| A1CR3                 | 1910-0016      | 0   | 2           | DIODE-GE 60V 60MA 1US DO-7                                       | 28480 1910-0016          |
| A1CR4                 | 1902-0031      | 2   | 1           | DIODE-ZNR 12.7V 5% DO-7 PD=.4W TC=+.061%                         | 28480 1902-0031          |
| A1CR5                 | 1901-0050      | 3   | 2           | 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                 | 1901-0040      | 1   |             | DIODE-SWITCHING 30V 50MA 2NS DO-35                               | 28480 1901-0040          |
| A1CR8                 | 1902-3082      | 9   | 1           | DIODE-ZNR 4.64V 5% DO-7 PD=.4W TC=.23%                           | 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                | 1910-0016      | 0   |             | DIODE-GE 60V 60MA 1US DO-7                                       | 28480 1910-0016          |
| A1CR16                | 1901-0040      | 1   |             | DIODE-SWITCHING 30V 50MA 2NS DO-35                               | 28480 1901-0040          |
| A1Q1                  | 1854-0071      | 7   | 5           | TRANSISTOR NPN SI PD=300MW FT=200MHZ                             | 28480 1854-0071          |
| A1Q4                  | 1854-0071      | 7   |             | TRANSISTOR NPN SI PD=300MW FT=200MHZ                             | 28480 1854-0071          |
| A1Q5                  | 1854-0071      | 7   |             | TRANSISTOR NPN PD=300MW FT=200MHZ                                | 28480 1854-0071          |
| A1Q6                  | 1854-0092      | 2   | 1           | TRANSISTOR NPN SI PF=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          |
| A1R1                  | 0683-2715      | 6   | 7           | RESISTOR 270 5% .25W FC TC=-400/+600                             | 01121 CB2715             |
| A1R2                  | 1810-0055      | 5   | 5           | NETWORK-RES 9-PIN-SIP .15-PIN-SPCG                               | 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<br>*FACTORY SELECTED PART | 01121 CB3355             |
| A1R5                  | 1810-0055      | 5   |             | NETWORK-RES 9-PIN-SIP .15-PIN-SPCG                               | 28480 1810-0055          |
| A1R6                  | 0683-3315      | 4   | 2           | RESISTOR 330 5% .25W FC TC=-400/+600                             | 01121 CB3315             |
| A1R7                  | 0683-1035      | 1   | 23          | RESISTOR 10K 5% .25W FC TC=-400/+700                             | 01121 CB1035             |
| A1R8                  | 0683-4725      | 2   | 5           | RESISTOR 4.7K 5% .25W FC TC=-400/+700                            | 01121 CB4725             |
| A1R9                  | 0683-1525      | 4   | 1           | RESISTOR 1.5K 5% .25W FC TC=-400/+700                            | 01121 CB1525             |
| A1R10                 | 0683-1025      | 9   | 21          | 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             |

SEE INTRODUCTION TO THIS SECTION FOR ORDERING INFORMATION

MODEL 5328A  
REPLACEABLE PARTS

TABLE 6-1. REPLACEABLE PARTS (CONTINUED)

| REFERENCE DESIGNATION  | HP PART NUMBER | QTY | DESCRIPTION                            | MFR CODE | MFR PART NUMBER  |
|------------------------|----------------|-----|--|----------|------------------|
| AlR15                  | 1810-0041      | 9   | NETWORK-RES 9-PIN-SIP .15-PIN-SPCG     | 28480    | 1810-0041        |
| AlR16                  | 0683-1025      | 9   | RESISTOR 1K 5% .25W FC TC=-400/+600    | 01121    | CB1025           |
| AlR17                  | 0683-1035      | 1   | RESISTOR 10K 5% .25W FC TC=-400/+700   | 01121    | CB1035           |
| AlR19                  | 1810-0055      | 5   | NETWORK-RES 9-PIN-SIP .15-PIN-SPCG     | 28480    | 1810-0055        |
| AlR23                  | 0683-2015      | 9   | RESISTOR 200 5% .25W FC TC=-400/+600   | 01121    | CB2015           |
| AlR27                  | 0757-0928      | 6   | RESISTOR 1.5K 2% .125W F TC=0+-100     | 24546    | C4-1/8-T0-1501-G |
| AlR28                  | 1810-0055      | 5   | NETWORK-RES 9-ON-SIP .15-PIN-SPCG      | 28480    | 1810-0055        |
| AlR29                  | 0757-0952      | 6   | RESISTOR 15K 2% .125W F TC=0+-100      | 24546    | C4-1/8-T0-1502-G |
| AlR30                  | 0683-1035      | 1   | RESISTOR 10K 5% .25W FC TC=-400/+700   | 01121    | CB1035           |
| AlR32                  | 0683-1035      | 1   | RESISTOR 10K 5% .25W FC TC=-400/+700   | 01121    | CB1035           |
| AlR33                  | 0683-1035      | 1   | RESISOTOR 10K 5% .25W TC=-400/+700     | 01121    | CB1035           |
| AlR34                  | 0683-2715      | 6   | RESISTOR 270 5% .25W FC TC=-400/+600   | 01121    | CB2715           |
| AlR35                  | 0683-5115      | 6   | RESISTOR 510 5% .25W FC TC=-400/+600   | 01121    | CB5115           |
| AlR36                  | 0683-1035      | 1   | RESISTOR 10K 5% .25W FC TC=-400/+700   | 01121    | CB1035           |
| AlR37                  | 0683-2715      | 6   | RESISTOR 270 5% .25W FC TC=-400/+600   | 01121    | CB2715           |
| AlR38                  | 0683-1035      | 1   | RESISTOR 10K 5% .25W FC TC=-400/+700   | 01121    | CB1035           |
| AlR39                  | 0683-1035      | 1   | RESISTOR 10K 5% .25W FC TC=-400/+700   | 01121    | CB1035           |
| AlR40                  | 0683-1035      | 1   | RESISTOR 10K 5% .25W FC TC=-400/+700   | 01121    | CB1035           |
| AlR41                  | 0683-1035      | 1   | RESISTOR 10K 5% .25W FC TC=-400/+700   | 01121    | CB1035           |
| AlR42                  | 1810-0055      | 5   | NETWORK-RES 9-PIN-SIP .15-PIN-SPCG     | 28480    | 1810-0055        |
| AlR43                  | 0683-1025      | 9   | RESISTOR 1K 5% .25W FC TC=-400/+600    | 01121    | CB1025           |
| AlR44                  | 0683-1035      | 1   | RESISTOR 10K 5% .25W FC TC=-400/+700   | 01121    | CB1035           |
| AlR45                  | 0683-1035      | 1   | RESISTOR 10K 5% .25W FC TC=-400/+700   | 01121    | CB1035           |
| AlR46                  | 0683-1545      | 8   | RESISTOR 150K 5% .25W FC TC=-800/+900  | 01121    | CB1545           |
| AlR48                  | 0683-1035      | 1   | RESISTOR 10K 5% .25W FC TC=-400/+700   | 01121    | CB1035           |
| AlR52                  | 0683-5635      | 5   | RESISOTR 56K 5% .25W FC TC=-400/+800   | 01121    | CB5635           |
| AlR55                  | 0683-1025      | 9   | RESISTOR 1K 5% .25W FC TC=-400/+600    | 01121    | CB1025           |
| AlR56                  | 0683-4725      | 2   | RESISTOR 4.7K 5% .25W FC TC=-400/+700  | 01121    | CB4725           |
| AlR57                  | 0683-6815      | 5   | RESISTOR 680 5% .25W FC TC=-400/+600   | 01121    | CB6815           |
| AlR58                  | 0683-1025      | 9   | RESISTOR 1K 5% .25W FC TC=-400/+600    | 01121    | CB1025           |
| AlR59                  | 0683-5605      | 9   | RESISTOR 56 5% .25W FC TC=-400/+500    | 01121    | CB5605           |
| AlR60                  | 0683-5605      | 9   | RESISTOR 56 5% .25W FC TC=-400/+500    | 01121    | CB5605           |
| AlR61                  | 0683-5605      | 9   | RESISTOR 56 5% .25W FC TC=-400/+500    | 01121    | CB5605           |
| AlR62                  | 0683-5605      | 9   | RESISTOR 56 5% .25W FC TC=-400/+500    | 01121    | CB5605           |
| AlR63                  | 0683-5605      | 9   | RESISTOR 56 5% .25W FC TC=-400/+500    | 01121    | CB5605           |
| AlR64                  | 0683-5605      | 9   | RESISTOR 56 5% .25W FC TC=-400/+500    | 01121    | CB5605           |
| AlR65                  | 0683-5605      | 9   | RESISTOR 56 5% .25W FC TC=-400/+500    | 01121    | CB5605           |
| AlR66                  | 0683-5605      | 9   | RESISTOR 56 5% .25W FC TC=-400/+500    | 01121    | CB5605           |
| AlR67                  | 0683-5605      | 9   | RESISTOR 56 5% .25W FC TC=-400/+500    | 01121    | CB5605           |
| AlR68                  | 0683-1035      | 1   | RESISTOR 10K 5% .25W FC TC=-400/+700   | 01121    | CB1035           |
| AlR69                  | 0757-0938      | 8   | RESISTOR 3.9K 2% .125W F TC=0+-100     | 24546    | C4-1/8-T0-3901-G |
| AlR70                  | 0757-0950      | 4   | RESISTOR 12K 2% .125W F TC=0+-100      | 24546    | C4-1/8-T0-1202-G |
| AlR71                  | 0757-0279      | 0   | RESISTOR 3.16K 1% .125W F TC=0+-100    | 24546    | C4-1/8-T0-3161-F |
| AlR72                  | 0757-0931      | 1   | RESISTOR 2K 2% .125W F TC=0+-100       | 24546    | C4-1/8-T0-2001-G |
| AlR73                  | 0683-1035      | 1   | RESISTOR 10K 5% .25W FC TC=-400/+700   | 01121    | CB1035           |
| AlR74                  | 0683-1035      | 1   | RESISTOR 10K 5% .25W FC TC=-400/+700   | 01121    | CB1035           |
| AlR75                  | 0683-1035      | 1   | RESISTOR 10K 5% .25W FC TC=-400/+700   | 01121    | CB1035           |
| AlR78                  | 0683-4315      | 6   | RESISTOR 430 5% .25W FC TC=-400/+700   | 01121    | CB4315           |
| AlR80                  | 0683-1035      | 1   | RESISTOR 10K 5% .25W FC TC=-400/+700   | 01121    | CB1035           |
| AlS1                   |                |     | NOT ASSIGNED                           |          |                  |
| AlS2                   |                |     | NOT ASSIGNED                           |          |                  |
| AlS3                   | 3101-1977      | 1   | SWITCH-SL DPDT-NS SUBMIN .5A 125VAC PC | 28480    | 3101-1977        |
| AlU1                   | 1820-0055      | 6   | IC CNTR TTL DECD SYNCHRO POS-EDGE-TRIG | 01295    | SN7490AN         |
| AlU2                   | 1820-1056      | 9   | IC SCHMITT-TRIG TTL NAND QUAD 2-INP    | 01295    | SN74132N         |
| AlU3                   | 1820-0175      | 1   | IC INV TTL HEX 1-INP                   | 01295    | SN7405N          |
| AlU4*                  | 1820-0632      | 5   | IC MISC                                | 28480    | 1820-0632        |
| *FACTORY SELECTED PART |                |     |  |          |                  |
| AlU5                   | 1820-0513      | 1   | IC GATE TTL AND QUAD 2-INP             | 01295    | SN7409N          |
| AlU6                   | 1820-0282      | 1   | IC GATE TTL EXCL-OR QUAD 2-INP         | 01295    | SN7486N          |
| AlU7                   | 1820-0511      | 9   | IC GATE TTL AND QUAD 2-INP             | 01295    | SN7408N          |
| AlU8                   | 1820-0174      | 0   | IC INV TTL HEX 1-INP                   | 01295    | SN7404N          |
| AlU9                   | 1820-0661      | 0   | IC GATE TTL OR QUAD 2-INP              | 01295    | SN7432N          |
| AlU10                  | 1820-1143      | 5   | IC CNTR TTL DECD SYNCHRO               | 27014    | DM8552N          |
| AlU11                  | 1820-0301      | 5   | IC LCH TTL D-TYPE 4-BIT                | 01295    | SN7475N          |
| AlU12                  | 1820-0634      | 7   | IC CNTR MOD DECD                       | 28480    | 1820-0634        |
| AlU13                  | 1820-0269      | 4   | IC GATE TTL NAND QUAD 2-INP            | 01295    | SN7403N          |
| AlU14                  | 1820-0513      | 1   | IC GATE TTL AND QUAD 2-INP             | 01295    | SN7409N          |
| AlU16                  | 1820-0537      | 9   | IC SCHMITT-TRIG TTL NAND DUAL 4-INP    | 01295    | SN7413N          |
| AlU17                  | 1820-0068      | 1   | IC GATE TTL NAND TPL 3-INP             | 01295    | SN74010N         |
| AlU18                  | 1820-0174      | 0   | IC INV TTL HEX 1-INP                   | 01295    | SN7404N          |
| AlU19                  | 1820-0077      | 2   | IC FF TTL D-TYPE POS-EDGE-TRIG CLEAR   | 01295    | SN7474N          |
| AlU20                  | 1820-0055      | 6   | IC CNTR DECD SYNCHRO POS-EDGE-TRIG     | 01295    | SN7490AN         |
| AlU21                  | 1820-0633      | 6   | IC MISC                                | 28480    | 1820-0633        |
| AlU22                  | 1820-0269      | 4   | IC GATE TTL NAND QUAD 2-INP            | 01295    | SN7403N          |
| AlU23                  | 1820-0328      | 6   | IC GATE TTL NOR QUAD 2-INP             | 01295    | SN7402N          |
| AlU24                  | 1820-0282      | 1   | IC GATE TTL EXCL-OR QUAD 2-INP         | 01295    | SN7486N          |
| AlU25                  | 1820-0301      | 5   | IC LCH TTL D-TYPE 4-BIT                | 01295    | SN7475N          |

SEE INTRODUCTION TO THIS SECTION FOR ORDERING INFORMATION



MODEL 5328A  
REPLACEABLE PARTS

TABLE 6-1. REPLACEABLE PARTS (CONTINUED)

| REFERENCE DESIGNATION                              | HP PART NUMBER | 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   | 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 1-INP           | 01295    | SN7404N              |
| A1U34  | 1820-0174      | 0   | IC INV TTL HEX 1-INP           | 01295    | SN7404N              |
| A1U35  | 1820-0174      | 0   | IC INV TTL HEX 1-INP           | 01295    | SN7404N              |
| A1U36  | 1820-0174      | 0   | IC INV TTL HEX 1-INP           | 01295    | SN7404N              |
| A1U37  | 1816-2251      | 9   | 1                              | 28480    | 1816-2251            |
| A1U38  | 1820-0661      | 0   | IC GATE TTL OR QUAD 2-INP      | 01295    | SN7432N              |
| A1U39  | 1820-0214      | 9   | 1                              | 02395    | SN7442N              |
| A1U40  | 1820-0054      | 5   | 1                              | 01295    | SN7400N              |
| A1U41  | 1820-0914      | 6   | 1                              | 047513   | MC8307P              |
| A1XU4  | 1200-0525      | 1   | 1                              | 28480    | 1200-0525            |
| A1XU12   | 1200-0473      | 8   | 2                              | 28480    | 1200-0473            |
| A1XU21   | 1200-0473      | 8   | 2                              | 28480    | 1200-0473            |
| A1 MISCELLANEOUS                                   |                |     |                                |          |                      |
|  | 0360-0124      | 3   | 2                              | 28480    | 0360-0124            |
|  | 0380-0640      | 0   | 1                              | 0000     | ORDER BY DESCRIPTION |
|  | 1200-0549      | 9   | 4                              | 28480    | 1200-0549            |
|  | 1251-2026      | 8   | 1                              | 28480    | 1251-2026            |
|  | 1251-2035      | 9   | 2                              | 28480    | 1251-2035            |
|  | 8159-0003      | 0   | 2                              | 28480    | 8159-0005            |
| A2   | 05328-60035    | 8   | 1                              | 28480    | 05328-60035          |
| ASSEMBLY, POWER SUPPLY (SERIES 1808)<br>OPTION 096 |                |     |                                |          |                      |
| A2C1   | 0180-2842      | 4   | 2                              | 28480    | 0180-2842            |
| A2C2   | 0180-2842      | 4   | 2                              | 28480    | 0180-2842            |
| A2C3#  | 0160-0576      | 5   | 7                              | 28480    | 0160-0576            |
| # ADDED IF NEEDED, NOT IN ALL INSTRUMENTS          |                |     |                                |          |                      |
| A2C4#  | 0160-0576      | 5   | 5                              | 28480    | 0160-0576            |
| # ADDED IF NEEDED, NOT IN ALL INSTRUMENTS          |                |     |                                |          |                      |
| A2C5*  | 0160-2203      | 9   | 1                              | 28480    | 0160-2203            |
| *FACTORY SELECTED PART                             |                |     |                                |          |                      |
| A2C6*  | 0160-0945      | 2   | 1                              | 28480    | 0160-0945            |
| *FACTORY SELECTED PART                             |                |     |                                |          |                      |
| A2C7   | 0180-0562      | 1   | 1                              | 56289    | 196D336X0010KA1      |
| A2C8   | 0160-3879      | 7   | 2                              | 28480    | 0160-3879            |
| A2C9   | 0180-2827      | 5   | 2                              | 28480    | 0180-2827            |
| A2C10  | 0180-2827      | 5   | 2                              | 28480    | 0180-2827            |
| A2C11  | 0180-2832      | 2   | 2                              | 28480    | 0180-2832            |
| USE EXACT REPLACEMENT PART                         |                |     |                                |          |                      |
| A2C12  | 0180-2832      | 2   | 2                              | 28480    | 0180-2832            |
| USE EXACT REPLACEMENT PART                         |                |     |                                |          |                      |
| A2C13  | 0180-0418      | 6   | 2                              | 28480    | 0180-0418            |
| A2C14  | 0180-0418      | 6   | 2                              | 28480    | 0180-0418            |
| A2C15  | 0140-0209      | 9   | 2                              | 72136    | DM15C050K0500WV1CR   |
| #ADDED IF NEEDED, NOT IN ALL INSTRUMENTS           |                |     |                                |          |                      |
| A2C16  | 0140-0209      | 9   | 2                              | 72136    | DM15C050K0500WV1CR   |
| A2C17  | 0180-0587      | 0   | 2                              | 56289    | 672D476H025CC5B      |
| A2C18  | 0180-0587      | 0   | 2                              | 56289    | 672D476H025CC5B      |
| A2C19  | 0160-0576      | 5   | 2                              | 28480    | 0160-0576            |
| A2C20#   | 0160-3879      | 7   | 3                              | 28480    | 0160-3879            |
| #ADDED IF NEEDED, NOT IN ALL INSTRUMENTS           |                |     |                                |          |                      |
| A2C21  | 0160-0128      | 3   | 2                              | 2840     | 0160-0128            |
| A2C22  | 0160-0128      | 3   | 2                              | 28480    | 0160-0128            |
| A2CR1  | 1902-0774      | 0   | 2                              | 28480    | 1902-0774            |
| A2CR2  | 1902-0774      | 0   | 2                              | 28480    | 1902-0774            |
| A2CR3  | 1901-1086      | 7   | 2                              | 04713    | MR820                |
| A2CR4  | 1901-1086      | 7   | 2                              | 04713    | MR820                |
| A2CR5  |                |     |                                |          | NOT ASSIGNED         |
| A2CR6  |                |     |                                |          | NOT ASSIGNED         |
| A2CR7  | 1902-0522      | 6   | 2                              | 04713    | 1N5340B              |
| A2CR8  | 1902-0522      | 6   | 2                              | 04713    | 1N5340B              |
| A2CR9  | 1901-0040      | 1   | 2                              | 28480    | 1901-0040            |
| A2CR10   | 1901-0040      | 1   | 2                              | 298480   | 1901-0040            |
| A2CR11   | 1902-0632      | 9   | 2                              | 04713    | 1N5354B              |
| A2CR12   | 1902-0632      | 9   | 2                              | 04713    | 1N5354B              |
| A2CR13   | 1901-0638      | 3   | 1                              | 04713    | MDA-970-2            |

SEE INTRODUCTION TO THIS SECTION FOR ORDERING INFORMATION

MODEL 5328A  
REPLACEABLE PARTS

TABLE 6-1. REPLACEABLE PARTS (CONTINUED)

| REFERENCE DESIGNATION | HP PART NUMBER | QTY | DESCRIPTION                           | MFR CODE | MFR PART NUMBER  |
|-----------------------|----------------|-----|---------------------------------------|----------|------------------|
| A2F1                  | 2110-0002      | 9   | FUSE 2A 250V FAST-BLO 1.25X.25 UL IEC | 75915    | 312002           |
| A2F2                  | 2110-0002      | 9   | FUSE 2A 250V FAST-BLO 1.25X.25 UL IEC | 75915    | 312002           |
| A2L1                  | 9100-3017      | 8   | INDUCTOR:FXD: 300UH AT 5A DC          | 28480    | 9100-3017        |
| A2L2                  | 9100-3017      | 8   | INDUCTOR:FXD: 300UH AT 5A DC          | 28480    | 9100-3017        |
| A2L3                  | 9100-3139      | 5   | COIL 75UH 15% .5DX.875LG=NOM          | 28480    | 9100-3139        |
| A2Q1                  | 1853-0363      | 8   | TRANSISTOR PNP SI PD=50W              | 03508    | X45H281          |
| A2Q2                  | 1854-0635      | 9   | TRANSISTOR NPN SI PD=50W              | 03508    | D44H5            |
| A2Q3                  | 1853-0326      | 3   | TRANSISTOR PNP SI PD=1W FT=50MHZ      | 28480    | 1853-0326        |
| A2Q4                  | 1854-0634      | 8   | TRANSISTOR NPN SI PD=1W FT=MHZ        | 04713    | MPS-U01          |
| A2Q5                  | 1854-0492      | 6   | TRANSISTOR NPN SI PD=250MHZ           | 28480    | 1854-0492        |
| A2Q6                  | 1853-0016      | 8   | TRANSISTOR PNP SI TO -92 PD=300MW     | 28480    | 1853-0016        |
| A2Q7                  | 1853-0363      | 8   | TRANSISTOR PNP SI PD=50W              | 03508    | X45H281          |
| A2Q8                  | 1854-0635      | 9   | TRANSISTOR NPN SI PF=50W              | 03508    | D44H5            |
| A2Q9                  | 1854-0492      | 6   | TRANSISTOR NPN SI PD=350MW FT=250MHZ  | 28480    | 1854-0492        |
| A2Q10                 | 1853-0016      | 8   | TRANSISTOR PNP SI TO=92 PD=300MW      | 28480    | 1853-0016        |
| A2Q11                 | 1854-0635      | 9   | TRANSISTOR NPN SI PD=50W              | 03508    | D44H5            |
| A2R1                  | 0761-0026      | 4   | RESISTOR 220 5% 1W MO TC=0+-200       | 28480    | 0761-0026        |
| A2R2                  | 0761-0026      | 4   | RESISTOR 220 5% 1W MO TC=0+-200       | 28480    | 0761-0026        |
| A2R3                  | 0683-1015      | 7   | RESISTOR 100 5% .25W FC TC=400/+500   | 01121    | CB1015           |
| A2R4                  | 0683-1015      | 7   | RESISTOR 100 5% .25W FC TC=-400/+500  | 01121    | CB1015           |
| A2R5                  | 0683-1025      | 9   | RESISTOR 1K 5% .25W FC TC=-400/+600   | 01121    | CB1025           |
| A2R6                  | 0683-1025      | 9   | RESISTOR 1K 5% .25W FC TC=-400/+600   | 01121    | CB1025           |
| A2R7                  | 0683-6815      | 5   | 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   | 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   | RESISTOR 820K 5% .25W FC TC=-800/+900 | 01121    | CB8245           |
| A2R12                 | 0683-1055      | 5   | RESISTOR 1M 5% .25W FC TC=-800/+900   | 01121    | CB1055           |
| A2R13                 | 0683-4725      | 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   | RESISTOR 31.6K 1% .125W F TC=0+-100   | 24546    | C4-1/8-T0-3162-F |
| A2R17                 | 0757-0428      | 1   | RESISTOR 1.62K 1% .125W F TC=0+-100   | 24546    | C4-1/8-T0-1621-F |
| A2R18                 | 0757-0454      | 3   | RESISTOR 33.2K 1% .125W F TC=0+-100   | 24546    | C4-1/8-T0-3322-F |
| A2R19                 | 0683-1025      | 9   | RESISTOR 4K 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   | 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   | 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   | 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   | RESISTOR 11K 5% .25W FC TC=-400/+800  | 01121    | CB1135           |
| A2R31                 | 0683-2715      | 6   | RESISTOR 270 5% .25W FC TC=-400/+600  | 01121    | CB2715           |
| A2R32                 | 0811-3050      | 7   | RESISTOR .75 5% .5W PW TC=0+-150      | 75042    | BW20-1-3/4-J     |
| A2R33                 |                |     | NOT ASSIGNED                          |          |                  |
| A2R34                 | 0811-1340      | 4   | RESISTOR 1 5% 5W PW TC=0+-50          | 28480    | 0811-1340        |
| A2R35                 | 0811-1340      | 4   | RESISTOR 1 5% 5W PW TC=0+-50          | 28480    | 0811-1340        |
| 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           |
| A2U1                  | 1826-0065      | 0   | IC 311 COMPARATOR 8-DIP-P             | 01295    | SN72311P         |
| A2U2                  | 1826-0065      | 0   | IC 311 COMPARATOR 8-DIP-P             | 01295    | SN72311P         |
| A2U3                  | 1820-0477      | 6   | IC OP AMP 8-DIP-P                     | 207014   | LM301AN          |
| A2U4                  | 1820-0477      | 6   | IC O AMP 8DIP-P                       | 27014    | LM301AN          |
| A2U5                  | 1820-0439      | 0   | IC V RGLTR 14-DIP-P                   | 07263    | 723PC            |
| A2XF1                 | 2110-0269      | 0   | FUSEHOLDER-CLIP TYPE.250-FUSE         | 28480    | 2110-0269        |
| A2XF2                 | 2110-0269      | 0   | FUSEHOLDER-CLIP TYPE.25D-FUSE         | 28480    | 2110-0269        |
| A2XQ1                 | 1251-3246      | 6   | CONNECTOR 3-PIN F                     | 28480    | 1251-3246        |
| A2XQ2                 | 1251-3246      | 6   | CONNECTOR 3-PIN F                     | 28480    | 1251-3246        |
| A2XQ7                 | 1251-3246      | 6   | CONNECTOR 3-PIN F                     | 28480    | 1251-3246        |
| A2XQ6                 | 1251-3246      | 6   | CONNECTOR 3-PIN F                     | 28480    | 1251-3246        |
| A2XQ11                | 1251-3246      | 6   | CONNECTOR 3-PIN F                     | 28480    | 1251-3246        |
| A3                    | 05328-60027    | 8   | OSCILLATOR SUPPORT (SERIES 1744)      | 28480    | 05328-60027      |
| A3A1                  | 10544-60011    | 3   | CRYSTAL OSCILLATOR ASSEMBLY           | 28480    | 10544-60011      |
| A3C1                  | 0180-1746      | 5   | CAPACITOR-FXD 15UF+-10% 20VDC TA      | 56289    | 150D156X9020B2   |
| A3C2                  | 0160-0576      | 5   | CAPACITOR-FXD .1UF +-20% 50VDC CER    | 28480    | 0160-0576        |
| A3C3                  | 0160-3877      | 5   | CAPACITOR-FXD 100PF +-20% 200VDC CER  | 28480    | 0160-3877        |
| A3C4                  | 0160-0576      | 5   | CAPACITOR-FXD .1UF +-20% 50VDC CER    | 28480    | 0160-0576        |
| A3C5                  | 0180-0116      | 1   | CAPACITOR-FXD 6.8UF+10% 35VDC TA      | 56289    | 150D685X9035B2   |

SEE INTRODUCTION TO THIS SECTION FOR ORDERING INFORMATION

MODEL 5328A  
REPLACEABLE PARTS

TABLE 6-1. REPLACEABLE PARTS (CONTINUED)

| REFERENCE DESIGNATION | HP PART NUMBER | QTY | DESCRIPTION                              | MFR CODE | MFR PART NUMBER      |
|-----------------------|----------------|-----|--|----------|----------------------|
| A3C6                  | 0160-0576      | 5   | CAPACITOR-FXD .1UF +-20% 50VDC CER       | 28480    | 0160-0576            |
| A3C7                  | 0160-3876      | 4   | CAPACITOR-FXD 47PF +-20% 200VDC CER      | 28480    | 0160-3876            |
| A3C9                  | 0160-2055      | 9   | CAPACITOR-FXD .01UF +80-20% 100VDC CER   | 28480    | 0160-2055            |
| A3C10                 | 0160-2055      | 9   | CAPACITOR-FXD .01UF +80-20% 100VDC CER   | 28480    | 0160-2055            |
| A3C11                 | 0140-0221      | 5   | CAPACITOR-FXD 220PF +-1% 300VDC MICA     | 72136    | DM15F221F0300WV1C    |
| A3C12                 | 0121-0180      | 5   | CAPACITOR-V TRMR-CER 15-60PF 200V PC-MTG | 52763    | 304324 15/60PF N1500 |
| A3C13                 | 0140-0221      | 5   | CAPACITOR-FXD 220PF +-1% 300VDC MICA     | 72136    | DM15F221F0300WV1C    |
| A3C14                 | 0160-3875      | 3   | CAPACITOR-FXD 22PF +-5% 200VDC CER 0+-30 | 28480    | 0160-3875            |
| A3C15                 | 0121-0180      | 5   | CAPACITOR-V TRMR-CER 15-60PF 200V PC-MTG | 52763    | 304324 15/60PF N1500 |
| A3C16                 | 0160-3456      | 6   | CAPACITOR-FXD 1000PF +-10% 1KVDC CER     | 28480    | 0160-3456            |
| A3C17                 | 0160-2055      | 9   | CAPACITOR-FXD .01UF +80-20% 100VDC CER   | 28480    | 0160-2055            |
| A3C18                 | 0160-2055      | 9   | CAPACITOR-FXD .01UF +80-20% 100VDC CER   | 28480    | 0160-2055            |
| A3C19                 | 0160-0576      | 5   | CAPACITOR-FXD .1UF +-20% 50VDC CER       | 28480    | 0160-0576            |
| A3CR1                 | 1902-0579      | 3   | DIODE-ZNR 5.11V 5% DO=15 PD=1W TC=-.009% | 28480    | 1902-0579            |
| A3CR2                 | 1901-0040      | 1   | DIODE-SWITCHING 30V 50MA 2NS DO-35       | 28480    | 1901-0040            |
| A3CR3                 | 1901-0040      | 1   | DIODE-SWITCHING 30V 50MA 2NS DO-35       | 28480    | 1901-0040            |
| A3L1                  | 9140-0131      | 5   | COIL-MLD 10MM 5% Q=80 .24DX.74LG-NOM     | 28480    | 9140-0131            |
| A3L2                  | 9100-1788      | 6   | CHOKE-WIDE BAND ZMAX=680 OHM@ 180 MHZ    | 02114    | VK200 20/48          |
| A3L3                  | 9140-0096      | 1   | COIL-MLD 1UH 10% Q=50 .155DX.375LG-NOM   | 28480    | 9140-0096            |
| A3L4                  | 9140-0096      | 1   | COIL-MLD 1UH 10% Q=50 .155DX.375LG-NOM   | 28480    | 9140-0096            |
| A3Q1                  | 1854-0215      | 1   | TRANSISTOR NPN SI PD=350MW FT=300MHZ     | 04713    | SPS 3611             |
| A3Q2                  | 1854-0215      | 1   | TRANSISTOR NPN SI PD=350MW FT=300MHZ     | 04713    | SPS 3611             |
| A3Q3                  | 1853-0036      | 2   | TRANSISOTR PNP SI PD=310MW FT=250MHZ     | 28480    | 1853-0036            |
| A3R1                  |                |     |  |          |                      |
| A3R2                  | 0683-1025      | 9   | RESISTOR 1K 5% .25W FC TC=-400/+600      | 01121    | CB1025               |
| A3R3                  | 0683-1025      | 9   | RESISTOR 1K 5% .25W FC TC=-400/+600      | 01121    | CB1025               |
| A3R5                  | 0683-1225      | 1   | RESISTOR 1.2K 5% .25W FC TC=-400/+700    | 01121    | CB1225               |
| A3R6                  | 0683-1035      | 1   | RESISTOR 10K 5% .25W FC TC=-400/+700     | 01121    | CB1035               |
| A3R7                  | 0683-0475      | 1   | RESISTOR 4.7 5% .25W FC TC=-400/+500     | 01121    | CB47G5               |
| A3R8                  | 0757-0200      | 7   | RESISTOR 5.62K 1% .125W F TC=0+-100      | 24546    | C4-1/8-T0-5621-F     |
| A3R9                  | 0757-0439      | 4   | RESISTOR 6.81K 1% .125W F TC=0+-100      | 24546    | C4-1/8-T0-6811-F     |
| A3R10                 | 0683-4715      | 0   | RESISTOR 470 5% .25W FC TC=-400/+600     | 01121    | CB4715               |
| A3R11                 | 0683-1015      | 7   | RESISTOR 100 5% .25W FC TC=-400/+500     | 01121    | CB1015               |
| A3R12                 | 0683-1005      | 5   | RESISTOR 10 5% .25W FC TC=-400/+500      | 01121    | CB1005               |
| A3R13                 | 0811-1856      | 7   | RESISTOR 250 5% 5W PW TC=0+-20           | 28480    | 0811-1856            |
| A3R14                 | 2100-3103      | 6   | RESISTOR-TRMR 10K 10% C SIDE-ADJ 17-TRN  | 02111    | 43P103               |
| A3R15                 | 0683-1025      | 9   | RESISTOR 1K 5% .25W FC TC=-400/+600      | 01121    | CB1025               |
| A3R16                 | 0683-1035      | 1   | RESISTOR 10K 5% .25W FC TC=-400/+700     | 01121    | CB1035               |
| A3R17                 | 0683-1035      | 1   | RESISTOR 10K 5% .25W FC TC=-400/+700     | 01121    | CB1035               |
| A3R18                 | 0683-1025      | 9   | RESISTOR 1K 5% .25W FC TC=-400/+600      | 01121    | CB1025               |
| A3R19                 | 0698-3136      | 8   | RESISTOR 17.8K 1% .125W F TC=0+-100      | 24546    | C4-1/8-T0-1782-F     |
| A3U1                  | 1820-1490      | 5   | IC CNTR TTL LS DECD ASYNCHRO             | 01295    | SN74LS90N            |
| A3U2                  | 1820-1428      | 9   | IC MUXR/DATA-SEL TTL LS 2-TO-1-LINE QUAD | 01295    | SN74LS158N           |
| A3U3                  | 1820-0439      | 0   | IC V RGLTR 14-DIP-P                      | 07263    | 723PC                |
| A3U4                  | 1820-1052      | 5   | IC XL TR ECL/TTL ECL-TO-TTL QUAD 2-INP   | 04913    | MC10125L             |
| A3U5                  | 1826-0276      | 5   | IC 78L05A V RGLTR TO-92                  | 04713    | MC78L05ACP           |
| A3W1                  | 05328-60115    | 5   | CABLE ASSEMBLY, OSCILLATOR               | 28480    | 05328-60115          |
|                       | 8120-0229      | 9   | CABLE-COAX 50-OHM 29PF/FT                | 28480    | 8120-0229            |
|                       | 0890-0029      | 0   | TUBING-HS .187-D/.093-RCVD .02-WALL      | 28480    | 0890-0029            |
|                       | 1250-0824      | 8   | CONNECTOR-RF SMC FEM UNMTD 50-OHM        | 28480    | 1250-0824            |
|                       | 1250-0870      | 4   | CONNECTOR-RF BNC FEM SGL-HOLE-RR 50-OHM  | 28480    | 1250-0870            |
|                       | 1250-0952      | 3   | CONTACT-RF CONN/TNCIFEM CTR              | 24931    | C232-2               |
|                       | 1250-0957      | 8   | BUSHING RF CONN BNC/TNCI FOR INTL        | 24931    | CS 105-2             |
|                       | 1250-0960      | 3   | SLEEVE-RF CONN SER BNC/TNC               | 28480    | 1250-0960            |
|                       | 1250-0964      | 7   | NUT-RF CONN BNC/TNCI CLAMP NUT FOR       | 24931    | NI26-2               |
|                       |                |     | A3 MISCELLANEOUS                         |          |                      |
|                       | 0380-0310      | 1   | STANDOFF-RVT-ON .75-IN-LG 6-32THD        | 0000     | ORDER BY DESCRIPTION |
|                       | 1250-0835      | 1   | CONNECTOR-RF SMC M PC 50-OHM             | 28480    | 1250-0835            |
|                       | 1251-2035      | 9   | CONNECTOR-PC EDGE 15-CONT/ROW 2ROWS      | 28480    | 1251-2035            |
|                       | 8159-0005      | 0   | WIRE 22AWG W PVC 1X22 80C                | 28480    | 8159-0005            |
| A4                    | 05328-60005    | 2   | FUNCTION SELECTOR                        | 28480    | 05328-60005          |
| A4C1                  |                |     | NOT ASSIGNED                             |          |                      |
| A4C2                  | 0160-3879      | 7   | CAPACITOR-FXD .01UF +-20% 100VDC CER     | 28480    | 0160-3879            |
| A4C3                  | 0160-4084      | 8   | CAPACITOR-FXD .1UF +-20% 50VDC CER       | 28460    | 0160-4084            |
| A4C4                  | 0140-0215      | 7   | CAPACITOR-FXD 80PF +-2% 300VDC MICA      | 72136    | DM15E800G0300WV1CR   |
| A4C5                  | 0140-0215      | 7   | CAPACITOR-FXD 80PF +-2% 300VDC MICA      | 72136    | DM15E800G0300WV1CR   |
| A4C6                  | 0160-2055      | 9   | CAPACITOR-FXD .01UF +80-20% 100VDC CER   | 28480    | 0160-2055            |
| A4C7                  | 0180-0210      | 6   | 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            |

SEE INTRODUCTION TO THIS SECTION FOR ORDERING INFORMATION

MODEL 5328A  
REPLACEABLE PARTS

TABLE 6-1. REPLACEABLE PARTS (CONTINUED)

| REFERENCE DESIGNATION                                     | HP PART NUMBER | QTY | DESCRIPTION                             | MFR CODE | MFR PART NUMBER    |
|---|----------------|-----|---|----------|--------------------|
| A4C11   | 0160-0342      | 3   | CAPACITOR-FXD 800PF +-1% 300VDC MICA    | 28480    | 0160-0342          |
| A4C12   | 0140-0214      | 6   | 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   | CAPACITOR-FXD 15PF +-5% 500VDC MICA     | 72136    | DM15C150J0500WV1CR |
| A4C17   | 0160-0153      | 4   | CAPACITOR-FXD 1000PF +-10% 200VDC POLYE | 28480    | 0160-0153          |
| A4Q1  | 1854-0215      | 1   | TRANSISTOR NPN SI PD=350MW FT=300MHZ    | 04713    | SPS 3611           |
| A4Q2  | 1854-0215      | 1   | TRANSISTOR NPN SI PD=350MW FT=300MHZ    | 04713    | SPS 3611           |
| A4Q3  | 1854-0215      | 1   | TRANSISTOR NPN SI PD=350MW FT=300MHZ    | 04713    | SPS 3611           |
| A4R1  | 0683-5115      | 6   | RESISTOR 510 5% .25W FC TC=-400/+600    | 01121    | CB5115             |
| A4R2  | 0683-1315      | 0   | RESISTOR 130 5% .25W FC TC=-400/+600    | 01121    | CB1315             |
| A4R3  | 0683-8205      | 1   | RESISTOR 82 5% .25W FC TC=-400/+500     | 01121    | CB8205             |
| 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   | RESISTOR 2K 5% .25W FC TC=-400/+700     | 01121    | CB2025             |
| A4R7  | 0683-1815      | 5   | 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/+300    | 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   | RESISTOR 1.8K 5% .25W FC TC=-400/+700   | 01121    | CB1825             |
| A4R15   | 0683-4315      | 6   | 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   | RESISTOR 82 5% .25W FC TC=-400/+500     | 01121    | CB8205             |
| A4R21   | 0683-1315      | 0   | 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   | 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   | RESISTOR 270 5% .25W FC TC=-400/+600    | 01121    | CB2715             |
| A4R28   | 0683-3315      | 4   | 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   | 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             |
| A4R41   | 0683-6815      | 5   | 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   | NETWORK-RES 9-PIN 81P .15-PIN-SPCG      | 28480    | 1810-0041          |
| A4R44   | 1810-0080      | 6   | NETWORK-RES 8-PIN-SIP .125-PIN-SPCG     | 28480    | 1810-0080          |
| A4R45   | 0698-5103      | 3   | RESISTOR 430 5% .125W CC TC=-330/+800   | 01121    | BB4315             |
| A4R46   | 0683-1825      | 7   | RESISTOR 1.8K 5% .25W FC TC=-400/+700   | 01121    | CB1825             |
| A4U1  | 1820-1225      | 4   | IC FF ECL D-M/8 DUAL                    | 04713    | MC10231P           |
| A4U2  | 1820-1052      | 5   | IC XLTR ECL/TTL ELC-TO-TTL QUAD 2-INP   | 04713    | MC10125L           |
| A4U3  | 1820-0629      | 0   | IC FF TTL 8 J-K NEG-EDGE-TRIG           | 01295    | SN748112N          |
| A4U4  | 1820-0629      | 0   | IC FF TTL 8 J-K NEG-EDGE-TRIG           | 01295    | SN748112N          |
| A4U5  | 1820-0622      | 3   | IC MUXR/DATA-SEL TTL 8-TO-1-LINE 8INP   | 01295    | SN74151AN          |
| A4U6  | 1820-0829      | 2   | IC MUXR/DATA-SEL ECL 8-TO-1-LINE 8-INP  | 04713    | MC10164L           |
| A4U7  | 1820-0809      | 8   | IC RCVR ECL LINE RCVR QUAD 2-INP        | 04713    | MC10115P           |
| A4U8  | 1820-0802      | 1   | IC GATE ECL NOR QUAD 2-INP              | 04713    | MC10102P           |
| A4U9  | 1820-0328      | 6   | IC GATE TTL NOR QUAD 2-INP              | 01295    | SN7402N            |
| A4U10   | 1820-0074      | 9   | IC GATE TTL AND-OR-INV 2-INP            | 01295    | SN7454N            |
| A4 MISCELLANEOUS  |                |     |   |          |                    |
|   | 1480-0116      | 8   | PIN-GRV .062-IN-DIA .25-IN-LG STL       | 28480    | 1480-0116          |
|   | 4040-0752      | 9   | EXTRACTOR-PC BOARD YEL POLYC            | 28480    | 4040-0752          |
| A5  |                |     | NOT ASSIGNED                            |          |                    |
| A6  |                |     | NOT ASSIGNED                            |          |                    |
| A7  |                |     | NOT ASSIGNED                            |          |                    |
| SEE INTRODUCTION TO THIS SECTION FOR ORDERING INFORMATION |                |     |   |          |                    |

MODEL 5328A  
REPLACEABLE PARTS

| REFERENCE DESIGNATION | HP PART NUMBER | QTY | DESCRIPTION                            | MFR CODE | MFR PART NUMBER  |
|-----------------------|----------------|-----|--|----------|------------------|
| A8                    | 05328-60032    | 5   | "C" CHANNEL INPUT (SERIES 1736)        | 28480    | 05328-60032      |
| A8C1                  | 0160-4084      | 8   | CAPACITOR-FXD .1UF +-20% 50VDC CER     | 28480    | 0160-4084        |
| A8C2                  | 0180-0428      | 8   | CAPACITOR-FXD 68UF+-20% 6VDC TA        | 28480    | 0180-0428        |
| A8C3                  | 0180-0428      | 8   | CAPACITOR-FXD 68UF+-20% 6VDC TA        | 28480    | 0180-0428        |
| A8C4                  | 0180-0155      | 8   | CAPACITOR-FXD 2.2UF+-20% 20VDC TA      | 56289    | 150D225X0020A2   |
| A8C5                  | 0160-4084      | 8   | CAPACITOR-FXD .1UF +-20% 50VDC CER     | 28480    | 0160-4084        |
| A8C6                  | 0180-1701      | 2   | CAPACITOR-FXD 68UF+-20% 6VDC TA        | 56289    | 150D685X0006A2   |
| A8C7                  | 0160-2599      | 6   | CAPACITOR-FXD 680PF +-10% 200VDC CER   | 28480    | 0160-2599        |
| A8C8                  | 0160-1084      | 8   | CAPACITOR-FXD .1UF +-20% 50VDC CER     | 28480    | 0160-1084        |
| A8C9                  | 0160-3879      | 7   | CAPACITOR-FXD .01UF +-20% 100VDC CER   | 28480    | 0160-3879        |
| A8C11                 | 0160-3878      | 6   | CAPACITOR-FXD 100PF +-20% 100VDC CER   | 28480    | 0160-3878        |
| A8C12                 | 0160-3879      | 7   | CAPACITOR-FXD .01UF +-20% 100VDC CER   | 28480    | 0160-3879        |
| A8C13                 | 0160-4084      | 8   | CPACITOR-FXD .1UF +-20% 50VDC CER      | 28480    | 0160-4084        |
| A8C14                 | 0180-0474      | 4   | CAPACITOR-FXD 15UF+-10% 20VDC TA       | 28480    | 0180-0474        |
| A8C15                 | 0180-0474      | 4   | CAPACITOR-FXD 15U+-10% 20VEDC TA       | 28480    | 0180-0474        |
| A8C16                 | 0160-4084      | 8   | CAPACITOR-FXD .1UF +-20% 50VDC CER     | 28480    | 0160-4084        |
| A8C17                 | 0160-3879      | 7   | CAPACITOR-FXD .01UF +-20% 100VDC CER   | 28480    | 0160-3879        |
| A8C18                 | 0160-3878      | 6   | CAPACITOR-FXD 100PF +-20% 100VDC CER   | 28480    | 0160-3878        |
| A8C20                 | 0160-3878      | 6   | CAPACITOR-FXD 1000PF +-20% 100VDC CER  | 28480    | 0160-3878        |
| A8C21                 | 0160-3879      | 7   | CAPACITOR-FXD .01UF +-20% 100VDC CER   | 28480    | 0160-3879        |
| A8C22                 | 0160-3879      | 7   | CAPACITOR-FXD .01UF +-20% 100VDC CER   | 28480    | 0160-3879        |
| A8C23                 | 0160-3879      | 7   | CAPACITOR-FXD .01UF +-20% 100VDC CER   | 28480    | 0160-3879        |
| A8C24                 | 0160-3878      | 6   | CAPACITOR-FXD 1000PF +-20% 100VDC CER  | 28480    | 0160-3878        |
| A8C25                 | 0160-4084      | 8   | CAPACITOR-FXD .1UF +-20% 50VDC CER     | 28480    | 0160-4084        |
| A8C26                 | 0160-3879      | 7   | CAPACITOR-FXD .01UF +-20% 100VDC CER   | 28480    | 0160-3879        |
| A8C27                 | 0180-0428      | 8   | CAPACITOR-FXD 68UF+-20% 6VDC TA        | 28480    | 0180-0428        |
| A8C28                 | 0160-2055      | 9   | CAPACITOR-FXD .01UF +80-20% 100VDC CER | 28480    | 0160-2055        |
| A8C29                 | 0160-2055      | 9   | CAPACITOR-FXD .01UF +80-20% 100VDC CER | 28480    | 0160-2055        |
| A8C30                 | 0160-2055      | 9   | CAPACITOR-FXD .01UF +80-20% 100VDC CER | 28480    | 0160-2055        |
| A8C31                 | 0160-3878      | 6   | CAPACITOR-FXD 1000PF +-20% 100VDC CER  | 28480    | 0160-3878        |
| A8C32                 | 0180-0428      | 8   | CAPACITOR-FXD 68UF+-20% 6VDC TA        | 28480    | 0180-0428        |
| A8C33                 | 0160-3878      | 6   | CAPACITOR-FXD 1000PF +-20% 100VDC CER  | 28480    | 0160-3878        |
| A8C34                 | 0160-4182      | 7   | CAPACITOR-FXD .01UF +-20% 200VDC CER   | 51642    | 200-200-X7R-103M |
| A8CR1                 | 1901-0050      | 3   | DIODE-SWITCHING 80V 200MA 2NS DO-35    | 28480    | 1901-0050        |
| A8CR2                 | 1901-0518      | 8   | DIODE-SCHOTTKY                         | 28480    | 1901-0518        |
| A8CR3                 | 1901-0518      | 8   | DIODE-SCHOTTKY                         | 28480    | 1901-0518        |
| A8CR4                 | 1901-0518      | 8   | DIODE-SCHOTTKY                         | 28480    | 1901-0518        |
| A8CR5                 | 1901-0518      | 8   | DIODE-SHOTTKY                          | 28480    | 1901-0518        |
| A8CR6                 | 1901-0535      | 9   | DIODE-SCHOTTKY                         | 28480    | 1901-0535        |
| A8CR7                 | 1901-0535      | 9   | DIODE-SCHOTTKY                         | 28480    | 1901-0535        |
| A8CR8                 | 1901-0050      | 3   | DIODE-SWITCHING 80V 200MA 2NS DO-35    | 28480    | 1901-0050        |
| A8CR9                 | 1901-0050      | 3   | DIODE-SWITCHING 80V 200MA 2NS DO-35    | 28480    | 1901-0050        |
| A8CR10                | 1901-0535      | 9   | DIODE-SCHOTTKY                         | 28480    | 1901-0535        |
| A8CR11                | 1901-0050      | 3   | DIODE-SWITCHING 80V 200MA 2NS DO-35    | 28480    | 1901-0050        |
| A8CR12                | 1901-0050      | 3   | DIODE-SWITCHING 80V 200MA 2NS DO-35    | 28480    | 1901-0050        |
| A8CR13                | 1901-0050      | 3   | DIODE-SWITCHING 80V 200MA 2NS DO-35    | 28480    | 1901-0050        |
| A8CR14                | 1901-0535      | 9   | DIODE-SCHOTTKY                         | 28480    | 1901-0535        |
| A8F1                  | 2110-0301      | 1   | FUSE .125 125V FAST-BLO .281X.093      | 28480    | 2110-0301        |
|                       | 05305-20104    | 1   | FUSE HOLDER                            | 28480    | 05305-20104      |
|                       | 05305-20105    | 2   | INSULATOR                              | 28480    | 05305-20105      |
|                       | 05305-60205    | 7   | CONNECTOR ASSEMBLY, BNC                | 28480    | 05305-60205      |
|                       | 05305-60206    | 8   | CONNECTOR ASSEMBLY, SMC                | 28480    | 05305-60206      |
| A8L1                  | 9100-1788      | 6   | CHOKE-WIDE BAND ZMAX=680 OHM@ 180 MHZ  | 02114    | VK200 20/48      |
| A8L2                  | 9100-1788      | 6   | CHOKE-WIDE BAND ZMAX=680 OHM@ 180 MHZ  | 02114    | VK200 20/48      |
| A8L3                  | 9140-0137      | 1   | COIL-MLD 1MH 5% Q=60 .19DX.44LG-NOM    | 28480    | 9140-0137        |
| A8L4                  | 9100-1788      | 6   | CHOKE-WIDE BAND ZMAX=680 OHM@ 180 MHZ  | 02114    | VK200 20/48      |
| A8L5                  | 05303-80001    | 1   | COIL, PEAKING                          | 28480    | 05303-80001      |
| A8Q1                  | 1854-0071      | 7   | TRANSISTOR NPN SI PD=300MW FT=200MHZ   | 28480    | 1854-0071        |
| A8Q2                  | 1854-0071      | 7   | TRANSISTOR NPN SI PD=300MW FT=200MHZ   | 28480    | 1854-0071        |
| A8Q3                  | 1854-0092      | 2   | TANSISTOR NPN SI PD=200MW FT=600MHZ    | 28480    | 1854-0092        |
| A8Q4                  | 1854-0092      | 2   | TRANSISTOR NPN SI PF=200MW FT=600MHZ   | 28480    | 1854-0092        |
| A8Q5                  | 1854-0092      | 2   | TRANSISTOR NPN SI PD=200MW FT=600MHZ   | 28480    | 1854-0092        |
| A8Q6                  | 1854-0092      | 2   | TRANSISTOR NPN SI PS=200MW FT=600MHZ   | 28480    | 1854-0092        |
| A8Q7                  | 1854-0071      | 7   | TRANSISTOR NPN SI P=300MW FT=200MHZ    | 28480    | 1854-0071        |
| A8Q8                  |                |     | NOT ASSIGNED                           |          |                  |
| A8Q9                  | 1853-0036      | 2   | TRANSISTOR PNP SI PD=310MW FT=250MHZ   | 28480    | 1853-0036        |
| A8R1                  | 0683-1035      | 1   | RESISTOR 10K 5% .25W FC TC=-400/+700   | 01121    | CB1035           |
| A8R2                  | 0683-1035      | 1   | RESISTOR 10K 5% .25W FC TC=-400/+700   | 01121    | CB1035           |
| A8R3                  | 0683-2715      | 6   | RESISTOR 270 5% .25W FC TC=-400/+600   | 01121    | CB2715           |
| A8R4                  | 0683-1055      | 5   | RESISTOR 1M 5% .25W FC TC=-800/+900    | 01121    | CB1055           |
| A8R5                  | 0683-1035      | 1   | RESISTOR 10K 5% .25W FC TC=-400/+700   | 01121    | CB1035           |

SEE INTRODUCTION TO THIS SECTION FOR ORDERING INFORMATION

MODEL 5328A  
REPLACEABLE PARTS

TABLE 6-1. REPLACEABLE PARTS (CONTINUED)

| REFERENCE DESIGNATION | HP PART NUMBER | QTY | DESCRIPTION  | MFR CODE | MFR PART NUMBER  |
|-----------------------|----------------|-----|--|----------|------------------|
| A8R6                  | 0683-1035      | 1   | RESISTOR 10K 5% .25W FC TC=-400/+700                           | 01121    | CB1035           |
| A8R7                  | 0683-1215      | 9   | RESISTOR 120 5% .25W FC TC=-400/+600                           | 01121    | CB1215           |
| A8R8                  | 0683-8215      | 3   | RESISTOR 820 5% .25W FC TC=-400/+600                           | 01121    | CB8215           |
| A8R9                  | 0683-1035      | 1   | RESISTOR 10K 5% .25W FC TC=-400/+700                           | 01121    | CB1035           |
| A8R10                 | 0698-8354      | 2   | RESISTOR 270 5% .125W CC TC=-330/+800                          | 01121    | BB2715           |
| A8R11                 | 0698-6283      | 2   | RESISTOR 10 5% .125W CC TC=-120/+400                           | 01121    | BB1005           |
| A8R12                 | 0683-5615      | 1   | RESISTOR 560 5% .25W FC TC=-400/+600                           | 01121    | CB5615           |
| A8R12                 | 2100-2522      | 1   | RESISTOR-TRMR 10K 10% C SIDE-ADJ 1-TRN                         | 30983    | ET50X103         |
| A8R13                 | 0698-3378      | 0   | RESISTOR 51 5% .125W CC TC=-270/+540                           | 01121    | BB5105           |
| A8R14                 | 0683-8205      | 1   | RESISTOR 82 5% .25W FC TC=-400/+500                            | 01121    | CB8205           |
| A8R15                 | 0683-1125      | 0   | RESISTOR 1.1K 5% .25W FC TC=-400/+700                          | 01121    | CB1125           |
| A8R16                 | 0683-8215      | 3   | RESISTOR 820 5% .25W FC TC=-400/+600                           | 01121    | CB8215           |
| A8R17                 | 0757-1001      | 8   | RESISTOR 56.2 1% .5W F TC=0+-100                               | 28480    | 0757-1001        |
| A8R18                 | 0683-3015      | 1   | RESISTOR 300 5% .25W FC TC=-400/+600                           | 01121    | CB3015           |
| A8R19                 | 0683-5125      | 8   | RESISTOR 5.1K 5% .25W FC TC=-400/+700                          | 01121    | CB5125           |
| A8R20                 | 0683-1215      | 9   | RESISTOR 120 5% .25W FC TC=-400/+600                           | 01121    | CB1215           |
| A8R21                 | 0683-5135      | 0   | RESISTOR 51K 5% .25W FC TC=-400/+800                           | 01121    | CB5135           |
| A8R22                 | 0683-4715      | 0   | RESISTOR 470 5% .25W FC TC=-400/+600                           | 01121    | CB4715           |
| A8R23                 | 0698-3378      | 0   | RESISTOR 51 5% .125W CC TC=-270/+540                           | 01121    | BB5105           |
| A8R24                 | 0683-5125      | 8   | RESISTOR 5.1K 5% .25W FC TC=-400/+700                          | 01121    | CB5125           |
| A8R25                 | 0683-1125      | 0   | RESISTOR 1.1K 5% .25W FC TC=-400/+700                          | 01121    | CB1125           |
| A8R26                 | 0683-8205      | 1   | RESISTOR 82 5% .25W FC TC=-400/+500                            | 01121    | CB8205           |
| A8R27                 | 0683-5105      | 4   | RESISTOR 51 5% .25W FC TC=-400/+500                            | 01121    | CB5105           |
| A8R28                 | 0683-5615      | 1   | RESISTOR 560 5% .25W FC TC=-400/+600                           | 01121    | CB5615           |
| A8R29*                | 0698-7080      | 9   | RESISTOR 27 5% .125W CC TC=-270/+540<br>*FACTORY SELECTED PART | 01121    | BB2705           |
| A8R30*                | 0695-7080      | 9   | RESISTOR 27 5% .125W CC TC=-270/+540<br>*FACTORY SELECTED PART | 01121    | BB2705           |
| A8R31                 | 0683-1125      | 0   | RESISTOR 1.1K 5% .25W FC TC=-400/+700                          | 01121    | CB1125           |
| A8R32                 | 0683-1125      | 0   | RESISTOR 1.1K 5% .25W FC TC=-400/+700                          | 01121    | CB1125           |
| A8R33                 | 0683-2025      | 1   | RESISTOR 2K 5% .25W FC TC=-400/+700                            | 01121    | CB2025           |
| A8R34                 | 0683-5105      | 4   | RESISTOR 51 5% .25W FC TC=-400/+500                            | 01121    | CB5105           |
| A8R35                 | 0683-5105      | 4   | RESISTOR 51 5% .25W FC TC=-400/+500                            | 01121    | CB5105           |
| A8R36                 | 0698-3378      | 0   | RESISTOR 51 5% .125W CC TC=-270/+540                           | 01121    | BB5105           |
| A8R37                 | 0698-3111      | 9   | RESISTOR 30 5% .125W CC TC=-270/+540                           | 01121    | BB3005           |
| A8R38                 | 0698-3378      | 0   | RESISTOR 51 5% .125W CC TC=-270/+540                           | 01121    | BB5105           |
| A8R39*                | 0683-2025      | 1   | RESISTOR 2K 5% .25W FC TC=-400/+700<br>*FACTORY SELECTED PART  | 01121    | CB2025           |
| A8R40*                | 0698-3378      | 0   | RESISTOR 51 5% .125W CC TC=-270/+540<br>*FACTORY SELECTED PART | 01121    | BB5105           |
| A8R41                 | 0698-4131      | 5   | RESISTOR 56 5% .125W CC TC=-270/+540                           | 01121    | BB5605           |
| A8R42*                | 0683-1215      | 9   | RESISTOR 120 5% .25W FC TC=-400/+600<br>*FACTORY SELECTED PART | 01121    | CB1215           |
| A8R43                 | 0683-1815      | 5   | RESISTOR 180 5% .25W FC TC=-400/+600                           | 01121    | CB1815           |
| A8R44                 | 0683-5105      | 4   | RESISTOR 51 5% .25W FC TC=-400/+500                            | 01121    | CB5105           |
| A8R45                 | 0683-5105      | 4   | RESISTOR 51 5% .25W FC TC=-400/+500                            | 01121    | CB5105           |
| A8R46                 | 0698-3378      | 0   | RESISTOR 51 5% .125W CC TC=-270/+540                           | 01121    | BB5105           |
| A8R47                 | 0683-4715      | 0   | RESISTOR 470 5% .25W FC TC=-400/+600                           | 01121    | CB4715           |
| A8R48                 | 0683-5125      | 8   | RESISTOR 5.1K 5% .25W FC TC=-400/+700                          | 01121    | CB5125           |
| A8R49                 | 0683-5125      | 8   | RESISTOR 5.1K 5% .25W FC TC=-400/+700                          | 01121    | CB5125           |
| A8R50                 | 0683-5135      | 0   | RESISTOR 51K 5% .25W FC TC=-400/+800                           | 01121    | CB5135           |
| A8R51                 | 0683-1215      | 9   | RESISTOR 120 5% .25W FC TC=-400/+600                           | 01121    | CB1215           |
| A8R52                 | 0683-3315      | 4   | RESISTOR 330 5% .25W FC TC=-400/+600                           | 01121    | CB3315           |
| A8R53                 | 0683-5615      | 1   | RESISTOR 560 5% .25W FC TC=-400/+600                           | 01121    | CB5615           |
| A8R54                 | 0683-3015      | 1   | RESISTOR 300 5% .25W FC TC=-400/+600                           | 01121    | CB3015           |
| A8R55                 | 0683-5125      | 8   | RESISTOR 5.1K 5% .25W FC TC=-400/+700                          | 01121    | CB5125           |
| A8R56                 | 0757-0965      | 1   | RESISTOR 51K 2% .125W F TC=0+-100                              | 24546    | C4-1/8-T0-5102-G |
| A8R57*                | 0757-0959      | 3   | RESISTOR 30K 2% .125W F TC=0+-100<br>*FACTORY SELECTED PART    | 24546    | C4-1/8-T0-3002-G |
| A8R58                 | 0757-0924      | 2   | RESISTOR 1K 2% .125W F TC=0+-100                               | 24546    | C4-1/8-T0-1001-G |
| A8R59                 | 0683-5105      | 4   | RESISTOR 51 5% .25W FC TC=-400/+500                            | 01121    | CB5105           |
| A8R60                 | 0683-5105      | 4   | RESISTOR 51 5% .25W FC TC=-400/+500                            | 01121    | CB5105           |
| A8R61                 | 0683-2215      | 1   | RESISTOR 220 5% .25W FC TC=-400/+600                           | 01121    | CB2215           |
| A8R62                 | 0683-5105      | 4   | RESISTOR 51 5% .25W FC TC=-400/+500                            | 01121    | CB5105           |
| A8R63                 | 0683-5105      | 4   | RESISTOR 51 5% .25W FC TC=-400/+500                            | 01121    | CB5105           |
| A8R64                 | 0683-1815      | 5   | RESISTOR 18005% .25W FC TC=-400/+600                           | 01121    | CB1815           |
| A8R65                 | 0683-4705      | 8   | RESISTOR 47 5% .25W FC TC=-400/+500                            | 01121    | CB4705           |
| A8R66                 | 0683-1025      | 9   | RESISTOR 1K 5% .25W FC TC=-400/+600                            | 01121    | CB1025           |
| A8R67                 | 0698-3378      | 0   | RESISTOR 51 5% .125W CC TC=-270/+540                           | 01121    | BB5105           |
| A8R68                 | 0683-1025      | 9   | RESISTOR 1K 5% .25W FC TC=-400/+600                            | 01121    | CB1025           |
| A8R69                 | 0683-2005      | 7   | RESISTOR 20 5% .25W FC TC=-400/+500                            | 01121    | CB2005           |
| A8R70                 | 0683-1025      | 9   | RESISTOR 1K 5% .25W FC TC=-400/+600                            | 01121    | CB1025           |
| A8R71                 | 0683-1025      | 9   | RESISTOR 1K 5% .25W FC TC=-400/+600                            | 01121    | CB1025           |
| A8R72                 | 0683-2005      | 7   | RESISTOR 20 5% .25W FC TC=-400/+500                            | 01121    | CB2005           |
| A8R73                 | 0683-1025      | 9   | RESISTOR 1K 5% .25W FC TC=-400/+600                            | 01121    | CB1025           |
| A8R74                 | 1810-0080      | 6   | NETWORK-RES 8-PIN-SIP .125-PIN-SPCG                            | 28480    | 1810-0080        |

SEE INTRODUCTION TO THIS SECTION FOR ORDERING INFORMATION

MODEL 5328A  
REPLACEABLE PARTS

TABLE 6-1. REPLACEABLE PARTS (CONTINUED)

| REFERENCE DESIGNATION | HP PART NUMBER | QTY | DESCRIPTION  | MFR CODE                                   | MFR PART NUMBER           |
|-----------------------|----------------|-----|--|--|---------------------------|
| A8R75                 | 0683-1525      | 4   | 7  | RESISTOR 1.5K 5% .25W FC TC=-400/+700      | 01121 CB1525              |
| A8R76                 | 0683-5125      | 8   | RESISTOR 5.1K 5% .25W FC TC=-400/+700                          | 01121 CB5125                               |                           |
| A8R77                 | 0683-5615      | 1   | RESISTOR 560 5% .25W FC TC=-400/+600                           | 01121 CB5615                               |                           |
| A8R78                 | 0683-2025      | 1   | RESISTOR 2K 5% .25W FC TC=-400/+700                            | 01121 CB2025                               |                           |
| A8R79                 | 0683-2715      | 6   | RESISTOR 270 5% .25W FC TC=-400/+600                           | 01121 CB2715                               |                           |
| A8R80                 | 0683-2025      | 1   | RESISTOR 2K 5% .25W FC TC=-400/+700                            | 01121 CB2025                               |                           |
| A8R81                 | 0683-2025      | 1   | RESISTOR 2K 5% .25W FC TC=-400/+700                            | 01121 CB2025                               |                           |
| A8R83*                | 0698-7080      | 9   | RESISTOR 27 5% .125W CC TC=-270/+540<br>*FACTORY SELECTED PART | 01121 BB2705                               |                           |
| A8R84*                | 0698-7080      | 9   | RESISTOR 27 5% .125W CC TC=-270/+540<br>*FACTORY SELECTED PART | 01121 BB2705                               |                           |
| A8R85                 | 2100-2633      | 5   | 3  | RESISTOR-TRMR 1K 10% C SIDE-ADJ 1-TRN      | 30983 ET50X102            |
| A8R86                 | 0683-1035      | 1   | RESISTOR 10K 5% .25W FC TC=-400/+700                           | 01121 CB1035                               |                           |
| A8R87                 |                |     | NOT ASSIGNED   |  |                           |
| A8R88                 |                |     | NOT ASSIGNED   |  |                           |
| A8R89                 | 0683-4745      | 6   | 1  | RESISTOR 470K 5% .25W FC TC=-800/+900      | 01121 CB4745              |
| A8U1                  | 1826-0084      | 3   | 1  | IC WIDEBAND AMPL                           | 28480 1826-0084           |
| A8U2*                 | 1826-0151      | 5   | 1  | IC, AMPLIFIER                              | 28480 1826-0151           |
| A8U2                  | 1826-0085      | 4   | 1  | IC WIDEBAND AMPL<br>*FACTORY SELECTED PART | 28480 1826-0085           |
| A8U3                  | 1820-2112      | 0   | 1  |  | 28480 1820-2112           |
| A8U4                  | 1820-0736      | 0   | 1  | IC CNTR ECL BIN DUAL                       | 28480 1820-0736           |
| A8U5                  | 1820-1019      | 4   | 1  | IC CNTR ECL BI-QUINARY                     | 28480 1820-1019           |
| A8U6                  | 1820-1052      | 5   | 2  | IC XLTR ECL/TTL ECL-TO-TTL QUAD 2-INP      | 04713 MC10125L            |
| A8U7                  | 1820-0301      | 5   | 1  | IC LCH TTL D-TYPE 4-BIT                    | 01295 SN7475N             |
| A8U8                  | 1820-0514      | 2   | 2  | IC GATE TTL NAND QUAD 2-INP                | 01295 SN7426N             |
| A8U9                  | 1826-0139      | 9   | 2  | IC 1428 OP AMP 8-DIP-P                     | 01928 CA1458G             |
| A8U10                 | 1826-0139      | 9   | IC 1458 OP AMP 8-DIP-P   | 01928 CA1458G                              |                           |
| A8U11                 | 1820-0803      | 2   | 3  | IC GATE ECL OR-NOR TPL                     | 04713 MC10105P            |
| A8U12                 | 1820-0514      | 2   | IC GATE TTL NAND QUAD 2-INP                                    | 01295 SN7426N                              |                           |
| A8U13                 | 1826-0419      | 8   | 1  | IC 8-DIP-P                                 | 27014 LM3909N             |
| A8W1                  | 05328-60116    | 6   | 1  | CABLE ASSEMBLY, FREQUENCY "C"              | 28480 05328-60116         |
|                       | 8120-0029      | 7   | 1  | CABLE-SHLD 18AWG 2-CNDCT JGK-JKT           | 28480 8120-0029           |
|                       | 05328-60119    | 9   | 1  | CABLE ASSEMBLY, TEST                       | 28480 05328-60119         |
|                       | 0890-0029      | 0   | 1  | TUBING-HS .187-D/.093-RCVD .02-WALL        | 28480 0890-0029           |
|                       | 1250-0824      | 8   | 1  | CONNECTOR-RF SMC FEM UNMTD 50-OHM          | 28480 1250-0824           |
|                       | 1250-0833      | 9   | 1  | TERMINATION-COAX CA CRP/CLP-COAX-CA FEM    | 28480 1250-0833           |
| A8W2                  | 05328-60120    | 2   |  | CABLE, OVERLOAD INDICATOR                  | 28480 05328-60120         |
|                       | 1200-0063      | 2   | 2  | CONNECTOR-SGL CONT SKT RND                 | 28480 1200-0063           |
|                       | 1990-0517      | 4   | 1  | LED-VISIBLE LUM-INT-3MCD IF=20MA-MAX       | 28480 5082-4655           |
|                       | 8150-0450      | 1   | 1  | WIRE 24AWG O 300 PVC 7X32 80C              | 28480 8150-0450           |
|                       | 8150-0451      | 2   | 1  | WIRE 24AWG Y 300V PVC 7X32 80C             | 28480 8150-0451           |
| A8 MISCELLANEAUS      |                |     |  |  |                           |
|                       | 0380-0310      | 1   | 4  | STANDOFF-RVT-ON .75-IN-LG 6-32THD          | 0000 ORDER BY DESCRIPTION |
|                       | 1200-0475      | 0   | 81   | CONNECTOR-SGL CONT SKT .016-IN-BBC-8Z      | 28480 1200-0475           |
|                       | 1251-0600      | 0   | 3  | CONNECTOR-SGL CONT PIN .114-MM-BSC-8Z SQ   | 28480 1251-0600           |
|                       | 1251-2229      | 3   | 2  | CONNECTOR-SGL CONT SKT .033-IN-BSC-8Z      | 28480 1251-2229           |
|                       | 1480-0116      | 8   | 3  | PIN-GRV .062-IN-DOA .25-IN-LG STL          | 28480 1480-0116           |
|                       | 4040-0747      | 2   | 1  | EXTRACTOR-PC BOARD GRA POLYC               | 28480 4040-0747           |
| A9                    |                |     |  | NOT ASSIGNED                               |                           |
| A10                   | 05328-60020    | 1   | 1  | SYNCHRONIZER                               | 28480 05328-60020         |
| A10C1                 | 0180-0428      | 8   |  | 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   |  | CAPACITOR-FXD .01UF +80-20% 100VDC CER     | 28480 0160-2055           |
| A10C4                 | 0160-3879      | 7   |  | 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   |  | CAPACITOR-FXD 3PF +- .25PF 500VDC CER      | 28480 0160-2244           |
| A10C9                 | 0160-3879      | 7   |  | CAPACITOR-FXD .01UF +-20% 100VDC CER       | 28480 0160-3879           |
| A10CR1                | 1902-3036      | 3   | 1  | DIODE-ZNR 3.16V 5% DO-7 PD=4W TC=-.064%    | 28480 1902-3036           |
| A10J1                 | 1200-0548      | 8   | 5  | SOCKET-IC 14-CONT 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                            |                           |
| A10Q1                 | 1854-0071      | 7   |  | TRANSISTORNNPN SI PD=300MW FT=200MHZ       | 28480 1854-0071           |
| A10R1                 | 0683-3315      | 4   |  | 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   |  | NETWORK-RES 8-PIN-SIP .125-PIN-SPCG        | 28480 1810-0080           |
| A10R4                 | 0683-5115      | 6   | 11   | RESISTOR 510 5% .25W FC TC=-400/+600       | 01121 CB5115              |
| A10R5                 | 1810-0080      | 6   | NETWORK-RES 8-PIN-SIP .125-PIN-SPCG                            | 28480 1810-0080                            |                           |

SEE INTRODUCTION TO THIS SECTION FOR ORDERING INFORMATION

MODEL 5328A  
REPLACEABLE PARTS

TABLE 6-1. REPLACEABLE PARTS (CONTINUED)

| REFERENCE DESIGNATION | HP PART NUMBER | QTY | DESCRIPTION                              | MFR CODE | MFR PART NUMBER      |
|-----------------------|----------------|-----|--|----------|----------------------|
| A10R6                 | 0683-2025      | 1   | RESISTOR 2K 5% .25W FC TC=-400/+700      | 01121    | CB2025               |
| A10R7                 | 0683-2225      | 3   | RESISTOR 2.2K 5% .25W FC TC=-400/+700    | 01121    | CB2225               |
| A10R8                 | 0683-4725      | 2   | 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   | RESISTOR 3K 5% .25W FC TC=-400/+700      | 01121    | CB3025               |
| A10R11                | 0683-1815      | 5   | 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   | RESISTOR 910 5% .25W FC TC=-400/+600     | 01121    | CB9115               |
| A10R14                | 1810-0080      | 6   | NETWORK-RES 8-PIN-SIP .125-PIN-SPCG      | 28480    | 1810-0080            |
| A10R15                | 0683-9115      | 4   | RESISTOR 910 5% .25W FC TC=-400/+600     | 01121    | CB9115               |
| A10R16                | 1810-0080      | 6   | NETWORK-RES 8-PIN-SIP .125-PIN-SPCG      | 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                | 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-PIN-SIP .125-PIN-SPCG      | 28480    | 1810-0080            |
| A10R23                | 0683-2225      | 3   | RESISTOR 2.2K 5% .25W FC TC=-400/+700    | 01121    | CB2225               |
| A10R24                | 0683-1035      | 1   | 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   | NETWORK-RES 8-PIN-SIP .125-PIN-SPCG      | 28480    | 1810-0020            |
| A10R27                | 0683-1025      | 9   | 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               |
| A10S1                 | 3101-1596      | 0   | 8 SWITCH-SL DPDT-NS MINTR 1A 125VAC PC   | 28480    | 3101-1596            |
| A10TP1                | 0360-0124      | 3   | CONNECTOR-SGL CONT PIN .04-IN-SBC-8Z RND | 28480    | 0360-0124            |
| A10TP2                | 0360-0124      | 3   | CONNECTOR-SGL CONT PIN .04-IN-BSC-8Z 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 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 KNOR QUAD 2-INP              | 04713    | MC10102P             |
| A10U6                 | 1820-0817      | 8   | 1 IC FF ECL D-M/S DUAL                   | 04713    | MC10131P             |
| A10U7                 | 1816-0821      | 5   | 1 IC SN74188N 256-BIT ROM TTL            | 01295    | SN74S188N PROGRAMMED |
| 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  | 14713    | MC10174P             |
| A10U12                | 1820-0803      | 2   | IC GATE ECL OR-NOR TPL                   | 04713    | MC10105P             |
| A10U13                | 1820-0803      | 2   | IC GATE ECL DR-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 CABLE ASSEMBLY, EXT LINE               | 28480    | 05328-60114          |
|                       |                |     | A10 MISCELLANEOUS                        |          |                      |
|                       | 1480-0116      | 8   | PIN-GRV .063-IN-DIA .25-IN-IN-LG STL     | 28480    | 1480-0116            |
|                       | 4040-0748      | 3   | 3 EXTRACTOR-PC BOARD BLK POLYC           | 28480    | 4040-0748            |
| A11                   | 05328-60023    | 4   | 1 DIGITAL TO ANALOG CONVERT              | 28480    | 05328-60023          |
| A11C1                 | 0180-0374      | 3   | 2 CAPACITOR-FXD 10UF+-10% 20VDC TA       | 56289    | 150D106X9020B2       |
| A11C2                 | 0160-3879      | 7   | CAPACITOR-FXD .01UF +-20% 100VDC CER     | 28480    | 0160-3879            |
| A11C3                 | 0180-0428      | 8   | CAPACITOR-FXD 68UF+-20% 6VDC TA          | 28480    | 0180-0428            |
| A11C4                 | 0180-0428      | 8   | CAPACITOR-FXD 68UF+-20% 6VDC TA          | 28480    | 0180-0428            |
| 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                | 0160-2746      | 2   | CAPACITOR-FXD 33PF +-10% 200VDC CER      | 28480    | 0160-2743            |
| A11C12                | 0160-3879      | 7   | CAPACITOR-FXD .01UF +-20% 100VDC CER     | 28480    | 0160-3879            |
| A11C13                | 0180-0428      | 8   | CAPACITOR-FXD 68UF+-20% 6VDC TA          | 28480    | 0180-0428            |
| A11C14                | 0180-0428      | 8   | CAPACITOR-FXD 68UF+-20% 6VDC TA          | 28480    | 0180-0428            |
| A11C15                | 0160-3879      | 7   | CAPACITOR-FXD .01UF +-20% 100VDC CER     | 28480    | 0160-3879            |
| 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            |

SEE INTRODUCTION TO THIS SECTION FOR ORDERING INFORMATION



MODEL 5328A  
REPLACEABLE PARTS

TABLE 6-1. REPLACEABLE PARTS (CONTINUED)

| REFERENCE DESIGNATION | HP PART NUMBER | QTY | DESCRIPTION   | MFR CODE | MFR PART NUMBER  |
|-----------------------|----------------|-----|---|----------|------------------|
| A11CR1                | 1901-0179      | 7   | 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   | DIODE-ZNR IN827 6.2V 5% DO-7 PD=.25W                          | 24046    | 1N827            |
| A11CR14               | 1902-0680      | 7   | DIODE-ZNR IN827 6.2V 5% DO-7 PD=.25W                          | 24046    | 1N827            |
| A11CR15               | 1901-0040      | 1   | 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   | SOCKET-IC 14-CONT DIP DIP-SLDR                                | 28480    | 1200-0548        |
| A11Q1                 | 1855-0081      | 1   | TRANSISTOR J-FET N-CHAN D-MODE SI                             | 01295    | 2N5245           |
| A11Q2                 | 1855-0416      | 6   | TRANSISTOR J-FET P-CHAN D-MODE SI                             | 28480    | 1855-0416        |
| A11Q3                 | 1855-0416      | 6   | TRANSISTOR J-FET P-CHAN D-MODE SI                             | 28480    | 1855-0416        |
| A11Q4                 | 1855-0081      | 1   | TRANSISTOR J-FET N-CHAN D-MODE SI                             | 01295    | 2N5245           |
| A11Q5                 | 1853-0020      | 4   | TRANSISTOR PNP SI PD=300MW FT=150MHZ                          | 28480    | 1853-0020        |
| A11Q6                 | 1854-0071      | 7   | TRANSISTOR NPN SI PD=300MW FT=200MHZ                          | 28480    | 1854-0071        |
| A11Q7                 | 1854-0071      | 7   | 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   | RESISTOR 620 5% .25W FC TC=-400/+600                          | 01121    | CB6215           |
| A11R2                 | 0757-0438      | 3   | RESISTOR 5.11K 1% .125W F TC=0+-100                           | 24546    | C4-1/8-T0-5111-F |
| A11R3                 | 0683-2015      | 9   | RESISTOR 200 5% .25W FC TC=-400/+600                          | 01121    | CB2015           |
| A11R4                 | 0683-4315      | 6   | RESISTOR 430 5% .25W FC TC=-400/+600                          | 01121    | CB4315           |
| A11R5                 | 0698-3153      | 9   | 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                           | 12546    | C4-1/8-T0-1782-F |
| A11R7*                | 0698-3156      | 2   | RESISTOR 14.7K 1% .125W F TC=0+-100                           | 24546    | C4-1/8-T0-1472-F |
| A11R7*                | 0698-3157      | 3   | RESISTOR 19.6K 1% .125W F TC=0+-100                           | 24546    | C4-1/8-T0-1962-F |
| A11R7*                | 0757-0199      | 3   | RESISTOR 21.5K 1% .125W F TC=0+-100                           | 24546    | C4-1/8-T0-2152-F |
| A11R7*                | 0757-0447      | 4   | RESISTOR 16.2K 1% .125W F TC=0+-100<br>*FACTORY SELECTED PART | 24546    | C4-1/8-T0-1622-F |
| A11R8                 | 0683-2015      | 9   | 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                | 0698-3156      | 2   | RESISTOR 14.7K 1% .125W F TC=0+-100                           | 24546    | C4-1/8-T0-1472-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   | 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-T03831-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   | 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   | 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   | 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   | RESISTOR 17.8K 1% .125W F TC=0+-100                           | 24546    | C4-1/8-T0-1782-F |
| A11R28*               | 0698-3156      | 2   | RESISTOR 14.7K 1% .125W F TC=0+-100                           | 24546    | C4-1/8-T0-1472-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<br>*FACTORY SELECTED PART | 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   | 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*               | 0698-3156      | 2   | RESISTOR 14.7K 1% .125W F TC=0+-100                           | 24546    | C4-1/8-T0-1472-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<br>*FACTORY SELECTED PART | 24546    | C4-1/8-T0-1622-F |

SEE INTRODUCTION TO THIS SECTION FOR ORDERING INFORMATION

MODEL 5328A  
REPLACEABLE PARTS

TABLE 6-1. REPLACEABLE PARTS (CONTINUED)

| REFERENCE DESIGNATION | HP PART NUMBER | QTY | DESCRIPTION                              | MFR CODE | MFR PART NUMBER  |
|-----------------------|----------------|-----|--|----------|------------------|
| 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                | 0683-1035      | 1   | RESISTOR 10K 5% .25W FC TC=-400/+700     | 01121    | CB1035           |
| A11R41                | 0757-0427      | 0   | RESISTOR 1.5K 1% .125W F TC=0+-100       | 24546    | C4-1/8-T0-1501-F |
| 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   | 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   | NETWORK-RES 9-PIN-SIP .15-PIN-SPCG       | 28480    | 1810-0055        |
| A11R50                | 0683-2055      | 7   | RESISTOR 2M 5% .25W FC TC=-900/+100      | 01121    | CB2055           |
| A11R51                | 0683-2055      | 7   | RESISTOR 2M 5% .25W FC TC=-900/+1100     | 01121    | CB2055           |
| A11TP1                | 0360-0124      | 3   | CONNECTOR-SGL CONT PIN .04-IN-BSC-8Z RND | 28480    | 0360-0124        |
| A11TP2                | 0360-0124      | 3   | CONNECTOR-SGL CONT PIN .04-IN-BSC-8Z RND | 28480    | 0360-0124        |
| A11TP3                | 0360-0124      | 3   | CONNECTOR-SGL CONT PIN .04-IN-BSC-8Z RNS | 28480    | 0360-0124        |
| A11TP4                | 0360-0124      | 3   | CONNECTOR-SGL CONT PIN .04-IN-BSC-8Z RND | 28480    | 0360-0124        |
| A11TP5                | 0360-0124      | 3   | CONNECTOR-SGL CONT PIN .04-IN-BSC-8Z RND | 28480    | 0360-0124        |
| A11TP6                | 0360-0124      | 3   | CONNECTOR-SGL CONT PIN .04-IN-BSC-8Z RND | 28480    | 0360-0124        |
| A11U1                 | 1826-0059      | 2   | IC 201A OP AMP TO-99                     | 04713    | MLM201AG         |
| A11U2                 | 1820-0693      | 8   | IC FF TTL S D-TYPE POS-EDGE-TRIG         | 01295    | SN74S74N         |
| A11U3                 | 1826-0161      | 7   | IC 324 OP AMP 14-DIP-P                   | 18324    | LM324-A          |
| A11U4                 | 1826-0059      | 2   | IC 201A OP TO 99                         | 04713    | MLM201AG         |
| A11U5                 | 1820-1425      | 6   | IC SCHMITT-TRIG TTL LS NAND QUAD 2-INP   | 01295    | SN74LS132N       |
| A11U6                 | 1826-0161      | 7   | IC 324 OP AMP 14-DIP-P                   | 18324    | LM324-A          |
| A11U7                 | 1820-0976      | 0   | IC SHF-RQTR CMOS D-TYPE SERIAL-IN        | 01928    | CD4015AF         |
| A11U8                 | 1820-1265      | 2   | IC MULTR CMOS                            | 04713    | MC14527BCP       |
| A11U9                 | 1820-1265      | 2   | IC MULTR CMOS                            | 04713    | MC14527BCP       |
| A11U10                | 1820-1265      | 2   | IC MULTR CMOS                            | 04713    | MC14527BCP       |
| A11U11                | 1820-0976      | 0   | IC SHF-RGTR CMOS D-TYPE SERIAL-IN        | 01928    | CD4015AF         |
| 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        | 01928    | CD4015AF         |
| A11U16                | 1820-0976      | 0   | IC SHF-RGTR CMOS D-TYPE SERIAL-IN        | 01928    | CD4015AF         |
| A11W1                 | 05328-60111    | 1   | CABLE ASSEMBLY, RF/A & B INPUT           | 28480    | 05328-60111      |
|                       | 8120-0229      | 9   | CABLE-COAX 50-OHM 29PF/FT                | 28480    | 8120-0229        |
|                       | 1250-0834      | 0   | TERMINATION-COAX CA CRP/CLP-COAX-CA FEM  | 28480    | 1250-0834        |
|                       | 1250-0870      | 4   | CONNECTOR-RF FEM SGL-HOLE-RR 50-OHM      | 28480    | 1250-0870        |
|                       | 1250-0952      | 3   | CONTACT-RF CONN BNC/TNCIFEMC CTR         | 24931    | C232-2           |
|                       | 1250-0957      | 8   | BUSHING RF CONN BNC/TNCI FOR INTL        | 24931    | CS 105-2         |
|                       | 1250-0960      | 3   | SLEEVE-RF CONN SER BNC/TNC               | 28480    | 1250-0960        |
|                       | 1250-0964      | 7   | NUT-RF CONN BNC/TNCI CLAMP NUT FOR       | 24931    | N126-2           |
| A11W2                 | 05328-60111    | 1   | CABLE ASSEMBLY, RF/A & B INPUT           | 28480    | 05328-60111      |
|                       | 8120-0229      | 9   | CABLE-COAX 50-OHM 29PF/FT                | 28480    | 8120-0229        |
|                       | 1250-0834      | 0   | TERMINATION-COAX CA CRP/CLP-COAX-CA FEM  | 28480    | 1250-0834        |
|                       | 1250-0870      | 4   | CONNECTOR-RF BNC FEM SGL-HOLE-RR 50-OHM  | 28480    | 1250-0870        |
|                       | 1250-0952      | 3   | CONTACT-RF CONN BNC/TNCIFEM CTR          | 24931    | C232-2           |
|                       | 1250-0957      | 8   | BUSHING RF CONN BNC/TNCI FOR INTL        | 24931    | CS 105-2         |
|                       | 1250-0960      | 3   | SLEVE-RF CONN SER BNC/TNC                | 28480    | 1250-0960        |
|                       | 1250-0964      | 7   | NUT-RF CONN BNC/TNCI CLAMP NUT FOR       | 24931    | N126-2           |
|                       |                |     | All MISCELLANEOUS                        |          |                  |
|                       | 0360-0065      | 1   | TERMINAL-STUD PKD-TUR SWGFRM-MTG         | 28480    | 0360-0065        |
|                       | 4040-0748      | 3   | EXTRACTOR-PC BOARD BLK POLYC             | 28480    | 4040-0748        |
| A12                   | 05328-60031    | 4   | A & B CHANNEL INPUT                      | 28480    | 05328-60031      |
| A12C1                 | 0160-3879      | 7   | 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   | CAPACITOR-FXD 2.2UF +-20% 50VDC CER      | 28480    | 0160-0128        |

SEE INTRODUCTION TO THIS SECTION FOR ORDERING INFORMATION

MODEL 5328A  
REPLACEABLE PARTS

TABLE 6-1. REPLACEABLE PARTS (CONTINUED)

| REFERENCE DESIGNATION | HP PART NUMBER | QTY | DESCRIPTION                                    | MFR CODE | MFR PART NUMBER   |
|-----------------------|----------------|-----|--|----------|-------------------|
| A12C11                | 0160-0128      | 3   | CAPACITOR-FXD 2.2UF +-20% 50VDC CER            | 28480    | 0160-0128         |
| A12C12                | 0180-0428      | 8   | CAPACITOR-FXD 68UF+-20% 6VDC TA                | 28480    | 0180-0428         |
| A12C13                | 0180-0428      | 8   | CAPACITOR-FXD 68UF+-20% 6VDC TA                | 28480    | 0180-0428         |
| 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                | 0180-0415      | 3   | 2 CAPACITOR-FXD 10UF+-20% 25VDC TA             | 28480    |                   |
| A12C18                | 0160-3879      | 7   | CAPACITOR-FXD .01UF +-20% 100VDC CER           | 28480    | 0160-3879         |
| A12C19                | 0180-0415      | 3   | CAPACITOR-FXD 10UF+-20% 25VDC TA               | 28480    | 0180-0415         |
| A12C20                | 0180-0428      | 8   | CAPACITOR-FXD 68UF+-20% 6VDC TA                | 28480    | 0180-0428         |
| A12C21                | 0180-0428      | 8   | CAPACITOR-FXD 68UF+-20% 6VDC TA                | 28480    | 0180-0428         |
| A12C22                | 0160-3876      | 4   | 2 CAPACITOR-FXD 47PF +-20% 200VDC CER          | 28480    | 0160-3876         |
| A12C23                | 0160-4423      | 9   | 2 CAPACITOR-FXD 470PF +-20% 500VDC CER         | 51642    | 200-500-X7P-471M  |
| A12C24                | 0160-3876      | 4   | CAPACITOR-FXD 47PF +-20% 200VDC CER            | 28480    | 0160-3876         |
| 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   | 2 CAPACITOR-FXD 3PF +- .25PF 500VDC CER        | 28480    | 0160-2244         |
|                       |                |     | *FACTORY SELECTED PART                         |          |                   |
| 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         |
|                       |                |     | *FACTORY SELECTED PART                         |          |                   |
| 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                | 0180-0428      | 8   | CAPACITOR-FXD 68UF+-20% 6VDC TA                | 28480    | 0180-0428         |
| A12C33                | 0140-0225      | 9   | 2 CAPACITOR-FXD 300PF +-1% 300VDC MICA         | 72136    | DM15F301F0300WV1C |
| A12C34                | 0140-0225      | 9   | CAPACITOR-FXD 300PF +-1% 300VDC MICA           | 72136    | DM15F301F0300WV1C |
| A12C35*               | 0160-3873      | 1   | 1 CAPACITOR-FXD 4.7PF +- .5PF 200VDC CER       | 28480    | 0160-3873         |
|                       |                |     | *FACTORY SELECTED PART                         |          |                   |
| A12C36*               | 0160-3874      | 2   | 1 CAPACITOR-FXD 10PF +- .5PF 200VDC CER        | 28480    | 0160-3874         |
|                       |                |     | *FACTORY SELECTED PART                         |          |                   |
| A12CR1                | 1902-3082      | 9   | 1 DIODE-ZNR 4.64V 5% DI-7 PD=.4W TC=-.023%     | 28480    | 1902-3082         |
| A12CR2                | 1901-0040      | 1   | DIODE-SWITCHING 30V 50MA 2NS DO-35             | 28480    | 1901-0040         |
| A12CR3                | 1901-0376      | 6   | 5 DIODE-GEN PRP 35V 50MA DO-7                  | 28480    | 1901-0376         |
| A12CR4                | 1901-0040      | 1   | DIODE-SWITCHING 30V 50MA 2NS DO-35             | 28480    | 1901-0040         |
| A12CR5                | 1901-0376      | 6   | DIODE-GEN PRP 35V 50MA DO-7                    | 28480    | 1901-0376         |
| A12CR6                | 1901-0376      | 6   | DIODE-GEN PRP 35V 50MA DO-7                    | 28480    | 1901-0376         |
| A12CR7                | 1902-0126      | 6   | 2 DIODE-ZNR 2.61V 5% DO-7 PD=.4W TC=.072%      | 28480    | 1902-0126         |
| A12CR8                | 1901-0376      | 6   | DIODE-HEN PRP 35V 50MA DO-7                    | 28480    | 1901-0376         |
| A12CR9                | 1902-0126      | 6   | DIODE-ZNR 2.6V 5% DO-7 PD=.4W TC=-.072%        | 28480    | 1902-0126         |
| A12CR10               | 1901-0376      | 6   | DIODE-GEN PRP 35V 50MA DO-7                    | 28480    | 1901-0376         |
| A12CR11               | 1901-0040      | 1   | DIODE-SWITCHING 30V 50MA 2NS DO-35             | 28480    | 1901-0040         |
| A12CR12               | 1901-0040      | 1   | DIODE-SWITCHING 30V 50MA 2NS DO-35             | 28480    | 1901-0040         |
| A12CR13               | 1901-0040      | 1   | DIODE-SWITCHING 30V 50MA 2NS DO-35             | 28480    | 1901-0040         |
| A12CR14               | 1901-0040      | 1   | DIODE-SWITCHING 30V 50MA 2NS DO-35             | 28480    | 1901-0040         |
| A12CR15               | 1901-0040      | 1   | DIODE-SWITCHING 30V 50MA 2NS DO-35             | 28480    | 1901-0040         |
| A12CR16               | 1901-0040      | 1   | DIODE-SWITCHING 30V 50MA 2NS DO-35             | 28480    | 1901-0040         |
| A12CR17               | 1901-0040      | 1   | DIODE-SWITCHING 30V 50MA 2NS DO-35             | 28480    | 1901-0040         |
| A12J1                 | 1200-0548      | 8   | SOCKET-IC 14-CONT DIP-SLDR                     | 28480    | 1200-0548         |
| A12K1                 | 0490-0642      | 5   | 1 RELAY-RED 2C 50MA 28VDC 5VDC-COIL 3VA        | 28480    | 0490-0642         |
| A12K2                 | 0490-1175      | 1   | 7 RELAY-REED SPST NO 5VDC COIL                 | 28480    | 0490-1175         |
| A12K3                 | 0490-1183      | 1   | 3 RELAY-REED SPST NO 5VDC COIL                 | 28480    | 0490-1183         |
| A12K4                 | 0490-1175      | 1   | SAME AS K2                                     | 28480    | 0490-1175         |
| A12K5                 | 0490-1183      | 1   | SAME AS K3                                     | 28480    | 0490-1183         |
| A12K6                 | 0490-1175      | 1   | SAME AS K2                                     | 28480    | 0490-1175         |
| A12K7                 | 0490-1175      | 1   | SAME AS K2                                     | 28480    | 0490-1175         |
| A12K8                 | 0490-1175      | 1   | SAME AS K2                                     | 28480    | 0490-1175         |
| A12K9                 | 0490-1175      | 1   | SAME AS K2                                     | 28480    | 0490-1175         |
| A12K10                | 0490-1175      | 1   | SAME AS K2                                     | 28480    | 0490-1175         |
| A12K11                | 0490-1183      | 1   | SAME AS K3                                     | 28480    | 0490-1183         |
| A12L1                 | 9100-2288      | 3   | 2 COIL-MLD 1MH 10% Q=30 .0950X.25LG-NOM        | 28480    | 9100-2288         |
| A12L2                 | 9100-2288      | 3   | COIL-MLD 1MH 10% Q=30 .095DX.25LG-NOM          | 28480    | 9100-2288         |
| A12L3                 | 9140-0178      | 0   | 2 COIL-MLD 12UH 12UH 10% Q=65 .155DX.375LG-NOM | 28480    | 9140-0178         |
| A12L4                 | 9140-0178      | 0   | COIL-MLD 12UH 105 Q=65 .155DX.375LG-NOM        | 28480    | 9140-0178         |
| A12Q1                 | 1854-0071      | 7   | TRANSISTOR NPN SI PD=300MW FT=200MHZ           | 28480    | 1854-0071         |
| A12Q3                 | 1855-0213      | 1   | 2 TRANSISTOR-JFET DUAL 2N5912 N-CHAN           | 17856    | 2N5912            |
| A12Q4                 | 1855-0213      | 1   | TRANSISTOR-JFET DUAL 2N5912 N-CHAN             | 17856    | 2N5912            |
| A12R1                 | 0698-5426      | 3   | 2 RESISTOR 10K 10% .125W CC TC=-350/+857       | 01121    | BB1031            |
| A12R2                 | 0698-5426      | 3   | RESISTOR 10K 10% .125W CC TC=-350/+857         | 01121    | BB1031            |
| A12R3                 | 1810-0080      | 6   | 2 NETWORK-RES 8-PIN-SIP .125-PIN SPCG          | 28480    | 1810-0080         |
| A12R4                 | 0683-3925      | 2   | RESISTOR 3.9K 5% .25W FC TC=-400/+700          | 01121    | CB3925            |
| A12R5                 | 0698-5999      | 5   | 2 RESISTOR 4.7K 5% .125W CC TC=-350/+857       | 01121    | BB4725            |

SEE INTRODUCTION TO THIS SECTION FOR ORDERING INFORMATION

MODEL 5328A  
REPLACEABLE PARTS

TABLE 6-1. REPLACEABLE PARTS (CONTINUED)

| REFERENCE DESIGNATION | HP PART NUMBER | QTY | DESCRIPTION                            | MFR CODE                                | MFR PART NUMBER    |                |
|-----------------------|----------------|-----|--|---|--------------------|----------------|
| A12R6                 | 0683-3925      | 2   | RESISTOR 3.9K 5% .25W FC TC=-400/+700  | 01121                                   | CB3925             |                |
| A12R7                 | 0683-4725      | 2   | RESISTOR 4.7K 5% .25W FC TC=-400/+700  | 01121                                   | CB4725             |                |
| A12R8                 | 0698-5999      | 5   | RESISTOR 4.7K 5% .125W CC TC=-350/+857 | 01121                                   | BB4725             |                |
| A12R9                 | 0683-8215      | 3   | 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                | 0675-1021      | 8   | RESISTOR 1K 10% .125W CC TC=-330/+800  | 01121                                   | BB1021             |                |
| A12R12                | 0683-1025      | 9   | RESISTOR 1K 5% .25W FC TC=-400/+600    | 01121                                   | CB1025             |                |
| A12R13                | 0675-1021      | 8   | RESISTOR 1K 10% .125W CC TC=-330/+800  | 01121                                   | BB1021             |                |
| A12R16                | 0683-5115      | 6   | 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   | 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   | 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                | 0683-3315      | 4   | RESISTOR 330 5% FC TC=-400/+600        | 01121                                   | CB3315             |                |
| A12R23                | 0683-1035      | 1   | RESISTOR 10K 5% .25W FC TC=-400/+700   | 01121                                   | CB1035             |                |
| A12R24                | 0683-3315      | 4   | RESISTOR 330 5% .25W FC TC=-400/+600   | 01121                                   | CB3315             |                |
| A12R25                | 0683-1035      | 1   | RESISTOR 10K 5% .25W FC TC=-400/+700   | 01121                                   | CB1035             |                |
| A12R26                | 2100-2632      | 4   | RESISTOR-TRMR 100 10% C SIDE-ADJ 1-TRN | 30983                                   | ET50X101           |                |
| A12R27                | 0698-7229      | 8   | RESISTOR 511 1% .05W F TC=0+-100       | 24546                                   | C3-1/8-T0-511R-G   |                |
| A12R28                | 2100-2632      | 4   | RESISTOR-TRMR 100 10% C SIDE-ADJ 1-TRN | 30983                                   | ET50X101           |                |
| A12R29                | 0698-5996      | 2   | RESISTOR 560 5% .125W CC TC=-330/+800  | 01121                                   | BB5615             |                |
| A12R30                | 0698-5996      | 2   | RESISTOR 560 5% .125W CC TC=-330/+800  | 01121                                   | BB5615             |                |
| A12R31                | 0698-7229      | 8   | RESISTOR 511 1% .05W F TC=0+-100       | 24546                                   | C3-1/8-T0-511R-G   |                |
| A12R32                | 0698-7230      | 1   | RESISTOR 562 1% .05W F TC=0+-100       | 24546                                   | C3-1/8-T0-562R-G   |                |
| A12R33                | 0683-5115      | 6   | RESISTOR 510 5% .25W FC TC=-400/+600   | 01121                                   | CB5115             |                |
| A12R34                | 0698-6283      | 2   | RESISTOR 10 5% .125W CC TC=-120/+400   | 01121                                   | BB1005             |                |
| A12R35                | 0698-7230      | 1   | RESISTOR 562 1% .05W F TC=0+-100       | 24546                                   | C3-1/8-T0-562R-G   |                |
| A12R36                | 0698-6283      | 2   | RESISTOR 10 5% .125W CC TC=-120/+400   | 01121                                   | BB1005             |                |
| A12R37                | 0683-1055      | 5   | 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                | 0683-2005      | 7   | RESISTOR 20 5% .25W FC TC=-400/+500    | 01121                                   | CB2005             |                |
| A12R40                | 0683-5115      | 6   | RESISTOR 510 5% .25W FC TC=-400/+600   | 01121                                   | CB5115             |                |
| A12R41                | 0683-2005      | 7   | RESISTOR 20 5% .25W FC TC=-400/+500    | 01121                                   | CB2005             |                |
| A12R42                | 0698-6400      | 5   | RESISTOR 900K 1% .25W F TC=0+-100      | 19701                                   | MF52C1/4-T0-9003-F |                |
| A12R43                | 0698-6974      | 8   | RESISTOR 90K .25% .125W F TC=0+-25     | 28480                                   | 0698-6974          |                |
| A12R44                | 0698-6974      | 8   | RESISTOR 90K .25% .125W F TC=0+-25     | 28480                                   | 0698-6974          |                |
| A12R45                | 0698-6400      | 5   | RESISTOR 900K 1% .25W F TC=0+-100      | 19701                                   | MF52C1/4-T0-9003-F |                |
| A12R46                | 0757-0442      | 9   | RESISTOR 10K 1% .125W F TC=0+-100      | 24546                                   | C4-1/8-T0-1002-F   |                |
| A12R47                | 0757-0442      | 9   | RESISTOR 10K 1% .125W F TC=0+-100      | 24546                                   | C4-1/8-T0-1002-F   |                |
| A12R48                | 0757-0931      | 1   | RESISTOR 2K 2% .125W F TC=0+-100       | 24546                                   | C4-1/8-T0-2001-G   |                |
| A12R49                | 0757-0900      | 4   | 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                | 0683-4725      | 2   | RESISTOR 4.7K 5% .25W FC TC=-400/+700  | 01121                                   | CB4725             |                |
| A12R53                | 0683-4725      | 2   | RESISTOR 4.7K 5% .25W FC TC=-400/+700  | 01121                                   | CB4725             |                |
| A12R54                | 0683-1015      | 7   | RESISTOR 100 5% .25W FC TC=-400/+500   | 01121                                   | CB1015             |                |
| A12R55                | 0683-1015      | 7   | RESISTOR 100 5% .25W FC TC=-400/+500   | 01121                                   | CB1015             |                |
| A12R56                | 2100-2633      | 5   | RESISTOR-TRMR 1K 10% C SIDE-ADJ 1-TRN  | 30983                                   | ET50X102           |                |
| A12R57                | 2100-2633      | 5   | RESISTOR-TRMR 1K 10% C SIDE-ADJ 1-TRN  | 30983                                   | ET50X102           |                |
| A12U1                 | 1820-0577      | 7   | IC INV TTL HEX 1-INP                   | 01295                                   | SN7416N            |                |
| A12U2                 | 1820-0805      | 4   | IC GATE ECL EXCL-OR/NOR TPL 1-INP      | 04713                                   | MC10107P           |                |
| A12U3                 | 1820-0577      | 7   | IC INV TTL HEX 1-INP                   | 01295                                   | SN7416N            |                |
| A12U4                 | 1826-0426      | 7   | IC COMPARATOR 16-DIP-C                 | 34335                                   | AM687DL            |                |
| A12XU4                | 1200-0475      | 0   | CONNECTOR-SGL CONT SKT .016-IN-BBC-8Z  | 28480                                   | 1200-0475          |                |
|                       |                |     | A12 MISCELLANEOUS                      |   |                    |                |
|                       | 1480-0116      | 8   | PIN-GRV .062-IN-DIA .25-IN-LG STL      | 28480                                   | 1480-0116          |                |
|                       | 4040-0748      | 3   | EXTRACTOR-PC BOARD BLK POLYC           | 28480                                   | 4040-0748          |                |
| A13                   |                |     | NOT ASSIGNED                           |   |                    |                |
| A14                   |                |     | NOT ASSIGNED                           |   |                    |                |
| A15                   | 05328-60019    | 8   | 1                                      | HP-IS INTERFACE BOARD (SERIES 1632)     | 28480              | 05328-60019    |
| A15C1                 | 0180-1735      | 2   | 1                                      | CAPACITOR-FXD .22UF+-10% 35VDC TA       | 5689               | 150D224X9035A2 |
| A15C2                 | 0170-0040      | 9   | 1                                      | CAPACITOR-FXD .047UF +-10% 200VDC POLYE | 56289              | 292P47392      |
| A15C3                 | 0180-0106      | 9   | 2                                      | CAPACITOR-FXD 60UF+-20% 6VDC TA         | 56289              | 150D606X000682 |
| A15C4                 | 0160-0154      | 5   | 1                                      | CAPACITOR-FXD 2200PF +-10% 200VDC POLYE | 28480              | 0160-0154      |
| A15C5                 | 0160-0161      | 4   | 1                                      | CAPACITOR-FXD .01UF +-10% 200VDC POLYE  | 28480              | 0160-0161      |

SEE INTRODUCTION TO THIS SECTION FOR ORDERING INFORMATION

MODEL 5328A  
REPLACEABLE PARTS

TABLE 6-1. REPLACEABLE PARTS (CONTINUED)

| REFERENCE DESIGNATION | HP PART NUMBER | QTY | DESCRIPTION                                 | MFR CODE | MFR PART NUMBER |
|-----------------------|----------------|-----|---|----------|-----------------|
| A15C6                 | 0170-0024      | 9   | CAPACITOR-FXD .022UF +-20% 200VDC POLYE     | 28480    | 0170-0024       |
| A15C7                 | 0180-0229      | 7   | CAPACITOR-FXD 33UF+-10% 10VDC TA            | 56289    | 150D336X901082  |
| A15C8                 | 0180-0229      | 7   | CAPACITOR-FXD 33UF+-10% 10VDC TA            | 56289    | 150D336X901082  |
| A1509                 | 0180-1746      | 5   | CAPACITOR-FXD 15UF+-10% 20VDC TA            | 56289    | 150D156X902082  |
| A15CR1                | 1910-0016      | 0   | DIODE-GE 60V 60MA 1US DO-7                  | 82480    | 1910-0016       |
| A15CR2                | 1910-0016      | 0   | DIODE-GE 60V 60MA 1US DO-7                  | 82480    | 1910-0016       |
| A15CR3                | 1910-0016      | 0   | DIODE-GE 60V 60MA 1US DO-7                  | 28480    | 1910-0016       |
| A15CR4                | 1910-0016      | 0   | DIODE-GE 60V 60MA 1US DO-7                  | 28480    | 1910-0016       |
| A15CR5                | 1910-0016      | 0   | DIODE-GE 60V 60MA 1US DO-7                  | 28480    | 1910-0016       |
| A15CR6                | 1910-0016      | 0   | DIODE-GE 60V 60MA 1US DO-7                  | 28480    | 1910-0016       |
| A15J6                 | 1251-3283      | 1   | CONNECTOR 24-PIN F MICRORIBBON              | 28480    | 1251-3283       |
| A15Q1                 | 1854-0215      | 1   | TRANSISTOR NPN SI PD=350MW FT=300MHZ        | 04713    | SPS 3611        |
| A15Q2                 | 1854-0215      | 1   | TRANSISTOR NPN SI PD=350MW FT=300MHZ        | 04713    | SPS 3611        |
| A15Q3                 | 1854-0215      | 1   | TRANSISTOR NPN SI PD=350MW FT=300MHZ        | 04713    | SPS 3611        |
| A15Q4                 | 1854-0215      | 1   | TRANSISTOR NPN SI PD=350MW FT=300MHZ        | 04713    | SPS 3611        |
| 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                 | 0683-3325      | 6   | RESISTOR 3.3K 5% .25W FC TC=-400/+700       | 01121    | CB3325          |
| A15R6                 | 0683-4725      | 2   | RESISTOR 4.7K 5% .25W FC TC=-400/+700       | 01121    | CB4725          |
| 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                | 0683-1235      | 3   | RESISTOR 12K 5% .25W FC TC=-400/+800        | 01121    | CB1235          |
| 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   | 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          |
| A15R26                | 0683-2025      | 1   | RESISTOR 2K 5% .25W FC TC=-400/+700         | 01121    | CB2025          |
| A15R27                | 0683-3025      | 3   | RESISTOR 3K 5% .25W FT TC=-400/+700         | 01121    | CB3025          |
| A15R28                | 0683-3025      | 3   | RESISTOR 3K 5% .25W FC TC=-400/+700         | 01121    | CB3025          |
| A15R29                | 1810-0136      | 3   | NETWORK-RES 10-PIN-SIP .1-PIN-SPCG          | 28480    | 1810-0136       |
| A15R30                | 1810-0136      | 3   | NETWORK-RES 10-PIN-SIP .1-PIN-SPCG          | 28480    | 1810-0136       |
| A15R31                | 1810-0055      | 5   | NETWORK-RES 9-PIN-SIP .15-PIN-SPCG          | 28480    | 1810-0055       |
| A15R32                | 1810-0055      | 5   | NETWORK-RES 9-PIN-SIP .15-PIN-SPCG          | 28480    | 1810-0055       |
| A15R33                | 1810-0055      | 5   | NETWORK-RES 9-PIN-SIP .15-PIN-SPCG          | 28480    | 1810-0055       |
| A15R34                | 1810-0055      | 5   | NETWORK-RES 9-PIN-SIP .15-PIN-SPCG          | 28480    | 1810-0055       |
| A15R35                | 0683-1035      | 1   | RESISTOR 10K 5% .25W FC TC=-400/+700        | 01121    | CB1035          |
| A1581                 | 3101-1973      | 7   | SWITCH-SL 7-1A-NS DIP-NS DIP-SLIDE-ASSY .1A | 28480    | 3101-1973       |
| A15U1                 | 1820-0261      | 6   | IC MV TTL MONOSTBL                          | 01295    | SN74121N        |
| A15U2                 | 1820-0904      | 4   | IC COMPTT TTL L MAGTD 5-BIT                 | 07263    | 93L24PC         |
| A15U3                 | 1820-0658      | 5   | IC MUXR/DATA-SEL TTL L 8-TO-1-LINE 8-INP    | 07263    | 93L12PC         |
| A15U4                 | 1820-0174      | 0   | IC INV TTL MEX 1-INP                        | 01295    | 8N7404N         |
| A15U5                 | 1820-0621      | 2   | IC BFR TTL NAND QUAD 2-INP                  | 01295    | 8N7438N         |
| A15U6                 | 1820-0658      | 5   | IC MUXR/DATA-SEL TTL L 8-TO-1-LINE 8-INP    | 07263    | 93L12PC         |
| A15U7                 | 1820-0099      | 8   | IC CNTR TTL BIN ASYNCHRO NEG-EDGE-TRIG      | 01295    | SN7493N         |
| A15U8                 | 1820-0658      | 5   | IC MUXR/DATA-SEL TTL L 8-TO-1-LINE 8-INP    | 07263    | 93L12PC         |
| A15U9                 | 1820-0174      | 0   | IC INV TTL HEX 1-INP                        | 01295    | 8N7404N         |
| A15U10                | 1820-0621      | 2   | IC BFR TTL NAND QUAD 2-INP                  | 01295    | 8N7438N         |
| A15U11                | 1820-0077      | 2   | IC FF TTL D-TYPE POS-EDGE-TRIG CLEAR        | 01295    | SN7474N         |
| A15U12                | 1820-0658      | 5   | IC MUXR/DATA-SEL TTL L 8-TO-1-LINE 8-INP    | 07263    | 93L12PC         |
| A15U13                | 1820-0627      | 8   | IC DCDR TTL L BCD-TO-DEC 4-TO-10-LINE       | 07263    | 93L01PC         |
| A15U14                | 1820-1057      | 0   | IC CNTR TTL L BIN SYNCHRO POS-EDGE-TRIG     | 27014    | DM86L76N        |
| A15U15                | 1820-0656      | 3   | IC MUXR/DATA-SEL TTL L 2-TO-1-LINE QUAD     | 01295    | SN74L98N        |
| A15U16                | 1820-0621      | 2   | IC BFR TTL NAND QUAD 2-INP                  | 01295    | SN7438N         |
| A15U17                | 1820-0054      | 5   | IC GATE TTL NAND QUAD 2-INP                 | 01295    | 8N7400N         |
| A15U18                | 1820-1056      | 9   | IC SCHMITT-TRIG TTL NAND QUAD 2-INP         | 01295    | SN74132N        |
| A15U19                | 1820-1358      | 4   | IC LCH TTL L COM CLEAR 8-BIT                | 07263    | 93L34PC         |
| A15U20                | 1820-0269      | 4   | IC GATE TTL NAND QUAD 2-INP                 | 01295    | SN7403N         |

SEE INTRODUCTION TO THIS SECTION FOR ORDERING INFORMATION

MODEL 5328A  
REPLACEABLE PARTS

TABLE 6-1. REPLACEABLE PARTS (CONTINUED)

| REFERENCE DESIGNATION | HP PART NUMBER | QTY | DESCRIPTION                              | MFR CODE | MFR PART NUMBER      |
|-----------------------|----------------|-----|--|----------|----------------------|
| A15U21                | 1820-0174      | 0   | IC INV TTL HEX 1-INP                     | 01295    | SN7404N              |
| A15U22                | 1818-2253      | 5   |  | 28480    | 1818-2253            |
| A15U23                | 1820-1057      | 0   | IC CNTR TTL L BIN SYNCHRO POS-EDGE-TRIG  | 27014    | DM86L76N             |
| A15U24                | 1820-0876      | 9   | IC LCH TTL L D-TYPE 4-BIT                | 01295    | SN74L75N             |
| A15U25                | 1820-0054      | 5   | IC GATE TTL NAND QUAD 2-INP              | 01295    | SN7400N              |
| A15U26                | 1820-1358      | 4   | IC LCH TTL L COM CLEAR 8-BIT             | 07263    | 93L34PC              |
| A15U27                | 1820-0269      | 4   | IC GATE TTL NAND QUAD 2-INP              | 01295    | SN7403N              |
| A15U28                | 1820-1166      | 2   | IC FF TTL L D-TYPE COM CLEAR QUAD        | 27014    | DM85L51N             |
| A15U29                | 1820-0054      | 5   | IC GATE TTL NAND QUAD 2-INP              | 01295    | SN7400N              |
| A15U30                | 1820-0282      | 1   | IC GATE TTL EXCL-DR QUAD 2-INP           | 01295    | SN7486N              |
| A15U31                | 1820-0077      | 2   | IC FF TTL D-TYPE POS-EDGE-TRIG CLEAR     | 01295    | SN7474N              |
| A15U32                | 1820-0658      | 5   | IC MUXR/DATA-SEL TTL L 8-TO-1-LINE 8-INP | 07263    | 93L12PC              |
| A15U33                | 1820-1358      | 4   | IC LCH TTL L COM CLEAR 8-BIT             | 07263    | 93L34PC              |
| A15U34                | 1820-1166      | 2   | IC FF TTL L D-TYPE COM CLEAR QUAD        | 27014    | DM85L51N             |
| A15W1                 | 05328-60110    | 0   | CABLE ASSEMBLY, HP-IB SINGLE             | 28480    | 05328-60110          |
|                       |                |     | A15 MISCELLANEOUS                        |          |                      |
|                       | 0380-0529      | 4   | STANDOFF-HEX 1.25-IN-LG 6.32THD          | 00000    | ORDER BY DESCRIPTION |
|                       | 0380-0644      | 4   | STANDOFF-METRIC SHORT STUD MOUNT: FOR    | 28480    | 0380-0644            |
|                       | 1200-0485      | 2   | SKT-IC,14 PIN, PC MTG: RT AGL: CONT      | 28480    | 1200-0485            |
|                       | 1530-1098      | 4   | CLEVIS 0.070-IN W SLT: 0.45-IN PIN CTR   | 00000    | ORDER BY DESCRIPTION |
| A16                   | 05328-60026    | 7   | DISPLAY ASSEMBLY (SERIES 1636)           | 28480    | 05328-60026          |
| A16C1                 | 0180-0124      | 1   | CAPACITOR-FXD 200UF=75-10% 6VDC AL       | 56289    | 30D207G006DC2        |
| 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                | 1910-0016      | 0   | DIODE-GE 60V 60MA 1US DO-7               | 28480    | 1910-0016            |
| A16CR5                | 1901-0040      | 1   | DIODE-SWITCHING 30V 50MA 2NS DO-35       | 28480    | 1901-0040            |
| A16DS1                | 1990-0437      | 7   | 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   | LED-VISIBLE LUM-INT=300UCD IF=50MA-MAX   | 28480    | 5082-4480            |
| A16DS11               | 1990-0404      | 8   | LED-VISIBLE LUM-INT=300UCD IF=50MA-MAX   | 28480    | 5082-4480            |
| A16DS12               | 1990-0404      | 8   | LED-VISIBLE LUM-INT=300UCD IF=50MA-MAX   | 28480    | 5082-4480            |
| A16DS13               | 1990-0404      | 8   | LED-VISIBLE LUM-INT=300UCD IF=50MA-MAX   | 28480    | 5082-4480            |
| A16DS14               | 1990-0404      | 8   | LED-VISIBLE LUM-INT=300UCD IF=50MA-MAX   | 28480    | 5082-4480            |
| A16DS15               | 1990-0404      | 8   | LED-VISIBLE LUM-INT=300UCD IF=50MA-MAX   | 28480    | 5082-4480            |
| A16DS16               | 1990-0404      | 8   | LED-VISIBLE LUM-INT=300UCD IF=50MA-MAX   | 28480    | 5082-4480            |
| A16DS17               | 1990-0404      | 8   | LED-VISIBLE LUM-INT=300UCD IF=50MA-MAX   | 28480    | 5082-4480            |
| A16DS18               | 1990-0404      | 8   | LED-VISIBLE LUM-INT=300UCD IF=50MA-MAX   | 28480    | 5082-4480            |
| A16DS19               | 1990-0404      | 8   | LED-VISIBLE LUM-INT=300UCD IF=50MA-MAX   | 28480    | 5082-4480            |
| A16Q1                 | 1853-0326      | 3   | TRANSISTOR PNP SI PD=1W FT=50MHZ         | 28480    | 1853-0326            |
| A16Q2                 | 1853-0326      | 3   | TRANSISTOR PNP SI PD=1W FT=50MHZ         | 28480    | 1853-0326            |
| A16Q3                 | 1853-0326      | 3   | TRANSISTOR PNP SI PD=1W FT=50MHZ         | 28480    | 1853-0326            |
| A16Q4                 | 1853-0326      | 3   | TRANSISTOR PNP SI PD=1W FT=50MHZ         | 28480    | 1853-0326            |
| A16Q5                 | 1853-0326      | 3   | TRANSISTOR PNP SI PD=1W FT=50MHZ         | 28480    | 1853-0326            |
| A16Q6                 | 1853-0326      | 3   | TRANSISTOR PNP SI PD=1W FT=50MHZ         | 28480    | 1853-0326            |
| A16Q7                 | 1853-0326      | 3   | TRANSISTOR PNP SI PD=1W FT=50MHZ         | 28480    | 1853-0326            |
| A16Q8                 | 1853-0326      | 3   | TRANSISTOR PNP SI PD=1W FT=50MHZ         | 28480    | 1853-0326            |
| A16Q9                 | 1853-0326      | 3   | TRANSISTOR PNP SI PD=1W FT=50MHZ         | 28480    | 1853-0326            |
| A16Q10                | 1854-0492      | 6   | TRANSISTOR NPN SI PD=350MW FT=250MHZ     | 28480    | 1854-0492            |
| A16Q11                | 1854-0492      | 6   | TRANSISTOR NPN SI PD=350MW FT=250MHZ     | 28480    | 1854-0492            |
| A16Q12                | 1854-0492      | 6   | TRANSISTOR NPN SI PD=350MW FT=250MHZ     | 28480    | 1854-0492            |
| A16Q13                | 1854-0492      | 6   | TRANSISTOR NPN SI PD=350MW FT=250MHZ     | 28480    | 1854-0492            |
| A16Q14                | 1854-0492      | 6   | TRANSISTOR NPN SI PD=350MW FT=250MHZ     | 28480    | 1854-0492            |
| A16Q15                | 1854-0492      | 6   | TRANSISTOR NPN SI PD=350MW FT=250MHZ     | 28480    | 1854-0492            |
| A16Q16                | 1854-0492      | 6   | TRANSISTOR NPN SI PD=350MW FT=250MHZ     | 28480    | 1854-0492            |
| A16Q17                | 1854-0492      | 6   | TRANSISTOR NPN SI PD=350MW FT=250MHZ     | 28480    | 1854-0492            |
| A16Q18                | 1854-0492      | 6   | TRANSISTOR NPN SI PD=350MW FT=250MHZ     | 28480    | 1854-0492            |
| A16Q19                | 1854-0492      | 6   | TRANSISTOR NPN SI PD=350MW FT=250MHZ     | 28480    | 1854-0492            |
| A16Q20                | 1854-0492      | 6   | TRANSISTOR NPN SI PD=350MW FT=250MHZ     | 28480    | 1854-0492            |
| A16Q21                | 1854-0492      | 6   | TRANSISTOR NPN SI PD=350MW FT=250MHZ     | 28480    | 1854-0492            |
| A16R1                 | 0683-3905      | 8   | 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   | NETWORK-RES 9-PIN-SIP .15-PIN-SPCG       | 28480    | 1810-0213            |
| A16R5                 | 0683-1005      | 5   | RESISTOR 10 5% .25W FC TC=400/+500       | 01121    | CB1005               |

SEE INTRODUCTION TO THIS SECTION FOR ORDERING INFORMATION

MODEL 5328A  
REPLACEABLE PARTS

TABLE 6-1. REPLACEABLE PARTS (CONTINUED)

| REFERENCE DESIGNATION | HP PART NUMBER | QTY | DESCRIPTION                              | MFR CODE | MFR PART NUMBER |
|-----------------------|----------------|-----|--|----------|-----------------|
| A16R6                 | 2100-3455      | 1   | RESISTOR-VAR CONTROL CCP 2.5M 20% 10CW   | 01121    | WP4G048P255RZ   |
| A16R7                 | 0683-2005      | 7   | RESISTOR 20 5% .25W FC TC=-400/+500      | 01121    | CB2005          |
| A16R8                 | 0683-3325      | 6   | RESISTOR 3.3K 5% .25W FC TC=-400/+700    | 01121    | CB3325          |
| A16R9                 | 0683-1025      | 9   | RESISTOR 1K 5% .25W FC TC=-400/+600      | 01121    | CB1025          |
| A16R10                | 0683-1025      | 9   | RESISTOR 1K 5% .25W FC TC=-400/+600      | 01121    | CB1025          |
| A16S1                 | 3101-1621      | 2   | SWITCH-TGL SUBMIN DPDT NS 2A 250VAC PC   | 28480    | 3101-1621       |
| A16S2                 | 3101-1940      | 8   | SWITCH-PB DPDT MOM .02A 20VAC            | 28480    | 3101-1940       |
| A16 MISCELLANEOUS     |                |     |  |          |                 |
|                       | 1200-0474      | 9   | SOCKET-IC 14-CONT DIP-SLDR               | 28480    | 1200-0474       |
|                       | 1251-0600      | 0   | CONNECTOR-SGL CONT PIN 1.143MM3BSC-SZ SQ | 28480    | 1251-0600       |
|                       | 1251-2582      | 1   | CONNECTOR-PC EDGE 24-CONT/ROW 2-ROWS     | 28480    | 1251-2582       |
|                       | 5001-0156      | 6   | CONTACT, PC                              | 28480    | 5001-0156       |
|                       | 5001-0157      | 7   | SPRING, PC                               | 28480    | 5001-0157       |
|                       | 5040-6948      | 8   | INSULATOR, MALE                          | 28480    | 5040-6948       |
|                       | 5040-6949      | 9   | INSULATOR, FEMALE                        | 28480    | 5040-6949       |
|                       | 05000-20017    | 7   | SPACER, LED, SINGLE                      | 28480    | 05000-20017     |
|                       | 05328-20252    | 7   | SPACER, STANDOFF                         | 28480    | 05328-20252     |
|                       | 05328-40003    | 8   | SPACER, LED, LONG                        | 28480    | 05328-40003     |
|                       | 3130-0498      | 0   | SHAFT & INDEX ASSEMBLY 45 DEG INDEX, 8   | 28480    | 3130-0498       |
|                       | 3130-0500      | 5   | SHAFT & INDEX ASSEMBLY 36 DEG INDEX; 10  | 28480    | 3130-0500       |
| A17                   |                |     | NOT ASSIGNED                             |          |                 |
| A18                   |                |     | NOT ASSIGNED                             |          |                 |
| A19                   | 05328-60030    | 3   | SWITCH ASSEMBLY (SERIES 1736)            | 28480    | 05328-60030     |
| A19C1                 | 0180-0106      | 9   | CAPACITOR-FXD 60UF+-20% 6VDC TA          | 56289    | 150D606X0006B2  |
| A19C2                 | 0160-3879      | 7   | 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   | CAPACITOR-FXD 15UF+-10% 20VDC TA         | 56289    | 150D156X9020B2  |
| A19C9                 | 0180-1746      | 5   | CAPACITOR-FXD 15UF+-10% 20VDC TA         | 56289    | 150D156X9020B2  |
| A19C10                | 0160-3490      | 8   | CAPACITOR-FXD 1UF +-20% 50VDC CER        | 28480    | 0160-3490       |
| A19CR2                | 1901-0040      | 1   | 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       |
| 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   | LED-VISIBLE LUM-INT-800UCD IF=30MA-MAX   | 28480    | 5082-4984       |
| A19DS3                | 1990-0485      | 5   | LED-VISIBLE LUM-INT-800UCD IF=30MA-MAX   | 28480    | 5082-4984       |
| A19J1                 | 1251-2034      | 8   | CONNECTOR-PC EDGE 10-CONT/ROW 2-ROWS     | 28480    | 1251-2034       |
| A19J2                 | 1250-1163      | 0   | CONNECTOR-RF BNC FEM PC 50-DHM           | 28480    | 1250-1163       |
| A19J3                 | 1251-1626      | 2   | CONNECTOR-PC EDGE 12-CONT/ROW 2-ROWS     | 28480    | 1251-1626       |
| A19J4                 | 1250-1163      | 0   | CONNECTOR-RF BNC FEM PC 50-OHM           | 28480    | 1250-1163       |
| A19R1                 | 2100-3516      | 5   | RESISTOR-VAR W/SW 10K 20% LIN SPST-NO    | 01121    | WRS4G056S103M   |
| A19R2                 | 0683-1035      | 1   | RESISTOR 10K 5% .25W FC TC=-400/+700     | 01121    | CB1035          |
| A19R5                 | 0683-1035      | 1   | RESISTOR 10K 5% .25W FC TC=-400/+700     | 01121    | CB1035          |
| 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          |
| 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          |
| 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 10LK 5% .25W FC TC=-400/+700    | 01121    | CB1035          |
| A19R17                | 0683-1525      | 4   | RESISTOR 1.5K 5% .25W FC TC=-400/+700    | 01121    | CB1525          |
| A19R18                | 0683-2715      | 6   | 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          |

SEE INTRODUCTION TO THIS SECTION FOR ORDERING INFORMATION

MODEL 5328A  
REPLACEABLE PARTS

TABLE 6-1. REPLACEABLE PARTS (CONTINUED)

| REFERENCE DESIGNATION | HP PART NUMBER | QTY | DESCRIPTION                              | MFR CODE                              | MFR PART NUMBER   |           |
|-----------------------|----------------|-----|--|---------------------------------------|-------------------|-----------|
| A19R21                | 0683-6815      | 5   | RESISTOR 680 5% FC TC=-400/+600          | 01121                                 | CR6815            |           |
| 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                | 0683-1525      | 4   |  | RESISTOR 1.5K .25W FC TC=-400/=700    | 01121             | CB1525    |
| A19R26                | 0683-2025      | 1   | RESISTOR 2K 5% .25W FC TC=-400/+700      | 01121                                 | CB2025            |           |
| 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     |           |
| A19S1                 | 3101-1596      | 0   | SWITCH-SL DPDT-NS MINTR 1A 125VAC PC     | 28480                                 | 3101-1596         |           |
| A19S2                 | 3101-1596      | 0   | SWITCH-SL DPDT-NS MINTR 1A 125VAC PC     | 28480                                 | 3101-1596         |           |
| A19S3                 | 3101-1596      | 0   | SWITCH-SL DPDT-NS MINTR 1A 125VAC PC     | 28480                                 | 3101-1596         |           |
| A1984                 | 3101-1313      | 9   | SWITCH-SL DP3T-NS MINTR .5A 125VAC/DC PC | 28480                                 | 3101-1313         |           |
| A19S5                 | 3101-1596      | 0   |  | SWITCH-SL DPDT-NS MINTR 1A 125VAC PC  | 28480             | 3101-1596 |
| A19S6                 | 3101-1596      | 0   | SWITCH-SL DPDT-NS MINTR 1A 125VAC PC     | 28480                                 | 3101-1596         |           |
| A19S7                 | 3101-1596      | 0   | SWITCH-SL DPDT-NS MINTR 1A 125VAC PC     | 28480                                 | 3101-1596         |           |
| A19S8                 | 3101-1596      | 0   | SWITCH-SL DPDT-NS MINTR 1A 125VAC PC     | 28480                                 | 3101-1596         |           |
| A19TP1                | 0360-0124      | 3   | CONNECTOR-SGL CONT PIN .04-IN-BSC-SZ RND | 28480                                 | 0360-0124         |           |
| A19U1                 | 1820-1052      | 5   | IC XLTR ECL/TTL ECL-TO-TTL QUAD 2-INP    | 04713                                 | MC10125L          |           |
| A19 MISCELLANEOUS     |                |     |  |                                       |                   |           |
|                       | 05328-40004    | 9   | 2  | STANDOFF, LED, SHORT                  | 28480 05328-40004 |           |
|                       | 05328-60121    |     | 1  | KIT-SPARE PARTS<br>CONSIST OF:        | 28480 05328-60121 |           |
|                       | 1990-0404      |     | 3  | LED, RED MIN                          | 28480 1990-0404   |           |
|                       | 1990-0437      |     | 3  | LED, INDICATOR                        | 28480 1990-0437   |           |
|                       | 1990-0485      |     | 1  | LED, GREEN MIN                        | 28480 1990-0485   |           |
|                       | 05328-60120    |     | 1  | CABLE ASSEMBLY, OVERLOAD              | 28480 05328-60120 |           |
|                       | 2110-0001      |     | 6  | FUSE, 1A F. BLO                       | 28480 2110-0001   |           |
|                       | 2110-0002      |     | 5  | FUSE, .A F. BLO                       | 28480 2110-0002   |           |
|                       | 2110-0301      |     | 5  | FUSE, .12A MIN. AX                    | 28480 2110-0301   |           |

SEE INTRODUCTION TO THIS SECTION FOR ORDERING INFORMATION



MODEL 5328A  
REPLACEABLE PARTS

TABLE 6-1. REPLACEABLE PARTS (CONTINUED)

| REFERENCE DESIGNATION | HP PART NUMBER | QTY | DESCRIPTION | MFR CODE  | MFR PART NUMBER            |
|-----------------------|----------------|-----|-------------|---|----------------------------|
| CHASSIS PARTS         |                |     |             |   |                            |
| B1                    | 0950-1589      | 7   | 1           | FAN AND CONTROL MODULE ASSEMBLY                 | 28480 0950-1589            |
| ClA                   | 0160-0676      | 6   | 2           | CAPACITOR-FXD 1800PF +-10%                      | 28480 0160-0676            |
| ClB                   | 0160-0676      | 6   |             | CAPACITOR-FXD 1800PF/1800PF +-10%               | 28480 0160-0676            |
| F1                    | 2110-0001      | 8   | 1           | FUSE 1A 250V FAST-BLO 1.25X.25 UL IEC           | 75915 312001               |
| F1                    | 2110-0002      | 9   | 1           | FUSE 2A 250V FAST-BLO 1.25X.25 UL IEC           | 75915 312002               |
|                       | 2110-0464      | 7   | 1           | FUSEHOLDER-EXTR POST 20A 300V UL/IEC            | 75915 345002-010           |
|                       | 2110-0465      | 8   | 1           | FUSEHOLDER CAP EXTR PST, BAYONET, 20A           | 28480 2110-0465            |
|                       | 2110-0467      | 0   | 1           | NUT-HEX 1/2-28 THD 0.688 A/F                    | 75915 903-070              |
| Q1                    | 0340-0765      | 6   | 5           | INSULATOR-XSTR KAPTON                           | 28480 0340-0765            |
| Q2                    | 0340-0765      | 6   |             | INSULATOR-XSTR KAPTON                           | 28480 0340-0765            |
| Q7                    | 0340-0765      | 6   |             | INSULATOR-XSTR KAPTON                           | 28480 0340-0765            |
| Q8                    | 0340-0765      | 6   |             | INSULATOR-XSTR KAPTON                           | 28480 0340-0765            |
| Q11                   | 0340-0765      | 6   |             | INSULATOR-XSTR KAPTON                           | 28480 0340-0765            |
| S1                    | 3101-1234      | 3   | 1           | SWITCH-SL DPDT-NS STD 1.5A 250VAC               | 28480 3101-1234            |
| T1                    | 9100-3046      | 3   | 1           | TRANSFORMER-PWR PRI: 100/120/220/240V           | 28480 9100-3046            |
| W1                    | 8120-1378      | 1   | 1           | CABLE ASSY 18AWG 3-CNDCT JGK-JKT                | 27480 8120-1378            |
| MISCELLANEOUS PARTS   |                |     |             |   |                            |
|                       | 0380-0004      | 0   | 2           | SPACER,RND .188.IN.LG .18.IN.ID                 | 00000 ORDER BY DESCRIPTION |
|                       | 1200-0547      | 7   | 6           | LOCK-DUAL INLINE PKG IC FOR 14 PIN              | 28480 1200-0547            |
|                       | 1250-0083      | 1   | 3           | CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM         | 28480 1250-0083            |
|                       | 1390-0406      | 8   | 4           | FASTENER-CATCH STRIKE PL 16 GA STL, 1.00        | 28480 1390-0406            |
|                       | 1400-0560      | 8   | 1           | CLAMP/HOLDER-CMPNT/CA (MISC)3                   | 28480 1400-0560            |
|                       | 2190-0016      | 3   | 1           | WASHER-LK INTL T 3/8 IN .377-IN-ID              | 28480 2190-0016            |
|                       | 4040-1214      | 0   | 1           | PANEL, PLASTIC                                  | 28480 4040-1214            |
|                       | 7101-0470      | 1   | 1           | COVER ASSEMBLY                                  | 28480 7101-0470            |
|                       | 7120-7018      | 3   | 1           | NAME PLATE, FRONT                               | 28480 7120-7018            |
|                       | 8120-0520      | 3   | 3           | CABLE ASSY                                      | 28480 8120-0520            |
|                       | 5040-7216      | 5   | 2           | WASHER, HANDLE                                  | 28480 5040-7216            |
|                       | 5040-7221      | 2   | 4           | FOOT, REAR                                      | 28480 5040-7221            |
|                       | 5040-7224      | 5   | 2           | HANDLE ADAPTER                                  | 28480 5040-7224            |
|                       | 8120-2176      | 9   | 1           | CABLE ASSY                                      | 28480 8120-2176            |
|                       | 05328-00003    | 4   | 1           | BRACKET,FRONT                                   | 28480 05328-00003          |
|                       | 05328-00011    | 4   | 1           | SHIELD, FREQUENCY C                             | 28480 05328-00011          |
|                       | 05328-00014    | 7   | 1           | PLATE, COVER, ASCII                             | 28480 05328-00014          |
|                       | 05328-00017    | 0   | 1           | PANEL, REAR                                     | 28480 05328-00017          |
|                       | 05328-00019    | 2   | 1           | BRACKET, FAN                                    | 28480 05328-00019          |
|                       | 05328-00020    | 5   | 1           | HANDLE, FRONT                                   | 28480 05328-00020          |
|                       | 05328-00021    | 6   | 1           | COVER, TOP                                      | 28480 05328-00021          |
|                       | 05328-00022    | 7   | 1           | COVER, BOTTOM                                   | 28480 05328-00022          |
|                       | 05328-20212    | 9   | 1           | PANEL, DISPLAY                                  | 28480 05328-20212          |
|                       | 05328-20217    | 4   | 1           | PANEL, FRONT                                    | 28480 05328-20217          |
|                       | 05328-20253    | 8   | 2           | THUMB SCREW                                     | 28480 05328-20253          |
|                       | 05328-60115    | 5   | 1           | CABLE ASSEMBLY, OSCILLATOR                      | 28480 05328-60115          |
|                       | 05328-60120    | 2   | 2           | CABLE ASSEMBLY, OVERLOAD INDICATOR (WITH A8DS1) | 28480 05328-60120          |
|                       | 05328-62016    | 9   | 2           | BOARD ASSEMBLY, EXTENDER                        | 28480 05328-62016          |
|                       | 05328-90055    | 4   | 1           | MANUAL, OPERATING AND SERVICE                   | 28480 05328-90055          |
|                       | 05328-90057    | 8   | 1           | BOOKLET, OPERATING                              | 28480 05328-90057          |
|                       | 1460-1345      | 5   | 2           | TILT STAND SST                                  | 28480 1460-1345            |
|                       | 2950-0001      | 8   | 6           | NUT-HEX-DBL-CHAM 3/8-32-THD .094-IN-THK         | 00000 ORDER BY DESCRIPTION |
|                       | 2950-0035      | 8   | 4           | NUT-HEX-DBL-0CHAM 15/32-32-THD                  | 00000 ORDER BY DESCRIPTION |
|                       | 0370-1005      | 2   | 1           | KNOB-BASE-PTR 3/8 JGK .125-IN-ID                | 28480 0370-1005            |
|                       | 0370-1097      | 2   | 1           | KNOB-BASE-PTR 1/2 JGK .125-IN-ID                | 28480 0370-1097            |
|                       | 0370-1107      | 5   | 2           | KNOB-BASE-PTR-AND-BAR 1/2 JGK .25-IN-ID         | 28480 0370-1107            |
|                       | 1251-2357      | 8   | 1           | CONNECTOR-AC PWR HP-9 MALE FLG-MTG              | 28480 1251-2357            |
|                       | 3101-0851      | 8   | 1           | CAP-PUSHBUTTON BLACK; .2-IN DIA; .155-IN        | 28480 3101-0851            |
|                       | 7120-0644      | 1   | 1           | LABEL, WARNING                                  | 28480 7120-0644            |
|                       | 7122-0097      | 2   | 1           | NAMEPLATE, REAR                                 | 28480 7122-0097            |
|                       | 5020-8801      | 4   | 1           | FRAME, FRONT, FULL                              | 28480 5020-8801            |
|                       | 5020-8802      | 5   | 1           | FRAME, REAR                                     | 28480 5020-8802            |
|                       | 5020-8831      | 0   | 2           |   | 28480 5020-8831            |
|                       | 5040-7201      | 8   | 4           | FOOT(STANDARD)                                  | 82480 5040-7201            |
|                       | 5040-7202      | 9   | 1           | TRIM, TOP                                       | 28480 5040-7202            |
|                       | 05328-00001    | 2   | 1           | BRACKET, MAIN                                   | 28480 05328-00001          |
|                       | 05328-00002    | 3   | 3           | BRACKET, CORNER                                 | 28480 05328-00002          |
|                       | 05328-00015    | 8   | 1           | INSULATOR, P.S.                                 | 28480 05328-00015          |

SEE INTRODUCTION TO THIS SECTION FOR ORDERING INFORMATION

Table 6-2. Manufacturers Code list

| Mfr No. | Manufacturer Name                   | Address                  | Zip Code |
|---------|-------------------------------------|--------------------------|----------|
| 00000   | U.S.A. Common                       | Any Supplier of the U.S. |          |
| 01121   | Allen-Bradley Co                    | Milwaukee, WI            | 53204    |
| 01295   | Texas Instr Inc Semicond Cmpnt Div  | Dallas, TX               | 75222    |
| 01928   | RCA Corp Solid State Div            | Somerville, NJ           | 08876    |
| 02111   | Spectrol Electronics Corp           | City of Ind, CA          | 91745    |
| 02114   | Ferroxcube Corp                     | Saugerties, NY           | 12477    |
| 03508   | GE Co Semiconductor Prod Dept       | Syracuse, NY             | 13201    |
| 04713   | Motorola Semiconductor Products     | Phoenix, AZ              | 85062    |
| 07263   | Fairchild Semiconductor Div         | Mountain View, CA        | 94042    |
| 17856   | Siliconix Inc                       | Santa Clara, CA          | 95054    |
| 18324   | Signetics Corp                      | Sunnyvale, CA            | 94086    |
| 19701   | Mepco/Electra Corp                  | Mineral Wells, TX        | 76067    |
| 24046   | Transitron Electronic Corp          | Wakefield, MA            | 01880    |
| 24546   | Corning Glass Works (Bradford)      | Bradford, PA             | 16701    |
| 24931   | Specialty Connector Co Inc          | Indianapolis, IN         | 46227    |
| 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    |
| 32997   | Bourns Inc Trimpot Prod Div         | Riverside, CA            | 92507    |
| 34335   | Advanced Micro Devices Inc          | Sunnyvale, CA            | 94086    |
| 51642   | Centre Engineering Inc              | State College, PA        | 16801    |
| 52763   | Stettner-Trush Inc                  | Cazenovia, NY            | 13035    |
| 56289   | Sprague Electric Co                 | North Adams, MA          | 01247    |
| 72136   | Electro Motive Corp Sub IEC         | Willimantic, CT          | 06226    |
| 73138   | Beckman Instruments Inc Helipot Div | Fullerton, CA            | 92634    |
| 75042   | TRW Inc Philadelphia Div            | Philadelphia, PA         | 19108    |
| 75915   | Littelfuse Inc                      | Des Plaines, IL          | 60016    |
| 84411   | TRW Capacitor Div                   | Ogallala, NE             | 69153    |

TABLE 6-3  
PART NUMBER - NATIONAL STOCK NUMBER  
CROSS REFERENCE INDEX

| PART<br>NUMBER | FSCM  | NATIONAL<br>STOCK<br>NUMBER | REPLACEMENT    |                             | SMR<br>CODE |
|----------------|-------|-----------------------------|----------------|-----------------------------|-------------|
|                |       |                             | PART<br>NUMBER | NATIONAL<br>STOCK<br>NUMBER |             |
| DV11PS18A      | 73899 | 5910-00-983-2623            |                |                             | XDHZZ       |
| 0121-0059      | 28480 | 5910-00-776-4185            |                |                             | XDHZZ       |
| 0121-0061      | 28480 | 5910-00-983-2623            |                |                             | XDHZZ       |
| 0121-0180      | 28480 | 5910-00-410-2393            |                |                             | XDHZZ       |
| 0140-0177      | 28480 | 5910-00-917-9737            |                |                             | XDHZZ       |
| 0140-0202      | 28480 | 5910-00-852-2655            |                |                             | XDHZZ       |
| 0140-0209      | 28480 | 5910-00-920-3776            |                |                             | XDHZZ       |
| 0140-0214      | 28480 | 5910-00-835-3251            |                |                             | XDHZZ       |
| 0140-0215      | 28480 | 5910-00-023-2355            |                |                             | XDHZZ       |
| 0140-0221      | 28480 | 5910-00-772-6728            |                |                             | XDHZZ       |
| 0140-0225      | 28480 | 5910-00-078-1950            |                |                             | XDHZZ       |
| 0150-0096      | 28480 | 5910-00-247-7226            |                |                             | XDHZZ       |
| 0160-0127      | 28480 | 5910-00-809-5484            |                |                             | XDHZZ       |
| 0160-0128      | 28480 | 5910-00-057-3934            |                |                             | XDHZZ       |
| 0160-0154      | 28480 | 5910-00-879-7210            |                |                             | XDHZZ       |
| 0160-0161      | 28480 | 5910-00-911-9271            |                |                             | XDHZZ       |
| 0160-0174      | 28480 | 5910-00-234-9817            |                |                             | XDHZZ       |
| 0160-0314      | 28480 | 5910-00-982-8390            |                |                             | XDHZZ       |
| 0160-0342      | 28480 | 5910-00-776-4176            |                |                             | XDHZZ       |
| 0160-2055      | 28480 | 5910-00-211-1611            |                |                             | XDHZZ       |
| 0160-2242      | 28480 | 5910-00-957-2765            |                |                             | XDHZZ       |
| 0160-2244      | 28480 | 5910-00-008-4451            |                |                             | XDHZZ       |
| 0160-2246      | 28480 | 5910-00-430-5697            |                |                             | XDHZZ       |
| 0160-3043      | 28480 | 5910-00-472-5006            |                |                             | XDHZZ       |
| 0160-3879      | 28480 | 5910-00-477-8011            |                |                             | XDHZZ       |
| 0170-0024      | 28480 | 5910-00-726-6249            |                |                             | XDHZZ       |
| 0170-0040      | 28480 | 5910-00-829-0245            |                |                             | XDHZZ       |
| 0170-0055      | 28480 | 5910-00-797-9742            |                |                             | XDHZZ       |
| 0180-0106      | 28480 | 5910-00-127-1668            |                |                             | XDHZZ       |
| 0180-0119      | 28480 | 5910-00-864-8416            |                |                             | XDHZZ       |
| 0180-0124      | 28480 | 5190-00-962-0338            |                |                             | XDHZZ       |
| 0180-0229      | 28480 | 5910-00-403-2449            |                |                             | XDHZZ       |
| 0180-0374      | 28480 | 5910-00-931-7050            |                |                             | XDHZZ       |
| 0180-1701      | 28480 | 5910-00-615-7483            |                |                             | XDHZZ       |
| 0180-1735      | 28480 | 5910-00-430-6016            |                |                             | XDHZZ       |
| 0180-1746      | 28480 | 5910-00-430-6036            |                |                             | XDHZZ       |
| 0360-0124      | 28480 | 5940-00-993-9338            |                |                             | XDHZZ       |
| 0675-1021      | 28480 | 5905-00-420-7124            |                |                             | XDHZZ       |
| 0683-1005      | 28480 | 5905-00-960-0099            |                |                             | XDHZZ       |
| 0683-1015      | 28480 | 5905-00-102-5294            |                |                             | XDHZZ       |
| 0683-1035      | 28480 | 5905-00-998-1929            |                |                             | XDHZZ       |
| 0683-2015      | 28480 | 5905-00-683-2239            |                |                             | XDHZZ       |
| 0683-2025      | 28480 | 5905-00-686-3370            |                |                             | XDHZZ       |
| 0683-2055      | 28480 | 5905-00-762-8168            |                |                             | XDHZZ       |
| 0683-2725      | 28480 | 5905-00-882-2723            |                |                             | XDHZZ       |
| 0683-3015      | 28480 | 5905-00-682-4110            |                |                             | XDHZZ       |
| 0683-3355      | 28480 | 5905-00-402-4264            |                |                             | XDHZZ       |
| 0683-3905      | 28480 | 5905-00-498-6059            |                |                             | XDHZZ       |
| 0683-5115      | 28480 | 5905-00-801-8272            |                |                             | XDHZZ       |
| 0683-5125      | 28480 | 5905-00-139-1642            |                |                             | XDHZZ       |
| 0683-6815      | 28480 | 5905-00-727-8001            |                |                             | XDHZZ       |
| 0698-3111      | 28480 | 5905-00-420-7126            |                |                             | XDHZZ       |
| 0698-3136      | 28480 | 5905-00-891-4247            |                |                             | XDHZZ       |
| 0698-3152      | 28480 | 5905-00-420-7130            |                |                             | XDHZZ       |
| 0698-3153      | 28480 | 5905-00-974-6081            |                |                             | XDHZZ       |
| 0698-3156      | 28480 | 5905-00-974-6084            |                |                             | XDHZZ       |
| 0698-3157      | 28480 | 5905-00-433-6904            |                |                             | XDHZZ       |
| 0698-3160      | 28480 | 5905-00-974-6078            |                |                             | XDHZZ       |
| 0698-3378      | 28480 | 5905-00-856-9865            |                |                             | XDHZZ       |
| 0698-5103      | 28480 | 5905-00-420-7139            |                |                             | XDHZZ       |
| 0698-5426      | 28480 | 5905-00-139-2271            |                |                             | XDHZZ       |
| 0698-5996      | 28480 | 5905-00-172-4901            |                |                             | XDHZZ       |
| 0698-5999      | 28480 | 5905-00-444-5552            |                |                             | XDHZZ       |
| 0757-0199      | 28480 | 5905-00-981-7513            |                |                             | XDHZZ       |
| 0757-0200      | 28480 | 5905-00-891-4224            |                |                             | XDHZZ       |
| 0757-0279      | 28480 | 5905-00-221-8310            |                |                             | XDHZZ       |

TABLE 6-3  
PART NUMBER - NATIONAL STOCK NUMBER

CROSS REFERENCE INDEX

| PART NUMBER | FSCM  | NATIONAL STOCK NUMBER | REPLACEMENT |      | SMR CODE |
|-------------|-------|-----------------------|-------------|------|----------|
|             |       |                       | PART NUMBER | FSCM |          |
| 0757-0280   | 28480 | 5905-00-853-8190      |             |      | XDHZZ    |
| 0757-0283   | 28480 | 5905-00-998-1909      |             |      | XDHZZ    |
| 0757-0421   | 28480 | 5905-00-891-4219      |             |      | XDHZZ    |
| 0757-0427   | 28480 | 5905-00-917-0578      |             |      | XDHZZ    |
| 0757-0428   | 28480 | 5905-00-998-1794      |             |      | XDHZZ    |
| 0757-0438   | 28480 | 5905-00-929-2529      |             |      | XDHZZ    |
| 0757-0439   | 28480 | 5905-00-990-0303      |             |      | XDHZZ    |
| 0757-0442   | 28480 | 5905-00-998-1792      |             |      | XDHZZ    |
| 0757-0447   | 28480 | 5905-00-981-7530      |             |      | XDHZZ    |
| 0757-0454   | 28480 | 5905-00-891-2811      |             |      | XDHZZ    |
| 0757-0900   | 28480 | 5905-00-935-8470      |             |      | XDHZZ    |
| 0757-0924   | 28480 | 5905-00-102-5693      |             |      | XDHZZ    |
| 0757-0931   | 28480 | 5905-00-998-1825      |             |      | XDHZZ    |
| 0757-0938   | 28480 | 5905-00-858-6501      |             |      | XDHZZ    |
| 0757-0950   | 28480 | 5905-00-935-8481      |             |      | XDHZZ    |
| 09-52-3030  | 27264 | 5935-00-238-5507      |             |      | XDHZZ    |
| 1200-0063   | 28480 | 5999-00-937-4420      |             |      | XDHZZ    |
| 1205-0011   | 28480 | 5999-00-789-3794      |             |      | XDHZZ    |
| 1250-0083   | 28480 | 5935-00-804-5144      |             |      | XDHZZ    |
| 1250-0835   | 28480 | 5935-00-068-3546      |             |      | XDHZZ    |
| 1250-0870   | 28480 | 5935-00-172-1007      |             |      | XDHZZ    |
| 1251-2026   | 28480 | 5935-00-446-8768      |             |      | XDHZZ    |
| 1251-2034   | 28480 | 5935-00-267-2973      |             |      | XDHZZ    |
| 1251-2357   | 28480 | 5935-00-233-6728      |             |      | XDHZZ    |
| 1251-3246   | 28480 | 5935-00-238-5507      |             |      | XDHZZ    |
| 1810-0020   | 28480 | 5905-00-173-3935      |             |      | XDHZZ    |
| 1810-0041   | 28480 | 5905-00-470-7377      |             |      | XDHZZ    |
| 1810-0055   | 28480 | 5905-00-548-0915      |             |      | XDHZZ    |
| 1820-0054   | 28480 | 5962-00-138-5248      |             |      | XDHZZ    |
| 1820-0055   | 28480 | 5962-00-493-5961      |             |      | XDHZZ    |
| 1820-0068   | 28480 | 5962-00-865-4626      |             |      | XDHZZ    |
| 1820-0074   | 28480 | 5962-00-451-6345      |             |      | XDHZZ    |
| 1820-0077   | 28480 | 5962-00-138-5250      |             |      | XDHZZ    |
| 1820-0099   | 28480 | 5962-00-102-7520      |             |      | XDHZZ    |
| 1820-0174   | 28480 | 5962-00-404-2559      |             |      | XDHZZ    |
| 1820-0175   | 28480 | 5962-00-229-8500      |             |      | XDHZZ    |
| 1820-0196   | 28480 | 5962-00-451-3131      |             |      | XDHZZ    |
| 1820-0223   | 28480 | 5962-00-614-5251      |             |      | XDHZZ    |
| 1820-0301   | 28480 | 5962-00-270-1960      |             |      | XDHZZ    |
| 1820-0328   | 28480 | 5962-00-009-1356      |             |      | XDHZZ    |
| 1820-0537   | 28480 | 5962-01-034-9974      |             |      | XDHZZ    |
| 1820-0736   | 28480 | 5962-00-513-2691      |             |      | XDHZZ    |
| 1820-0802   | 28480 | 5962-00-496-2209      |             |      | XDHZZ    |
| 1820-1019   | 28480 | 5962-01-022-3250      |             |      | XDHZZ    |
| 1853-0016   | 28480 | 5961-00-901-4862      |             |      | XDHZZ    |
| 1853-0020   | 28480 | 5961-00-904-2540      |             |      | XDHZZ    |
| 1853-0036   | 28480 | 5961-00-931-0372      |             |      | XDHZZ    |
| 1853-0326   | 28480 | 5961-00-471-2984      |             |      | XDHZZ    |
| 1854-0071   | 28480 | 5961-00-137-4608      |             |      | XDHZZ    |
| 1854-0092   | 28480 | 5961-00-943-7572      |             |      | XDHZZ    |
| 1854-0215   | 28480 | 5961-00-892-8706      |             |      | XDHZZ    |
| 1855-0081   | 82480 | 5961-00-350-8299      |             |      | XDHZZ    |
| 1901-0040   | 28480 | 5961-00-965-5917      |             |      | XDHZZ    |
| 1901-0050   | 28480 | 5961-00-914-7496      |             |      | XDHZZ    |
| 1901-0376   | 28480 | 5961-00-790-7834      |             |      | XDHZZ    |
| 1901-0518   | 28480 | 5961-00-430-6819      |             |      | XDHZZ    |
| 1901-0535   | 28480 | 5961-00-451-8685      |             |      | XDHZZ    |
| 1901-0638   | 28480 | 5961-00-471-2987      |             |      | XDHZZ    |
| 1902-0031   | 28480 | 5961-00-718-7329      |             |      | XDHZZ    |
| 1902-0074   | 28480 | 5961-00-766-1459      |             |      | XDHZZ    |
| 1902-0126   | 28480 | 5961-00-780-8330      |             |      | XDHZZ    |
| 1902-0579   | 28480 | 5961-00-452-0438      |             |      | XDHZZ    |
| 1902-0774   | 28480 | 5961-00-057-7873      |             |      | XDHZZ    |
| 1902-3036   | 28480 | 5961-00-350-2205      |             |      | XDHZZ    |
| 1902-3082   | 28480 | 5961-00-448-9737      |             |      | XDHZZ    |
| 1902-3224   | 28480 | 5961-00-195-3526      |             |      | XDHZZ    |
| 1910-0016   | 28480 | 5961-00-954-9182      |             |      | XDHZZ    |

TABLE 6-3  
 PART NUMBER - NATIONAL STOCK NUMBER  
 CROSS REFERENCE INDEX

| PART<br>NUMBER | FSCM  | NATIONAL<br>STOCK<br>NUMBER | REPLACEMENT    |                             | SMR<br>CODE |
|----------------|-------|-----------------------------|----------------|-----------------------------|-------------|
|                |       |                             | PART<br>NUMBER | NATIONAL<br>STOCK<br>NUMBER |             |
| 2100-1738      | 28480 | 5905-00-256-8993            |                |                             | KDHZZ       |
| 2100-2522      | 28480 | 5905-00-476-5797            |                |                             | KDHZZ       |
| 2100-2632      | 28480 | 5905-00-476-5718            |                |                             | KDHZZ       |
| 2100-2633      | 28480 | 5905-00-476-5796            |                |                             | KDHZZ       |
| 2110-0269      | 28480 | 5999-00-333-9620            |                |                             | KDHZZ       |
| 2950-0001      | 28480 | 5310-00-450-3324            |                |                             | KDHZZ       |
| 2950-0035      | 28480 | 5310-00-454-1335            |                |                             | KDHZZ       |
| 3101-1234      | 28480 | 5930-00-406-8746            |                |                             | KDHZZ       |
| 4040-0747      | 28480 | 5999-00-230-8833            |                |                             | KDHZZ       |
| 4040-0748      | 2848C | 5999-00-230-8834            |                |                             | KDHZZ       |
| 4040-0752      | 28480 | 5999-00-230-8832            |                |                             | KDHZZ       |
| 8120-1378      | 28480 | 6150-00-008-5075            |                |                             | KDHZZ       |
| 8159-0005      | 28480 | 6625-01-014-3446            |                |                             | KDHZZ       |
| 9100-2288      | 28480 | 5950-01-013-7377            |                |                             | KDHZZ       |
| 9140-0096      | 28480 | 5950-00-138-1381            |                |                             | KDHZZ       |
| 9140-0131      | 28480 | 5905-00-919-5713            |                |                             | KDHZZ       |
| 9140-0137      | 28480 | 5950-00-984-3433            |                |                             | KDHZZ       |
| 9140-0178      | 28480 | 5950-00-199-7652            |                |                             | KDHZZ       |



**SECTION VII  
MANUAL CHANGES**

**7-1. INTRODUCTION**

7-2. This section contains information for adapting this manual to instruments for which the content does not apply directly. This manual applies directly to instruments having serial prefix 1808A. Refer to Section I for additional important information about serial number coverage.

**7-3. MANUAL CHANGES SHEET**

7-4. Instruments having serial prefixes higher than 1808A are covered with a "Manual Changes" sheet, following.

**MANUAL DESCRIPTION**

INSTRUMENT: 5328A/H42 Frequency Counter  
 Operating and Service Manual  
 SERIAL PREFIX: 1808A  
  
 DATE PRINTED: JUNE 1978  
 HP PART NO: 05328-90055  
 MICROFICHE NO: 05328-90056

**CHANGE DATE** July 7, 1978  
 (This change supersedes all earlier dated changes)

- Make all changes listed as ERRATA.
- Check the following table for your instrument's serial prefix or serial number and make listed change(s) to manual

| IF YOUR INSTRUMENT HAS SERIAL PREFIX OR SERIAL NUMBER | MAKE THE FOLLOWING CHANGES TO YOUR MANUAL | IF YOUR INSTRUMENT HAS SERIAL PREFIX OR SERIAL NUMBER | MAKE THE FOLLOWING CHANGES TO YOUR MANUAL |
|---|---|---|---|
| ▶ 1828A   | 1   |   |   |
|   |   |   |   |

▶ NEW OR REVISED ITEM

▶ EFIRATA

- ▶ Page 6-16, Table 6-1, A12 (05328-60031) Replaceable Parts:  
 Add (SERIES 1636) to the Description of A12.
- ▶ Page 8-33, Figure 8-20, A12 Component Locator:  
 Change "C4" to C3 and "C3" to C4. The "C3" and "C4" component locators are transposed in the illustration.
- ▶ Page 1-2, Paragraph 1-17:  
 Add the following sentence: The 05328-60121 Spare Parts Kit is described a the end of Table 6-1.
- ▶ Page Page 1-2, Table 1-1, Equipment Supplied:  
 Add KIT-SPARE PARTS HP PART NUMBER 05328-60121.
- ▶ Page Page 1-2, Paragraph 1-19:  
 Change "5328AF/096" to read 5328 A/H42.
- ▶ Page 6-12, Table 6-1, A8 (05328-60032) Replaceable Parts:  
 Change A8R40\* to HP Part No. 0698-4132 6; RESISTOR 62 5% .125W CC TC=-270/+540; 01121; BB6205.  
 Change A8R67 to A8R67\*; 0698-4132 6; RESISTOR 62 5% .125W CC TC=-270/+540; 01121; BB6205; "FACTORY SELECTED PART.
- ▶ Page Page 8-27, Figure 8-14, A8 (05328-60032) Schematic Diagram:  
 Change A8R40 and R67 to 62 ohms.
- ▶ Page Page 8-21, Figure 8-10, A3/A3A1 Schematic Diagram and Component Locator:  
 Change reference designator for capacitor connected to U4A pin 4 in A3 schematic diagram from C22 to C14.  
 Change reference designator for diode located below J2 and R16 in A3 component locator from CR4 to CR3.



► CHANGE 1 (1828A)

► Pages 6-7 and 6-8, Table 6-1, A2 (05328-60035) Replaceable Parts:

Change A2 series number from 1808 to 1828.

Change A2R34 and R35 from 0811-1340 (**1 $\Omega$** ) to 0812-0021; RESISTOR **0.47 $\Omega$**  5%  
3W WW TC=0  $\pm$  90; 91637; CW2B1-3-T2-47/100-J.

► Page 8-19, Figure 8-9, A2 (05328-60035) schematic Diagram:

Change "SERIES 1808" at top of diagram to SERIES 1828.

Change A2R34 and R35 from 1.0 to 0.47 ohms.

► Page 6-24, Table 2, Manufacturers Code List:

Add 91637 DALE ELECTRONICS INC. COLUMBUS, NE 68601

► Pages 6-16 and 6-17, Table 6-1, A12 (05328-60031) Replaceable Parts:

Change A12 series number from 1636 to 1828.

Change A12CR7 and CR9 from 1902-0126 (2.61V) to 1902-3048; DIODE-ZNR 3.48V 5% DO-7  
PD= .4W TC= -.058%; 28480; 1902-3048.

► **Page** Page 8-33, Figure 8-20, A12 (05328-60031) Schematic Diagram:

Change A12 series number from 1636 to 1828.

Change voltage adjacent to A12CR7 and CR9 from 2.61 to 3.48V



## SECTION VIII SCHEMATIC DIAGRAMS

### 8-1. INTRODUCTION

8-2. This section contains schematic diagrams and part locators. The part locators show the location by reference designator.

### 8-3. SCHEMATIC DIAGRAM SYMBOLS AND REFERENCE DESIGNATORS

8-4. Figure 8-1 shows the symbols used on the schematic diagrams. At the bottom of Figure 8-1, the system for reference designators, assemblies, and subassemblies are shown.

### 8-5. Reference Designations

8-6. Assemblies such as printed-circuit boards are assigned numbers in sequence, A1, A2, etc. As shown in Figure 8-1, subassemblies within an assembly are given a subordinate A number. For example, rectifier subassembly A1 has the complete designator of A25A1. For individual components, the complete designator is determined by adding the assembly number and subassembly number if any. For example, CR1 on the rectifier assembly is designated A25A1CR1.

### 8-7. SIGNAL MNEMONICS

8-8. Table 8-1 contains a list of the mnemonics used to identify signals on the schematic diagrams.

### 8-9. IDENTIFICATION MARKINGS ON PRINTED-CIRCUIT BOARDS

8-10. HP printed-circuit boards (see Figure 8-1) have four identification numbers: an assembly part number, a series number, a revision letter, and a production code.

8-11. The assembly part number has 10 digits (such as 05328-60018) and is the primary identification. All assemblies with the same part number are interchangeable. When a production change is made on an assembly that makes it incompatible with previous assemblies, a change in part number is required. The series number (such as 1704A) is used to document minor electrical changes. As changes are made, the series number is incremented. When replacement boards are ordered, you may receive a replacement with a different series number. If there is a difference between the series number marked on the board and the schematic in this manual, a minor electrical difference exists. If the number on the printed-circuit board is lower than that on the schematic, refer to Section VII for backdating information. If it is higher, refer to the loose leaf manual change sheets for this manual. If the manual change sheets are missing, contact your local Hewlett-Packard Sales and Service Office. See the listing on the back cover of this manual.

8-12. Revision letters (A, B, etc.) denote changes in printed-circuit layout. For example, if a capacitor type is changed (electrical value may remain the same) and requires different spacing for its leads, the printed-circuit board layout is changed and the revision letter is incremented to the next letter. When a revision letter changes, the series number is also usually changed. The production code is the four-digit seven-segment number used for production purposes.

**Model 5328A**  
**Schematic Diagrams**

8-13. Symbols are used on PC boards to aid in identifying pin numbers, diode elements, etc., as follows:

**Δ OR □**

**IDENTIFIES:**

Pin 1 of dip and flat-pack IC's.  
Tab of TO CASES.  
+ side of electrolytic capacitors.  
Pin 1 of resistor packs.  
Cathode of diodes.  
Section I of dip switches.

**8-14. ASSEMBLY LOCATIONS AND COMPONENT LOCATORS**

6-15. Figures in this section show the front, rear, and top views of the 5328A. The front and rear views shows reference designators of the front and rear panel controls, connectors, and indicators. The top view shows assembly locations. Component locators for each printed-circuit assembly are located next to the schematics.

**8-16. FACTORY SELECTED COMPONENTS**

8-17. Factory selected parts are identified by an asterisk on the schematic and in the parts list. The nominal value is shown on the schematics and is listed in the table of replaceable parts. A table-format summary on the schematic indexes factory selected parts by reference designator, describes what they are selected for and the range of normal values.

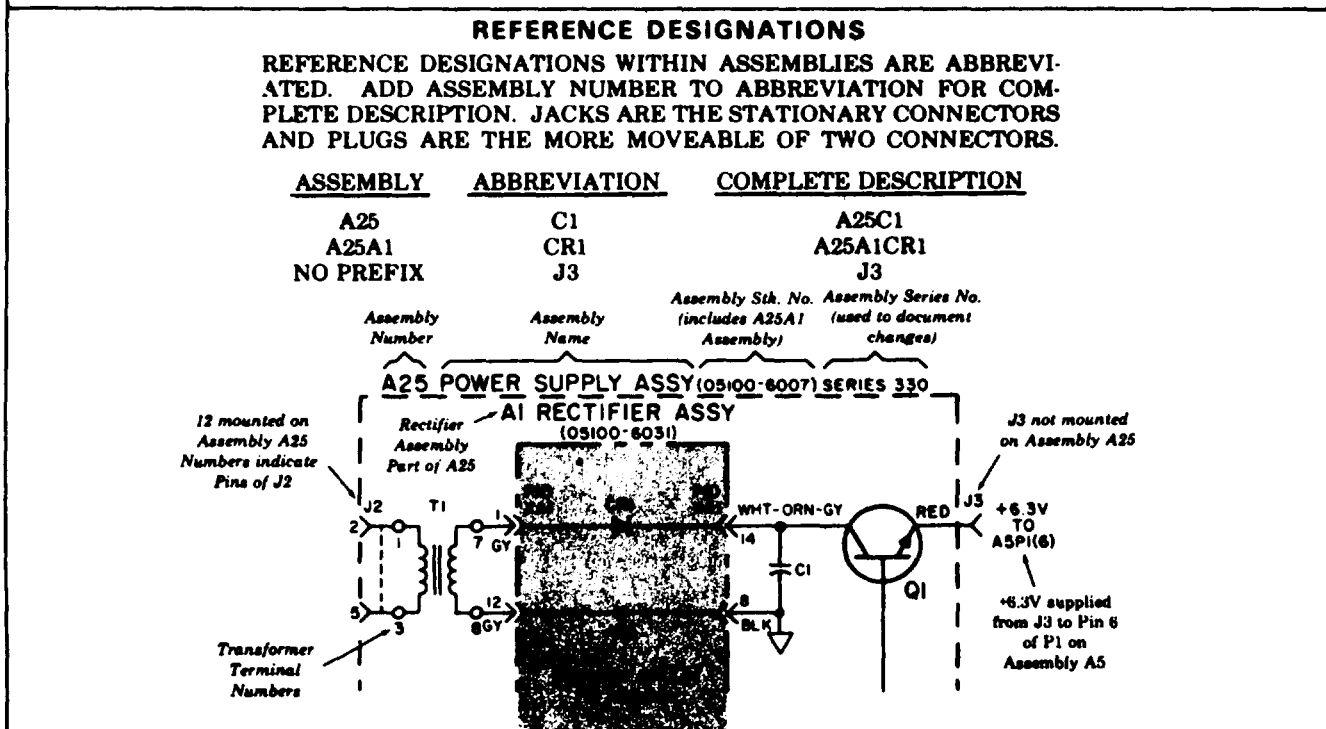
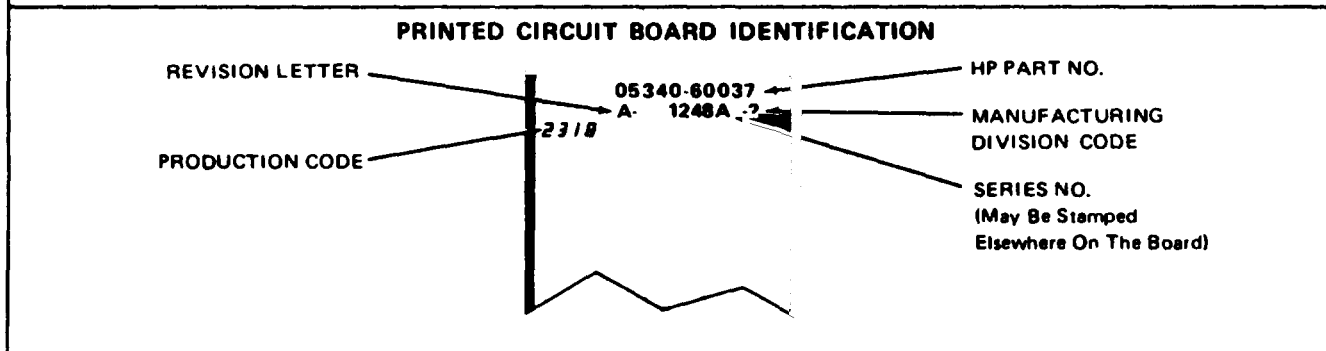
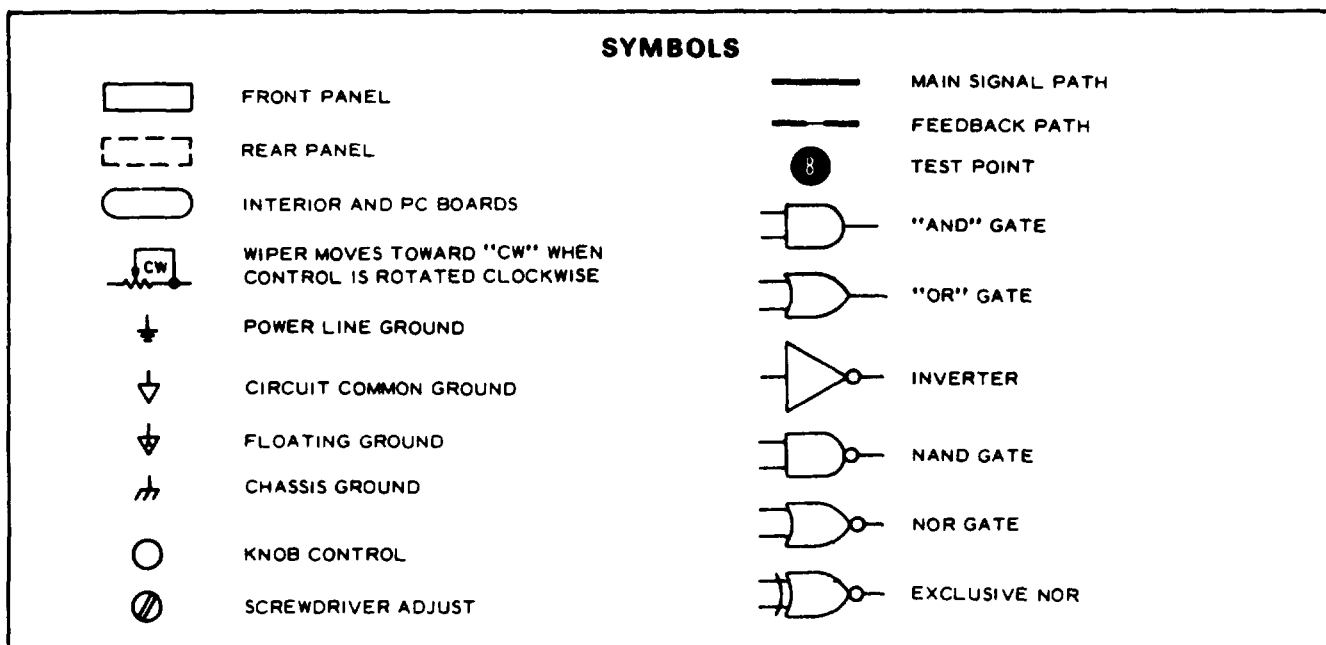


Figure 8-1. Schematic Diagram Notes

*Table 8-1. Signal Mnemonics*

| MNEMONIC   | DESCRIPTION   |
|--|---|
| A<br>$\overline{A}$  | Output of Time Interval Unit, A channel. ECL levels.  |
| R (A0)<br>R (A1)   | Non-latched ROM bits that drive Arming Multiplexer select lines on Function Selector. TTL levels.                           |
| B<br>B   | Output of Time Interval Unit, B channel. ECL levels.  |
| C<br>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. Digit address clock to display. TTL levels.  |
| Data A<br>Data B<br>Data C<br>Data D                             | TTL 4-bit BCD code. Data going to display and HP-IB.  |
| Digit A<br>Digit B<br>Digit C<br>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)<br>F Code B (FB)<br>F Code C (FC)<br>F Code D (FD) | Function code from function switch. TTL levels.   |
| FS   | Function Selector.  |
| $\overline{GOSC}$<br>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)   | Non-latched ROM bit which enables the TTL level Channel A signal from the Function Selector to be counted by the Time Base. |

Table 8-1. Signal Mnemonics (Continued)

| MNEMONIC                      | DESCRIPTION   |
|-------------------------------|---|
| RL (HTBB)                     | Latched ROM bit which enables the TTL level Channel B signal from the Function Selector to be counted by the Time Base.   |
| R (HTBO)                      | Non-latched ROM bit which enables the time base to count the oscillator output.   |
| RL (IA)<br>RL (IB)<br>RL (IC) | TTL level latched ROM bits that drive High Speed Multiplexer select lines on Function Selector.   |
| L 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 disable display. TTL active low blanks display except LHS annunciators.   |
| LDP                           | Low decimal point. TTL active low turns decimal points on. Must be timed with digit address code to display selected decimal points.  |
| 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 RM 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)                       | Non-latched ROM line which is high in stop totalize and low in start.   |
| RL (LTOT)                     | Low totalize. Latched ROM bit low in totalize mode. TTL level.  |
| LTR                           | Low transfer. TTL active low used in DCA.   |
| MG<br>MG                      | Main gate. Accurate signal to drive remote gate such as channel C. ECL levels.  |
| OSC                           | 10 MHz oscillator. TTL level.   |

Table 8-1. Signal Mnemonics (Continued)

| MNEMONIC          | DESCRIPTION  |
|-------------------|--|
| OSC<br>OSC        | 100 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 or 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)          | Latched ROM bits that drive Time Base select code inputs.  |
| RL (TBB)          |  |
| RL (TBC)          |  |
| TBI               | TTL signal that drives Time Base.  |
| TBO               | Time Base scaled output. TTL levels.   |
| TBS Code A (TBSA) | Time Base code input to ROM controlled by the Time Base switch. TTL levels.  |
| TBS Code B (TBSB) |  |
| TBS Code C (TBSC) |  |
| TI                | Time interval. Output of Time Interval module used in time interval measurements, ECL levels.  |
| TI                |  |



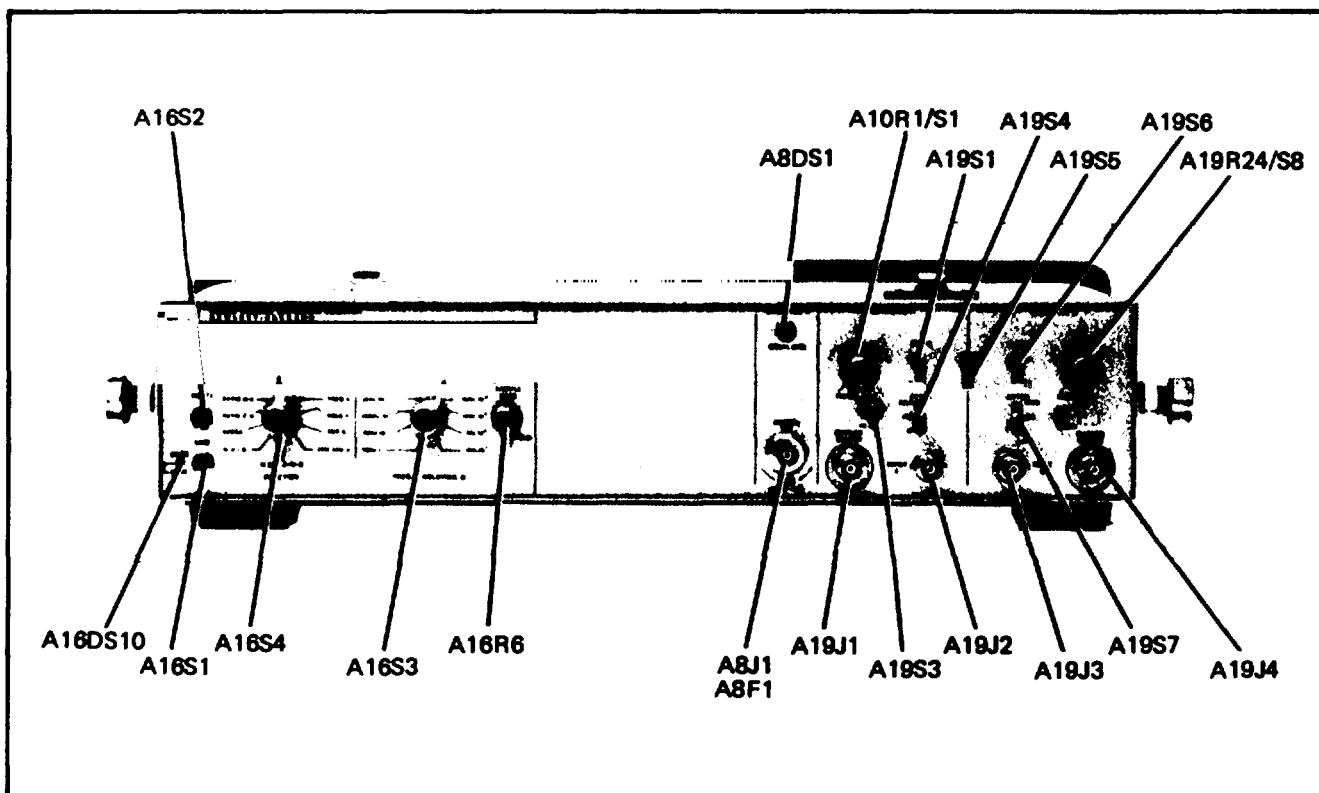


Figure 8-2. 5328A Front View

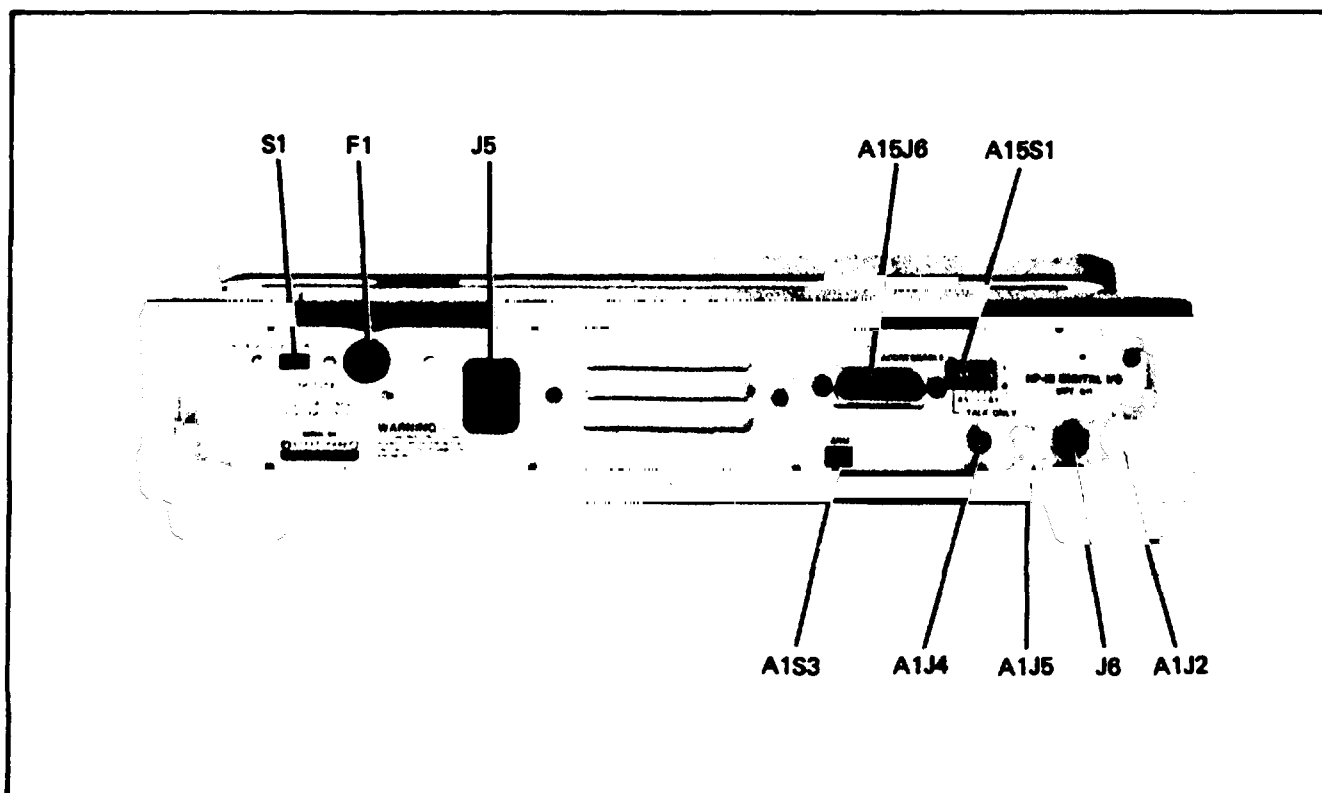


Figure 8-3 5328A Rear View

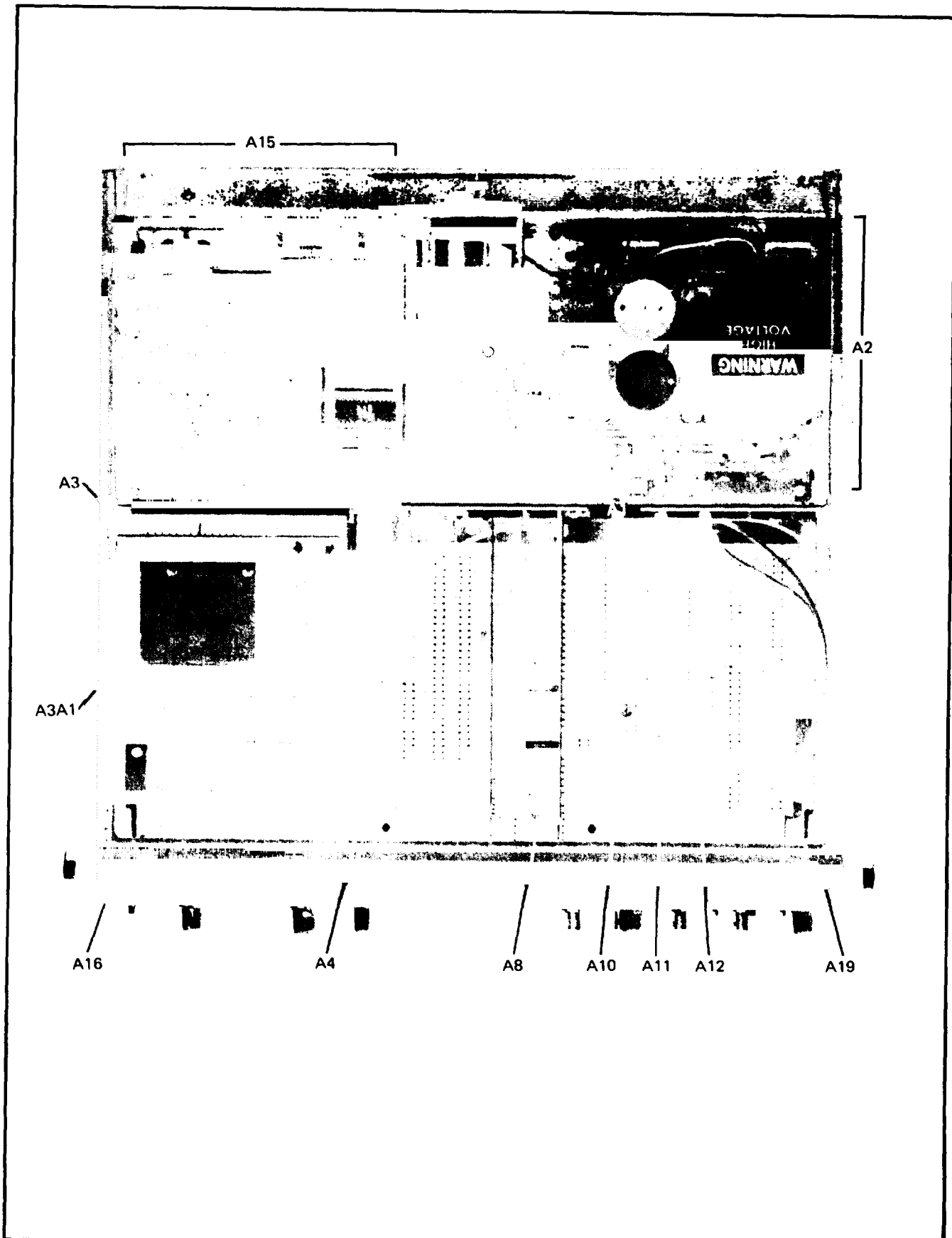


Figure 8-4. 5328A Top View

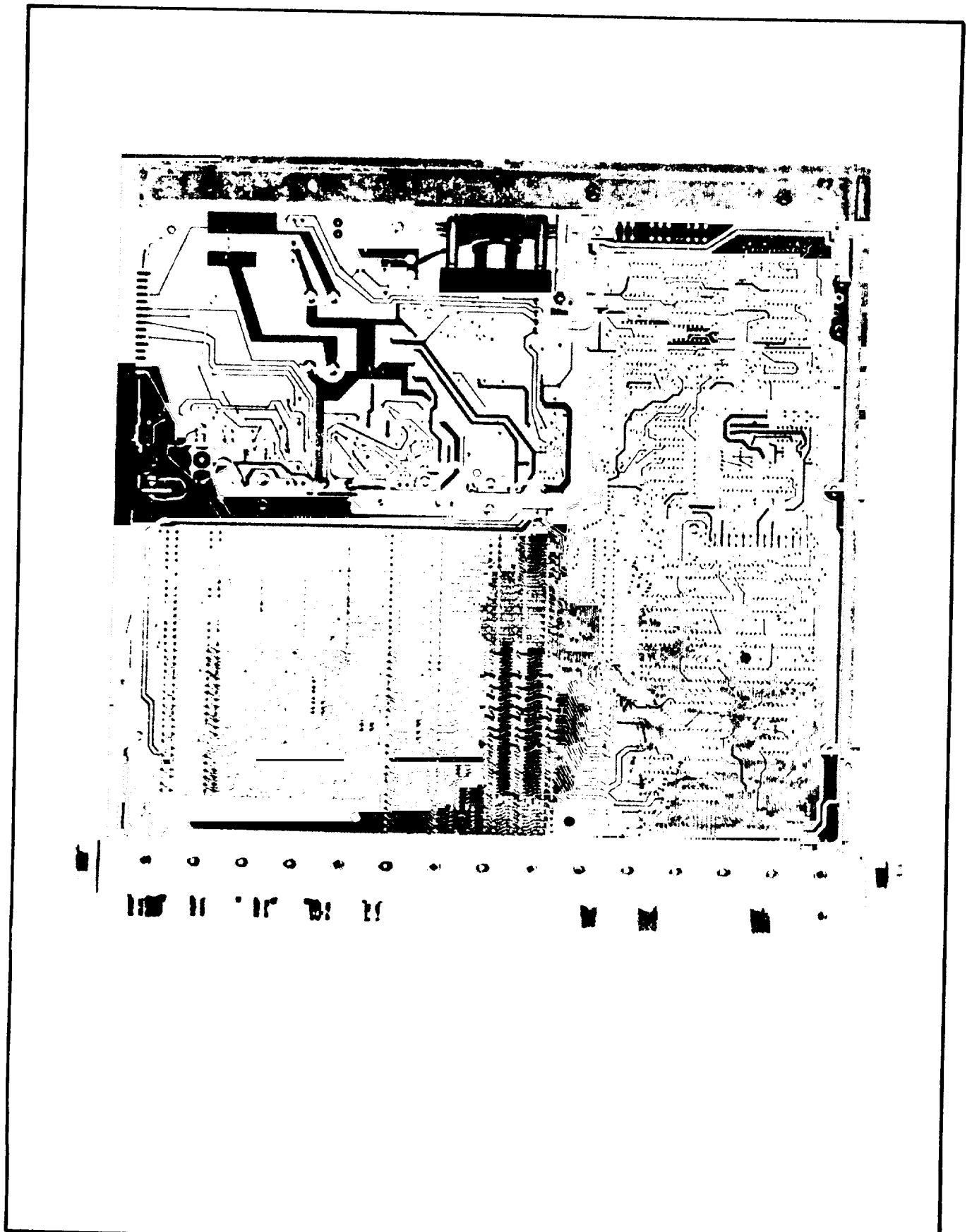


Figure 8-5. 5328A Bottom View



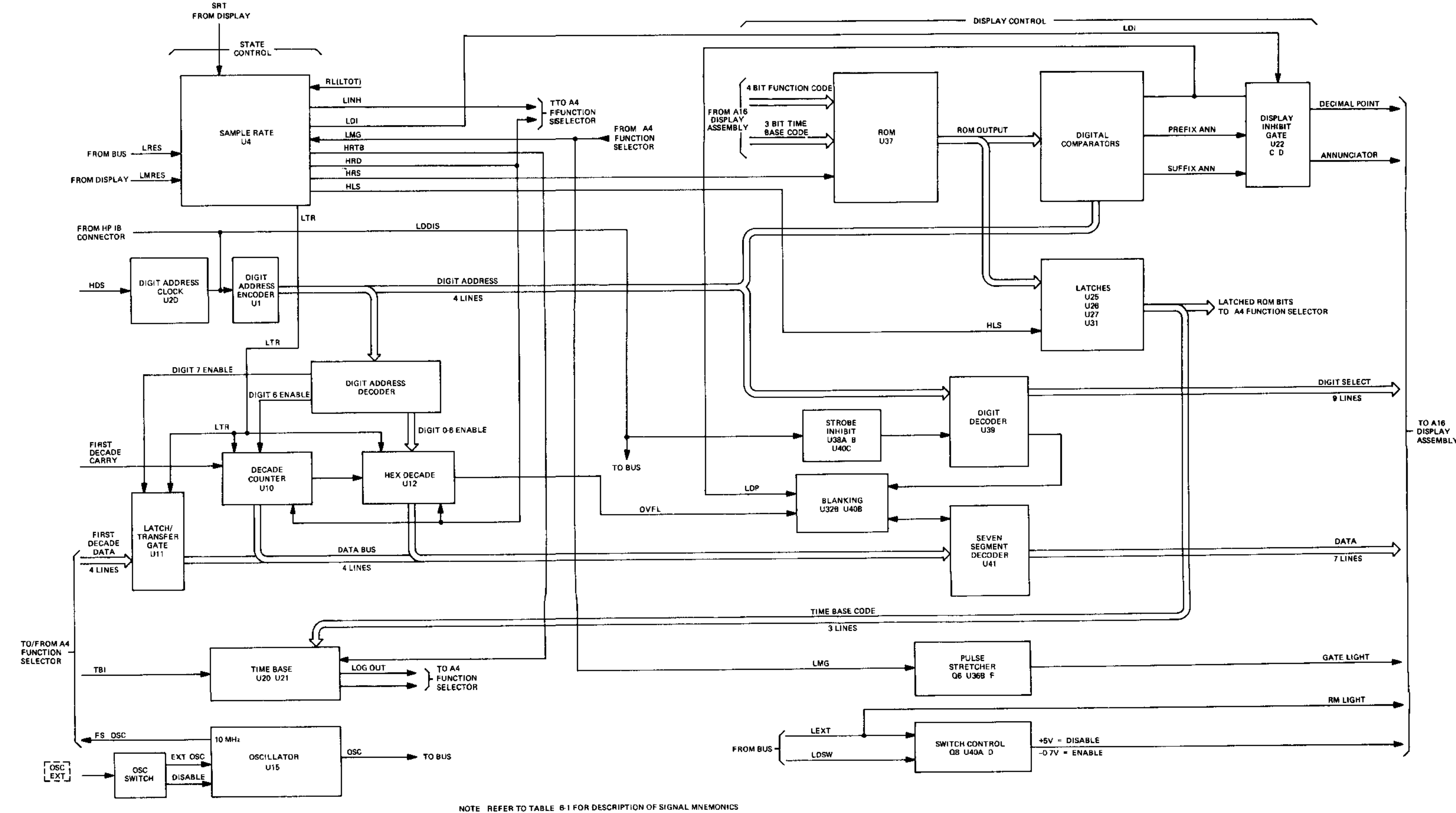
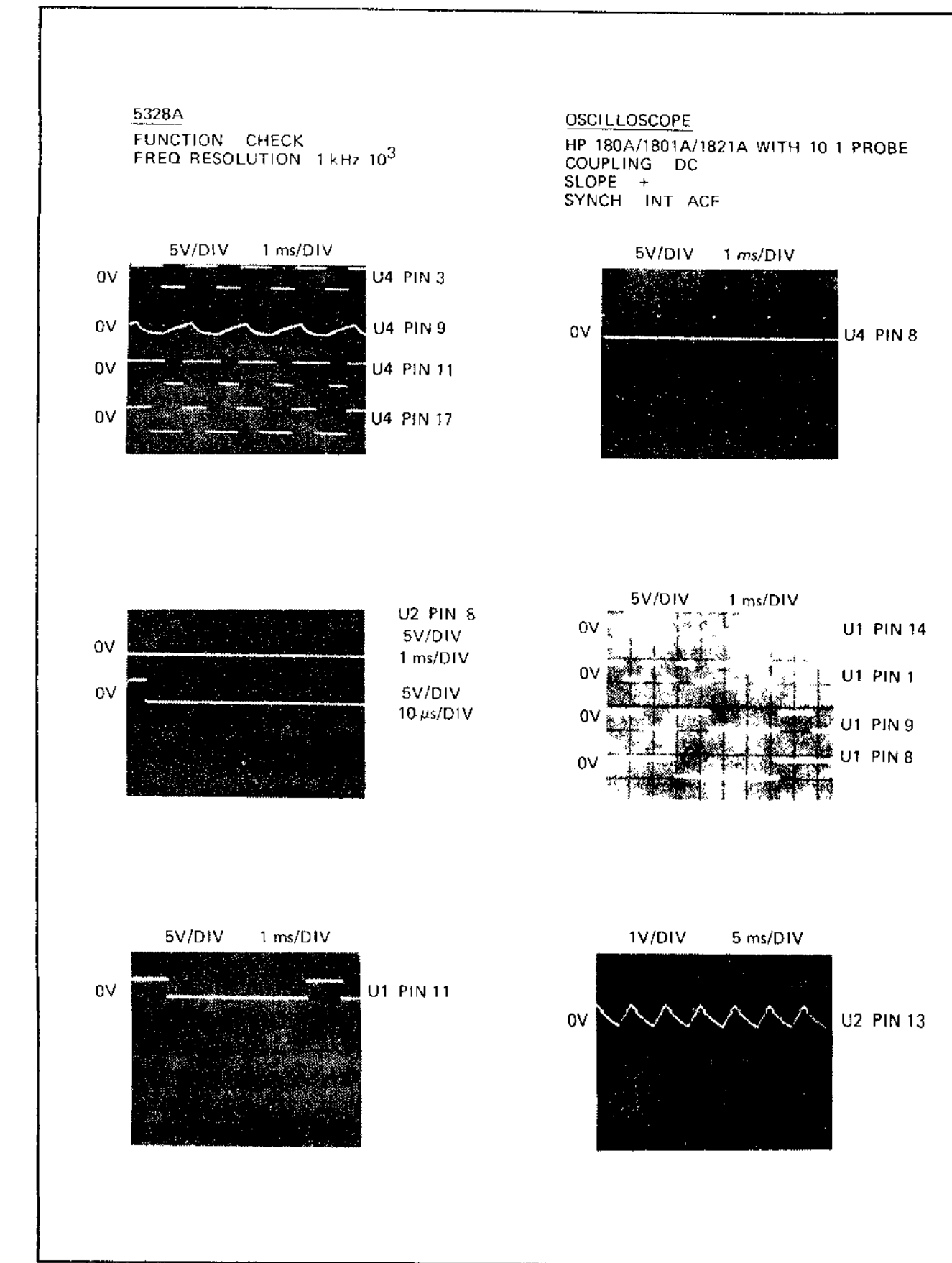


Figure 8-6. A1 Motherboard

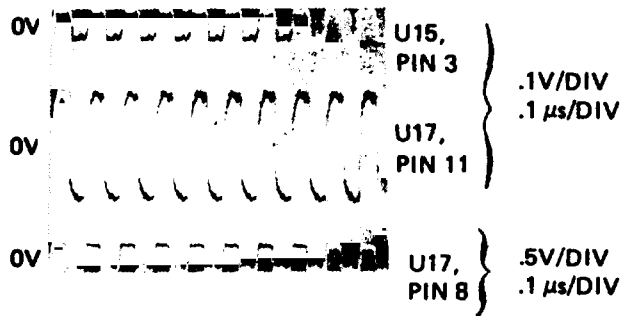
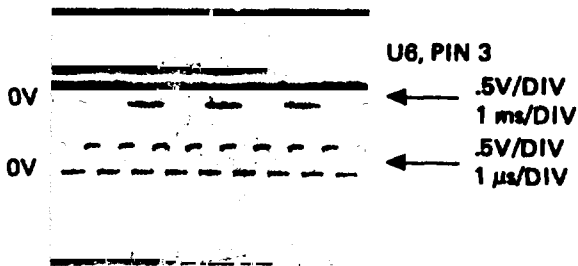
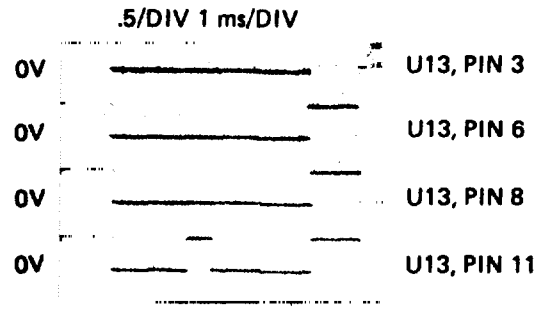
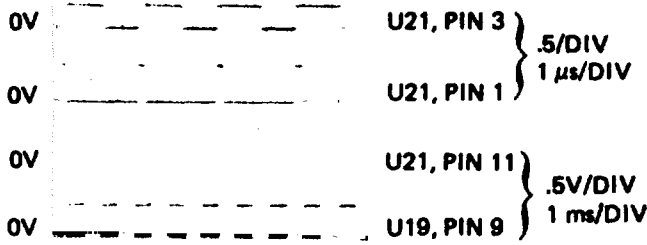
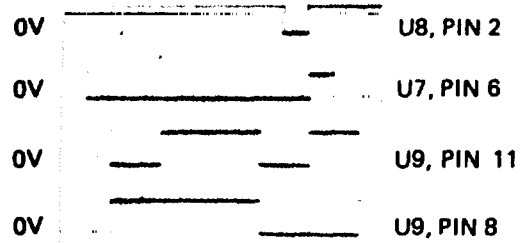
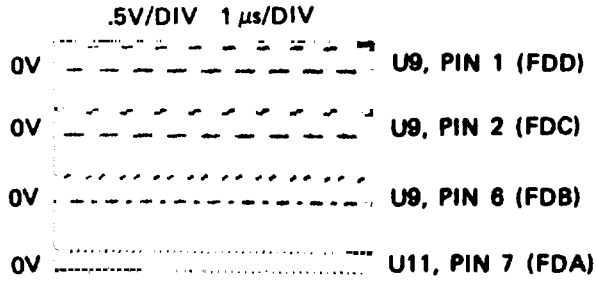


**5328A**

**FUNCTION: CHECK**  
**FREQ RESOLUTION: 1 kHz 10<sup>3</sup>**

**OSCILLOSCOPE**

**HP 180A/1801A/1821A WITH 10:1 PROBE**  
**COUPLING: DC**  
**SLOPE: +**  
**SYNCH: INT, ACF**



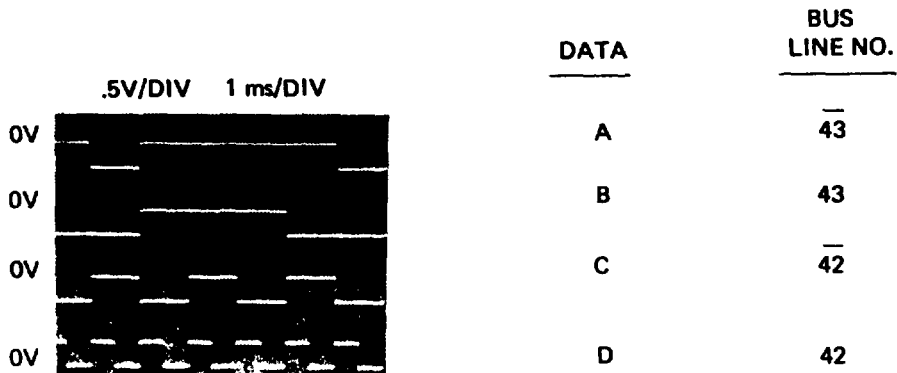
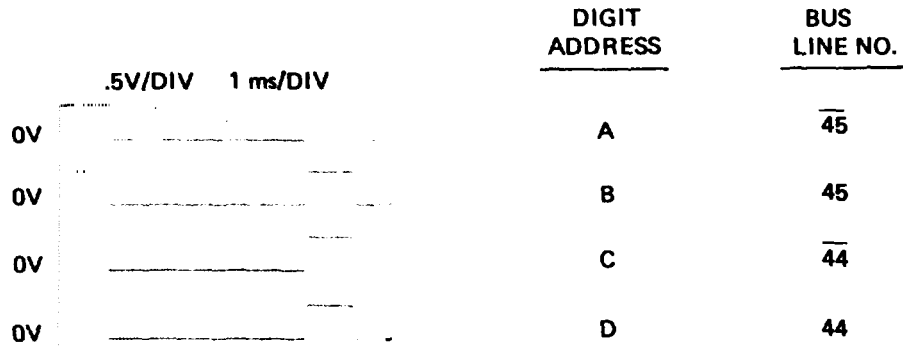
P/O Figure 8-7. A1 Motherboard Assembly

5328A

FUNCTION: CHECK  
FREQ RESOLUTION: 1 kHz 10<sup>3</sup>

OSCILLOSCOPE

HP 180A/1801A/1802A WITH 10:1 PROBE  
COUPLING: DC  
SLOPE: +  
SYNCH: INT, ACF



P/O Figure 8-7. A1 Motherboard Assembly



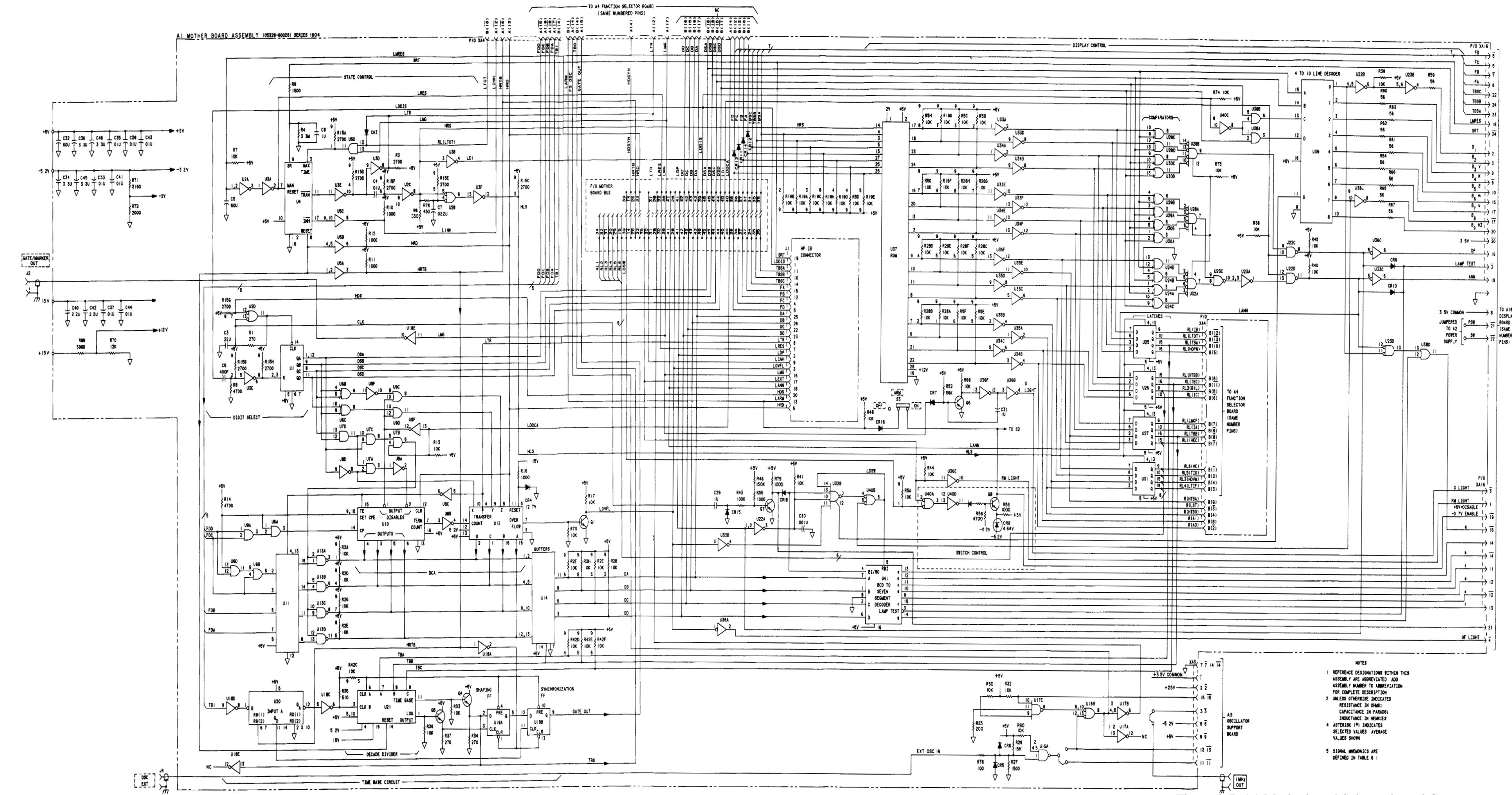
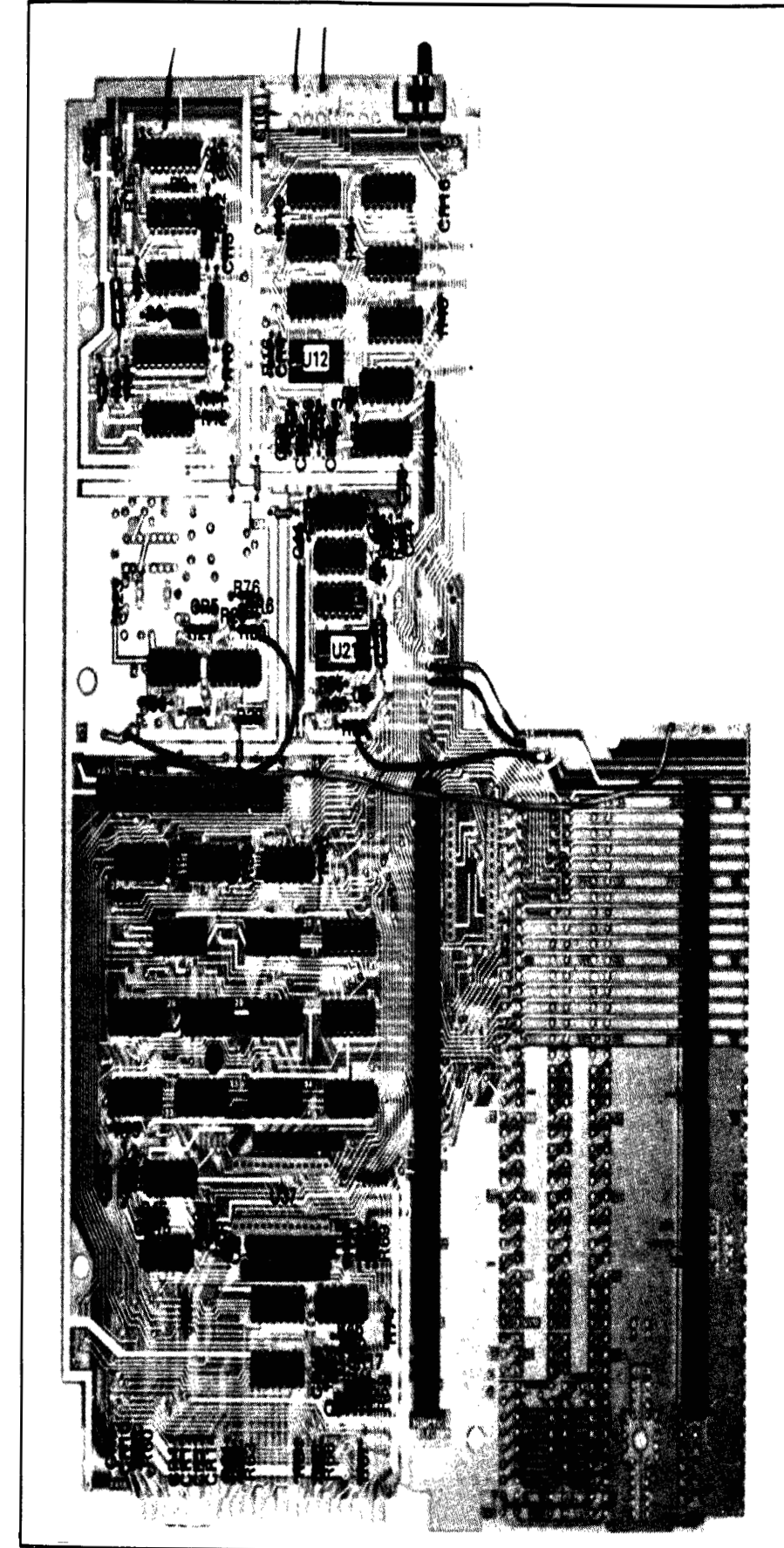


Figure 8-7. A1 Motherboard Schematic and Components  
(Sheet 1 of 2)

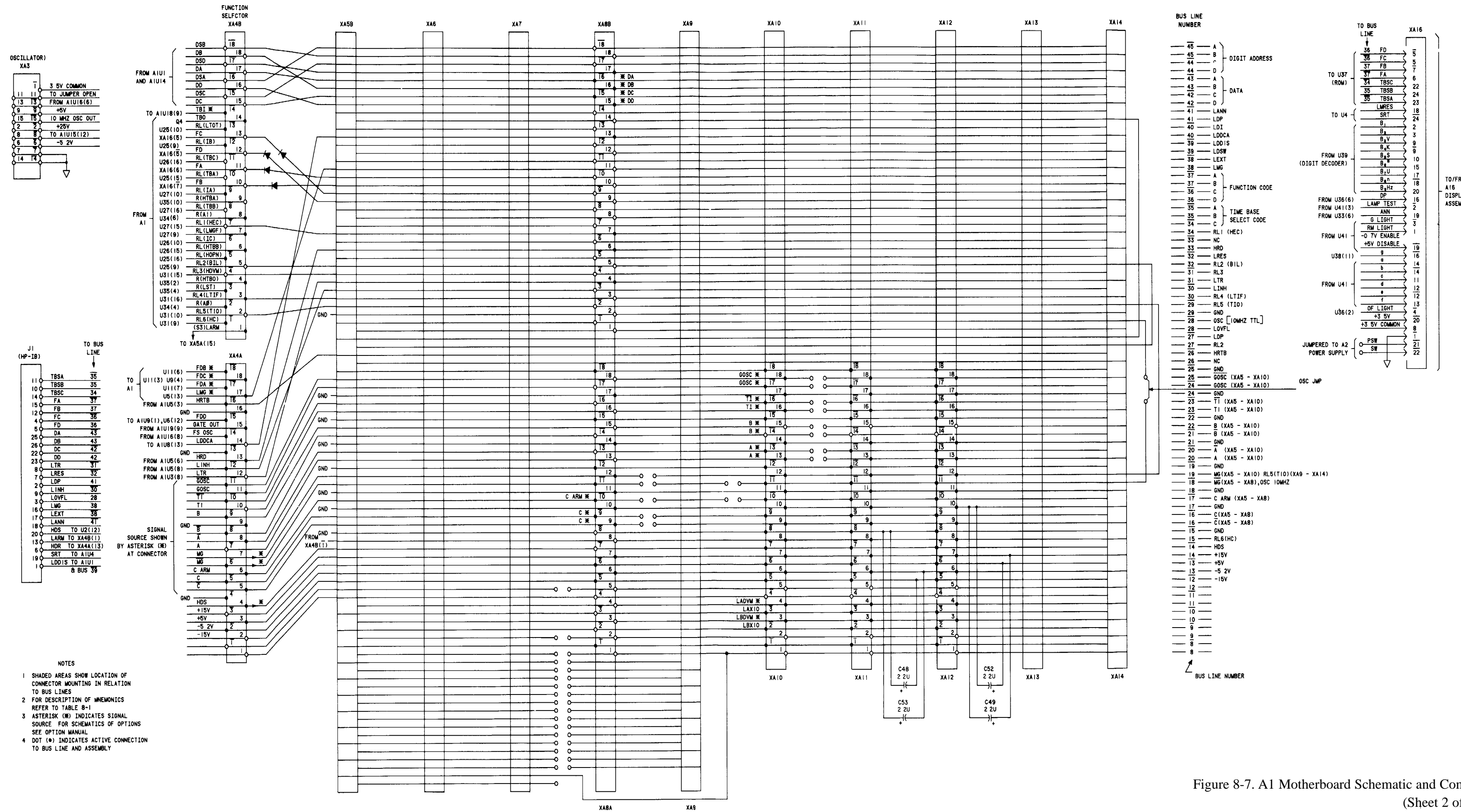
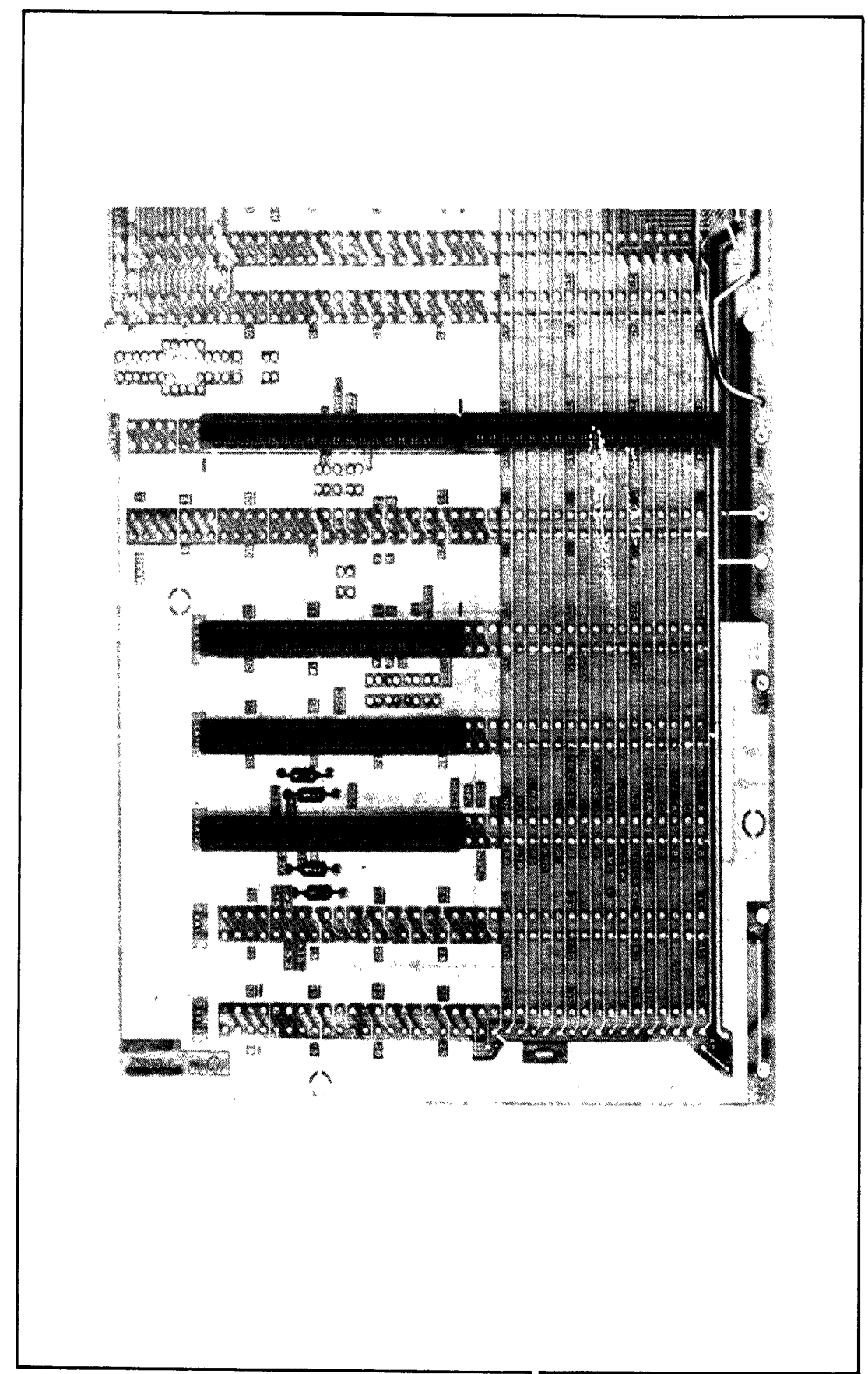
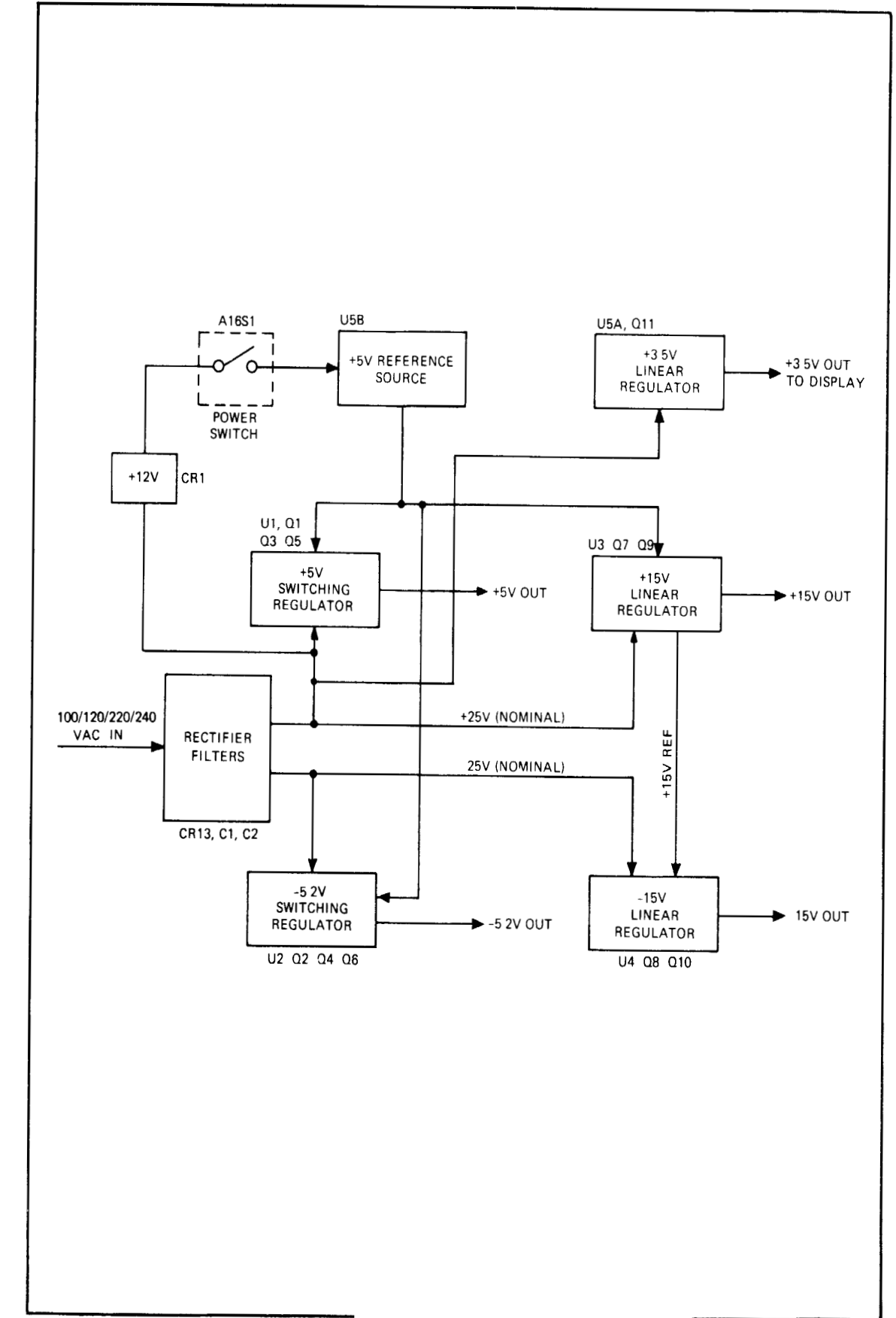


Figure 8-7. A1 Motherboard Schematic and Components  
(Sheet 2 of 2)



R-1R

Figure 8-8

Figure 8-8. A2 Power Supply Block Diagram

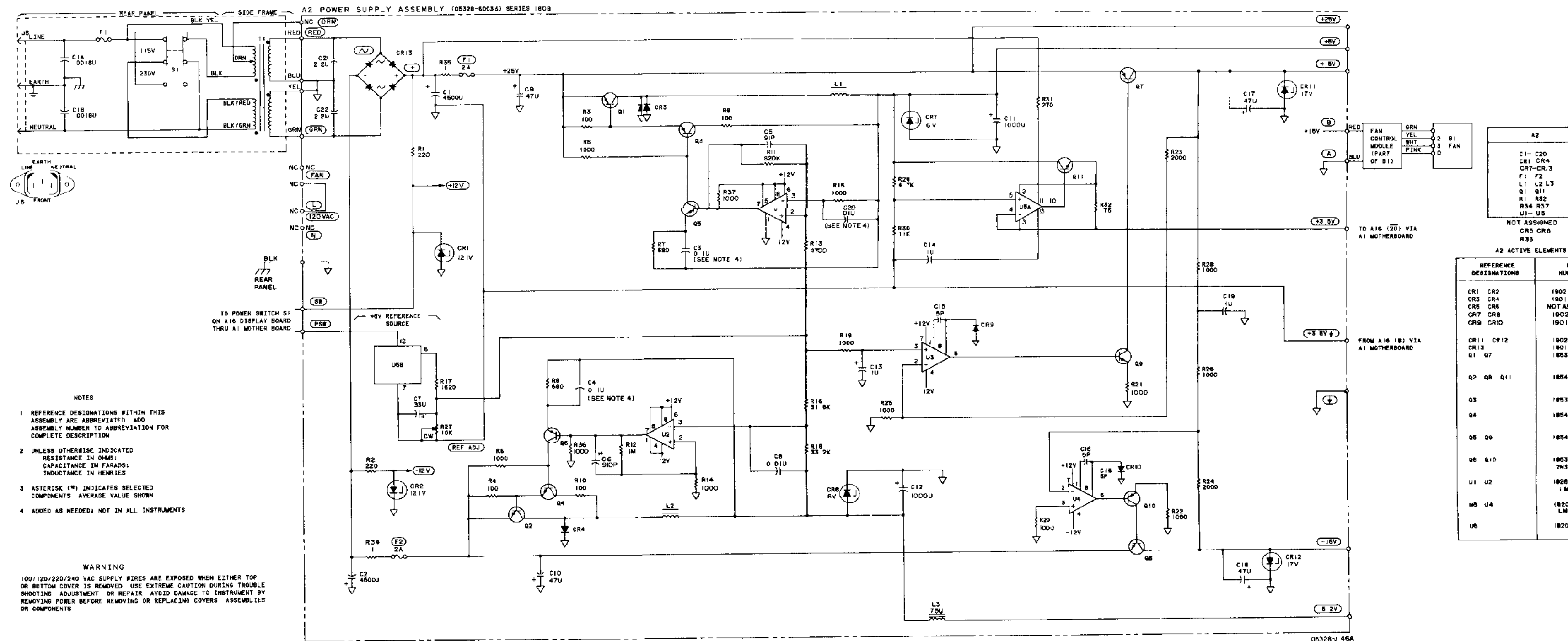
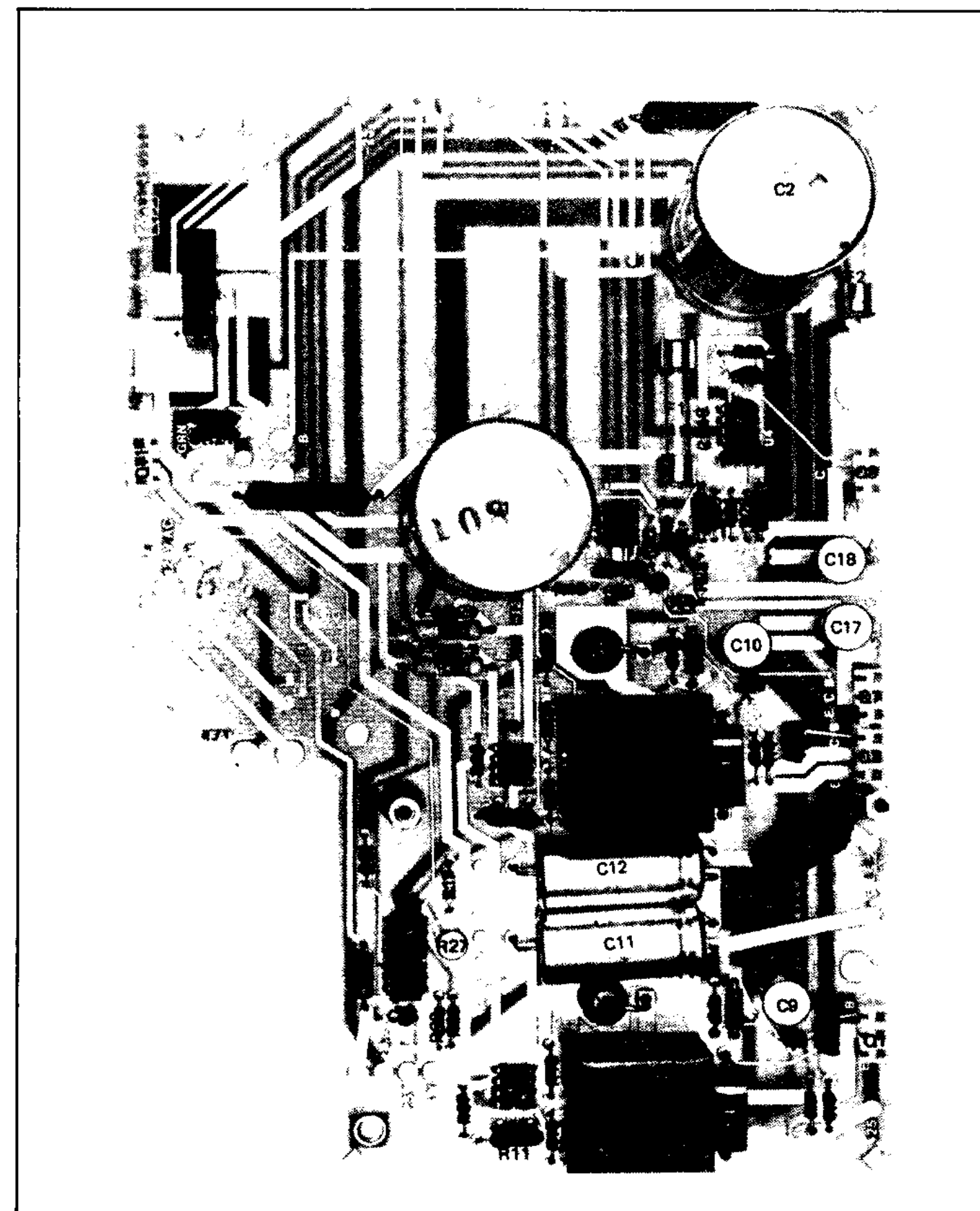
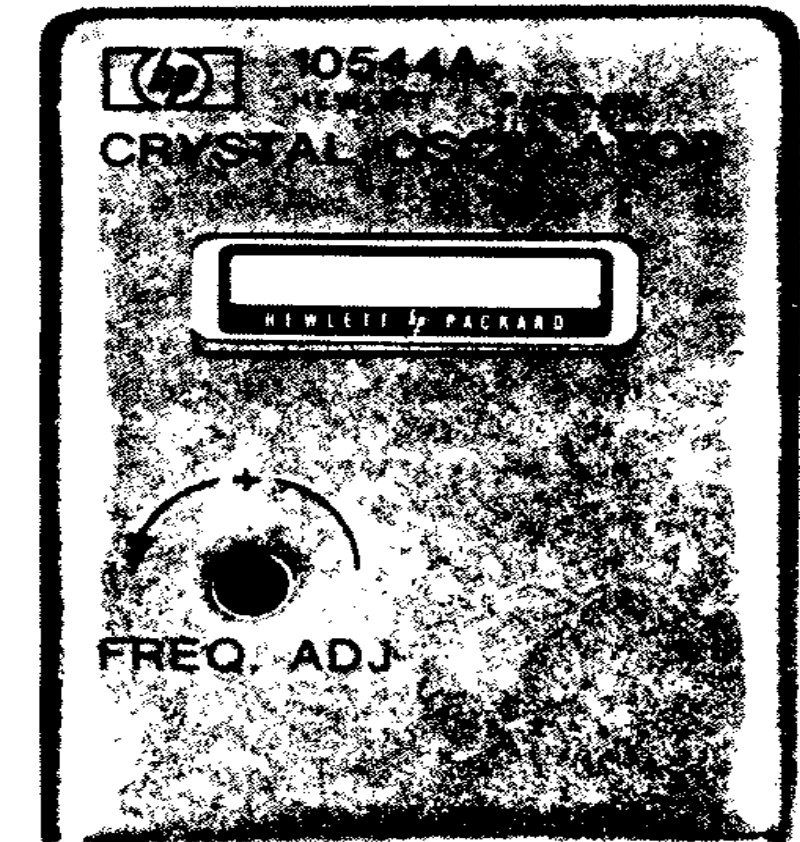


Figure 8-9. A2 Power Supply Schematic and Components



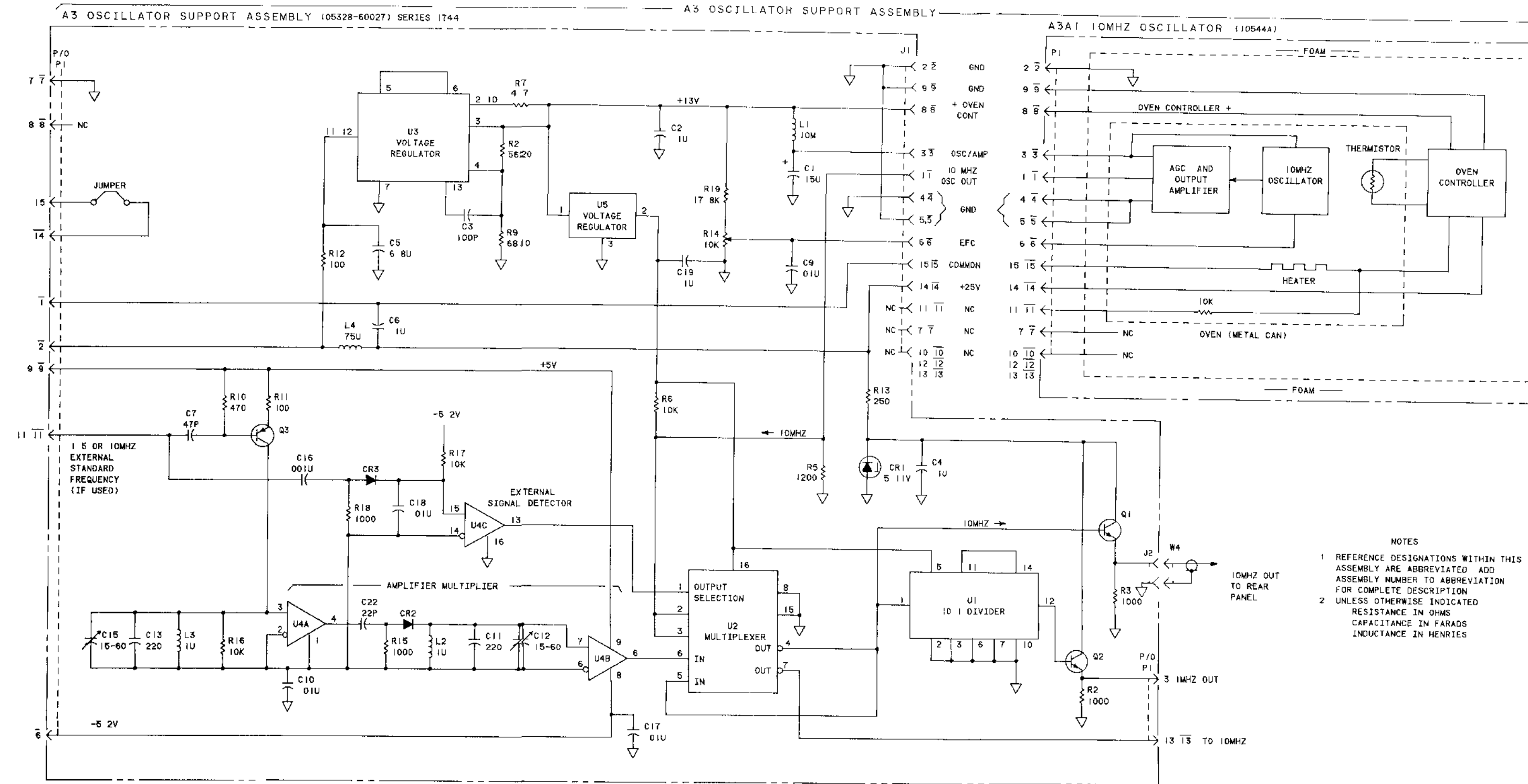
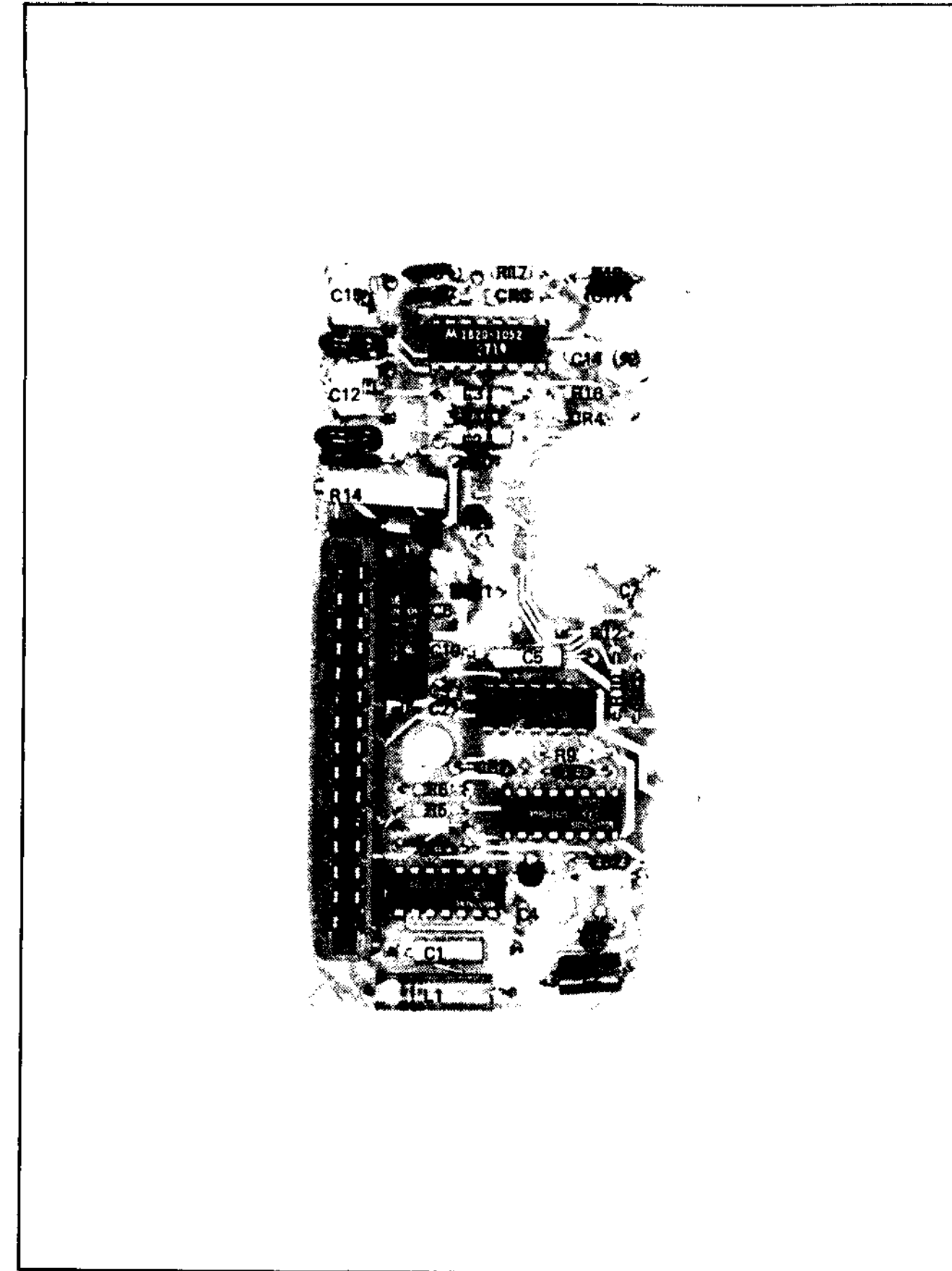


Figure 8-10. A3/A3A1 Oscillator Support Schematic and Components

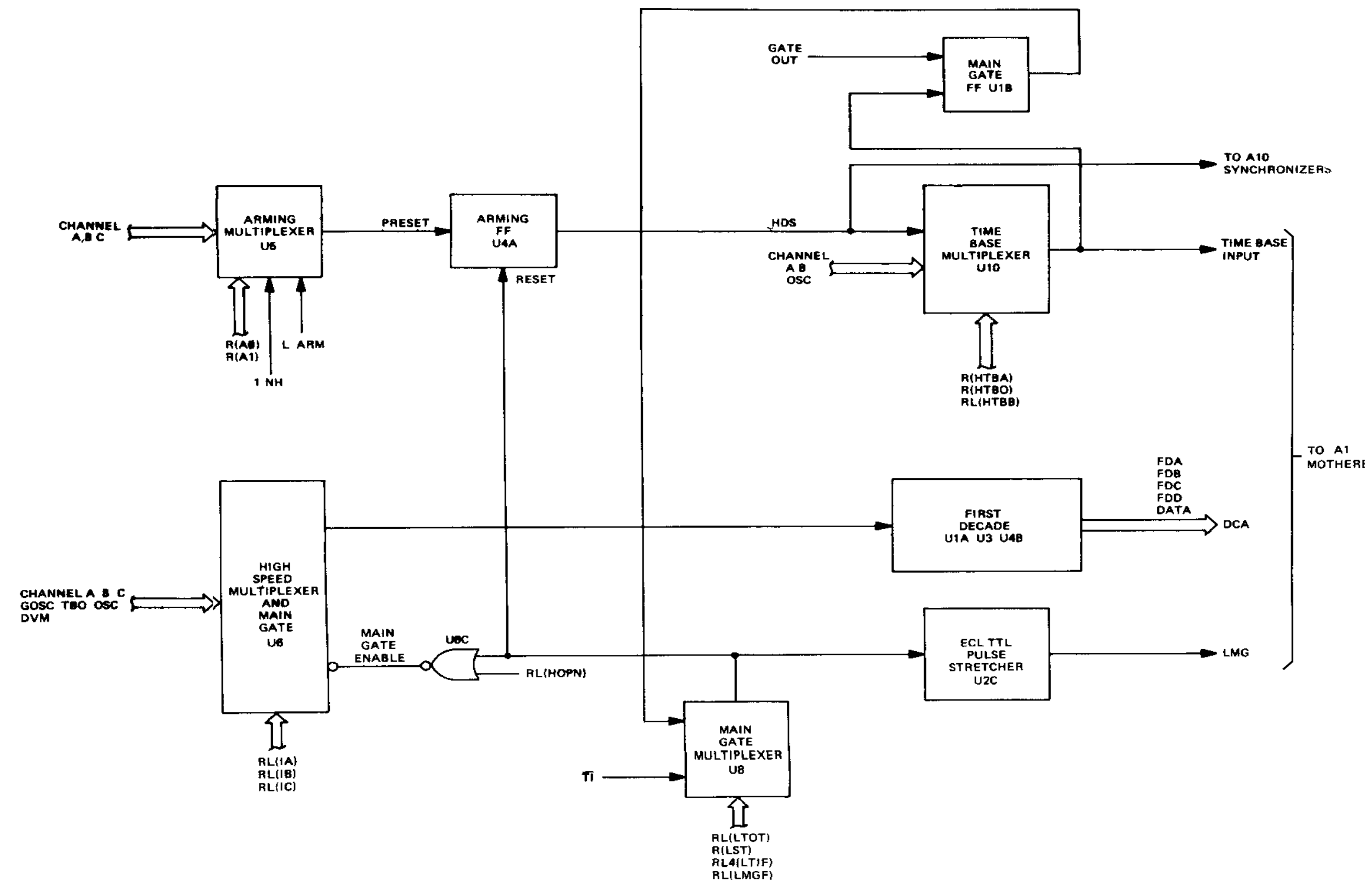


Figure 8-11. A4 Function Selector Block Diagram

Model 5328A  
Schematic Diagrams

P1A PINS

|    |   |          |
|----|---|----------|
| 1  | - | DVM      |
| 2  | - | -15V     |
| 3  | - | +5V      |
| 4  | - | HDS*     |
| 5  | - | C        |
| 6  | - | C ARM    |
| 7  | - | MG*      |
| 8  | - | A        |
| 9  | - | GND      |
| 10 | - | T1       |
| 11 | - | GOSC     |
| 12 | - | LTR      |
| 13 | - | HRD      |
| 14 | - | LDDCA    |
| 15 | - | GATE OUT |
| 16 | - | GND      |
| 17 | - | LMG*     |
| 18 | - | FDC*     |

\*SIGNAL SOURCE

|    |   |        |
|----|---|--------|
| 1  | - | DVM    |
| 2  | - | -5.2V  |
| 3  | - | +15V   |
| 4  | - | GND    |
| 5  | - | C      |
| 6  | - | MG*    |
| 7  | - | A      |
| 8  | - | B      |
| 9  | - | B      |
| 10 | - | T1     |
| 11 | - | GOSC   |
| 12 | - | GND    |
| 13 | - | FS OSC |
| 14 | - | FS OSC |
| 15 | - | FDD*   |
| 16 | - | HRTB   |
| 17 | - | FDA*   |
| 18 | - | FDB*   |

P1B PINS

|    |   |           |
|----|---|-----------|
| 1  | - | L ARM     |
| 2  | - | RL5(TIO)  |
| 3  | - | RL4(LTIF) |
| 4  | - | R(HTBO)   |
| 5  | - | RL2(BIL)  |
| 6  | - | RL(HTBB)  |
| 7  | - | RL(LMGF)  |
| 8  | - | R(A1)     |
| 9  | - | R(HTBA)   |
| 10 | - | FB        |
| 11 | - | FA        |
| 12 | - | FD        |
| 13 | - | FC        |
| 14 | - | TBO       |
| 15 | - | DATA C    |
| 16 | - | DATA D    |
| 17 | - | DATA A    |
| 18 | - | DATA B    |

NC

|    |   |          |
|----|---|----------|
| 1  | - | RL6(HC)  |
| 2  | - | R(A0)    |
| 3  | - | R(LST)   |
| 4  | - | RL3(HDV) |
| 5  | - | RL(HOPN) |
| 6  | - | RL(IC)   |
| 7  | - | RL1(HEC) |
| 8  | - | RL(TBB)  |
| 9  | - | RL(LIA)  |
| 10 | - | RL(TBA)  |
| 11 | - | RL(TBC)  |
| 12 | - | RL(IB)   |
| 13 | - | RL(LTOT) |
| 14 | - | TBI*     |
| 15 | - | DS C     |
| 16 | - | DS A     |
| 17 | - | DS D     |
| 18 | - | DS B     |

\*SIGNAL SOURCE



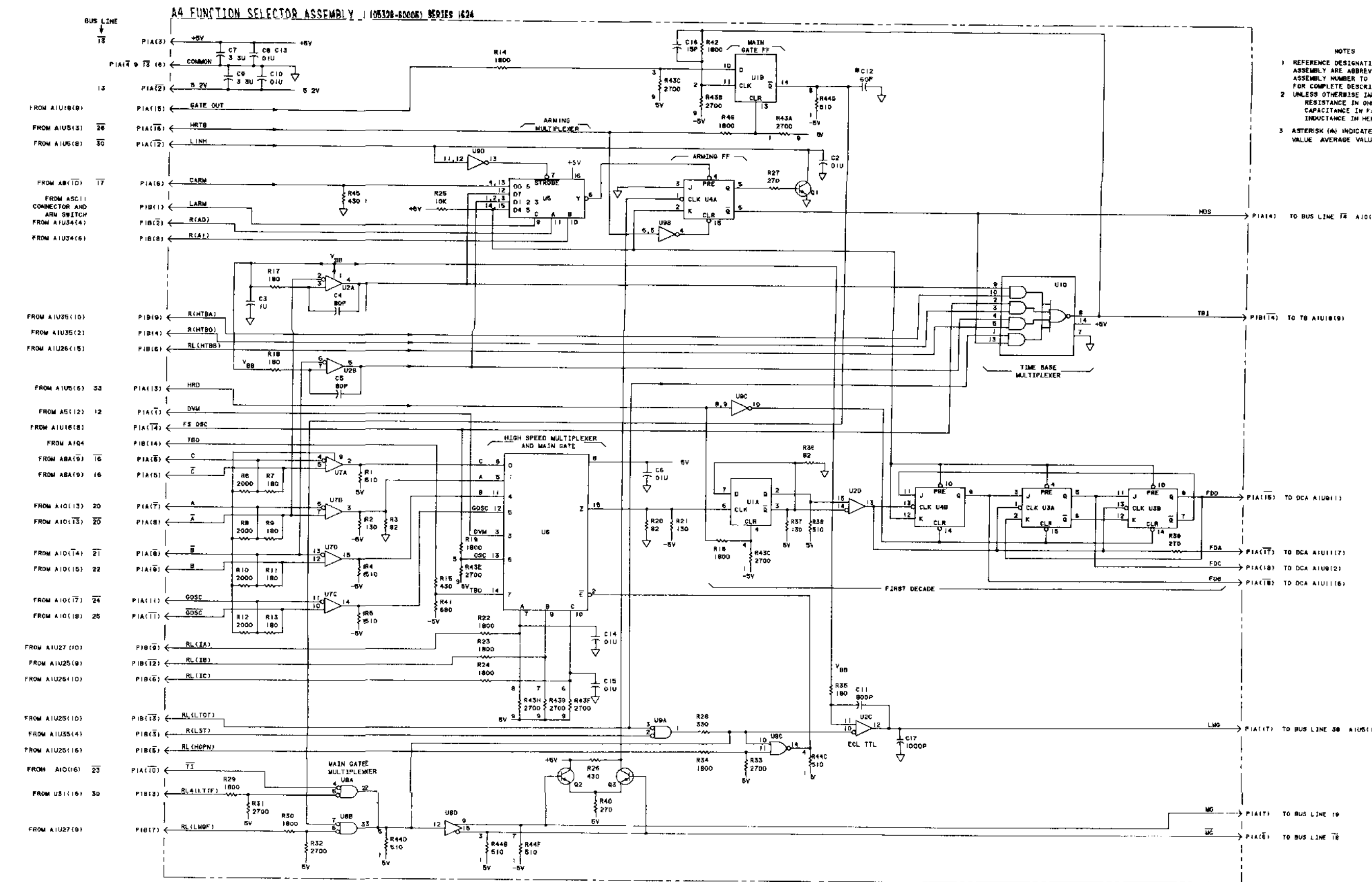
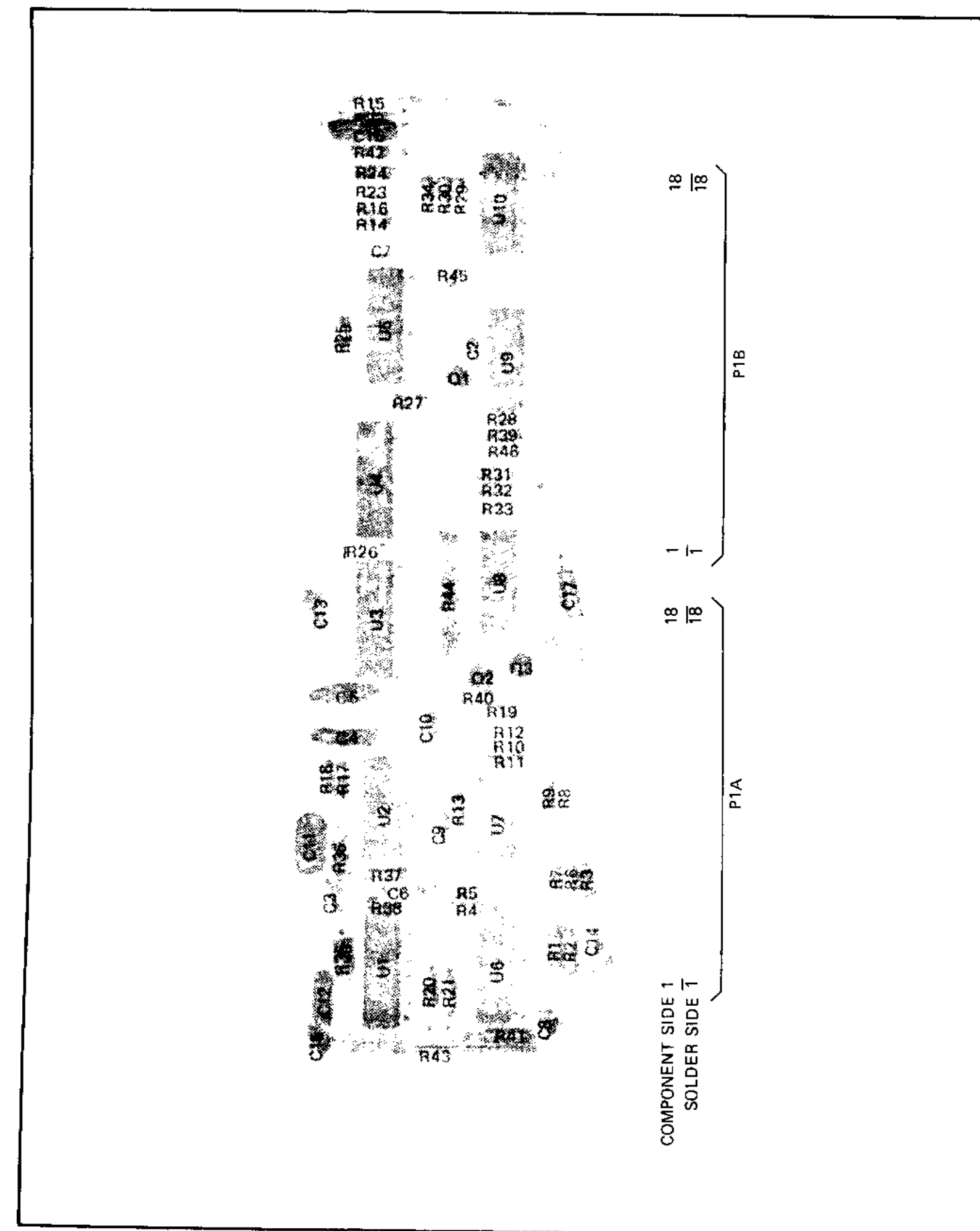


Figure 8-12. A4 Function Selector Schematic and Components

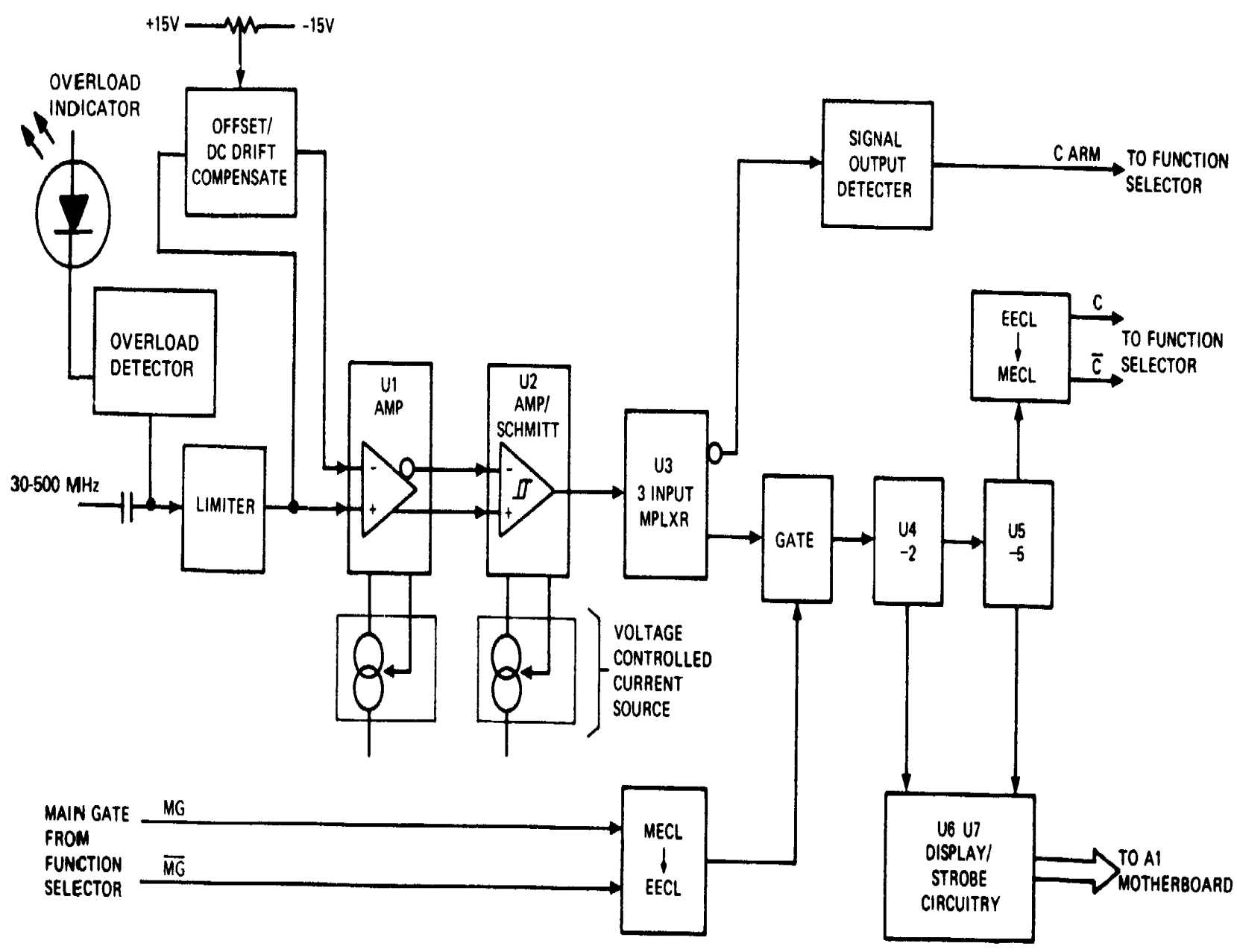
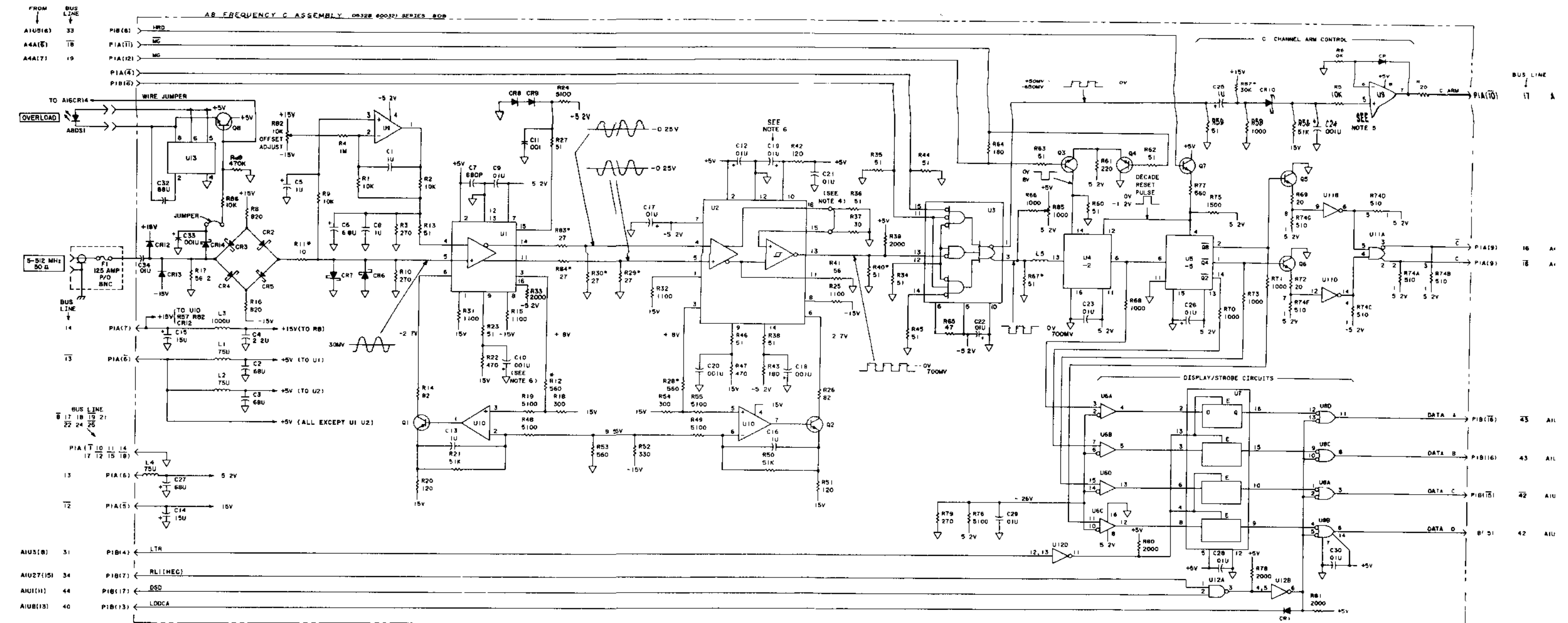
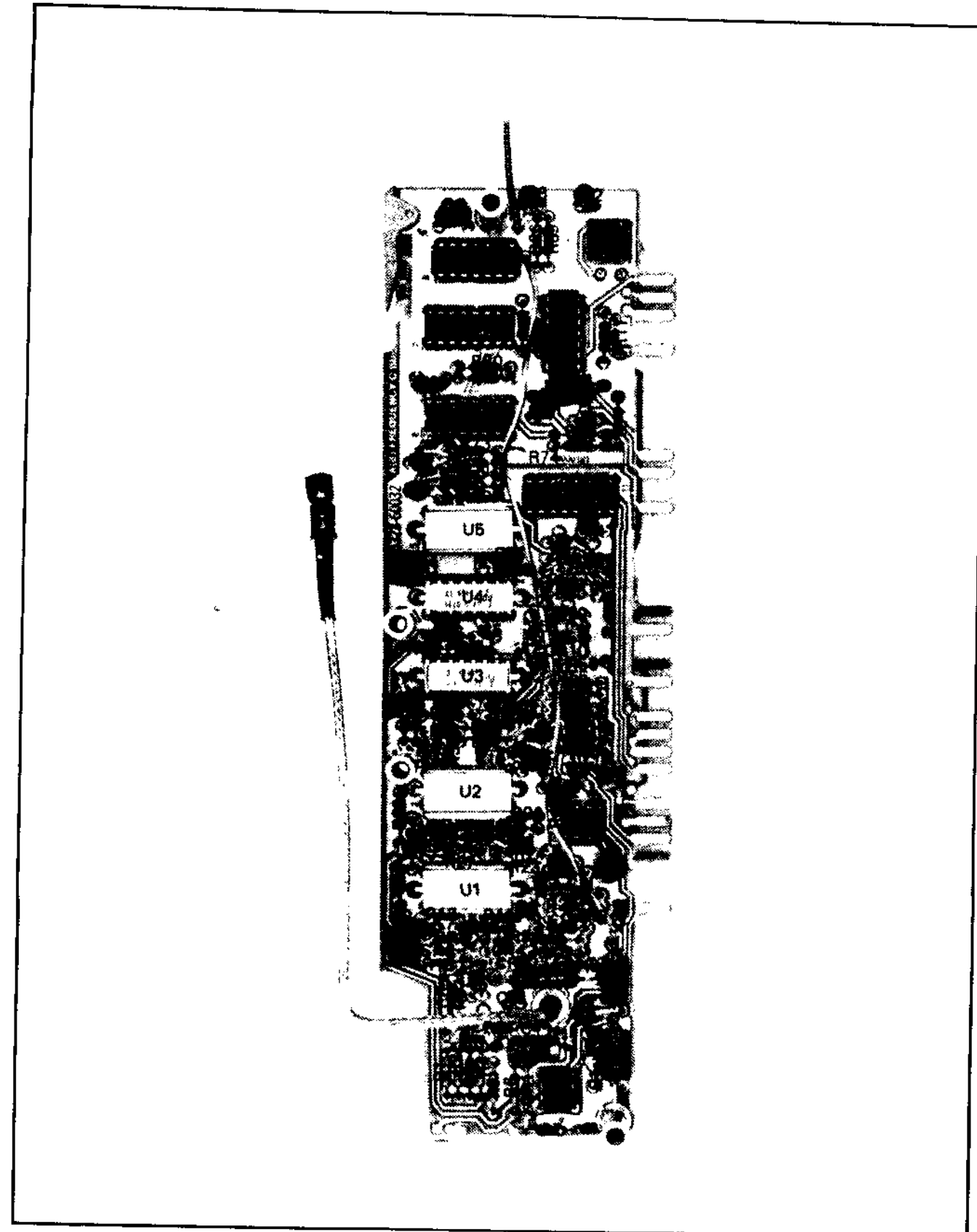


Figure 8-13. A8 Channel "C" Block Diagram

Model 5328A  
Schematic Diagrams



- 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
  - ASTERISK (\*) INDICATES SELECTED COMPONENT AVERAGE VALUES SHOWN
  - JUMPER BETWEEN U2(15) AND U2(16) NORMALLY OMITTED. ADDED FOR LOWER SENSITIVITY.
  - IF NO INPUT COUNTED THE VOLTAGE AT U2(15) IS LOWER THAN U2(16).
  - C10 NORMALLY OMITTED (ADDED WHEN NECESSARY TO BOOST HIGH FREQUENCY GAIN).
- FACTORY SELECTED PARTS**
- | Reference Designator | Selected Part            | Normal Value Range |
|----------------------|--------------------------|--------------------|
| R83                  | FO Opt num AC            | R83 84 125 30      |
| R84                  | signal determine gain of | (TOTAL = 56)       |
| R85                  | First Stage              | 37 20              |
| R86                  |                          | 30 20              |
| R87                  |                          | 20 20              |
| R88                  |                          | 24 30              |
| R89                  |                          | 20 20              |
| R90                  |                          | 15 36              |
| R91                  |                          | 12 36              |
| R92                  |                          | 1 20               |
| R93                  |                          | 1 20               |
| R94                  | For Optimum AC Signal    | 51-42              |
| R97                  | For Optimum AC Signal    | 560 x 100          |
| R98                  | For Optimum Base U 1     | 560 100            |
| R12                  | For Optimum Base U 1     | 26 x 10k           |
| R12                  | For Threshold Detection  | 26 x 10k           |
| R11                  | Optimum Sensitivity      | 10 x 15 2          |

Figure 8-14. A8 Channel "C" Schematic and Components

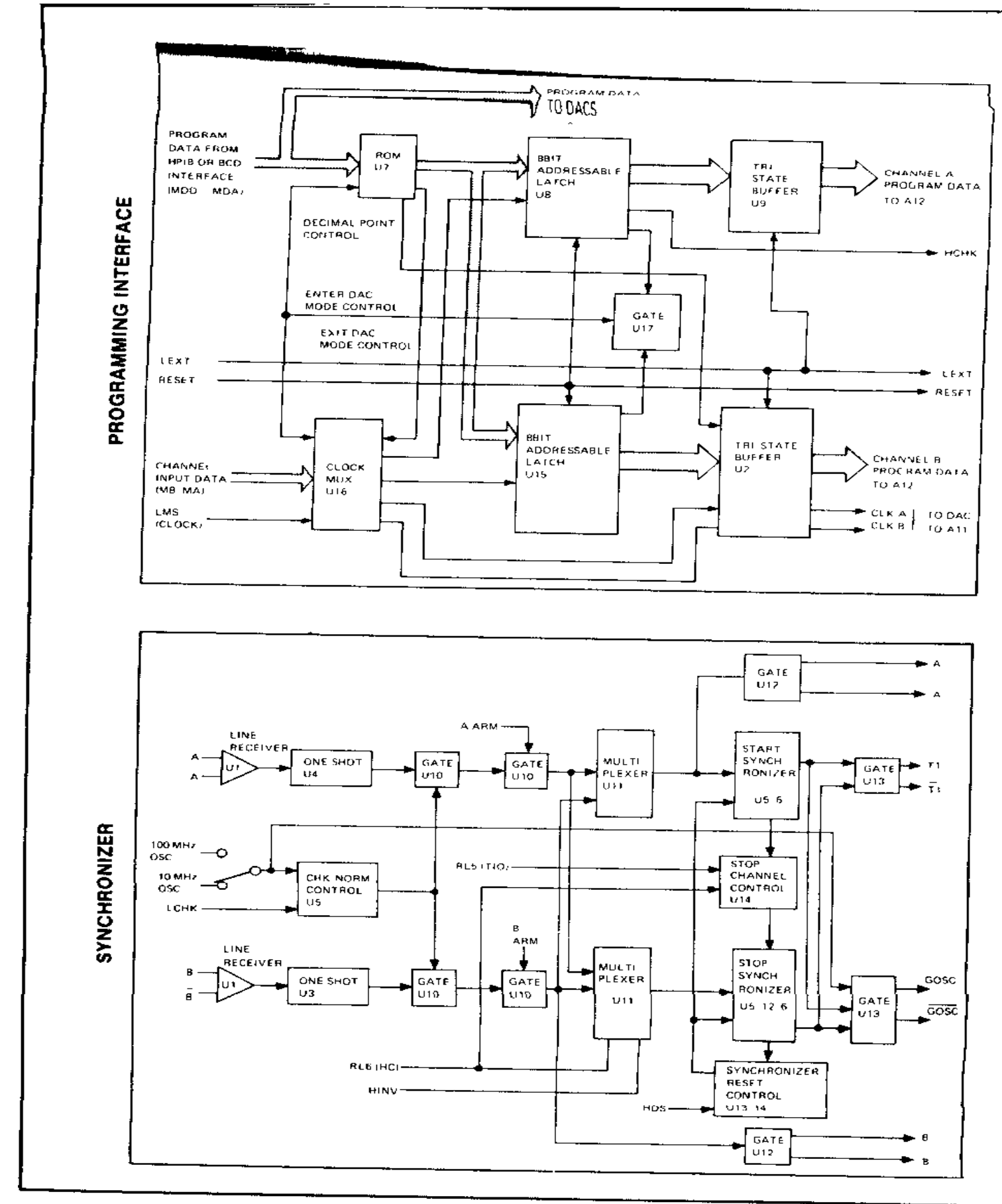


Figure 8-15. A10 Synchronizer Block Diagram



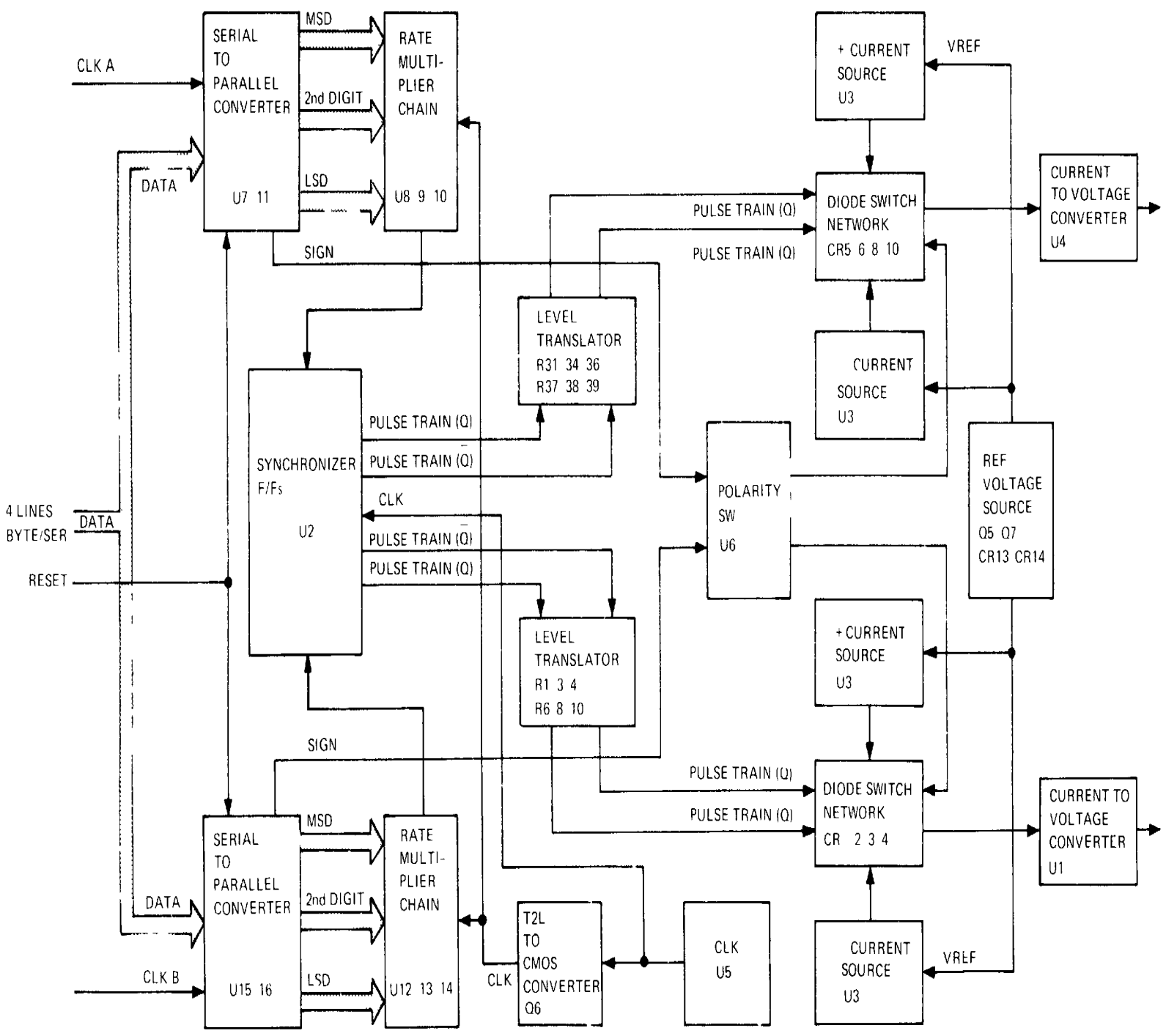
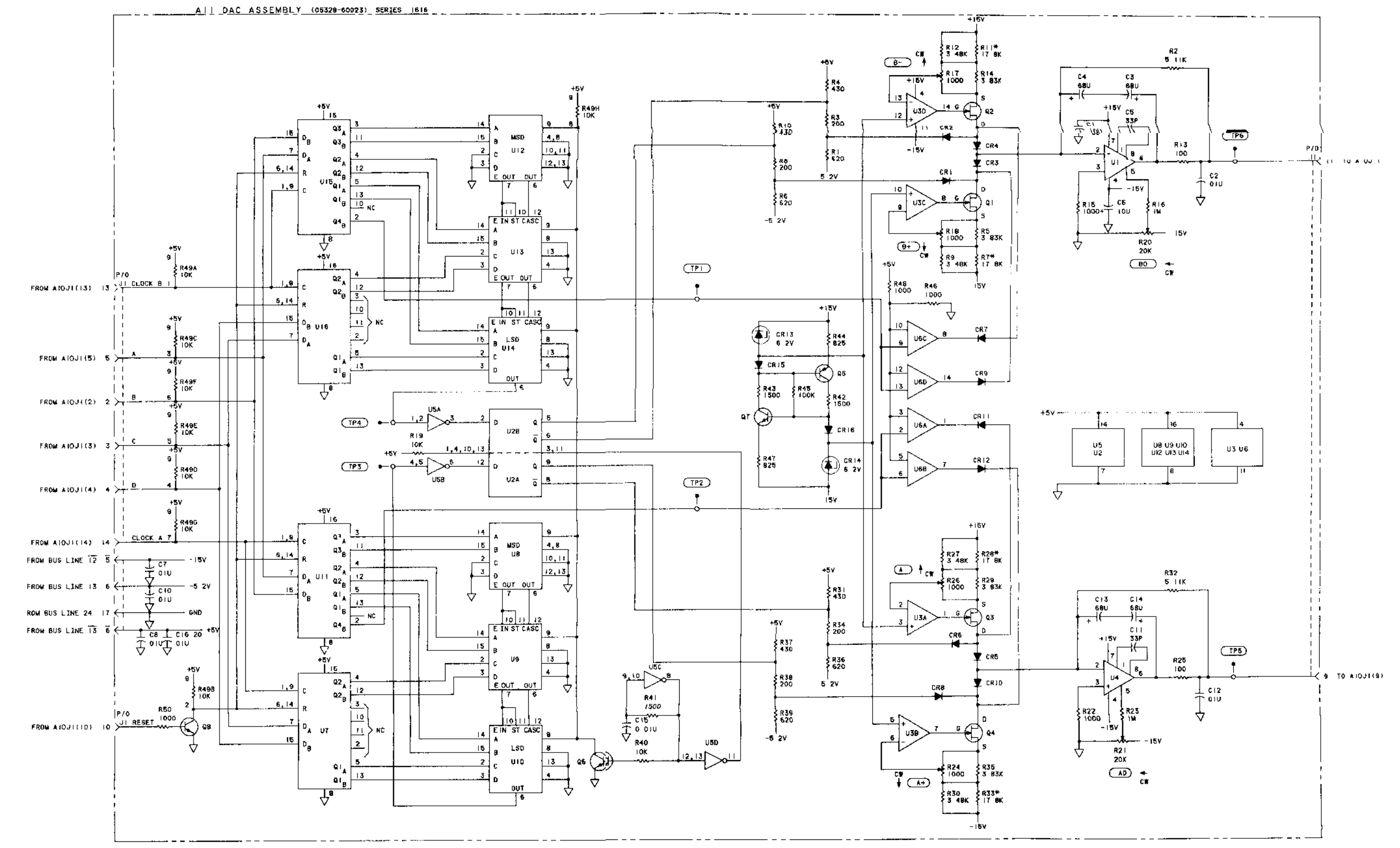
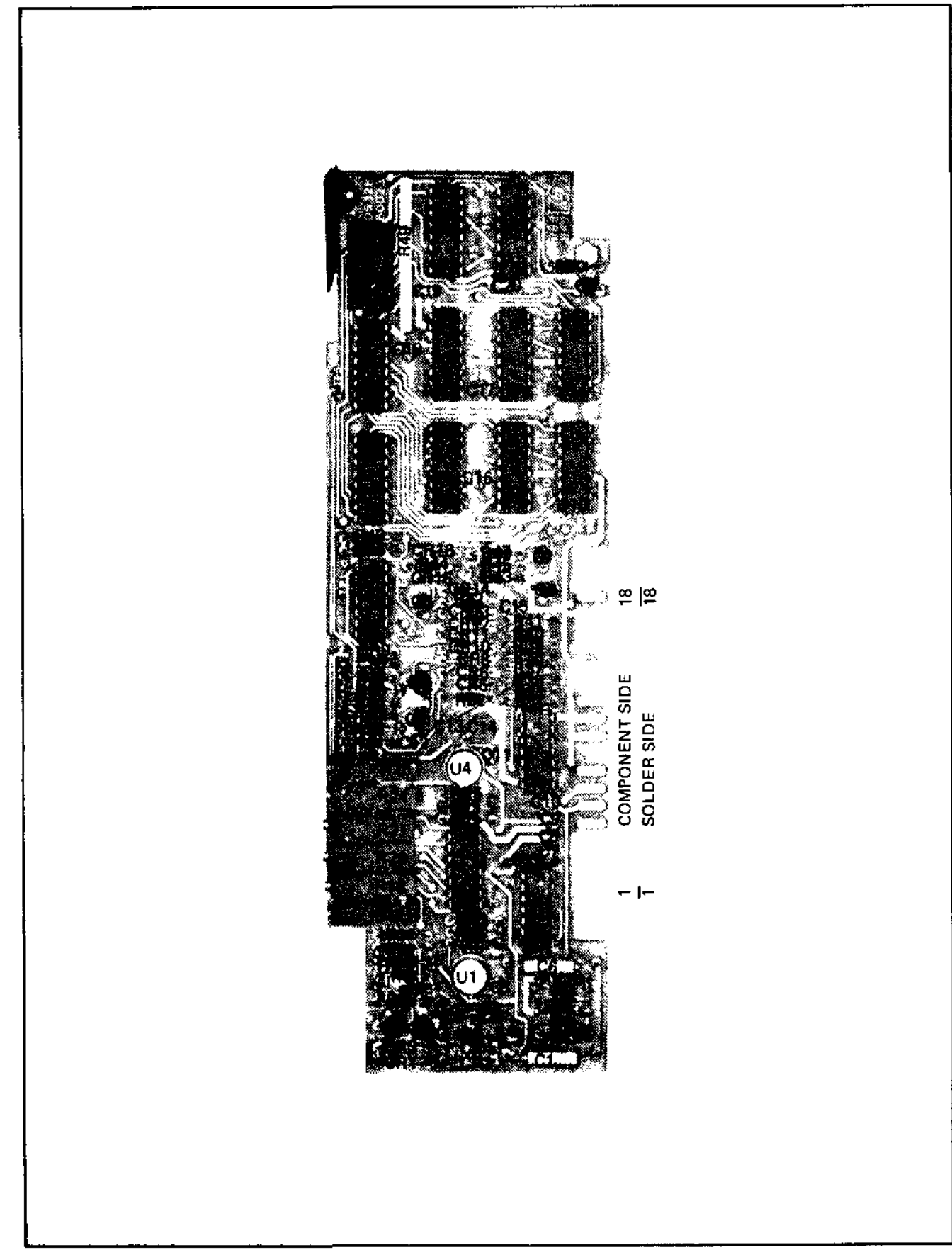


Figure 8-17. All Digital-to-Analog Converter Block Diagram



- 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-CR18 |
| U1-U8    |
| R1-RES   |
| TP1-TP6  |
| UT1-UT6  |

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<br>2M5245    |
| Q2, Q3                     | 1855-0416              |
| Q6, Q7, Q8                 | 1804-0071<br>2N339     |
| U1, U4                     | 1826-0059<br>LM201A    |
| U2                         | 1820-0893<br>SN74574N  |
| U3, U6                     | 1826-0161<br>LM324     |
| U5                         | 1820-1425<br>SN74ALS2N |
| U7, U11, U15               | 1820-0976<br>CD4015AE  |
| U16                        | 1820-0976<br>CD4015AE  |
| U8, U9, U10, U12, U13, U14 | 1820-285<br>MC14527CP  |

Figure 8-18. A11 Digital-to-Analog Converter Schematic and Components

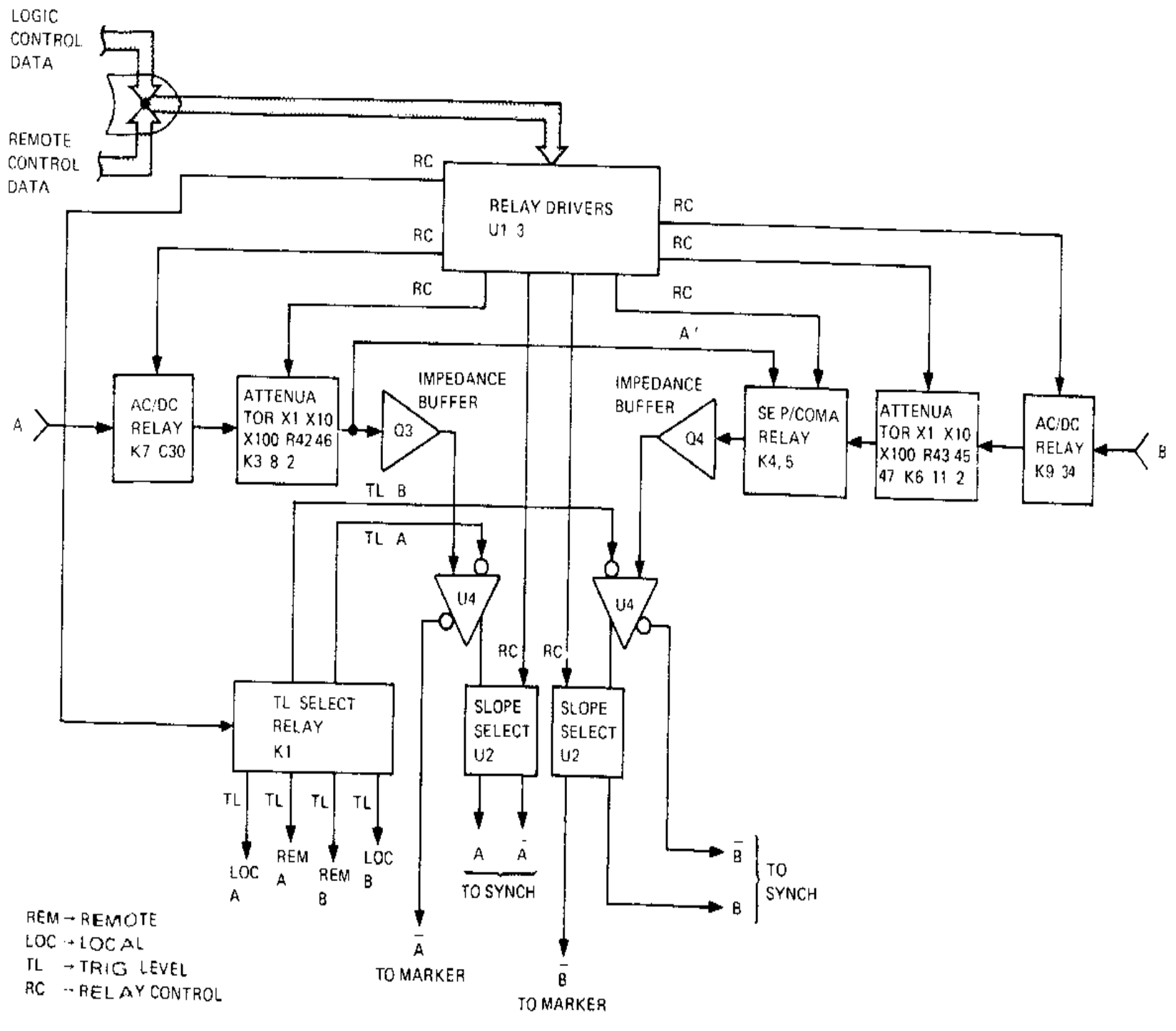


Figure 8-19. A12 "A-B" Channel Block Diagram



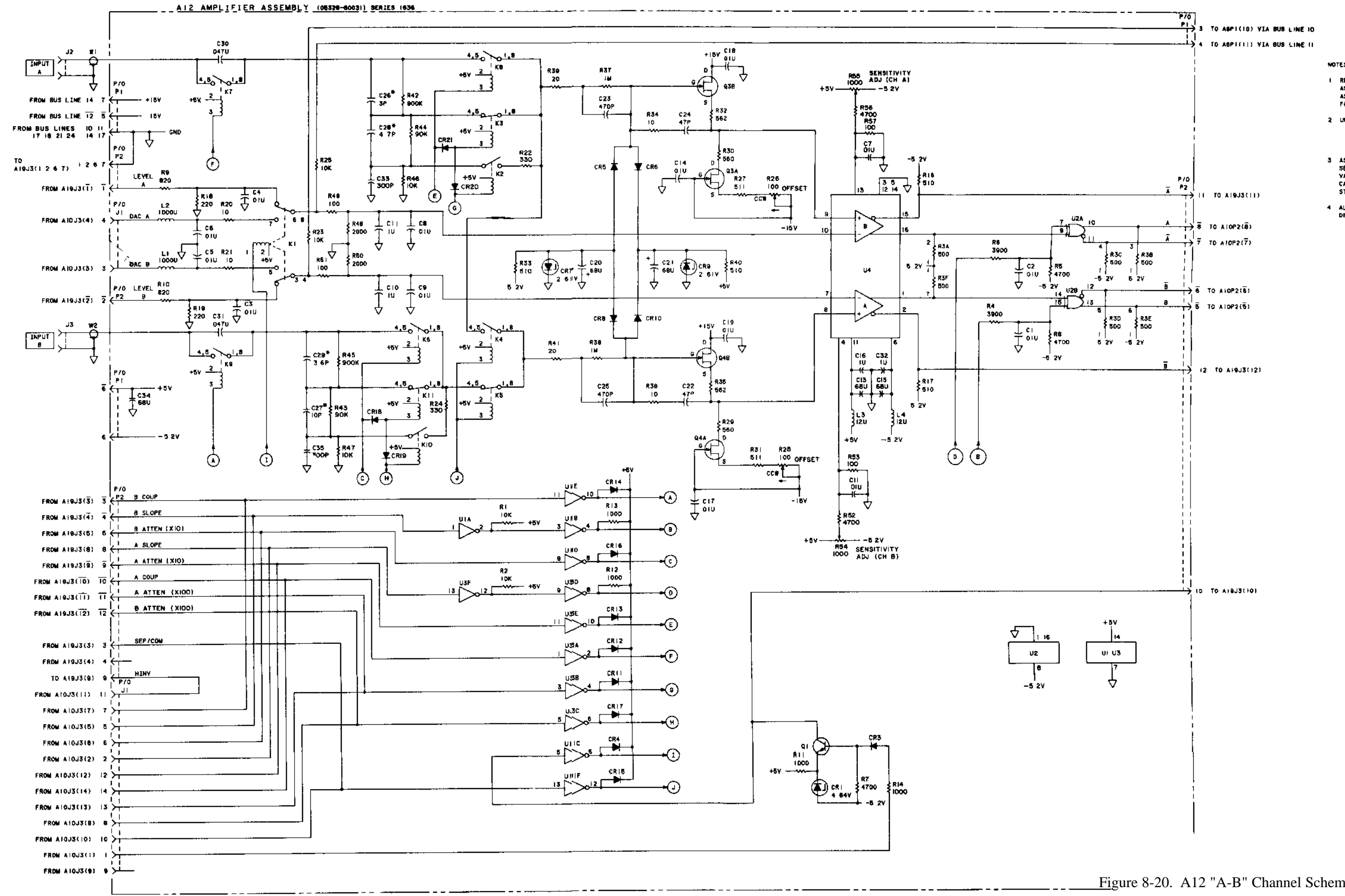
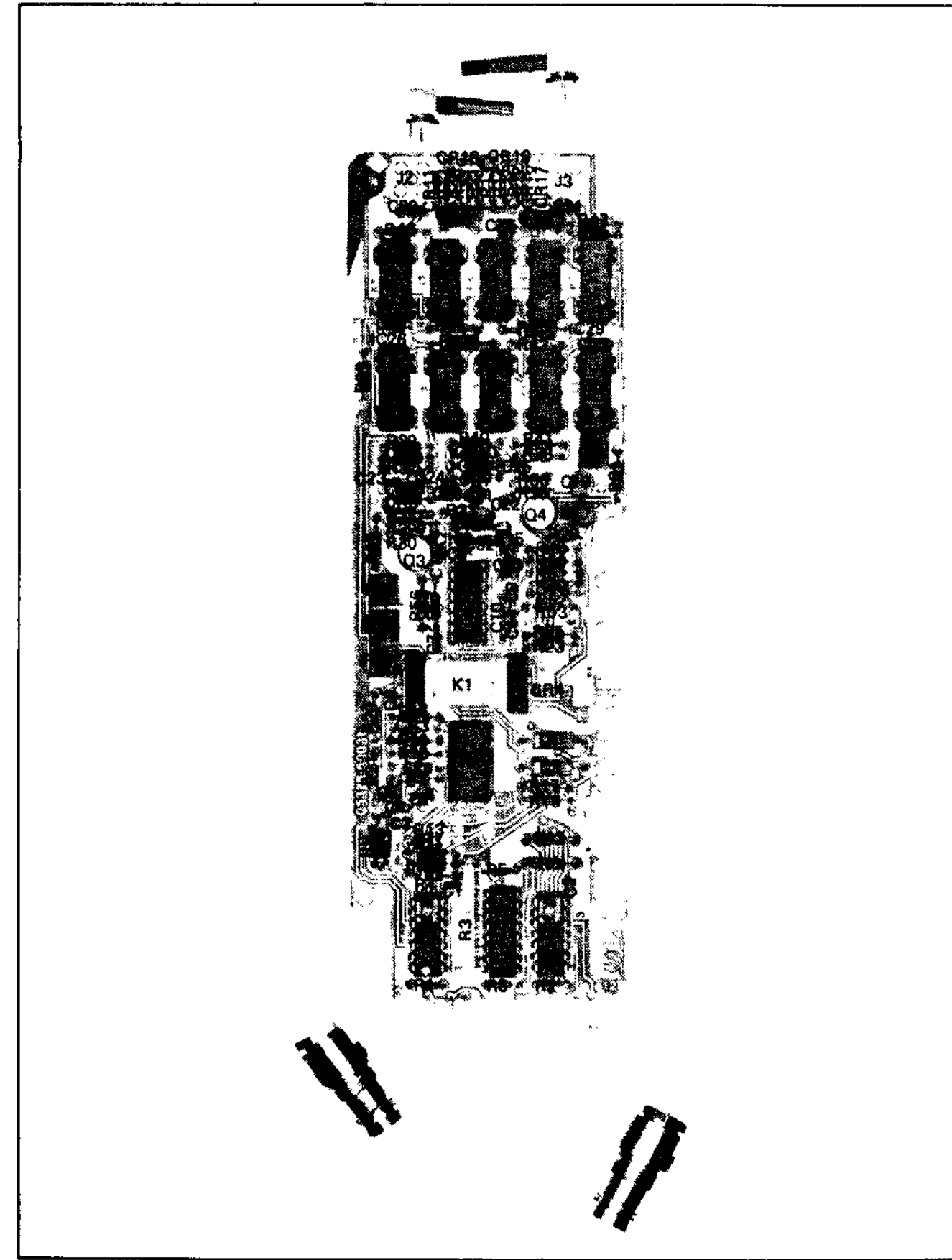


Figure 8-20. A12 "A-B" Channel Schematic and Components

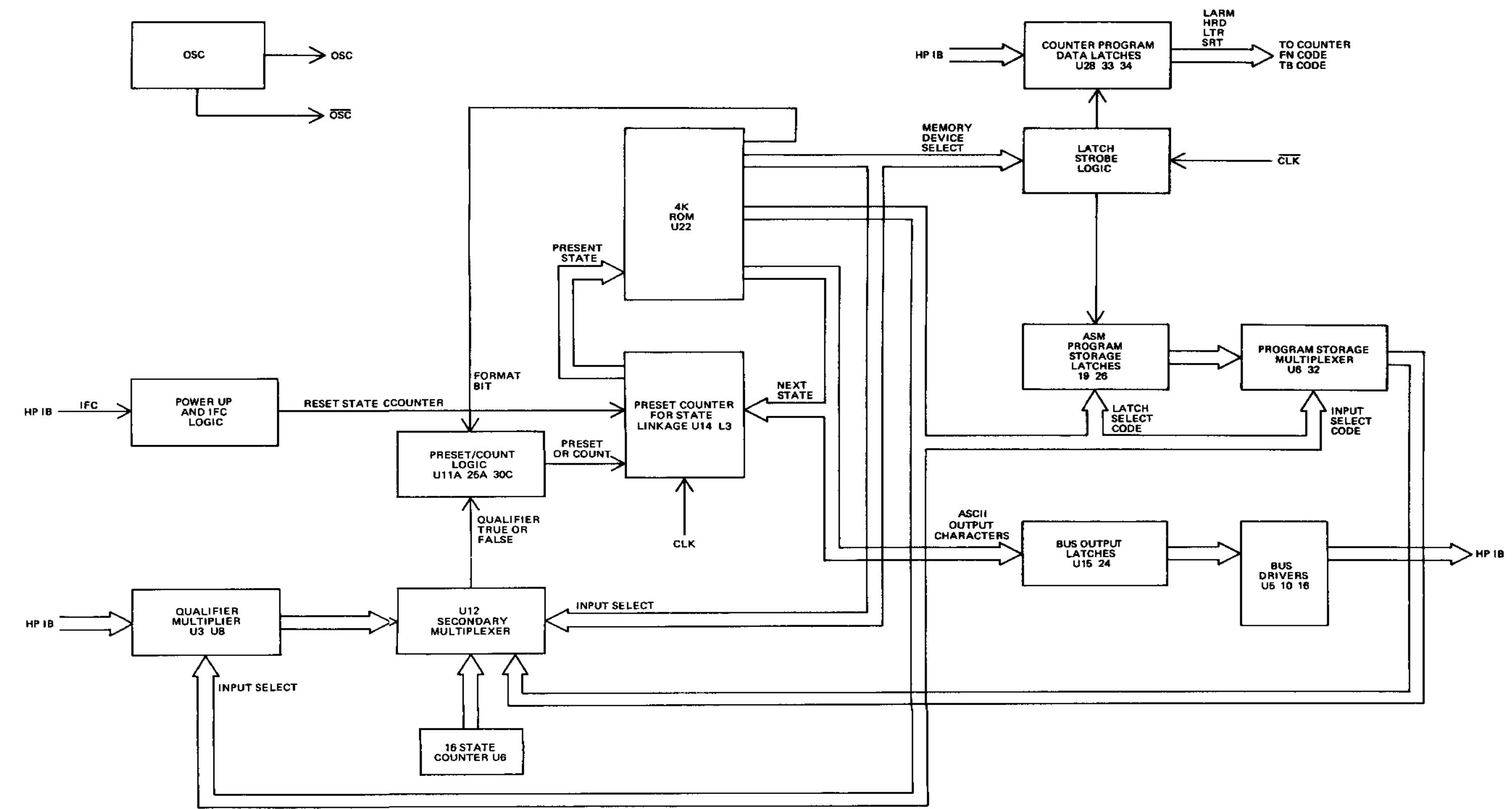
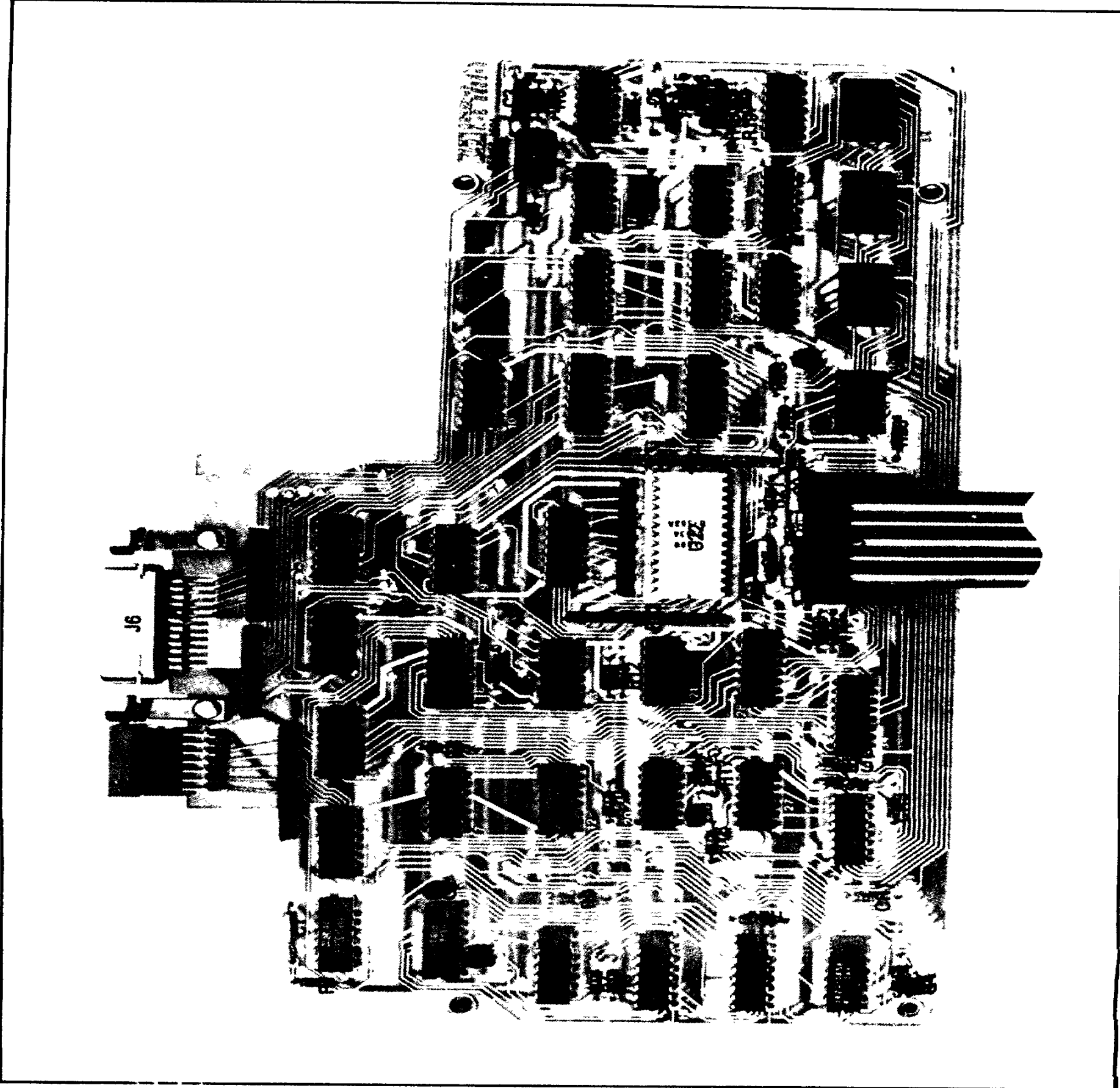


Figure 8-21. A15 HP-IB Interface Block Diagram



P/O Figure 8-22. A15 HP-IB Interface Schematic and Components

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) → A16(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 → X4(B17) → BUS (43)
- 26 DB → XA4(B18) → BUS (43)
- 27 CND
- 28 -5V

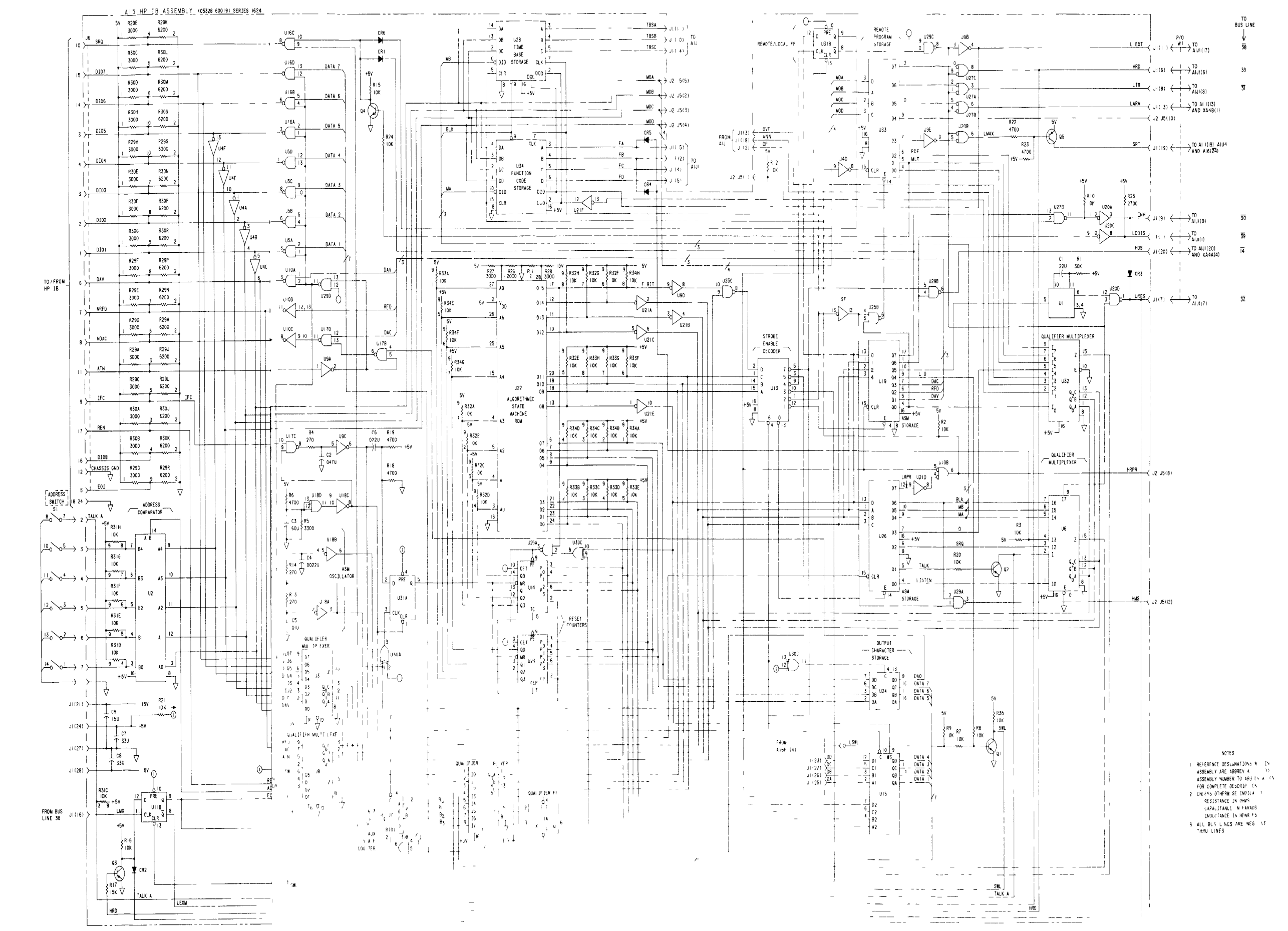


Figure 8-22. A15 HP-IB Interface Schematic and Components

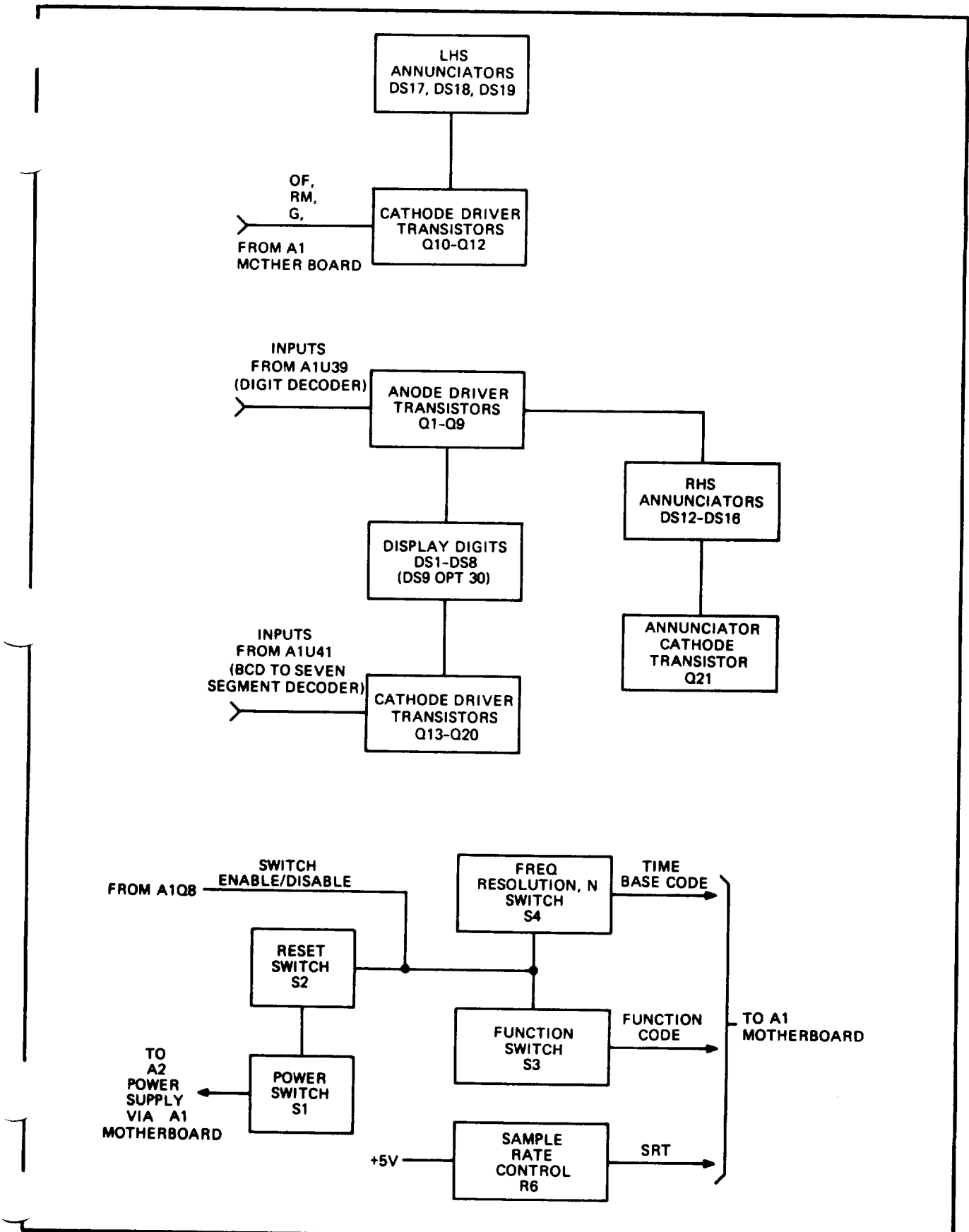
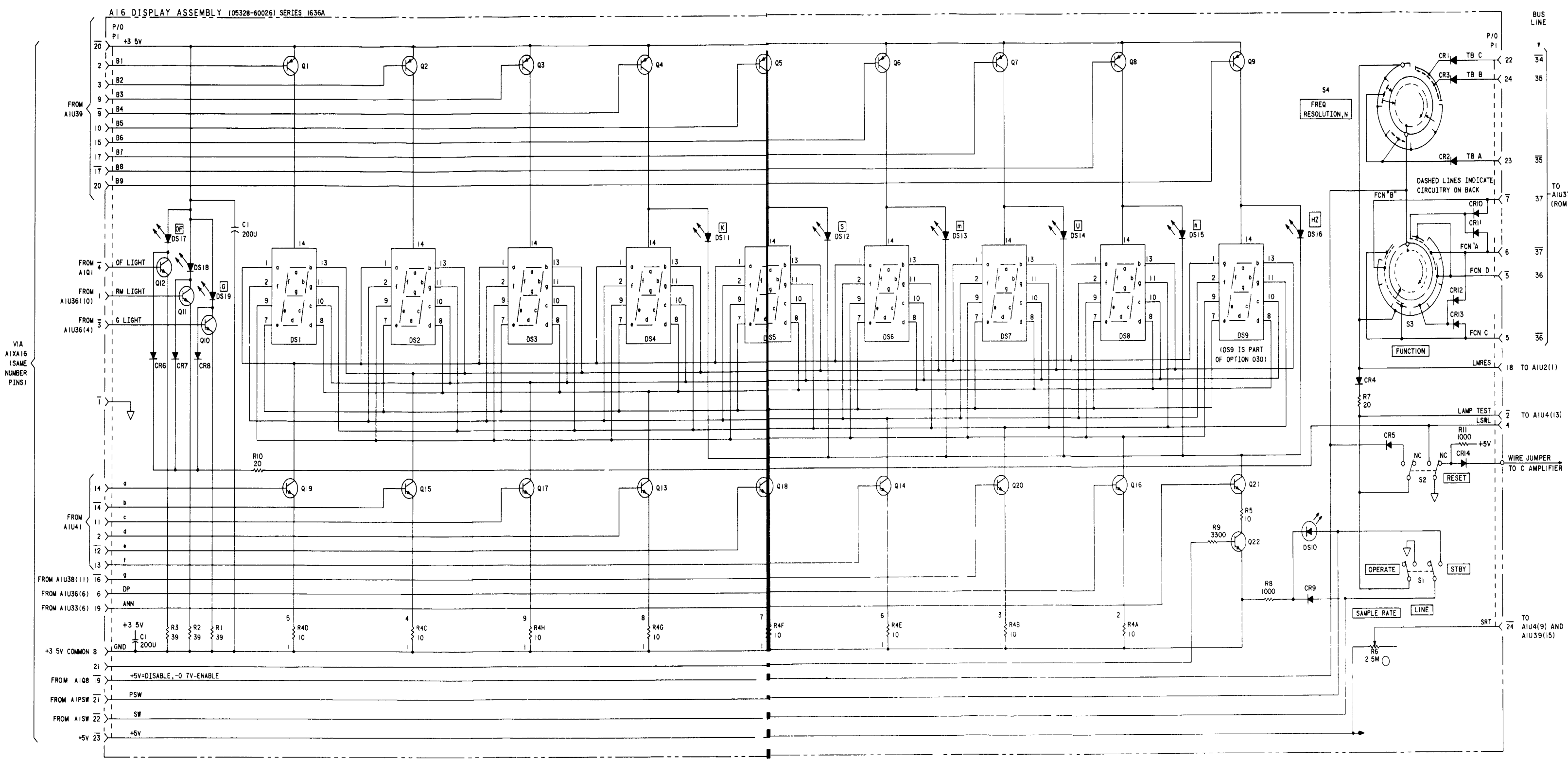
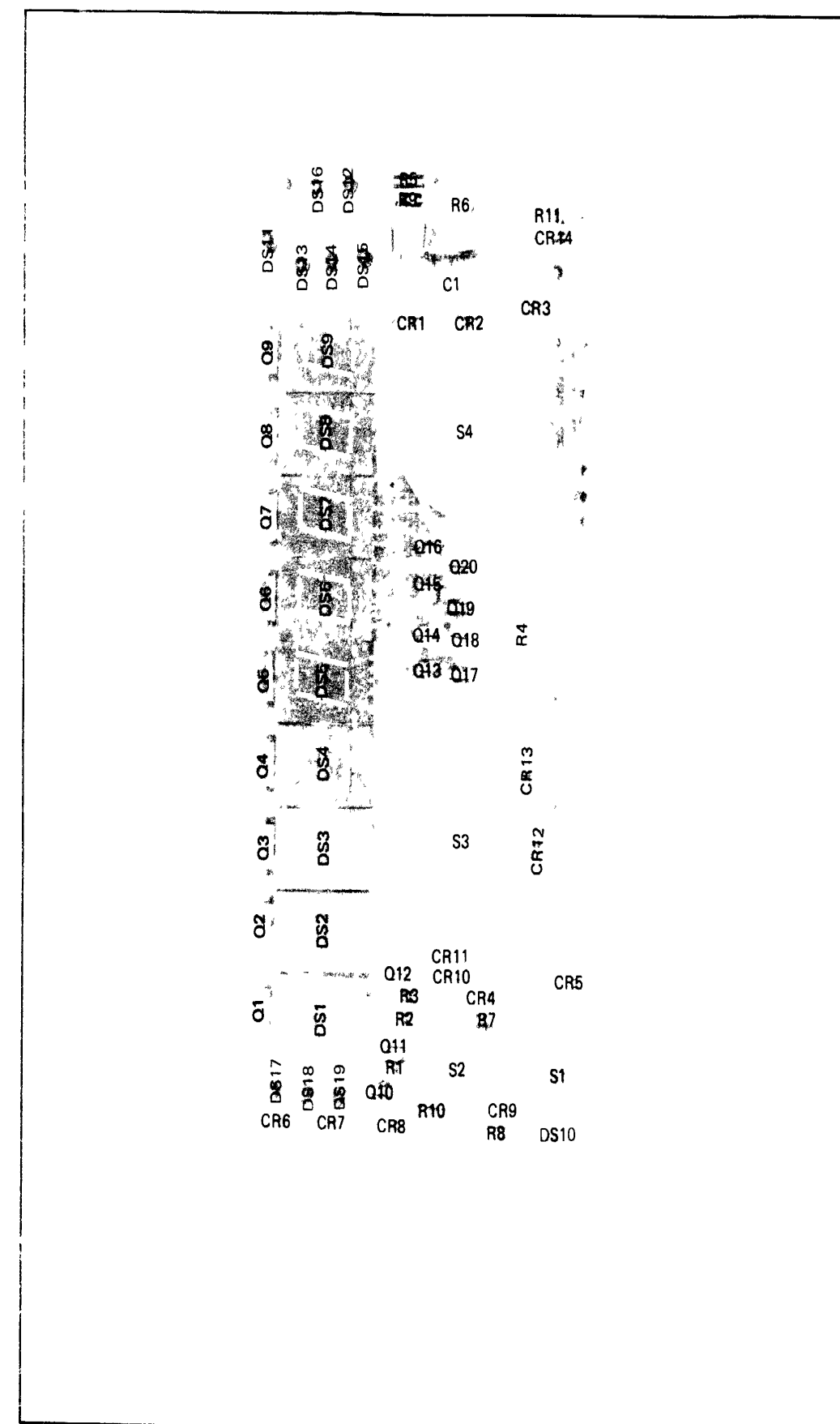


Figure 8-23. A16 Display Block Diagram

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 | - | LSLO NC  | 21 | - | } POWER SWITCH                |
| 22 | - | TBS C    | 22 | - |                               |
| 23 | - | TBS A    | 23 | - | +5V                           |
| 24 | - | TBS C    | 24 | - | SRT                           |

P/O Figure 8-24. A16 Display Schematic and Components



S4 TABLE

| TBS | TBS | TBS | RESOLUTION                    |
|-----|-----|-----|-------------------------------|
| 0   | 0   | 0   | 1HZ(10 <sup>1</sup> ) 1US     |
| 0   | 0   | 1   | 10KHZ(10 <sup>2</sup> ) 100US |
| 0   | 1   | 0   | 10KHZ(10 <sup>2</sup> ) 1MS   |
| 1   | 0   | 0   | 1KHZ(10 <sup>1</sup> ) 10US   |
| 1   | 0   | 1   | 10KHZ(10 <sup>2</sup> ) 100US |
| 1   | 1   | 0   | 1KHZ(10 <sup>1</sup> ) 10US   |
| 1   | 1   | 1   | 10KHZ(10 <sup>2</sup> ) 100US |

\* SWITCH S4 SHOWN IN THIS POSITION

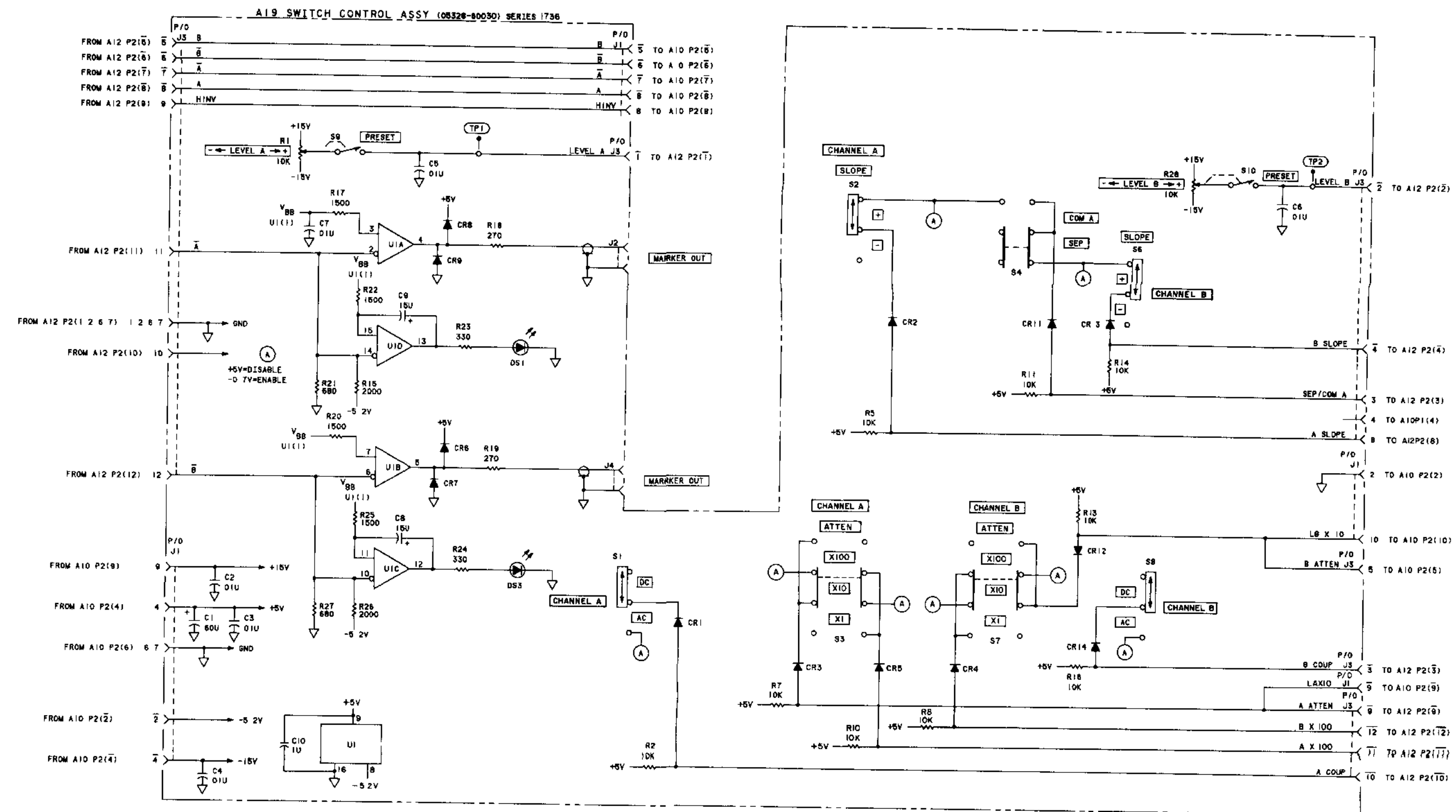
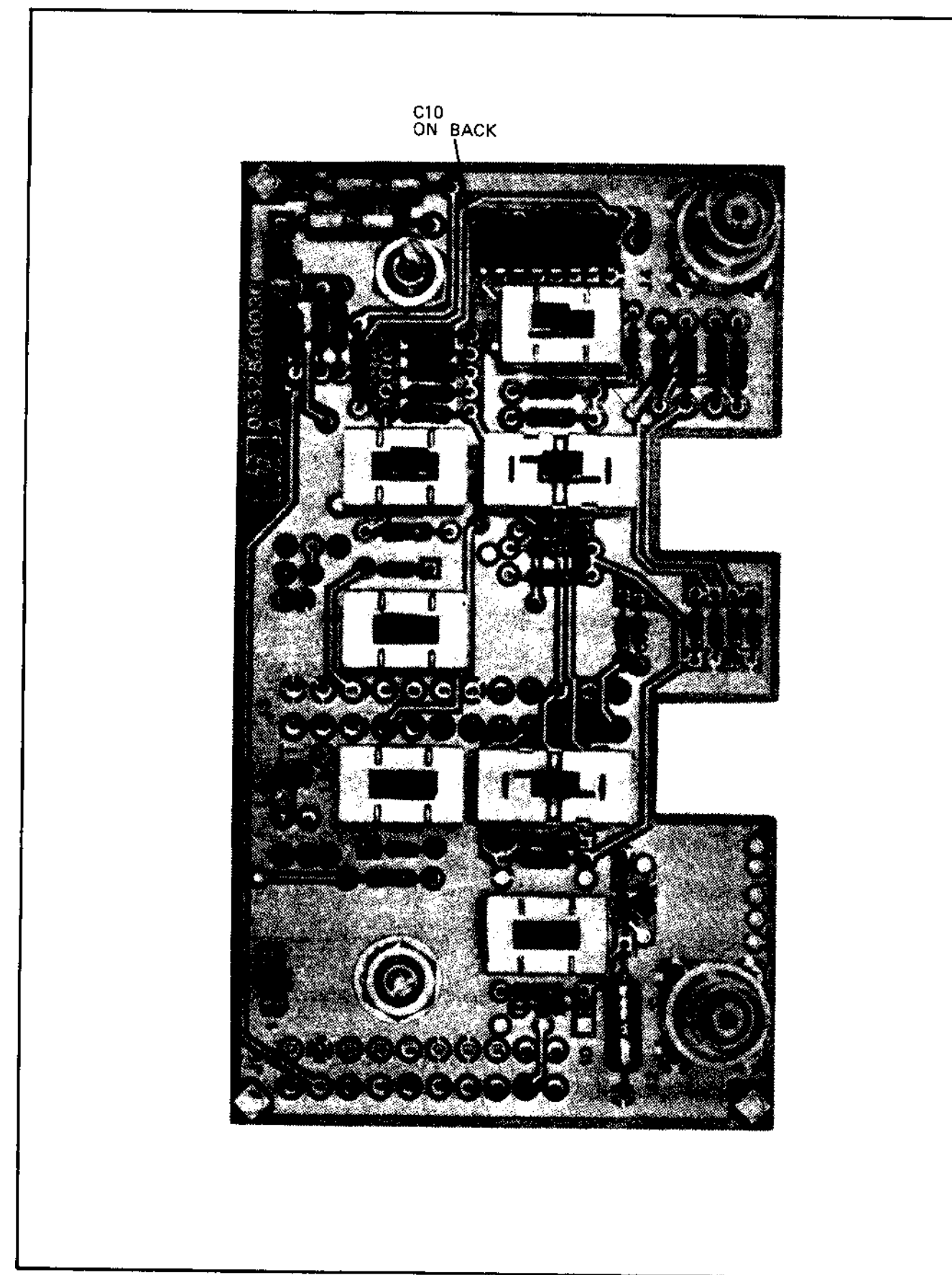
S3 TABLE

| FO | FC | FB | FA | FUNCTION   |
|----|----|----|----|------------|
| 1  | 1  | 0  | 0  | CHECK      |
| 1  | 1  | 1  | 0  | FREQ C     |
| 1  | 1  | 1  | 1  | DW         |
| 0  | 1  | 0  | 0  | FREQ A     |
| 0  | 1  | 1  | 0  | PER A      |
| 1  | 0  | 0  | 1  | PER AVG A  |
| 1  | 0  | 1  | 0  | RATIO B/A  |
| 1  | 0  | 1  | 1  | T1 A-B     |
| 1  | 0  | 0  | 1  | T1 AVG A-B |
| 1  | 1  | 0  | 1  | RATIO C/A  |

\* SWITCH S3 SHOWN IN THIS POSITION

- NOTES
1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED ADD FOR COMPLETE DESCRIPTION UNLESS OTHERWISE INDICATED
  2. UNLESS OTHERWISE INDICATED RESISTANCE IN OHMS CAPACITANCE IN FARADS INDUCTANCE IN HENRIES
  3. ASTERISK(\*) INDICATES SELECTED COMPONENT AVERAGE VALUES SHOWN

Figure 8-24. A16 Display Schematic and Components



- 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.

Figure 8-25. A19 Switch/Attenuator Schematic and Components



APPENDIX A

REFERENCES

- |              |  |
|--------------|--|
| DA Pam 310-4 | Index of Technical Manuals, Technical Bulletins, Supply Manuals (Types 7, 8, and 9), Supply Bulletins, and Lubrication Orders.                       |
| DA Pam 310-7 | US Army Equipment Index of Modification Work Orders.   |
| TB 43-0118   | Field Instructions for Painting and Preserving Electronics Command Equipment Including Camouflage Pattern Painting of Electrical Equipment Shelters. |
| TM 38-750    | The Army Maintenance Management System (TAMMS).  |
| TM 750-244-2 | Procedures for Destruction of electronics Material to Prevent Enemy Use (Electronics Command).   |



**APPENDIX B**  
**COMPONENTS OF END ITEM LIST**

**Section I. INTRODUCTION**

**B-1. Scope**

This appendix lists integral components of and basic issue items for the AN/USM-459 to help you inventory items required for safe and efficient operation.

**B-2. General**

This Components of End Item List is divided into the following sections:

a. Section II. Integral Components of the End Item. These items, when assembled, comprise the and must accompany it whenever it is transferred or turned in. The illustrations will help you identify these items.

b. Section III. Basic Issue Items. These are the minimum essential items required to place the in operation, to operate it, and to perform emergency repairs. Although shipped separately packed they must accompany the during operation and whenever it is transferred between accountable officers. The illustrations will assist you with hard-to-identify items. This manual is your authority to requisition replacement BII, based on TOE/MTOE authorization of the end item.

**B-3. Explanation of Columns**

a. Illustration. This column is divided as follows:

(1) Figure number. Indicates the figure number

of the illustration on which the item is shown.

(2) Item number. The number used to identify item called out in the illustration.

b. National Stock Number. Indicates the National stock number assigned to the item and which will be used for requisitioning.

c. Description. Indicates the Federal item name and, if required, a minimum description to identify the item. The part number indicates the primary number used by the manufacturer, which controls the design and characteristics of the item by means of its engineering drawings, specifications, standards, and inspection requirements to identify an item or range of items. Following the part number, the Federal Supply Code for Manufacturers (FSCM) is shown in parentheses.

d. Location. The physical location of each item listed-is given in this column. The lists are designed to inventory all items in one area of the major item before moving onto an adjacent area.

e. Usable on Code. Not applicable.

f. Quantity Required (Qty Reqd). This column lists the quantity of each item required for a complete major item.

g. Quantity. This column is left blank for use during an inventory. Under the Rcvd column, list the quantity you actually receive on your major item. The Date columns are for your use when you inventory the major item.

| SECTION II INTEGRAL COMPONENTS OF END ITEM |          |   |              |        |      |          |
|--|----------|---|--------------|--------|------|----------|
| (1)  | (2)      | (3)   | (4)          | (5)    | (6)  | (7)      |
| ILLUSTRATION                               | NATIONAL | DESCRIPTION   | LOCATION     | USABLE | QTY  | QUANTITY |
| (A)  | (B)      | STOCK   |              | ON     | REQD |          |
| FIG  | ITEM     | NUMBER  |              | CODE   |      |          |
| NO.  | NO.      | PART NUMBER   | (FSCM)       |        |      | RCVD     |
| 1-1  | 1        | 6625-01-061-8929  |              |        |      | 1        |
|  |          | COUNTER ELECTRONIC DIGITAL READOUT,<br>TS-3662/U<br>5328A/E42 (28480) |              |        |      |          |
| 1-1  | 2        | 6625-01-061-8905  | INSIDE COVER |        |      | 1        |
|  |          | EXTENDER BOARD<br>05328-62016 (28480)                                 |              |        |      |          |
| 1-1  | 3        |   | INSIDE COVER |        |      | 1        |
|  |          | POWER CORD<br>8120-1348 (28480)                                       |              |        |      |          |
| 1-1  | 4        | 6625-01-061-8904  | INSIDE COVER |        |      | 1        |
|  |          | COVER ASSEMBLY<br>7101-0470 (28480)                                   |              |        |      |          |

| SECTION III  |                  | BASIC ISSUE ITEMS                       |             |          | (4)    | (5)  | (6)      | (7) |
|--------------|------------------|---|-------------|----------|--------|------|----------|-----|
| (1)          | (2)              | (3)                                     |             |          | (4)    | (5)  | (6)      | (7) |
| ILLUSTRATION | NATIONAL         | DESCRIPTION                             |             | LOCATION | USABLE | QTY  | QUANTITY |     |
| (A)          | (B)              | STOCK                                   |             |          | ON     | REQD |          |     |
| FIG          | ITEM             | NUMBER                                  | PART NUMBER | (FSCM)   | CODE   |      | RCVD     |     |
| NO.          | NO.              |   |             |          |        |      |          |     |
| 1            | 5920-00-280-8342 | FUSE, 1 AMP F. BLO<br>2110-0001 (28480) |             |          |        | 1    |          |     |
| 2            | 5920-00-793-4592 | FUSE, 2 AMP F. BLO<br>2110-0002 (28480) |             |          |        | 1    |          |     |
| 3            |                  | MANUAL TM 11-6625-2941-14&P             |             |          |        | 1    |          |     |
| 4            | 5920-00-010-5920 | FUSE 3 AMP                              |             |          |        | 1    |          |     |
| 5            |                  | FUSE 125 AMP<br>2110-0311 (28480)       |             |          |        | 1    |          |     |



**APPENDIX D**  
**MAINTENANCE ALLOCATION**

**Section I. INTRODUCTION**

**D-1. General**

This appendix provides a summary of the maintenance operations for AN/USM-459. It authorizes categories of maintenance for specific maintenance functions on repairable items and components and the tools and equipment required to perform each function. This appendix may be used as an aid in planning maintenance operations.

**D-2. Maintenance Function**

Maintenance functions will be limited to and defined as follows:

a. Inspect. To determine the serviceability of an item by comparing its physical, mechanical, and/or electrical characteristics with established standards through examination.

b. Test. To verify serviceability and to detect incipient failure by measuring the mechanical or electrical characteristics of an item and comparing those characteristics with prescribed standards.

c. Service. Operations required periodically to keep an item in proper operating condition; i.e., to clean (decontaminate), to preserve, to drain, to paint, or to replenish fuel, lubricants, hydraulic fluids, or compressed air supplies.

d. Adjust. To maintain, within prescribed limits, by bringing into proper or exact position, or by setting the operating characteristics to the specified parameters.

e. Align. To adjust specified variable elements of an item to bring about optimum or desired performance.

f. Calibrate. To determine and cause corrections to be made or to be adjusted on instruments or test measuring and diagnostic equipments used in precision measurement. Consists of comparisons of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared.

g. Install. The act of emplacing, seating, or fixing into position an item, part, module (component or assembly) in a manner to allow the proper functioning of the equipment or system.

h. Replace. The act of substituting a serviceable like type part, subassembly, or module (component or assembly) for an unserviceable counterpart.

i. Repair. The application of maintenance services (inspect, test, service, adjust, align, calibrate, replace) or other maintenance actions (welding, grinding, riveting, straightening, facing, remachining, or resurfacing) to restore serviceability to an item by correcting specific damage,

fault, malfunction, or failure in a part, subassembly, module (component or assembly), end item, or system.

j. Overhaul. That maintenance effort (service/action) necessary to restore an item to a completely serviceable/operational condition as prescribed by maintenance standards (i.e., DMWR) in appropriate technical publications. Overhaul is normally the highest degree of maintenance performed by the Army. Overhaul does not normally return an item to like new condition.

k. Rebuild. Consists of those services/actions necessary for the restoration of unserviceable equipment to a like new condition in accordance with original manufacturing standards. Rebuild is the highest degree of materiel maintenance applied to Army equipment. The rebuild operation includes the act of returning to zero those age measurements (hours, miles, etc.) considered in classifying Army equipment/components.

**D-3. Column Entries**

a. Column 1, Group Number. Column 1 lists group numbers, the purpose of which is to identify components, assemblies, subassemblies, and modules with the next higher assembly.

b. Column 2, Component/Assembly. Column 2 contains the noun names of components, assemblies, subassemblies, and modules for which maintenance is authorized.

c. Column 3, Maintenance Functions. Column 3 lists the functions to be performed on the item listed in column 2. When items are listed without maintenance functions, it is solely for purpose of having the group numbers in the MAC and RPSTL coincide.

d. Column 4, Maintenance Category. Column 4 specifies, by the listing of a "work time" figure in the appropriate subcolumn(s), the lowest level of maintenance authorized to perform the function listed in column 3. This figure represents the active time required to perform that maintenance function at the indicated category of maintenance. If the number or complexity of the tasks within the listed maintenance function vary at different maintenance categories, appropriate "work time" figures will be shown for each category. The number of task-hours specified by the "work time" figure represents the average time required to restore an item (assembly, subassembly, component, module, end item or system) to a serviceable condition under typical field operating conditions. This time includes preparation time, troubleshooting time, and quality assurance/quality control time in addition to the

time required to perform the specific tasks identified for the maintenance functions authorized in the maintenance allocation chart. Subcolumns of column 4 are as follows:

- C – Operator/Crew
- O – Organizational
- F – Direct Support
- H – General Support
- D – Depot

e. Column 5, Tools and Equipment. Column 5 specifies by code, those common tool sets (not individual tools) and special tools, test and support equipment required to perform the designated function.

f. Column 6, Remarks. Column 6 contains an alphabetic code which leads to the remark in Section IV, Remarks, which is pertinent to the item opposite the particular code.

#### **D-4. Tool and Test Equipment Requirements (Sec III)**

a. Tool or Test Equipment Reference Code. The numbers in this column coincide with the numbers

used in the tools and equipment column of the MAC. The numbers indicate the applicable tool or test equipment for the maintenance functions.

b. Maintenance Category. The codes in this column indicate the maintenance category allocated the tool or test equipment.

c. Nomenclature. This column lists the noun name and nomenclature of the tools and test equipment required to perform the maintenance functions.

d. National/NATO Stock Number. This column lists the National/NATO stock number of the specific tool or test equipment.

e. Tool Number. This column lists the manufacturer's part number of the tool followed by the Federal Supply Code for manufacturers (5-digit) in parentheses.

#### **D-5. Remarks (Sec IV)**

a. Reference Code. This code refers to the appropriate item in section II, column 6.

b. Remarks. This column provides the required explanatory information necessary to clarify items appearing in section II.



SECTION II MAINTENANCE ALLOCATION CHART  
FOR  
ELECTRONIC COUNTER AN/USM-459

| (1)<br>GROUP<br>NUMBER | (2)<br>COMPONENT/ASSEMBLY                                  | (3)<br>MAINTENANCE<br>FUNCTION                  | (4)<br>MAINTENANCE CATEGORY |   |   |                   |      | (5)<br>TOOLS<br>AND<br>EQPT.                 | (6)<br>REMARKS |
|------------------------|--|---|-----------------------------|---|---|-------------------|------|--|----------------|
|                        |  |   | C                           | O | F | H                 | D    |  |                |
| 00                     | ELECTRONIC COUNTER AN/USM-459                              | Inspect<br>Test<br>Adjust<br>Repair<br>Overhaul | 0.1                         |   |   | 1.0<br>1.5<br>2.0 | 10.0 | 1<br>2 thru 9<br>2 thru 11<br>2<br>2 thru 12 | A              |
| 01                     | ELECTRONIC COUNTER TS-3662/U                               | Repair<br>Overhaul                              |                             |   |   | 2.0               | 10.0 | 2<br>2 thru 12                               |                |
| 0101                   | CIRCUIT CARD ASSEMBLY A1 (MOTHERBOARD)                     | Inspect<br>Repair                               |                             |   |   | 0.1               | 1.0  | 1<br>2,11                                    | B              |
| 0102                   | CIRCUIT CARD ASSEMBLY A2 (POWER SUPPLY)                    | Inspect<br>Repair                               |                             |   |   | 0.1               | 1.0  | 1<br>2,11                                    | B              |
| 0103                   | CIRCUIT CARD ASSEMBLY A3 (OSCILLATOR)                      | Inspect<br>Repair                               |                             |   |   | 0.1               | 1.0  | 1<br>2,11                                    | B              |
| 010301                 | OSCILLATOR A3A1  | Inspect   |                             |   |   | 0.1               |      | 1  |                |
| 0104                   | CIRCUIT CARD ASSEMBLY A4 (FUNCTION SELECTOR)               | Inspect<br>Repair                               |                             |   |   | 0.1               | 1.0  | 1<br>1,2,11                                  | B              |
| 0105                   | CIRCUIT CARD ASSEMBLY A8 ("C" CHANNEL INPUT)               | Inspect<br>Repair                               |                             |   |   | 0.1               | 1.0  | 1<br>2,11                                    | B              |
| 0106                   | CIRCUIT CARD ASSEMBLY A10 (SYNCHRONIZER)                   | Inspect<br>Repair                               |                             |   |   | 0.1               | 1.0  | 1<br>2,11                                    | B              |
| 0107                   | CIRCUIT CARD ASSEMBLY A11 (DIGITAL-TO-ANALOG<br>CONVERTER) | Inspect<br>Repair                               |                             |   |   | 0.1               | 1.0  | 1<br>2,11                                    | B              |
| 0108                   | CIRCUIT CARD ASSEMBLY A12 ("A-B" CHANNEL INPUT)            | Inspect<br>Repair                               |                             |   |   | 0.1               | 1.0  | 1<br>2,11                                    | B              |
| 0109                   | CIRCUIT CARD ASSEMBLY A15 (HP-1B INTERFACE)                | Inspect<br>Repair                               |                             |   |   | 0.1               | 1.0  | 1<br>2,11                                    | B              |
| 0110                   | CIRCUIT CARD ASSEMBLY A16 (DISPLAY)                        | Inspect<br>Repair                               |                             |   |   | 0.1               | 1.0  | 1<br>2,11                                    | B              |
| 0111                   | CIRCUIT CARD ASSEMBLY A19 (ATTENUATOR)                     | Inspect<br>Repair                               |                             |   |   | 0.1               | 1.0  | 1<br>2,11                                    | B              |
| 02                     | COVER, P/N 7101-0470                                       | Inspect<br>Repair                               | 0.1                         |   |   |                   | 1.0  | 1<br>2                                       |                |
| 03                     | EXTENDER BOARD, P/N 05328-62016                            | Inspect<br>Repair                               | 0.1                         |   |   |                   | 1.0  | 1<br>2 thru 11                               | B              |
| 04                     | POWER CORD, P/N 8120-1348                                  | Inspect<br>Repair                               | 0.1                         |   |   |                   | 1.0  | 1<br>2                                       | B              |

SECTION III TOOL AND TEST EQUIPMENT REQUIREMENTS  
FOR

ELECTRONIC COUNTER UN/USM-459

| TOOL OR TEST<br>EQUIPMENT<br>REF CODE | MAINTENANCE<br>CATEGORY | NOMENCLATURE   | NATIONAL/NATO<br>STOCK NUMBER                            | TOOL NUMBER |
|---------------------------------------|-------------------------|--|--|-------------|
| 1                                     | 0                       | TOOL KIT, ELECTRONIC COUNTER TK-101/G  | 5180-00-064-5178   |             |
| 2                                     | H,D                     | TOOL KIT, ELECTRONIC COUNTER TK-100/G  | 5180-00-605-0079   |             |
| 3                                     | H,D                     | OSCILLATOR, H.P. 652A  | 4931-00-113-2943   |             |
| 4                                     | H,D                     | VOLTMETER, SAMPLING ME-426/U   | 6625-00-113-3491   |             |
| 5                                     | H,D                     | SIGNAL GENERATOR SG-1112(V)1/U   | 6625-00-566-3067   |             |
| 6                                     | H,D                     | OSCILLOSCOPE SYSTEM (MAINFRAME)<br>WITH AMPLIFIER PLUG-IN HP-1402<br>AND HP-1411 | 4931-00-491-0261<br>4931-00-491-0262<br>4931-00-491-0265 |             |
| 7                                     | H,D                     | PULSE GENERATOR SG-1105  | 6625-01-010-3524   |             |
| 8                                     | H,D                     | SIGNAL GENERATOR HP 608 CR   | 6625-00-487-2878   |             |
| 9                                     | H,D                     | POWER SUPPLY PP-7547/U (HP 6113A)  |  |             |
| 10                                    | H,D                     | VOLTMETER HP 3490  | 6625-01-010-9255   |             |
| 11                                    | H,D                     | REPAIR KIT PRINTED WIRING BOARD MK-772/U   | 5999-00-757-7042   |             |
| 12                                    | H,D                     | TRANSISTOR TEST SET TS-1836C/U   | 6625-00-159-2263   |             |

THE FOLLOWING EQUIPMENTS WILL BE USED WHEN THE PROGRAMING  
FUNCTION OF THE AN/USM-459 REQUIRES CHECK FOR USE WITH ATE.  
THIS CHECK WILL BE PREFORMED AT THE CONTRACTORS FACILITY.

GENERATOR/SWEEPER HP-8601A  
CONTROLLER/COMPUTER HP-9825A  
FUNCTION GENERATOR HP-3312A

SECTION IV. REMARKS

| REFERENCE<br>CODE | REMARKS   |
|-------------------|---|
| A                 | BY REPLACEMENT OF CIRCUIT CARD ASSEMBLIES A2, A4, A8, A10, A11, A12, A15, A16, AND A19.<br>OSCILLATOR A3, AND CHASSIS MOUNTED COMPONENTS. |
| B                 | BY REPLACEMENT OF INDIVIDUAL COMPONENTS.  |



**By Order of the Secretary of the Army:**

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*General, United States Army*  
*Chief of Staff*

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USA ERDAW (1)  
Ft Gordon (10)  
Ft Hauchuca (10)  
Ft Carson (5)  
Army Dep (1) except:  
LBAD (14)  
SAAD (30)  
TOAD (14)  
SHAD (3)  
Ft Gillem (10)  
USA Dep (1)  
Sig Sec USA Dep (1)  
Ft Richardson (CERCOM Ofc) (2)  
Units org under fol TOE:  
29-207 (2)  
29-610 (2)

NG: None

USAR: None

For explanation of abbreviations used, see AR 310-50.



RECOMMENDED CHANGES TO EQUIPMENT TECHNICAL MANUALS



**SOMETHING WRONG WITH THIS MANUAL?**

THEN... JOT DOWN THE DOPE ABOUT IT ON THIS FORM, TEAR IT OUT, FOLD IT AND DROP IT IN THE MAIL!

FROM: (YOUR UNIT'S COMPLETE ADDRESS)

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Stateside Army Depot  
ATTN: AMSTA-US  
Stateside, N.J. 07703

DATE 4 April 1978

PUBLICATION NUMBER: TM 11-5840-340-14&P      DATE: 23 Jan 74      TITLE: Radar Set / PLC-76

BE EXACT... PIN-POINT WHERE IT IS

IN THIS SPACE TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT:

TEAR ALONG DOTTED LINE

| PAGE NO. | PARA-GRAPH | FIGURE NO. | TABLE NO. |  |
|----------|------------|------------|-----------|--|
| 2-25     | 2-28       |            |           | <p>Recommend that the installation antenna alignment procedure be changed throughout to specify a 2° IFF antenna lag rather than 1°.</p> <p>REASON: Experience has shown that with only a 1° lag, the antenna servo system is too sensitive to wind gusting in excess of 35 knots, and has a tendency to rapidly accelerate and decelerate as it hunts, causing strain to the drive train. Hunting is minimized by adjusting the lag to 2° without degradation of operation.</p> |
| 3-10     | 3-3        |            | 3-1       | <p>Item 5, Function column. Change "2 db" to "3db."</p> <p>REASON: The adjustment procedure for the TRANS POWER FAULT indicator calls for a 3 db (500 watts) adjustment to light the TRANS POWER FAULT indicator.</p>  |
| 5-6      | 5-8        |            |           | <p>Add new step f.1 to read, "Replace cover plate removed in step e.1, above."</p> <p>REASON: To replace the cover plate.</p>  |
| E-5      |            |            |           | <p>For item 2, change the NSN to read: 5835-00-134-9186.</p> <p>REASON: Accuracy.</p>  |
| E-8      |            | E-3        |           | <p>Identify the cover on the junction box (item no. 5).</p> <p>REASON: It is a separate item and is not called out on figure 19.</p>   |
| E-9      |            |            |           | <p>Add the cover of the junction box as an item in the listing for figure 19.</p> <p>REASON: Same as above.</p>  |

TYPED NAME, GRADE OR TITLE, AND TELEPHONE NUMBER

SSG I. M. DeSpirito 999-1776

SIGNATURE

*SSA I. M. DeSpirito*

DA FORM 2028-2  
1 AUG 74

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PUBLICATION NUMBER

TM 11-6625-2941-14&P

DATE

28 Mar 79

TITLE

BE EXACT... PIN-POINT WHERE IT IS

| PAGE NO. | PARA-GRAPH | FIGURE NO. | TABLE NO. |
|----------|------------|------------|-----------|
|----------|------------|------------|-----------|

IN THIS SPACE TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT:

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