Errata

Title & Document Type: **5328AH99 500 MHz Universal Frequency Counter Operating and Service Manual**

Manual Part Number: **05328-90101**

Revision Date: **June 1984**

About this Manual

We've added this manual to the Agilent website in an effort to help you support your product. This manual provides the best information we could find. It may be incomplete or contain dated information, and the scan quality may not be ideal. If we find a better copy in the future, we will add it to the Agilent website.

HP References in this Manual

This manual may contain references to HP or Hewlett-Packard. Please note that Hewlett-Packard's former test and measurement, life sciences, and chemical analysis businesses are now part of Agilent Technologies. The HP XXXX referred to in this document is now the Agilent XXXX. For example, model number HP8648A is now model number Agilent 8648A. We have made no changes to this manual copy.

Support for Your Product

Agilent no longer sells or supports this product. You will find any other available product information on the Agilent Test & Measurement website:

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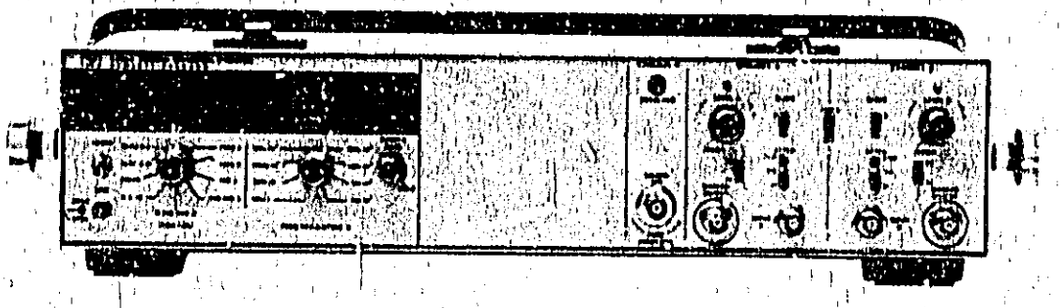
Search for the model number of this product, and the resulting product page will guide you to any available information. Our service centers may be able to perform calibration if no repair parts are needed, but no other support from Agilent is available.

Agilent Technologies

OPERATING AND SERVICE MANUAL

HP 5328AH99
500 MHz Universal Frequency Counter



HEWLETT PACKARD

HP 5328AH99

SAFETY

This product has been designed and tested according to International Safety Requirements. To ensure safe operation and to keep the product safe, the information, cautions, and warnings in this manual must be heeded. Refer to Section I for general safety considerations applicable to this product.

CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and to the calibration facilities of other International Standards Organization members.

WARRANTY

This Hewlett-Packard product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by HP. However, warranty service for products installed by HP and certain other products designated by HP will be performed at Buyer's facility at no charge within the HP service travel area. Outside HP service travel areas, warranty service will be performed at Buyer's facility only upon HP's prior agreement and Buyer shall pay HP's round trip travel expenses.

For products returned to HP for warranty service, Buyer shall prepay shipping charges to HP and HP shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to HP from another country.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. HP SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

EXCLUSIVE REMEDIES

THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. HP SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

ASSISTANCE

Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products.

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

HEWLETT PACKARD

OPERATING AND SERVICE MANUAL

HP 5328AH99
500 MHz Universal Frequency Counter

SERIAL PREFIX: 2424A

This manual applies to Hewlett-Packard Model 5328AH99 Counters with serial prefix number 2424A.

MANUAL PART NUMBER 05328-90101
Microfiche Part Number 05328-90102

Printed: JUNE 1984

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (Continued)

SAFETY CONSIDERATIONS

GENERAL

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

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

BEFORE APPLYING POWER

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

SAFETY EARTH GROUND

An uninterruptible safety earth ground must be provided from the main power source to the product input wiring terminals, power cord, or supplied power cord set.

SAFETY SYMBOLS

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

Indicates hazardous voltages.

Indicates earth (ground) terminal.

WARNING

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

CAUTION

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

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

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

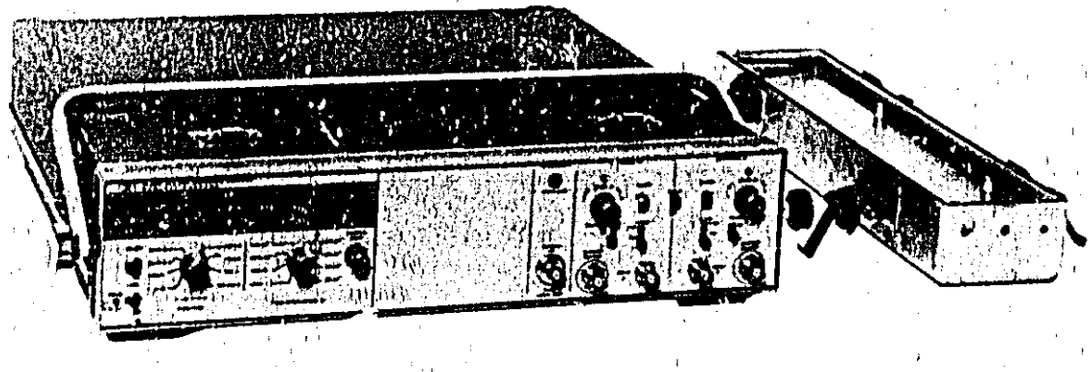
If this instrument is to be energized via an autotransformer (for voltage reduction) make sure the common terminal is connected to the earth terminal of the power source.

Servicing instructions are for use by service-trained personnel only. To avoid dangerous electric shock, do not perform any servicing unless qualified to do so.

Adjustments described in the manual are performed with power supplied to the instrument while protective covers are removed. Energy available at many points may, if contacted, result in personal injury.

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

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



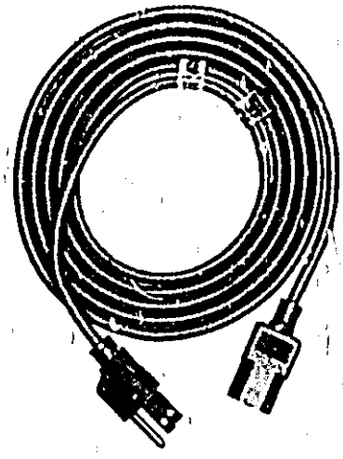


Figure 1-1. Model HP 5328AH99 500 MHz Universal Frequency Counter

SECTION I
GENERAL INFORMATION

1-1. SCOPE OF MANUAL

1-2. This manual provides operating and service information for the Hewlett-Packard Model 5328AH99 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	SCHEMATIC 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 1-3*) make the 5328A suited for a wide range of applications.

1-11. The rear panel controlled "ARM" feature of the HP 5328A is useful in applications such as burst frequency measurements, and pulse 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 picoseconds, with resolution to 10 picoseconds 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-IB). 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 1-1* lists equipment supplied with the 5328A and *Table 1-2* 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 Extender Board, 18 pin	8120-1348 05328-62016

Table 1-2. Accessories Available

DESCRIPTION	HP PART NUMBER
HP Interface Bus Interconnect Cable	10631A, 914 mm (3 ft. long) 10631B, 1828 mm (6 ft. long) 10631C, 3656 mm (12 ft. long) 10631D, 0.5 m (1½ ft. long)
Front Handle Kit Rack Flange Kit (for instruments without handles) Rack and Handle Kit (installation instructions included with above kits)	5061-0088 5061-0074 5061-0075
Service Kit: Function Selector and POM Kit	05328-82004

1-18. SPECIFICATIONS

1-19. *Table 1-3* lists detailed specifications for the 5328A.

Table 1-3. HP 5328A Counter Specifications

CHANNELS A AND B

INPUT CHARACTERISTICS

Range
- DC Coupled: 0 to 100 MHz
- AC Coupled: 20 Hz to 100 MHz
- Common A: 10 MHz maximum

Sensitivity: 30 mV rms, 0—35 MHz (dc coupled)
- 20 Hz—35 MHz (ac coupled)
- 60 mV rms, 35 MHz—100 MHz
- Minimum pulse width 5 ns, 170 mV p-p.

Coupling: ac or dc switch selectable.

Impedance:
- Separate: 1 MΩ NOMINAL || 70 pF NOMINAL.
- Common: 500 KΩ NOMINAL || 140 pF NOMINAL.

Trigger Level: Variable over ±2.5 volts times attenuator setting with 0 volt NOMINAL preset position.
- Usable range: 20% to 80% of signal amplitude.

Trigger Slope: Independent selection of + or - slope.

Attenuators: X1, X10, X100 NOMINAL.

Dynamic Range: 30 mV to 1V rms times attenuator setting, 0—35 MHz; 60 mV to 0.5V rms times attenuator setting, 35 MHz to 100 MHz

Maximum Input:
- DC coupled, X1: 250V rms, dc — 20 kHz
- 100V rms, 20 Hz — 50 kHz
- 5×10^6V rms/freq., 50 kHz — 1 MHz
- 5V rms 1 MHz — 100 MHz
- DC coupled, X10 and X100: 250V rms, dc — 0.5 MHz
- 1.25×10^8V rms/freq., .5—25 MHz
- 5V rms, 25 MHz—100 MHz
- AC coupled: 200V (peak ac + dc), 0—20 Hz.
- Same as dc coupled above 20 Hz.

Channel Input: Separate or Common A.

Marker Outputs: A and B channel Schmidt trigger outputs available on front panel; NOMINALLY 0 to 500 mV levels into 50Ω; <20 ns delay.

FREQUENCY MEASUREMENTS

Frequency A
- Range: 0—100 MHz direct count.
- Resolution: 1 MHz to 0.1 Hz in decade steps.
- Accuracy: ±1 count ± Time Base Error × Frequency.
- Display: kHz, MHz.

PERIOD MEASUREMENTS

Period A
- Range: 10^{-8} Hz—10 MHz
- Resolution: 100 ns to 1 s in decade steps.
- Accuracy: ±1 count ± Time Base Error × Period ±trigger error*
- Display: μs, ms, s

Period Average A
- Range: 10^{-9} Hz—10 MHz
- Resolution: 100 ns—.01 μs in decade steps.
- Accuracy: ±1 count displayed ± Time Base Error × Period

$$\pm \frac{\text{trigger error*}}{\text{no. of periods averaged}}$$

- Display: μs, ns

TIME INTERVAL MEASUREMENTS

Time Interval A to B
- Range: 100 ns to 10^8 seconds
- Minimum pulse width: 25 ns
- Resolution: 100 ns to 1-second in decade steps.
- Accuracy: ±1 count ± Trigger Error* ± Trigger Level Timing Error* ± Time Base Error × T.I.
- Display: μs, ms, s.

Time Interval Average A to B
- Range: 0.1 ns to 10 seconds.
- Resolution:

$$\pm \frac{100\text{ ns}}{\sqrt{\text{no. intervals averaged}}}$$

- Accuracy:

$$\pm \frac{100\text{ ns} + \text{Trigger Error*}}{\sqrt{\text{no. intervals averaged}}} \pm 4\text{ns} \pm \text{Time Base Error} \times \text{T.I.} \pm \text{Trigger Level Timing Error*}$$

- Minimum Dead Time: 150 ns from one STOP to next START
- Display: μs, ns.

RATIO MEASUREMENT

Ratio B/A or C/A
- Range A: 0—10 MHz
- Range B: 0—100 MHz
- Range C: 50—500 MHz

Resolution: 1 part $\frac{B}{A} \times N$

Accuracy: ±1 count of B or C ± Trigger Error* of A times frequency of B or C (N>1). For N=1, add 12 ns times frequency of B or C.

---

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

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

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

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

Trigger Level Timing Error (X1):

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

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

Table 1-3. HP 5328A Counter Specifications (Continued)

PROGRAMMABLE OPERATION (CHANNELS A AND B)

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; use all in all functions except Ratio B/A.

Trigger level is programmable in 10 mV steps in X1; 100 mV in X10; 1V in X100.

Trigger level accuracy under remote control:
X1: ±35 mV
X10, X100: NOMINAL

CHANNEL C

INPUT CHARACTERISTICS

Range: 50 MHz to 500 MHz direct count
Sensitivity: 15 mV rms, 50 MHz—500 MHz
Coupling: AC
Trigger Level: 0 volts NOMINAL, fixed.
Impedance: 50Ω NOMINAL
Maximum Input: 5 volts rms, 50—500 MHz
Input Protection: Input BNC fused; accessible from front panel.
Overload Indicator: Flashing indicator warns of potential overload conditions.
Resolution: 1 MHz to 0.1 Hz in decade steps.
Accuracy: ±1 count ± Time Base Error × Frequency.
Display: Hz, kHz, MHz

TIME BASE

Outputs: 1 MHz and 10 MHz available at rear panel BNC in standby and operate modes.
Output Level: 1 volt rms into 50Ω
External Input: Operates from 1, 2.5, 5, and 10 MHz input at 1V rms.
Input Impedance 1 KΩ NOMINAL || 30 pF NOMINAL.
Counter automatically switches to external mode when external input is present.
Oscillator Aging Rate: $<5 \times 10^{-10}$/day after a 48-hour warmup. Oscillator oven is energized when power cable is connected to line voltage.

GENERAL

Power Requirements: 115V, +12%, -10%, 47—53 Hz, 57—63 Hz, 380—420 Hz, or 230V, +5%, -10%, 47—66 Hz; 150 VA max.
Display: Nine-digit LED.
Sample Rate: Variable from less than 10 milliseconds to more than 5 s and HOLD.
Arming: Rear panel ARM (ON-OFF) switch. Refer to operation for details.
Blanking: Suppresses leading zeros and digits below selected resolution.
Hold: HOLDs count between samples.
Trigger Lights: Indicate for channels A and B where input signals are with reference to trigger levels.
Check Signal: Place FUNCTION switch in CHECK; Counter displays 10 MHz ±1 count.
Operating Temperature: 0 to 50°C.

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 100 VA maximum. To avoid instrument damage, the rer 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. The LINE FUSE is accessible from the rear panel. The instrument is shipped with the correct fuse for the country of destination installed, and the VOLTAGE SELECTOR switch is set properly.

2-10. To change the operating voltage of the instrument:

a. Disconnect the ac power cable.

b. Set the VOLTAGE SELECTOR switch to 115V or 230V. The selected voltage will be visible on the VOLTAGE SELECTOR switch.

c. Install a 2-amp fuse for 115V operation or install a 1-amp fuse for 230V operation.

d. Reconnect the ac power cable.

2-11. 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.

2-12. To accommodate the different power receptacles used throughout the world, this instrument is supplied with one of the power cables shown in *Table 2-1*. Connect the power cable to a power source receptacle that has a grounded third conductor.

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 1-2*.

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

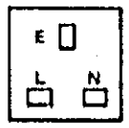
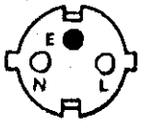
2-20. Original Packaging

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 returend 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.

Table 2-1. AC Power Cables Available

PLUG TYPE	CABLE HP PART NO.	*CD	PLUG DESCRIPTION	CABLE LENGTH (INCHES)	CABLE COLOR	FOR USE IN COUNTRY
250V 	8120-1351 8120-1703	0 6	Straight **BS1363A 90°	90 90	Mint Gray Mint Gray	United Kingdom, Cyprus, Nigeria Rhodesia, Singapore
250V 	8120-1369 8120-0696	0 4	Straight **NZS5198/ASC112 90°	79 87	Gray Gray	Australlia, New Zealand
250V 	8120-1689 8120-1692	7 2	Straight **CEE7-Y11 90°	79 79	Mint Gray Mint Gray	East and West Europe, Saudi Arabia, Egypt, So Africa, India (Unpolarized in many nations)
125V 	8120-1348 8120-1398 8120-1754 8120-1378 8120-1521 8120-1676	5 5 7 1 6 2	Straight **NEMA5-15P 90° Straight **NEMA5-15P Straight **NEMA5-15P 90° Straight **NEMA5-15P	80 80 36 80 80 30	Black Black Black Jade Gray Jade Gray Jade Gray	United States, Canada, Japan (100V or 200V), Mexico, Philippines, Taiwan
250V 	8120-2104	3	Straight **SEV1011 1959-24507 Type 12	79	Gray	Switzerland
250V 	8120-0698	6	Straight **NEMA6-15P			United States, Canada
220V 	8120-2956 8120-2957	2 3	Straight **DHCK 107 90°	79 79	Gray Gray	Denmark

*CD = Check Digit (refer to Section VI).
**Part number shown for plug is Industry Identifier for plug only. Number shown for cable is HP Part Number for complete cable including plug.
E = Earth Ground L = Line N = Neutral

2-24. Other Packaging Methods

2-25. If factory packaging is not available, good commerical 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.

OPERATION

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 50 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 a 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 3-1* 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.

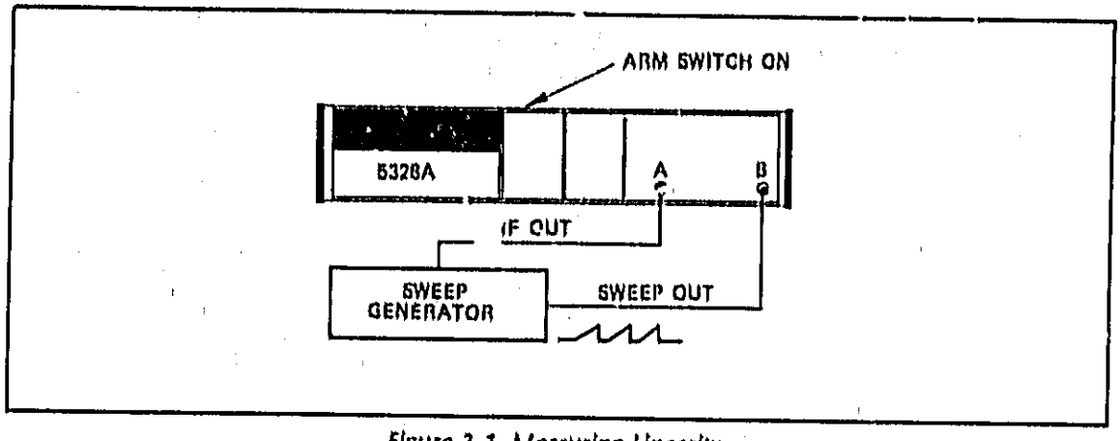


Figure 3-1. Measuring Linearity

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 = $\frac{100\ ns}{N}$). 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.

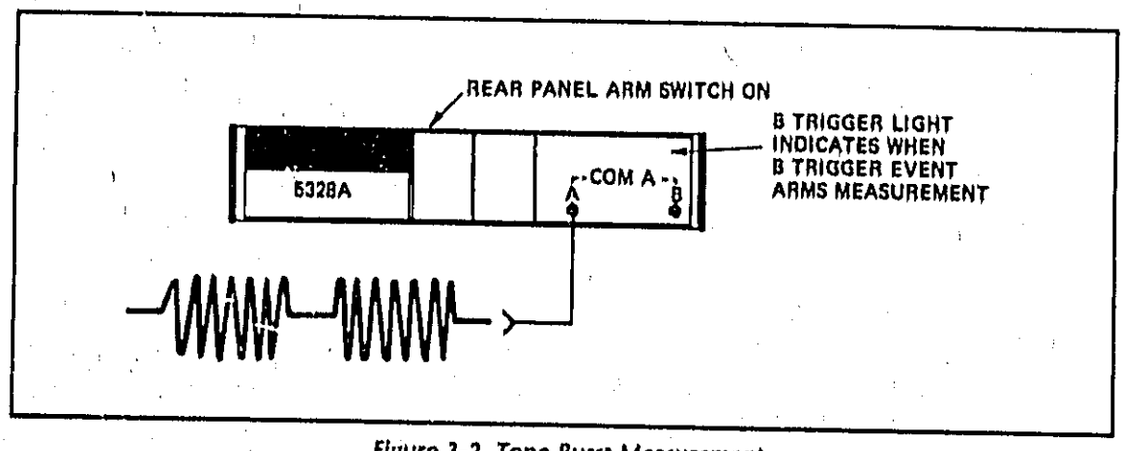


Figure 3-2. Tone Burst Measurement

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 150 ns deadtime. Deadtime is the time between the preceding time interval stop event and the current time interval start event as shown in *Figure 3-3*.

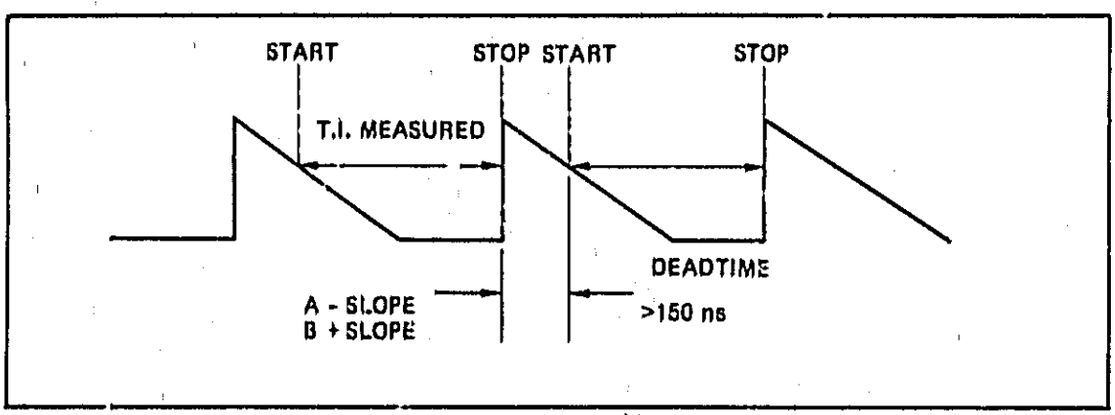


Figure 3-3. Deadtime

3-17. The time interval averaging technique is based on the fact that if the ±1 count error is truly random it can be further 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 *asynchronous* to the instrument's clock. Under these conditions the resolution of the measurement is:

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

where N = the number of time intervals averaged. It bears repeating that the input signal frequency must *not* be a subharmonic of the internal clock frequency — which is 10 MHz.

3-18. 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.

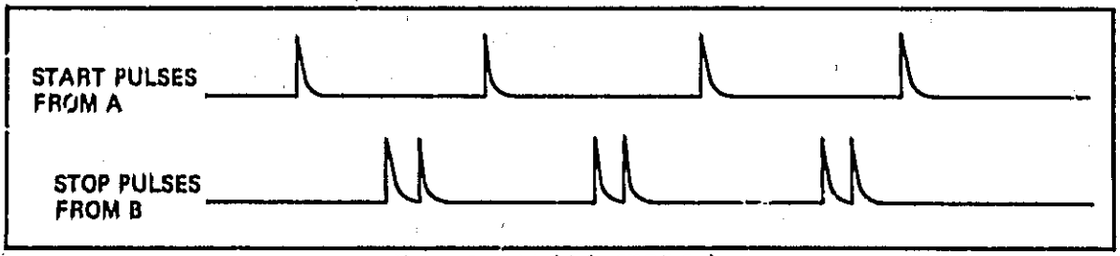


Figure 3-4. Multiple STOP Pulses

3-19. 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.

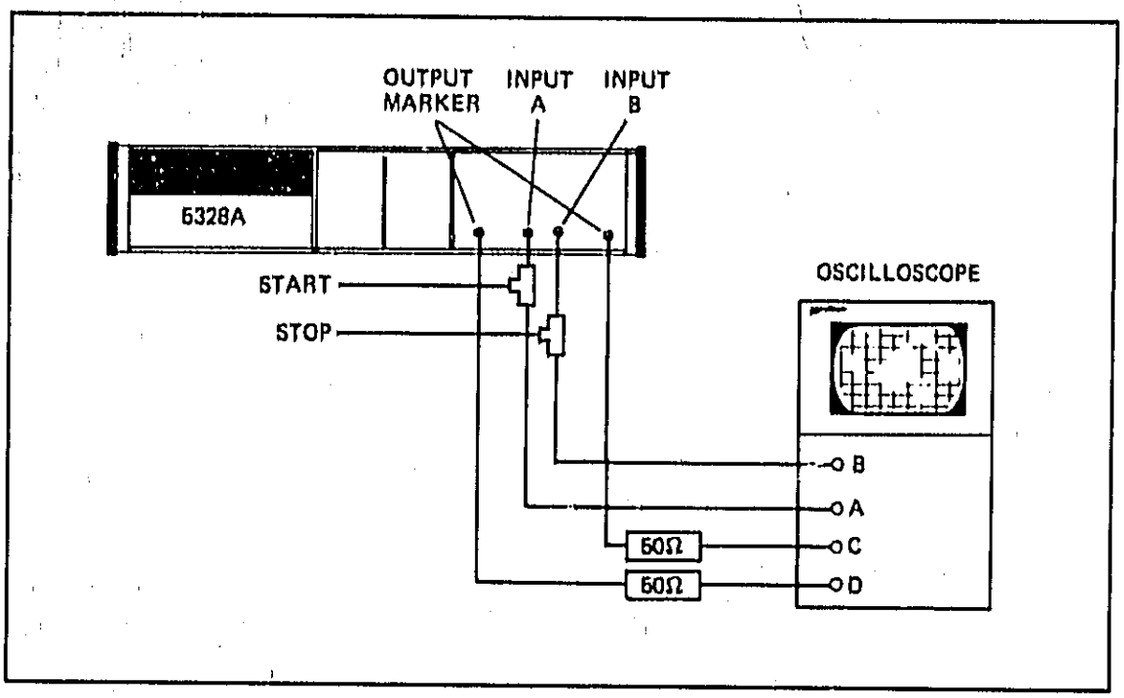


Figure 3-5. Monitoring Marker Outputs

3-20. 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).

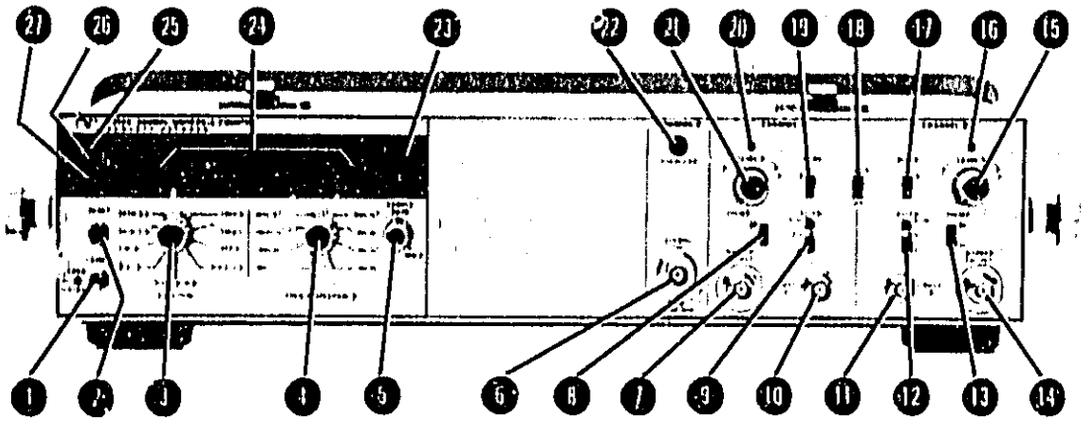
3-21. RATIO MEASUREMENTS

3-22. For ratio measurements, the 5328A has wide bandwidth, good sensitivity, and complete signal conditioning of the Channel A, B, and C input amplifiers.

3-23. 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 x N (or C/A x 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.

3-24. OPERATING CONTROLS

3-25. All of the front and rear panel operating controls are shown and described in *Figures 3-6* and *3-7*.



1. LINE switch ❶. 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 ❷. 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 ❸. 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. HP 5328A Front Panel Operating Summary

4. FREQ RESOLUTION, N selection switch ④. 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 (seconds)	RESOLUTION (Hz)
1	1×10^{-6}	1 M
10	10×10^{-6}	100 k
10^2	100×10^{-6}	10 k
10^3	1×10^{-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 less than 10 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 500 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 ±2.5 volts. In X10, ±24 volts. In X100, ±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 ㉕. Indicates that one or more of the most-significant digits (digits left-most from the decimal point) are not displayed.

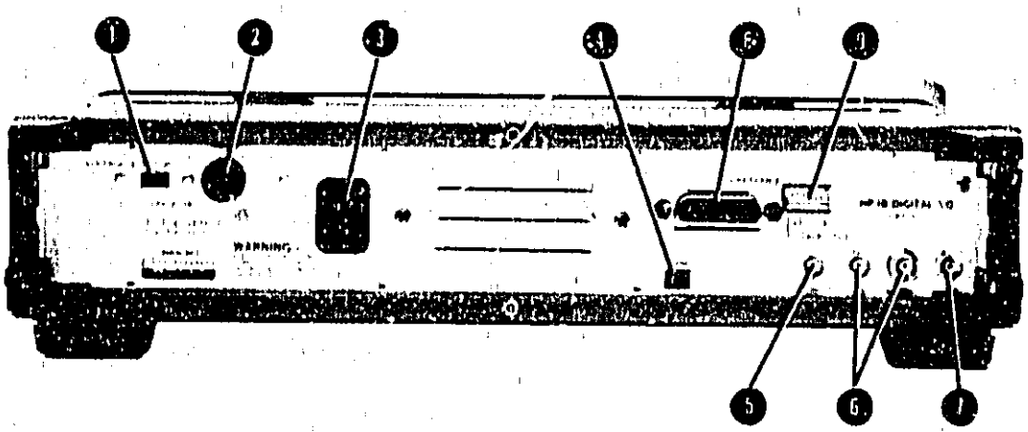
17. RMT (remote) annunciator ㉖. Lights when 5328A is in remote operation.

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 ㉓. Indicates the units multiplier of the measurement.

20. Nine-digit LED display ㉔ shows all measurements.

Figure 3-6. HP 5328A Front Panel Operating 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. HP 5328A Rear Panel Controls and Connectors

3-26. FUNCTION OF CONTROLS, INDICATORS, INPUTS, AND OUTPUTS

3-27. The following paragraphs provide a detailed description of the function of controls, indicators, and connectors.

3-28. Display

3-29. 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, μ, 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.

3-30. Power (Line)

3-31. 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. Therfore, 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.

3-32. Reset

3-33. 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.

3-34. Sample Rate Control

3-35. The SAMPLE RATE control sets the minimum time between samples. The time is continuously variable from less than 10 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.

3-36. Arming

3-37. The counter may be armed internally (i.e., made ready to start a measurement) by the SAMPLE RATE control, or externally by the input signal itself, (arming off) or by a signal *not* directly involved in the measurement (arming on). *Table 3-1* is an arming status table. A rear panel switch turns ARMing either ON or OFF. The counter is armed within 1 μs after the event at the B arming input and is armed within 10 μs 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

3-38. Frequency Resolution, N Switch

3-39. 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.I. 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 μs
100 kHz	10	10 μs
1 MHz	1	1 μs

3-40. *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, 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.

3-41. Input Channel Section

3-42. 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.

3-43. HP-IB PROGRAMMABLE INPUT CONTROLS. In COM A position, the output of the Channel B attenutor 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.

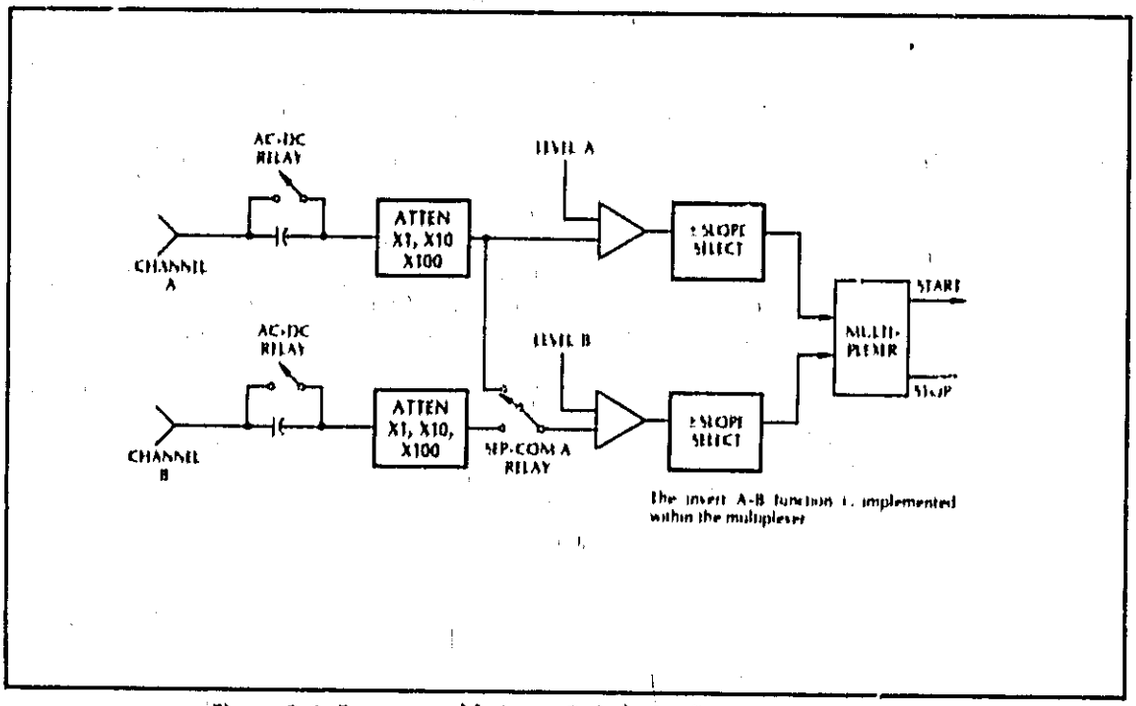


Figure 3-8. Programmable Input Switch Configuration for COM A

3-44. The A and B input amplifiers have independent LEVEL and SLOPE controls regardless of the mode of operation (SEP or COM A).

3-45. A and B Channel Signal Conditioning

3-46. 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.

3-47. 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.

3-48. SLOPE SWITCH. The ±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.

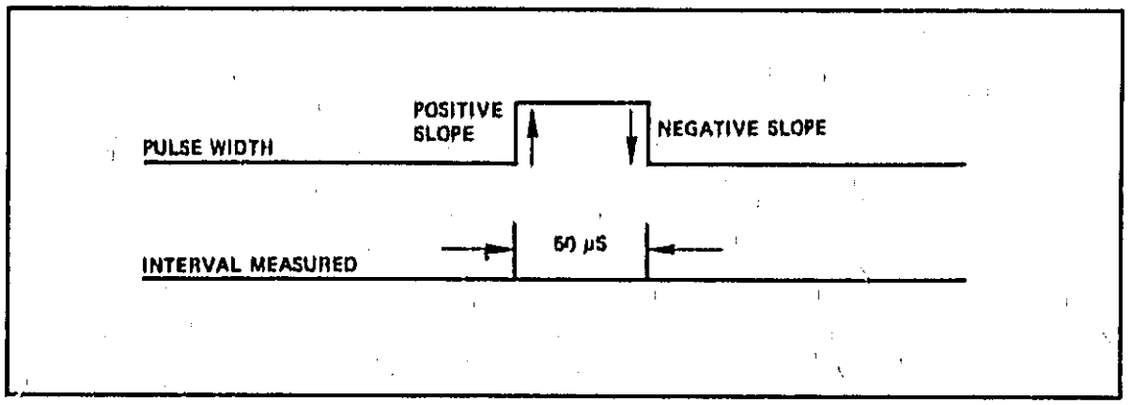


Figure 3-9. Slope Switch Settings

3-49. LEVEL CONTROL. The LEVEL control for each channel is adjustable over the range of ±2.5V 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.

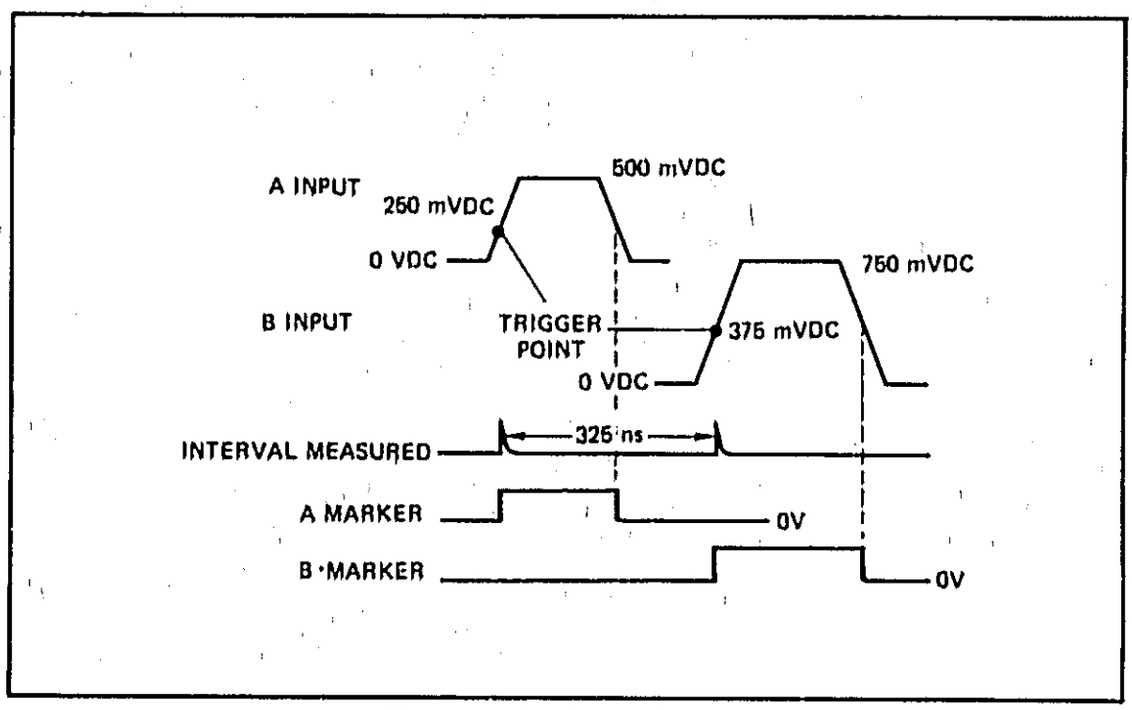


Figure 3-10. Level Control Settings

3-50. Channel C Input

3-51. The CHANNEL C 500 MHz 50Ω 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).

3-52. "C" Channel Overload Indicator

3-53. The OVERLOAD (CHANNEL C) indicator will flash on and off if the voltage maximum is exceeded at the "C" channel input.

3-54. Hysteresis Band of Trigger Levels

3-55. The width of the trigger level hysteresis band, shown in *Figure 3-11* 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 mV peak-to-peak. The signal must pass through the entire hysteresis band before a trigger pulse is generated. If the SLOPE switch is set to "+", the trigger pulse occurs at the top of the hystersis band. If the SLOPE switch is set to "–", the trigger pulse occurs at the bottom of the hysteresis band.

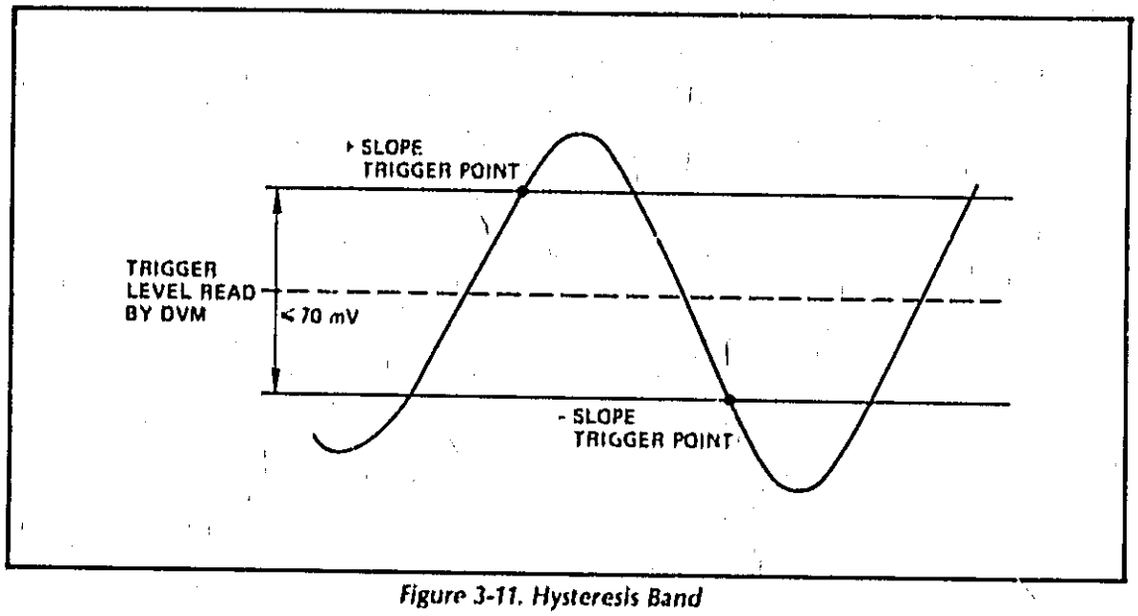


Figure 3-11. Hysteresis Band

3-56. 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).

3-57. The value to use for the hysteresis band depends on the frequency; or, for pulses, it depends on the rise time.

3-58. External Frequency Standard Input

3-59. 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 kΩ (maximum input of 5 volts peak-to-peak).

3-60. Marker Outputs

3-61. 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 500 mV levels into 50Ω 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 marker can indicate the presence of noise triggering. These outputs are protected from inadvertently applied voltage to ±5V dc.

3-62. Gate/Marker Out

3-63. 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.

3-64. 1 MHz and 10 MHz Frequency Standard Outputs

3-65. 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.

3-66. Trigger Lights

3-67. 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.

3-68. 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.

3-69. PROGRAMMING OPERATION

3-70. The 5328A Universal Counter is fully compatible with the Hewlett-Packard Interface Bus (HP-IB) IEEE Standard 488-1978 Appendix C.

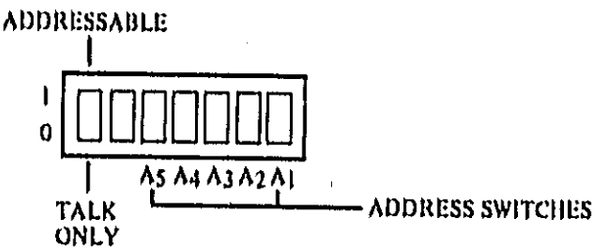
3-71. Procedures for verification of proper operation of the 5328A in the remote mode are contained in paragraphs 5-37 through 5-42.

3-72. SETTING ADDRESS SWITCHES

3-73. 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.

3-74. The five right-hand switches, A_5 through A_1, 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. Addresssing



ASCII ADDRESS CODES

A_5	A_4	A_3	A_2	A_1	ASCII LISTEN ADDRESS	ASCII TALK ADDRESS
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	>	^

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. When the "P" command is executed, the DACs go to zero (0) volts.

1. Initialization
   P Remote Program Initialize
2. Function
   F4 Freq. A
   F6 Period A
   F7 Per. Avg. A
   F8 T.I. A→B
   F9 Ratio T/A
   F: T.I. Avg. A→B
   F< Check
   F= Ratio C/A
   F> Freq. C
   F? DVM
3. Time Base

Code	Freq Res	Multiplier	Time Res (Std)
G0	**1 MHz**	**1**	**100 ns**
G1	100 kHz	10	1 μs
G2	10 kHz	10^2	10 μs
G3	1 kHz	10^3	100 μs
G4	100 Hz	10^4	1 ms
G5	10 Hz	10^5	10 ms
G6	1 Hz	10^6	100 ms
G7	0.1 Hz	10^7	1 s

4. Single-Multiple Measurement
   S0 Single measurement, Hold sample rate, Trigger required.
   S1 Multiple measurement, Not Hold, No trigger required.
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 DC
    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_1 d_2 d_3 •

    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+100•" 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_1 d_2 d_3 •
    See Group 15, Trigger Level A, for details
17. Channel Invert
    B8 Normal (A is main channel)
    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 HP 5328A transmits the following string of characters to output a measurement.

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

"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:

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

The 5328A 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 HP 5328A obeys the following HP-IB 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 is 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)

USA STANDARD CODE FOR INFORMATION INTERCHANGE

BITS				b_7 b_6 b_5	$0\,0\,0$	$0\,0\,1$	$0\,1\,0$	$0\,1\,1$	$1\,0\,0$	$1\,0\,1$	$1\,1\,0$	$1\,1\,1$
b_4	b_3	b_2	b_1	ROW	0	1	2	3	4	5	6	7
0	0	0	0	0	NUL	DLE	SP (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 HP 5328A, using the HP 9825A Desktop Computer as a computing controller.

3-81. Example 1

3-82. This program sets the HP 5328A into its CHECK mode, with 1 Hz resolution. The program takes a measurement (trg 701) and reads it into the A register of the HP 9825A. After waiting 500 ms, the program loops back to line 1 for the next trigger.

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

```
 100000000.00
 100000000.00
 100000000.00
 100000000.00
 100000000.00
 100000000.00
.100000000.00
 100000000.00
```

3-83. Example 2

3-84. This program sets the 5328A into its Frequency mode with 1 Hz resolution. The program takes a frequency measurement, reads it into the A register of the HP 9825A, and prints the results. The calculator computes the period from the frequency measurement and prints the calculated period. The program then sets the HP 5328A into its PERIOD mode with 10 μs resolution. A period measurement is made, read into the C register of the HP 9825A and printed. After waiting 2 seconds, the program loops back to line 0 for the next trigger.

```
0: wrt 701,"PF4G
 6S13R"
1: red 701,A
2: prt "MEASURED
  FREQ=",A,"
          HZ"
3: 1/A→B;flt 2
4: prt "CALC
 PERIOD=",B,"
           sec"
5: wrt 701,"PF7C
 2S13R"
6: red 701,C
7: prt "MEASURED
  PERIOD=",C,"
            sec"
8: prt "--------
 --------";spc
 2:wait 2000
9: gto 0
10: end
*31082
```

```
MEASURED FREQ=
        9.73e 05
           HZ
CALC PERIOD=
        1.03e-06
           sec
MEASURED PERIOD=
        1.03e-06
           sec
----------------

MEASURED FREQ=
        9.73e 05
           HZ
CALC PERIOD=
        1.03e-06
           sec
MEASURED PERIOD=
        1.03e-06
           sec
----------------
```

THEORY

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

$$f = \frac{n}{t} \qquad (1)$$

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*.

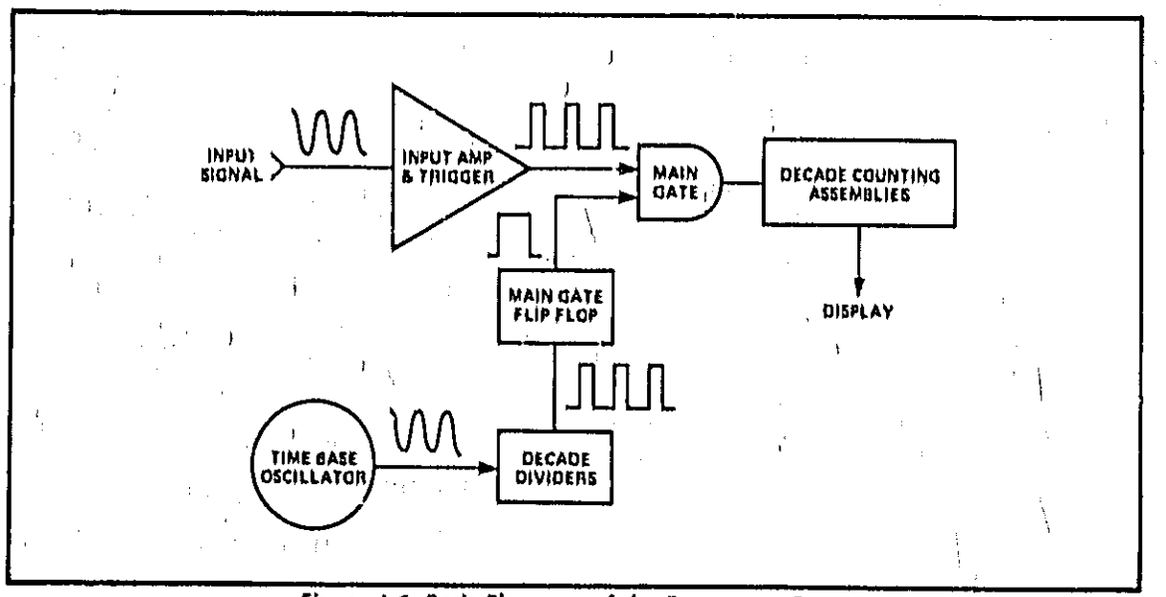


Figure 4-1. Basic Elements of the Frequency Counter

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 4-1* 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. The is the basis for **multiple period averaging**. Period and period averaging techniques are used to increase measurement accuracy on low frequency measurements.

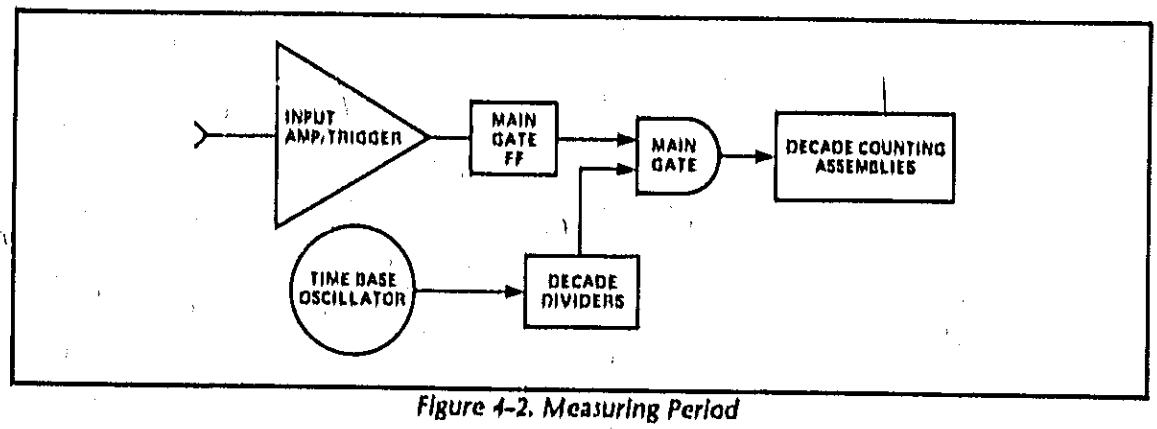


Figure 4-2. Measuring Period

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. For higher resolution the signal at frequency f 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*.

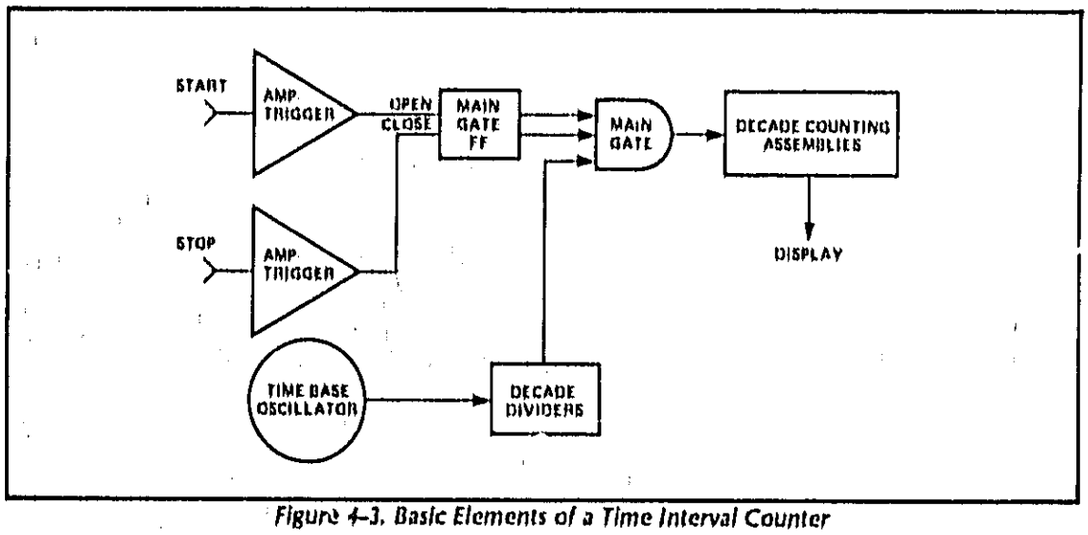


Figure 4-3. Basic Elements of a Time Interval Counter

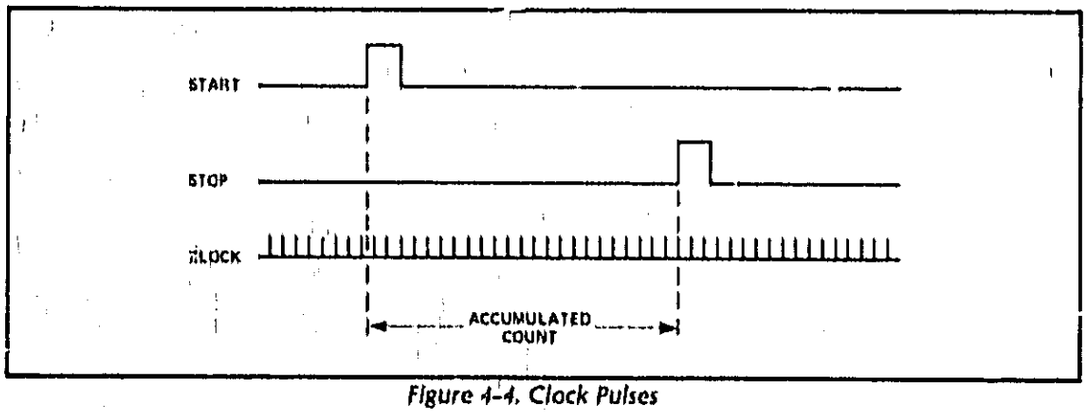


Figure 4-4. Clock Pulses

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^n 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 ±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 asynchronous 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 picoseconds 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 picoseconds.

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 indeterminant 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 answered 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 picoseconds to be measured.

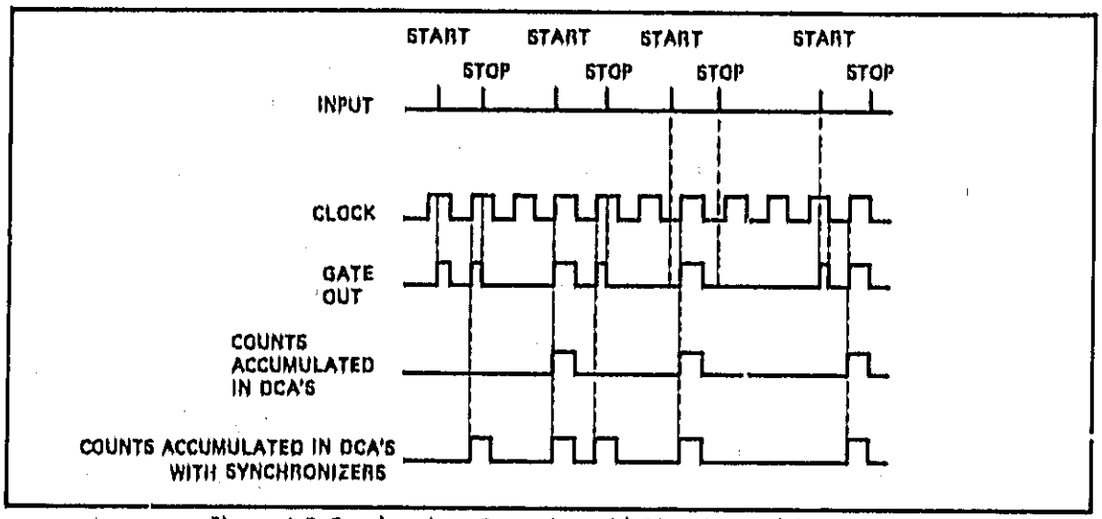


Figure 4-5. Synchronizer Operation with Time Interval Averaging

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 ±1 count ambiguity, the time base error and trigger error. These are discussed in the following paragraphs.

4-36. An additional source of measurement error may exist if the External Frequency Standard input is incorrectly used. The counter automatically switches to external mode when an external input of 1, 2.5, 5, or 10 MHz is present. Caution should be observed to assure that the external frequency standard is of higher stability than the internal oscillator supplied with the counter. When an external standard of 1, 2.5, or 5 MHz is used, the input is multiplied by 10, 4, or 2 in order to obtain the 10 MHz required. Because of the multiplication factor, the signal should have a high signal-to-noise ratio and a high slew-rate, otherwise errors may be introduced, especially when measuring higher frequencies with Channel C. A noise free 1 MHz external frequency standard requiring a multiplication factor of 10 will easily meet the performance accuracy of 1 LSD rms.

4-37. ±1 COUNT AMBIGUITY. Since the signal input to the main gate of the counter and the clock input are not coherent, an inherent ±1 count ambiguity exits in the count accumulated in the decade counting assemblies. This is illustrated by *Figure 4-6*.

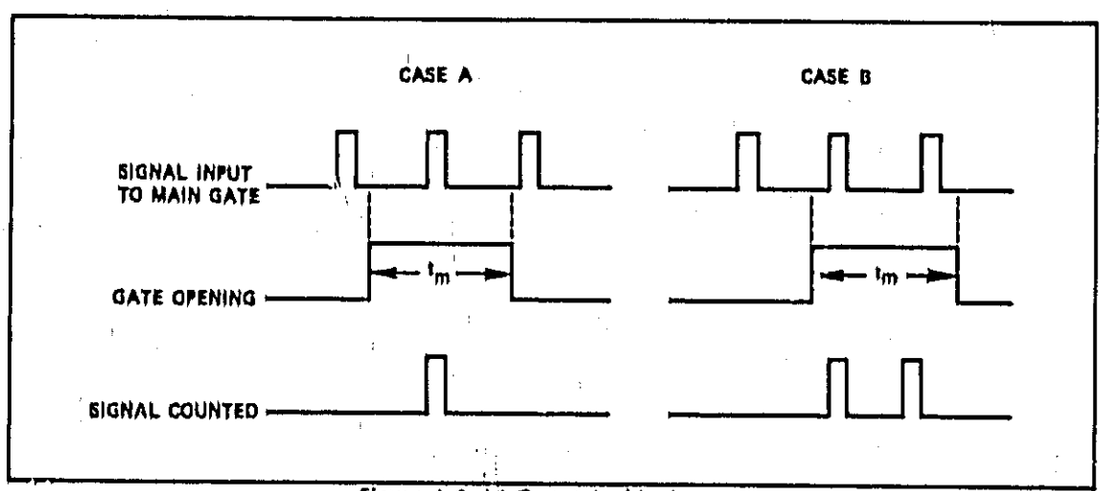


Figure 4-6. ±1 Count Ambiguity

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, ±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:

±1 count error, relative frequency measurement error

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

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:

±1 count error; relative period measurement error

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

4-40. MAIN GATE REQUIREMENTS. The ±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 ±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 1×10^{-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 $1 \times 10^{-6} \times 10^{-1} = 1 \times 10^{-7}$ 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 and time interval measurements, however, this uncertainty produces like error in the time the gate is open, since it is this signal that controls the gate.

4-46. In general the trigger error is defined as follows:

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

Where e_i = Effective rms noise of counter's input channel (300 μV TYPICAL)
Where e_n = rms noise voltage of input signal for a 100 MHz bandwidth

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

Trigger Level Timing Error (X1):

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

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

4-47. For time internal measurements, trigger error is generally negligible when compared to the systematic error introduced by the uncertainty in the setting of trigger levels. Averaging reduces the trigger error still further (but not the trigger level undertainty error). The error is reduced by $\sqrt{N}$ for time interval averaging and by N for period averaging.

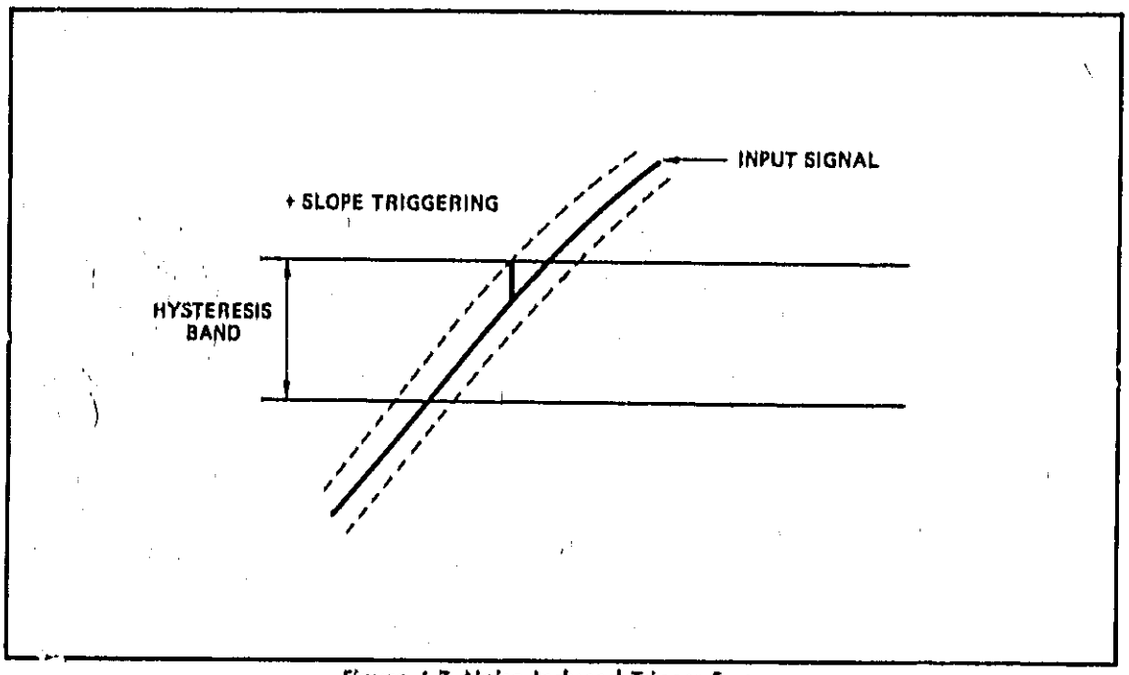


Figure 4-7. Noise Induced Trigger Error

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

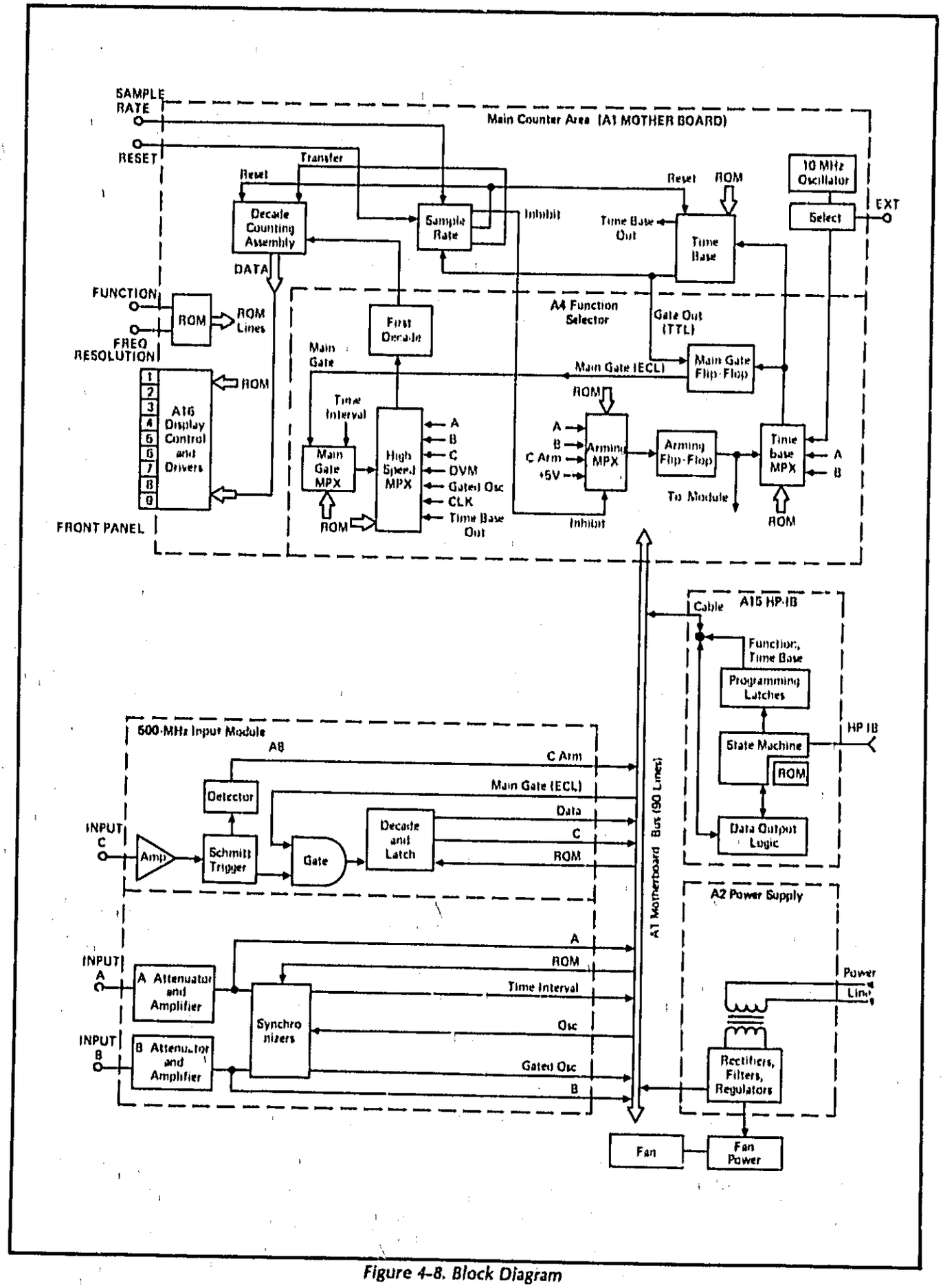


Figure 4-8. Block Diagram

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 multiplexers 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 50Ω 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-IB) 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 comprises circuits U1, U2, U3, U4, and U5. 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 designed HP 10811-60111) is in a 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 Circuits

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, 2.5, 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, 2.5, 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 HP 10811-60111, A3A1 Oscillator.

4-73. A3A1 Oscillator (HP 10811-60111)

4-74. This oscillator is a field-repairable module and is described in its own Operating and Service Manual, HP Part Number 10811-90002.

4-75. DECADE COUNTING ASSEMBLY (DCA)

4-76. The 5328A DCA comprises Decade Counter/Latches (U10 and U14) 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 of the most-significant-digit. Digits 0 through 5 are processed by U10, digit 6 by U14, and digit 7 by U12.

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 comprises 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 transitors 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 cylce, 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 8-1* 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 1A, 1B, and 1C 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 (LMGF), or (LTOT•LST), signal operating through U8 and enabled by ROM lines LMGF, LTIF, (LTOT•LST), 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 $\overline{MG}$ 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 A1 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 Syncrhonizers (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. U5 thus selects either C-ARM, B, $\overline{B}$, 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 $\overline{A}$ and $\overline{B}$ 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 resynchronizing 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 U5. Assuming that self arm has been selected, A will have been selected 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) U1(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 A1 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, $\overline{A}$, B, $\overline{B}$, TI, $\overline{TI}$, GOSC, and $\overline{GOSC}$ 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 decodes serial data bytes, stores the information in latches, and control signal conditioning via the latched outputs.

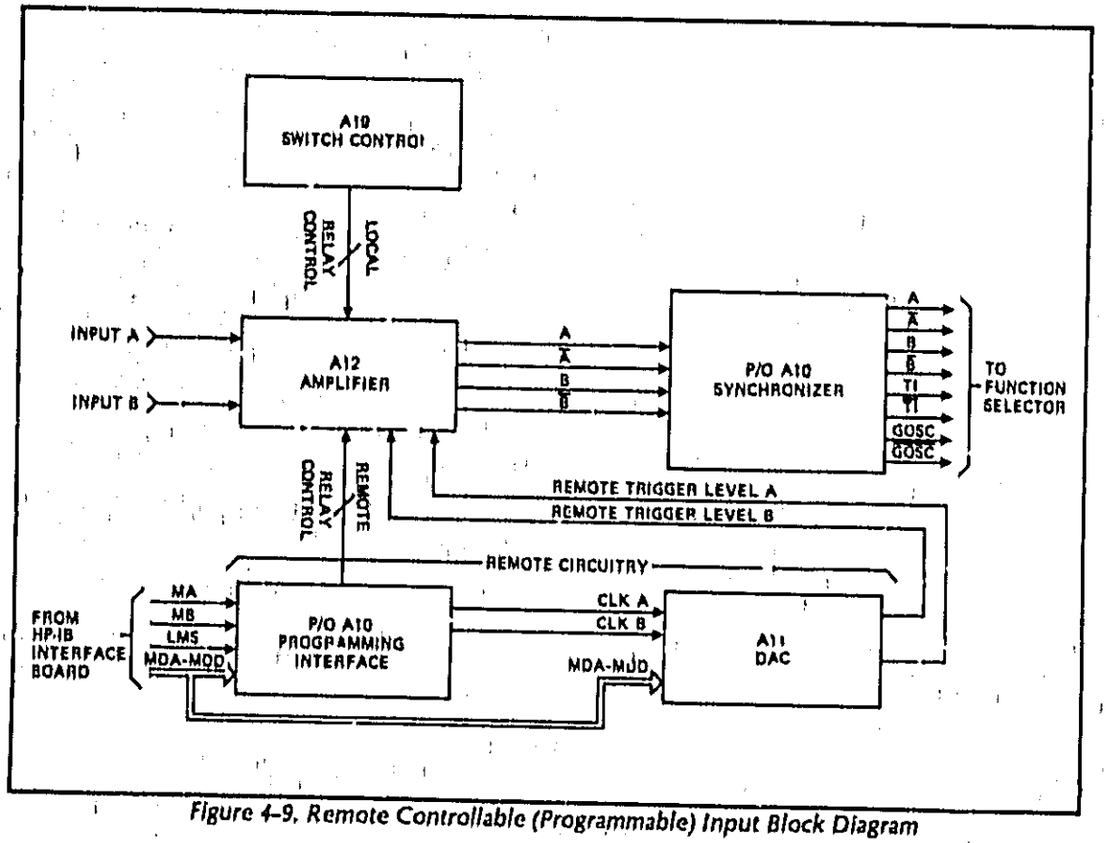


Figure 4-9. Remote Controllable (Programmable) Input Block Diagram

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 4-1* for proper format). The asterisk causes the programming interface to revert back to the non-DAC control mode. In this mode, the A11 board stops accepting data, and the programming interface latches again accept the input data.

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

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.

Commands to A channel are preceded by A
Commands to B channel are preceded by B

Trigger levels are programmed using the following format

±X.Y Z*

Where X is volts
Y is 100 s of mV
Z is 10 x of mV
* is used to terminate inputs to the DAC's

Control	Function	Code
Coupling	AC	2
	DC	3
Slope	+	4
	–	5
Atten	X100	1
	X10	6
	X1	7
Separate/Com	Separate	A8
	Common A	A9

NOTE
Underlined codes are default conditions.

Invert	Normal	B8
	A&B Inverted	B9

The check function overrides all other programming commands for A&B channels.

EXAMPLES:

The instruction:

wrt 701, "PF;G5S137A3579-1.25*B37+1.65*R"
Input circuits related programming information

Will program a 5328A with listen address of 9 to:

Function	Channel A	Channel B
P=remote initialize		
Time Interval Avg A to B	DC Coupled	DC Coupled
Multiplier 10^5	-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 dc coupled 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 ±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 ±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 A19 Switch 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 A10 Synchronizer board or the A19 Switch 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 feed through 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 $\overline{A}$ 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 $\overline{TI}$ and $\overline{GOSC}$ 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 $\overline{TI}$ output low, signaling to the function selector that the time interval has started. When $\overline{TI}$ goes low, $\overline{GOSC}$ (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 $\overline{TI}$ and $\overline{GOSC}$ 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.

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 3-3* 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 ±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 preceeded 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 U2C 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 pulese are synchronized and shaped by U2A. The Q and $\overline{Q}$ 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 average 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 bridge limiter circuit composed of diodes CR4, CR5, CR6, CR7, and a 50-ohm termination R3. The bridge limiter limits the input signals to protect amplifier U2. It also precludes the problem of miscounts or double counts due to amplifier distortion under high drive conditions. Diodes CR2 and CR3 provide input protection. The diodes will start conducting when the input voltage reaches ~7 volts, thereby blowing out the fuse (F1). Overload detection circuitry consists of R1, R2, C1, C3, CR1, Q1, and U1. Detector circuit CR1-C3-R2-R1, senses the input overload condition, (~3 volts to 7 volts) then it turns off Q1, which allows U1 LED flasher to flash the overload LED. The flash rate is controlled by the value of C1. The input signal passes through the bridge limiter and ac couples into amplifier U2. U2 is a 1 GHz amplifier that provides approximately 14 dB gain. The gain can be changed by changing the value of R6.

4-159. The ouptut signal from U2 (~700 mV p-p), ac coupled into amplifier/Schmitt trigger U3. The Schmitt trigger output (U3 pin 19) is a logic (EECL) level from zero volts to approximately -600 mV. This signal enters into the divide-by-10 counting chain composed of U4 (divide-by-2) and U6 (divide-by-5). The outputs from the decade divider are then level shifted (EECL to ECL) and sent to the A4 Function Selector as C and $\overline{C}$ signals. Circuit U7 translates the information in the divide-by-10 counting chain (U4 and U6) to TTL level. The information is then shifted into a quad latch (U9) where it is stored for strobing into the display. When the least-significant-digit is being strobed, U10 decodes that and enables U11 which sends the least-significant-digit information stored in U9 into the display. The Schitt trigger output (U3 pin 18) goes into a detector sends a "C ARM" command to the Function Selector (A4). CR9, C20, and R36 are used to disable the C ARM line during power-up operation which ensures that a zero is displayed.

4-160. 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 of U4 then goes low (-600 mV) and the input signal passes through U4 (divide-by-2) and U6 (divide-by-5) is translated to ECL levels, and 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 the divide-by-10 counting chain (U4 and U6) stops in its present state. Circuits U7, U9, U10, and U11 translate the information to TTL level, store it, and strobe it into the least-significant-digit of the display.

4-161. The Offset Voltage Adjustment circuit is a voltage divider composed of resistors R7, R11, R12, and R13. The adjustment is to adjust the dc voltage at pin 5 of U3, 4 mV more negative than the measured dc voltage at pin 7 of U3. This will ensure the output of U3 pin 18 will be high (0 volts); and the ouptut of U3 pin 19 will be a low (-600 mV), with no inputs.

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-IB 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 subroutine 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

4-184. 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 5-10, 5-11,* and *5-12.* The output of U30C is determined by the "not" bit from the ROM (through U21E) and the output of the Qualifier FF U11A. The preprogrammed 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 4-10*, 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 U11B.)

4-193. QUALIFIER MULTIPLEXERS. Five 8-to-1 multiplexers are connected to allow 36 lines to be multiplexed into 1 line. ASM ROM U22 controls multiplexers U3, U6, U8, and U32 to select individual line qualifiers and U12 to select one of these multiplexers. 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

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 10-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.

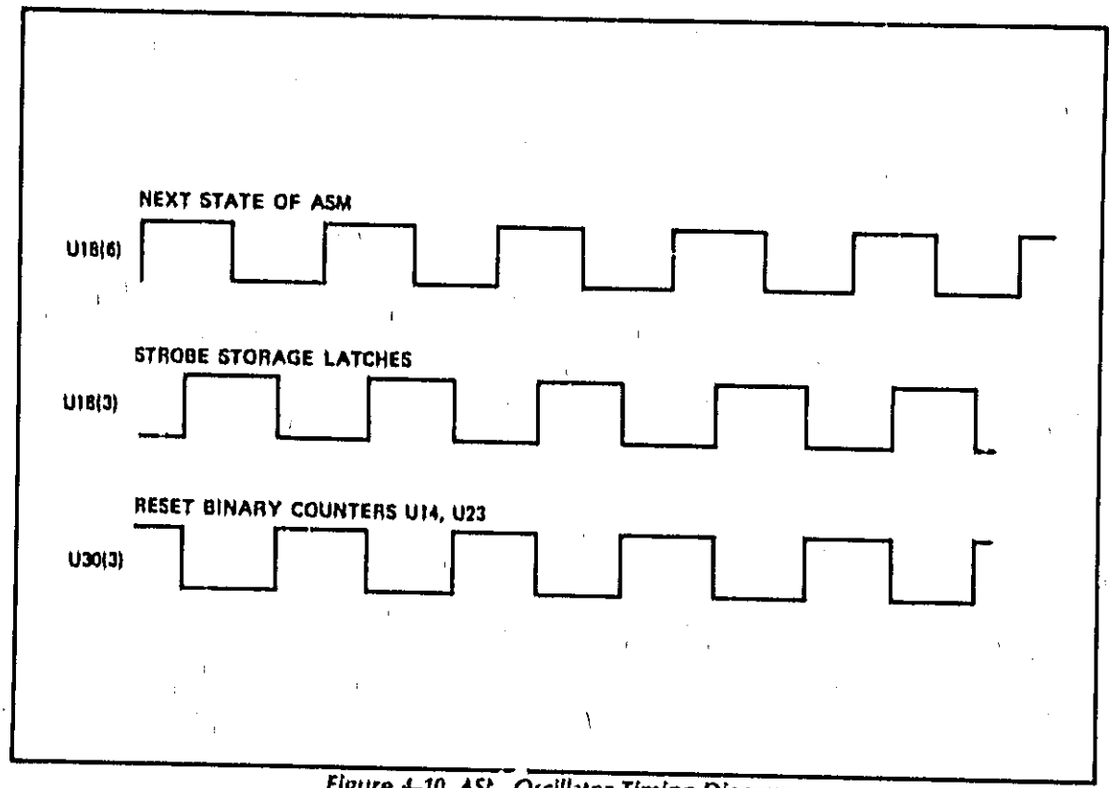


Figure 4-10. ASM, Oscillator Timing Diagram

MAINTENANCE

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.

Table 5-1. HP 5328A Assembly Identification

"A" NUMBER	DESCRIPTION	HP PART NO.
A1	Main (Motherboard)	05328-60048
A2	Power Supply	05328-60047
A3	Oscillator Support (Holds 10811A Oscillator)	05328-60038
A3A1	Oscillator 10811A	10811-60111
A4	Function Selector	05328-60005
A5	Not Used	
A6	Not Used	
A7	Not Used	
A8	"C" Channel Input	05328-60045
A9	Not Used	
A10	Synchronizer	05328-60020
A11	Digital-to-Analog Converter	05328-60023
A12	"A-B" Channel Input	05328-60042
A13	Not Used	
A14	Not Used	
A15	HP-IB Interface	05328-60043
A16	Display	05328-60026
A17	Not Used	
A18	Not Used	
A19	Switch (Attenuator)	05328-60030

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.

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 5-2, Recommended Test Equipment

INSTRUCTION TYPE	REQUIRED CHARACTERISTICS	RECOMMEND TYPE
Frequency Standard	1 MHz Output	
Oscilloscope Vertical Plug-In Time Base Plug-In	50 MHz Bandwidth 50 mV/cm Sensitivity 50 MHz Bandwidth	HP 180A HP 1801A HP 1820A
Test Oscillator	10 Hz to 10 MHz at 5V p-p	HP 654A
VHF Signal Generator	10 MHz to 500 MHz	HP 8640B
Frequency Counter	10 to 80 MHz Frequency Measurements	HP 5381A
Digital Multimeter	10V range .01% Accuracy	HP 3490A
DC Voltmeter	0 to 200 Vdc, 1% Accuracy	HP 970A
AC VTVM	0 to 250 Vac	HP 400F
Logic Probe	Logic State Test	HP 10525T
Logic Pulser	State Activator	HP 10526T
Logic Comparator	IC Test	HP 10529A
Controller	HP-IB Compatible	HP 9825A
HP-IB Calculator Interface	Connects HP 9825A to HP-IB	HP 98034A
Printer	Compatible with HP 9825A	HP 9866A, HP 9871A
Pulser Generator	0.5 Hz to 25 MHz at 1V	HP 8008A
DC Power Supply	0—10V Stable to ±1 mV	HP 6213A
RMS Voltmeter	RMS ac Voltage 0—10V Range	HP 3400A
Oscilloscope	275 MHz Bandwith	HP 1725A
Power Meter Power Sensor	Frequency Range 10 MHz - 1 GHz Power Range 30 dBm - 0 dBm	HP 436A HP 8481A

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 HP 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. Mechanicl 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

115/230 VAC SUPPLY WIRES ARE EXPOSED WHEN EITHER TOP OR BOTTOM COVER IS REMOVED. USE EXTREME CAUTION DURING TROUBLESHOOTING, ADJUSTMENT, OR REPAIR. AVOID PERSONAL INJURY AND DAMAGE TO INSTRUMENT BY REMOVING POWER BEFORE REMOVING OR REPLACING COVERS, ASSEMBLIES, OR COMPONENTS. ALL MAINTENANCE AND REPAIR MUST BE PERFORMED BY QUALIFIED SERVICE PERSONNEL.

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 integrate 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. The clean the holes.

Table 5-4. Performance Test

1. SENSITIVITY — CHANNEL A

Specification:

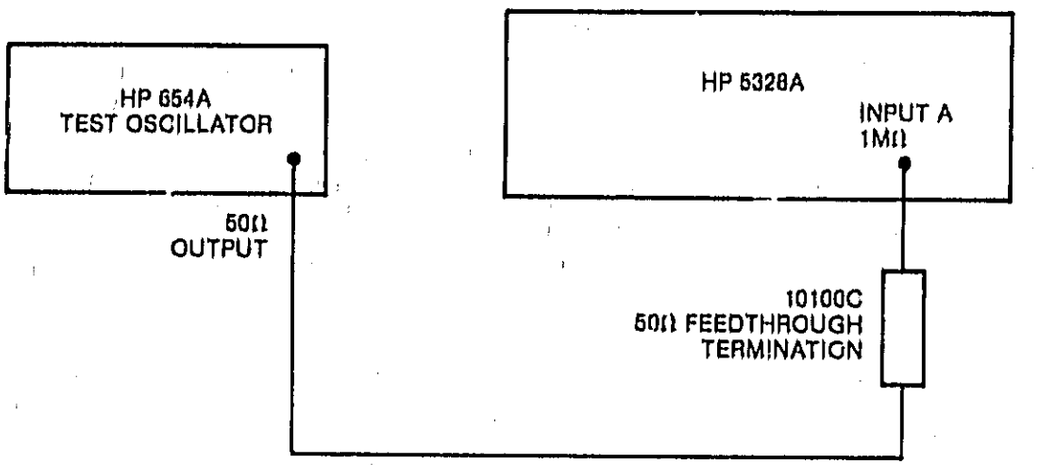
30 mV rms, 0-35 MHz (dc coupled)
20 Hz-35 MHz (ac coupled)

60 mV rms, 35 MHz-100 MHz

Description: A signal generator with calibrated output is set to the specified 5328A 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 A, ATTEN A X1, SEP. Rear panel ARM switch should be set to OFF.
- Set the 654A for 30 mV rms. Vary the 654A frequency from 10 Hz to 10 MHz and verify that the 5328A displays the proper frequency. Adjust the 5328A LEVEL A control as necessary to achieve a stable display. Mark results on performance test record a the end of these procedures.

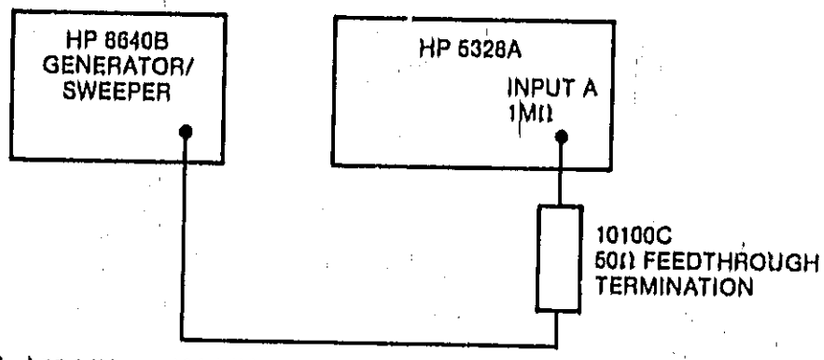
(2) AC coupled 20 Hz to 10 MHz

- Set the 5328A to AC coupling.
- Set the 654A for 30 mV rms. Vary the 654A frequency from 20 Hz to 10 MHz and verify that the counter displays the proper frequency. Adjust the 5328A 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 RESOLUTION to 10 Hz.
- Set the 8640B for an output level of 30 mV rms. Vary the 8640B's frequency from 10 MHz to 35 MHz and verify that the counter displays correct frequency readings. Increase the 8640B output level to 60 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.
- Repeat part (1) third step above. Mark results on performance test record.

2. SENSITIVITY - CHANNEL B/RATIO B/A

The counter will measure the ratio of the frequency at B (0 to 100 MHz) to the frequency at A (0 to 10 MHz) for N counts of A.

Specifications:

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

60 mV rms, 35 MHz-100 MHz

Description:

10 Hz to 10 MHz: SENSITIVITY Channel B

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 the A Channel. The generator is set to the specified 5328A signal sensitivity level and varied over the specified frequency range. The counter must display the correct frequency.

10 MHz to 100 MHz: SENSITIVITY Channel B and RATIO B/A

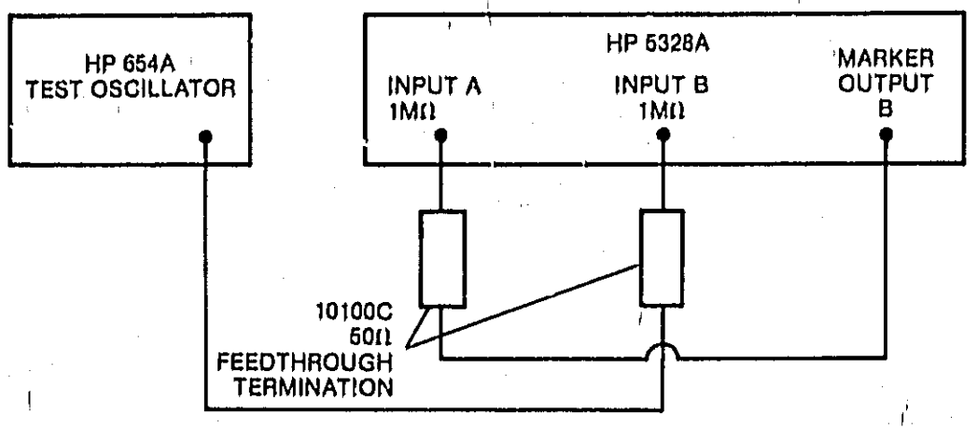
The 10 MHz time base output from the rear panel of the 5328A drives the A Channel. The 8640B drives the B Channel. The 5328A is set to RATIO B/A.

The generator is set to the specified 5328A signal sensitivity level and varied over the specified frequency range. The counter must display the correct RATIO.

Table 5-4. Performance Test (Continued)

a. 10 Hz to 10 MHz

Setup:



(1) DC coupled 10 Hz to 10 MHz

- Set 5328A to FREQ A, 1 Hz RESOLUTION, SAMPLE RATE fully ccw, Level A and B to PRESET, A and B ATTN X1, A Channel to AC, B Channel to DC, SEP.
- Set the 654A to 30 mV rms. Vary the 654A frequency from 10 Hz to 10 MHz and verify that the 5328A Channel B MARKER OUTPUT is the correct frequency as read by the A Channel. Adjust the 5328A LEVEL A and B controls as necessary to achieve a stable display. Mark results on performance test record.

(2) AC coupled 20 Hz to 10 MHz

- Set HP 5328A to ac coupling B Channel.
- With the 654A set to 30 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 the A Channel. Adjust the 5328A LEVEL A and B controls as necessary to achieve a stable display. Mark results on performance test record.

b. 10 MHz to 100 MHz

Setup:

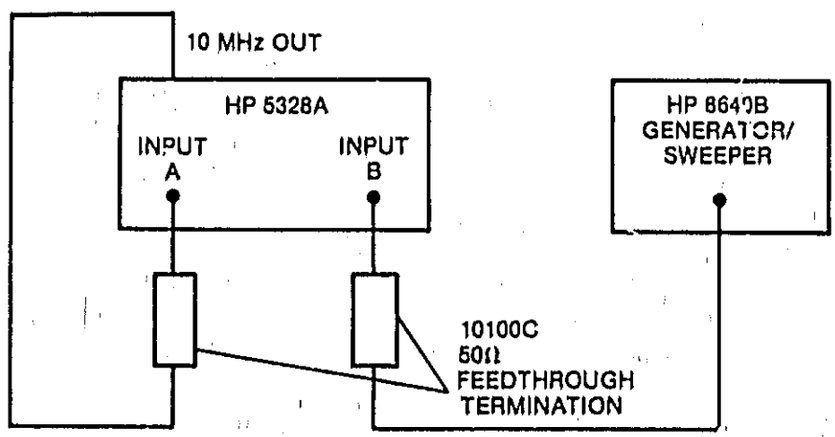


Table 5-4. Performance Test (Continued)

(1) DC coupled 10 MHz to 100 MHz

- Set counter to RATIO B/A, 1 Hz RESOLUTION, LEVEL A and B PRESET, A ATTN X10, B ATTN X1, A Channel AC, B Channel DC, SEP.
- Set the 8640B for an output level of 30 mV rms. Vary the 8640B's frequency from 10 MHz to 35 MHz and verify that the 5328A measures the correct ratio. Increase the 8640B output level to 60 mV rms and vary the frequency from 35 MHz to 100 MHz. Counter must continue displaying the correct ratio. Adjust the 5328A LEVEL A and B controls as necessary to achieve a stable display. Mark results on performance test record.

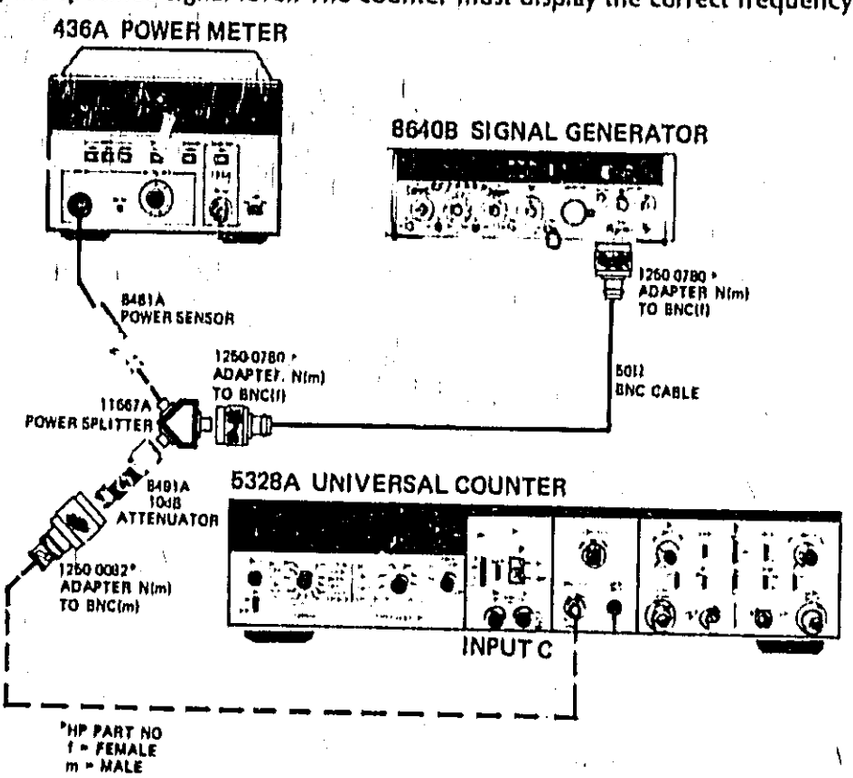
(2) AC coupled 10 MHz to 100 MHz

- Set counter to ac coupling B Channel.
- Repeat part 2 of step (1) above.

3. SENSITIVITY - Channel C

Specification: -23.47 dBm (15 mV rms) 50-500 MHz.

Description: A signal generator is connected through a power splitter to the 5328A Channel C input and a power meter. The signal generator is varied over the frequency range maintaining the specified signal level. The counter must display the correct frequency.



NOTE

Dotted lines represent direct connections, not cabling.

- Set the 5328A to FREQ C, RESOLUTION to 1 kHz (10), and SAMPLE RATE to midrange.
- Set the signal generator to provide -13.5 dBm at 50 MHz, as measured on the HP 436A Power Meter. Instrument counts at 50 MHz. Set the signal generator to 100 MHz, 250 MHz, and 500 MHz (at -13.5 dBm at each frequency) and verify that the instrument counts at each frequency. Mark results on performance test record.

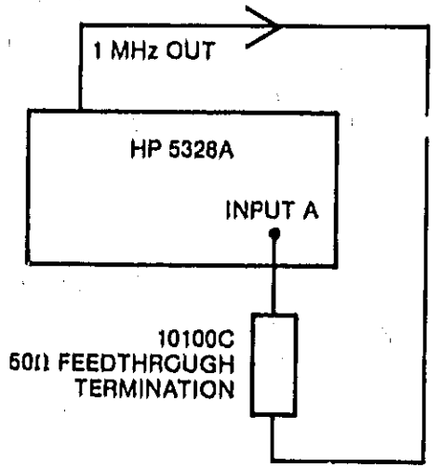
Table 5-4. Performance Test (Continued)

4. PERIOD AND PERIOD AVERAGE

Specifications:

PER A — counter will measure periods of signals to 10 MHz with resolutions from 100 ns to 1 s 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 to 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 the 5328A Function switch to PER A; Freq Resolution, N switch to 1 MHz, 1; Level A to PRESET; AC coupling; X .0 ATTN; SEP. Verify that the counter displays 1.0 µs. Mark results on performance test record.
- Set the 5328A Function switch to PER AVG A and the Freq Resolution, N switch to 1 Hz, 10⁶. Verify that the counter displays approximately 1000.0000 ns with 0.1 ps resolution. Mark results on performance test record.

5. RATIO C/A

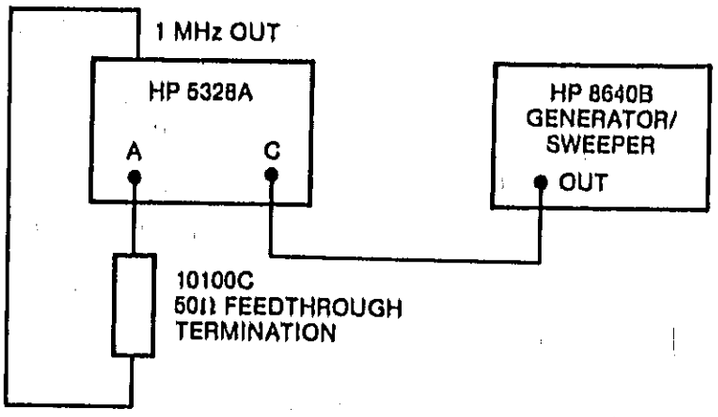
Specification:

Counter will measure the ratio of the frequency at C (50 to 500 MHz) to the requency 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 input channel of the counter. The Hp 8640B is used to drive the Channel C.

Table 5-4. Performance Test (Continued)

Setup:



- Set the 5328A Function switch to RATIO C/A; Freq Resolution, N switch to 1 kHz, 10³; Level A to PRESET, AC coupling, SEP.
- Connect the HP 8640B output to Channel C INPUT; set the HP 8640B to output 500 MHz at 30 mV rms. Verify that the counter displays approximately 500.000 MHz. Mark results on performance test record.

6. TIME INTERVAL AND TIME INTERVAL AVERAGE

Specification:

T.I. A→B — counter measures time intervals (100 ns to 10^8 s) between a start signal at the Channel A input and stop signal at the Channel B input.

T.I. AVG A→B — counter measures time interval (0.1 ns to 10 s) between a start signal at the Channel A input and a stop signal at the Channel B input. The number of time intervals over which the time interval average measurement is made can be selected by the FREQ RESOLUTION, N switch.

Description: A 1.1 MHz signal drives the A and B Channel inputs of the 5328A counter.

Setup:

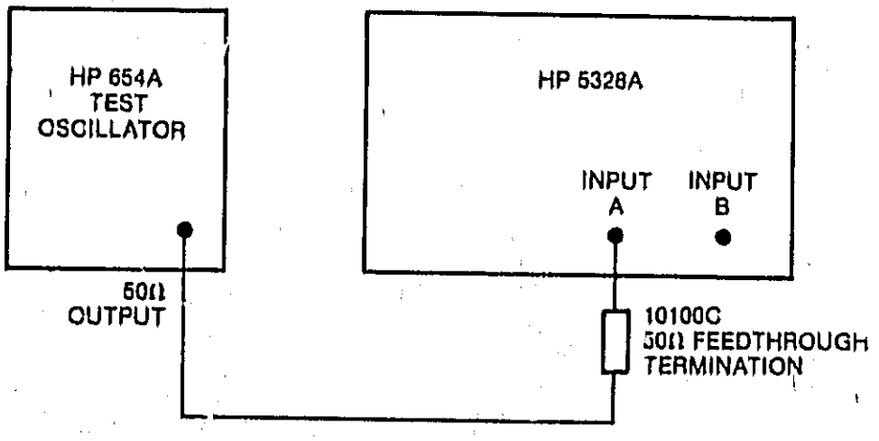


Table 5-4. Performance Test (Continued)

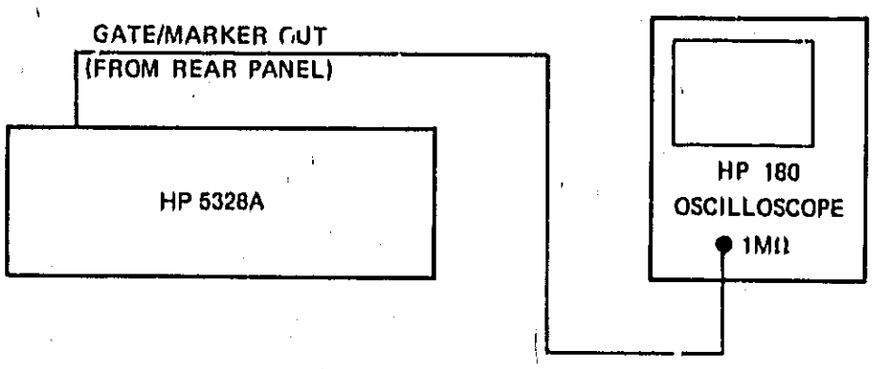
NOTE

For this test, do NOT use a synthesized signal.

- Set the 654A to 1.1 MHz and 30 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 ATTN on both channels, COM A.
- Set the Channel A SLOPE to (+) and the Channel B SLOPE to (–). Verify that the counter display 0.5 μs ±0.2 μs. 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 454.XXXX ns. Mark results on performance test record.
- Change Channel A SLOPE to (–) and Channel B SLOPE to (+). Verify that the counter displays 454.XXXX ns. Mark results on performance test record.

7. GATE/MARKER OUT AND SAMPLE RATE

Setup:



- Set the HP 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 2.4V and the sample delay (time during which GATE/MARKER OUT is Low) must be less than 10 ms. Mark results on performance test record.

Table 5-4. Performance Test (Continued)

8. REMOTE TRIGGER LEVEL TEST

Setup:

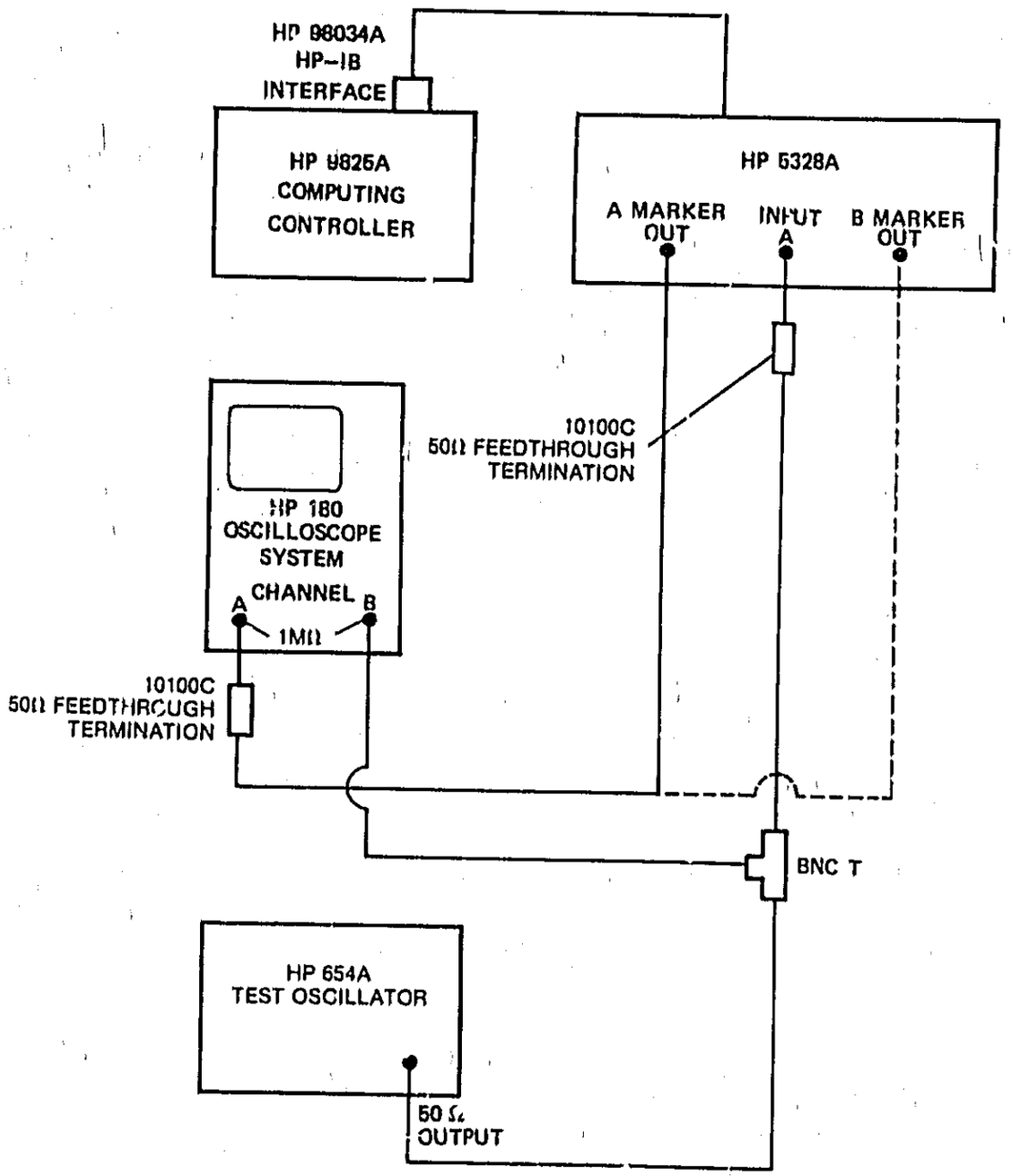
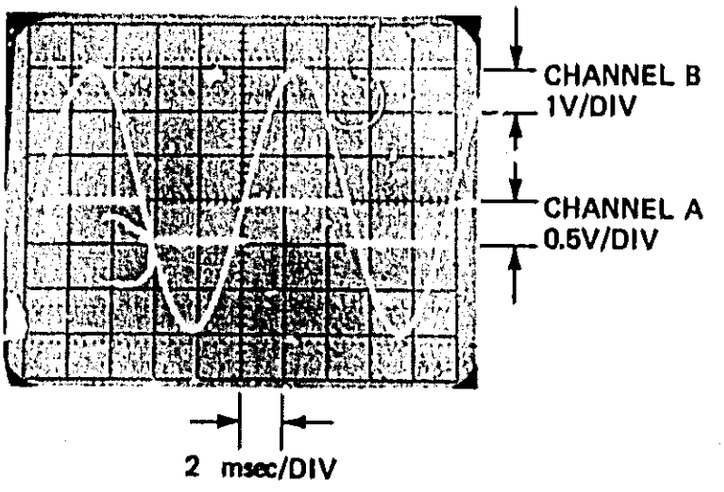


Table 5-4. Performance Test (Continued)

- Set Channels A and B of the HP 5328A to dc coupling, COM A, X1 ATTN, and FREQ A.
- Set the HP 654A 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 HP 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 sine wave at 0 volts.
- Execute the following from the HP 9825A keyboard:

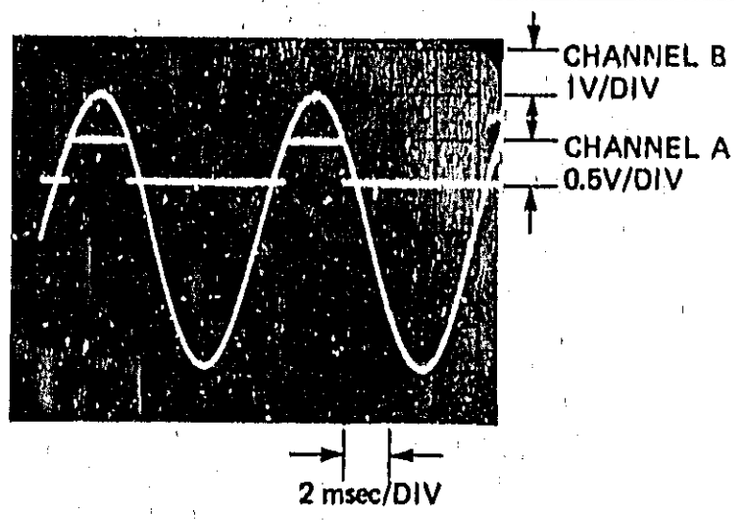
  wrt 701, "PF4G6S13A379+200*B37+200*R"

- 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 waveforms as shown.

MAINTENANCE

CON'T

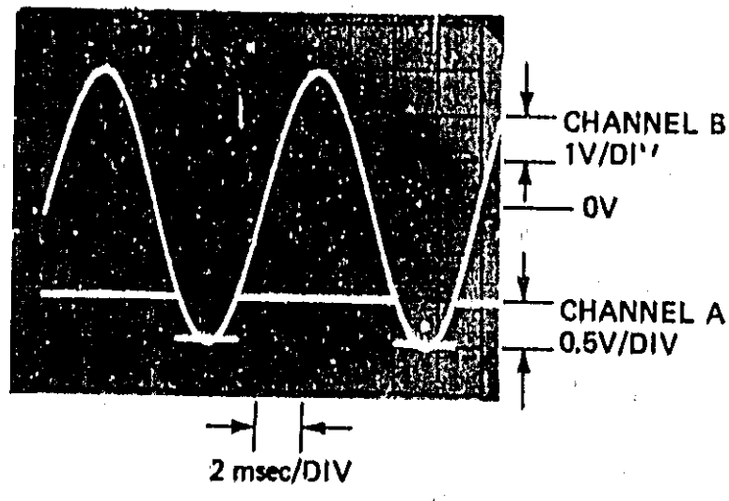
Table 5-4. Performance Test (Continued)



- Connect the HP 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 HP 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 HP 5328A B marker output to the A Channel ofthe oscillosocpe. 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 TEST RECORD

HEWLETT-PACKARD MODEL 5328AH99 Date: _____
500 MHz Universal Frequency Counter

Serial Number: _____ Test Performed by: _____

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 B		
	(1) 10 Hz-10 MHz, dc	_____	_____
	(2) 20 Hz-10 MHz, ac	_____	_____
	b. Sensitivity, Channel B/Ratio B/A		
	(1) 10 MHz-100 MHz, dc	_____	_____
	(2) 10 MHz-100 MHz, ac	_____	_____
3	Sensitivity, Channel C		
	50 MHz-500 MHz	_____	_____
4	Period and Period Average		
	1.0 μs display	_____	_____
	Approximately 1000.0000 ns display with 0.1 ps resolution	_____	_____
5	RATIO C/A	_____	_____

PERFORMANCE TEST RECORD (Continued)

TEST	DESCRIPTION	RESULTS	
		PASS	FAIL
6	TIME INTERVAL AND TIME INTERVAL AVERAGE		
	T.I. A→B -0.5 μs display	_____	_____
	T.I. AVG A→B, (+) to (-), 454.XXXX ns display	_____	_____
	T.I. AVG A→B, (-) to (+), 454.XXXX ns display	_____	_____
7	GATE/MARKER OUT 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. ATTN TEST	_____	_____
	(1) ATTN X1 Test	_____	_____
	(2) ATTN X10 Test	_____	_____
	(3) ATTN 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 repair has been made 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 5-1*. Using the appropriate sweep speed, adjust the oscillator until the movement of the pattern is stopped or nearly stopped. Detailed oscillator adjustment procedures are described in paragraph 5-28.

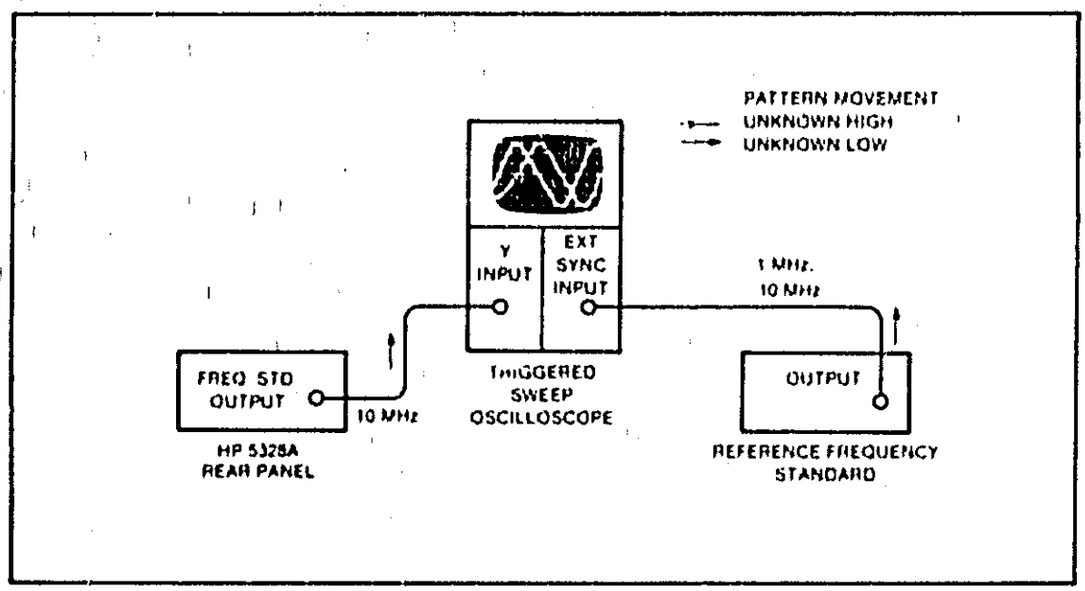


Figure 5-1. 10 MHz Oscillator Frequency Check

5-25. Channels A and B Sensitivity-Offset Adjustments

Setup:

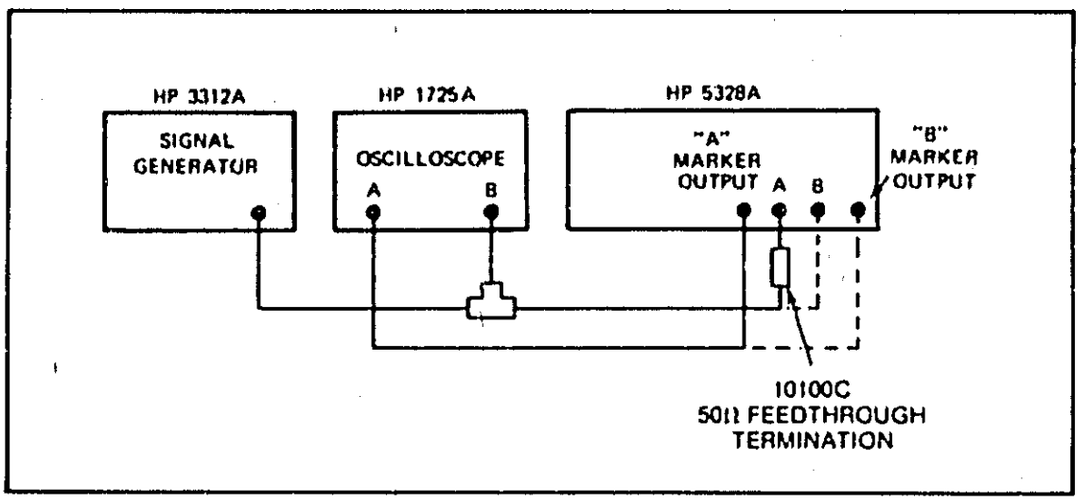


Figure 5-2. Sensitivity-Offset Adjustment Set-up, 10 kHz at 10 mVrms

1. Adjust channel A and B sentivity-offset as follows:

   a. Remove top cover of the HP 5328A to gain access to variable resistors R26, R28, R54, R55 on the A12 Amplifier Assembly, 05328-60042 (see A12 component locator in Section VIII).

   b. Set the 5328A front panel controls as follows:

      FUNCTION ..... FREQ A
      RESOLUTION ..... 10 Hz, 10^5
      AC/DC (A & B) ..... DC
      ATTN (A & B) X1
      LEVEL (A & B) ..... PRESET
      SEP/COM A ..... SEP

   c. Set HP 5328A rear panel controls as follows:

      ARM ..... OFF

   d. Set oscilloscope as follows:

      MODE ..... X-Y
      CHANNEL A ..... 0.2 mV/cm, 50Ω
      CHANNEL B ..... 0.05 mV/cm, 1 MΩ
      HORIZONTAL DISPLAY ..... MAG X10

   e. Connect test equipment per *Figure* 5-2. For the HP 5328A Channel A adjustment, connect signal generator's output to HP 5328A INPUT A and to scope's Channel B; connect the scope Channel A to HP 5328A Channel A MARKER OUTPUT.

   f. Set the HP 3312A Function Generator to output a 10 kHz sine wave signal at 10 mV rms (28 mV p-p).

   g. Set scope in the X-Y mode. Ground both scopes input and calibrate scope (dot in center of screen).

   h. Set both R26 (offset) and R55 (sensitivity) pots in the midrange position. Vary R26 (offset) to get hysteresis in the center of oscilloscope screen. Adjust R55 (sensitivity) to 20 mV p-p (X-axis); see *Figure* 5-3. This completes the adjustment for the HP 5328A Channel A.

   i. Disconnect oscilloscope's Channel A cable from the HP 5328A "A" MARKER OUTPUT and reconnect it to "B" MARKER OUTPUT. Disconnect signal generator's output from HP 5328A Channel A INPUT and connect it to the HP 5328A Channel B INPUT.

   j. Set both R28 (offset) and R54 (sensitivity) pots in the midrange position. Adjust R28 to locate the picture in the center of the oscilloscope screen; adjust R54 to 20 mV p-p (X-axis). This is the end of Channel B adjustments. Turn-off and disconnect all test equipment.

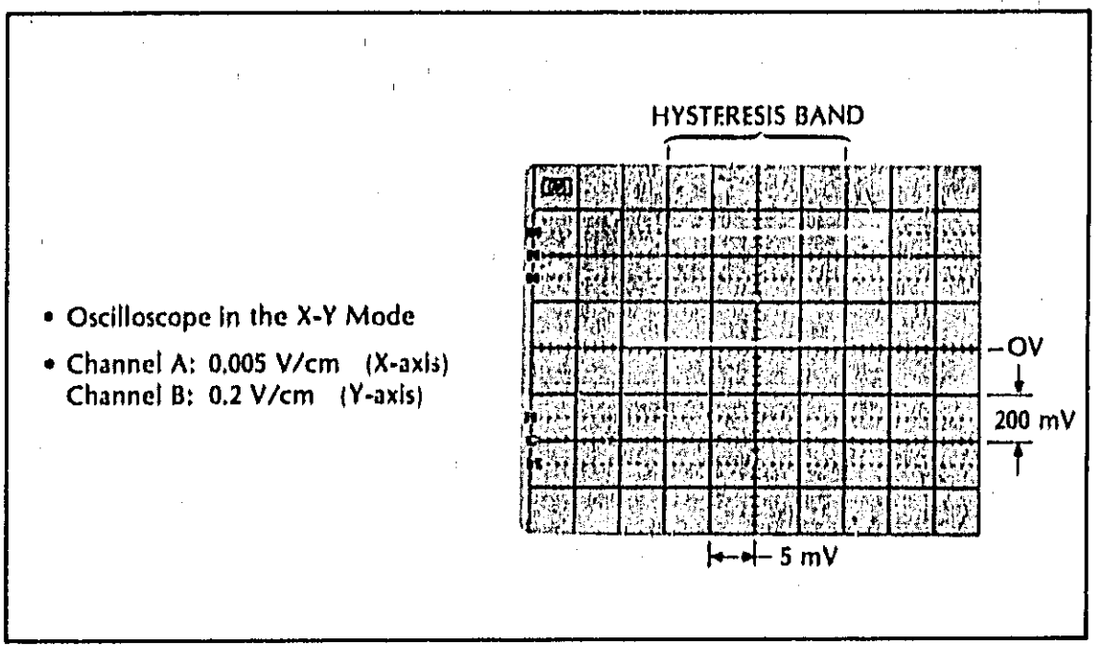


Figure 5-3. Hysteresis Adjustment

5-26. Channel C Offset Adjustments

a. Remove the top cover of the HP 5328A to gain access to variable resistor A8R12 (OFST).

b. Connect the HP 3490A Voltmeter to A8U3 pin 7. Measure and record this voltage.

c. Move the HP 3490A Voltmeter to A8U3 pin 5.

d. Adjust A8R12 (OFST) until A8U3 pin 5 is 4 mV more negative than A8U3 pin 7.

e. Replace the top cover.

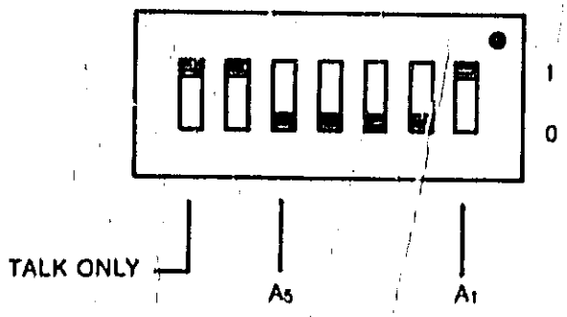
5-27. Digital-to-Analog Converter Adjustment Procedure

The following adjustment procedure adjusts the A11 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 HP 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 volts 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 HP 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 Sensitivity-Offset Adjustments". In this adjustment, follow the procedure outlined in paragraph 5-25, but adjust for optimum sensitivity by continuing to decrease the signal generator level below 15 mV rms and adjusting resistors A12R26, R28, R54, and R55 for stable counter displays.

a. Set up the equipment as in *Figure 5-4*. Set the rear panel address switches on the HP 5328A to:



Set the 654A test oscillator to 20 kHz at a level of 25 mV rms (70 mV p-p). Set the HP 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 HP 9825A the following:

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

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

c. Connect the HP 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 COM A.)

d. Connect power supply as in the figure and adjust for a dc level of 2.00 volts (±2 mV) as read on the DVM.

e. Execute the following from the keyboard of the HP 9825A:

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

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

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

g. Connect the HP 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 (±2 mV).

i. Execute the following from the keyboard of the HP 9825A:

wrt 701, "PF4G5S1S3A379-200*B37-200*R"

j. Adjust A11R26 for a 50% duty cycle on the A Marker output signal.

k. Connect the HP 5328A B Marker output to the B Channel of the oscilloscope. Adjust A11R17 for a 50% duty cycle on the B Marker output signal.

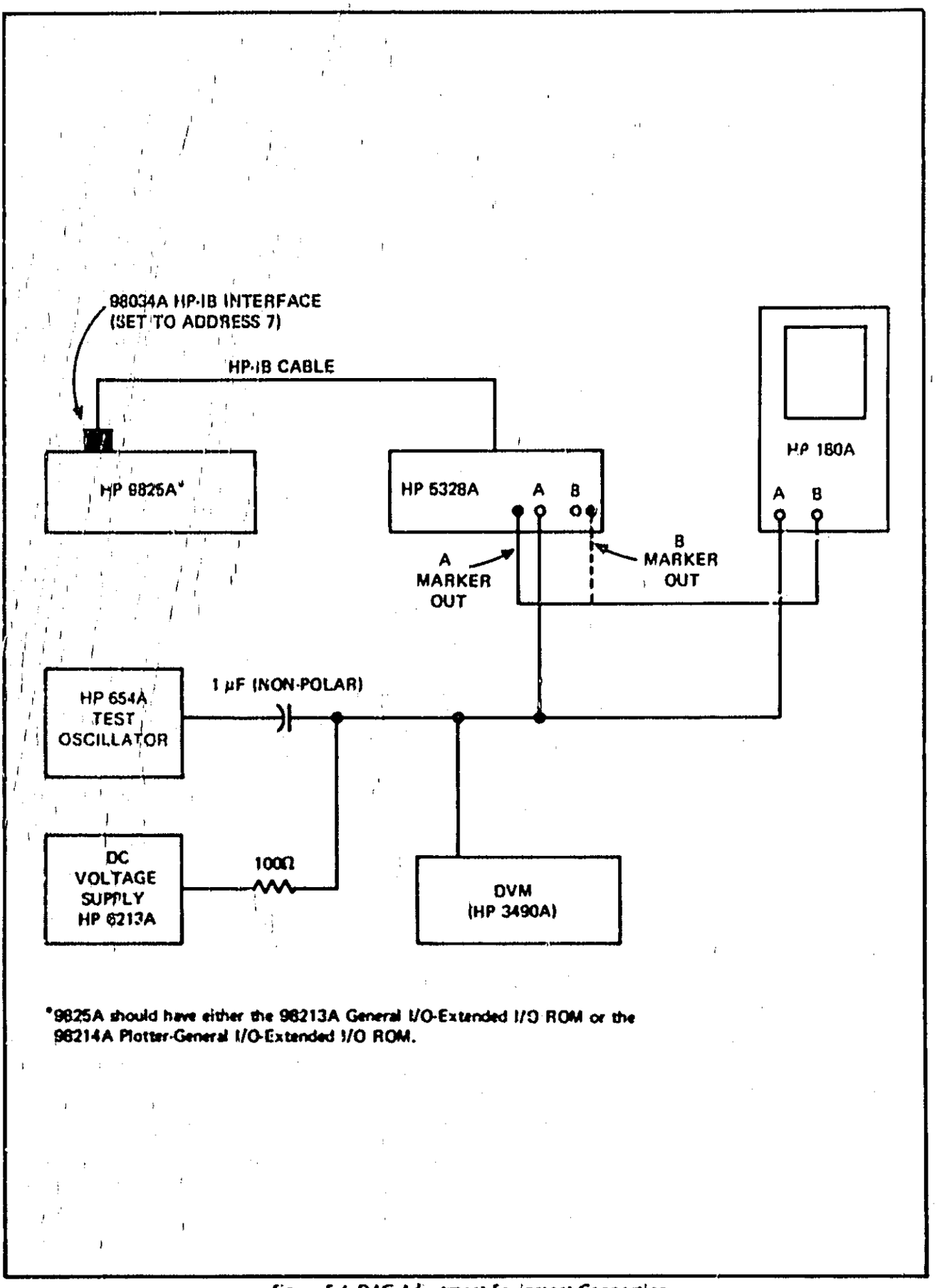
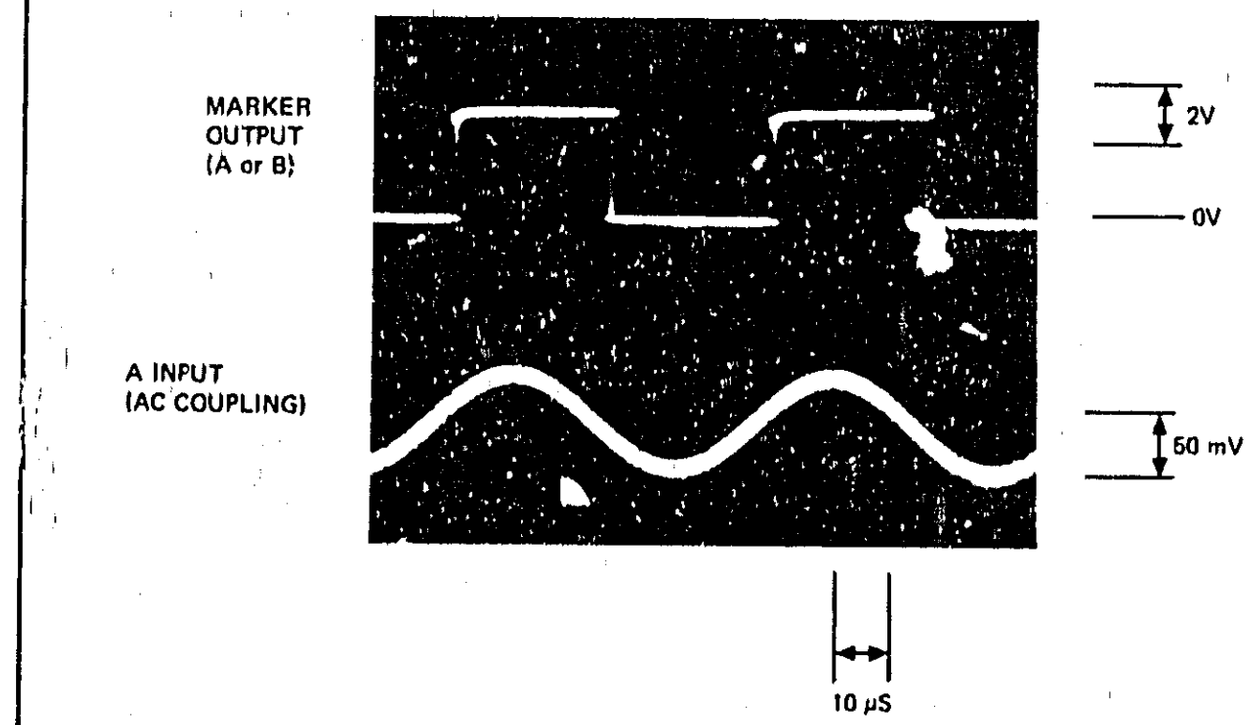


Figure 5-4. DAC Adjustment Equipment Connections



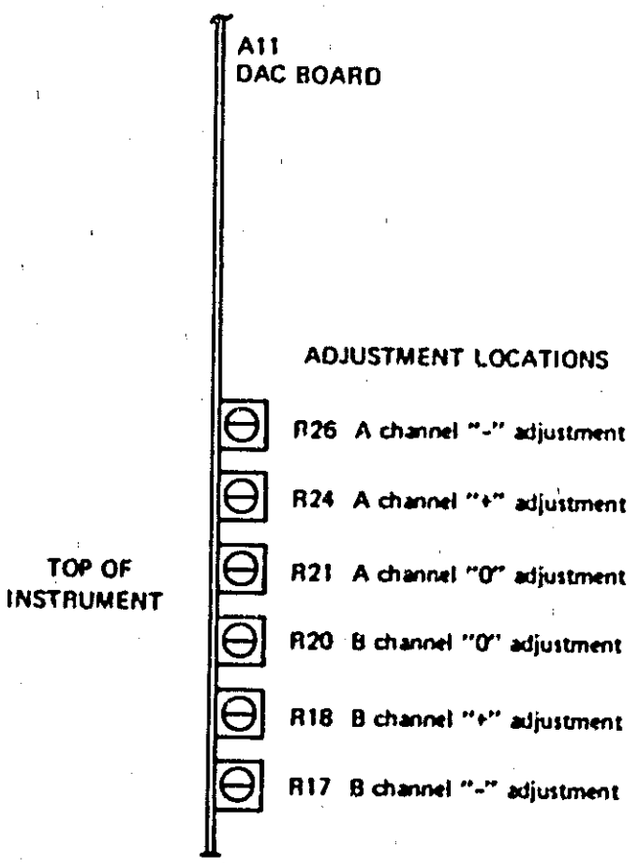


Figure 5-5. DAC Adjustment Oscilloscope Readout and Adjustment Locations

5-28. OSCILLATOR ADJUSTMENT

5-29. Allow a 24-hour warm-up before this adjustment is made.

Setup:

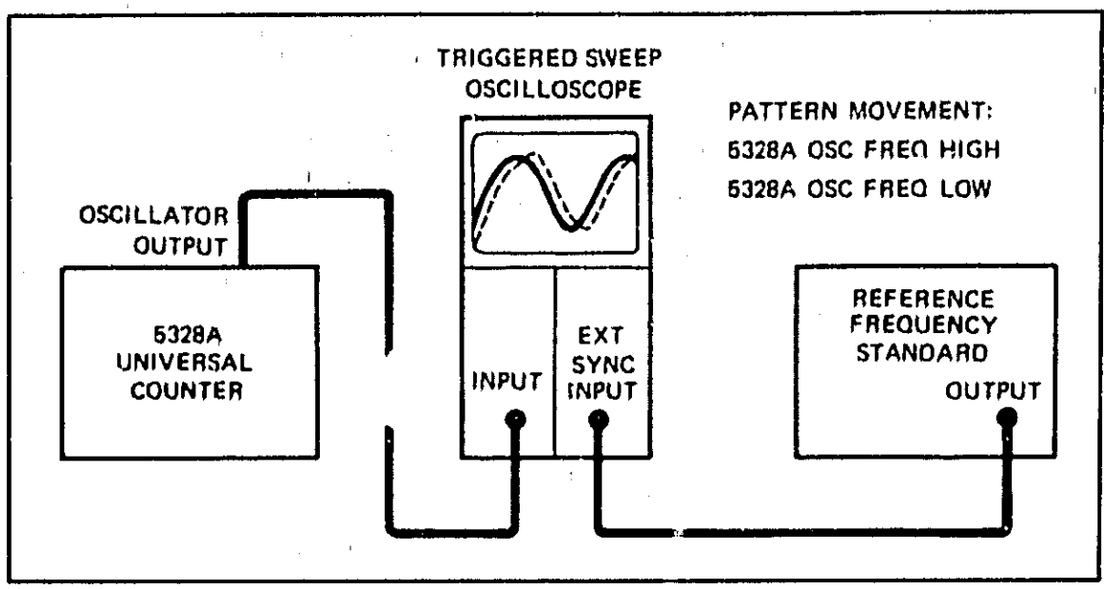


Figure 5-6. Oscillator Adjustment Setup

a. Connect reference frequency standard (multiple of 10 MHz) to the EXTERNAL SYNC INPUT of the oscillator.

b. Set HP 5328A rear panel OSC INT/EXT to INT and connect oscillator output BNC to Channel A of the oscilloscope.

c. Adjust FREQ ADJ on 10811-60111 Crystal Oscillator unit and A3R14 (FINE ADJ) for minimum sideways movement of the 10 MHz displayed signal.

d. By timing the sideways movement (divisions per second on the oscilloscope), the approximate offset can be determined based on the oscilloscope sweep speed as shown below:

Table 5-5. Calibration

MOVEMENT	SWEEP SPEED			NOTES
	1 μ/div.	0.1 μs/div.	0.01 μs/div.	
1 div/s 1 div/10 s 1 div/100 s	1×10^{-6} 1×10^{-7} 1×10^{-8}	1×10^{-7} 1×10^{-8} 1×10^{-9}	1×10^{-8} 1×10^{-9} 1×10^{-10}	With second hand of watch or clock, measure the trace movement of the oscilloscope for 1 division.

5-30. For example, if the trace moves 1 division in 10 seconds and the sweep speed is 0.01 μs/div., the oscillator signal is within 1×10^{-9} of the reference frequency, as can be seen from the Calibration Table above. A calculation can also be made as follows:

$$\frac{\Delta t}{t} = \frac{\Delta f}{f}$$

$$\frac{0.01\ \mu s/div.}{10\ s/div.} = 1 \times 10^{-9}$$

5-31. Adjustment of A3 Amplifier-Multiplier

1. Connect 5328A, HP 8640, and HP 180 as shown in *Figure 5-7.*

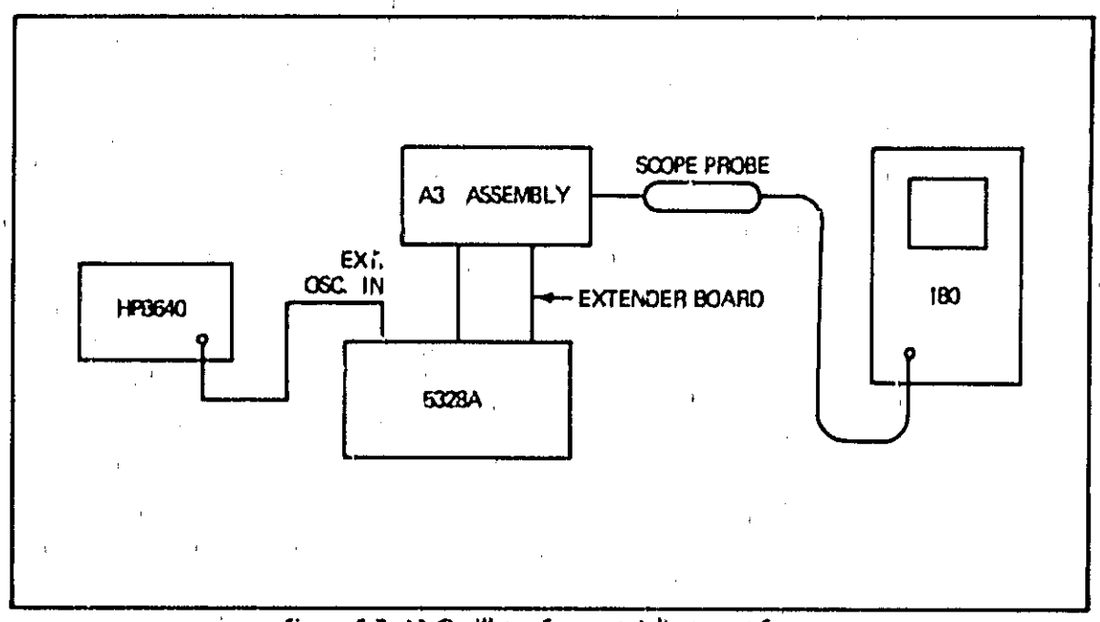


Figure 5-7. A3 Oscillator Support Adjustment Setup

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 A3J2 (6) non-component side of A3 circuit board.
5. Adjust A3C15 and A3C12 to minimize side-jitter in trace, as shown in *Figure 5-8.*
6. Put the scope in X10 and fine-tune the adjustments for minimum jitter.

5-32. TROUBLESHOOTING

5-33. 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.

5-34. TROUBLESHOOTING AIDS

5-35. 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.

5-36. Extender Board

5-37. Two extender boards are supplied with the 5328A to extend the A4 Function Selector Assembly or the A8 Frequency C Assembly. One extender board is required to extend the A10 assembly for the 5328A.

A3 Out of Adjustment

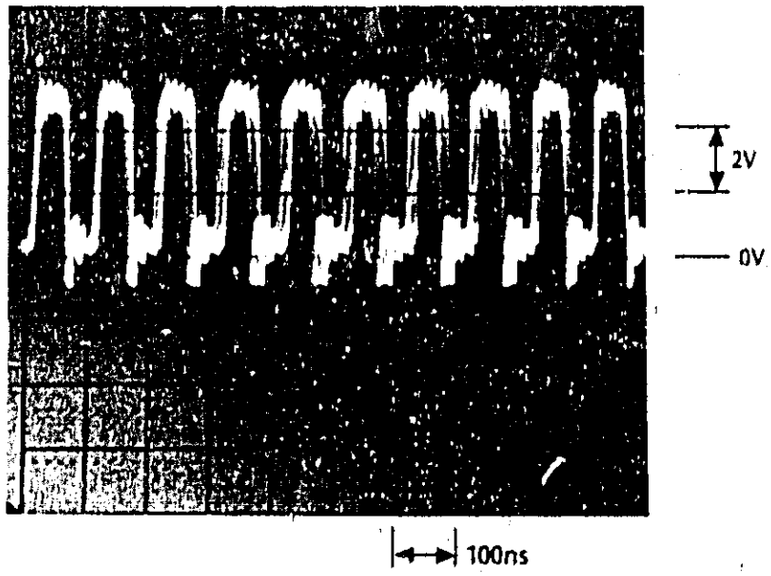


Figure 5-5A

15. C12 Adjusted for Minimum Jitter

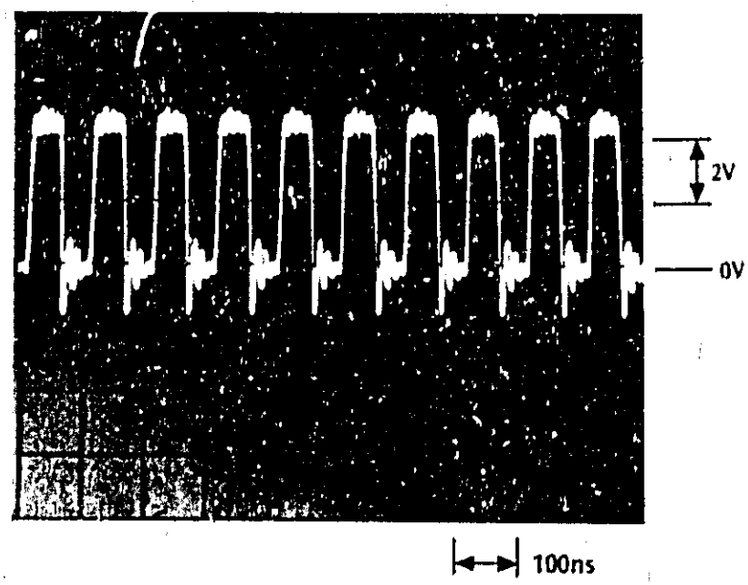


Figure 5-5B

Figure 5-8. A3 Minimum Jitter Adjustment

5-38. IC Troubleshooting

5-39. 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 5-6*, using an HP Model 10528A Logic Clip or a Model 10525T Logic Probe. A dark pattern indicates a logic high.

5-40. Function Signals

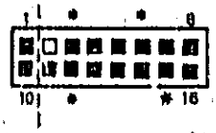
5-41. *Table 5-7* lists the functional signals at pertinent points for each position of the FUNCTION switch. This information can be used to isolate problems that may occur in any of the various modes of operation.

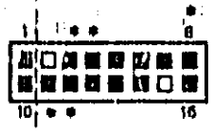
Table 5-6. IC Troubleshooting, A1 Motherboard

5328A Display: [illegible]
(See preceding Initial conditions)

NOTE

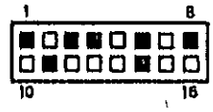
When checking a 14-pin IC with the 16-pin logic clip, ignore the patterns for pins 8 and 9 of the Logic Clip as shown by the dotted line on the pattern.

U22  14 PIN

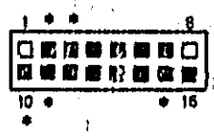
U23  14 PIN

U24  14 PIN

U25  16 PIN

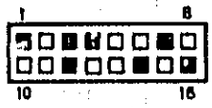
U26  16 PIN

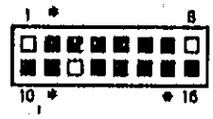
U27  16 PIN

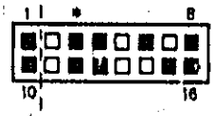
U28  16 PIN

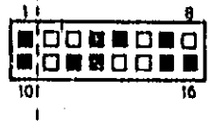
U29  14 PIN

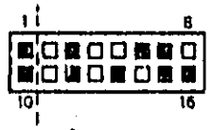
U30  14 PIN

U31  16 PIN

U32  16 PIN

U33  14 PIN

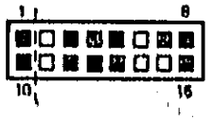
U34  14 PIN

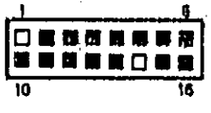
U35  14 PIN

U36  14 PIN

U37  14 PIN

U39  16 PIN

U40  14 PIN

U41  16 PIN

*Indicates dimly lit

Table 5-6. 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	H	L	L	H
	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 5-6. IC Troubleshooting, A1 Motherboard (Continued)

PINS U25		FREQ RESOLUTION							
		1 MHz 10^{0}	.1 MHz 10^{-1}	10 kHz 10^{-2}	1 kHz 10^{-3}	.1 kHz 10^{-4}	10 Hz 10^{-5}	1 Hz 10^{-6}	.1 Hz 10^{-7}
INPUTS	2	L	L	L	L	L	L	L	L
	3	H	H	H	H	H	H	H	H
	6	H	H	L	L	H	H	L	L
	7	H	L	H	L	H	L	H	L
OUTPUTS	9	H	H	H	H	H	H	H	H
	10	H	H	H	H	H	H	H	H
	15	L	H	L	H	L	H	L	H
	16	L	L	L	L	L	L	L	L
U26									
INPUTS	2	L	L	L	L	L	L	L	L
	3	H	H	H	H	L	L	L	L
	6	H	H	H	H	H	H	H	H
	7	L	L	L	L	H	H	H	H
OUTPUTS	9	L	L	L	L	L	L	L	L
	10	H	H	H	H	H	H	H	H
	15	L	L	L	L	H	H	H	H
	16	L	L	L	L	L	L	L	L
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 5-6. IC Troubleshooting, A1 Motherboard (Continued)

U37
(ROM STATES WITH A4 REMOVED)

1	-2V	15	L
2	+5V	16	GND
3	L	17	L
4	L	18	L
5	L	19	L
6	L	20	H
7	H	21	H
8	L	22	L
9	H	23	L
10	H	24	H
11	H	25	H
12	H	26	H
13	L	27	L
14	L	28	+12V

Table 5-7. HP 5328A Functional Signals

NOTE
N=0-7 (Exponent of 10 on FREQ RESOLUTION, N Switch.
N=0 is position 1 on switch, All other positions N≠0).
CLK = 10 MHz
• = Don't care

Function Switch	Displayed Number FREQ • TIME (Hz) (Seconds)	Signal to TB (Output A4U10) IF N=0	IF N≠0	Signal to 1st Decade (Output A4U6) IF N=0	N≠0	Arming (Output A4U5) Norm	Armed	Main Gate (Input A4U6) IF N=0	IF N≠0	Gate (Opt. 030) (Input A8U4)
FREQ A	$A \bullet \frac{10^{(N+1)}}{CLK}$	CLK	CLK	A	A	A	B	MGFF	MGFF	•
PER A	$\frac{CLK}{10^N} \bullet PER\ A$	•	CLK	GOSC	TBO	Free	B	Open	TI	•
PER AVG A	$CLK \bullet 10^N\ PER\ A$	•	A	GOSC	CLK	Free	B	Open	MGFF	•
TI A→B	$\frac{CLK}{10^N} \bullet TO\ A \rightarrow B$	•	CLK	GOSC	TBO	Free	CA	Open	TI	•
TI AVG A→B	$(CLK \bullet 10^N) \bullet TI\ A \rightarrow B$	•	B	GOSC	GOSC	Free	CA	Open	MGFF	•
FREQ C (Option 030)	$C \bullet \frac{10^{(N+1)}}{CLK}$	CLK	CLK	C	C	CA	B	Open	Open	MGFF
RATIO B/A	$B \bullet \frac{10^N}{A}$	†•	A	B	B	Free	CA	TI	MGFF	•
RATIO C/A	$C \bullet \frac{10^N}{A}$	•	A	C	C	Free	B	Open	Open	TI IF N=0 MGFF IF N≠0
CHECK	$CLK \bullet \frac{10^{(N+1)}}{CLK}$	CLK	CLK	CLK	CLK	Free	B	MGFF	MGFF	•

NOTES
† = ROM makes "A" into period = gate time
CA = CARM

5-42. HP-IB VERIFICATION USING THE HP9825A

5-43. The following program checks the 5328A for proper operation on the HP-IB. The program is designed to operate with the 5328A connected to a HP9825A Desktop Computer as a controller.

5-44. To perform the verification, connect the 5328A as shown in *Figure* 5-9, and set the rear panel address switches to decimal equivalent one.

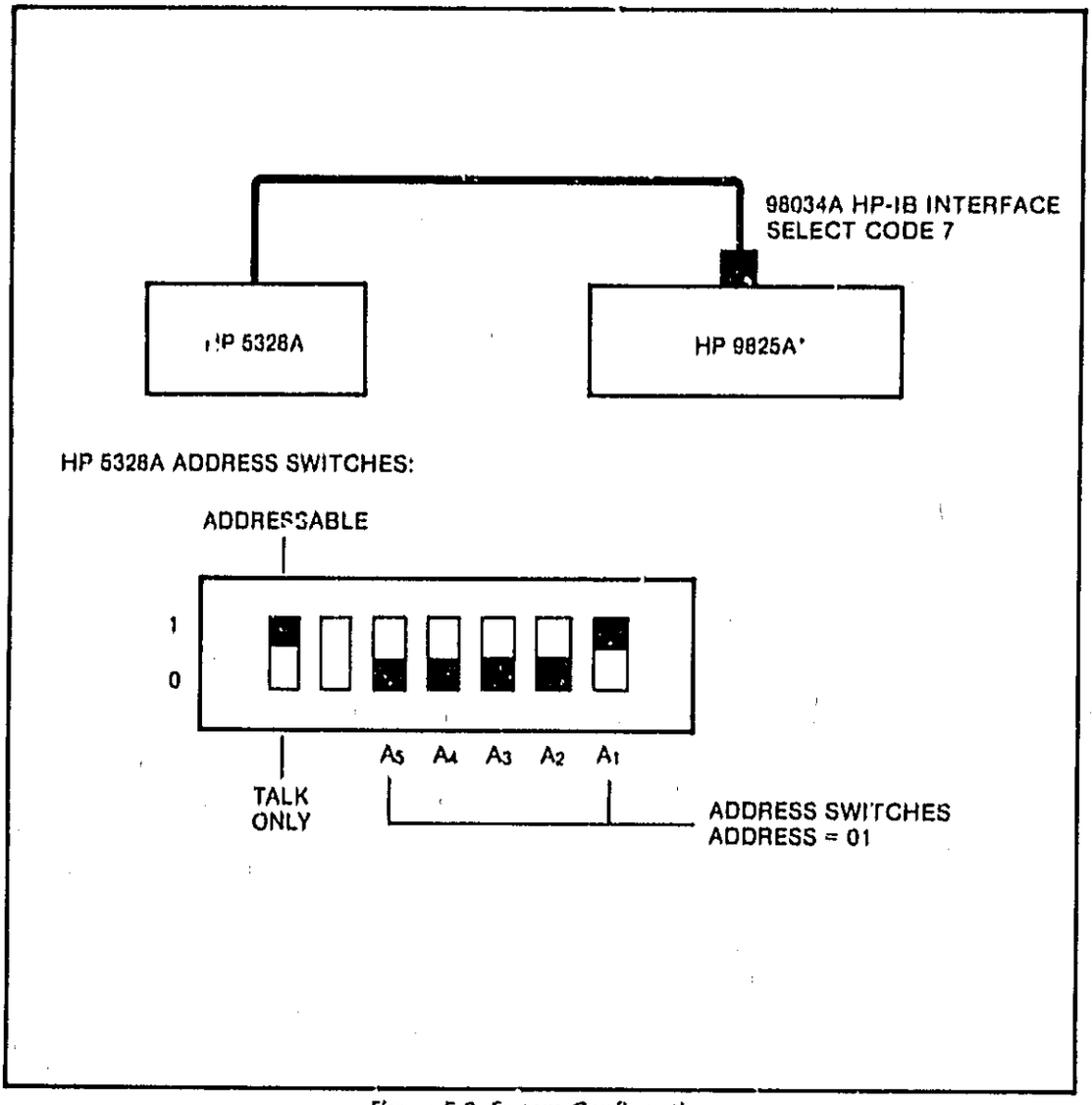


Figure 5-9. System Configuration

5-45. The program listed in *Table 5-8* may be keyed into the HP 9825A or may be loaded from an HP-IB Verification cassette, **HP P/N 59300-10001**, (Revision J or later) which also contains HP-IB verification programs for many other instruments. To run the program on the cassette, insert the cassette into the HP 9825A, Load file 0, and press **RUN**. Enter "5328" when the instrument model number is requested. When HP 9825A displays "5328A Option 006 or H42 (1=Y, 0=N)?", then press **CONTINUE**. Answer with a 1 on the next question. The HP 9825A will then load into memory the HP 5328A verification program.

5-46. The HP 5328A HP-IB Verification Program goes through 17 check points. The information in *Table 5-3 A, 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 (→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**.

```
  5328A/H99
  500 MHz FREQ
  COUNTER

  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
 + 10.000000E+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
 MEASMNT

----------
CHECK POINT 13
*ATTENUATOR

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

CHECK POINT 15
*COUPLING

----------
CHECK POINT 17
BUS COMMANDS:
*LOCAL LOCKOUT
*DEVICE CLEAR
*SELECTED DEVICE
 CLEAR
*GROUP EXECUTE
 TRIGGER
*SERIAL POLL
 STATUS BYTE=
            64.00
*GO TO LOCAL

END OF TEST.
```

Figure 5-10. Sample Printout

Table 5-8. Program Listing

```
0: dim A$[16],B$[16],C$[40];dsp "MODEL 5328A/H99 FREQ COUNTER"
1: prt "  5328A/H99","  500 MHz FREQ","  COUNTER";spc
2: prt "  HP-IB TEST5";spc ;"----------------"→A$;"****************"→B$
3: prt B$;spc
4: "code":ent "select code?",C
5: if C=721;dsp "error: calculator address";wait 1000;gto "code"
6: if C>730;dsp "out of address range→high";wait 1000;gto "code"
7: if C<700;dsp "out of address range→low";wait 1000;gto "code"
8: dev "S",C
9: "1":prt "CHECK POINT 1"
10: rem "S"
11: prt "*REMOTE";beep;spc 2
12: dsp "CHECK POINT 1--PRESS CONTINUE";stp
13: if L=1;gto "1"
14: "2":prt A$,"CHECK POINT 2"
15: wrt "S","PP<G3S13R"
16: red "S",C$;prt "*CHECK=",C$;beep;spc 2
17: dsp "CHECK POINT 2--PRESS CONTINUE";stp
18: if L=1;gto "2"
19: "3":prt A$,"CHECK POINT 3","RESOLUTION"
20: 1→X
21: "LOOP":fmt 2,"G",f.0,"R"
22: wrt "S,2",X
23: red "S",C$;prt C$
24: X+1→X
25: if X=8;gto +2
26: gto "LOOP"
27: dsp "CHECK POINT 3--PRESS CONTINUE";beep;stp
28: spc 2;if L=1;gto "3"
29: "4":prt A$,"CHECK POINT 4"
30: wrt "S","F4R"
31: prt "*FREQ A";beep;spc 2
32: dsp "CHECK POINT 4--PRESS CONTINUE";stp
33: if L=1;gto "4"
34: "5":prt A$,"CHECK POINT 5"
35: wrt "S","F9R"
36: prt "*RATIO B/A";beep;spc 2
37: dsp "CHECK POINT 5--PRESS CONTINUE";stp
38: if L=1;gto "5"
39: "6":prt A$,"CHECK POINT 6"
40: wrt "S","F6R"
41: prt "*PERIOD A";beep;spc 2
42: dsp "CHECK POINT 6--PRESS CONTINUE";stp
43: if L=1;gto "6"
44: "7":prt A$,"CHECK POINT 7"
45: wrt "S","F7R"
46: prt "*PER.AVG.A";beep;spc 2
47: dsp "CHECK POINT 7--PRESS CONTINUE";stp
48: if L=1;gto "7"
49: "8":prt A$,"CHECK POINT 8"
50: wrt "S","F8R"
51: prt "*T.I.A→B";beep;spc 2
52: dsp "CHECK POINT 8--PRESS CONTINUE";stp
53: if L=1;gto "8"
```

Table 5-8. Program Listing (Continued)

```
 54: "9":prt A$,"CHECK POINT 9"
 55: wrt "S","F:R"
 56: prt "*T.I.AVG.A-B";beep;spc 2
 57: dsp "CHECK POINT 9--PRESS CONTINUE";stp
 58: if L=1;gto "9"
 59: "10":prt A$,"CHECK POINT 10"
 60: wrt "S","F>R"
 61: prt "FREQ C";beep;spc 2
 62: dsp "CHECK POINT 10--PRESS CONTINUE";stp
 63: if L=1;gto "10"
 64: "11":prt A$,"CHECK POINT 11"
 65: wrt "S","F=R"
 66: prt "RATIO C/A";beep;spc 2
 67: dsp "CHECK POINT 11--PRESS CONTINUE";stp
 68: if L=1;gto "11"
 69: "12":prt A$,"CHECK POINT 12"
 70: wrt "S","F<G1S137R"
 71: dsp "MANUAL OK?--PRESS CONTINUE";stp
 72: prt "*SAMPLE RATE"
 73: wrt "S","S60R"
 74: dsp "GATE LIGHT OFF?-PRESS CONTINUE";stp
 75: prt "*SINGLE/MULTIPLE MEASMNT";beep;spc 2
 76: dsp "CHECK POINT 12--PRESS CONTINUE";stp
 77: if L=1;gto "12"
 78: "13":prt A$,"CHECK POINT 13"
 79: wrt "S","PF4G4S13A379B37R"
 80: dsp "STEPS 1,2-PRESS CONTINUE";stp
 81: wrt "S","PF4G4S13A139B13R";wait 1000
 82: prt "*ATTENUATOR";beep;spc 2
 83: dsp "CHECK POINT 13--PRESS CONTINUE";stp
 84: if L=1;gto "13"
 85: "14":prt A$,"CHECK POINT 14"
 86: dsp "STEP 3--PRESS CONTINUE";stp
 87: wrt "S","PF9G3S13A79B7R"
 88: wait 2000
 89: dsp "STEP 4--PRESS CONTINUE";stp
 90: wrt "S","PF4G5S13B79R";wait 2000
 91: prt "*SEPARATE/COMMON","*NORMAL/INVERTED";beep;spc 2
 92: dsp "CHECK POINT 14-PRESS CONTINUE";stp
 93: if L=1;gto "14"
 94: "15":prt A$,"CHECK POINT 15"
 95: wrt "S","PF4G4S13A79B7R"
 96: dsp "STEPS 5,6--PRESS CONTINUE";stp
 97: wrt "S","PF4G4S13A379B37R"
 98: prt "*COUPLING";beep;spc 2
 99: dsp "CHECK POINT 15-PRESS CONTINUE";stp
100: if L=1;gto "15"
101: "16":prt A$,"CHECK POINT 16"
102: wrt "S","PF4G6S136A379+000*B37+000*R"
103: dsp "STEPS 7,8--PRESS CONTINUE";stp
104: wrt "S","PF4G6S136A379+040*B37+040*R"
105: prt "*TRIGGER LEVELS";spc
106: dsp "TRIGGER LVLS-PRESS CONTINUE";stp
107: dsp "STEPS 9,10,11,12-PRESS CONTINUE";stp
108: wrt "S","PF:S137A379+040*B37+050*R"
109: prt "  CHNL B,+SLOPE"
110: dsp "CHANNEL B,+SLOPE--PRESS CONTINUE";stp
```

Table 5-8. Program Listing (Continued)

```
111: wrt "S","PF:S137A379+040*B375+050*R"
112: prt "  CHNL B,-SLOPE"
113: dsp "CHNL B,-SLOPE--PRESS CONTINUE";stp
114: wrt "S","PF:S137A379+050*B375+040*R"
115: prt "  CHNL A,+SLOPE"
116: dsp "CHNL A,+SLOPE-PRESS CONTINUE";stp
117: wrt "S","PF:S137A3795+050*B375+040*R"
118: prt "  CHNL A,-SLOPE";spc 2
119: dsp "CHNL A,-SLOPE-PRESS CONTINUE";stp
120: dsp "CHECK POINT 16-PRESS CONTINUE";stp
121: if L=1;gto "16"
122: "17";prt A$,"CHECK POINT 17"
123: prt "BUS COMMANDS:"
124: rem "S";dsp "REMOTE?-PRESS CONTINUE";stp
125: llo 7;dsp "LOCAL LOCKOUT?-PRESS CONTINUE";stp
126: prt "*LOCAL LOCKOUT"
127: wrt "S","PF<S13G3R"
128: dsp "10.000MHZ?-PRESS CONTINUE";stp
129: clr 7;prt "*DEVICE CLEAR";beep
130: dsp "DCL-PRESS CONTINUE";stp
131: wrt "S","PF<S13G3R"
132: dsp "10.000MHZ?-PRESS CONTINUE";stp
133: clr "S";prt "*SELECTED DEVICE CLEAR";beep
134: dsp "SDC-PRESS CONTINUE";stp
135: wrt "S","PF<G3S03R"
136: dsp "IN HOLD?-PRESS CONTINUE";stp
137: wait 1000;trg 7;beep;wait 2000;trg "S";beep;wait 1000
138: prt "*GROUP EXECUTE  TRIGGER"
139: dsp "GET-PRESS CONTINUE";stp
140: wrt "S","PF<G7S12R"
141: rds("S")→A;dsp A
142: if A=0;gto -1
143: prt "*SERIAL POLL"," STATUS BYTE=",A
144: dsp "SERIAL POLL-PRESS CONTINUE";stp
145: lcl 7;dsp "COUNTER IN LOCAL?-PRESS CONTINUE";stp
146: prt "*GO TO LOCAL";spc 2
147: rem "S"
148: dsp "CHECK POINT 17-PRESS CONTINUE";stp
149: if L=1;gto "17"
150: "END";dsp "END OF TEST."
151: prt "END OF TEST.";beep;spc 5
152: end
*7485
```

Table 5-9A Program Description

CHECK POINT	TEST	OBSERVE ON HP 5328A
1	REMOTE	Front panel (RMT) annunciator should be on.
2	CHECK	Counter should read 10.000 MHz.
3	RESOLUTION	The HP 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 Hz.
5	RATIO B/A	Counter display should read 0.0000000.
6	PERIOD A	Counter display should read 0. s.
7	PERIOD AVERAGE A	Counter display should read 0.00000 ns.
8	T.I. A–B	Counter display should read 0. s.
9	T.I. AVERAGE A–B	Counter display should read 0.00000 ns.
10	FREQ C	Counter display should read 0.0000 Hz.
11	RATIO C/A	Counter display should read 0.0000000.
12	SAMPLE RATE SINGLE/MULTIPLE MEASUREMENT	When calculator displays MANUAL OK?, verify that front panel SAMPLE RATE control can be manually adjusted as seen from GATE LIGHT flashing rate. When calculator displays GATE LIGHT OFF?, verify that GATE LIGHT is truly off.

5-47. Connect a function generator to the 5328 input channels and monitor the signal with an oscilloscope as shown in *Figure 5-11.*

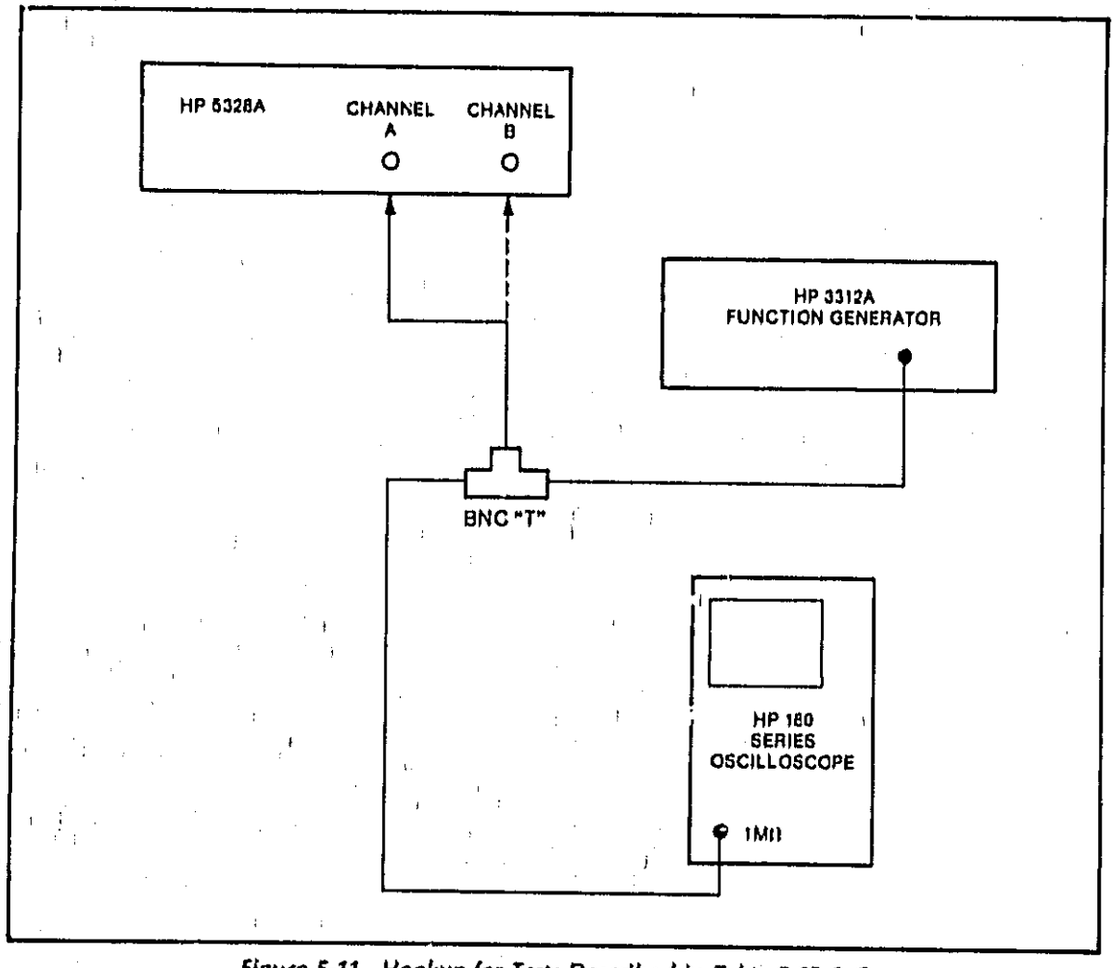


Figure 5-11. Hookup for Tests Described in Table 5-9B & C

Table 5-9B. 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 sine wave centered at 0V dc as seen on the oscilloscope. Connect the function generator's output to Channel A of the counter. Set the counter's LEVEL A and B to PRESET. HP 5328A trigger lights should be blinking.
	2		When the HP 9825A **CONTINUE** key is pressed, verify that the counter trigger lights stop blinking.
14	3	SEPARATE/ COMMON NORMAL/ INVERTED	With function generator connected to Channel A of counter, when **CONTINUE** key of HP 9825A is pressed, verify counter readout as 1,000.
	4		With function generator connected to Channel B of counter, when **CONTINUE** key of HP 9825A 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 +0.4V dc offset as seen on the oscilloscope (*Figure 5-11*). Connect signal to counter's Channel A input. Counter's Channel A and B trigger lights should be blinking.
	6		When the HP 9825A **CONTINUE** key is pressed, observe the counter's trigger lights stop blinking.
16	7	SLOPE/ TRIGGER LEVEL	Set the function generator to a triangular pulse output of 1 kHz at 300 mV p-p with a +0.4V dc offset as seen on the oscilloscope (*Figure 5-11*). Connect the function generator's ouput to Channel A of the counter. Set the counter's LEVEL A and B to PRESET.
	8		When the HP 9825A **CONTINUE** key is pressed, observe Channel A and B trigger lights commence blinking.
	9	CHANNEL B +SLOPE	When the HP 9825A **CONTINUE** key is pressed, counter should display approximately 150 µs ±75 µs (wide tolerance).
	10	CHANNEL B -SLOPE	When the HP 9825A **CONTINUE** key is pressed, counter should display approximately 400 µs ±100 µs (wide tolerance).
	11	CHANNEL A +SLOPE	When the HP 9825A **CONTINUE** key is pressed, counter should display approximately 400 µs ±100 µs (wide tolerance).
	12	CHANNEL A -SLOPE	When the HP 9825A **CONTINUE** key is pressed, counter should display approximately 150 µs ±75 µs (wide tolerance).

Table 5-9C. Program Description

CHECK POINT	TEST	COUNTER DISPLAY READOUT
17	LOCAL LOCKOUT (LLO)	When the HP 9825A **CONTINUE** key is pressed, verify that the counter (RMT) annunciator is on.
		When the HP 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 remains ON.)
	DEVICE CLEAR (DCL)	When the HP 9825A **CONTINUE** key is pressed, verify that counter displays 10.000 MHz. When the HP 9825A **CONTINUE** key is again pressed, counter will reset to its Remote Program Initialize mode and display "0".
	SELECTED DEVICE CLEAR (SDC)	When the HP 9825A **CONTINUE** key is pressed, verify that counter displays 10.00 MHz. When the HP 9825A **CONTINUE** key is again pressed, counter will reset to its Remote Program Initialize mode and display "0".
	GROUP EXECUTE TRIGGER (GET)	When the HP 9825A **CONTINUE** key is pressed, verify that counter is in Hold (Gate Light off). When the HP 9825A **CONTINUE** key is again pressed, Gate Light should flash twice and counter should display 10.000 MHz.
	SERIAL POLL (SPE/SPD)	When the HP 9825A **CONTINUE** key is pressed, counter should display (0.0000000 MHz) and Gate Light should go off. Calculator should print (STATUS BYTE = 64.00).
	GO TO LOCAL (GTL)	When the HP 9825A **CONTINUE** key is pressed, verify that counter is in Local (RMT annunciator off). When HP 9825A **CONTINUE** key is again pressed, counter will go into remote.
		END OF TEST.

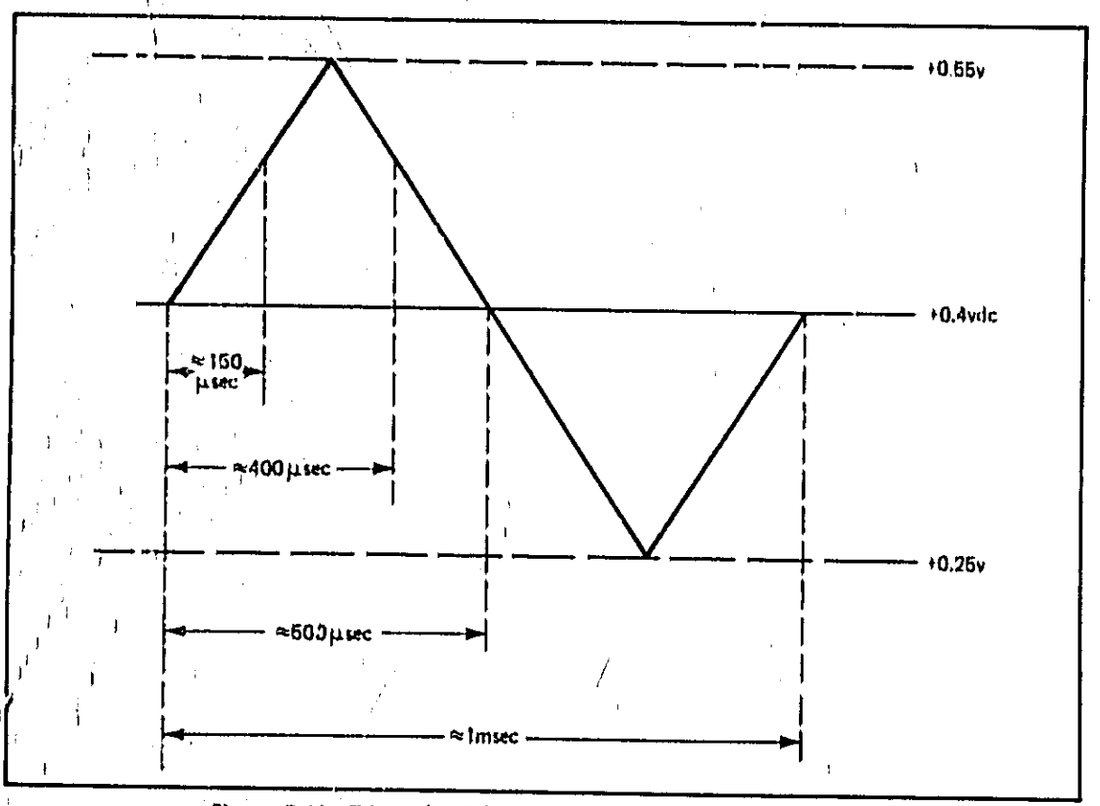


Figure 5-12. Triangular Pulse Observed in Steps 5 and 7, Table 5-9B

Table 5-10. HP 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 Out
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
RED	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
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

Table 5-10. HP 5328A A15 Qualifiers and Signal Mnemonics (Continued)

QUALIFIERS		
SIGNAL	**SOURCE**	**DESCRIPTION**
LS		Measurement does not have dimension of time. Output POS EXP
HS		Opposite of LS
HLTCH		Latch Data into U28, U33, or U34
LRMT		Go to Local
HRMT		Go to Remote
LD		Decimal Point has not been outputted
HD		Decimal Point has been outputted
LMB		Enable Time Base Code Latch Input, Module Select Code. Also used in putting out Exponent
HMB		Opposite of LMB
LMS		Enable Function and Time Base Code Latches Disable Module Strobe Line
HMS		Opposite of LMS
LDAV		HP 5328A says Data Not Valid
HDAV		HP 5328A says Data Valid
LRFD		HP 5328A says Not Ready for Data
HRFD		HP 5328A says Ready for Data
LDAC		HP 5328A says Data not Accepted
HDAC		HP 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 LDDIS
LINH		Inhibit Counter from Arming
LRST		Turn OFF Counter Mainframe Reset
HRST		Turn ON Counter Mainframe Reset
LSRQ		Output (on U15, U24) Binary 0 on ASCII Bus
HSRQ		Output (on U15, U24) Binary 64 on ASCII Bus
ASP		Output (on U15, U24) ASCII Space
LDAO		Output (on U15, U24) all HIGHS on Bus and Disarm DAC Line
HDAO		Output (on U15, U24) all HIGHS o Bus and Arm DAC Line. All succeeding bits put out on U15, U24 to be put on HP-IB as ASCII Characters.
ADIG		ASCII Digit from Display
ALF		ASCII Line Feed
A0		ASCII 0
ACR		ASCII Carriage Return
AE		ASCII E
ADP		ASCII Decimal Point
A3		ASCII 3
A6		ASCII 6
A9		ASCII 9
A+		ASCII +
A-		ASCII -
AOVE		ASCII Letter O

5-48. TROUBLESHOOTING INPUT CHANNELS

5-49. 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.

5-50. Local Mode Troubleshooting

5-51. Local Mode Troubleshooting consists of the troubleshooting flowchart in *Figure 13*. These flowcharts are intended to help isolate local operation problems.

5-52. The flowchart in *Figure 5-13* is intended for overall local operation troubleshooting. *Table 5-11* Relay Operation shows required levels, control lines, and the relay involved for any function. *Table 5-12* Relay Control Logic shows the output line and level required for proper relay operation in a function. These *Tables, 5-11 and 5-12*, are to be used with the Local Mode Troubleshooting Flowchart (Figure 5-13).

5-53. 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 A11 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 5-11. 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 5-12. Relay Control Logic

Function	Channel A	Channel B
Slope +	A10J3 Pin 2 Low	A10J3 Pin 5 Low
Slope −	A10 J3 Pin 2 High	A10J3 Pin 5 High
X1	A10J3 Pin 12 High	A10J3 Pin 6 High
Attn X10	A10J3 Pin 12 Low	A10J3 Pin 6 Low
X100	A10J3 Pin 13 High	A10J3 Pin 8 High
Coupling AC	A10J3 Pin 14 Low	A10J3 Pin 7 Low
Coupling DC	A10J3 Pin 14 High	A10J3 Pin 7 High
SEP, COM A	SEP A10J3 Pin 10 Low COM A A10J3 Pin 10 High	

5-54. Remote Mode Troubleshooting

5-55. 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.

Table 5-13. Program Interface Operation

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

5-56. Programming Logic Troubleshooting includes *Tables 5-13 and 5-14. Table 5-13* 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 5-14.*

5-57. DAC Troubleshooting includes a checkout procedure that does not require a programming source. *Table 5-15* DAC Logic Levels gives the required logic output levels for proper operation. The information in *Table 5-16* 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.

5-58. 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 A11 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 0V ±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 15.*

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 5-15* refer to B channel DAC circuit locations.

h. If the A and B channel DAC output voltages were the same as in *Table 5-15* the board is functioning correctly. If a digital output form *Table 5-15* 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 5-16.*

j. Pulse A11J1(14) and again using the oscilloscope check for signals in line 2 of *Table 5-16.*

k. Pulse A11J1(14) three more times, stopping after each pulse to verify the next line in *Table 5-16* 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 5-16.*

m. Refer to *Table 5-17* match the symptom received with the probable cause of trouble.

Table 5-15. 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 5-16. A11 DAC Signals

	TP3(4)	A11U2 Pin 8(6) Pin 9(5)	Anode CR5, CR6 (2, 4)	Cathode CR8, CR10 (1, 3)	TP5(6)
Reset Pulse U11 Pin 14	No Pulses	No Pulses	No Pulses	No Pulses	0,00± 3.05 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 5-17. A11 DAC Troubleshooting

Symptom	Probable Cause
Pulses wrong at TP4	U12, U13, or U14
Pulses wrong at TP3	U8, U9, or U10
Pulses wrong at U2 output	U2
Pulses wrong at drain of Q2	Q2, CR2, CR4, U1, or U3
Pulses wrong at drain of Q1	Q1, CR1, CR3, U1, or U3
Pulses wrong at drain of Q4	Q4, CR8, CR10, U4, or U3
Pulses wrong at drain of Q3	Q3, CR5, CR6, U4, or U3
If pulses at all points good	U4 for Channel A U1 for Channel B

5-59. REMOVAL AND REPLACEMENT INSTRUCTIONS

5-60. Removal and replacement instructions are provided for the instrument cover, the time interval module (assemblies A10 and A19) and A16 Display Assembly.

5-61. Instrument Cover Removal

5-62. 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.

5-63. Time Interval Module (Assemblies A10 and A19) Removal Replacement

5-64. 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.

5-65. A16 Display Assembly Removal and Replacement

5-66. 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 FREQ RESOLUTION switch control knob is removed or if the associated printed-circuit board switch is disassembled, the knob and switch must be aligned during replacement as described in the 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 FREQ A and set the knob of the FREQ RESOLUTION switch to 10^2 (10 kHz). .1 kHz position and tighten the two set screws on each knob with a suitable allen wrench.

5-67. Signature Analysis Troubleshooting A15

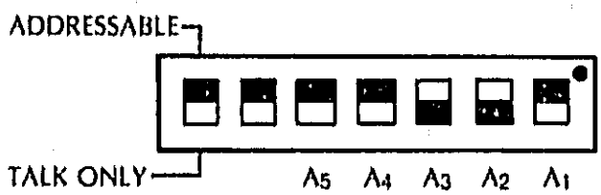
5-68. This procedure utilizing signature analysis as a troubleshooting tool for the A15 HP-IB assembly should be used after a failure has been detected with the 5328A HP-IB Verification program.

5-69. The 5328A Option 011 functional block diagram is divided into sections to help the technician understand and troubleshoot the A15 HP-IB assembly board. By observing the signatures at the sections output and input, a failure can be localized to a section level; then, within the section, the failure can be located to the component level. Signatures are provided in *Table 5-18*.

1. Remove power from 5328A.
2. Make sure that there is no cable attached to A15J6 (HP-IB connector).
3. Make only the following connections between A15W1 and A15J1:

A15W1 Pin #	to	A15J1 Pin #
21	→	21
24	→	24
27	→	27
28	→	28

4. Setup 5328A address switches as follows:



5. Connect A15U22(17) to ground, to provide for free-running condition.
6. Connect the 5004A Signature Analyzer POD connections as follows:

   CLOCK → A15U18(3)

   START/STOP → A15U23(15) (Not shown on schematic)

   GROUND → A15U18(7)

7. Set 5004A Signature Analyzer front panel switches as follows:

   START and STOP _____ ⌝_

   CLOCK _____ ⌟

NOTE

If an input/out of a given device is ACTIVE-LOW, then the 5004A front panel CLOCK switch must be ... ⌞

8. Apply power to 5328A.

NOTE

Because the preset counters (U14 and U23) have two functions: a) increment the ASM through all its address, and b) provide the jump-address when so instructed (U22(17) and U30C(8) are high), it is possible that they could have good signatures and still be the source of the problem, due to the fact that in "free-running" we are incrementing the addresses only. On those rare cases, refer to "Local Troubleshooting Flowchart" in the 5328A Option 001 Operating and Service Manual.

Table 5-18. HP 5328A A15 (05328-60043) Signatures

PIN #	U1	U2	U3	U4	U5	U6	U7	U8	U9	U10	PIN #
1		0000	HP43	A5PC	CC34	H418	72H6	0000	CC34	6577	1
2		80AH	H4C4	1PHU	H4C4	2P04	0000 5603 ↓	CC34	0000	CC34	2
3		CC34 ↓	6C84	HOCO	6U80	7248	0000 5603 ↓	6F76	U45C	HP43	3
4		0000	1PHU	6C84	CC34	4U6U	X	CC34	4U6U	5A72	4
5	PFU9	0000	F21F	6U80	6C84	COAO	CC34	CC34	0000	CC34	5
6		CC34 ↓	3425	H4C4	HOCO	489U	X	0000	CC34	P146	6
7		CC34 ↓	H9H2	0000	0000	92C7	X	A9C2	0000	0000	7
8		0000	0000	5A72	A5PC	0000	0000	0000	CC34	A9C2	8
9		3425	295A	P146	1PHU	U45C	0000	U94A	0000	1286	9
10		F21F	0000	F21F	CC34	0000	0000	0000	CC34	1286	10
11		1PHU	2AP5	7928	7928	U92U	0000	2AP5	0000	U94A	11
12		6C84	59H7	3425	F21F	59H7	72H6	59H7	0000 09CH ↓	427P	12
13		H4C4	U92U	8U11	CC34	2AP5	X	U92U	CC34 C289 ↓	427	13
14		6F76	6F3P	CC34	CC34	183A	CC34 UHUH ↓	6HPA	CC34	CC34	14
15		57PU	H70A			A30P		H6HP			15
16		CC34	CC34			CC34		CC34			16

NOTES:

1. X = Don't Care
2. ↓ = 5004A CLOCK switch must be in ⌐ (Negative edge)

Table 5-18. HP 5328A A13 (05328-60043) Signatures (Continued)

PIN #	U11	U12	U13	U14	U15	U16	U17	U19	U20	U21	PIN #
1	CC34	H70A	918F	CC34	36UF	CC34	CC34	U92U	7FPC	91H1	1
2	UOFC	H6HP	CC34 0000 ⌊	CC34	CC34	3425	CC34	59H7	7FPC	2AP5	2
3	0000 CC34 ⌊	6FC1	CC34 PH37 ⌊	J6UF	CC34	8U11	0000	2AP5	0000	P2P3	3
4	CC34	A30P	CC34 AAPF ⌊	H474	H474	CC34	14PA	U934	U45C	59H7	4
5	1PFC	72H6	CC34 UHUH ⌊	5F44	CC34	62P6	0000	6577	CC34	421C	5
6	A5UU	0000	P7H1 CC34 ⌊	8P2P	5F44	H9H2	CC34	427P	4U6U	U92U	6
7	0000	0000	P545 CC34 ⌊	CC34	8P2P	0000	0000	A9C2	0000	0000	7
8	CC34	0000	0000	0000	0000	CC34	0000	0000	9FUU	5A72	8
9	0000	0000	CC34 2CAA ⌊	CC34	5378	0000	CC34	FU6U	27FC	P146	9
10	CC34	0000	CC34 9AA5 ⌊	CC34	CC34 AAPF ⌊	3352	CC34	PFU9	27FC	5378	10
11	CC34	6U2A	CC34 C289 ⌊	5CPO	F21F	295A	1286	27FC	X	P84F	11
12	X	7U3H	CC34 P545 ⌊	P5PH	CC34	CC34	A9C2	F7HU	X	0000	12
13	CC34 9AA5 ⌊	918F	CC34 P7H1 ⌊	725C	1PHU	926P	CC34	5378	U45C	CC34	13
14	CC34	4CUU	7U3H	96PF	6C84	CC34	CC34	CC34 P545 ⌊	CC34	CC34	14
15		UOFC	6U2A	826P	H4C4			CC34			15
16		CC34	CC34	CC34	CC34			CC34			16

NOTES:

1. X = Don't Care
2. ⌊ = 5004A CLOCK switch must be in ⌐_ (Negative edge).

Table 5-18. HP 5326A A15 (05328-60043) Signatures (Continued)

PIN #	U23	U24	U25	U26	U27	U28	U29	U30	U31	U32	U33	U34	PIN #
1	CC34	8U11	0000	U92U	U45C	4U6U	0000 09CH ⌐	0000 CC34 ⌐	CC34	U934	6C84	4U6U	1
2	CC34	967U	U687	59H7	96P9	0000	92C7 P832 ⌐	CC34	CC34	CC34	1PHU	0000	2
3	967U	3F88	CC34	2AP5	0000	0000	CC34 684F ⌐	CC34 0000 ⌐	CC34 0000 ⌐	0000	F21F	4U6U	3
4	3F88	0000 11H8 ⌐	0000 09CH ⌐	H41B	U45C	0000	27FC 82FC ⌐	CC34	CC34	CC34	0000	4U6U	4
5	b11C	CC34	U934	9530	0000 PF8C ⌐	0000	CC34 UHUH ⌐	CC34 PH37 ⌐	CC34	71C4	0000	0000	5
6	67CO	B11C	CC34 8666 ⌐	7248	0000	0000	9FUU 39UU ⌐	0000 5603 ⌐	0000	0000	0000 H22C ⌐	0000	6
7	B26P	67CO	0000	71C4	0000	CC34 C289 ⌐	0000	0000	0000	0000	0000	CC34 C289 ⌐	7
8	0000	AUHP	CC34 0000 ⌐	0000	0000	0000	U45C	U687	4U6U	0000	0000	0000	8
9	CC34	14PA	0000 CC34 ⌐	COAO	U45C	92C7	CC34	A5UU	U45C	0000 H22C ⌐	0000	92C7 P832 ⌐	9
10	CC34	926P	CC34	489U	0000	489U	4U6U	5378	CC34	0000	0000 PF8C ⌐	COAO	10
11	6PCP	295A	0000	92C7	7FPC	CC34	CC34	0000 11H8 ⌐	CC34 2CAA ⌐	U92U	96P9	F21F	11
12	77F7	0000	CC34	P146	CC34	1PHU	CC34	CC34	5378	59H7	0000	1PHU	12
13	B5PA	0000 11H8 ⌐	CC34	5378	F7HU	6C84	0000	CC34 AAPF ⌐	CC34	2AP5	H4C4	6C84	13
14	7P25	H9H2	CC34	CC34 P7H1 ⌐	CC34	H4C4	CC34	CC34	CC34	H785	CC34 8666 ⌐	H4C4	14
15	UP73	62P6		CC34		P146				6FC1	5A72	P146	15
16	CC34	3425		CC34		CC34				CC34	CC34	CC34	16

NOTES:

1. X = Don't Care
2. ⌐ = 5004A CLOCK switch must be in ⌐ (Negative edge)

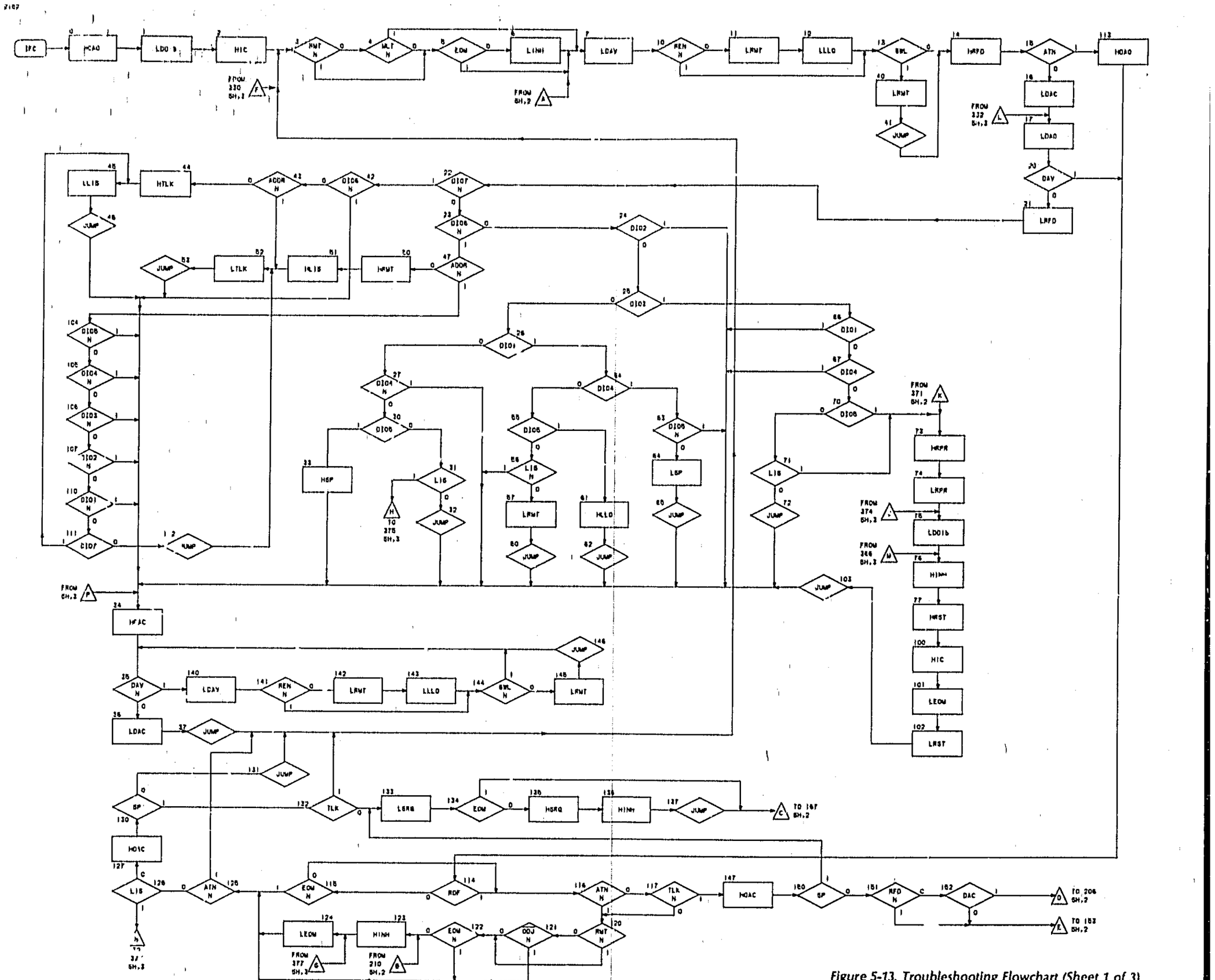


Figure 5-13. Troubleshooting Flowchart (Sheet 1 of 3)

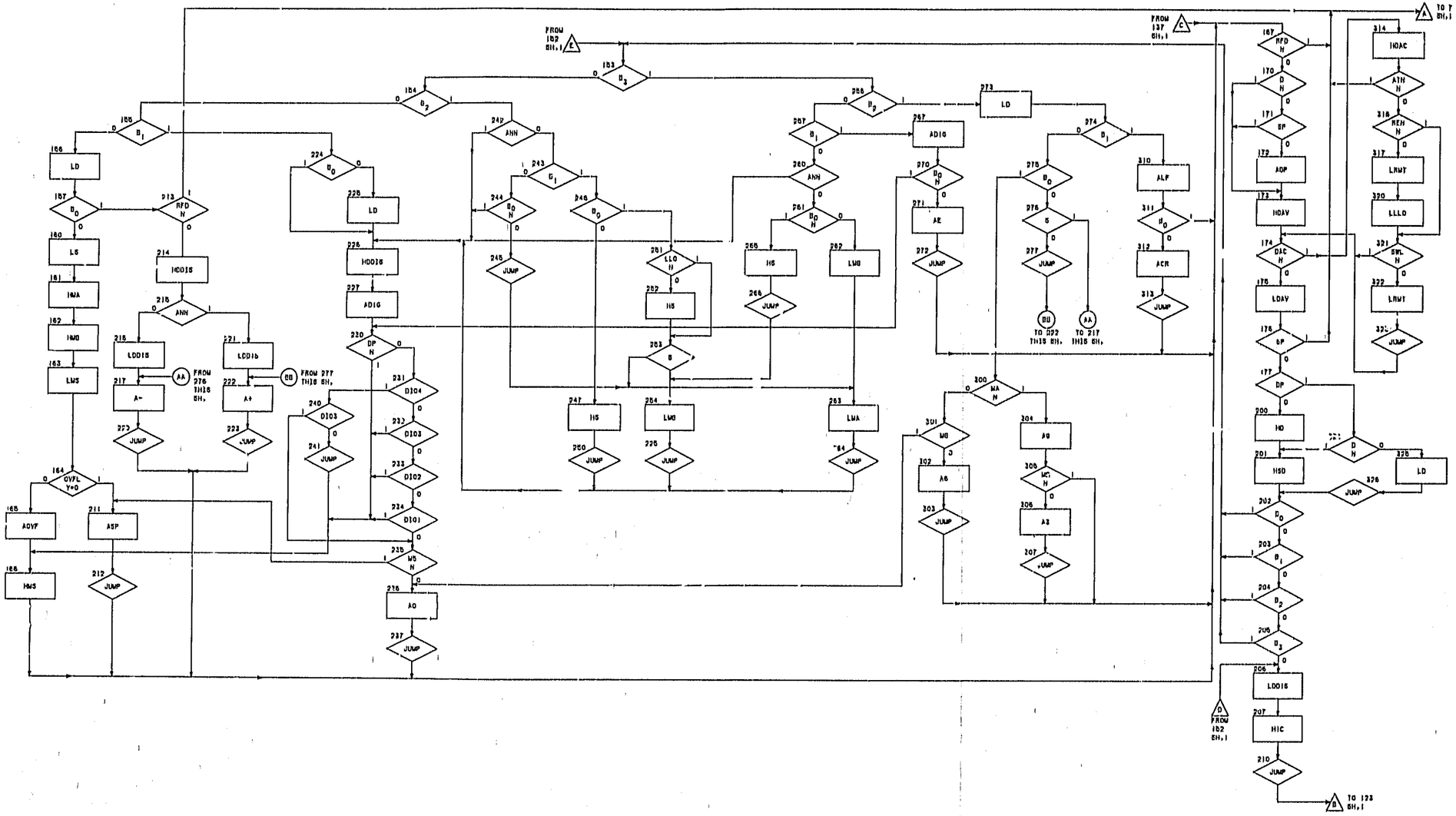


Figure 5-13. Troubleshooting Flowchart (Sheet 2 of 3)

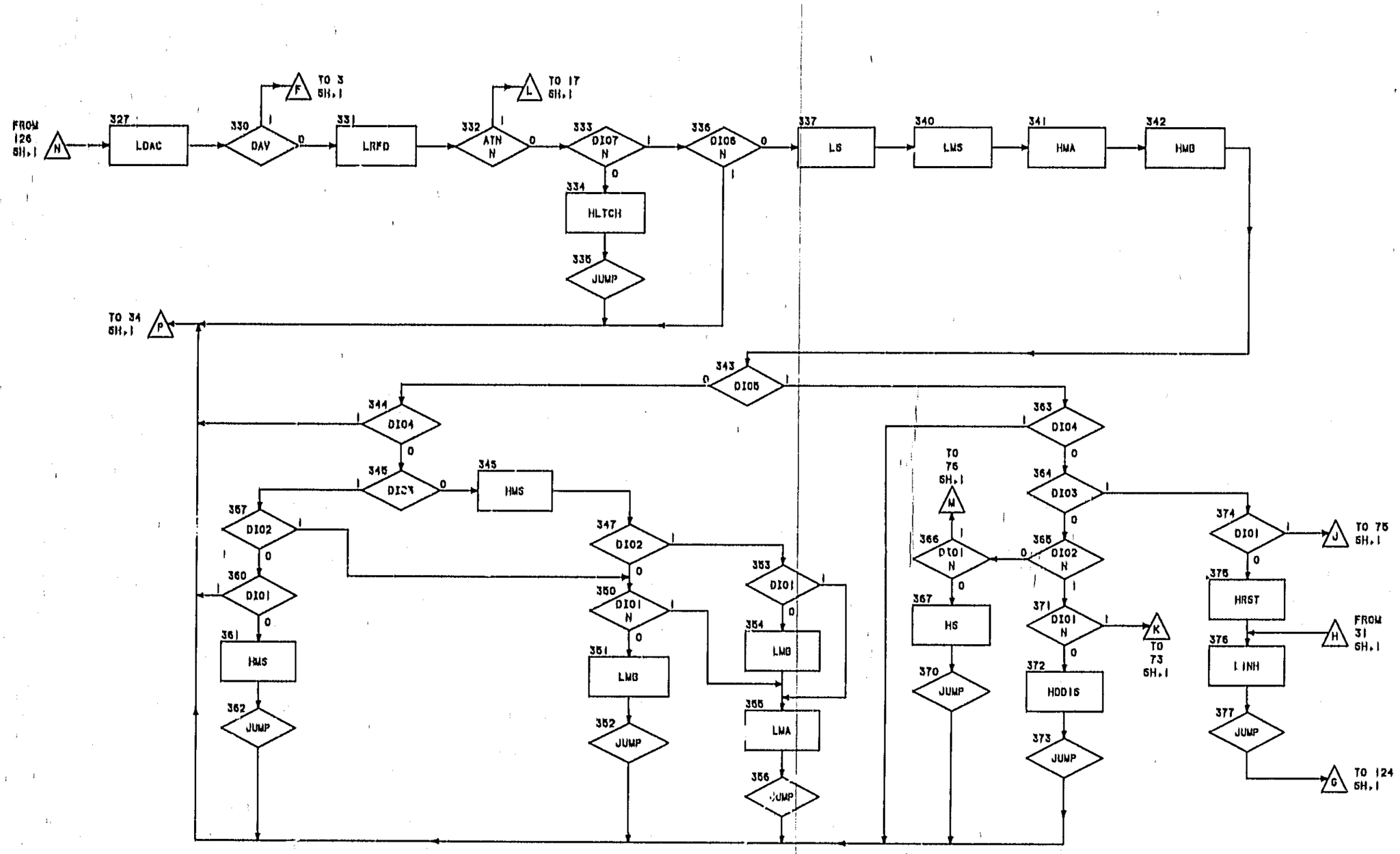
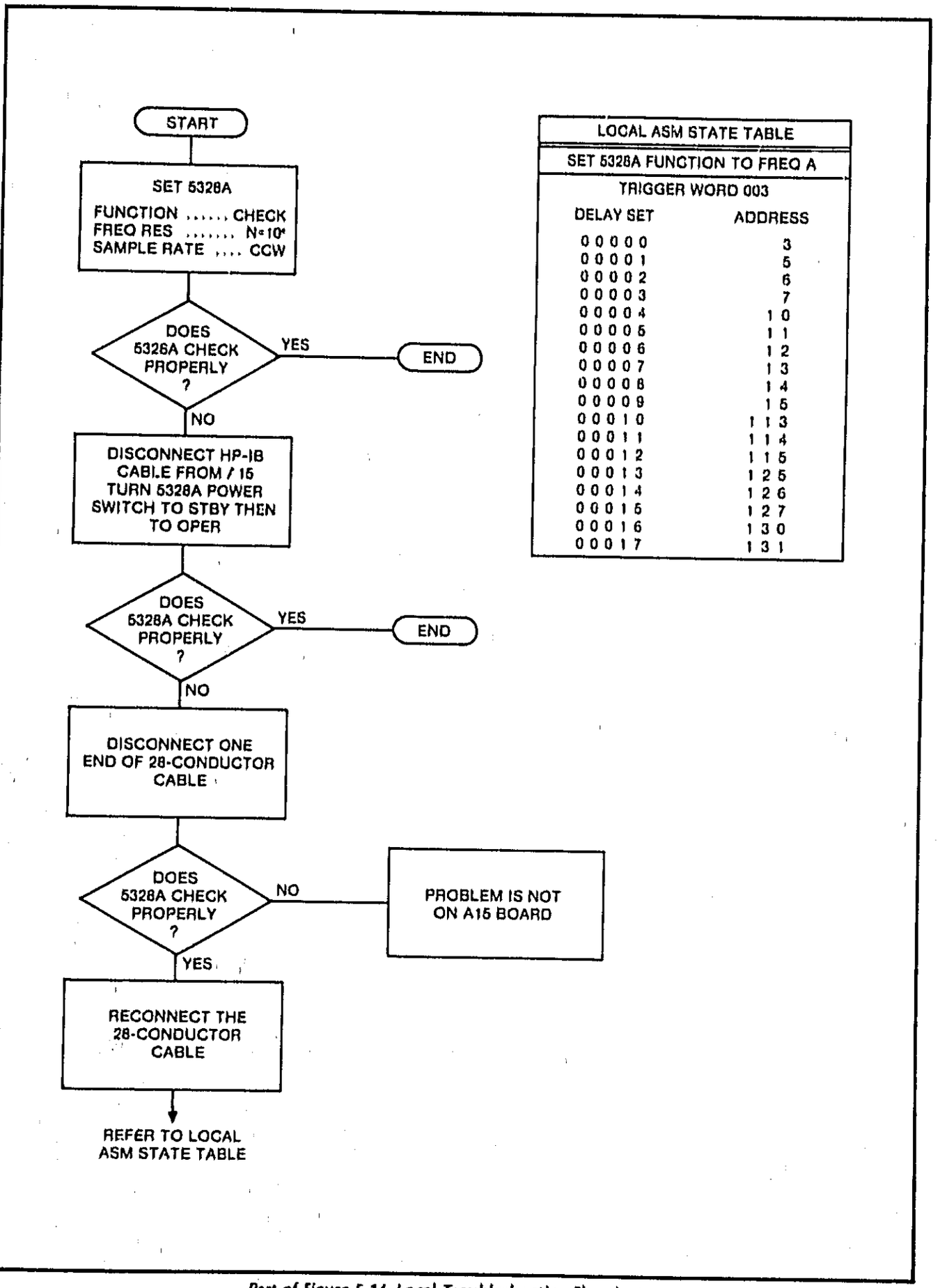


Figure 5-13. Troubleshooting Flowchart (Sheet 3 of 3)



LOCAL ASM STATE TABLE

SET 5328A FUNCTION TO FREQ A

TRIGGER WORD 003

DELAY SET	ADDRESS
00000	3
00001	5
00002	6
00003	7
00004	10
00005	11
00006	12
00007	13
00008	14
00009	15
00010	113
00011	114
00012	115
00013	125
00014	126
00015	127
00016	130
00017	131

Part of Figure 5-14. Local Troubleshooting Flowchart

OPTION 030 FREQUENCY C TROUBLESHOOTING FLOWCHART

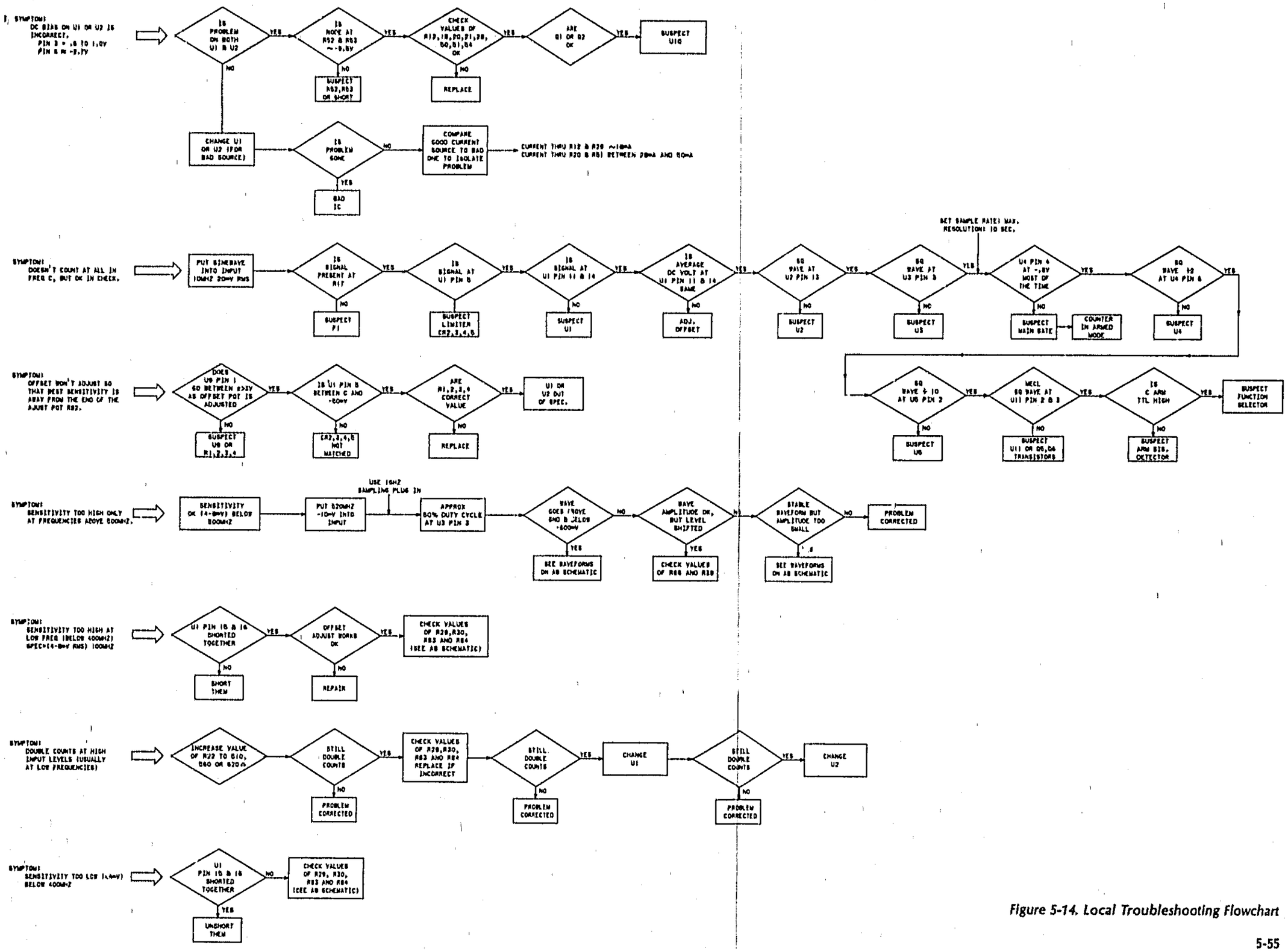


Figure 5-14. Local Troubleshooting Flowchart

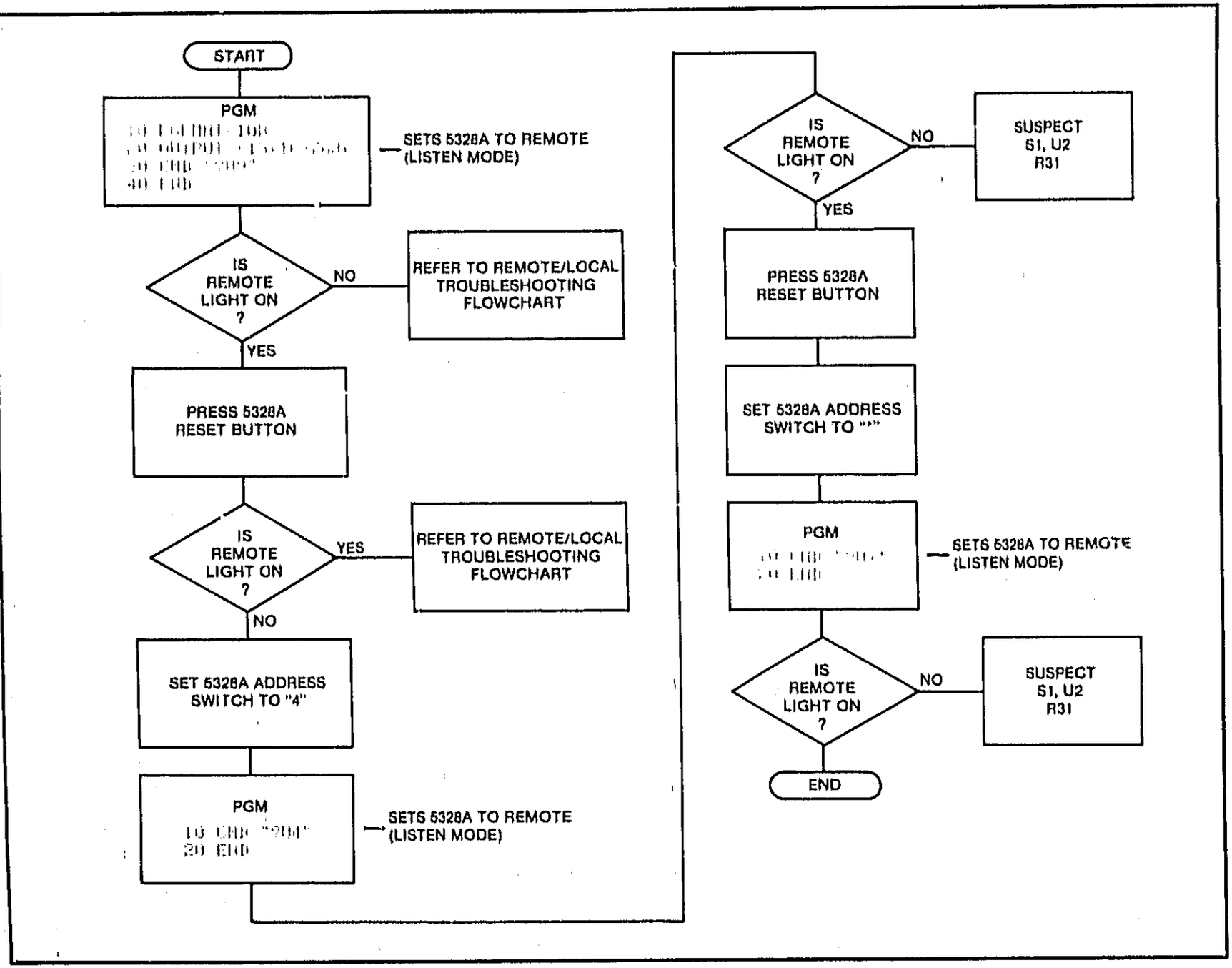


Figure 5-15. Address Switch Troubleshooting Flowchart

PARTS LIST

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION

6-2. This section contains information for ordering replacement parts. *Table 6-1* lists abbreviations used in the parts lists, schematics, and throughout the manual. *Table 6-2* 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 in *Table 6-3*.

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.

e. Check digit.

f. Quantity required.

Table 6-1. Abbreviations and Reference Designations

REFERENCE DESIGNATIONS

A	= assembly
AT	= attenuator, isolator, termination
B	= fan; motor
BT	= battery
C	= capacitor
CP	= coupler
CR	= diode, diode thyristor, varactor
DC	= directional coupler
DL	= delay line
DS	= annunciator; signaling device (audible or visual); lamp; LED
E	= miscellaneous electrical part
F	= fuse
FL	= filter
H	= hardware
HY	= circulator
J	= electrical connector (stationary portion); jack
K	= relay
L	= coil; inductor
M	= metal
MP	= miscellaneous mechanical part
P	= electrical connector (movable portion); plug
Q	= transistor; SCR; triode thyristor
R	= resistor
RT	= thermistor
S	= switch
T	= transformer
TB	= terminal board
TC	= thermocouple
TP	= test point
U	= integrated circuit, microcircuit
V	= electron tube
VR	= voltage regulator, breakdown diode
W	= cable, transmission path, wire
X	= socket
Y	= crystal unit-piezo-electric
Z	= tuned cavity, tuned circuit

ABBREVIATIONS

A	= ampere
ac	= alternating current
ACCESS	= accessory
ADJ	= adjustment
A/D	= analog-to-digital
AF	= audio frequency
AFC	= automatic frequency control
AGC	= automatic gain control
AL	= aluminum
ALC	= automatic level control
AM	= amplitude modulation
AMPL	= amplifier
APC	= automatic phase control
ASSY	= assembly
AUX	= auxiliary
AVG	= average
AWG	= american wire gauge
BAL	= balance
BCD	= binary coded decimal
BD	= board
BE CU	= beryllium copper
BFO	= beat frequency oscillator
BH	= binder head
BKDN	= breakdown
BP	= bandpass
BPF	= bandpass filter
BRS	= brass
BWO	= backward-wave oscillator
CAL	= calibrate
CCW	= counterclockwise
CER	= ceramic
CHAN	= channel
cm	= centimeter
CMO	= coaxial
COEF	= coefficient
COM	= common
COMP	= composition
COMPL	= complete
CONN	= connector
CP	= cadmium plate
CRT	= cathode-ray tube
CTL	= complementary translator logic
CW	= continuous wave
cw	= clockwise
D/A	= digital-to-analog
dB	= decibel
dBm	= decibel referred to 1 mW
dc	= direct current
deg	= degree (temperature interval or difference)
°	= degree (plane angle)
°C	= degree Celsius (centigrade)
°F	= degree Fahrenheit
°K	= degree Kelvin
DEPC	= deposited carbon
DET	= detector
diam	= diameter
DIA	= diameter (used in parts list)
DIFF AMPL	= differential amplifier
div	= division
DPDT	= double-pole, double-throw
DR	= drive
DSB	= double sideband
DTL	= diode translator logic
DVM	= digital voltmeter
ECL	= emitter coupled logic
EMF	= electromotive force
EDP	= electronic data processing
ELECT	= electrolytic
ENCAP	= encapsulated
EXT	= external
F	= farad
FET	= field-effect transistor
F/F	= flip-flop
FH	= flat head
FIL H	= fillister head
FM	= frequency modulation
FP	= front panel
FREQ	= frequency
FXD	= fixed
g	= gram
GE	= germanium
GHz	= gigahertz
GL	= glass
GND	= ground(ed)
H	= henry
h	= hour
HET	= heterodyne
HEX	= hexagonal
HD	= head
HDW	= hardware
HF	= high frequency
HG	= mercury
HI	= high
HP	= Hewlett-Packard
HPF	= high pass filter
HR	= hour (used in parts list)
HV	= high voltage
Hz	= hertz
IC	= integrated circuit
ID	= inside diameter
IF	= intermediate frequency
IMPG	= impregnated
in	= inch
INCD	= incandescent
INCL	= include(s)
INP	= input
INS	= insulation
INT	= internal
kg	= kilogram
kHz	= kilohertz
kΩ	= kilohm
kV	= kilovolt
lb	= pound
LC	= inductance-capacitance
LED	= light-emitting diode
LF	= low frequency
LG	= long
LH	= left hand
LIM	= limit
LIN	= linear taper (used in parts list)
lin	= linear
LK WASH	= lockwasher
LO	= low; local oscillator
LOG	= logarithmic taper (used in parts list)
log	= logarithmic
LPF	= low pass filter
LV	= low voltage
m	= metre (distance)
mA	= milliampere
MAX	= maximum
MΩ	= megohm
MEG	= meg (10⁶) (used in parts list)
MET FLM	= metal film
MET OX	= metal oxide
MF	= medium frequency; microfarad (used in parts list)
MFR	= manufacturer
mg	= milligram
MHz	= megahertz
mH	= millihenry
mho	= conductance
MIN	= minimum
min	= minute (time)
′	= minute (plane angle)
MINAT	= miniature
mm	= millimetre
MOD	= modulator
MOM	= momentary
MOS	= metal-oxide semiconductor
ms	= millisecond
MTG	= mounting
MTR	= meter (indicating device)
mV	= millivolt
mVac	= millivolt, ac
mVdc	= millivolt, dc
mVpk	= millivolt, peak
mVp-p	= millivolt, peak-to-peak
mVrms	= millivolt, rms
mW	= milliwatt
MUX	= multiplex
MY	= mylar
μA	= microampere
μF	= microfarad
μH	= microhenry
μmho	= micromho
μs	= microsecond
μV	= microvolt
μVac	= microvolt, ac
μVdc	= microvolt, dc
μVpk	= microvolt, peak
μVp-p	= microvolt, peak-to-peak
μVrms	= microvolt, rms
μW	= microwatt
nA	= nanoampere
NC	= no connection
N/C	= normally closed
NE	= neon
NEG	= negative
NF	= nanofarad
NI PL	= nickel plate
N/O	= normally open
NOM	= nominal
NORM	= normal
NPN	= negative-positive-negative
NPO	= negative-positive zero (zero temperature coefficient)
NRFR	= not recommended for field replacement
ns	= nanosecond
NSR	= not separately replaceable
nW	= nanowatt
OBD	= order by description
OD	= outside diameter
OH	= oval head
OP AMPL	= operational amplifier
OPT	= option
OSC	= oscillator
OX	= oxide
oz	= ounce
Ω	= ohm
P	= peak (used in parts list)
PAM	= pulse-amplitude modulation
PC	= printed circuit
PCM	= pulse-code modulation; pulse-count modulation
PDM	= pulse-duration modulation
pF	= picofarad
PH BRZ	= phosphor bronze
PHL	= phillips
PIN	= positive-intrinsic-negative
PIV	= peak inverse voltage
pk	= peak
PL	= phase lock
PLO	= phase lock oscillator
PM	= phase modulation
PNP	= positive-negative-positive
P/O	= part of
POLY	= polystyrene
PORC	= porcelain
POS	= positive; position(al) (used in parts list)
POSN	= position
POT	= potentiometer
p-p	= peak-to-peak
PP	= peak-to-peak (used in parts list)
PPM	= pulse-position modulation
PREAMPL	= preamplifier
PRF	= pulse-repetition frequency
PRR	= pulse repetition rate
ps	= picosecond
PT	= point
PTM	= pulse-time modulation
PWM	= pulse-width modulation
PWV	= peak working voltage
RC	= resistance-capacitance
RECT	= rectifier
REF	= reference
REG	= regulated
REPL	= replaceable
RF	= radio frequency
RFI	= radio frequency interference
RH	= round head, right hand
RLC	= resistance-inductance-capacitance
RMO	= rack mount only
rms	= root-mean-square
RND	= round
ROM	= read-only memory
R&P	= rack and panel
RWV	= reverse working voltage
S	= scattering parameter
s	= second (time)
″	= second (plane angle)
S-B	= slow-blow fuse (used in parts list)
SCR	= silicon controlled rectifier; screw
SE	= selenium
SECT	= sections
SEMICON	= semiconductor
SHF	= superhigh frequency
SI	= silicon
SIL	= silver
SL	= slide
SNR	= signal-to-noise ratio
SPDT	= single-pole, double-throw
SPG	= spring
SR	= split ring
SPST	= single-pole, single-throw
SSB	= single sideband
SST	= stainless steel
STL	= steel
SQ	= square
SWR	= standing-wave ratio
SYNC	= synchronize
T	= time (slow-blow fuse)
TA	= tantalum
TC	= temperature compensating
TD	= time delay
TERM	= terminal
TFT	= thin-film transistor
TGL	= toggle
THD	= thread
THRU	= through
TI	= titanium
TOL	= tolerance
TRIM	= trimmer
TSTR	= transistor
TTL	= transistor-transistor logic
TV	= television
TVI	= television interference
TWT	= traveling wave tube
U	= micro (10⁻⁶) (used in parts list)
UF	= microfarad (used in parts list)
UHF	= ultrahigh frequency
UNREG	= unregulated
V	= volt
VA	= voltampere
Vac	= volts ac
VAR	= variable
VCO	= voltage-controlled oscillator
Vdc	= volts dc
VF/CW	= volts, dc, working (used in parts list)
VF)	= volts, filtered
VFO	= variable-frequency oscillator
VHF	= very-high frequency
Vpk	= volts peak
Vp-p	= volts peak-to-peak
Vrms	= volts rms
VSWR	= voltage standing wave ratio
VTO	= voltage-tuned oscillator
VTVM	= vacuum-tube voltmeter
V(S)	= volts, switched
W	= watt
W	= with
W/PIV	= working inverse voltage
WW	= wirewound
W/O	= without
YIG	= yttrium-iron-garnet
Zo	= characteristic impedance

NOTE

All abbreviations in the parts list will be in upper case.

MULTIPLIERS

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

6-5. HP PART NUMBER ORGANIZATION

6-6. The 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-	Crystals
0410-	Crystals
0470-	Adhesives
0490-	Relays
0510-	Fasteners
0674- through 0778-	Resistors, Fixed (non-wire wound)
0811- through 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- through 1912-	Diodes
1920- through 1952-	Vacuum Tubes
1990-	Semiconductor Photosensitive and Light-Emitting Diodes
3100- through 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:

Type of Part	Prefix
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 indicate the type of parts. For example, 05328-60001 is an assembly used in the 5328A. Following is a list of suffixes commonly used.

Type of Part	P/N Suffix
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.

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1	05328-60048	0	1	MOTHERBOARD (MAIN), SERIES 0424	28480	05328-60048
A1C1				NOT ASSIGNED		
A1C2				NOT ASSIGNED		
A1C3	0180-0180	3	1	CAPACITOR-FXD 4.7UF+-10% 35VDC TA	56289	150D475X9035B2
A1C4	0160-0161	4	2	CAPACITOR-FXD .01UF +-10% 200VDC POLYE	28480	0160-0161
A1C5*	0180-0184	9	3	CAPACITOR-FXD 68UF+-20% 6VDC TA	56289	150D686X0006B2
A1C6	0140-0177	0	1	CAPACITOR-FXD 460PF +-1% 300VDC MICA	72136	DM15F461F0300WV1CR
A1C7	0170-0024	4	2	CAPACITOR-FXD .022UF +-20% 200VDC POLYE	28480	0170-0024
A1C8	0180-0192	6	1	CAPACITOR-FXD .33UF+-20% 35VDC TA	56289	150D334X0035A2
A1C10	0160-0314	9	1	CAPACITOR-FXD .01UF +-5% 400VDC POLYE	04411	663UW10354MP
A1C29	0180-0238	0	2	CAPACITOR-FXD 1UF+-20% 50VDC TA	56289	150D105X0050A2
A1C30	0176-0153	4	1	CAPACITOR-FXD 1000PF +-10% 200VDC POLYE	28480	0180-0153
A1C31	0180-0238	0		CAPACITOR-FXD 1UF+-20% 50VDC TA	56289	150D105X0050B2
A1C32	0180-0184	9		CAPACITOR-FXD 68UF+-20% 6VDC TA	56289	150D686X0006B2
A1C33	0160-4554	7	7	CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C34	0180-0210	6	6	CAPACITOR-FXD 3.3UF+-20% 15VDC TA	56289	150D335X0015A2
A1C35	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C36	0180-0210	6		CAPACITOR-FXD 3.3UF+-20% 15VDC TA	56289	150D335X0015A2
A1C37	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C39	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C40	0180-0155	8	6	CAPACITOR-FXD 2.2UF+-20% 20VDC TA	56289	150D225X0020A2
A1C41	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C42	0180-0155	8		CAPACITOR-FXD 2.2UF+-20% 20VDC TA	56289	150D225X0020A2
A1C43	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50 VDC CER	28480	0160-4554
A1C44	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C45	0180-0210	6		CAPACITOR-FXD 3.3UF+-20% 15VDC TA	56289	150D335X0015A2
A1C46	0180-0210	6		CAPACITOR-FXD 3.3UF+-20% 15VDC TA	56289	150D335X0015A2
A1C47				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
A1C54	0180-0116	1	2	CAPACITOR-FXD 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A1CR1				NOT ASSIGNED		
A1CR3	1910-0016	0	9	DIODE-GE 60V 60MA 1US DO-7	28480	1910-0016
A1CR4				NOT ASSIGNED		
A1CR5	1901-0050	3	6	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	55	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1CR8	1902-3082	9	4	DIODE ZNR 4.64V 5% DO-35 PD=.4W	28480	1902-3082
A1CR9	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1CR10	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1CR11	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1CR12	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1CR13	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1CR14	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1CR15	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
A1CR21	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1M1	1010-0071	0	1	5,000 ELAPSED TIME METER		T-000-4
A1Q1	1854-0071	7	10	TRANSISTOR NPN SI PD=300MW FT=250MHZ	28480	1854-0071
A1Q4	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=250MHZ	28480	1854-0071
A1Q5	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=250MHZ	28480	1854-0071
A1Q6	1854-0092	2	5	TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A1Q7	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=250MHZ	28480	1854-0071
A1Q11	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=250MHZ	28480	1854-0071
A1Q10	0053-0036	1	1	LUG-THERMOCOUPLE ALUMEL	27907	TLAL-20
A1R1	0698-3444	1	1	RESISTOR 31.6 1% .125W F TC=0+-100	24546	C4-1/8-T0-31R6-F
A1R2	1810-0055	5	10	NETWORK-RES 9-SIP10.0K OHM X 8	28480	1810-0055
A1R3	0683-2725	0	5	RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A1R4*	0683-3355	2	1	RESISTOR 3.3M 5% .25W FC TC=-900/+1300	01121	CB3355
A1R5	1810-0055	5		NETWORK-RES 9-SIP10.0K OHM X 8	28480	1810-0055
A1R6	660 -.15	4	11	RESISTOR 330 5% .25W FC TC=-400/+600	01121	CB3315
A1R7	666 -.035	1	50	RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R8	0683-4725	2	11	RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A1R9	0683-1525	4		RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	CB1525
A1R10	0683-1025	9	27	RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A1R11	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A1R12	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A1R13	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R14	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A1R15	1810-0041	9	2	NETWORK-RES 9-SIP2.7K OHM X 8	28480	1810-0041

See introduction to this section for ordering information
*Indicates factory selected value

Table 6-2. Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1R16				NOT ASSIGNED		
A1R17	0683-1035	1		RESISTOR 10K 5% ,25W FC TC=-400/+700	01121	CB1035
A1R19	1810-0055	5		NETWORK-RES 9-SIP10,0K OHM X B	28480	1810-0055
A1R23	0683-2015	9	5	RESISTOR 200 5% ,25W FC TC=-400/+600	01121	CB2015
A1R27	0683-1225	1	2	RESISTOR 1.2K 5% ,25W FC TC=-400/+700	01121	CB1225
A1R28	1810-0055	5		NETWORK-RES 9-SIP10,0K OHM X B	28480	1810-0055
A1R29	0757-0952	6	1	RESISTOR 15K 2% ,125W F TC=0+-100	24546	C4-1/8-T0-1502-G
A1R30	0683-1035	1		RESISTOR 10K 5% ,25W FC TC=-400/+700	01121	CB1035
A1R32	0683-1035	1		RESISTOR 10K 5% ,25W FC TC=-400/+700	01121	CB1035
A1R33	0683-1035	1		RESISTOR 10K 5% ,25W FC TC=-400/+700	01121	CB1035
A1R34	0683-2715	6	12	RESISTOR 270 5% ,25W FC TC=-400/+600	01121	CB2715
A1R35	0683-5115	6	17	RESISTOR 510 5% ,25W FC TC=-400/+600	01121	CB5115
A1R36	0683-1035	1		RESISTOR 10K 5% ,25W FC TC=-400/+700	01121	CB1035
A1R37	0683-2715	6		RESISTOR 270 5% ,25W FC TC=-400/+600	01121	CB2715
A1R38	0683-1035	1		RESISTOR 10K 5% ,25W FC TC=-400/+700	01121	CB1035
A1R39	0683-1035	1		RESISTOR 10K 5% ,25W FC TC=-400/+700	01121	CB1035
A1R40	0683-1035	1		RESISTOR 10K 5% ,25W FC TC=-400/+700	01121	CB1035
A1R41	0683-1035	1		RESISTOR 10K 5% ,25W FC TC=-400/+700	01121	CB1035
A1R42	1810-0055	5		NETWORK-RES 9-SIP10,0K OHM X B	28480	1810-0055
A1R43	0683-1025	9		RESISTOR 1K 5% ,25W FC TC=-400/+600	01121	CB1025
A1R44	0683-1035	1		RESISTOR 10K 5% ,25W FC TC=-400/+700	01121	CB1035
A1R45	0683-1035	1		RESISTOR 10K 5% ,25W FC TC=-400/+700	01121	CB1035
A1R46	0683-1545	0	1	RESISTOR 150K 5% ,25W FC TC=-800/+900	01121	CB1545
A1R48	0683-1035	1		RESISTOR 10K 5% ,25W FC TC=-400/+700	01121	CB1035
A1R50	0683-5635	5	1	RESISTOR 56K 5% ,25W FC TC=-400/+800	01121	CB5635
A1R55	0683-1025	9		RESISTOR 1K 5% ,25W FC TC=-400/+600	01121	CB1025
A1R56	0683-4725	2		RESISTOR 4.7K 5% ,25W FC TC=-400/+700	01121	CB4725
A1R57	0683-6815	5	6	RESISTOR 680 5% ,25W FC TC=-400/+600	01121	CB6815
A1R58	0683-1025	9		RESISTOR 1K 5% ,25W FC TC=-400/+600	01121	CB1025
A1R59	0683-5605	9	9	RESISTOR 56 5% ,25W FC TC=-400/+500	01121	CB5605
A1R60	0683-5605	9		RESISTOR 56 5% ,25W FC TC=-400/+500	01121	CB5605
A1R61	0683-5605	9		RESISTOR 56 5% ,25W FC TC=-400/+500	01121	CB5605
A1R62	0683-5605	9		RESISTOR 56 5% ,25W FC TC=-400/+500	01121	CB5605
A1R63	0683-5605	9		RESISTOR 56 5% ,25W FC TC=-400/+500	01121	CB5605
A1R64	0683-5605	9		RESISTOR 56 5% ,25W FC TC=-400/+500	01121	CB5605
A1R65	0683-5605	9		RESISTOR 56 5% ,25W FC TC=-400/+500	01121	CB5605
A1R66	0683-5605	9		RESISTOR 56 5% ,25W FC TC=-400/+500	01121	CB5605
A1R67	0683-5605	9		RESISTOR 56 5% ,25W FC TC=-400/+500	01121	CB5605
A1R68	0683-1035	1		RESISTOR 10K 5% ,25W FC TC=-400/+700	01121	CB1035
A1R69	0757-0935	5	1	RESISTOR 3K 2% ,125W F TC=0+-100	24546	C4-1/8-T0-3001-G
A1R70	0757-0959	4	1	RESISTOR 12K 2% ,125W F TC=0+-100	24546	C4-1/8-T0-1202-G
A1R71	0757-0779	0	2	RESISTOR 3.16K 1% ,125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A1R72	0757-0941	1	3	RESISTOR 2K 2% ,125W F TC=0+-100	24546	C4-1/8-T0-2001-G
A1R73	0683-1035	1		RESISTOR 10K 5% ,25W FC TC=-400/+700	01121	CB1035
A1R74	0683-1035	1		RESISTOR 10K 5% ,25W FC TC=-400/+700	01121	CB1035
A1R75	0683-1035	1		RESISTOR 10K 5% ,25W FC TC=-400/+700	01121	CB1035
A1R76	0698-3441	8	2	RESISTOR 215 1% ,125W F TC=0+-100	24546	C4-1/8-T0-215R-F
A1R78	0683-4315	6	7	RESISTOR 430 5% ,25W FC TC=-400/+600	01121	CB4315
A1R80	0683-1035	1		RESISTOR 10K 5% ,25W FC TC=-400/+700	01121	CB1035
A1R82	0683-0625	9	1	RESISTOR-FXD 6.0K 5% ,25W	28480	0683-0625
A1R83	0698-4037	8	1	RESISTOR 46.4 1% ,125W F TC=0+-100	24546	C4-1/8-T0-46R4-F
A1R84	0757-0422	5	1	RESISTOR 909 1% ,125W F TC=0+-100	24546	C4-1/8-T0-9090-F
A1R85	0698-7236	7	0	RESISTOR 1K 1% ,05W F TC=0+-100	24546	C3-1/8-T0-1001-F
A1R86	0698-4087	9	1	RESISTOR 1.07M 1% .5W F TC=0+100	01074	K8479
A1B1				NOT ASSIGNED		
A1B2				NOT ASSIGNED		
A1S3	3101-1977	1	1	SWITCH-SL DPDT SUBMIN ,5A 125VAC PC	28480	3101-1977
A1U1	1820-0856	6	2	IC CNTR TTL DECD SYNCHRO POS-EDGE-TRIG	01295	SN7490AN
A1U2	1820-1056	9	1	IC SCHMITT-TRIG TTL NAND QUAD 2-INP	01295	SN74132N
A1U3	1820-0175	1	1	IC INV TTL HEX 1-INP	01295	SN7405N
A1U4*	1820-0632	5	1	IC MISC	28480	1820-0632
A1U4	1820-1401	8	1	IC MISC	28480	1820-1401
A1U5	1820-0513	1	2	IC GATE TTL AND QUAD 2-INP	01295	SN7409N
A1U6	1820-0202	1	4	IC GATE TTL EXCL-OR QUAD 2-INP	01295	SN7486N
A1U7	1820-0511	9	1	IC GATE TTL AND QUAD 2-INP	01295	SN7408N
A1U8	1820-0174	0	6	IC INV TTL HEX	01295	SN7404N
A1U9	1820-0661	0	2	IC GATE TTL OR QUAD 2-INP	01295	SN7432N
A1U10	1820-0632	6	1	IC MISC PROG	28480	1820-0633
A1U11	1820-0513	6	6	IC GATE TTL	01295	SN20573
A1U12	1820-3237	7	1	IC CNTR QUAD 2 INPUT DECD	01295	SN74ALS1623
A1U13				NOT ASSIGNED		
A1U14	1820-1442	7		IC GATE TTL DECD ASYNC	01295	SN67203
A1U16	1820-0537	9	1	IC SCHMITT-TRIG TTL NAND DUAL 4-INP	01295	SN7413N
A1U17	1820-0060	1	1	IC GATE TTL NAND HEX 3-INP	01295	SN7410N
A1U18	1820-0174	0		IC INV TTL HEX	01295	SN7404N
A1U19	1820-0877	2	1	IC FF TTL D-TYPE POS-EDGE-TRIG CLEAR	01295	SN7474N
A1U20	1820-0856	6		IC CNTR TTL DECD SYNCHRO POS-EDGE-TRIG	01295	SN7490AN

See introduction to this section for ordering information
*Indicates factory selected value

Table 6-2. Replaceable Parts (Continued)

Reference Designation	HP Part Number	CD	Qty	Description	Mfr Code	Mfr Part Number
A1U21	1820-2317	5	1	IC CNTR BIPOLAR DECD	26480	1080-0101
A1U22	1820-0849	A		IC GATE TTL NAND QUAD 2-INP	01295	SN7403N
A1U23	1820-0328	6	2	IC GATE TTL NOR QUAD 2-INP	01295	SN7402N
A1U24	1820-0202	1		IC GATE TTL EXCL-OR QUAD 2-INP	01295	SN7486N
A1U25	1820-0301	5		IC LCH TTL D-TYPE 4-BIT	01295	SN7475N
A1U26	1820-0301	5		IC LCH TTL D-TYPE 4-BIT	01295	SN7475N
A1U27	1820-0538	0	2	IC GATE TTL NOR DUAL 4-INP	01295	SN7423N
A1U28	1820-0202	1		IC GATE TTL EXCL-OR QUAD 2-INP	01295	SN7486N
A1U29	1820-0202	1		IC GATE TTL EXCL-OR QUAD 2-INP	01295	SN7486N
A1U30						
A1U31	1820-0301	5		IC LCH TTL D-TYPE 4-BIT	01295	SN7475N
A1U32	1820-0538	0		IC GATE TTL NOR DUAL 4-INP	01295	SN7423N
A1U33	1820-0174	0		IC INV TTL HEX	01295	SN7404N
A1U34	1820-0174	0		IC INV TTL HEX	01295	SN7404N
A1U35	1820-0174	0		IC INV TTL HEX	01295	SN7404N
A1U36	1820-0174	0		IC INV TTL HEX	01295	SN7404N
A1U37	1818-2261	7	1	ROM	28480	1818-2261
A1U7	1820-0661	0		IC GATE TTL OR QUAD 2-INP	01295	SN7432N
A1U[illegible]	1820-0214	9	1	IC DCDR TTL BCD-TO-DEC 4-TO-10 LINE	01295	SN7442AN
A1U48	1820-0054	5	1	IC GATE TTL NAND QUAD 2-INP	01295	SN7400N
A1U49	1820-1644	1	1	IC DCDR TTL LS BCD-TO-7-SEG 4-TO-7-LINE	01295	SN74LS248N
A1XF1/F2	2110-0269	0	1	FUSE CLIP	02603	13060
A1XU4	1200-0639	0	1	SOCKET-IC 20-CONT DIP DIP-SLDR	28480	1200-0639
A1XU15	1200-0473	0	2	SOCKET-IC 16-CONT DIP DIP-SLDR	28480	1200-0473
A1XU21	1200-0473	0		SOCKET-IC 16-CONT DIP DIP-SLDR	28480	1200-0473
A1XU22	1200-0549	7	4	SOCKET-DIRP 14-CONT DIP DIP-SLDR	28480	1200-0549
A1XU37	1200-0567	1	3	SOCKET-IC 28-CONT DIP DIP-CLDR	28480	1200-0567
				A1 MISCELLANEOUS		
	0360-0124	3	24	CONNECTOR-SGL CONT PIN ,04-IN-DIC-GZ RND	28480	0360-0124
	0380-0640	0	1	STANDOFF-RND ,5-IN-LG 6-32THD ,25-IN-OD	03888	ORDER BY DESCRIPTION
	1251-2026	8	1	CONNECTOR-PC EDGE 18-CONT/ROW 2-ROWS	28480	1251-2026
	1251-2035	9	2	CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-2035
	0159-0005	8	1	RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	0159-0005

See introduction to this section for ordering information
*Indicates factory selected value

Table 6-2. Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A2	05328-60047	8	1	ASSEMBLY, POWER SUPPLY (SERIES 2318)	28480	05328-60047
A2C1	0180-2042	4	2	CAPACITOR-FXD 4500UF+-20% 35VDC AL	28480	0180-2042
A2C2	0180-2042	4		CAPACITOR-FXD 4500UF+-20% 35VDC AL	28480	0180-2042
A2C3	0160-0576	5	9	CAPACITOR-FXD .1UF +-20% 50VDC CER *ADDED IF NEEDED;NOT IN ALL INSTRUMENTS	28480	0160-0576
A2C4	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER *ADDED IF NEEDED;NOT IN ALL INSTRUMENTS	28480	0160-0576
A2C5*	0160-2203	9	1	CAPACITOR-FXD 91PF +-5% 300VDC MICA 0+70	28480	0160-2203
A2C6*	0160-0945	2	1	CAPACITOR-FXD 215PF +-5% 100VDC MICA	28480	0160-0945
A2C7	0180-0582	1	2	CAPACITOR-FXD 33UF+-20% 10VDC TA	56289	196D336X0010KA1
A2C8	0160-3079	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3079
A2C9	0180-2027	5	2	CAPACITOR-FXD 47UF+100-10% 40VDC AL	28480	0180-2027
A2C10	0180-2027	5		CAPACITOR-FXD 47UF+100-10% 40VDC AL	28480	0180-2027
A2C11	0180-2032	2	2	CAPACITOR-FXD 1000UF+100-10% 12VDC AL USE EXACT REPLACEMENT PART	28480	0180-2032
A2C12	0180-2032	2		CAPACITOR-FXD 1000UF+100-10% 12VDC AL USE EXACT REPLACEMENT PART	28480	0180-2032
A2C13	0180-0410	6	1	CAPACITOR-FXD 1UF+-20% 35VDC TA	28480	0180-0410
A2C14	0160-0576	9	1	CAPACITOR-FXD 220PF +-20% 100VDC CER	28932	5824EM100B0221M
A2C15	0160-2199	2	2	CAPACITOR-FXD 30PF +-5% 300VDC MICA *ADDED IF NEEDED;NOT IN ALL INSTRUMENTS	28480	0160-2199
A2C16	0160-2197	2		CAPACITOR-FXD 30PF +-5% 300VDC MICA	28480	0160-2199
A2C17	0180-0507	0	2	CAPACITOR-FXD 47UF+100-10% 25VDC AL	56289	672D476H025CC5B
A2C18	0180-0507	0		CAPACITOR-FXD 47UF+100-10% 25VDC AL	56289	672D476H025CC5B
A2C19	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A2C20	0160-3079	7	64	CAPACITOR-FXD .01UF +-20% 100VDC CER *ADDED IF NEEDED;NOT IN ALL INSTRUMENTS	28480	0160-3079
A2C21	0160-0120	3	4	CAPACITOR-FXD 0.2UF +-20% 50VDC CER	28480	0160-0120
A2C22	0160-0120	3		CAPACITOR-FXD 0.2UF +-20% 50VDC CER	28480	0160-0120
A2C23	0180-2021	9	3	CAPACITOR-FXD 22UF+-20% 35VDC TA	28480	0180-2021
A2C24	0180-2021	9		CAPACITOR-FXD 22UF+-20% 35VDC TA	28480	0180-2021
A2C25	0180-2021	9		CAPACITOR-FXD 22UF+-20% 35VDC TA	28480	0180-2021
A2CR1	1902-0774	8	2	DIODE-ZNR 12.1V 10% DO-15 PD=1W	28480	1902-0774
A2CR2	1902-0774	8		DIODE-ZNR 12.1V 10% DO-15 PD=1W	28480	1902-0774
A2CR3	1901-1006	7	2	DIODE-PWR RECT 50V 6A 200NS	04713	XR820
A2CR4	1901-1006	7		DIODE-PWR RECT 50V 6A 200NS	04713	XR820
A2CR5				NOT ASSIGNED		
A2CR6				NOT ASSIGNED		
A2CR7	1902-0522	6	2	DIODE-ZNR 1N5340B 6V 5% PD=5W IR=1UA	04713	1N5340B
A2CR8	1902-0522	6		DIODE-ZNR 1N5340B 6V 5% PD=5W IR=1UA	04713	1N5340B
A2CR9	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A2CR10	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A2CR11	1902-0632	9	2	DIODE-ZNR 1N5354B 17V 5% PD=5W TC=+.075%	04713	1N5354B
A2CR12	1902-0632	9		DIODE-ZNR 1N5354B 17V 5% PD=5W TC=+.075%	04713	1N5354B
A2CR13	1901-0638	3	1	DIODE-FW BRDG 100V 4A	04713	MDA-970-2
A2F1	2110-0002	9	3	FUSE 2A 250V NTD 1.25X.25 UL	75915	312002
A2F2	2110-0002	9		FUSE 2A 250V NTD 1.25X.25 UL	75915	312002
A2L1	9100-3017	8	2	380 MH AT 5 AMP DC	28480	9100-3017
A2L2	9100-3017	8		380 MH AT 5 AMP DC	28480	9100-3017
A2L3	9100-3139	5	1	INDUCTOR 75UH 10% .50X.875LG	28480	9100-3139
A2Q1	1853-0363	0	2	TRANSISTOR PNP SI PD=50W FT=20MHZ	03508	X45H201
A2Q2	1854-0635	9	3	TRANSISTOR NPN SI PD=50W FT=20MHZ	03508	D44H5
A2Q3	1853-0326	3	18	TRANSISTOR PNP SI PD=1W FT=50MHZ	04713	MPS-U51
A2Q4	1854-0634	8	1	TRANSISTOR NPN SI PD=1W FT=50MHZ	04713	MPS-U01
A2Q5	1854-0492	6	14	TRANSISTOR NPN SI PD=350MW FT=250MHZ	04713	MPS3643
A2Q6	1853-0016	8	2	TRANSISTOR PNP SI TO-92 PD=300MW	28480	1853-0016
A2Q7	1853-0363	0		TRANSISTOR PNP SI PD=50W FT=20MHZ	03508	X45H201
A2Q8	1854-0635	9		TRANSISTOR NPN SI PD=50W FT=20MHZ	03508	D44H5
A2Q9	1854-0492	6		TRANSISTOR NPN SI PD=350MW FT=250MHZ	04713	MPS3643
A2Q10	1853-0016	8		TRANSISTOR PNP SI TO-92 PD=300MW	28480	1853-0016
A2Q11	1854-0635	9		TRANSISTOR NPN SI PD=50W FT=20MHZ	03508	D44H5
A2R1	0812-0094	5	2	RESISTOR 390 5% 3W PW TC=0+-20	28480	0812-0094
A2R2	0812-0094	5		RESISTOR 390 5% 3W PW TC=0+-20	28480	0812-0094
A2R3	0683-1015	7	8	RESISTOR 100 5% .25W FC TC=-400/+600	01121	CB1015
A2R4	0683-1015	7		RESISTOR 100 5% .25W FC TC=-400/+600	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	0683-6015	5		RESISTOR 680 5% .25W FC TC=-400/+600	01121	CB6815
A2R8	0683-6015	5		RESISTOR 680 5% .25W FC TC=-400/+600	01121	CB6815
A2R9	0698-3620	5	2	RESISTOR 100 5% 2W MO TC=0+-200	28480	0698-3620
A2R10	0698-3620	5		RESISTOR 100 5% 2W MO TC=0+-200	28480	0698-3620
A2R11*	0683-0245	9	1	RESISTOR 820K 5% .25W FC TC=-800/+900	01121	CB0245
A2R12*	0683-1055	5	5	RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A2R13	0698-3153	1	2	RESISTOR 4.64K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4641-F
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

See Introduction to this section for ordering information
*Indicates factory selected value

Table 6-2. Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A2R16	0698-6991	9	1	RESISTOR 31.6K ,1% ,125W F TC=0+-50	28480	0698-6991
A2R17	0757-0420	1	1	RESISTOR 1.82K 1% ,125W F TC=0+-100	24546	C4-1/8-T0-1821-F
A2R18	0698-0086	9	1	RESISTOR 33.2K ,1% ,125W F TC=0+-25	28480	0698-0086
A2R19	0683-1025	9		RESISTOR 1K 5% ,25W FC TC=-400/+600	01121	CB1025
A2R20	0683-1025	9		RESISTOR 1K 5% ,25W FC TC=-400/+600	01121	CB1025
A2R21	0683-1025	9		RESISTOR 1K 5% ,25W FC TC=-400/+600	01121	CB1025
A2R22	0683-1025	9		RESISTOR 1K 5% ,25W FC TC=-400/+600	01121	CB1025
A2R23	0686-6612	1	1	RESISTOR 2K ,1% ,125W TC=0+50	01074	K8479
A2R24	0698-6612	1	1	RESISTOR 2K ,1% ,125W F TC=0+-50	28480	0698-6612
A2R25	0686-6362	8	1	RESISTOR 1K ,1% ,125W FC TC=0+-5	01074	K8479
A2R26	0698-6362	8	2	RESISTOR 1K ,1% ,125W F TC=0+-25	28480	0698-6362
A2R27	2188-1730	9	1	RESISTOR-TRMR 10K 10% C TOP-ADJ 1-TRN	73138	82PR10K
A2R28	0698-6362	8		RESISTOR 1K ,1% ,125W F TC=0+-25	28480	0698-6362
A2R29	0698-3155	1		RESISTOR 4.64K 1% ,125W F TC=0+-100	24546	C4-1/8-T0-4641-F
A2R30	0757-0443	0	1	RESISTOR 11K 1% ,125W F TC=0+-100	24546	C4-1/8-T0-1102-F
A2R31	0683-2715	6		RESISTOR 270 5% ,25W FC TC=-400/+600	01121	CB2715
A2R32	0811-3859	7	1	RESISTOR .75 5% ,5W PW TC=0+-150	75042	PW20-1-3/4-J
A2R33				NOT ASSIGNED		
A2R34	0812-0021	0	2	RESISTOR .47 5% 3W PW TC=0+-90	91637	CW2B1-3-T2-A27/100-J
A2R35	0812-0021	0		RESISTOR .47 5% 3W PW TC=0+-90	91637	CW2B1-3-T2-A27/100-J
A2R36	0683-1025	9		RESISTOR 1K 5% ,25W FC TC=-400/+600	01121	CB1025
A2R37	0683-1025	9		RESISTOR 1K 5% ,25W FC TC=-400/+600	01121	CB1025
A2R38	0683-1025	9		RESISTOR 1K 5% ,25W FC TC=-400/+600	01121	CB1025
A2U1	1826-0065	0	2	IC COMPARATOR FSCN 8-DIP P PKG	08545	UPC311C
A2U2	1826-0065	8		IC COMPARATOR FSCN 8-DIP P PKG	08545	UPC311C
A2U3	1828-0477	6	2	IC OP AMP GP 8-DIP-P PKG	08545	UPC301AC
A2U4	1828-0477	6		IC OP AMP GP 8-DIP-P PKG	08545	UPC301AC
A2U5	1826-0439	0	2	IC V REGLTR 14-DIP-P	07263	723PC
A2XF1	2110-0269	0	4	FUSEHOLDER-CLIP TYPE,250-FUSE	28480	2110-0269
A2XF2	2110-0269	0		FUSEHOLDER-CLIP TYPE,250-FUSE	28480	2110-0269
A2XQ1	1200-0666	1	5	SOCKET-XSTR 3-CONT	28480	1200-0666
A2XQ2	1200-0666	1		SOCKET-XSTR 3-CONT	28480	1200-0666
A2XQ7	1200-0666	1		SOCKET-XSTR 3-CONT	28480	1200-0666
A2XQ8	1200-0666	1		SOCKET-XSTR 3-CONT	28480	1200-0666
A2XQ11	1200-0666	1		SOCKET-XSTR 3-CONT	28480	1200-0666

See introduction to this section for ordering information
*Indicates factory selected value

Table 6-2. Replaceable Parts (Continued)

Reference Designation	HP Part Number	CD	Qty	Description	Mfr Code	Mfr Part Number
A3	05328-60038	1	1	OSCILLATOR SUPPORT (SERIES 2224)	28480	05328-60038
A3A1	10011-60111	8	1	CRYSTAL OSCILLATOR ASSEMBLY	28480	10011-60111
A3C1	0180-1746	5	4	CAPACITOR-FXD 150UF+-10% 20VDC TA	56289	150D156X9020B2
A3C2	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A3C3	0160-3077	5	1	CAPACITOR-FXD 100PF +-20% 200VDC CER	28480	0160-3077
A3C4	0160-057_	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A3C5	0180-0116	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A3C6	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A3C7	0160-3076	4	3	CAPACITOR-FXD 47PF +-20% 200VDC CER	28480	0160-3076
A3C9	0160-2055	7	11	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	2	CAPACITOR-FXD 220PF +-1% 300VDC MICA	72136	DM15F221F0300WV1C
A3C12	0121-0100	5	2	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	0160-3075	3	1	CAPACITOR-FXD 22PF +-5% 200VDC CER 0+ 30	28480	0160-3075
A3C15	0121-0100	5		CAPACITOR-V TRMR-CER 15-60PF 200V PC MTG	52763	304324 15/60PF N1500
A3C16	0160-3456	6	1	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	0180-2016	2	2	CAPACITOR-FXD 68UF+-20% 10VDC TA	28480	0180-2016
A3C20	0180-2617	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	28480	0180-2617
A3CR1				NOT ASSIGNED		
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
A3CR4	1901-0535	9	7	DIODE-GEN PUR SCHOTTKY	28480	1901-0535
A3CR5	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A3L1	9140-0131	5	1	INDUCTOR RF-CH-MLD 10MH 5% .250X.750LG	28480	9140-0131
A3L2	9100-1700	6	5	CHOKE-WIDE BAND 2MAX-600 OHMS 100 MHZ	82114	VK200 20/4B
A3L3	9140-0696	1	2	INDUCTOR RF-CH-MLD 1UH 10% .166DX.305LG	28480	9140-0696
A3L4	9140-0696	1		INDUCTOR RF-CH-MLD 1UH 10% .166DX.305LG	28480	9140-0696
A3Q1	1854-0215	1	9	TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	SN3904
A3Q2	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	SN3904
A3Q3	1853-0036	2	3	TRANSISTOR PNP SI PD=310MW FT=250MHZ	28480	1853-0036
A3R1				NOT ASSIGNED		
A3R2	0757-0280	3	5	RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A3R3	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
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	0683-4725	1	1	RESISTOR 4.7 5% .25W FC TC=-400/+500	01121	CB4725
A3R8	0757-0288	7	1	RESISTOR 5.62K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5621-F
A3R9	0757-0439	4	1	RESISTOR 6.81K 1% .125W F TC=0+-100	24546	C4-1/8-T0-6811-F
A3R10	0683-4715	8	1	RESISTOR 470 5% .25W FC TC=-400/+500	01121	CB4715
A3R11	0683-1015	7		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A3R12	0683-1005	5	4	RESISTOR 10 5% .25W FC TC=-400/+500	01121	CB1005
A3R13				NOT ASSIGNED		
A3R14	2100-3183	6	1	RESISTOR-TRMR 10K 10% C SIDE-ADJ 17-TRN	02111	43P103
A3R15	0757-0200	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
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	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A3R19	0698-3136	8	1	RESISTOR 17.8K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1782-F
A3R20*	0757-0274	5	1	RESISTOR 1.21K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1211-F
A3R21	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A3R22	0698-3441	0		RESISTOR 215 1% .125W F TC=0+-100	24546	C4-1/8-T0-215R-F
A3U1	1820-1490	5	1	IC CNTR TTL LS DECD ASYNCHRO	01295	SN74LS90N
A3U2	1820-1420	9	1	IC MUXR/DATA-SEL TTL LS 2-TO-1-LINE QUAD	01295	SN74LS158N
A3U3	1820-0439	8		IC V REGLTR 14-DIP-P	07263	723PC
A3U4	1820-1462	5	4	IC XLTR ECL ECL-TO-TTL QUAD 2-INP	04713	MC10125L
A3U5	05328-60002	1	1	IC ASSEMBLY-+5V REGULATOR WIRED	28480	05328-60002
A3W1	05328-60115	5		CABLE ASSEMBLY, OSCILLATOR	28480	05328-60115
	0160-0229	9	3	CABLE-COAX 50-OHM 29PF/FT	28480	0160-0229
	0098-0029	0	1	TUBING-HS .107-D/.093-RCVD .02-WALL	28480	0098-0029
	1250-0024	8	1	CONNECTOR-RF BNC FEM UNMTD 50-OHM	28480	1250-0024
	1250-0070	4	3	CONNECTOR-RF BNC FEM SCL-HOLE-RR 50-OHM	28480	1250-0070
	1250-0952	3	3	CONTACT-RF CONN BNC/TNC:FEM CTR	24931	C232-2
	1250-0957	8	3	BUSHING RF CONN BNC/TNC: FOR INTL	24931	CG 105-2
	1250-0969	3	3	SLEEVE-RF CONN SLR BNC/TNC	28480	1250-0969
	1250-0964	7	3	NUT-RF CONN BNC/TNC: CLAMP NUT FOR	24931	N126-2
				A3 MISCELLANEOUS		
	0380-0310	1	5	STANDOFF-RVT-BN .75-IN-LG 6-32THD	00000	ORDER BY DESCRIPTION
	1250-0035	1	1	CONNECTOR-RF BNC M PC 50-OHM	28480	1250-0035
	1251-2635	9		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-2635

See introduction to this section for ordering information
*Indicates factory selected value

Table 6-2. Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A4	05328-60005	B	1	FUNCTION SELECTOR (SERIES 3221)	28480	05328-60005
A4C1				NOT ASSIGNED		
A4C2	0160-3079	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	20400	0160-3079
A4C3	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	20400	0160-0576
A4C4	0140-0215	7	2	CAPACITOR-FXD 680PF +-2% 300VDC MICA	72136	DM15E681G300WV1CM
A4C5	0140-0215	7		CAPACITOR-FXD 68PF +-2% 300VDC MICA	72136	DM15E680G300WV1CM
A4C6	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	20400	0160-2055
A4C7	0180-0218	6		CAPACITOR-FXD 3.3UF+-20% 15VDC TA	56289	150D335X0015A2
A4C8	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	20400	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	20400	0160-2055
A4C11	0160-0342	3	1	CAPACITOR-FXD 680PF +-1% 300VDC MICA	28480	0160-0342
A4C12	0140-0214	6	1	CAPACITOR-FXD 68PF +-5% 300VDC MICA	72136	DM15E680J300WV1CM
A4C13	0160-2055	9		CAPACITOR-FXD .01UF +[illegible]-20% 100VDC CER	20400	0160-2055
A4C14	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	20400	0160-2055
A4C15	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	20400	0160-2055
A4C16	0140-0212	2	1	CAPACITOR-FXD 15PF +-5% 500VDC MICA	72136	DM15C150J500WV1CM
A4C17	0160-4040	6	3	CAPACITOR-FXD 1000PF +-5% 100VDC CER	20400	0160-4040
A4Q1	1854-[illegible]15	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	SPS3904
A4Q2	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	SPS3904
A4Q3	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	SPS3904
A4R1	0683-5115	6		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A4R2	0683-5115	6		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
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	10	RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A4R7	0683-1015	5	8	RESISTOR 100 5% .25W FC TC=-400/+600	01121	CB1015
A4R8	0683-2025	1		RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A4R9	0683-1015	5		RESISTOR 100 5% .25W FC TC=-400/+600	01121	CB1015
A4R10	0683-2025	1		RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A4R11	0683-1015	5		RESISTOR 100 5% .25W FC TC=-400/+600	01121	CB1015
A4R12	0683-2025	1		RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A4R13	0683-1015	5		RESISTOR 100 5% .25W FC TC=-400/+600	01121	CB1015
A4R14	0683-1025	7	11	RESISTOR 1.0K 5% .25W FC TC=-400/+700	01121	CB1025
A4R15	0683-4315	6		RESISTOR 430 5% .25W FC TC=-400/+600	01121	CB4315
A4R16	0683-1025	7		RESISTOR 1.0K 5% .25W FC TC=-400/+700	01121	CB1025
A4R17	0683-1015	5		RESISTOR 100 5% .25W FC TC=-400/+600	01121	CB1015
A4R18	0683-1015	5		RESISTOR 100 5% .25W FC TC=-400/+600	01121	CB1015
A4R19	0683-1025	7		RESISTOR 1.0K 5% .25W FC TC=-400/+700	01121	CB1025
A4R20	0683-0265	1	2	RESISTOR 82 5% .25W FC TC=-400/+500	01121	CB0265
A4R21	0683-1315	8	2	RESISTOR 130 5% .25W FC TC=-400/+600	01121	CB1315
A4R22	0683-1025	7		RESISTOR 1.0K 5% .25W FC TC=-400/+700	01121	CB1025
A4R23	0683-1025	7		RESISTOR 1.0K 5% .25W FC TC=-400/+700	01121	CB1025
A4R24	0683-1025	7		RESISTOR 1.0K 5% .25W FC TC=-400/+700	01121	CB1025
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	0683-1025	7		RESISTOR 1.0K 5% .25W FC TC=-400/+700	01121	CB1025
A4R30	0683-1025	7		RESISTOR 1.0K 5% .25W FC TC=-400/+700	01121	CB1025
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	0683-1025	7		RESISTOR 1.0K 5% .25W FC TC=-400/+700	01121	CB1025
A4R35	0683-1015	5		RESISTOR 100 5% .25W FC TC=-400/+600	01121	CB1015
A4R36	0683-0265	1		RESISTOR 82 5% .25W FC TC=-400/+500	01121	CB0265
A4R37	0683-1315	8		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	0683-6015	5		RESISTOR 600 5% .25W FC TC=-400/+600	01121	CB6015
A4R42	0683-1025	7		RESISTOR 1.0K 5% .25W FC TC=-400/+700	01121	CB1025
A4R43	1810-0041	9		NETWORK RES 9 DIP2.7K OHM X 8	28480	1810-0041
A4R44	1810-0008	6	8	NETWORK-RES 8-DIP560.8 OHM X 7	28480	1810-0008
A4R45	0698-3447	4	1	RESISTOR 422 1% .125W F TC=0+-100	24546	C4-1/8-T0-422R-F
A4R46	0683-1025	7		RESISTOR 1.0K 5% .25W FC TC=-400/+700	01121	CB1025
A4U1*	1820-1225	4	1	IC FF ECL D-M/S DUAL	04713	MC10231P
A4U2	1820-1052	5		IC XLTR ECL ECL-TO-TTL QUAD 2-INP	04713	MC10125L
A4U3	1820-0629	8	2	IC FF TTL S J-K NEG-EDGE-TRIG	01295	SN74S112N
A4U4	1820-0629	8		IC FF TTL S J-K NEG-EDGE-TRIG	01295	SN74S112N
A4U5	1820-0622	3	1	IC MUXR/DATA-SEL TTL S-TO-1-LINE S-INP	01295	SN74151AN
A4U6	1820-0829	2	1	IC MUXR/DATA-SEL ECL S-TO-1-LINE S-INP	04713	MC10164L
A4U7	1820-0089	8	1	IC RCVR ECL LINE RCVR QUAD 2-INP	04713	MC10115P
A4U8	1820-0082	1	6	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	1	IC GATE TTL AND-OR-INV 2-INP	01295	SN7454N
				MISCELLANEOUS PARTS		
	1400-0116	8	4	PIN-GRV .062-IN-DIA .25-IN-LG STL	28480	1400-0116
	4040-0752	9	1	EXTR-PC BD YEL POLYC .062-BD-THKNS	28480	4040-0752

See introduction to this section for ordering information
*Indicates factory selected value

Table 6-2. Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A5				NOT ASSIGNED		
A6				NOT ASSIGNED		
A7				NOT ASSIGNED		
A8	05328-60046	0	1	FREQUENCY C BOARD ASSEMBLY 2216	28480	05328-60046
A8C1	0180-0562	1		CAPACITOR-FXD 33UF+-20% 10VDC TA	56289	196D336X9010KA1
A8C2	0160-3079	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3079
A8C3	0160-4848	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4848
A8C4	0160-4848	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4848
A8C5	0180-2617	1	6	CAPACITOR-FXD 6.8UF+-10% 35VDC TA	05000	D68D685X9035K
A8C6	0160-3079	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3079
A8C7	0160-3079	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3079
A8C8	0160-3079	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3079
A8C9	0180-2617	1	2	CAPACITOR-FXD 47UF+-20% 10VDC TA	28480	0180-2617
A8C10	0180-2617	1		CAPACITOR-FXD 47UF+-20% 10VDC TA	28480	0180-2617
A8C11	0160-3079	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3079
A8C12	0160-3079	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3079
A8C13	0180-2617	1	1	CAPACITOR-FXD 6.8UF +-10% 35VDC TA	28480	0180-2617
A8C14	0160-3079	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3079
A8C15	0160-3079	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3079
A8C16	0160-3079	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3079
A8C17	0160-3079	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3079
A8C18	0160-4109	6	1	CAPACITOR-FXD 100PF +-5PF 200VDC CER	28480	0160-4109
A8C19	0160-3079	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3079
A8C20	0180-2617	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	05000	D68D685X9035K
A8C21	0160-3079	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3079
A8C22	0160-3079	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3079
A8C23	0160-3079	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3079
A8C24	0160-3079	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3079
A8CR1	1901-0535	9		DIODE-SM SIG SCHOTTKY	28480	1901-0535
A8CR2	1901-0858	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0858
A8CR3	1901-0858	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0858
A8CR4	1901-0535	9		DIODE-SM SIG SCHOTTKY	28480	1901-0535
A8CR5	1901-0535	9		DIODE-SM SIG SCHOTTKY	28480	1901-0535
A8CR6	1901-0535	9		DIODE-SM SIG SCHOTTKY	28480	1901-0535
A8CR7	1901-0535	9		DIODE-SM SIG SCHOTTKY	28480	1901-0535
A8CR8	1901-0535	9		DIODE-SM SIG SCHOTTKY	28480	1901-0535
A8CR9	1901-0858	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0858
A8CR10	1901-0858	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0858
A8F1	1250-1894			FUSED CONNECTOR ASSY-BNC		
A8L1	9100-1700	6		CHOKE-WIDE BAND ZMAX=600 OHMS 100 MHZ	82114	VK200 20/40
A8L2	9100-1700	6		CHOKE-WIDE BAND ZMAX=600 OHMS 100 MHZ	82114	VK200 20/40
A8L3	9100-1700	6		CHOKE-WIDE BAND ZMAX=600 OHMS 100 MHZ	82114	VK200 20/40
A8L4	9135-0074	4	1	INDUCTOR RF-CH-MLD 47NH 4% .100DX.225LG	28480	9135-0074
A8L5	9100-1720	6		CHOKE-WIDE BAND ZMAX=600 OHMS 100 MHZ	82114	VK200 20/40
A8Q1	1853-0836	2		TRANSISTOR PNP SI PD=310MW FT=250MHZ	28480	1853-0836
A8Q2	1854-0892	2		TRANSISTOR NPN SI PD=200MW FT=650MHZ	28480	1854-0892
A8Q3	1854-0892	2		TRANSISTOR NPN SI PD=200MW FT=650MHZ	28480	1854-0892
A8Q4	1853-0892	2		TRANSISTOR NPN SI PD=200MW FT=650MHZ	28480	1854-0892
A8Q5	1854-0892	2		TRANSISTOR NPN SI PD=200MW FT=650MHZ	28480	1854-0892
A8Q6	1854-0871	7		TRANSISTOR NPN SI PD=360MW FT=200MHZ	28480	1854-0871
A8R1	0698-3268	9	1	RESISTOR 464K 1% .125W F TC=0+-100	28480	0698-3268
A8R2	0698-7268	7	0	RESISTOR 10K 1% .05W F TC=0+-100	24546	C3-1/8-TO-1002-F
A8R3	0757-1081	6	1	RESISTOR 56.2 1% .5W F TC=0+-100	28480	0757-1081
A8R4	0698-8804	9	2	RESISTOR 2.15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2151-F
A8R5	0698-8804	9		RESISTOR 2.15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2151-F
A8R6	0698-7216	3	1	RESISTOR 147 1% .05W F TC=0+-100	24546	C3-1/8-T0-147R-F
A8R7	0698-7257	2	1	RESISTOR 7.5K 1% .05W F TC=0+-100	24546	C3-1/8-T0-7501-F
A8R8	0698-7212	9	4	RESISTOR 100 1% .05W F TC=0+-100	24546	C3-1/8-T0-100R-F
A8R9	0698-7196	8	1	RESISTOR 21.5 1% .05W F TC=0+-100	24546	C3-1/8-T0-21R5-F
A8R10	0698-7212	9		RESISTOR 100 1% .05W F TC=0+-100	24546	C3-1/8-T0-100R-F
A8R11	0698-7212	9		RESISTOR 100 1% .05W F TC=0+-100	24546	C3-1/8-T0-100R-F
A8R12	2100-3632	4	1	RESISTOR-TRMR 100 10% C SIDE-ADJ 1-TRN	30983	E150X101
A8R13	0698-7236	7		RESISTOR 1K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1001-F
A8R14	0698-7268	9	2	RESISTOR 147K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1473-F
A8R15	0698-7204	5	1	RESISTOR 100K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1003-F
A8R16	0698-7190	8	1	RESISTOR 20.1 1% .05W F TC=0+-100	24546	C3-1/8-T0-20R1-F
A8R17	0698-7228	9	1	RESISTOR 215 1% .05W F TC=0+-100	24546	C3-1/8-T0-215R-F
A8R18	0698-7206	0	1	RESISTOR 61.1 1% .05W F TC=0+100	02995	1970I
A8R19	0698-7260	7		RESISTOR 10K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1002-F
A8R20	0698-3432	7	1	RESISTOR 26.1 1% .125W F TC=0+-100	83060	RNC55-1/8-T0 26R1-F
A8R21	0698-7206	0	5	RESISTOR 61.1 1% .05W F TC=0+-100	24546	C3-1/8-T0-61R1-F
A8R22	0698-7206	0	1	RESISTOR 61.1 1% .05W F TC=0+100	02995	1970I
A8R23	0698-7218	5	1	RESISTOR 178 1% .05W F TC=0+-100	24546	C3-1/8-T0-178R-F
A8R24	0698-7208	9		RESISTOR 147K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1473-F
A8R25*	0698-7259	4	1	RESISTOR 9.09K 1% .05W F TC=0+-100	24546	C3-1/8-T0-9091-F

See Introduction to this section for ordering information
*Indicates factory selected value

Table 6-2. Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A0R26	0698-7285	6		RESISTOR 51.1 1% .05W F TC=0+-100	24546	C3-1/8-TO-51R1-F
A0R27	0698-7268	7		RESISTOR 10K 1% .05W F TC=0+-100	24546	C3-1/8-TO-1002-F
A0R28	0698-7268	7		RESISTOR 10K 1% .05W F TC=0+-100	24546	C3-1/8-TO-1002-F
A0R29	0698-7285	6		RESISTOR 51.1 1% .05W F TC=0+-100	24546	C3-1/8-TO-51R1-F
A0R30	0698-7236	7		RESISTOR 1K 1% .05W F TC=0+-100	24546	C3-1/8-TO-1001-F
A0R31	0698-7285	6		RESISTOR 51.1 1% .05W F TC=0+-100	24546	C3-1/8-TO-51R1-F
A0R32	0698-7219	6	1	RESISTOR 196 1% .05W F TC=0+-100	24546	C3-1/8-TO-1960-F
A0R33	0698-7240	3	1	RESISTOR 1.47K 1% .05W F TC=0+-100	24546	C3-1/8-TO-1471-F
A0R34	0698-7285	6		RESISTOR 51.1 1% .05W F TC=0+-100	24546	C3-1/8-TO-51R1-F
A0R35	0698-7268	7		RESISTOR 10K 1% .05W F TC=0+-100	24546	C3-1/8-TO-1002-F
A0R36	0698-7268	7		RESISTOR 10K 1% .05W F TC=0+-100	24546	C3-1/8-TO-1002-F
A0R37	0698-7195	7	2	RESISTOR 17.6 1% .05W F TC=0+-100	24546	C3-1/8-TO-17R6-F
A0R38	0698-7236	7		RESISTOR 1K 1% .05W F TC=0+-100	24546	C3-1/8-TO-1001-F
A0R39	0698-7236	7		RESISTOR 1K 1% .05W F TC=0+-100	24546	C3-1/8-TO-1001-F
A0R40	0698-7236	7		RESISTOR 1K 1% .05W F TC=0+-100	24546	C3-1/8-TO-1001-F
A0R41	0698-7239	1	5	RESISTOR 562 1% .05W F TC=0+-100	24546	C3-1/8-TO-5620-F
A0R42	0698-7196	7		RESISTOR 19.6 1% .05W F TC=0+-100	24546	C3-1/8-TO-19R6-F
A0R43	1810-0008	6		NETWORK-RES 8-SIP500.8 OHM X 7	28480	1810-0008
A0R44	0698-7222	1	1	RESISTOR 261 1% .05W F TC=0+-100	24546	C3-1/8-TO-2610-F
A0R45	0698-7253	8	1	RESISTOR 5.11K 1% .05W F TC=0+-100	24546	C3-1/8-TO-5111-F
A0R46	0698-7243	6	3	RESISTOR 1.96K 1% .05W F TC=0+-100	24546	C3-1/8-TO-1961-F
A0R47	0698-7243	6		RESISTOR 1.96K 1% .05W F TC=0+-100	24546	C3-1/8-TO-1961-F
A0R48	0698-7243	6		RESISTOR 1.96K 1% .05W F TC=0+-100	24546	C3-1/8-TO-1961-F
A0TP1	0360-0124	3		CONNECTOR-SGL CONT PIN .04-IN-BSC-GZ RND	28480	0360-0124
A0TP2	0360-0124	3		CONNECTOR-SGL CONT PIN .04-IN-BSC-GZ RND	28480	0360-0124
A0TP3	0360-0124	3		CONNECTOR-SGL CONT PIN .04-IN-BSC-GZ RND	28480	0360-0124
A0TP4	0360-0124	3		CONNECTOR-SGL CONT PIN .04-IN-BSC-GZ RND	28480	0360-0124
A0TP5	0360-0124	3		CONNECTOR-SGL CONT PIN .04-IN-BSC-GZ RND	28480	0360-0124
A0TP6	0360-0124	3		CONNECTOR-SGL CONT PIN .04-IN-BSC-GZ RND	28480	0360-0124
A0TP7	0360-0124	3		CONNECTOR-SGL CONT PIN .04-IN-BSC-GZ RND	28480	0360-0124
A0U1	1826-0419	8	1	IC 8-DIP-P PKG	27014	LM3989N
A0U2	1826-0372	2	1	IC MISC 8-DIP-P PKG	28480	1826-0372
A0U3	1828-0990	9	1	AMP, SCHMITT TRIGGER	28480	1DA1
A0U4	1820-2080	5	1	IC FF ECL D-M/S POS-EDGE-TRIG	28480	1820-2080
A0U5	1826-0521	3	1	IC OP AMP LOW-BIAS-H-INPD DUAL 8-DIP-P	01295	TL072CP
A0U6	1820-1819	4	1	IC CNTR ECL DI-QUINARY	28480	1820-1819
A0U7	1820-1852	5		IC XLTR ECL ECL-TO-TTL QUAD 2-INP	04713	MC10125L
A0U8	1820-0883	2	3	IC GATE ECL OR-NOR TPL	04713	MC10105P
A0U9	1820-0381	5		IC LCH TTL D-TYPE 4-BIT	01295	SN7475N
A0U10	1820-0514	2	2	IC GATE TTL NAND QUAD 2-INP	01295	SN7426N
A0U11	1820-0514	2		IC GATE TTL NAND QUAD 2-INP	01295	SN7426N
A0W1	05328-60116	6	1	CABLE ASSY-FREQUENCY C	28480	05328-60116
A0W2	05328-60127	9	1	CABLE ASSY-OVERLOAD INDICATOR	28480	05328-60127
A0W3	05328-60114	4	2	CABLE ASSY-EXT LINC	28480	05328-60114
A0XU4	1200-0475	0	2	CONNECTOR-SGL CONT SKT .017-IN-BSC-GZ	28480	1200-0475
	1205-0061	0	1	HEAT SINK TO-5/TO-39-CS	28480	1205-0061
	1251-2229	3	2	CONNECTOR-SGL CONT SKT .033-IN-BSC-GZ	28480	1251-2229
	1400-0116	0		PIN-CBV .062-IN-DIA .25-IN-LG STL	28480	1400-0116
	4040-0747	2	1	EXTR-PC BD GRA POLYC .062-BD-THKNS	28480	4040-0747
A8				NOT ASSIGNED		

See introduction to this section for ordering information
*Indicates factory selected value

Table 6-2. Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A10	05328-60020	1	1	SYNCHRONIZER (SERIES 2211)	28480	05328-60020
A10C1	0180-0428	0	7	CAPACITOR-FXD 68UF+-20% 6VDC TA	80164	0180-0428
A10C2	0180-0428	0		CAPACITOR-FXD 68UF+-20% 6VDC TA	56289	0180-0428
A10C3	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	56289	0160-2055
A10C4	0160-3079	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3079
A10C5	0160-3079	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3079
A10C6	0121-0059	7	1	CAPACITOR-V TRMR-CER 8-80PF 350V PC-MTG	52763	3043PA 8/80PF NPO
A10C7	0160-2244	8	1	CAPACITOR-FXD 3PF +-.25PF 500VDC CER	28480	0160-2244
A10C8	0160-3079	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3079
A10C9	0160-3079	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3079
A10CR1	1902-3036	3	1	DIODE-ZNR 3.16V 5% DO-7 PD=.4W TC=-.064%	28480	1902-3036
A10J1	1200-0540	8	5	SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0540
A10J2	1200-0540	8		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0540
A10J3	1200-0540	8		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0540
A10Q1	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=300MHZ	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-SIP330,0 OHM X 7	28480	1810-0080
A10R4	0683-5115	6		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A10R5	1810-0080	6		NETWORK-RES 8-SIP330,0 OHM X 7	28480	1810-0080
A10R6	0683-2025	1		RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A10R7	0683-2225	3	3	RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225
A10R8	0683-4725	2		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	3	RESISTOR 3K 5% .25W FC TC=-400/+700	01121	CB3025
A10R11	0683-1015	5		RESISTOR 100 5% .25W FC TC=-400/+600	01121	CB1015
A10R12	0683-5115	6		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A10R13	0683-9115	4	2	RESISTOR 910 5% .25W FC TC=-400/+600	01121	CB9115
A10R14	1810-0080	6		NETWORK-RES 8-SIP330,0 OHM X 7	28480	1810-0080
A10R15	0683-9115	4		RESISTOR 910 5% .25W FC TC=-400/+600	01121	CB9115
A10R16	1810-0080	6		NETWORK-RES 8-SIP330,0 OHM X 7	28480	1810-0080
A10R17	0683-5115	6		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A10R18	0683-2025	1		RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A10R19	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-SIP330,0 OHM X 7	28480	1810-0080
A10R23	0683-2225	3		RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225
A10R24	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A10R25	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1 126				NOT ASSIGNED		
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
A10R30	0698-7212	9		RESISTOR 100 1% .25W F TC=0+-100	24546	C3-1/8-TO-100R-F
A10S1	3101-1596	0	0	SWITCH-SL DPDT MINTR 1A 125VAC PC	28480	3101-1596
A10TP1	0360-0124	3		CONNECTOR-SGL CONT PIN .04-IN-BSC-GZ BND	28480	0360-0124
A10TP2	0360-0124	3		CONNECTOR-SGL CONT PIN .04-IN-BSC-GZ BND	28480	0360-0124
A10TP3	0360-0124	3		CONNECTOR-SGL CONT PIN .04-IN-BSC-GZ BND	28480	0360-0124
A10TP4	0360-0124	3		CONNECTOR-SGL CONT PIN .04-IN-BSC-GZ BND	28480	0360-0124
A10U1	1820-1320	0	1	IC RCVR ECL LINE RCVR TPL 2-INP	04713	MC10216L
A10U2	1820-1049	0	2	IC DCDR TTL NON-INV HEX	01295	SN74367N
A10U3	1820-0882	1		IC GATE ECL NOR QUAD 2-INP	04713	MC10102P
A10U4	1820-0812	1		IC GATE ECL NOR QUAD 2-INP	04713	MC10102P
A10U5	1820-0882	1		IC GATE ECL NOR QUAD 2-INP	04713	MC10102P
A10U6	1820-0817	8	1	IC FF ECL D-M/S DUAL	04713	MC10131P
A10U7*	05328-00003	5	1	IC PROGRAM-ROM	28480	05328-00003
A10U8	1820-0731	0	2	IC LCH TTL COM CLEAR 8-BIT	67263	9334PC
A10U9	1820-1049	0		IC DCDR TTL NON-INV HEX	01295	SN74367N
A10U10	1820-0882	1		IC GATE ECL NOR QUAD 2-INP	04713	MC10102P
A10U11	1820-1359	5	1	IC MUXR/DATA-SEL ECL 4-TO-1-LINE DUAL	04713	MC10174P
A10U12	1820-0883	2		IC GATE ECL OR-NOR TPL	04713	MC10105P
A10U13	1820-0883	2		IC GATE ECL OR-NOR TPL	04713	MC10105P
A10U14	1820-0882	1		IC GATE ECL NOR QUAD 2-INP	04713	MC10102P
A10U15	1820-0833	0		IC LCH TTL COM CLEAR 3-BIT	04713	MC10182P
A10U16	1820-1245	0	1	IC DCDR TTL LS 2-TO-4-LINE DUAL 2-INP	67263	9334PC
A10U17	1820-1206	3	1	IC GATE TTL LS QR QUAD 2-INP	01295	SN74LS155N
A10W1	05328-60114	4		CABLE ASSEMBLY, EXT LINE	01295	SN74LS32N
				A10 MISCELLANEOUS	28480	05328-60114
	1400-0116	8		PIN-CRV .062-IN-DIA .75-IN-LG STL	28480	1400-0116
	4040-0748	3	3	EXTR-PC BD BLK POLYC .062-BD-THKNS	28480	4040-0748

See introduction to this section for ordering information
*Indicates factory selected value

Table 6-2. Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A11	05328-60023	4	1	DIGITAL TO ANALOG CONVERTER (SERIES 1952)	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	0180-2617	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	25088	296D685X9035R
A11C4	0180-2617	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	25088	296D685X9035R
A11C5	0160-2743	2	2	CAPACITOR-FXD 33PF +-10% 200VDC CER	28480	0160-2743
A11C6	0180-0374	3		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A11C7	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A11C8	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A11C9	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A11C10	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A11C11	0160-2743	2		CAPACITOR-FXD 33PF +-10% 200VDC CER	28480	0160-2743
A11C12	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A11C13	0180-2617	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	25088	296D685X9035R
A11C14	0180-2617	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	25088	296D685X9035R
A11C15	0160-0572	1	1	CAPACITOR-FXD 2200PF +-20% 100VDC CER	28480	0160-0572
A11C16	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A11C17	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A11C18	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A11C19	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A11C20	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A11CR1	1901-0179	7	12	DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A11CR2	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A11CR3	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A11CR4	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A11CR5	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A11CR6	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A11CR7	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A11CR8	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A11CR9	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A11CR10	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A11CR11	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A11CR12	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A11CR13	1902-0680	7	2	DIODE-ZNR 1N827 4.2V 5% DO-7 PD=.4W	24046	1N827
A11CR14	1902-0680	7		DIODE-ZNR 1N827 4.2V 5% DO-7 PD=.4W	24046	1N827
A11CR15	1901-0040	1		DIODE-SWITCHING 35V 50MA RNG DO-35	28480	1901-0040
A11CR16	1901-0040	1		DIODE-SWITCHING 35V 50MA RNG DO-35	28480	1901-0040
A11J1	1200-0540	8		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0540
A11Q1	1855-0081	1	2	TRANSISTOR J-FET N-CHAN D MODE SI	28480	1855-0081
A11Q2	1855-0416	6	2	TRANSISTOR J-FET P-CHAN D-MODE TO-18 SI	28480	1855-0416
A11Q3	1855-0416	6		TRANSISTOR J-FET P-CHAN D-MODE TO-18 SI	28480	1855-0416
A11Q4	1855-0081	1		TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0081
A11Q5	1853-0020	4	1	TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A11Q6				NOT ASSIGNED		
A11Q7	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A11Q8	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A11R1	0683-6215	9	4	RESISTOR 620 5% .25W FC TC=-400/+600	01121	CB6215
A11R2	0757-0438	3	2	RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A11R3	0683-2015	9		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	4	RESISTOR 3.03K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3031-F
A11R6	0683-6215	9		RESISTOR 620 5% .25W FC TC=-400/+600	01121	CB6215
A11R7	0698-3156	2	4	RESISTOR 14.7K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1472-F
A11R8	0683-2015	9		RESISTOR 200 5% .25W FC TC=-400/+600	01121	CB2015
A11R9	0698-3152	8	4	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	0698-3156	2		RESISTOR 14.7K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1472-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/+600	01121	CB1015
A11R14	0698-3153	9		RESISTOR 3.03K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3031-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	2100-2785	2	4	RESISTOR-TRMR 1K 10% C SIDE-ADJ 17-TRN	32997	3009P-1-102
A11R18	2100-2785	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	2100-2563	0	2	RESISTOR-TRMR 20K 10% C SIDE-ADJ 17-TRN	32997	3009P-1-203
A11R21	2100-2563	0		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	2100-2785	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	2100-2785	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	0698-3156	2		RESISTOR 14.7K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1472-F
A11R29	0698-3153	9		RESISTOR 3.03K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3031-F
A11R30	0698-3152	8		RESISTOR 3.48K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3481-F

See introduction to this section for ordering information
*Indicates factory selected value

Table 6-2. Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
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-TO-5111-F
A11R33	0698-3156	2		RESISTOR 14.7K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1472-F
A11R34	0683-2015	9		RESISTOR 200 5% .25W FC TC=-400/+600	01121	CB2015
A11R35	0698-3153	9		RESISTOR 3.03K 1% .125W F TC=0+-100	24546	C4-1/8-TO-3031-F
A11R36	0683-6815	9		RESISTOR 680 5% .25W FC TC=-400/+600	01121	CB6815
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	0683-6815	9		RESISTOR 680 5% .25W FC TC=-400/+600	01121	CB6815
A11R40				NOT ASSIGNED		
A11R41	0757-0424	2	1	RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1001-F
A11R42	0683-7505	4		RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	CB1505
A11R43	0683-1525	4		RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	CB1525
A11R44	0757-0421	4	2	RESISTOR 845 1% .125W F TC=0+-100	24546	C4-1/8-TO-8450-F
A11R45	0683-1045	3	1	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-TO-8250-F
A11R48	0683-1055	9		RESISTOR 1M 5% .25W FC TC=-400/+600	01121	CB1055
A11R49	1810-0055	5		NETWORK-RES 9-SIP 10K OHM X 8	28480	1810-0055
A11R50	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A11R51	0683-2055	7	2	RESISTOR 2M 5% .25W FC TC=-900/+1100	01121	CB2055
A11R52	0683-2055	7		RESISTOR 2M 5% .25W FC TC=-900/+1100	01121	CB2055
A11R53*	0683-1525	4	0	RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	CB1525
A11TP1	0360-0124	3		CONNECTOR-SGL CONT PIN ,04-IN-DSC-07 BND	28480	0360-0124
A11TP2	0360-0124	3		CONNECTOR-SGL CONT PIN ,04-IN-DSC-07 BND	28480	0360-0124
A11TP3	0360-0124	3		CONNECTOR-SGL CONT PIN ,04-IN-DSC-07 BND	28480	0360-0124
A11TP4	0360-0124	3		CONNECTOR-SGL CONT PIN ,04-IN-DSC-07 BND	28480	0360-0124
A11TP5	0360-0124	3		CONNECTOR-SGL CONT PIN ,04-IN DSC-07 BND	28480	0360-0124
A11TP6	0360-0124	3		CONNECTOR-SGL CONT PIN ,04 IN-DSC-07 BND	28480	0360-0124
A11U1	1826-0059	2	2	IC OP AMP GP TO-99 PKG	01295	LM301AL
A11U2	1820-0693	0	1	IC FF TTL D D-TYPE POS-EDGE-TRIG	01295	SN74S74N
A11U3	1826-0161	7	2	IC OP AMP GP QUAD 14-DIP-P PKG	04713	MLM324P
A11U4	1826-0059	2		IC OP AMP GP TO-99 PKG	01295	LM201AL
A11U5	1820-1425	6	2	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS132N
A11U6	1826-0[illegible]	7		IC OP AMP GP QUAD 14-DIP-P PKG	04713	MLM324P
A11U7	1820-0976	0	4	IC SHF-REGTR CMOS D-TYPE SERIAL-IN	3L686	CD4015BE
A11U8	1820-1265	2	6	IC MULTR CMOS	04713	MC14527BCP
A11U9	1820-1265	2		IC MULTR CMOS	04713	MC14527BCP
A11U10	1820-1265	2		IC MULTR CMOS	04713	MC14527BCP
A11U11	1820-0976	0		IC SHF-REGTR CMOS D-TYPE SERIAL-IN	3L686	CD4015BE
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-REGTR CMOS D-TYPE SERIAL-IN	3L686	CD4015BE
A11U16	1820-0976	0		IC SHF-REGTR CMOS D-TYPE SERIAL-IN	3L686	CD4015BE
				A11 MISCELLANEOUS		
	0360-0845	1	8	TERMINAL-STUD PRD-TUR BRASS-NTG	28480	0360-0845
	4040-0748	3		EXTR-PC BD ILK POLYC .062-BD-THKNS	28480	4040-0748
A12	05328-60042	7	1	A & B CHANNEL INPUT (SERIES 2248)	28480	05328-60042
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
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		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576

See introduction to this section for ordering information
*Indicates factory selected value

Table 6-2. Replaceable Parts (Continued)

Reference Designation	HP Part Number	CD	Qty	Description	Mfr Code	Mfr Part Number
A1DC16	0160-3879	6		CAPACITOR-FXD .1UF +-80% 50VDC CER	28480	0160-3879
A1DC17	0180-0416	3	2	CAPACITOR-FXD 100UF+-20% 20VDC TA	28480	0180-0416
A1DC18	0160-3879	7		CAPACITOR-FXD .01UF +-80% 100VDC CER	28480	0160-3879
A1DC19	0180-0416	3		CAPACITOR-FXD 100UF+-20% 20VDC TA	28480	0180-0416
A1FC20	0180-0428	0		CAPACITOR-FXD 220UF+-20% 6VDC TA	28480	0180-0428
A1DC21	0180-0428	0		CAPACITOR-FXD 220UF+-20% 6VDC TA	28480	0180-0428
A1DC22	0160-3878	4		CAPACITOR-FXD 47PF +-20% 500VDC CER	28480	0160-3878
A1DC23	0160-4483	9	P	CAPACITOR-FXD 470PF +-20% 500VDC CER	01686	RPE0-500-X7R-471M
A1DC24	0160-3878	4		CAPACITOR-FXD 47PF +-20% 500VDC CER	28480	0160-3878
A1DC25	0160-4483	9		CAPACITOR-FXD 470PF +-20% 500VDC CER	01686	RPE0-500-X7R-471M
A1DC26*	0160-2242	6	1	CAPACITOR-FXD 8.4PF +-.25PF 500VDC CER	28480	0160-2242
A1DC27	0160-3874	8	1	CAPACITOR-FXD 18PF +-.5PF 500VDC CER	28480	0160-3874
A1DC28*	0160-3873	1	1	CAPACITOR-FXD 4.7PF +-.5PF 500VDC CER	28480	0160-3873
A1DC29	0160-2246	8	1	CAPACITOR-FXD 3.6PF +-.25PF 500VDC CER	28480	0160-2246
A1DC30	0160-4484	0	2	CAPACITOR-FXD .0470UF +-20% 100VDC CER	01686	RPE0-500-X7R-473M
A1DC31	0160-4484	0		CAPACITOR-FXD .0470UF +-20% 100VDC CER	01686	RPE0-500-X7R-473M
A1DC32	0160-3879	7		CAPACITOR-FXD .01UF +-80% 100VDC CER	28480	0160-3879
A1DC33	0140-0205	9	P	CAPACITOR-FXD 300PF +-1% 300VDC MICA	72136	DM15F301F0300WV1C
A1DC34	0180-0428	0		CAPACITOR-FXD 220UF+-20% 6VDC TA	28480	0180-0428
A1DC35	0140-0205	9		CAPACITOR-FXD 300PF +-1% 300VDC MICA	72136	DM15F301F0300WV1C
A1DC36				NOT ASSIGNED		
A1DC37	0160-3879	7		CAPACITOR-FXD .01UF +-80% 100VDC CER	28480	0160-3879
A1DC38	0160-3879	7		CAPACITOR-FXD .01UF +-80% 100VDC CER	28480	0160-3879
A1DC39	0160-3879	7		CAPACITOR-FXD .01UF +-80% 100VDC CER	28480	0160-3879
A1DC40	0160-3879	7		CAPACITOR-FXD .01UF +-80% 100VDC CER	28480	0160-3879
A1DC41	0160-3879	7		CAPACITOR-FXD .01UF +-80% 100VDC CER	28480	0160-3879
A1DCR1	1902-3082	9		DIODE-ZNR 4.64V 5% DO-35 PD=.4W	28480	1902-3082
A1DCR2				NOT ASSIGNED		
A1DCR3	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1DCR4	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1DCR5	1901-0376	6	4	DIODE-GEN PRP 30V 50MA DO-35	28480	1901-0376
A1DCR6	1901-0376	6		DIODE-GEN PRP 30V 50MA DO-35	28480	1901-0376
A1DCR7	1902-3040	7	2	DIODE-ZNR 3.48V 5% DO-35 PD=.4W	28480	1902-3040
A1DCR8	1901-0376	6		DIODE-GEN PRP 30V 50MA DO-35	28480	1901-0376
A1DCR9	1902-3040	7		DIODE-ZNR 3.48V 5% DO-35 PD=.4W	28480	1902-3040
A1DCR10	1901-0376	6		DIODE-GEN PRP 30V 50MA DO-35	28480	1901-0376
A1DCR11	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1DCR12	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1DCR13	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1DCR14	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1DCR15	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1DCR16	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1DCR17	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1DCR18	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1DCR19	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1DCR20	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1DCR21	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1DCR22	1902-3082	9		DIODE-ZNR 4.64V 5% DO-35 PD=.4W	28480	1902-3082
A1DCR23	1902-3082	9		DIODE-ZNR 4.64V 5% DO-35 PD=.4W	28480	1902-3082
A1DJ1	1200-0540	8		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0540
A1DK1	0490-0642	5	1	RELAY-REED SC 500MA 200VDC 5VDC-COIL 3VA	28480	0490-0642
A1DK2	0490-1175	1	4	RELAY-REED 1A 500MA 100VDC 5VDC-COIL	28480	0490-1175
A1DK3	0490-1103	1	3	RELAY-REED 1B 500MA 100VDC 5VDC-COIL	28480	0490-1103
A1DK4	05320-00041	0		RELAY SHIELDED	28480	05320-00041
A1DK5	0490-1103	1		RELAY-REED 1B 500MA 100VDC 5VDC-COIL	28480	0490-1103
A1DK6	0490-1175	1		RELAY-REED 1A 500MA 100VDC 5VDC-COIL	28480	0490-1175
A1DK7	05320-00041	0		RELAY SHIELDED	28480	05320-00041
A1DK8	0490-1175	1		RELAY-REED 1A 500MA 100VDC 5VDC-COIL	28480	0490-1175
A1DK9	05320-00041	0		RELAY SHIELDED	28480	05320-00041
A1DK10	0490-1175	1		RELAY-REED 1A 500MA 100VDC 5VDC-COIL	28480	0490-1175
A1DK11	0490-1103	1		RELAY-REED 1B 500MA 100VDC 5VDC-COIL	28480	0490-1103
A1DL1	9100-2200	3	2	INDUCTOR RF-CH-MLD 1UH 10% .105DX.24LG	28480	9100-2200
A1DL2	9100-2200	3		INDUCTOR RF-CH-MLD 1UH 10% .105DX.24LG	28480	9100-2200
A1DL3	9140-0170	0	2	INDUCTOR RF-CH-MLD 100UH 10% .166DX.305LG	28480	9140-0170
A1DL4	9140-0170	0		INDUCTOR RF-CH-MLD 100UH 10% .166DX.305LG	28480	9140-0170
A1DQ1	1854-0071	7		TRANSISTOR NPN SI PD=360MW FT=250MHZ	28480	1854-0071
A1DQ3	1855-0213	1	2	TRANSISTOR-JFET DUAL N-CHAN D-MODE TO-78	28480	1855-0213
A1DQ4	1855-0213	1		TRANSISTOR-JFET DUAL N-CHAN D-MODE TO-78	28480	1855-0213
A1DR1	0698-7268	7		RESISTOR 10K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1002-F
A1DR2	0698-7268	7		RESISTOR 10K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1002-F
A1DR3	1810-0008	6		NETWORK-RES 8-DIP500.8 OHM X 7	28480	1810-0008
A1DR4	0683-3925	2	2	RESISTOR 3.9K 5% .25W FC TC=-400/+700	01121	CB3925
A1DR5	0698-7262	7	2	RESISTOR 4.64K 1% .05W F TC=0+-100	24546	C3-1/8-T0-4641-F

See introduction to this section for ordering information
*Indicates factory selected value

Table 6-2. Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1R8A	0683-3925	8		RESISTOR 3.9K 5% .25W FC TC=-400/+700	01121	CB3925
A1R87	0757-0199	3	1	RESISTOR 21.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2152-F
A1R88	0757-0282	3	1	RESISTOR 4.64K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4641-F
A1R89	0683-0275	3	8	RESISTOR 2700 5% .25W FC TC=-400/+800	01121	CB2715
A1R810	0683-0275	3		RESISTOR 2700 5% .25W FC TC=-400/+800	01121	CB2715
A1R811	0698-7234	7		RESISTOR 1K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1001-F
A1R812	0683-1325	9		RESISTOR 1K 5% .25W FC TC=-400/+800	01121	CB1025
A1R813	0698-7234	7		RESISTOR 1K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1001-F
A1R814	0757-0279	8		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A1R815	0683-0115	6		RESISTOR 510 5% .25W FC TC=-400/+800	01121	CB5115
A1R817	0683-0115	6		RESISTOR 510 5% .25W FC TC=-400/+800	01121	CB5115
A1R818	0683-0215	1	P	RESISTOR 210 5% .25W FC TC=-400/+800	01121	CB2115
A1R819	0683-0215	1		RESISTOR 210 5% .25W FC TC=-400/+800	01121	CB2115
A1R820	0683-1605	5		RESISTOR 16 5% .25W FC TC=-400/+800	01121	CB1605
A1R821	0683-1005	5		RESISTOR 10 5% .25W FC TC=-400/+800	01121	CB1005
A1R822	0683-3315	4		RESISTOR 330 5% .25W FC TC=-400/+800	01121	CB3315
A1R823	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R824	0683-3315	4		RESISTOR 330 5% .25W FC TC=-400/+800	01121	CB3315
A1R825	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R826				NOT ASSIGNED		
A1R827	0698-7229	0	P	RESISTOR 511 1% .05W F TC=0+-100	24546	C3-1/8-T0-5110-F
A1R828				NOT ASSIGNED		
A1R829	0698-7238	1		RESISTOR 562 1% .05W F TC=0+-100	24546	C3-1/8-T0-5620-F
A1R830	0698-7238	1		RESISTOR 562 1% .05W F TC=0+-100	24546	C3-1/8-T0-5620-F
A1R831	0698-7229	0		RESISTOR 511 1% .05W F TC=0+-100	24546	C3-1/8-T0-5110-F
A1R832	0698-7238	1		RESISTOR 562 1% .05W F TC=0+-100	24546	C3-1/8-T0-5620-F
A1R833	0683-5115	4		RESISTOR 510 5% .25W FC TC=-400/+800	01121	CB5115
A1R834	0698-7100	0	P	RESISTOR 10 1% .05W F TC=0+-100	24546	C3-1/8-T0-10R0-F
A1R835	0698-7238	1		RESISTOR 562 1% .05W F TC=0+-100	24546	C3-1/8-T0-5620-F
A1R836	0698-7100	0		RESISTOR 10 1% .05W F TC=0+-100	24546	C3-1/8-T0-10R0-F
A1R837	0683-1055	5		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A1R838	0683-1055	5		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A1R839	0683-2065	7	4	RESISTOR 20 5% .25W FC TC=-400/+600	01121	CB2065
A1R840	0683-5115	6		RESISTOR 510 5% .25W FC TC=-400/+800	01121	CB5115
A1R841	0683-2065	7		RESISTOR 20 5% .25W FC TC=-400/+600	01121	CB2065
A1R842	0698-6480	0	P	RESISTOR 9880 1% .25W F TC=0+-100	19701	MF0DC1/4-T0-9883 F
A1R843	0698-6974	0	P	RESISTOR 98K .05% .125W F TC=0+-25	28480	0698-6974
A1R844	0698-6974	0		RESISTOR 98K .05% .125W F TC=0+-25	28480	0698-6974
A1R845	0698-6480	0		RESISTOR 9880 1% .25W F TC=0+-100	19701	MF0DC1/4-T0-9883-F
A1R846	0757-0442	9	P	RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A1R847	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A1R848	0757-0721	1		RESISTOR 2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2001-G
A1R849	0757-0988	4	P	RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-G
A1R850	0757-0721	1		RESISTOR 2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2001-G
A1R851	0757-0988	4		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-G
A1R852	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A1R853	0683-1015	7		RESISTOR 100 5% .25W FC TC=-400/+800	01121	CB1015
A1R854	0683-1015	7		RESISTOR 100 5% .25W FC TC=-400/+800	01121	CB1015
A1R855				NOT ASSIGNED		
A1R856	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A1R857	0683-1015	7		RESISTOR 100 5% .25W FC TC=-400/+800	01121	CB1015
A1U1	1820-0577	7	P	IC INV TTL HEX 1-INP	01295	SN74LSN
A1U2	1820-0805	4	1	IC GATE ECL EXCL-OR/NOR 1FL 2-INP	04713	MC10107P
A1U3	1820-0577	7		IC INV TTL HEX 1-INP	01295	SN74LSN
A1U4	1826-0404	7	1	IC COMPARATOR 16 DUAL 16-DIP-C PKG	34335	AM687ADL
A1W1	05328-60105	7	P	CABLE-RF A & B IN	28480	05328-60105
	8120-1944	9	P	CABLE-COAX 95-OHM 13 PF/FT	28480	8120-1944
	1250-0034	0		TERMINATION-COAX CA CRP/CLP-COAX-CA PC	28480	1250-0034
	1250-0070	4		CONNECTOR-RF BNC FEM SGL-HOLE-RR 50-OHM	28480	1250-0070
	1250-0752	3		CONTACT-RF CONN BNC/TNC/FEM CTR	24931	C232-R
	1250-0937	8		BUSHING RF CONN BNC/TNC; FOR INTL	24931	CC 105-R
	1250-0748	3		SLEEVE-RF CONN SER BNC/TNC	28480	1250-0960
	1250-0964	7		NUT-RF CONN BNC/TNC; CLAMP NUT FOR	24931	H124-R
A1W2	05328-60105	7		CABLE-RF A & B IN	28480	05328-60105
A1W3W4	8120-1944	9		CABLE-COAX 95-OHM 13 PF/FT	28480	8120-1944
	1250-0034	0		TERMINATION-COAX CA CRP/CLP-COAX-CA PC	28480	1250-0034
	1250-0070	4		CONNECTOR-RF BNC FEM SGL-HOLE-RR 50-OHM	28480	1250-0070
	1250-0752	3		CONTACT-RF CONN BNC/TNC/FEM CTR	24931	C232-R
	1250-0937	8		BUSHING RF CONN BNC/TNC; FOR INTL	24931	CC 105-R
	1250-0748	3		SLEEVE-RF CONN SER BNC/TNC	28480	1250-0960
	1250-0964	7		NUT-RF CONN BNC/TNC; CLAMP NUT FOR	24931	H124-R
	1250-0475	0		CONNECTOR-SGL CONT SKT .017-IN-DGC-BZ	28480	1250-0475
				A1R MISCELLANEOUS		
	1400-0114	8		PIN-CRV .042-IN-DIA .95-IN-LG STL	28480	1400-0114
	4040-0740	3		EXTR-PC BD BLK POLYC .812-BD-THKNS	28480	4040-0740

See Introduction to this section for ordering information
*Indicates factory selected value

Table 6-2. Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A10				NOT ASSIGNED		
A11				NOT ASSIGNED		
A12	05328-60043	B	1	HPIB INTERFACE BOARD (SERIES 3424)	28480	05328-60043
A1C1	0160-2483	1	1	CAPACITOR-FXD .022UF +-10% 05VDC POLYE	28480	0160-2483
A1C2	0170-0049	7	1	CAPACITOR-FXD .047UF +-10% 200VDC POLYE	56289	29EP47392
A1C3				NOT ASSIGNED		
A1C4	0160-0154	5	1	CAPACITOR-FXD 2200PF +-10% 200VDC POLYE	28480	0160-0154
A1C5	0160-0161	A		CAPACITOR-FXD .01UF +-10% 200VDC POLYE	28480	0160-0161
A1C6	0170-0024	9		CAPACITOR-FXD .022UF +-20% 200VDC POLYE	28480	0170-0024
A1C7	0180-0049	7	2	CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2
A1C8	0180-0049	7		CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2
A1C9	0180-1746	5		CAPACITOR-FXD 150UF+-10% 20VDC TA	56289	150D156X9020B2
A1C10	0160-3870	6	1	CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3870
A1CR1	1910-0016	0		DIODE-GE 60V 60MA 100 DO-7	28480	1910-0016
A1CR2	1910-0016	0		DIODE-GE 60V 60MA 100 DO-7	28480	1910-0016
A1CR3	1910-0016	0		DIODE-GE 60V 60MA 100 DO-7	28480	1910-0016
A1CR4	1910-0016	0		DIODE-GE 60V 60MA 100 DO-7	28480	1910-0016
A1CR5	1910-0016	0		DIODE-GE 60V 60MA 100 DO-7	28480	1910-0016
A1CR6	1910-0016	0		DIODE-GE 60V 60MA 100 DO-7	28480	1910-0016
A1J6	1251-3203	1	1	CONNECTOR 24-PIN F MICRORIBBON	28480	1251-3203
A1MP1	1480-0531	3	2	CLAMP-CABLE .13 DIA .375-WD ABS	28480	1480-0531
A1MP2	1480-0531	3		CLAMP-CABLE .13 DIA .375-WD ABS	28480	1480-0531
A1Q1	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A1Q2	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A1Q3	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A1Q4	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A1Q5	1853-0036	2		TRANSISTOR PNP SI PD=310MW FT=250MHZ	28480	1853-0036
A1R1	0683-3935	5	1	RESISTOR 39K 5% .25W FC TC=-400/+800	01121	CB3935
A1R2	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R3	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R4	0683-2715	6		RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A1R5	0683-3325	6	2	RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A1R6	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A1R7	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R8	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R9	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R10	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R11	0683-1235	3	1	RESISTOR 12K 5% .25W FC TC=-400/+800	01121	CB1235
A1R12	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R13	0683-2715	6		RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A1R14	0683-2715	6		RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A1R15	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R16	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R17	0683-1535	6	1	RESISTOR 15K 5% .25W FC TC=-400/+800	01121	CB1535
A1R18	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A1R19	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A1R20	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R21	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R22	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A1R23	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A1R24	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R25	0683-2725	0		RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A1R26	0683-2025	1		RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A1R27	0683-3025	3		RESISTOR 3K 5% .25W FC TC=-400/+700	01121	CB3025
A1R28	0698-3154	0	1	RESISTOR 4.22K 1% .125W TC=0+100	00746	2M627
A1R29	1810-0136	3	2	NETWORK-RES 10-SIP MULTI-VALUE	28480	1810-0136
A1R30	1810-0136	3		NETWORK-RES 10-SIP MULTI-VALUE	28480	1810-0136
A1R31	1810-0055	5		NETWORK-RES 9-SIP10.0K OHM X 8	28480	1810-0055
A1R32	1810-0055	5		NETWORK-RES 9-SIP10.0K OHM X 8	28480	1810-0055
A1R33	1810-0055	5		NETWORK-RES 9-SIP10.0K OHM X 8	28480	1810-0055
A1R34	1810-0055	5		NETWORK-RES 9-SIP10.0K OHM X 8	28480	1810-0055
A1R35	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R36	0683-2715	6		RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A1S1	3101-1973	7	1	SWITCH-SL 7-1A DIP-SLIDE-ASSY .1A 50VDC	28480	3101-1973
A1U1	1820-0761	6	1	IC NV TTL MONOSTBL	01295	SN74121N
A1U2	1820-0786	4	1	IC COMPTR TTL MAGID 8-BIT	07263	9324PC
A1U3	1820-0615	4	4	IC MUXR/DATA-SEL TTL 8-TO-1-LINE 0-INP	04713	MC831CP
A1U4	1820-1199	1	2	IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A1U5	1820-1289	4	3	IC GTE TTL LS NAND QUAD 2-INP	01295	SN74LS30N

See introduction to this section for ordering information
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Table 6-2. Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1BU6	1820-0816	4		IC MUXR/DATA-SEL TTL 8-TO-1-LINE 8-INP	04713	MC8318P
A1BU7	1820-1470	9	1	IC CNTR TTL LS BIN ASYNCHRO	01295	SN74LS93N
A1BU8	1820-0816	4		IC MUXR/DATA-SEL TTL 8-TO-1-LINE 8-INP	04713	MC8318P
A1BU9	1820-1192	4	1	IC REGTR TTL D-TYPE 4-BIT	01295	SN74173N
A1BU10	1820-1209	4		IC BFR TTL LS NAND QUAD 2-INP	01295	SN74LS38N
A1BU11	1820-1112	8	2	IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
A1BU12	1820-0816	8	1	IC MUXR/DATA-SEL TTL 8-TO-1-LINE QUAD	07263	7328PC
A1BU13	1820-0111	8	1	IC DCDR TTL BCD-TO-DEC 4-TO-10-LINE	04713	MC8301P
A1BU14	1820-1430	3	1	IC CNTR TTL LS BIN SYNCHRO POS-EDGE-TRIG	01295	SN74LS161AN
A1BU15	1820-1444	9	1	IC MUXR/DATA-SEL TTL LS 2-TO-1-LINE QUAD	01295	SN74LS257N
A1BU16	1820-1209	4		IC BFR TTL LS NAND QUAD 2-INP	01295	SN74LS38N
A1BU17	1820-1197	9	3	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A1BU18	1820-1405	6		IC SCHMITT-TRIG TTL LS NAND QUAD 2-INP	01295	SN74LS132N
A1BU19	1820-1729	3	2	IC LCH TTL LS COM CLEAR D-BIT	01295	SN74LS259N
A1BU20	1820-1193	5	2	IC CNTR TTL LS BIN ASYNCHRO	01295	SN74LS197N
A1BU21	1820-1199	1		IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A1BU22	1818-2853	5		IC NMOS 4096 (4K) ROM	28480	1818-2853
A1BU23	1820-1057	8	1	IC CNTR TTL L BIN SYNCHRO POS-EDGE-TRIG	27014	DM86L76N
A1BU24	1820-1411	0	1	IC LCH TTL LS D-TYPE 4-BIT	01295	SN74LS75N
A1BU25	1820-1197	9		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A1BU26	1820-1729	3		IC LCH TTL LS COM CLEAR D-BIT	01295	SN74LS259N
A1BU27	1820-1193	5		IC CNTR TTL LS BIN ASYNCHRO	01295	SN74LS197N
A1BU28	1820-1665	2	2	IC REGTR TTL LS D-TYPE QUAD	04713	SN74LS173N
A1BU29	1820-1197	9		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A1BU30	1820-1211	0	1	IC GATE TTL LS EXCL-OR QUAD 2-INP	01295	SN74LS86AN
A1BU31	1820-1112	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
A1BU32	1820-0816	8		IC MUXR/DATA-SEL TTL 8-TO-1-LINE 8-INP	04713	MC8318P
A1BU33	1820-1350	4	1	IC LCH TTL L COM CLEAR D-BIT	07263	93L34PC
A1BU34	1820-1665	2		IC REGTR TTL LS D-TYPE QUAD	04713	SN74LS173N
A1BW1	05328-60116	0	1	CABLE ASSEMBLY, HP-IB SINGLE	28480	05328-60116
A1BW2	0120-2176	9		CABLE ASSY 26AWG 20-CNDCT	28480	0120-2176
A1BXU32	1200-0567	1		SOCKET-IC 20-CONT DIP DIP-SLDR	28480	1200-0567
A1BXU35	1200-0567	1		SOCKET-IC 20-CONT DIP DIP-SLDR	28480	1200-0567
				A1B MISCELLANEOUS		
	0380-0329	4	4	STANDOFF-HEX 1.25-IN-LG 6-32THD	00000	ORDER BY DESCRIPTION
	0380-0644	4	2	STANDOFF-HEX .327-IN-LG 6-32THD	00000	ORDER BY DESCRIPTION
	1200-0465	2	4	SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0465
	1535-1098	4	2	CLEVIS 0.078-IN W SLT: 0.454-IN PIN CTR	00000	ORDER BY DESCRIPTION

See introduction to this section for ordering information
*Indicates factory selected value

Table 6-2. Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1A	05328-60026	7	1	DISPLAY ASSEMBLY (SERIES 1638)	28480	05328-60026
A1AC1	0180-0124	1	1	CAPACITOR-FXD 220UF+75-10% 6VDC AL	56289	30D227G006BC2
A1ACR1	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1ACR2	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1ACR3	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1ACR4	1910-0016	0		DIODE-GE 60V 60MA TUB DO-7	28480	1910-0016
A1ACR5	1901-0040	1		DIODE SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1ACR6-A1ACR14	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1AD1	1990-0437	7	7	DISPLAY NUM-SEG 1-CHAR .43-H	28480	5082-7751
A1AD2	1990-0437	7		DISPLAY-NUM-SEG 1-CHAR .43-H	28480	5082-7751
A1AD3	1990-0437	7		DISPLAY-NUM-SEG 1-CHAR .43-H	28480	5082-7751
A1AD4	1990-0437	7		DISPLAY-NUM-SEG 1-CHAR .43-H	28480	5082-7751
A1AD5	1990-0437	7		DISPLAY-NUM-SEG 1-CHAR .43-H	28480	5082-7751
A1AD6	1990-0437	7		DISPLAY-NUM-SEG 1-CHAR .43-H	28480	5082-7751
A1AD7	1990-0437	7		DISPLAY-NUM-SEG 1-CHAR .43-H	28480	5082-7751
A1AD8	1990-0437	7		DISPLAY-NUM-SEG 1-CHAR .43-H	28480	5082-7751
A1AD9	1990-0437	7		DISPLAY-NUM-SEG 1-CHAR .43-H	28480	5082-7751
A1AD11	1990-0484	0	18	LED-LAMP LUM-INT=300UCD IF=50MA-MAX	28480	5082-4400
A1AD12	1990-0484	0		LED-LAMP LUM-INT=300UCD IF=50MA-MAX	28480	5082-4400
A1AD13	1990-0484	0		LED-LAMP LUM-INT=300UCD IF=50MA-MAX	28480	5082-4400
A1AD14	1990-0484	0		LED-LAMP LUM-INT=300UCD IF=50MA-MAX	28480	5082-4400
A1AD15	1990-0484	0		LED-LAMP LUM-INT=300UCD IF=50MA-MAX	28480	5082-4400
A1AD16	1990-0484	0		LED-LAMP LUM-INT=300UCD IF=50MA-MAX	28480	5082-4400
A1AD17	1990-0484	0		LED-LAMP LUM-INT=300UCD IF=50MA-MAX	28480	5082-4400
A1AD18	1990-0484	0		LED-LAMP LUM-INT=300UCD IF=50MA-MAX	28480	5082-4400
A1AD19	1990-0484	0		LED-LAMP LUM-INT=300UCD IF=50MA-MAX	28480	5082-4400
A1AD20	1990-0484	0		LED-LAMP LUM-INT=300UCD IF=50MA-MAX	28480	5082-4400
A1AQ1	1853-0326	3		TRANSISTOR PNP SI PD=1W FT=50MHZ	04713	MPS-U51
A1AQ2	1853-0326	3		TRANSISTOR PNP SI PD=1W FT=50MHZ	04713	MPS-U51
A1AQ3	1853-0326	3		TRANSISTOR PNP SI PD=1W FT=50MHZ	04713	MPS-U51
A1AQ4	1853-0326	3		TRANSISTOR PNP SI PD=1W FT=50MHZ	04713	MPS-U51
A1AQ5	1853-0326	3		TRANSISTOR PNP SI PD=1W FT=50MHZ	04713	MPS-U51
A1AQ6	1853-0326	3		TRANSISTOR PNP SI PD=1W FT=50MHZ	04713	MPS-U51
A1AQ7	1853-0326	3		TRANSISTOR PNP SI PD=1W FT=50MHZ	04713	MPS-U51
A1AQ8	1853-0326	3		TRANSISTOR PNP SI PD=1W FT=50MHZ	04713	MPS-U51
A1AQ9	1853-0326	3		TRANSISTOR PNP SI PD=1W FT=50MHZ	04713	MPS-U51
A1AQ10	1854-0492	6		TRANSISTOR NPN SI PD=350MW FT=250MHZ	04713	MPS3643
A1AQ11	1854-0492	6		TRANSISTOR NPN SI PD=350MW FT=250MHZ	04713	MPS3643
A1AQ12	1854-0492	6		TRANSISTOR NPN SI PD=350MW FT=250MHZ	04713	MPS3643
A1AQ13	1854-0492	6		TRANSISTOR NPN SI PD=350MW FT=250MHZ	04713	MPS3643
A1AQ14	1854-0492	6		TRANSISTOR NPN SI PD=350MW FT=250MHZ	04713	MPS3643
A1AQ15	1854-0492	6		TRANSISTOR NPN SI PD=350MW FT=250MHZ	04713	MPS3643
A1AQ16	1854-0492	6		TRANSISTOR NPN SI PD=350MW FT=250MHZ	04713	MPS3643
A1AQ17	1854-0492	6		TRANSISTOR NPN SI PD=350MW FT=250MHZ	04713	MPS3643
A1AQ18	1854-0492	6		TRANSISTOR NPN SI PD=350MW FT=250MHZ	04713	MPS3643
A1AQ19	1854-0492	6		TRANSISTOR NPN SI PD=350MW FT=250MHZ	04713	MPS3643
A1AQ20	1854-0492	6		TRANSISTOR NPN SI PD=350MW FT=250MHZ	04713	MPS3643
A1AQ21	1854-0492	6		TRANSISTOR NPN SI PD=350MW FT=250MHZ	04713	MPS3643
A1AR1	0683-3985	8	3	RESISTOR 39 5% .25W FC TC=-400/+500	01121	CB3905
A1AR2	0683-3985	8		RESISTOR 39 5% .25W FC TC=-400/+500	01121	CB3905
A1AR3	0683-3905	0		RESISTOR 39 5% .25W FC TC=-400/+500	01121	CB3905
A1AR4	1810-0213	7	1	NETWORK-RES 9-SIP 10.0 OHM X 8	91637	CSP09C01-1003
A1AR5	0683 1005	5		RESISTOR 10 5% .25W FC TC=-400/+500	01121	CB1005
A1AR6	2100-3455	1	1	RESISTOR-VAR CONTROL CCP 2.5M 20% 10CW	01121	WP4C040WP25BRZ
A1AR7	0683-2005	7		RESISTOR 20 5% .25W FC TC=-400/+500	01121	CB2005
A1AR8	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A1AR9	0683-3325	6		RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A1AR10	0683-2005	7		RESISTOR 20 5% .25W FC TC=-400/+500	01121	CB2005
A1AR11	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A1AS1	3101-2245	8	1	SWITCH-TGL SUBMIN DPDT RA 250VAC PC	28480	3101-2245
A1AS2	3101-1940	0	1	SWITCH-PB DPDT MOM .5PA 28VAC	28480	3101-1940
				A1A MISCELLANEOUS		
	1200-0630	7	7	SOCKET-IC 14-CONT DIP DIP SLDR	28480	1200-0630
	1251-0600	0	1	CONNECTOR-BDL CONT PIN 1.14-MM-BSC-GZ SD	28480	1251-0600
	1251-2502	1	1	CONNECTOR-PC EDGE 24-CONT/ROW 2-ROWS	28480	1251-2502
	5001-0156	6	1	CONTACT, PC	28480	5001-0156
	5001-0157	7	1	SPRING, PC	28480	5001-0157
	5040-6940	8	1	INSULATOR, MALE	28480	5040-6940
	5040-6949	9	1	INSULATOR, FEMALE	28480	5040-6949
	05000-28017	7	1	SPACER, LED, SINGLE	28480	05000-28017
	05328-28052	7	2	SPACER, STANDOFF	28480	05328-28052
	05328-40003	8	1	SPACER, LED, LONG	28480	05328-40003
	3130-0490	0	1	SHAFT & INDEX ASSEMBLY 1.562 STRUT CTR	28480	3130-0490
	3130-0500	5	1	SHAFT & INDEX ASSEMBLY 1.562 STRUT CTR	28480	3130-0500

See introduction to this section for ordering information
*Indicates factory selected value

Table 6-2. Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A17				NOT ASSIGNED		
A18				NOT ASSIGNED		
A19	05328-60030	3	1	SWITCH ASSEMBLY (SERIES 1844)	28480	05328-60030
A19C1	0180-0186	7		CAPACITOR-FXD 68UF+ 20% 6VDC ;A	56289	150D686X9006A2
A19C2	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	20400	0160-3879
A19C3	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	20400	0160-3879
A19C4	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	20400	0160-3879
A19C5	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	20400	0160-3879
A19C6	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	20400	0160-3879
A19C7	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	20400	0160-3879
A19C8	0180-1746	5		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A19C9	0180-1746	5		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A19C10	0160-3499	8	1	CAPACITOR-FXD 1UF +-20% 50VDC CER	20400	0160-3499
A19CR2	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	20400	1901-0040
A19CR3	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	20400	1901-0040
A19CR4	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	20400	1901-0040
A19CR5	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	20400	1901-0040
A19CR6	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	20400	1901-0040
A19CR7	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	20400	1901-0040
A19CR8	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	20400	1901-0040
A19CR9	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	20400	1901-0040
A19CR11	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	20400	1901-0040
A19CR12	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	20400	1901-0040
A19CR13	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	20400	1901-0040
A19CR14	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	20400	1901-0040
A19CR15	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	20400	1901-0040
A19DS1	1990-0485	5	2	LED-LAMP LUM-INT=660UCD IF=30MA MAX	20400	5082-4984
A19DS3	1990-0485	5		LED-LAMP LUM-INT=660UCD IF=30MA MAX	20400	5082-4984
A19J1	1251-2834	0	1	CONNECTOR-PC EDGE 10-CONT/ROW 2 ROWS	20400	1251-2834
A19J2	1250-1163	8	2	CONNECTOR-RF BNC FEM SGL-HOLE-RR 50-OHM	20400	1250-1163
A19J3	1251-1626	2	1	CONNECTOR-PC EDGE 12-CONT/ROW 2-ROWS	20400	1251-1626
A19J4	1250-1163	8		CONNECTOR-RF BNC FEM SGL-HOLE-RR 50-OHM	20400	1250-1163
A19R1	2100-3516	5	2	RESISTOR-VAR W/SW 10K 20% LIN SPST-NO	01121	WN04AC06A103M
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 10K 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
A19R21	0683-6815	5		RESISTOR 680 5% .25W FC TC=-400/+600	01121	CB6815
A19R22	0683-1525	4		RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	CB1525
A19R23	0683-3315	4		RESISTOR 330 5% .25W FC TC=-400/+600	01121	CB3315
A19R24	0683-3315	4		RESISTOR 330 5% .25W FC TC=-400/+600	01121	CB3315
A19R25	0683-1525	4		RESISTOR 1.5K 5% .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	WN04AC06A103M
A19R29	0698-8072	1	2	RESISTOR 39K 5% .125W CC TC=-466/+076	01121	BB3935
A19R30	0698-8072	1		RESISTOR 39K 5% .125W CC TC=-466/+076	01121	BB3935
A19S1	3101-1596	0		SWITCH-SL DPDT MINTR 1A 125VAC PC	28480	3101-1596
A19S2	3101-1596	0		SWITCH-SL DPDT MINTR 1A 125VAC PC	20400	3101-1596
A19S3	3101-1313	0	2	SWITCH-SL, DP3T-NS MINTR .5A 125VAC PC	28480	3101-1313
A19S4	3101-1956	9	1	SWITCH-SL, DPDT-NS MINTR 1A 125VAC/DC PC	28480	3101-1956
A19S5				NOT ASSIGNED		
A19S6	3101-1596	0		SWITCH-SL DPDT MINTR 1A 125VAC PC	20400	3101-1596
A19S7	3101-1313	0		SWITCH-SL, DP3T-NS MINTR .5A 125VAC PC	28480	3101-1313
A19S8	3101-1596	0		SWITCH-SL DPDT MINTR 1A 125VAC PC	20400	3101-1596
A19TP1	0360-0124	3		CONNECTOR-SGL CONT PIN .04-IN-DSC-OZ BRS	28480	0360-0124
A19U1	1820-1052	5		IC XLTR ECL ECL-TO-TTL QUAD 2-INP	04713	MC10125L
				A19 MISCELLANEOUS		
	05328-40004	9	2	STANDOFF, LED, SHORT	28480	05328-40004

See introduction to this section for ordering information
*Indicates factory selected value

Table 6-2. Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
				CHASSIS PARTS		
A1	8950-1509	7	1	FAN AND CONTROL MODULE ASSEMBLY	28480	8950-1509
F1	2110-0081	8	1	FUSE 1A 250V NTD 1.25X.25 UL	75915	312001
F1	2110-0002	9		FUSE 2A 250V NTE 1.25X.25 UL	75915	312002
	2110-0564	8	1	FUSEHOLDER-EXTR POST 20A 300 V UL/IEC	75915	2110-0564
	2110-0565	9	1	FUSEHOLDER CAP EXTR POST 20A 300V UL/IEC	28480	2110-0565
	2110-0560	3	1	FUSEHOLDER COMPONENT (HEX NUT) 1/2-20	28480	2110-0560
J6	9100-3910	0	1	FILTER-LINE CCC-2A-TERMS	28480	9100-3910
Q1	0340-0765	6	6	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
	3101-1234	3	1	SWITCH-SL DPDT STD 1.5A 250VAC SLDR-LUG	28480	3101-1234
T1	9100-2620	7	1	TRANSFORMER-POWER 115/230V 48-440HZ	28480	9100-2620
W1	8120-1370	1	1	CABLE ASSY 18AWG 3-CNDCT JCK-JKT	28480	8120-1370
W2	05328-60126	8	1	CABLE AY-EXT REF IN	28480	05328-60126
				MISCELLANEOUS PARTS		
	0380-0004	0	2	SPACER-RND .109-IN-LG .18-IN-ID	00000	ORDER BY DESCRIPTION
	1200-0547	7	6	LOCK-DUAL INLINE PKG IC FOR 14 PIN	28480	1200-0547
	1250-0803	1	3	CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM	28480	1250-0803
	1390-0486	0	4	FASTENER-CATCH SPRING PL 16 GA SIL; 1.00	28480	1390-0486
	1400-0560	8	1	CL-SET-LED-MTG .265-DIA .375-WD POLYP	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,FRONT	28480	7101-0470
	7120-6470	3	1	NAME PLATE, FRONT	28480	7120-6470
	8120-0520	3	3	CABLE ASSY	28480	8120-0520
	5040-7216	5	2	WASHER, HANDLE	28480	5040-7216
	5040-7201	2	4	FOOT, REAR	28480	5040-7201
	5040-7224	5	2	HANDLE ADAPTER	28480	5040-7224
	8120-2176	9	2	CABLE ASSY	28480	8120-2176
	05328-00003	4	2	BRACKET, FRONT	28480	05320-00003
	05320-00011	4	1	SHIELD, FREQUENCY C NOTE THE FREQUENCY C SHIELD MAY OR MAY NOT BE INCLUDED IN ALL INSTRUMENTS.	28480	05320-00011
	05320-00014	7	1	PLATE, COVER, ASCII	28480	05320-00014
	05320-00017	0	1	PANEL, REAR	28480	05320-00017
	05320-00019	2	1	BRACKET, FAN	28480	05320-00019
	05320-00020	5	1	HANDLE, FRONT	28480	05320-00020
	05320-00021	6	1	COVER, TOP	28480	05320-00021
	05320-00022	7	1	COVER, BOTTOM	28480	05320-00022
	05320-20212	9	1	PANEL, DISPLAY	28480	05320-20212
	05320-20217	4	1	PANEL, FRONT	28480	05320-20217
	05320-20253	0	2	THUMB SCREW	28480	05320-20253
	05320-60115	5	2	CABLE ASSEMBLY, OSCILLATOR	28480	05320-60115
	05320-60016	9	2	BOARD ASSEMBLY, EXTENDER	28480	05320-60016
	05320-90061	3	1	MANUAL, OPERATING AND SERVICE	28480	05320-90061
	05320-90048	0	1	BOOKLET, OPERATING	28480	05320-90048
	1460-1345	5	2	TILT STAND SST	28480	1460-1345
	2950-0001	0	6	NUT-HEX-DBL-CHAM 3/8-32-THD .093-IN-THK	00000	ORDER BY DESCRIPTION
	0590-1251	6	4	NUT-EFFLY 15/32-32-THD .1-IN-THK .562-WD	00000	ORDER BY DESCRIPTION
	0370-1005	2	1	KNOB-BASE-PTR 3/8 JCK .125-IN-ID	28480	0370-1005
	0370-1097	2	1	KNOB-BASE-PTR 1/2 JCK .125-IN-ID	28480	0370-1097
	0370-2994	0	2	KNOB-BASE PTR AND BAR 1/2 JCK .25-IN-ID	28480	0370-2994
	3101-0051	0	1	CAP-PUSHBUTTON (BLACK) .2-IN DIA) .155-IN	28480	3101-0051
	7120-0644	1	1	LABEL, WARNING	28480	7120-0644
	7122-0197	2	1	NAMEPLATE, REAR	28480	7122-0197
	5020-8001	4	1	FRAME, FRONT, FULL	28480	5020-8001
	5020-8002	5	1	FRAME, REAR	28480	5020-8002
	5020-8031	0	2	SIDE STRUTS	28480	5020-8031
	5040-7201	8	4	FOOT(STANDARD)	28480	5040-7201
	5040-7202	9	1	TRIM, TOP	28480	5040-7202
	05320-00001	2	1	BRACKET, MAIN	28480	05320-00001
	05320-00002	3	3	BRACKET, CORNER	28480	05320-00002
	0360-1190	5	1	TERMINAL-SLDR LUG PL-MTG FOR-#3/8-SLR	28480	0360-1190
	5320-20223	9	1	HP-IB SHIELD	28480	5320-20223

See introduction to this section for ordering information
*Indicates factory selected value

Table 6-3. Manufacturer Code List

MFR. NO.	MANUFACTURER NAME	ADDRESS	ZIP CODE
50545	Nippon Electric Company	Tokyo	
00000	Any Satisfactory Supplier		
01121	Allen-Bradley Co.	Milwaukee, WI	53204
01295	Texas Instr. Inc. Semicond. Cmpnt. Div.	Dallas, TX	75222
02111	Spectrol Electronics Corp.	City of Ind., CA	91745
02114	Ferroxcube Corp.	Saugerties, NY	12477
03508	GE Co. Semiconductor Prod. Dept.	Auburn, NY	13201
03888	K D I Pyrofilm Corp.	Whippany, NJ	07981
04713	Motorola Semiconductor Products	Phoenix, AZ	85008
07263	Fairchild Semiconductor Div.	Mountain View, CA	94042
19701	MEPCO/Electra Corp.	Mineral Wells, TX	76067
20932	EMCON Div ITW.	San Diego, CA	92129
24046	Transitron Electronic Corp.	Wakefield, MA	01880
24546	Corning Glass Works (Bradford)	Bradford, PA	16701
24931	Specialty Connector Co., Inc.	Greenwood, IN	46227
25088	Siemens Corp.	Iselin, NJ	08830
27014	National Semiconductor Corp.	Santa Clara, CA	95051
28480	Hewlett-Packard Co. Corporate Hq.	Palo Alto, CA	94304
29907	Omega Engineering Inc.	Stamford, CT	06907
3L585	RCA Corp. Solid State Div.	Sommerville, NJ	
30983	MEPCO/Electra Corp.	San Diego, CA	92121
32997	Bourns Inc., Trimpot Prod. Div.	Riberside, CA	92507
34335	Advanced Micro Devices Inc.	Sunnyvale, CA	94086
51642	Centre Engineering Inc.	State College, CA	16801
52763	Stettner Electronics Inc.	Chattanooga, TN	13035
56289	Sprague Electric Co.	North Adams, MA	01247
72136	Electro Motive Corp.	Florence, SC	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
91637	Dale Electronics Inc.	Columbus, NE	68601

BACK DATING MANUAL CHANGES

SECTION VII
MANUAL CHANGES

7-1. INTRODUCTION

7-2. This section contains information for adapting this manual to instruments with serial prefixes other than that listed on the title page. This manual applies directly to instruments with serial prefix numbers listed on the title page. Refer to Section I for additional important information about serial number coverage.

7-3. MANUAL CHANGES

7-4. Instruments having serial number prefixes highter than those listed on the title page of this manual are covered with a "Manual Changes" sheet included with this manual. If this change sheet is missing, the information can be supplied by any Hewlett-Packard Sales and Service Office listed at the back of this manual.

7-5. If your instrument's serial number prefix is lower than that listed on the title page of this manual, this manual must be modified to correctly apply to your instrument. To determine which changes must be made to this manual, locate your instrument's serial number prefix in *Table 7-1* and make the indicated changes.

Table 7-1. Manual Backdating

IF YOUR 328A HAS SERIAL PREFIX	THEN MAKE THE FOLLOWING CHANGES TO THIS MANUAL
2402	1
2329	1,2
2318	1,2,*
2248	1,2,3,4
2234	1,2,3,4,5
2233	1,2,3,4,5,6
2225	1,2,3,4,5,6,7
2224	1,2,3,4,5,6,7,8
2221	1,2,3,4,5,6,7,8,9
2220	1,2,3,4,5,6,7,8,9,10
2216	1 through 11
2214	1 through 12
2211	1 through 13
2151	1 through 14
2144	1 through 15
2138	1 through 16
2131	1 through 17
2126	1 through 18
2124	1 through 19
2105	1 thorugh 20
2047	1 through 21
2041	1 through 22
2023	1 through 23
2017	1 through 24

CHANGE 1 (2402A)

Table 6-2, A1 Motherboard (05328-60048) Replaceable Parts:
Change part number to 05328-60028.
Change series number to 240~.
Change A1U10 to 1820-1143 ; Inchronous DECD CNTR, TTL.
Change A1U11 to 1820-0301, TTL D-Type Latch.
Change A1U12 to 1820-0634, PMOS DECD CNTR.
Change A1U14 to 1820-0513, 2 INPUT, QUAD TTL AND GATE.
Change A1U21 to 1820-0633, PMOS IC.
Add A1CR4, 1902-0031, 12.7V Zener Diode.
Add A1R16, 0683-1025, 1K 5% .25W.
Add A1U13, 1820-0269, TTL 2 INPUT QUAD NAND GATE.
Delete XM1A/B, 2100-0269, Fuse Holder Clips.
Delete A1M1, 1010-0071, Elapsed Time Meter.
Delete A1R86, 0698-4987, 1.07M-ohm 1% .5W.

Figure 8-7, A1 (05328-60048) Motherboard Schematic Diagram and Component Locator:
Replace the A1 Motherboard Schematic (05328-60048) and Component Locator with Figure 7-1, A1 Motherboard (05328-60028) Schematic Diagram, (Series 2402) and Component Locator.

Table 6-2, A2 Power Supply (05328-60047) Replaceable Parts:
Change part number to 05328-60035 and series number to 2216.
Change A2R23 to 0698-6446, 2.162K .1% .125W.
Change A2R25 to 0698-8498, 1.02K .1% .125W.

Figure 8-9, A2 Power Supply Schematic Diagram:
Change series to 2216.
Change A2R23 to 2.162K.
Change A2R24 to 1.02K.

Table 6-2, A8 C Channel Input (05328-60046) Replaceable Parts:
Change the part number to 05328-60045 and series number to 2231.
Change A8F1 from 1250-1899 to the following parts assembly:
A8F1 0590-0038, Hex Nut.
A8F1 2110-0301, Fuse.
A8 F1 2190-0124, Washer.
A8F1 05305-20104, Fuse Holder.
A8F1 05305-20105, Insulator.
A8F1 05305-60205, BNC Connector.
A8F1 05305-60206, SMC Connector Assembly.
Change A8R18 and A8R22 to 0698-7209.
Change A8U3 to 1826-0570, IC.

Table 6-2, A15 HP-IB (05328-60043) Replaceable Parts:
Change the part number to 05328-60039 and series number to 2402.
Change A15R11 to 0683-1235, 12K, 5%, .25W.
Change A15R28 to 0683-3025, 3K, 5%, .25W.

Figure 8-22, A15 HP-IB (05328-60043) Schematic Diagram:
Change the part number to 05328-60039 and series number to 2402.
Change A14R11 to 12K.
Change A15R28 to 3K.

CHASSIS PARTS:
Change the Fuse Post from 2110-0564 to 2110-0464.
Change the Fuse Post Cap from 2110-0565 to 2110-0465.
Change the 1/2-inch Fuse Post Nut from 2110-0569 to 2110-0467.

CHANGE 2 (2329A)
Table 6-2, A1 (05328-60028) Replaceable Parts (A1 Miscellaneous):
Change A1 series to 2329.
Change XU22, XU37 to 1200-0567 SOCKET-IC 28-CONT DIP DIP-SLDR, change quantity from 4 to 2.
Change XU4 from 1200-0525 to 1200-0639 SOCKET-IC 20-CONT DIP DIP-SLDR.

Figure 8-7, A1 Motherboard Schematic and Components:
Change A1 series to 2329.

Table 6-2, A15 (05328-60039) Replaceable Parts:
Change A15 series to 2329.
Delete XU22, XU35 1200-0567 SOCKET-IC 28-CONT DIP DIP-SLDR.

Figure 8-22, A15 HP-IB Interface Schematic and Components:
Change A15 series to 2225.

CHANGE 3 (2318A)
Table 6-2, A8 "C" Channel Input" Assembly (05328-60045) Replaceable Parts:
Delete an asterisk from R14 0698-7208 to indicate factory selected value.
Delete alternate R14* 0698-7270 RESISTOR 26.1K 1% .05W F TC=0±100.

CHANGE 4 (2348A)
Change 4 affects instruments with the following serial numbers:

2318A56501	2318A56588
56521	56589
56553	56594
56576	56602
56580	56608
56583	56618
56585	

Table 6-2, A1 (05328-60048) Replaceable Parts:
Change A1 series to 2226.
Change the A1 Motherboard part number to 05328-60028.
Change part number of A1CR7 to 1901-0040.

CHANGE 5 (2234A)
Table 6-2. A12 (05328-60042) Replaceable Parts:
Change A12 series to 2224.
Change K7 and K9 to 05328-60041 RELAY-SHIELDED.

CHANGE 6 (2233A)
Table 6-2, A8 (05328-60045) Replaceable Parts:
Change A8 series to 2223.

Figure 8-14, A8 Channel "C" Schematic and Components:
Change A8 series to 2223.
Change C20 connections to be between -5V and the junction of R46 and R47.
Change the HP Part Number for A1U41 to 1820-0914.

The instruments with the following serial numbers have CHANGE 6:

2234A55007	2234A55357	2234A55382	2234A55397	2234A55413
55261	55358	55385	55398	55416
55326	55361	55386	55400	55419
55334	55365	55388	55404	55423
55339	55374	THRU	55405	55425
55344	55377	55391	55407	THRU
55353	55378	55393	55409	55675
55355	55381	55395	55411	

CHANGE 7 (2225A)
Table 6-2, A1 (05328-60028) Replaceable Parts:
Change A1 series to 2138.
Change C33, 35, 37, 39, 41, 43, 44 to 0160-2055 .01µF 100VDC.
Change C54 to 0180-2617 CAPACITOR-FXD 6.8µF ±10% 35VDC TA.
Change R76 to 0698-7220 RESISTOR 215 1% .05W F.

Figure 8-7, A1 Motherboard Schematic and Components:
Change A1 series to 2138.
Open the line between C4 and Pin 11 of U4. Connect C4 to Pin 9 of U3D.
Change U2C to an inverting amplifier with Pin 10 open.

Table 6-2, A15 (05328-60039) Replaceable Parts:
Change U3, U6, U8, U12, and U32 to 1820-0658, IC TTL 93L12.
Change U2 to 1820-0904, IC TTL 93L24.
Change U24 to 1820-0876, IC TTL 74L75.
Change U19, U26, and U33 to 1820-1358, IC TTL 93L34.

Table 6-2, A16 (05328-60026) Miscellaneous:
Change HP Part Number for SOCKET-IC 14-CONT to 1200-0474.

CHANGE 8 (2224A)
Table 6-2, A15 (05328-60039) Replaceable Parts:
Change U14 and U23 to 1820-1057, IC-TTL 86J76.
Delete A15MP1 and MP2; 1400-0531; CLAMP-CABLE.

CHANGE 9 (2221A)
Table 6-2, A3 (05328-60038) Replaceable Parts:
Change A3 series to 2126.
Delete A3CR4; 1901-0535; DIODE-SM SIG SCHOTTKY.
Delete A3CR5; 1901-0040; DIODE-SWITCHING 30V 50MA 2NS DO-35.
Delete A3R22; 0698-3441; RESISTOR 215 1% .125W F TC=0±100.

Figure 8-10, A3/A3A1 Oscillator Support Schematic and Components:
Delete CR4, CR5, and R22.
Connect pin 6 of U4B to the negative side of variable capacitor C12.
Connect pins 2 and 3 of U2.
Delete pins 13 and 14 of U2.
Delete the connection between pin 5 of U4B and pin 3 of U2.
Connect pins 4 and 5 of U2.
Connect pin 1 of U1 to the base of Q1.
Delete pin 12 of U2.

CHANGE 10 (2220A)
Table 6-2, A4 (05328-60005) Replaceable Parts:
Change A4 series to 2151.
Change A4C3 to 0160-4084 .1µF 50V.
Change A4C17 to 0160-4556, 1000pF, 20%, 100V.
Change A4R45 to 0698-5103, 430 ohm 5%.

Figure 8-12, A4 Function Selector Schematic and Components:
Change A4 series to 2151.
Change the value of R45 to 430.

CHANGE 11 (2216A)
Table 6-2, A15 (05328-60039) Replaceable Parts:
Change A15 series to 2138.
Change A15U17, U25, U29 to 1820-0054 TTL 7400 GTE.
Change A15U11, U31 to 1820-0077 TTL 7474 F/F.
Change A15U7 to 1820-0099 IC-TTL 7493.
Change A15U4, U9, U21 to 1820-0174 TTL 7404 INV.
Change A15U20, U27 to 1820-0269 TTL 7403 GTE.
Change A15U30 to 1820-0282 IC TTL 7486.
Change A15U5, U10, U16 to 1820-0621 TTL 7438 BFR.
Change A15U13 to 1820-0627 IC TTL 93L01.
Change A15U15 to 1820-0656 4-BIT MULT 74L98.
Change A15U18 to 1820-1056 IC-TTL 74132.

CHANGE 12 (2214A)

Table 6-2, A2 (05328-60035) Replaceable Parts:
Change A2 series to 2138.
Change R13 to 0683-4725, 4.7K 5% .25W.
Change R16 to 0698-3160, 31.00K 1% .12W
Change R18 to 0757-0454, 33.2K 1%.
Change R23 to 0698-0084, 2.10K 1% .12W.
Change R24 to 0757-0283, 2.00K 1% .12W.
Change R25 to 0757-0280, 1.00K 1% .12W
Change R26 to 0757-0280, 1.00K 1% .12W.
Change R28 to 0757-0280, 1.00K 1% .12W.
Change R29 to 0683-4725, 4.7K 5% .25W.
Change R30 to 0683-1135, 11K 5% .25W.

Table 6-2, A12 (05328-60042) Replaceable Parts:
Change A12 series to 2124.
Change R7 to 0683-4725 4.7K 5% .25W.
Change R14 to 0698-1025 Resistor 100 ohm 5% .25W.

Figure 8-9, A2 Power Supply Schematic and Components:
Change A2 series to 2138.
Change R13 and R29 to 4.7K.
Change R18 to 33.2K.
Change R23 to 2.1K.

Figure 8-20, A12 "A-B" Channel Schematic and Components:
Change A12 series to 2124.
Change R7 value to 4.7K ohms.
Change R14 value to 100 ohms.

CHANGE 13 (2211)

Table 6-2, Replaceable Parts:
Add 05328-60120, CABLE ASSEMBLY, OVERLOAD INDICATOR.

Table 6-2, A8 "C" Channel Input Assembly (05328-60045) Replaceable Parts:
Add A8W1 05328-60116 CABLE ASSY-FREQUENCY C.
Add A8W2 05328-60120 A8-A16 INTERCONNECT RESET.
Add A8W3 05328-60110 CABLE ASSY-HP-IB SING.
Change A8 to A1.
Delete W1 05328-60116 CABLE ASSY-FREQUENCY C.
Delete W2 05328-60127 CABLE ASSY-OVERLOAD INDICATOR.
Delete W3 05328-60114 CABLE ASSY-EXT LINE.

CHANGE 14 (2151A)

Table 6-2, A10 (05328-60020) Replaceable Parts:
Change A10 series to 1708.
Delete R30; 0696-7212; Qty=1; RESISTOR 100 1% .05W F TC=0±100.

Figure 8-16, A10 Synchronizer Schematic and Components:
Change series at top of diagram to 1708.
Add R30 100 ohms resistor in series with P1 pin $\overline{16}$ and junction of U13A(2) and R14A.
Delete the following note, under NOTES, as shown:

4. Instruments with Serial Numbers 2211A52481 thru 2211A62660 do not have resistor R30 (0698-7212) in series with P1 pin $\overline{16}$ and junction of U13A(2) and R14A.

NOTE: The following instrument have CHANGE 12:
2214A5248-52850,
2211A52851-53135

CHANGE 15 (2144A)
Table 6-2, Miscellaneous Replaceable Parts:
Change 0590-1251 to 2950-0035 Brass Hex Nut.
NOTE: This is preferred replacement part and is directly interchangeable with the old part. The Serial Prefix of the instrument remains 2151.

NOTE: The instruments have CHANGE 12:

2151A52051	2151A52322	2151A52375	2151A52411-52415	2151A52454
52069	52333	52387	52418-52421	52457
52111	52334	52391	52425	52459-52461
52127	52341	52393	52426	52464-52476
52219	52343	52394	52428-52437	52479
52293	52348	52398	52439-52441	52480
52302	52351	52400	52443	
52304	52358	52402	52444	
52309	52364	52407	52447-52450	
52316	52366	52408	52453	

CHANGE 16 (2138A)
Table 6-2, A8 "C" Channel Input Assembly (05328-60045) Replaceable Parts:
Change A8 series to 2138.
Change A8C4, A8C13, and A8C20 to 0180-0474 15μF 20% 20V.

Figure 8-14, A8 "C" Channel Input Assembly (05328-60045) Schematic Diagram:
Change the series at the top of diagram to 2138.
Change the value of C4, C13, and C20 to 15μF.

Table 6-2, A4 (05328-60005) Replaceable Parts:
Change A4 series to 2016.
Change A4C17 to 0160-0153.

Figure 8-12, A4 Function Selector Schematic Diagram:
Change A4 series to 2016 at top of diagram.

CHANGE 17 (2131)
Table 6-2, A8 "C" Channel Input Assembly (05328-60045) Replaceable Parts:
Delete an asterisk (*) from R19 and R25; *Factory Selected Value.

Figure 8-14, A8 "C" Channel Input Assembly Schematic Diagram:
Delete an asterisk (*) from R19 and R25; *Factory Selected Value.

Paragraph 8-16. FACTORY SELECTED COMPONENTS:
Delete the procedures to select A8R19 and A8R25.

CHANGE 18 (2126)
Paragraphs 4-157 through 4-161, A8 Channel C Input:
Replace with the attached paragraphs 4-157 through 4-161.

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 to 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 ±600 mV to protect amplifier U1. Fuse (F1) is rated at 125 mA and blows when the input voltage reaches about 7 volts. The signal passes through amplifier U1 (with a single ended gain of ≈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 (÷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. Circuits U10, Q1, Q2, and various resistors consitute a current source to properly bias U1 and U2. The circuit draws approximately 16 mA out of pin 3 of 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.

CHANGE 18 (Cont'd)

Table 5-1, 5328A Assembly Identification:
Change the A8 "C" Channel Input assembly part number to 05328-60032.

Paragraph 5-26, Channel C Sensitivity Adjustment:
Replace paragraph 5-26 with the following paragraph:

5-26. Channel C Sensitivity Adjustments:

a. Remove top cover to 5320A to gain access to variable resistors A8R82 and A8R85.

b. Set counter front panel controls as follows:

FUNCTION ..... FREQ C
RESOLUTION ..... 0.1 kHz, 10^4
SAMPLE RATE ..... midrange

c. Connect HP 8640B Signal Generator (or equivalent) to INPUT C. Set signal generator to 100 MHz at 50 mV rms.

d. Slowly decrease Channel C signal source output level to 15 mV rms, while adjusting resistor A8R82 for stable counter display.

e. Set signal generator to 512 MHz at 50 mV rms and redue signal level to the point where counter display is no longer stable.

f. Adjust resistor A8R85 for stable counter display.

Table 6-2, A2 Replaceable Parts List:
Change the A2 series to 2124.
Change A2R23 to 0757-0283, 2.00K, 1%.

Table 6-2, A8 "C" Channel Input:
Replace the A8 Replaceable Parts List with Table 7-2 for the 05328-60032 series 2124.

Table 6-2, Miscellaneous Parts:
Delete the following:

05328-20223 HP-IB SHIELD

Figure 8-8, A2 Power Supply Block Diagram:
Change +15.75V OUT to +15 OUT.

Figure 8-9, A2 Power Supply Schematic and Components:
Change series to 2124.
Change A2R23 to 2.00K 1%.
Change the +15.75V supply outpu. to +15V.

Figure 8-13, A8 Channel "C" Diagram:
Replace with Figure 7-2, A8 Channel "C" Block Diagram.

Figure 8-14, A3 Channel "C" Schematic Diagram and Component Locator:
Replace with Figure 7-3, A8 Channel "C" Schematic Diagram and Component Locator.

Table 6-2, A8 Channel "C" Replaceable Parts List:
Replace with Table 7-2, A8 Channel "C" Replaceable Parts.

CHANGE 19 (2124)

Paragraph 4-70, 4-72 (NOTE), and 4-73:
Change 10811-60111 to 10544A.
Paragraph 4-74: Change second sentence to read:
The oscillator specifications are given in *Table 1-3*. This oscillator is a factory-serviced assembly. No circuit description is given here.

NOTE: All references to 10811A or 10811-60111 that may appear in this manual, should be change to 10544A.

Table 6-2, A3 (05328-60038) Replaceable Parts:
Change series to 1904.
Change A3A1 to 10811-60101.
Change A3R2, R3, R15, and R18 to 0683-1025 1.00K 5% .25W.
Delete A3R21; 0757-0280; RESISTOR 1K 1% .125W F TC=0±100 (CRB14).
Delete A3R20; 0757-0274; RESISTOR 1.21K 1% .125W F TC=0±100 (CRB14).
Delete (*) to A3R20, indicating factory selected value.
Delete A3C19; 0180-2816; CAPACITOR-FXD 68µF ±20% 10VDC TA (196D1148).
Delete A3C20; 0180-2617; CAPACITOR-FXD 6.8µF ±10% 35VDC TA (T368B685K035ASC8240).
Under A3 MISCELLANEOUS:
Add Lead Elect 8159-0005; WIRE 22 AWG W PVC 1X22 80C (28480).

Figure 8-10, A3/A3A1 Oscillator Support Schematic and Components:
Change series at top of diagram to 1904.
Add A3A1 10 MHz Oscillator Schematic Diagram and photograph. (Refer to 10811A Operating and Service Manual for Schematic Diagram.)
Delete R19, R20, R21, C19, and C20.

Table 6-2, A1 (05328-60028) Replaceable Parts:
Change A1 series to 2017.
Change A1R1 to 0683-2715, 270, 5% 25W.
Change A1R76 to 0698-2215, 220 ohms.
Change A1C3 to 0180-0230, 1µF, 50V.
Delete A1R83; 0698-4037; RESISTOR 46.4 1% .125W F TC=0±100 (CRB14).
Delete A1R84; 0757-0422; RESISTOR 909 1% .125W F TC=0±100 (CRB14).
Delete A1R85; 0698-7236; RESISTOR 1K 1% .05W F TC=0±100 (MF3C).
Delete A1Q10; 0853-0036; TRANSISTOR PNP SI PD=310MW FT=250MHz (SKA3334).
Delete A1C54; 0180-2617; CAPACITOR-FXD 6.8µF ±10% 35VDC TA (T368B685K035ASC8240).

Table 6-2, Replaceable Parts:
Under CHASSIS PARTS:
Delete W2; 05328-60126; CABLE AY-EXT REF IN.
Under MISCELLANEOUS PARTS:
Delete 0360-1190; TERMINAL-SLDR LUG PL-MTG FOR-#3/8-SCR (720-,380H).

Figure 8-7, A1 Motherboard Schematic and Components (Sheet 1 of 2):
Change series at top of diagram to 2017.
Delete C54, R83, R84, R85, and Q10.
Delete the shielded cable symbol from the "EXT OSC IN" line.

CHANGE 20 (2105)

Table 6-2, A2 (05328-60035) Replaceable Parts:
Change A2 series to 2023.
Change A2XQ1, XQ2, XQ7, XQ8, and XQ11 to 1251-3246, SOCKET-XSTR 3-CONT.

Table 6-2, A12 (05328-60042) Replaceable Parts:
Change A12 series to 2023.
Change A12W1 and W2 to 05328-60111.
Change the following resistors as shown:

REFERENCE DESIGNATION	HP PART NO.	DESCRIPTION
A12R1, R2	0698-5426	RESISTOR 10K 10% .125W
A12R5, R8	0698-5999	RESISTOR 4.64K 5% .125W
A12R11, R13	0675-1021	RESISTOR 1K 10% .12W
A12R29, R30	0698-5996	RESISTOR 560 5% .125W
A12R34, R36	0698-6283	RESISTOR 10 5% 1.8W

Figure 8-9, A2 Power Supply Schematic and Components:
Change series at top of digaram to 2023.
Move C2 to between R2 and R34.
Delete C23.
Delete C24.
Move R1 connection from +12V and R35 to between +12V and the plus (+) side of CR13.
Move R35 from between F1 and C9 to between C1 and F1.

Figure 8-20, A12 "A-B" Channel Schematic and Components:
Change series at top of diagram to 2023.
Move R24 to between 4,5 of K10 and 1,8 of K11.
Move R22 to between 4,5 of K2 and the vertical line going from R39 to 4,5 of K4.

CHANGE 21 (2047)

Table 6-2, Replaceable Parts:
Change A15U28 and A15U34 to 1820-1166 DM85L51.

CHANGE 22 (2041)

Table 6-2, A2 Replaceable Parts:
Change A2 series to 2041.
Change A2C14 to 0180-0418, 1µF, CAPACITOR-FXD 1µF ±20% 35VDC.
Delete A2C23, C24, C25; 0180-2821; CAPACITOR-FXD 22µF ±20% 35VDC TA; 28480.
Delete A2R38; 0683-1025; RESISTOR 1K 5% .25W FC TC=-400/600; 01121; CB1025.

Figure 8-9, A2 Power Supply Schematic Diagram:
Change A2 series to 2041.
Change A2C14 to 1µF.
Delete R38, 1K from the base to the emitter of A2Q11.
Delete C25, 22U from the "+3.5V" line to "+3.5V" common, positive side to +3.5V.
Delete C23, 22U near the cathode of CR1, from the "12V" line to common, positive side to +12V.
Delete C24, 22U near the anode of CR2, from the "-12V" line to common, positive side to common.

NOTE: Instrument Serial Numbers 2047A16694 through 2047A16753 include the modifications in CHANGE 23.

Table 6-2, A8 (05328-60032) Replaceable Parts:
Change A8 series to 2041.
Delete an asterisk (*) to A8C10 and A8C19.
Delete A8C35; 0160-3878; CAPACITOR-FXD 1000PF ±20% 100VDC CER.
Delete NOTE: A8R93* (previously added to CHANGE 23) is not normally needed when A8C35 is installed.
Delete A8R92*; 0757-0280; RESISTOR 1K 1% .125W F TC=0±100.

CHANGE 22 (Cont'd)

Table 6-2, Replaceable Chassis Parts:
Change the quantity of 05328-00003; BRACKET, FRONT to 1.
Delete the following note to 05328-00011; SHIELD, FREQUENCY C:

NOTE

The FREQUENCY C SHIELD may or may not be included in all instruments.

Figure 8-14, A8 Channel "C" Schematic Diagram:
Change A8 series to 2041.
Delete C35 (1000PF) from U2(7) to U2(10) at the junction of C19 and R42.
Delete NOTE: R93* (previously added in CHANGE 23) is not normally needed when C35 is installed.
Delete asterisk (*) by C10 and C19.
Delete R92* (1K).

NOTE: Instruments with Serial Numbers 2047A16694 through 2047A16753 include the modifications in CHANGE 23.

CHANGE 23 (2023)

Table 6-2, A8 (05328-60032) Replaceable Parts:
Change series to 2023.
Change A8C25 to 0160-4084, .1μF, 50V.
Delete A8R93*; 0698-5996; RESISTOR 560 OHMS 5% .125W CC TC=-330/+800.
*A8R93 is a factory selected value.

Figure 8-14, A8 Channel "C" Schematic:
Change series to 2023.
Delete R93* 560 ohms between U2 Pin 4 and U2 Pin 11.

CHANGE 24 (2017)

Table 6-2, A2 Power Supply Replaceable Parts:
Change A2 series to 1936.
Change A2C15 and C16 to 0140-0209; CAPACITOR-FXD 5PF 500V.

Table 6-2, A8 Replaceable Parts:
Change A8 series to 2017.
Change A8U9 to 1826-0139; MC 1458 DUAL COMPARATOR.

Table 6-2, A12 Replaceable Parts:
Change A12 series to 1828.
Change A12K4 to 05328-80041 RELAY, SHIELD, D.

Figure 8-9, A2 Power Supply Schematic Diagram:
Change the series to 1936.
Change A2C15 and C16 to 5PF.

Figure 8-20, A12 "A-B" Channel Schematic Diagram:
Change A12 series to 1828.

Table 7-2. A8 Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A8	05328-60032	8	1	"C" CHANNEL INPUT (SERIES 2424)	28480	05328-60032
A8C1	0160-4084	8	6	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A8C2	0180-0428	8	11	CAPACITOR-FXD 68UF+-20% 6VDC TA	28480	0180-0428
A8C3	0180-0428	8		CAPACITOR-FXD 68UF+-20% 6VDC TA	28480	0180-0428
A8C4	0180-0135	8	1	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	1	CAPACITOR-FXD 6.8UF+-20% 6VDC TA	56289	150D685X0006A2
A8C7	0160-2599	6	1	CAPACITOR-FXD 680PF +-10% 200VDC CER	28480	0160-2599
A8C8	0160-4084	8		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A8C9	0160-3879	7	45	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A8C10	0160-3878	6	9	CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A8C11	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A8C12	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A8C13	0160-4084	8		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A8C14	0180-0474	4	2	CAPACITOR-FXD 15UF+-10% 20VDC TA	28480	0180-0474
A8C15	0180-0474	4		CAPACITOR-FXD 15UF+-10% 20VDC 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 1000PF +-20% 100VDC CER	28480	0160-3878
A8C19	0160-3878	6		CAPACITOR-FXD 1000PF +-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	4	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
	0160-3878	6				
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	1	CAPACITOR-FXD .01UF +-20% 200VDC CER	51642	200-200-X7R-103M
A8CR1	1901-0050	3	6	DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A8CR2	1901-0518	8	4	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-SCHOTTKY	28480	1901-0518
A8CR6	1901-0535	9	4	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	1	FUSE .125A 125V .281X.093	28480	2110-0301
	05305-20104	1	1	FUSE HOLDER	28480	05305-20104
	05305-20105	2	1	INSULATOR	28480	05305-20105
	05305-60205	7	1	CONNECTOR ASSEMBLY, BNC	28480	05305-60205
	05305-60206	8	1	CONNECTOR ASSEMBLY, BNC	28480	05305-60206
A8L1	9100-1788	6	3	CHOKE-WIDE BAND ZMAX=680 OHMS 180 MHZ	02114	VK200 20/4B
A8L2	9100-1788	6		CHOKE-WIDE BAND ZMAX=680 OHMS 180 MHZ	02114	VK200 20/4B
A8L3	9140-0137	1	1	INDUCTOR-RF-CH-MLD 1MH 5% .20X.65LG Q=40	28480	9140-0137
A8L4	9100-1788	6		CHOKE-WIDE BAND ZMAX=680 OHMS 180 MHZ	02114	VK200 20/4B
A8Q1	1854-0071	7	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	4	TRANSISTOR NPN SI PD=200MW FT=800MHZ	28480	1854-0092
A8Q4	1854-0092	2		TRANSISTOR NPN SI PD=200MW FT=800MHZ	28480	1854-0092
A8Q5	1854-0092	2		TRANSISTOR NPN SI PD=200MW FT=800MHZ	28480	1854-0092
A8Q6	1854-0092	2		TRANSISTOR NPN SI PD=200MW FT=800MHZ	28480	1854-0092
A8Q7	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A8Q9	1853-0036	2	2	TRANSISTOR PNP SI PD=310MW FT=250MHZ	28480	1853-0036
A8R1	0683-1035	1	33	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	4	6	RESISTOR 270 5% .25W FC TC=-900/+800	01121	CB2715
A8R4	0683-1055	5	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
*Indicates factory selected value

Table 7-2. A8 Replaceable Parts (Continued)

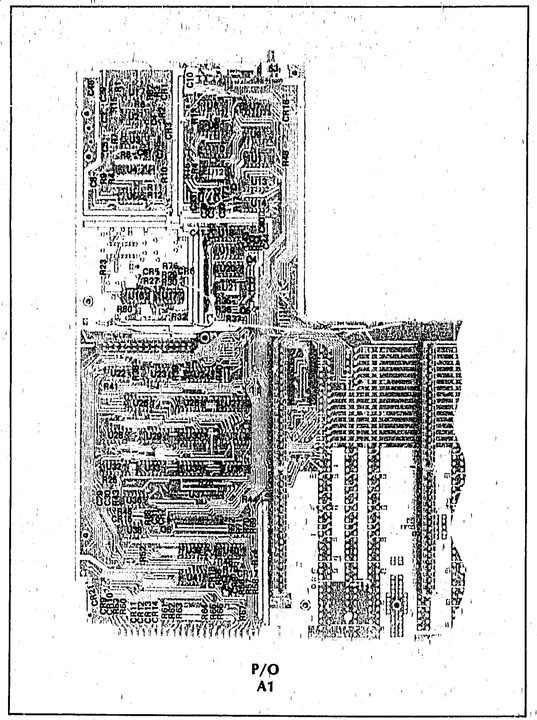
Reference Designation	HP Part Number	c d	Qty	Description	Mfr Code	Mfr Part Number
A8R6	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A8R7	0683-1215	9		RESISTOR 120 5% .25W FC TC=-400/+800	01121	CB1215
A8R8	0683-4715	3	4	RESISTOR 470 5% .25W FC TC=-400/+800	01121	CB4715
A8R9	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A8R10	0698-6354	2	1	RESISTOR 870 5% .125W CC TC=-330/+860	01121	BB8715
A8R11	0698-6283	2	3	RESISTOR 10 5% .125W CC TC=-120/+480	01121	BB1005
A8R12	0683-5615	1	4	RESISTOR 560 5% .25W FC TC=-400/+800	01121	CB5615
A8R13	2100-2522	1	1	RESISTOR-TRMR 10K 10% C BODE-ADJ 1-TRN	30983	RT50X103
A8R14	0698-3378	0	5	RESISTOR 51 5% .125W CC TC=-270/+540	01121	BB5105
A8R15	0683-8205	1	2	RESISTOR 82 5% .25W FC TC=-400/+500	01121	CB8205
A8R16	0683-1125	0	4	RESISTOR 1.1K 5% .25W FC TC=-400/+700	01121	CB1125
A8R17	0683-8215	3		RESISTOR 820 5% .25W FC TC=-400/+800	01121	CB8215
A8R18	0757-1001	8	1	RESISTOR 96.2 1% .5W F TC=0+-100	28480	0757-1001
A8R19	0683-3015	1	2	RESISTOR 300 5% .25W FC TC=-400/+800	01121	CB3015
A8R20	0683-5125	A	6	RESISTOR 5.1K 5% .25W FC TC=-400/+700	01121	CB5125
A8R21	0683-1215	9		RESISTOR 120 5% .25W FC TC=-400/+800	01121	CB1215
A8R22	0683-5135	0	2	RESISTOR 51K 5% .25W FC TC=-400/+800	01121	CB5135
A8R23	0683-4715	0	2	RESISTOR 470 5% .25W FC TC=-400/+800	01121	CB4715
A8R24	0698-3378	0		RESISTOR 51 5% .125W CC TC=-270/+540	01121	BB5105
A8R25	0683-5125	A		RESISTOR 5.1K 5% .25W FC TC=-400/+700	01121	CB5125
A8R26	0683-1125	0		RESISTOR 1.1K 5% .25W FC TC=-400/+700	01121	CB1125
A8R27	0683-8205	1		RESISTOR 82 5% .25W FC TC=-400/+500	01121	CB8205
A8R28	0683-5105	A	11	RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A8R29	0683-5615	1		RESISTOR 560 5% .25W FC TC=-400/+800	01121	CB5615
A8R30*	0698-7080	9	4	RESISTOR 27 5% .125W CC TC=-270/+540	01121	BB2705
A8R31	0698-7080	9		RESISTOR 27 5% .125W CC TC=-270/+540	01121	BB2705
A8R32	0683-1125	0		RESISTOR 1.1K 5% .25W FC TC=-400/+700	01121	CB1125
A8R33	0683-1125	0		RESISTOR 1.1K 5% .25W FC TC=-400/+700	01121	CB1125
A8R34	0683-2025	1	10	RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A8R35	0683-5105	A		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A8R36	0683-5105	A		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A8R37	0698-3378	0		RESISTOR 51 5% .125W CC TC=-270/+540	01121	BB5105
A8R38	0698-3111	9	1	RESISTOR 30 5% .125W CC TC=-270/+540	01121	BB3005
A8R39	0698-3378	0		RESISTOR 51 5% .125W CC TC=-270/+540	01121	BB5105
A8R40	0683-6825	7	1	RESISTOR 6.8K 5% .25W FC TC=-400/+700	01121	CB6825
A8R41	0698-4132	H		RESISTOR 62 5% .125W CC TC=-270/+540	01121	BB6205
A8R42	0698-4131	5	1	RESISTOR 56 5% .125W CC TC=-270/+540	01121	BB5605
A8R43*	0683-1215	9	A	RESISTOR 120 5% .25W FC TC=-400/+800	01121	CB1215
A8R44	0683-1815	7	3	RESISTOR 180 5% .25W FC TC=-400/+800	01121	CB1815
A8R45	0683-5105	A		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A8R46	0683-5105	A		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A8R47	0698-3378	0		RESISTOR 51 5% .125W CC TC=-270/+540	01121	BB5105
A8R48	0683-4715	0		RESISTOR 470 5% .25W FC TC=-400/+800	01121	CB4715
A8R49	0683-5125	A		RESISTOR 5.1K 5% .25W FC TC=-400/+700	01121	CB5125
A8R50	0683-5125	A		RESISTOR 5.1K 5% .25W FC TC=-400/+700	01121	CB5125
A8R51	0683-5135	0		RESISTOR 51K 5% .25W FC TC=-400/+800	01121	CB5135
A8R52	0683-1215	9		RESISTOR 120 5% .25W FC TC=-400/+800	01121	CB1215
A8R53	0683-3315	4	7	RESISTOR 330 5% .25W FC TC=-400/+800	01121	CB3315
A8R54	0683-5615	1		RESISTOR 560 5% .25W FC TC=-400/+800	01121	CB5615
A8R55	0683-3015	1		RESISTOR 300 5% .25W FC TC=-400/+800	01121	CB3015
A8R56	0683-5125	A		RESISTOR 5.1K 5% .25W FC TC=-400/+700	01121	CB5125
A8R57	0757-0465	1	1	RESISTOR 511K 1% .125W F TC=0+-100	24546	C4-1/8-TP-5102-F
A8R58*	0757-0459	3	1	RESISTOR 30K 1% .125W F TC=0+-100	24546	C4-1/8-TP-3002-F
A8R59	0757-0920	2	2	RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-TP-1001-F
A8R60	0683-5105	A		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A8R61	0683-5105	A		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A8R62	0683-2215	1	3	RESISTOR 220 5% .25W FC TC=-400/+800	01121	CB2215
A8R63	0683-5105	A		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A8R64	0683-5105	A		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A8R65	0683-1815	7		RESISTOR 180 5% .25W FC TC=-400/+800	01121	CB1815
A8R66	0683-4705	A	1	RESISTOR 47 5% .25W FC TC=-400/+500	01121	CB4705
A8R67	0683-1025	9	15	RESISTOR 1K 5% .25W FC TC=-400/+800	01121	CB1025
A8R68*	0698-4132	6	2	RESISTOR 62 5% .125W CC TC=-270/+540	01121	BB6205
A8R69	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+800	01121	CB1025
A8R70	0683-2005	7	6	RESISTOR 20 5% .25W FC TC=-400/+700	01121	CB2005
A8R71	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+800	01121	CB1025
A8R72	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+800	01121	CB1025
A8R73	0683-2005	7		RESISTOR 20 5% .25W FC TC=-400/+500	01121	CB2005
A8R74	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+800	01121	CB1025
A8R75	1810-0080	6	7	NETWORK-RES 8-SIP500.0 OHM X 7	28480	1810-0080
A8R76	0683-1525	4		RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	CB1525
A8R77	0683-5125	A		RESISTOR 5.1K 5% .25W FC TC=-400/+700	01121	CB5125
A8R78	0683-5615	1		RESISTOR 560 5% .25W FC TC=-400/+800	01121	CB5615
A8R79	0683-2025	1		RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A8R80	0683-2715	6		RESISTOR 270 5% .25W FC TC=-400/+800	01121	CB2715

BACK DATING MANUAL CHANGES CON'T

Table 7-2. A8 Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
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
A8R82	2100-3793	0	1	RESISTOR-TRMR 10K 10% C SIDE-ADJ 17-TRN	28480	2100-3793
A8R83*	0698-7080	9		RESISTOR 27 5% .125W CC TC=-270/+940	01121	BB2705
A8R84*	0698-7080	9		RESISTOR 27 5% .125W CC TC=-270/+940	01121	BB2705
A8R85	2100-2633	5	1	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 4700 5% .25W FC TC=-800/+900	01121	CB4745
A8R90	0683-5105	4		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A8R91	0683-5105	4		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A8U1	1826-0084	3	1	IC WIDEBAND AMPL MB	28480	1826-0084
A8U2	1826-0085	4	1	IC WIDEBAND AMPL MB	28480	1826-0085
A8U3	1820-1999	9	1	IC	28480	1820-1999
A8U4	1820-2000	5	1	IC FF ECL D-M/S POS-EDGE-TRIG	28480	1820-2000
A8U5	1820-1019	4	1	IC CNTR ECL MI-QUINARY	28480	1820-1019
A8U6	1820-1052	5	2	IC XLTR ECL ECL-TO-TTL QUAD 2-INP	04713	MC10125L
A8U7	1820-0301	5	1	IC LCH TTL D-TYPE 8-BIT	01295	SN7475N
A8U8	1820-0511	2	2	IC GATE TTL NAND QUAD 2-INP	01295	SN7426N
A8U9	1826-0139	9	2	IC OP AMP GP DUAL 8-DIP-P	01928	CA1458G
A8U10	1826-0139	9		IC OP AMP GP DUAL 8-DIP-P	01928	CA1458G
A8U11	1820-0803	2	3	IC GATE ECL OR-NOR TPL	04713	MC10105P
A8U12	1820-0511	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-MS .187-OD/.093-RCVD .02-WALL	28480	0890-0029
	1250-0828	8	1	CONNECTOR-RF BNC FEM UNMTD 50-OHM	28480	1250-0828
	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
	1200-0083	2	2	CONNECTOR-SGL CONT SKT .04-IN-BSC-BZ AND	28480	1200-0083
	1990-0517	4	1	LED-VISIBLE LUM-INT=3MCD IF=20MA-MAX	28480	5082-4855
	8150-0450	1	1	WIRE 24AWG 0 300V PVC 7X32 BOC	28480	8150-0450
	8150-0451	2	1	WIRE 24AWG Y 300V PVC 7X32 BOC	28480	8150-0451
				A8 MISCELLANEOUS		
	0380-0310	1	4	STANDOFF-RVT-ON .75-IN-LG 6-32THD	00000	ORDER BY DESCRIPTION
	1200-0479	0	81	CONNECTOR-SGL CONT SKT .018-IN-BSC-BZ	28480	1200-0479
	1251-0600	0	3	CONNECTOR-SGL CONT PIN .14-MM-BSC-BZ BO	28480	1251-0600
	1251-2329	3	2	CONNECTOR-SGL CONT SKT .033-IN-BSC-BZ	28480	1251-2329
	1480-0116	5	3	PIN-GRV .062-IN-DIA .25-IN-LG BTL	28480	1480-0116
	4040-0747	2	1	EXTR-PC BD GRA POLYC .062-BD-THKNS	28480	4040-0747

See introduction to this section for ordering information
*Indicates factory selected value



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A1

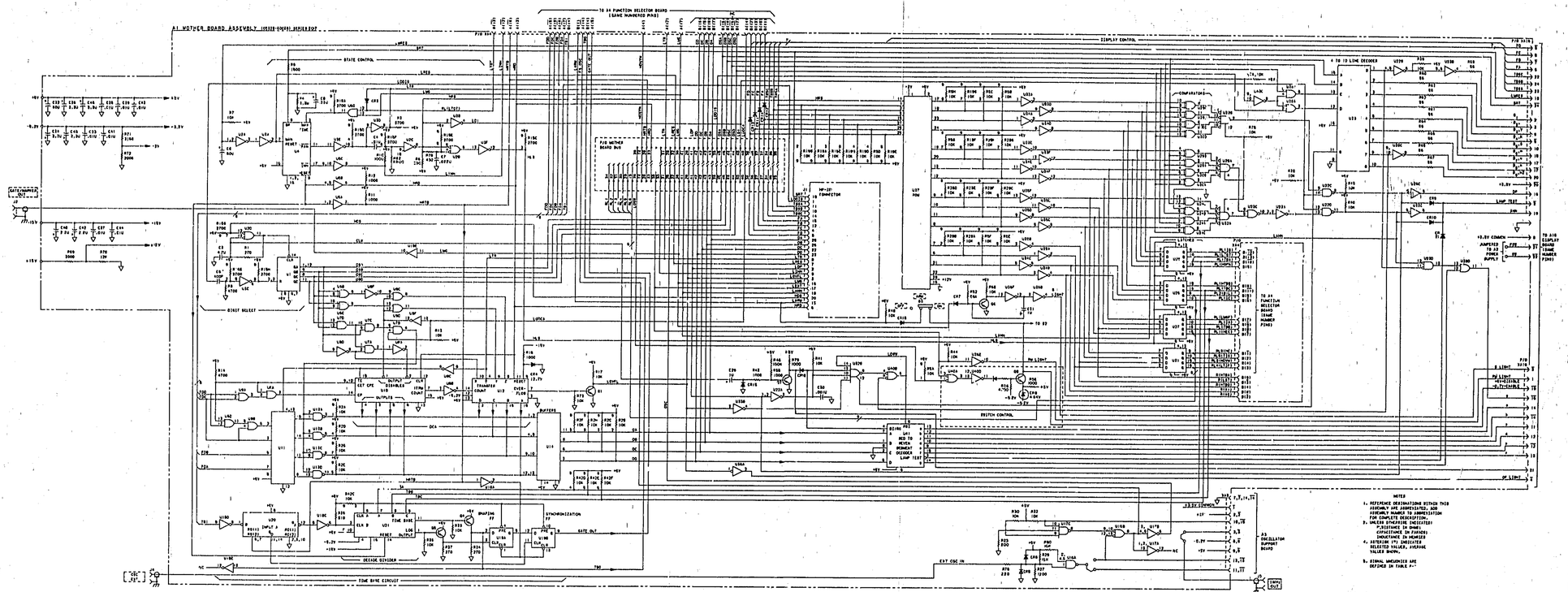
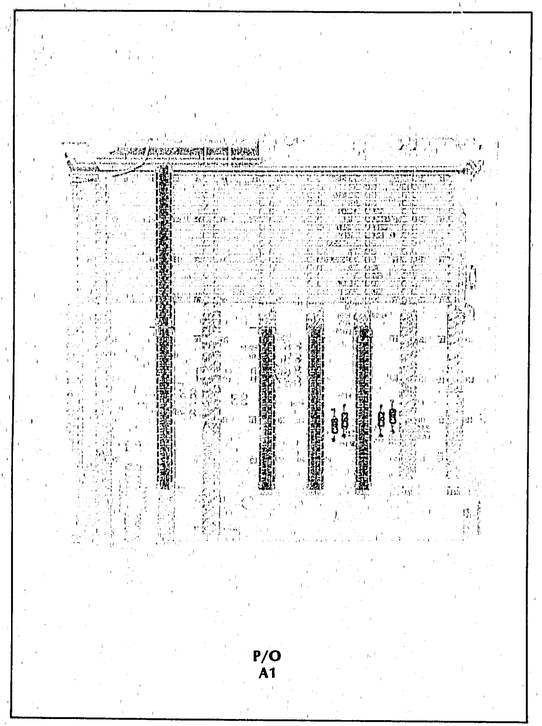


Figure 7-1. A1 Motherboard Schematic Diagram
(Sheet 1 of 2)



P/O
A1

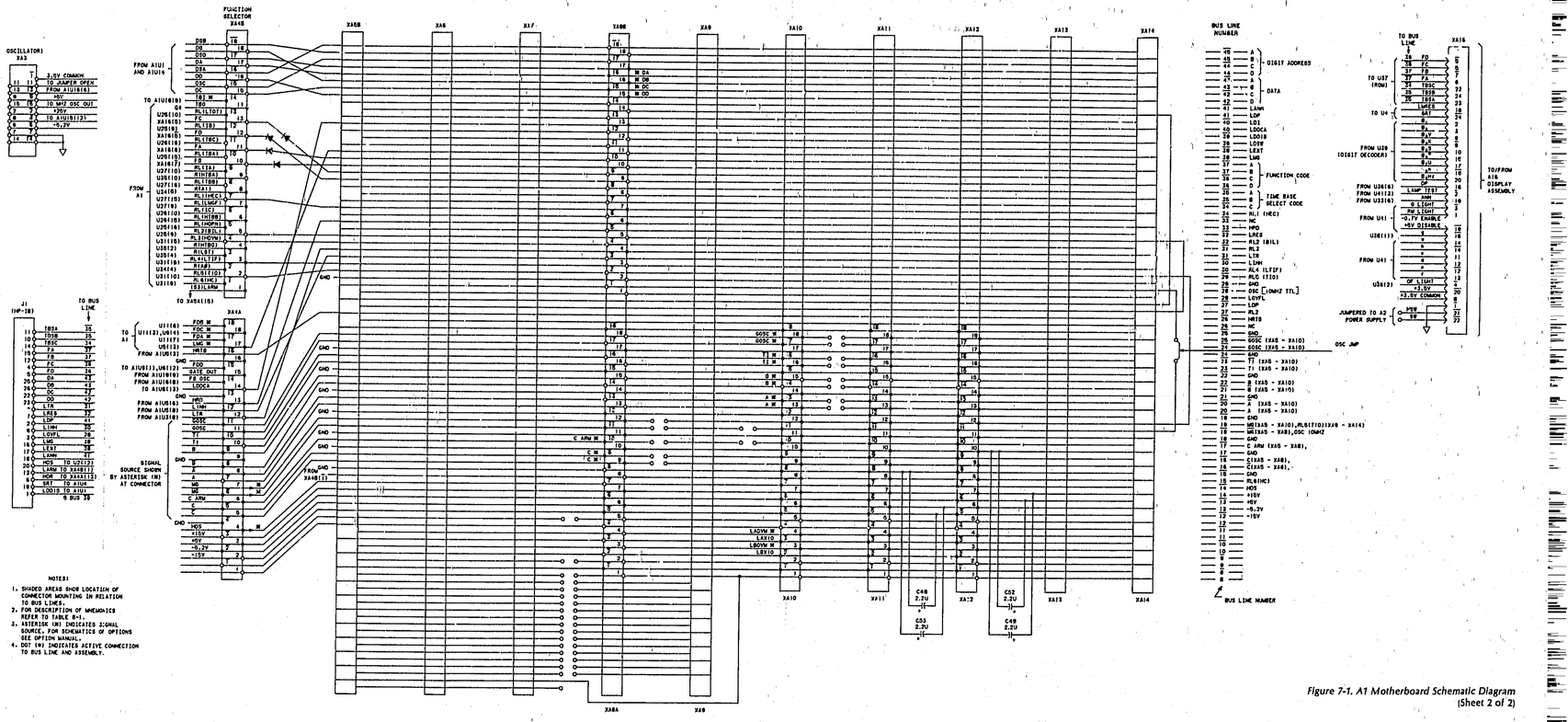
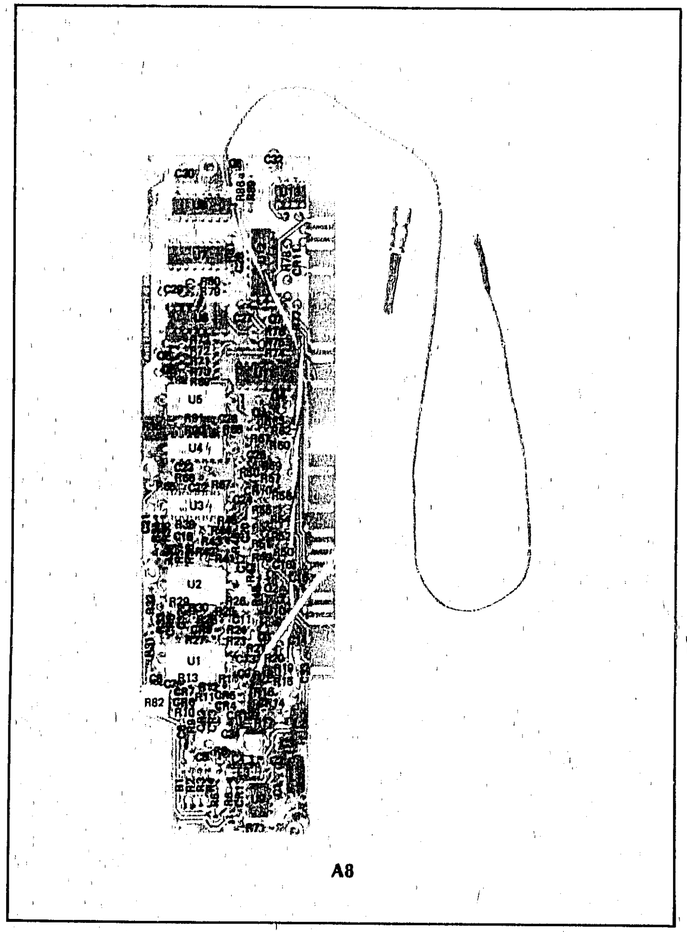


Figure 7-1. A1 Motherboard Schematic Diagram
(Sheet 2 of 2)



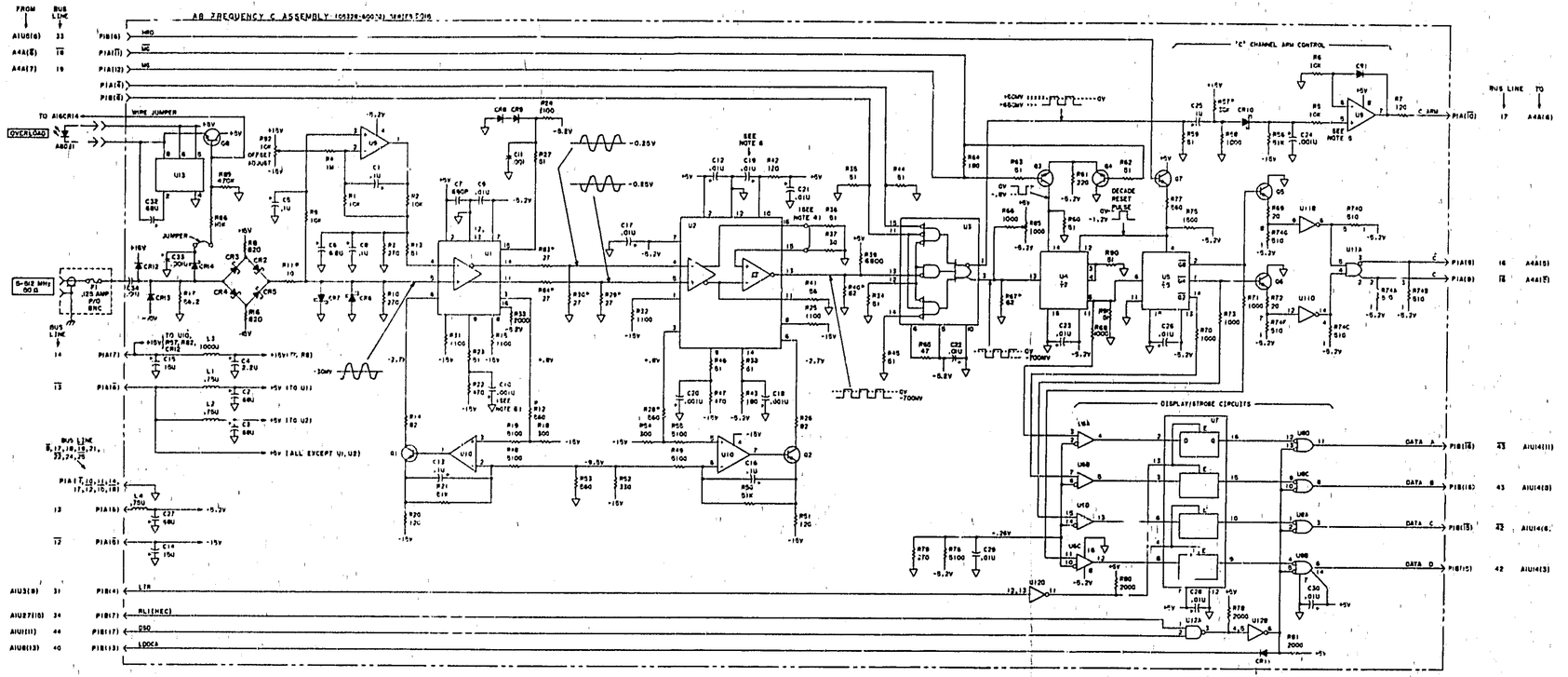


Figure 7-3. A8 Channel C Schematic Diagram

SCHEMATIC DIAGRAMS

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 electricla difference exists. If the number of 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 changes sheet 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.

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 1 of dip switches.

8-14. ASSEMBLY LOCATIONS AND COMPONENT LOCATORS

8-15. Figures in this section show the front, rear, and top views of the 5328A. The front and rear view 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 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.

8-18. PROCEDURES TO SELECT A8R19

8-19. When selecting the optimum value for A8 R19 use a 1%, .05W resistor (NOMINAL VALUE is 10k, select values ranging from 3.16K to OPEN). The value selected is for optimum sensitivity over the frequency range of the Channel C board (50 MHz to 500 MHz). Following is a partial list of the values and HP part number for resistors which may be used. Values between 3.16K and OPEN, other than those listed, may also be used.

VALUE	HP PART NO.
3.16K	0698-7248
3.83K	0698-7250
4.64K	0698-7252
5.62K	0698-7254
6.81K	0698-7256
8.25K	0698-7258
9.09K*	0698-7259
10.0K	0698-7260
12.1K	0698-7262
14.7K	0698-7264
OPEN	————

*NOMINAL VALUE

a. Connect the output from an 8640B Signal Generator to the HP 5328A front panel Channel C input (50Ω), through a power splitter.

b. Connect the HP 5328A rear panel 10 MHz OUT to the rear panel TIME BASE of the 8640B Signal Generator. Set the 8640B rear panel reference selector switch to EXT.

c. Set the 8640B Signal Generator FREQUENCY to 500 MHz; AMPLITUDE to 30 mV rms.

d. Set the HP 5328A FUNCTION to FREQ C; RESOLUTION to .1 kHz; SAMPLE RATE to fully ccw position.

e. Adjust the amplitude of the 8640B Signal Generator as low as possible while still maintaining a stable count with the HP 5328A. Check the reading on the Power Meter.

f. The Power Meter should read -16.16 dBm or less (e.g., -17 dBm). If the reading is -16.16 dBm or less, the value of A8R19 is acceptable and the procedure is completed. If the Power Meter reading is greater than -16.16 dBm (e.g., -15 dBm), record the dBm level and go to step g.

g. Select the next lower value resistor (than the value installed) for A8R19. Repeat steps e and f.

NOTE

If it is necessary to select a value less than 3.16K for A8R19 to obtain optimum sensitivity for teh HP 5328A, the problem is located elsewhere.

8-20. PROCEDURE TO SELECT A8R25

8-21. When selecting the optimum value for A8R25 use 1%, .05W resistor (NOMINAL VALUE is 9.09K, select values ranging from 3.16K to OPEN). The value selected is for a ZERO (±1 count) in the rightmost digit of the HP 5328A display at 500 MHz. Following is a partial list of the values and HP part numbers for resistors which may be used. Values between 3.16K and OPEN, other than those listed, may also be used.

VALUE	HP PART NO.
3.16K	0698-7248
3.83K	0698-7250
4.64K	0698-7252
5.62K	0698-7254
6.81K	0698-7256
8.25K	0698-7258
9.09K*	0698-7259
10.0K	0698-7260
12.1K	0698-7262
14.7K	0698-7264
OPEN	———

*NOMINAL VALUE

a. Connect the output from an 8640B Signal Generator to the HP 5328A front panel Channel C input (50Ω), through a power splitter. Refer to performance test set-up shown in test three of *Table 5-4* (SENSITIVITY - Channel C).

b. Connect the HP 5328A rear panel 10 MHz OUT to the rear panel TIME BASE of the 8640B Signal Generator. Set the 8640B rear panel reference selector switch to EXT.

c. Set the 8640B Signal Generator FREQUENCY to 500 MHz; AMPLITUDE to 30 mV rms.

d. Set the HP 5328A FUNCTION to FREQ C; RESOLUTION to .1 kHz; SAMPLE RATE to MIDRANGE.

e. The HP 5328A display should read 500.0000 MHz (±1 count in the rightmost digit of the display) with the Power Meter reading at approximately -17.5 dBm. If the HP 5328A display reads 500.0000 MHz (±1 count), the value of A8R25 is acceptable. If the rightmost digit of the HP 5328A display is greater or less than ±1 count, go to step f.

f. If the rightmost digit of the HP 5328A display is greater than ±1 count, select the next lower value resistor (than the value installed) for A8R25. Repeat step e. If the rightmost digit of the HP 5328A display is less than ±1 count, select the next higher value resistor (than the value installed) for A8R25. Repeat step e.

8-22. PROCEDURE TO SELECT A GROUNDING WIRE FOR THE HEAT SINK STUD ON A8U3

NOTE

The HP 5328A instrument you have may or may not have a grounding wire on the heat sink stud of A8U3.

8-23. The stud on A8U3 may be grounded for one of two reasons. First, if the HP 5328A A8 Channel C Input Assembly (05328-60045) is prone to arming by itself with no input signal. Secondly, if the sensitivity of the HP 5328A is greater than 11 mV (−16.16 dBm reading on the Power Meter) at 500 MHz and cannot be improved by the selection of A8R19. See Paragraph 8-18.

CAUTION

Extreme care must be used not to overheat A8U3 when soldering the grounding wire to the heat sink stud.

SYMBOLS

FRONT PANEL

REAR PANEL

INTERIOR AND PC BOARDS

WIPER MOVES TOWARD "CW" WHEN CONTROL IS ROTATED CLOCKWISE

POWER LINE GROUND

CIRCUIT COMMON GROUND

FLOATING GROUND

CHASSIS GROUND

KNOB CONTROL

SCREWDRIVER ADJUST

MAIN SIGNAL PATH

FEEDBACK PATH

TEST POINT

"AND" GATE

"OR" GATE

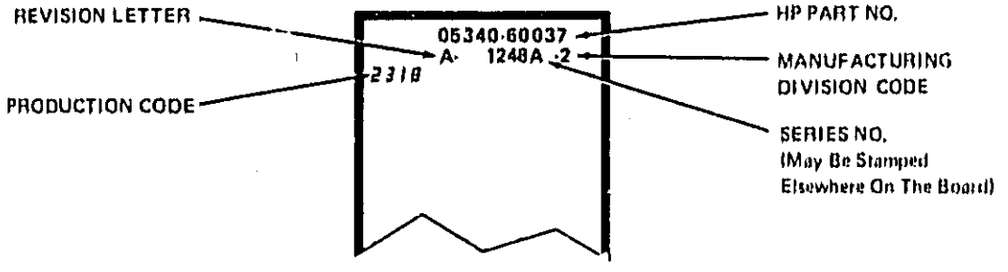
"INVERTER

NAND GATE

NOR GATE

EXCLUSIVE NOR

PRINTED CIRCUIT BOARD IDENTIFICATION



REFERENCE DESIGNATIONS

REFERENCE DESIGNATIONS WITHIN ASSEMBLIES ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION. JACKS ARE THE STATIONARY CONNECTORS AND PLUGS ARE THE MORE MOVEABLE OF TWO CONNECTORS.

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

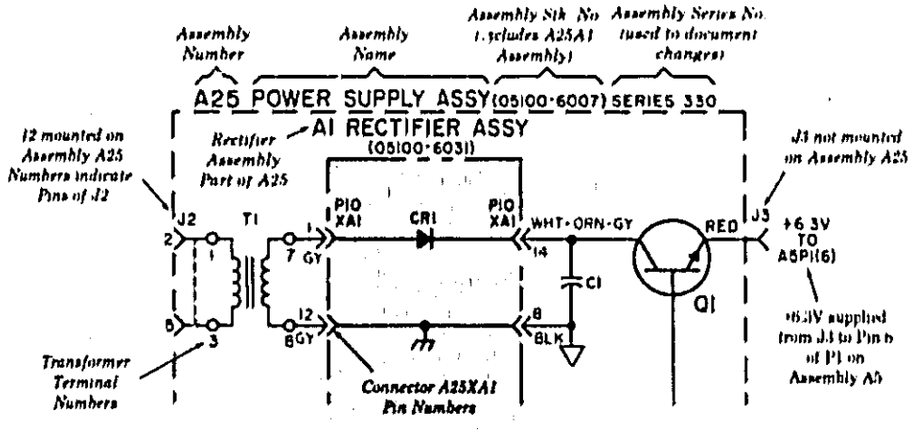


Figure 8-1. Schematic Diagram Notes

Table 8-1. Signal Mnemonics

MNEMONIC	DESCRIPTION
A $\overline{A}$	Output of Time Interval Unit, A channel. ECL levels.
R (AØ) R (A1)	Non-latched ROM bits that drive Arming Multiplexer select lines on Function Selector. TTL levels.
B $\overline{B}$	Output of Time Interval Unit, B channel. ECL levels.
C $\overline{C}$	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 Data B Data C Data D	TTL 4-bit BCD code. Data going to display and HP-IB.
Digit A Digit B Digit C Digit D	TTL 4-bit digit address code. Controls interchange of data.
DVM	Frequency line counted by Function Selector to give display reading. ECL level.
F Code A (FA) F Code B (FB) F Code C (FC) F Code D (FD)	Function code from function switch. TTL levels.
FS	Function Selector.
$\overline{GOSC}$ 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) RL (IB) 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 $\overline{\text{MG}}$	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
$\frac{\text{OSC}}{\overline{\text{OSC}}}$	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) RL (TBB) RL (TBC)	Latched ROM bits that drive Time Base select code inputs.
TBI TBO	TTL signal that drives Time Base. Time Base scaled output. TTL levels.
TBS Code A (TBSA) TBS Code B (TBSB) TBS Code C (TBSC)	Time Base code input to ROM controlled by the Time Base switch. TTL levels.
$\frac{\text{TI}}{\overline{\text{TI}}}$	Time Interval. Output of Time Interval module used in time interval measurements. ECL levels.

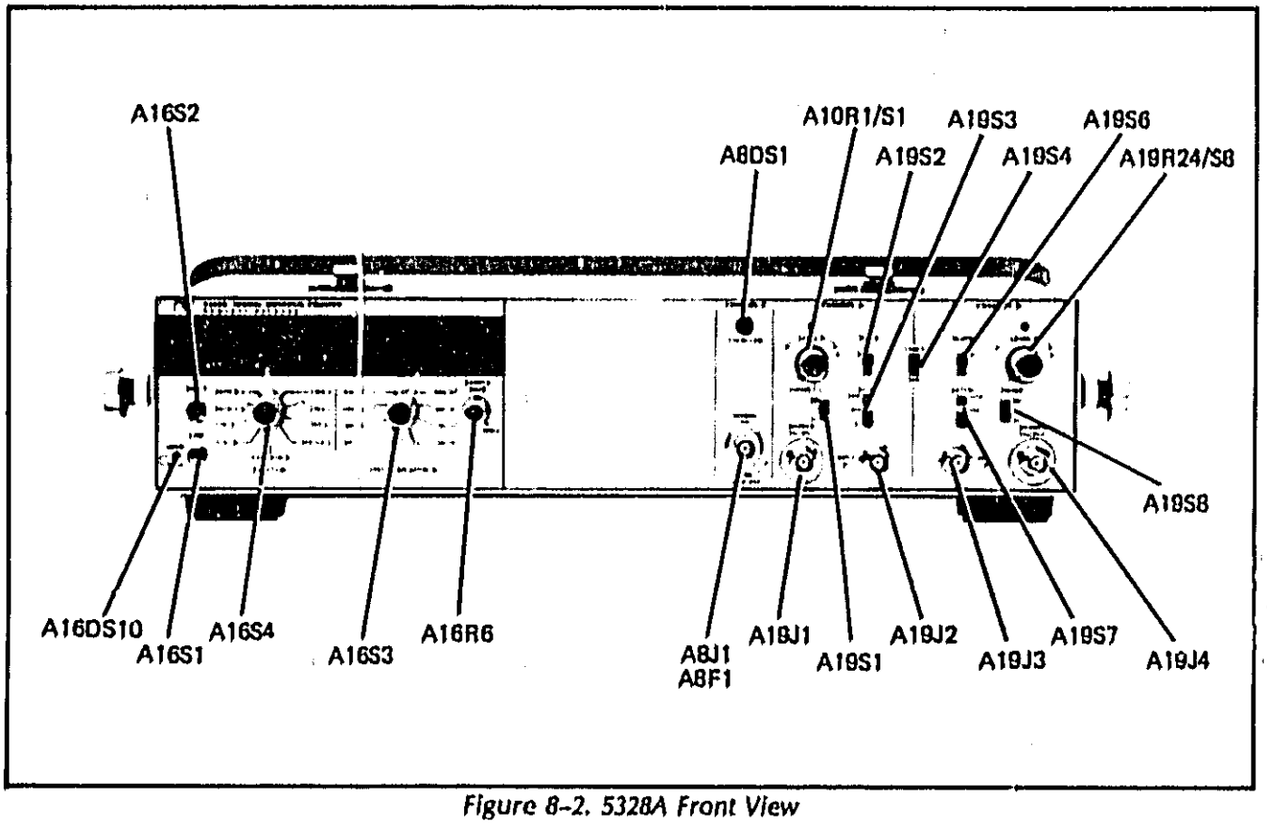


Figure 8-2. 5328A Front View

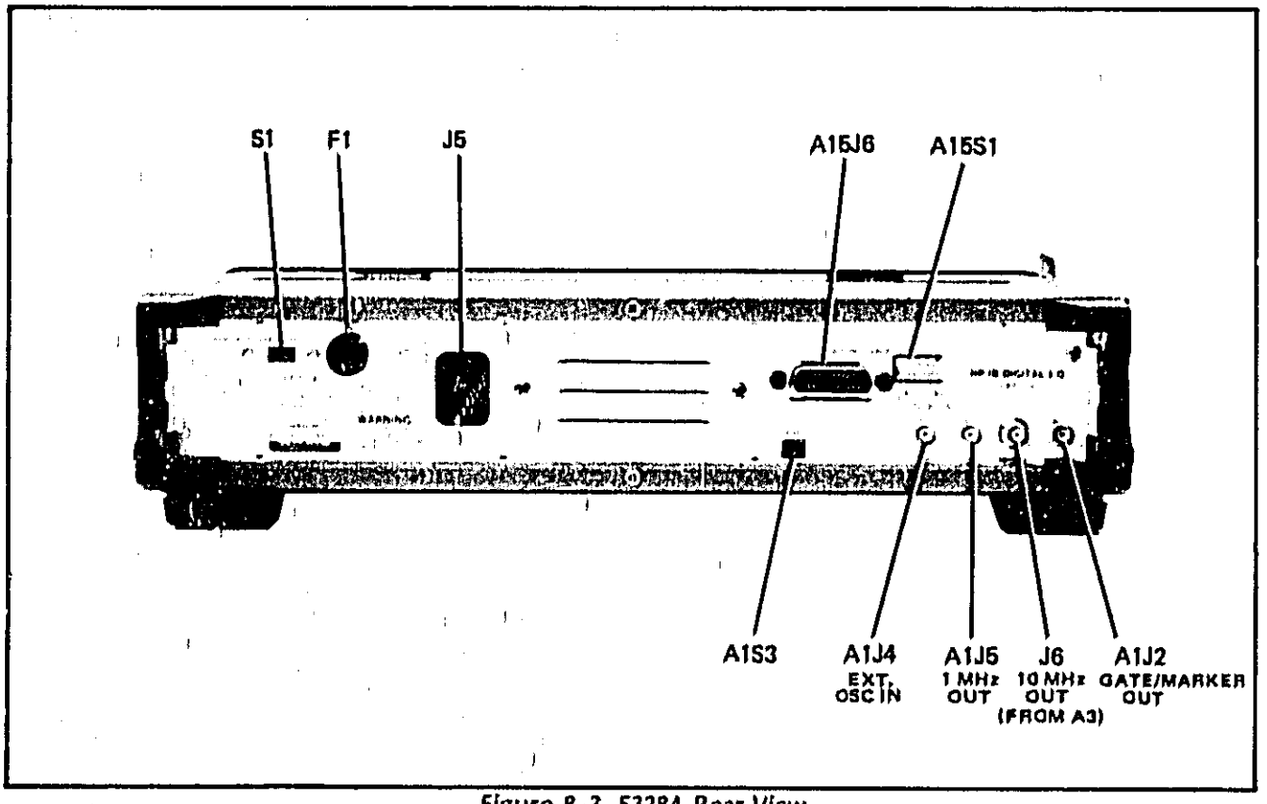


Figure 8-3. 5328A Rear View

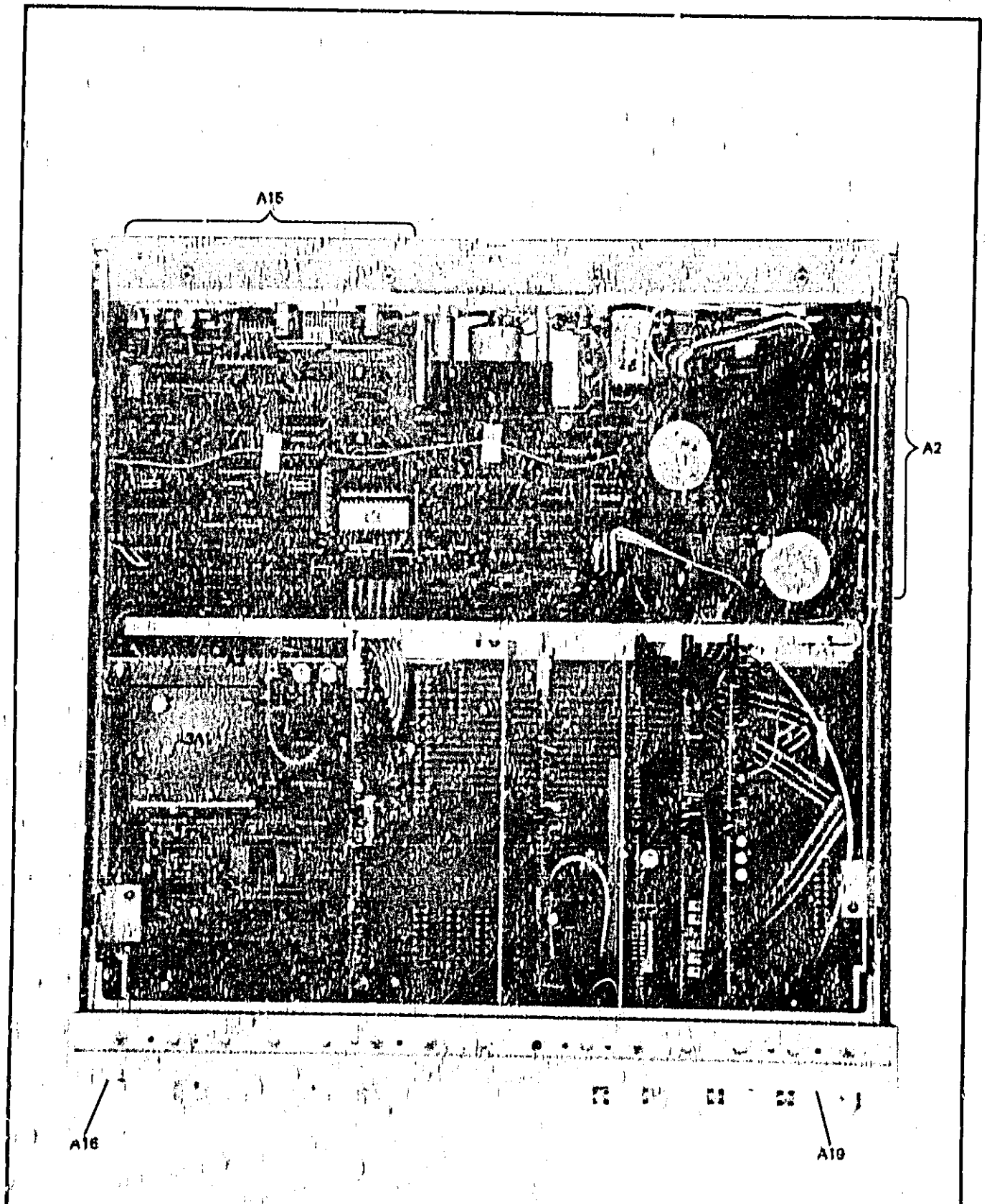


Figure 8-4. HP 5328A/155 Top View

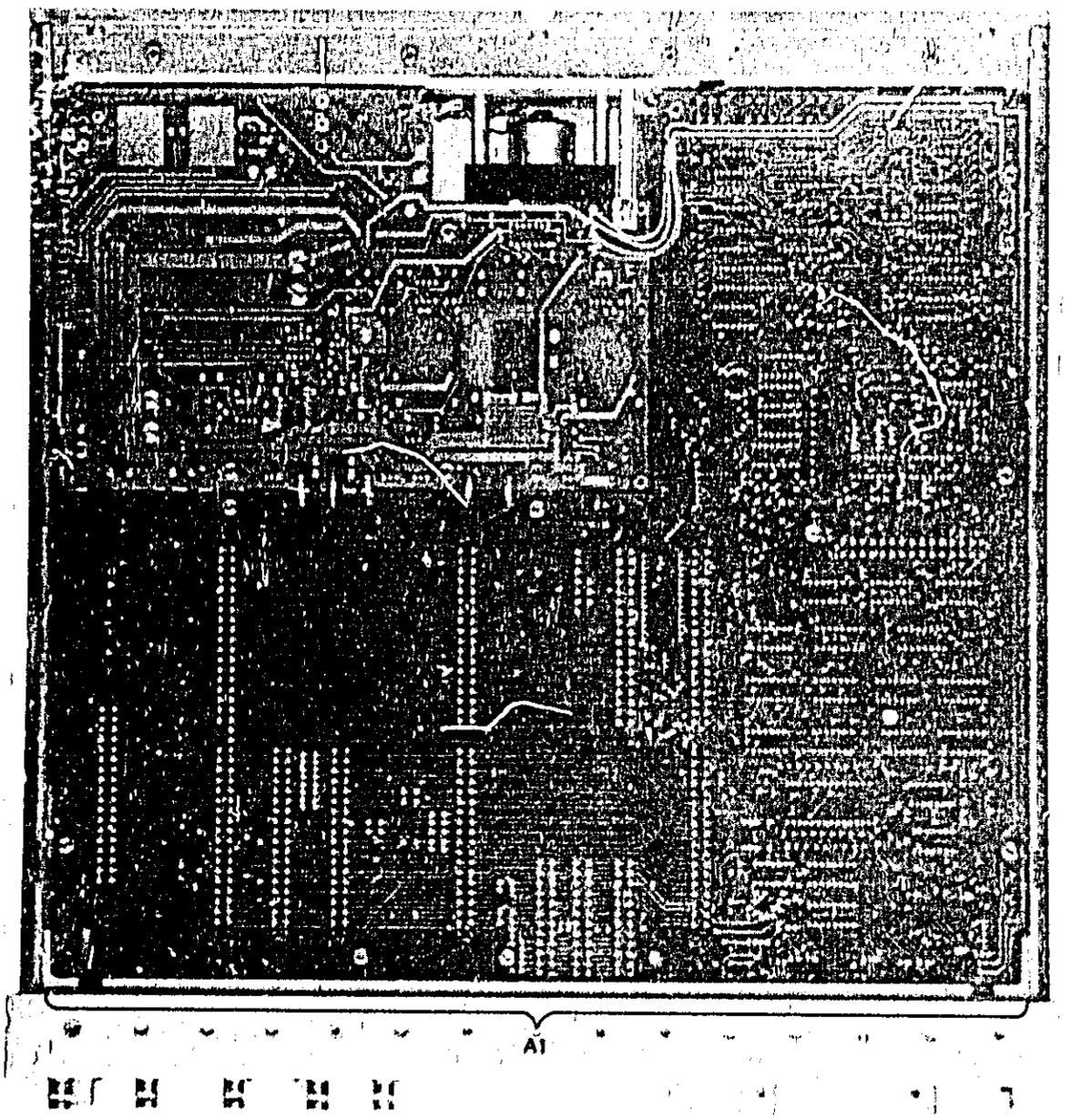


Figure 8-5. HP 5328AH99 Bottom View

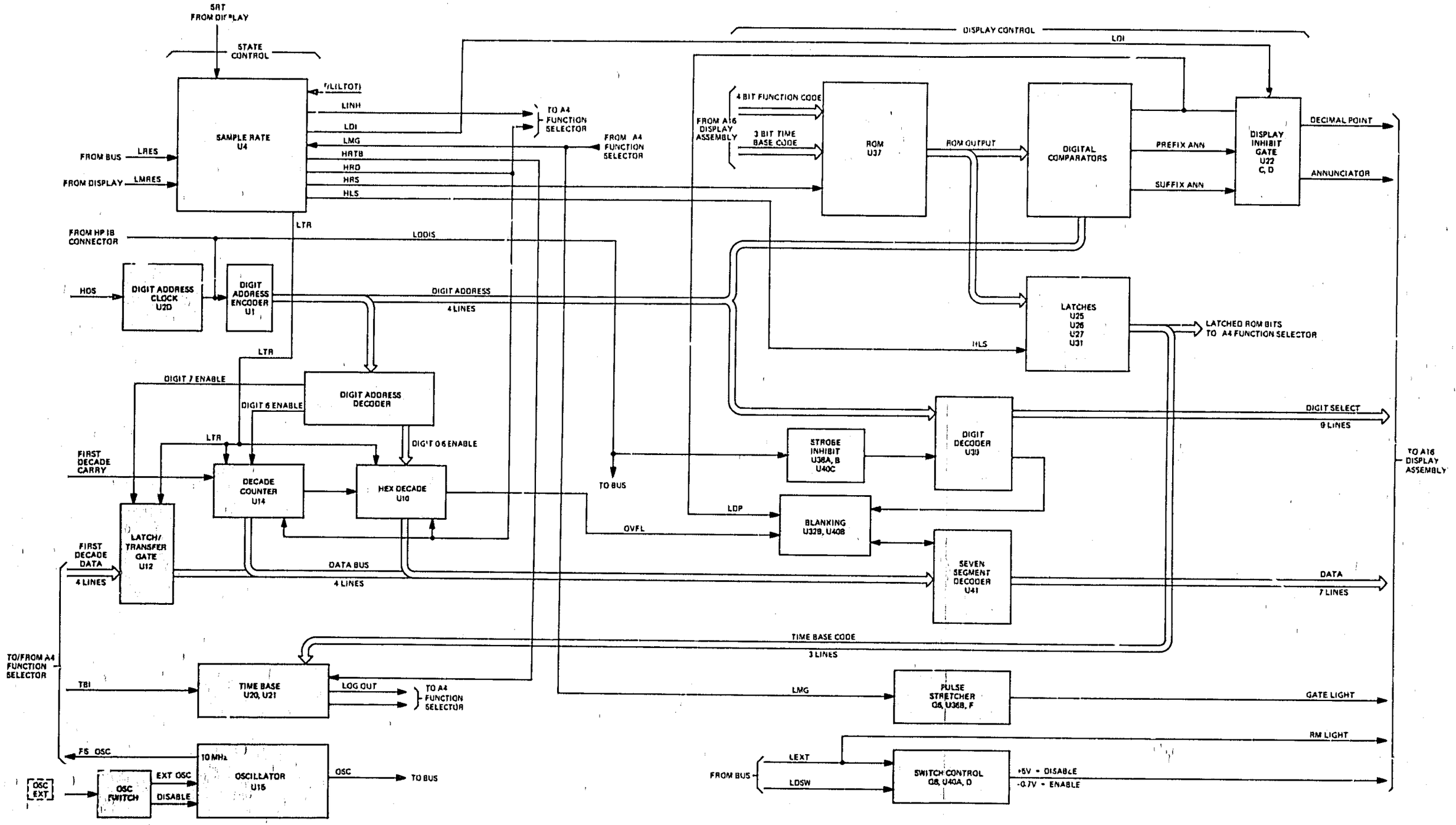


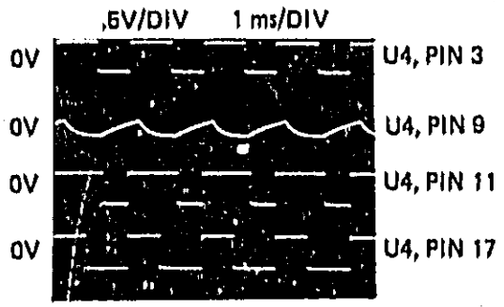
Figure 8-6. A1 Motherboard Block Diagram

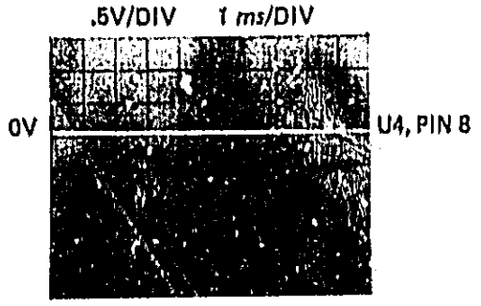
6328A

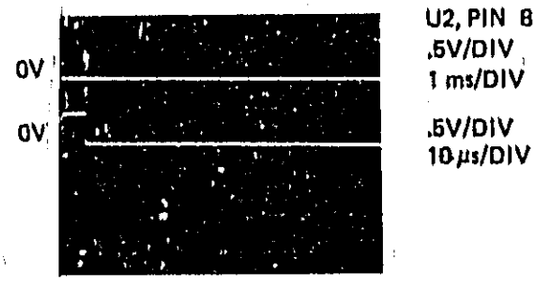
FUNCTION: CHECK
FREQ RESOLUTION: 1 kHz 10^3

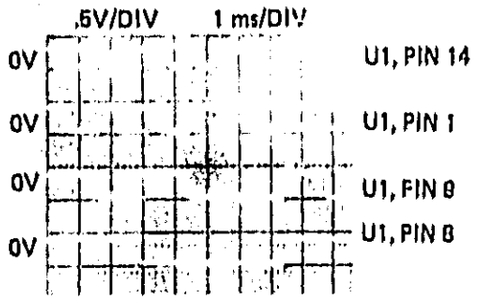
OSCILLOSCOPE

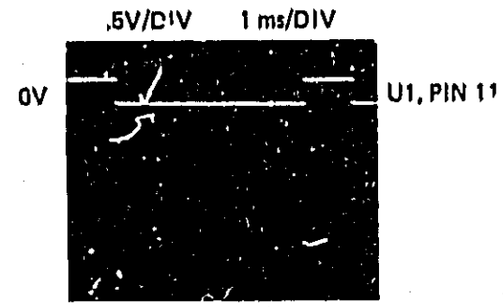
HP 180A/1801A/1821A WITH 10:1 PROBE
COUPLING: DC
SLOPE: +
SYNCH: INT, ACF

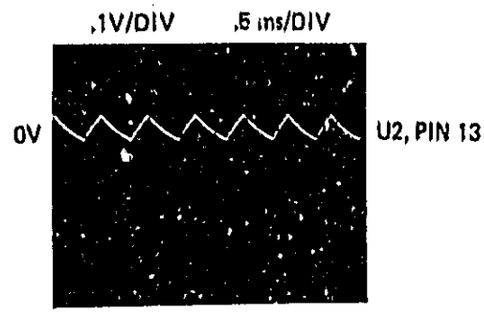








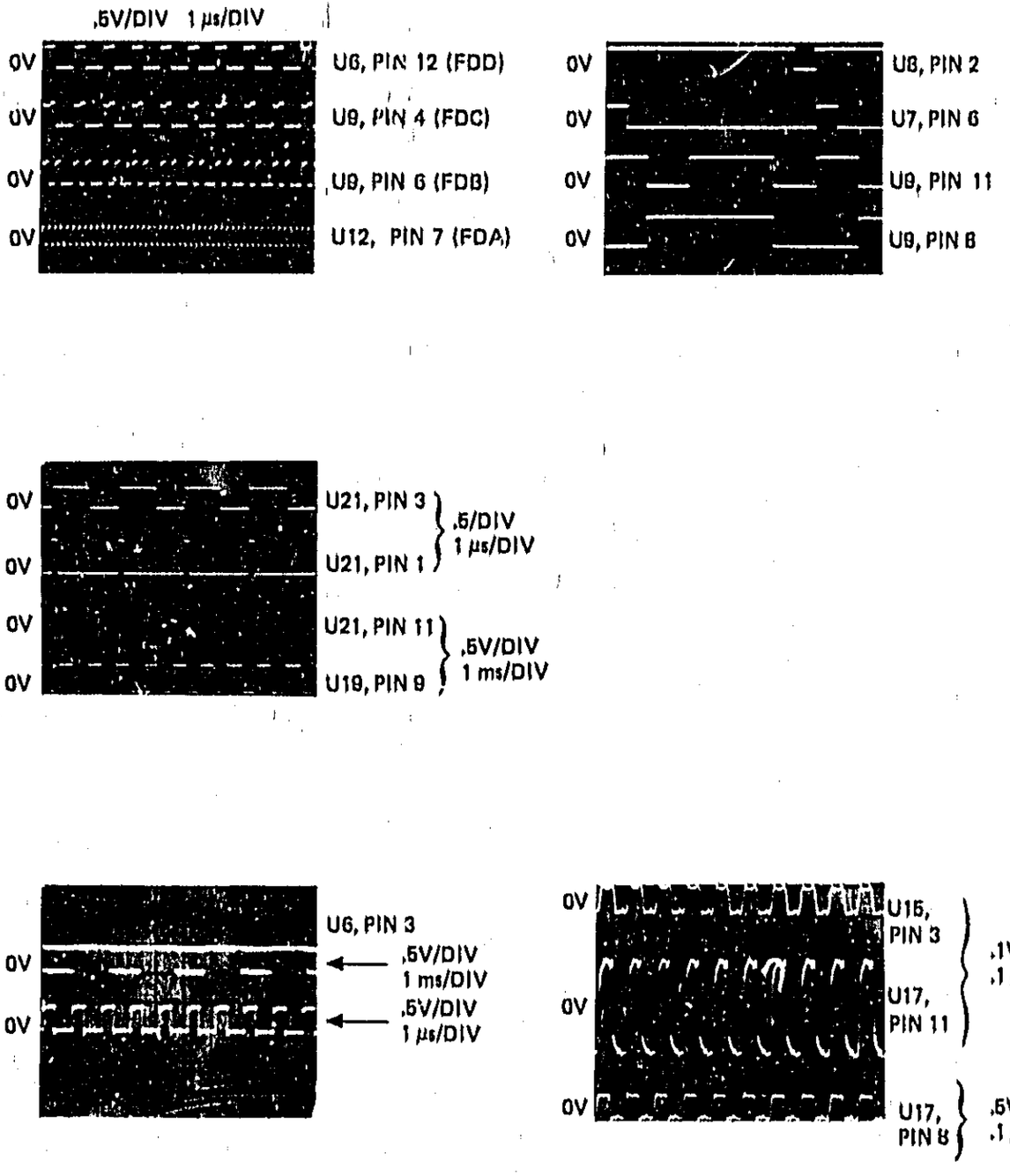




P/O Figure 8-7. A1 Motherboard Assembly

5328A
FUNCTION: CHECK
FREQ RESOLUTION: 1 kHz '0[3]

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



P/O Figure 6-7. A1 Motherboard Assembly

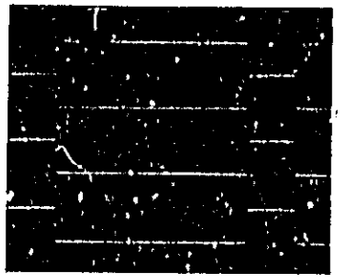
5328A

FUNCTION: CHECK
FREQ RESOLUTION: 1 kHz 10^3

OSCILLOSCOPE

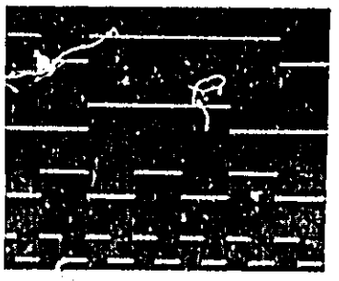
HP 180A/1801A/1802A WITH 10:1 PROBE
COUPLING: DC
SLOPE: +
SYNCH: INT, ACF

,5V/DIV 1 ms/DIV



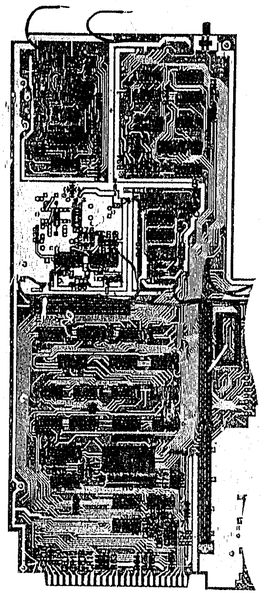
DIGIT ADDRESS	BUS LINE NO.
A	$\overline{45}$
B	45
C	$\overline{44}$
D	44

,5V/DIV 1 ms/DIV



DATA	BUS LINE NO.
A	$\overline{43}$
B	43
C	$\overline{42}$
D	42

P/O Figure 8-7. A1 Motherboard Assembly



P/O
A1

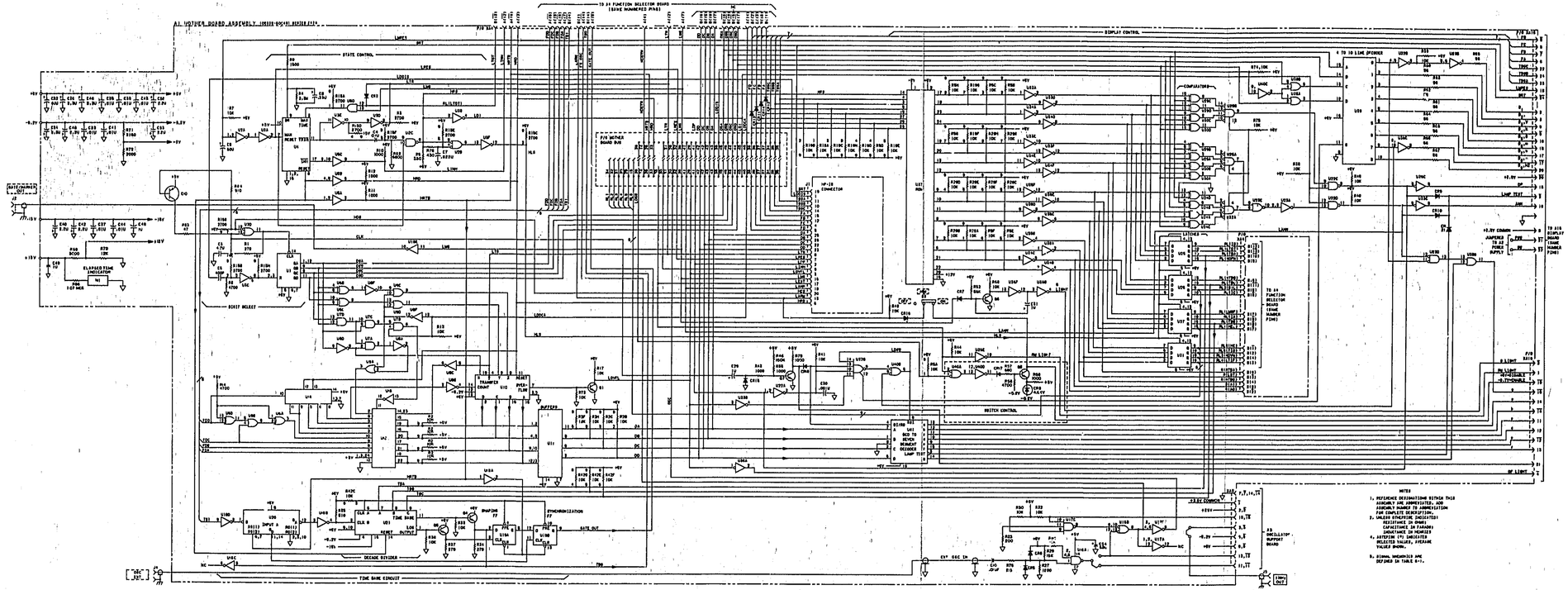
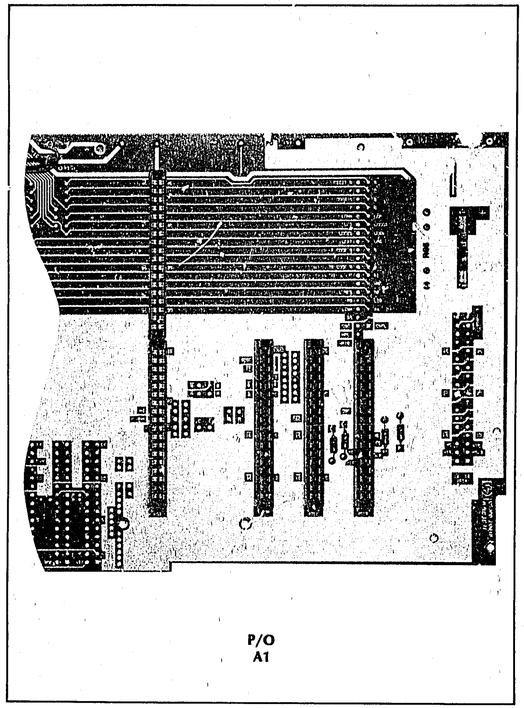
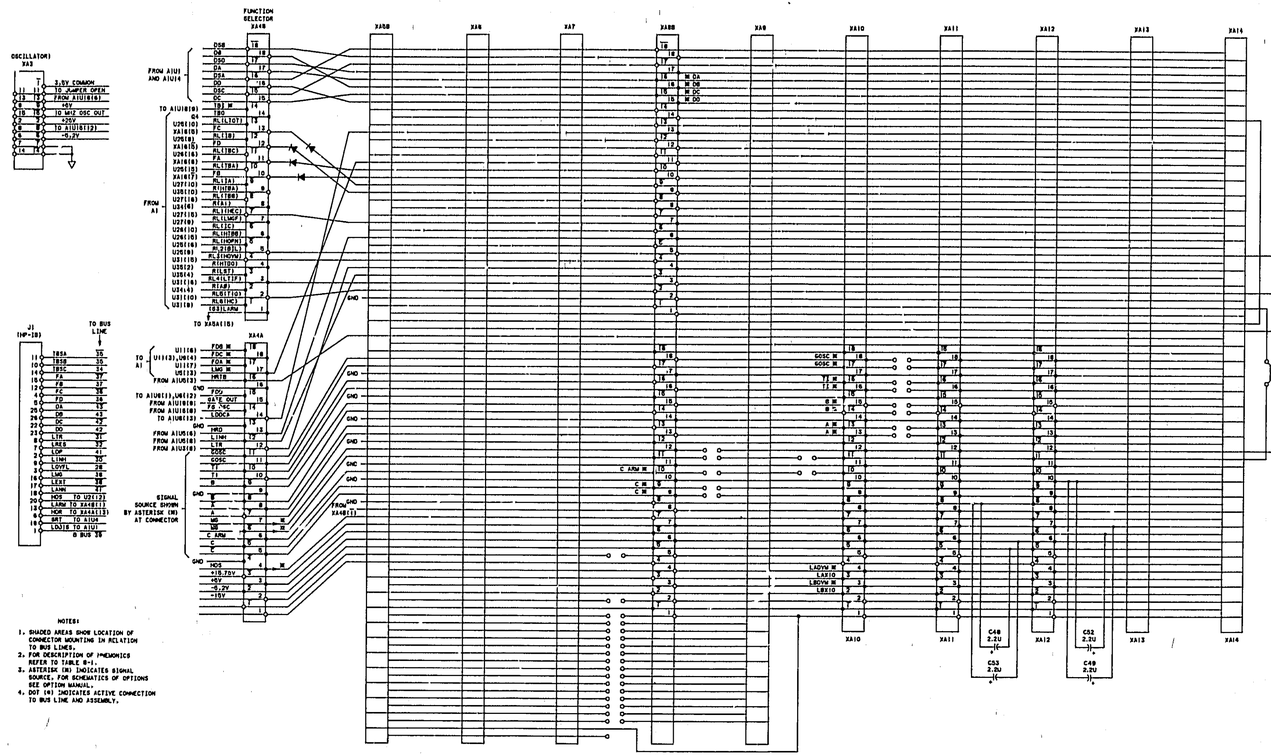


Figure 8-7. A1 Motherboard Block Diagram
(Sheet 1 of 2)



P/O
A1



NOTES:
1. SHADED AREAS SHOW LOCATION OF CONNECTOR MOUNTING IN RELATION TO BUS LINES.
2. FOR DESCRIPTION OF MNEMONICS REFER TO TABLE 8-1.
3. ASTERISK (*) INDICATES SIGNAL SOURCE. FOR SCHEMATICS OF OPTIONS SEE OPTION MANUAL.
4. DOT (•) INDICATES ACTIVE CONNECTION TO BUS LINE AND ASSEMBLY.

Figure 8-7. A1 Motherboard Block Diagram
(Sheet 2 of 2)

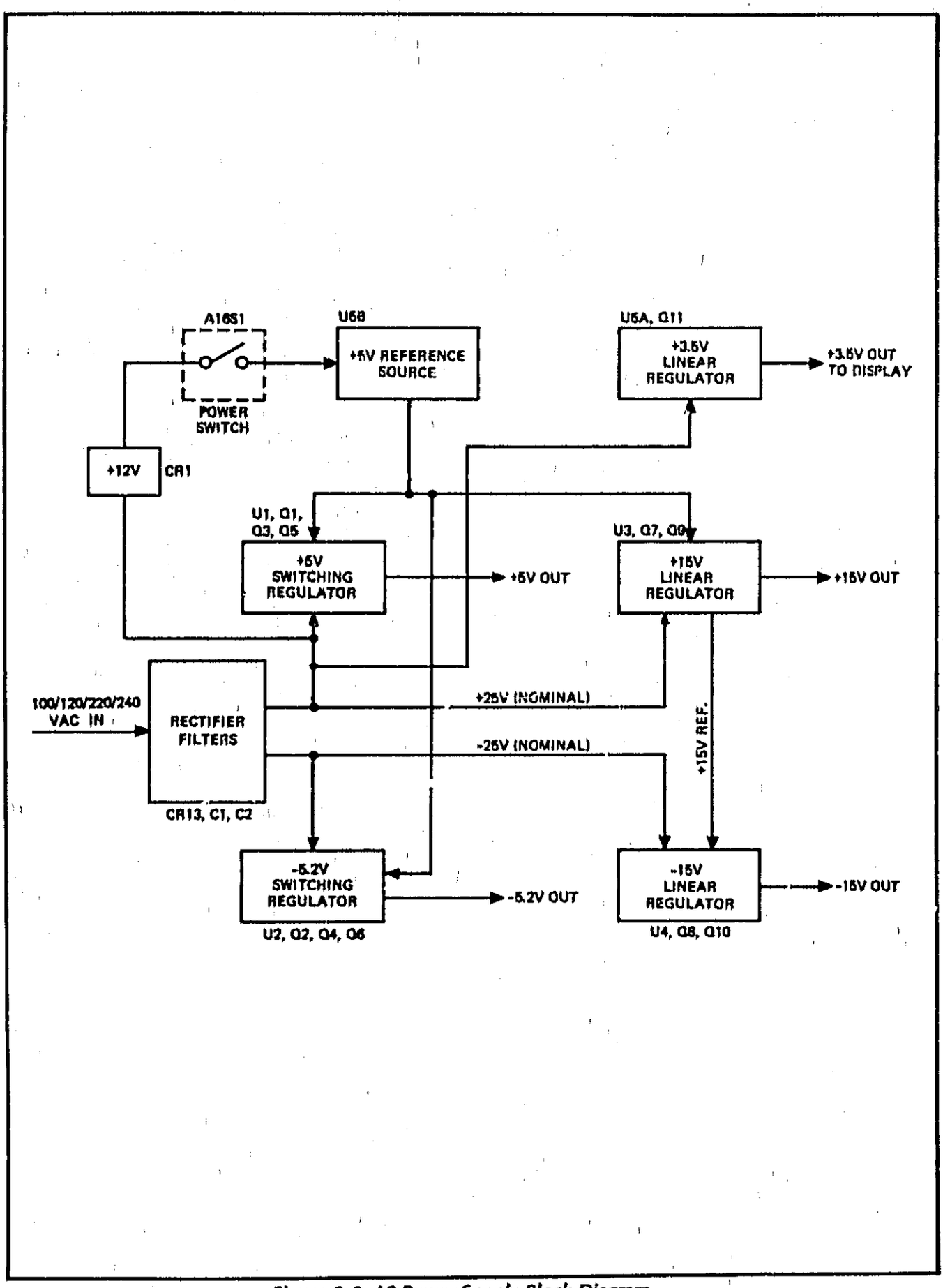
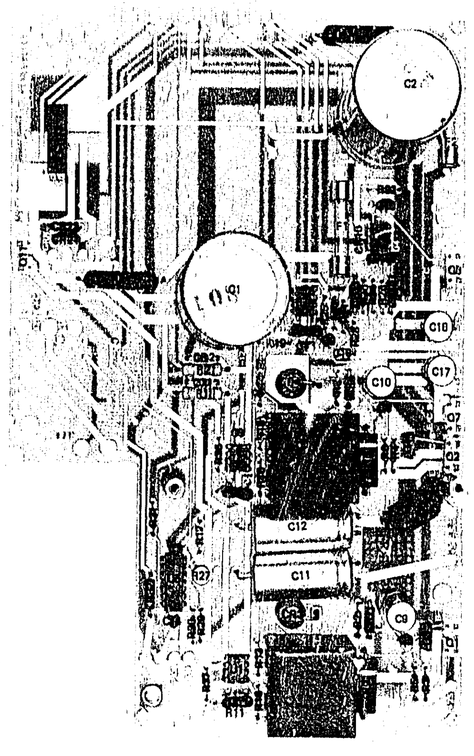


Figure 8-8. A2 Power Supply Block Diagram



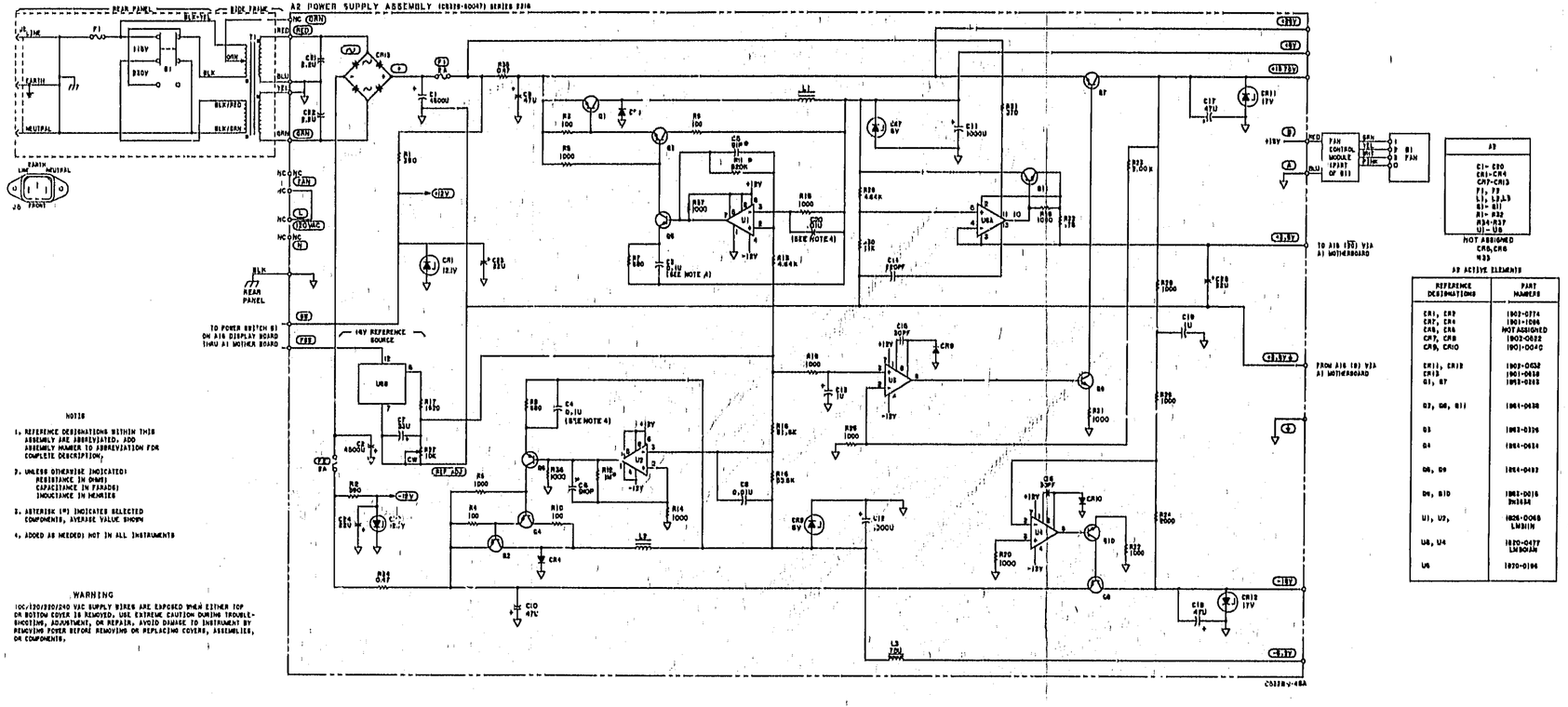
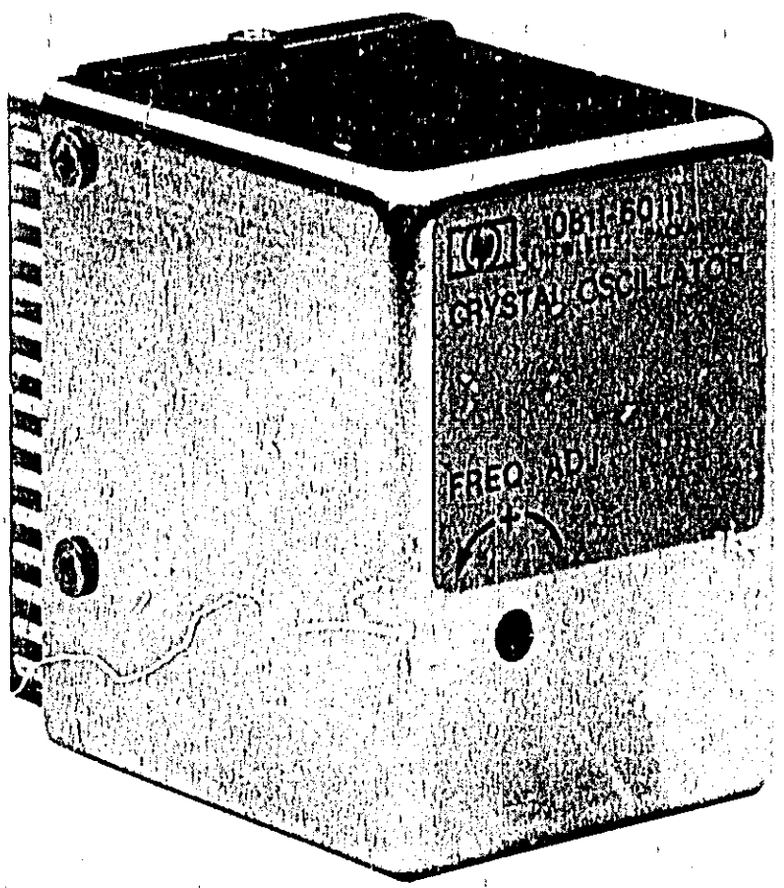
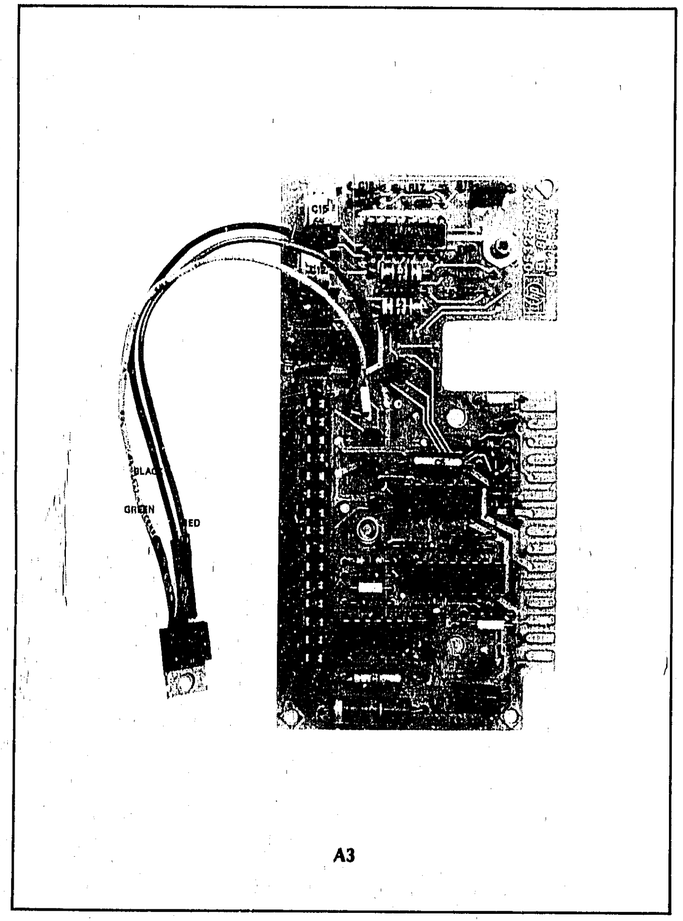


Figure 8-9. A2 Power Supply Schematic Diagram



A3/A3A1

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



A3

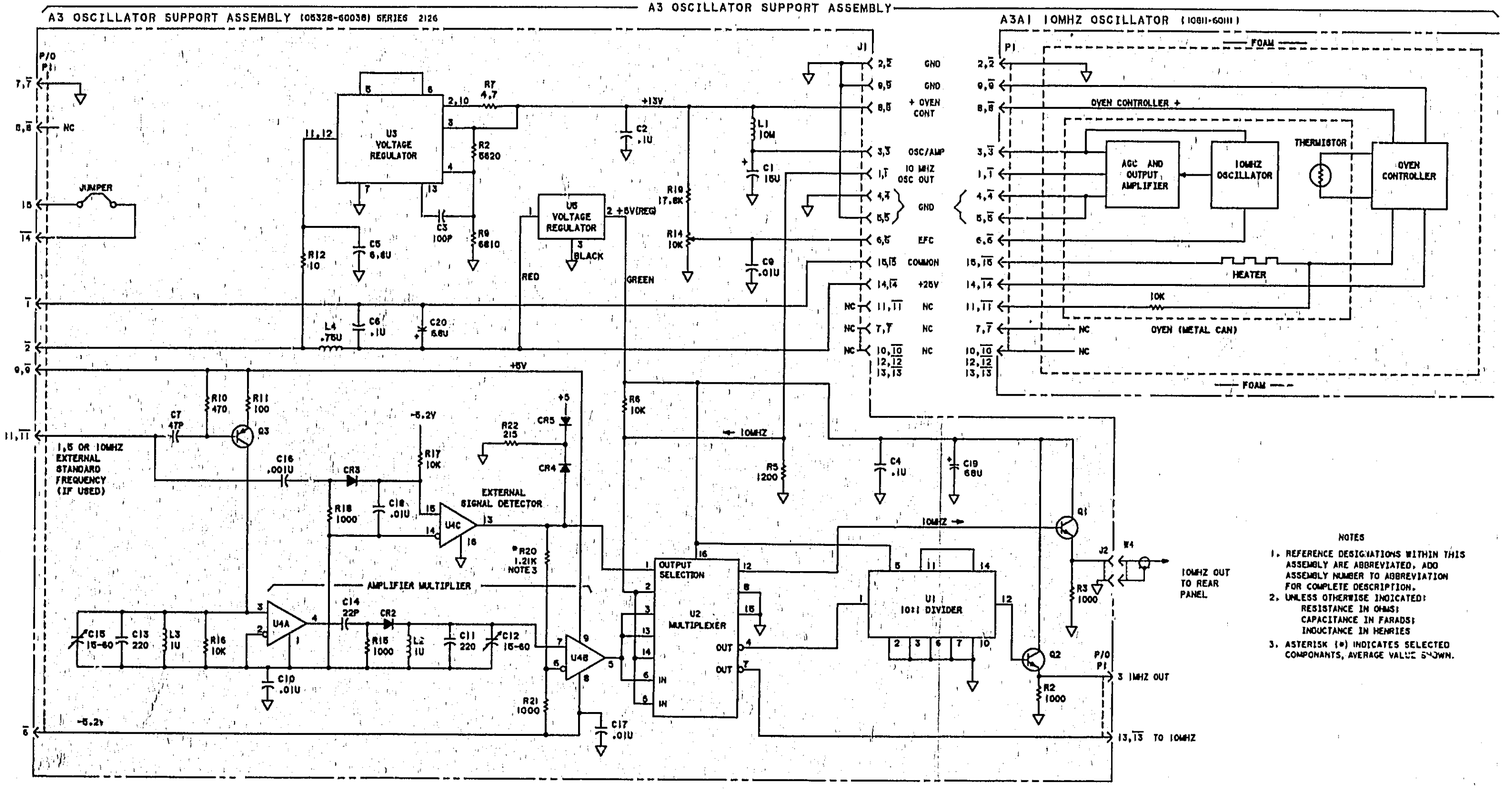


Figure 8-10. A3/A3A1 Oscillator Support Schematic Diagram

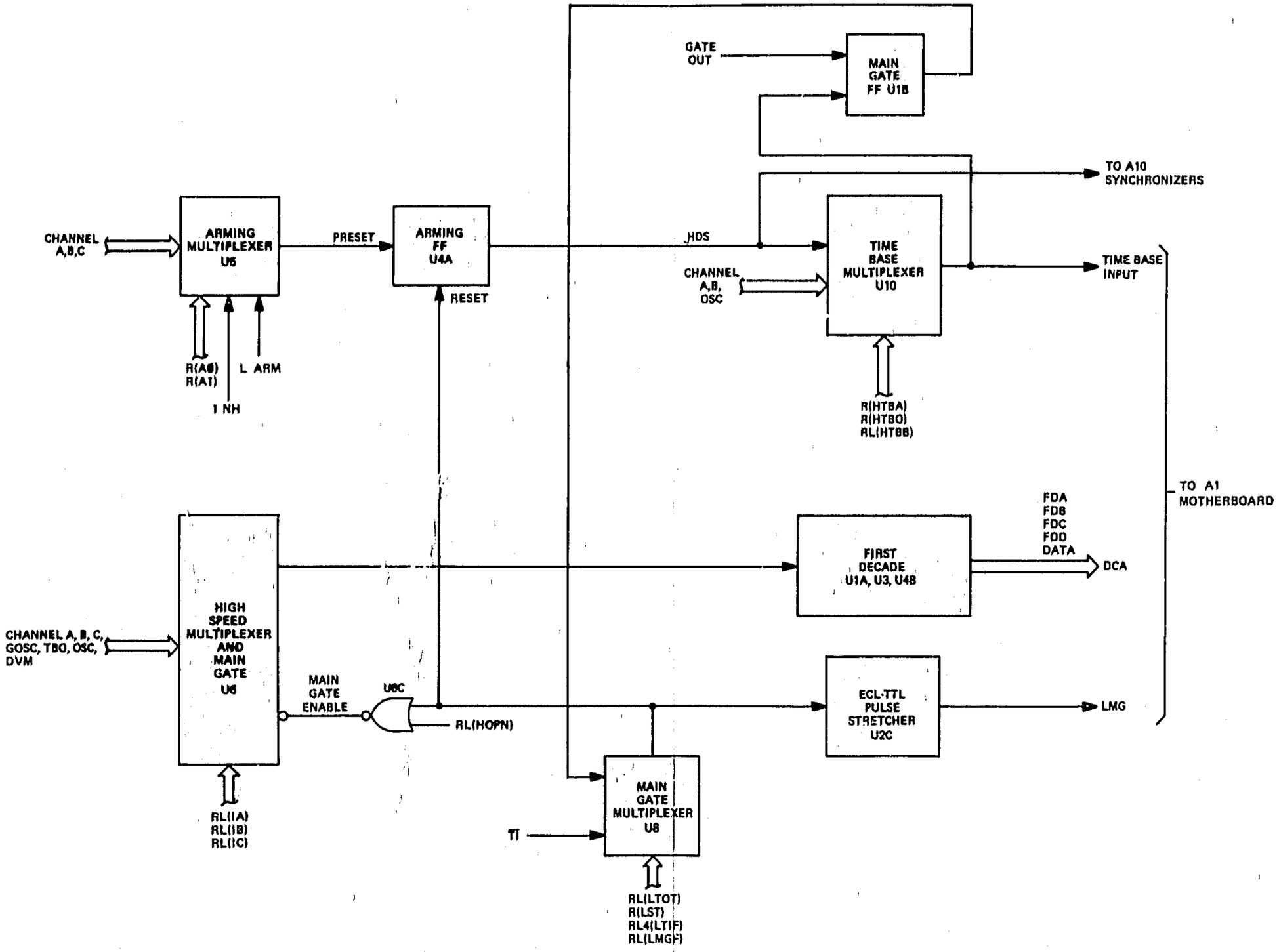


Figure 8-11. A4 Function Selector Block Diagram

P1A PINS

1	–	$\overline{\text{DVM}}$	$\overline{1}$	–	DVM
2	–	-15V	$\overline{2}$	–	-5.2V
3	–	+5V	$\overline{3}$	–	+15V
4	–	HDS*	$\overline{4}$	–	GND
5	–	$\overline{\text{C}}$	$\overline{5}$	–	C
6	–	C ARM	$\overline{6}$	–	$\overline{\text{MG}}$*
7	–	MG*	$\overline{7}$	–	A
8	–	$\overline{\text{A}}$	$\overline{8}$	–	$\overline{\text{B}}$
9	–	GND	$\overline{9}$	–	B
10	–	TI	$\overline{10}$	–	$\overline{\text{TI}}$
11	–	GOSC	$\overline{11}$	–	$\overline{\text{GOSC}}$
12	–	LTR	$\overline{12}$	–	GND
13	–	HRD	$\overline{13}$	–	FS OSC
14	–	LDDCA	$\overline{14}$	–	FS OSC
15	–	GATE OUT	$\overline{15}$	–	FDD*
16	–	GND	$\overline{16}$	–	HRTB
17	–	LMG*	$\overline{17}$	–	FDA*
18	–	FDC*	$\overline{18}$	–	FDB*

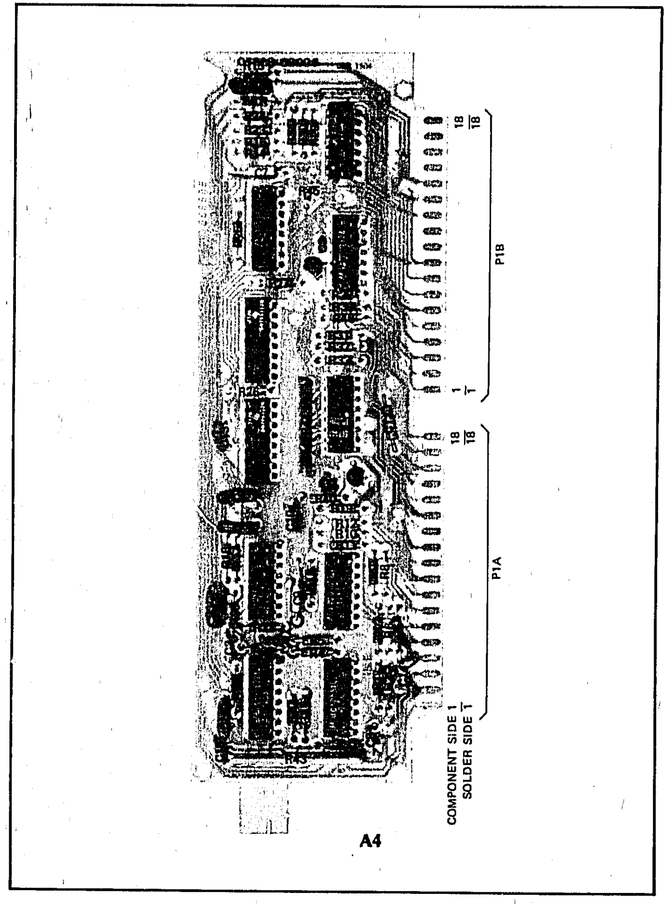
*SIGNAL SOURCE

P1B PINS

1	–	L ARM	$\overline{1}$	–	RL6(HC)
2	–	RL5(TIO)	$\overline{2}$	–	R(A0)
3	–	RL4(LTIF)	$\overline{3}$	–	R(LST)
4	–	R(HTBO)	$\overline{4}$	–	RL3(HDVM)
5	–	RL2(BIL)	$\overline{5}$	–	RL(HOPN)
6	–	RL(HTBB)	$\overline{6}$	–	RL(IC)
7	–	RL(LMGF)	$\overline{7}$	–	RL1(HEC)
8	–	R(A1)	$\overline{8}$	–	RL(TBB)
9	–	R(HTBA)	$\overline{9}$	–	RL(IA)
10	–	FB	$\overline{10}$	–	RL(TBA)
11	–	FA	$\overline{11}$	–	RL(TBC)
12	–	FD	$\overline{12}$	–	RL(IB)
13	–	FC	$\overline{13}$	–	RL(LTOT)
14	–	TBO (NC)	$\overline{14}$	–	TBI*
15	–	DATA C	$\overline{15}$	–	DS C
16	–	DATA D	$\overline{16}$	–	DS A (NC)
17	–	DATA A	$\overline{17}$	–	DS D
18	–	DATA B	$\overline{18}$	–	DS B

*SIGNAL SOURCE

P/O Figure 8-12. A4 Function Selector Assembly



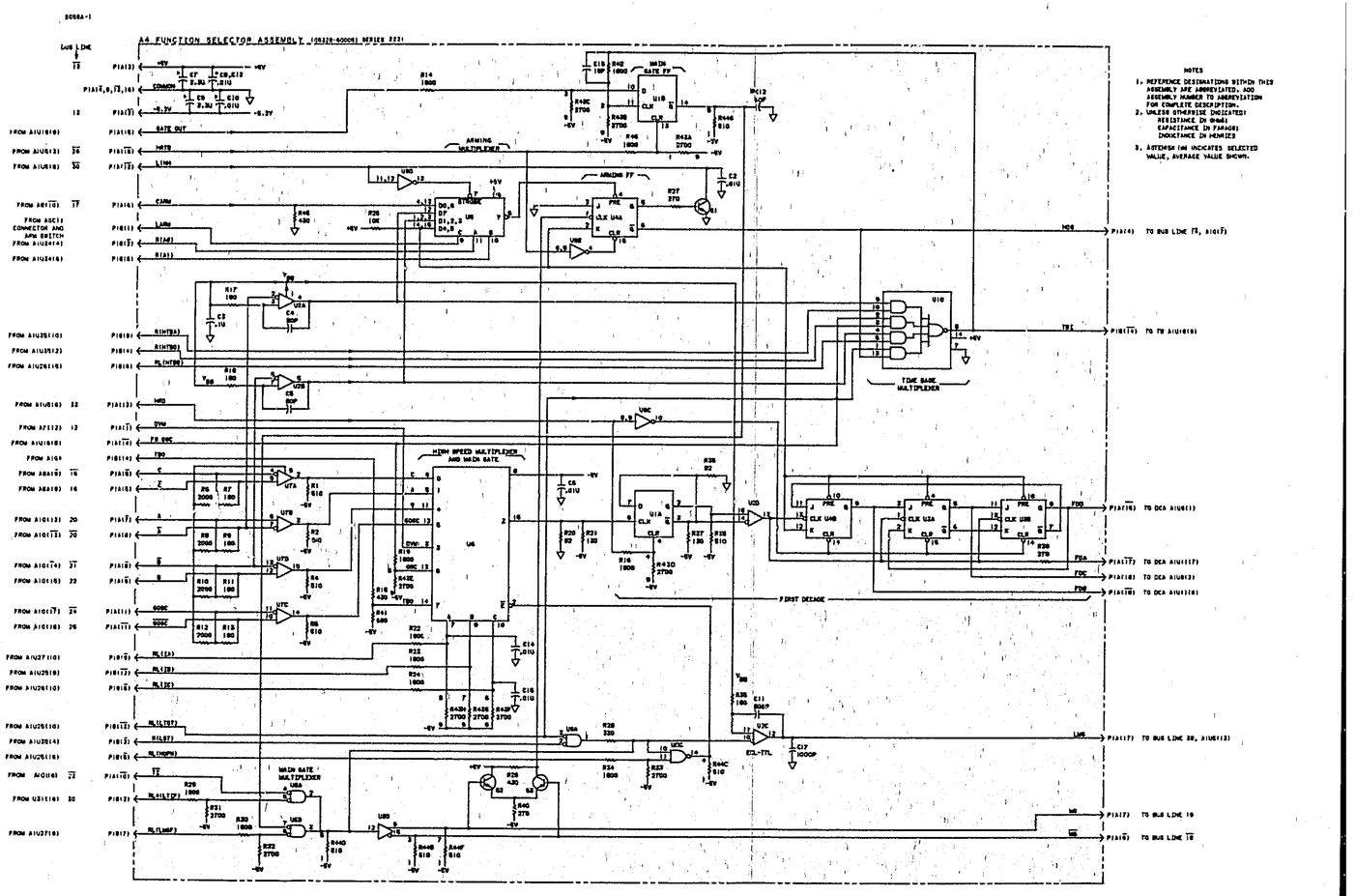


Figure 8-12. A4 Function Selector Schematic Diagram

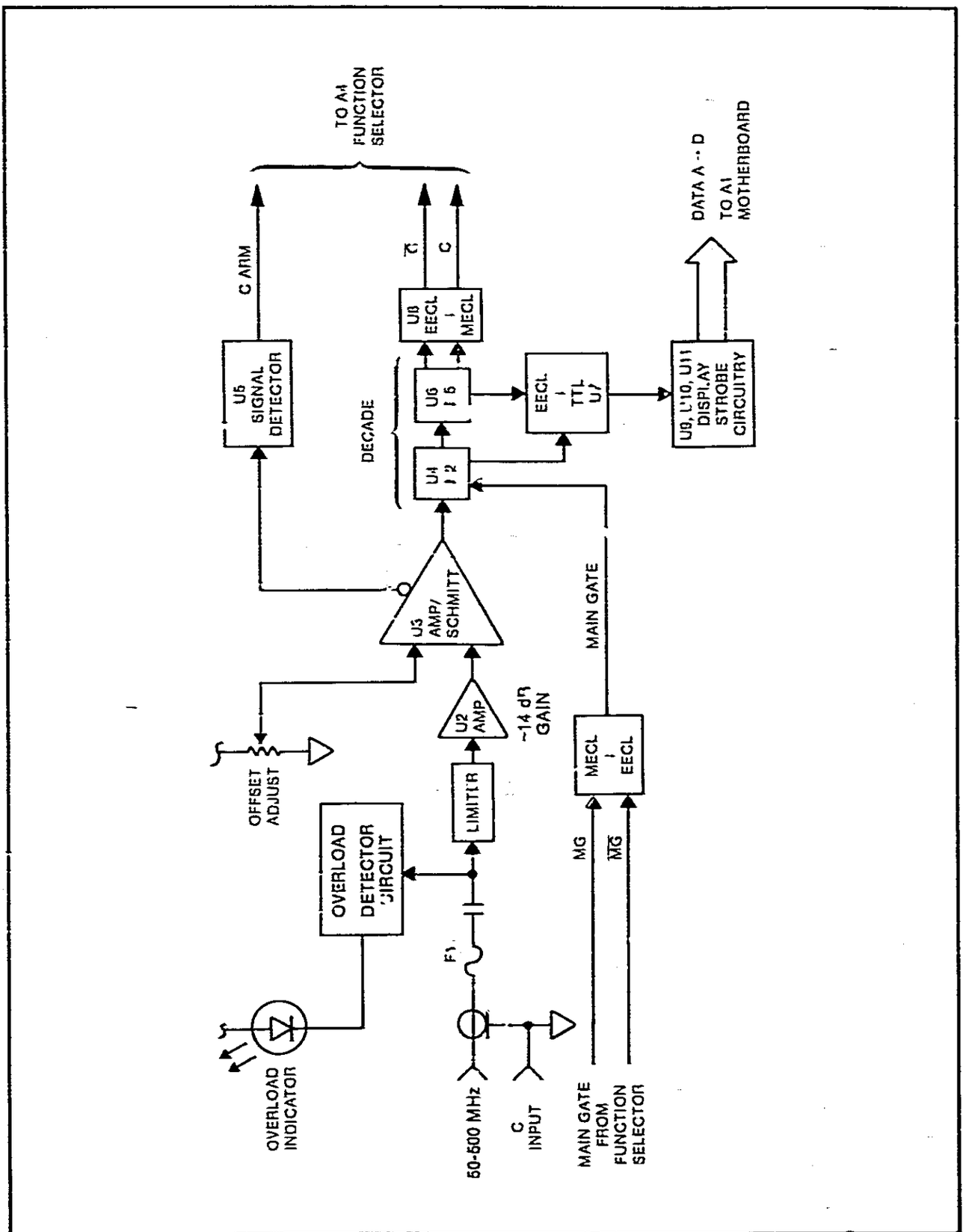
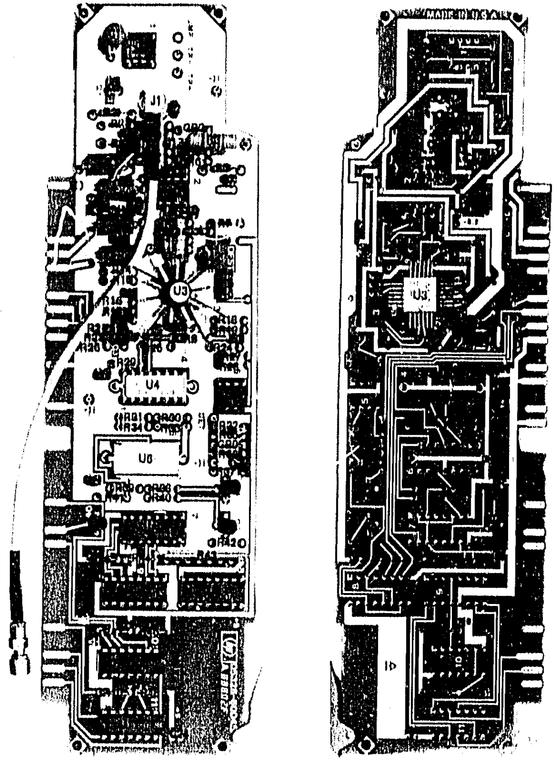


Figure 8-13. A8 Channel "C" Block Diagram



A8

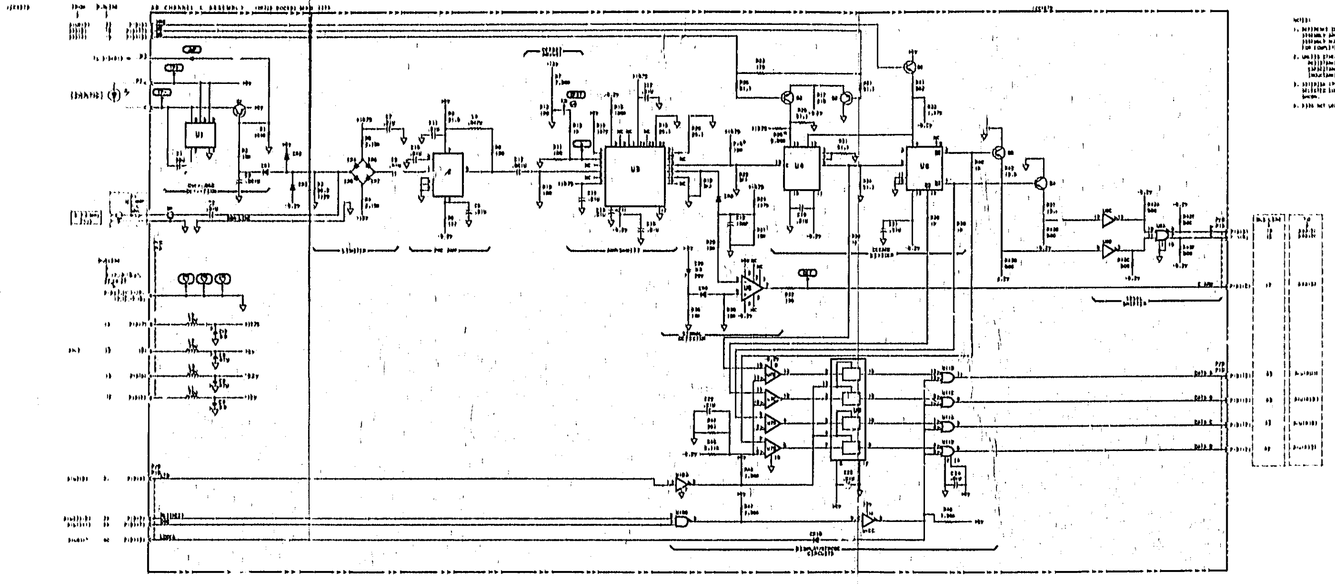


Figure 8-13. A8 Channel C Block Diagram

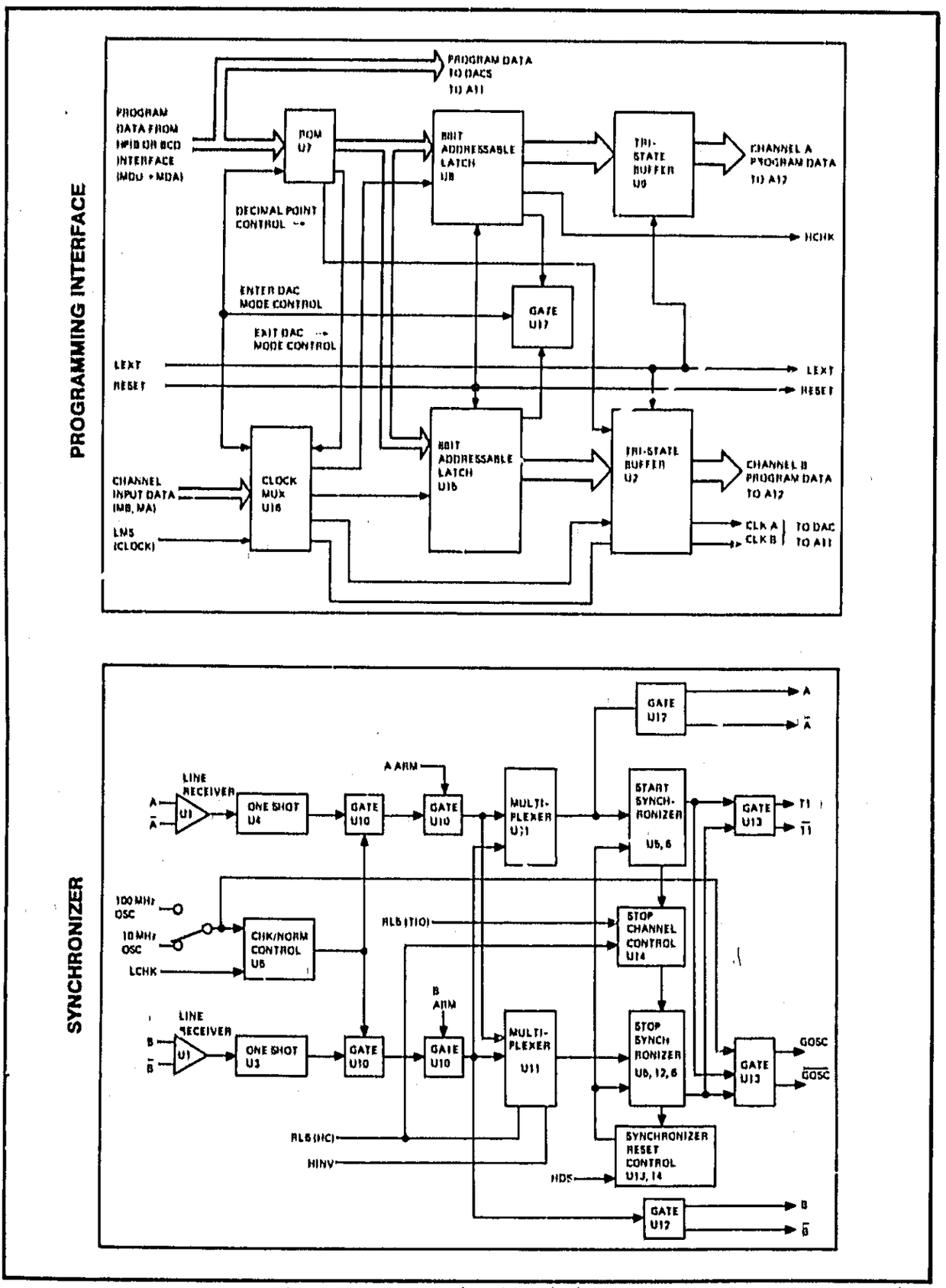
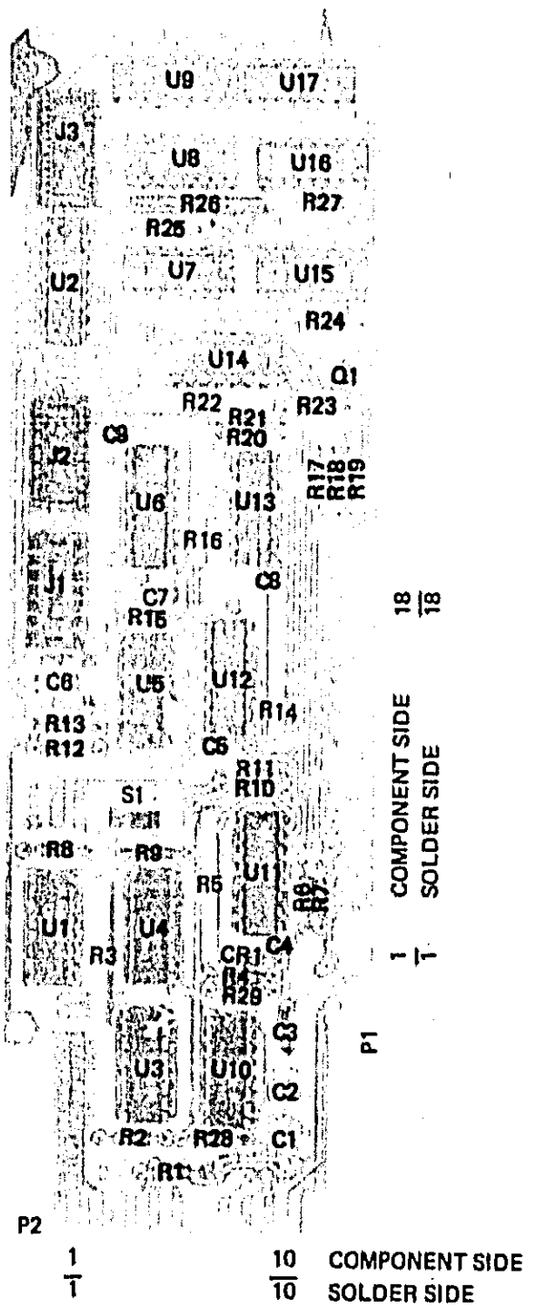


Figure 8-15. A10 Synchronizer Block Diagram


U9
U17
J3
U8
U16
R26
R27
R25
U2
U7
U15
R24
U14
Q1
R22
R21
R23
C9
R20
J2
R17
R18
R19
U6
U13
R16
J1
C8
C7
R15
18/18
C6
U5
U12
R14
R13
R12
C5
R11
R10
S1
R8
R9
U11
R5
R6
R7
U1
U4
C4
R3
CR1
R4
R29
C3
P1
1/1
COMPONENT SIDE
SOLDER SIDE
U3
U10
C2
R2
R28
C1
R1
P2
1/1
10/10
COMPONENT SIDE
SOLDER SIDE

A10

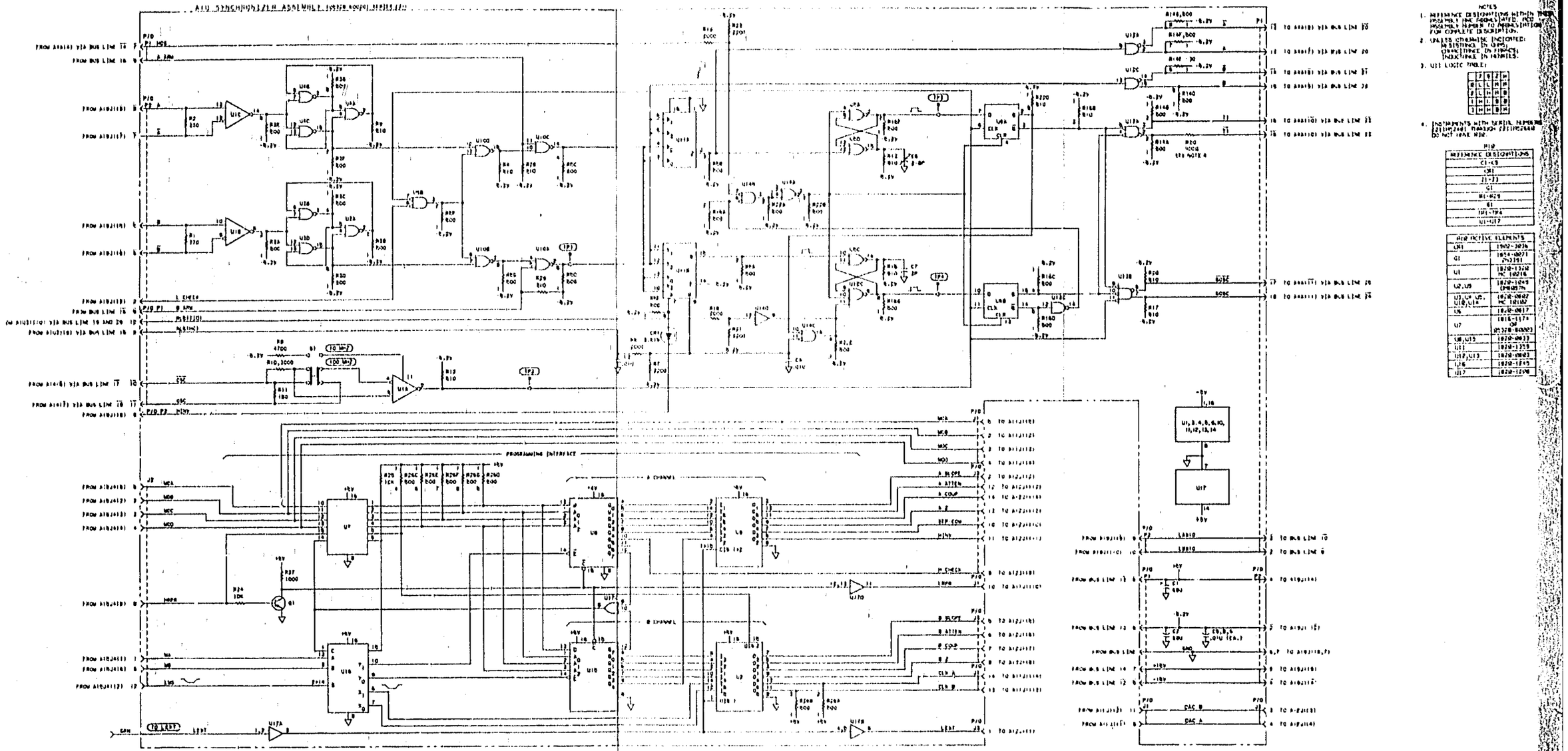


Figure 8-16. A10 Synchronizer Schematic Diagram

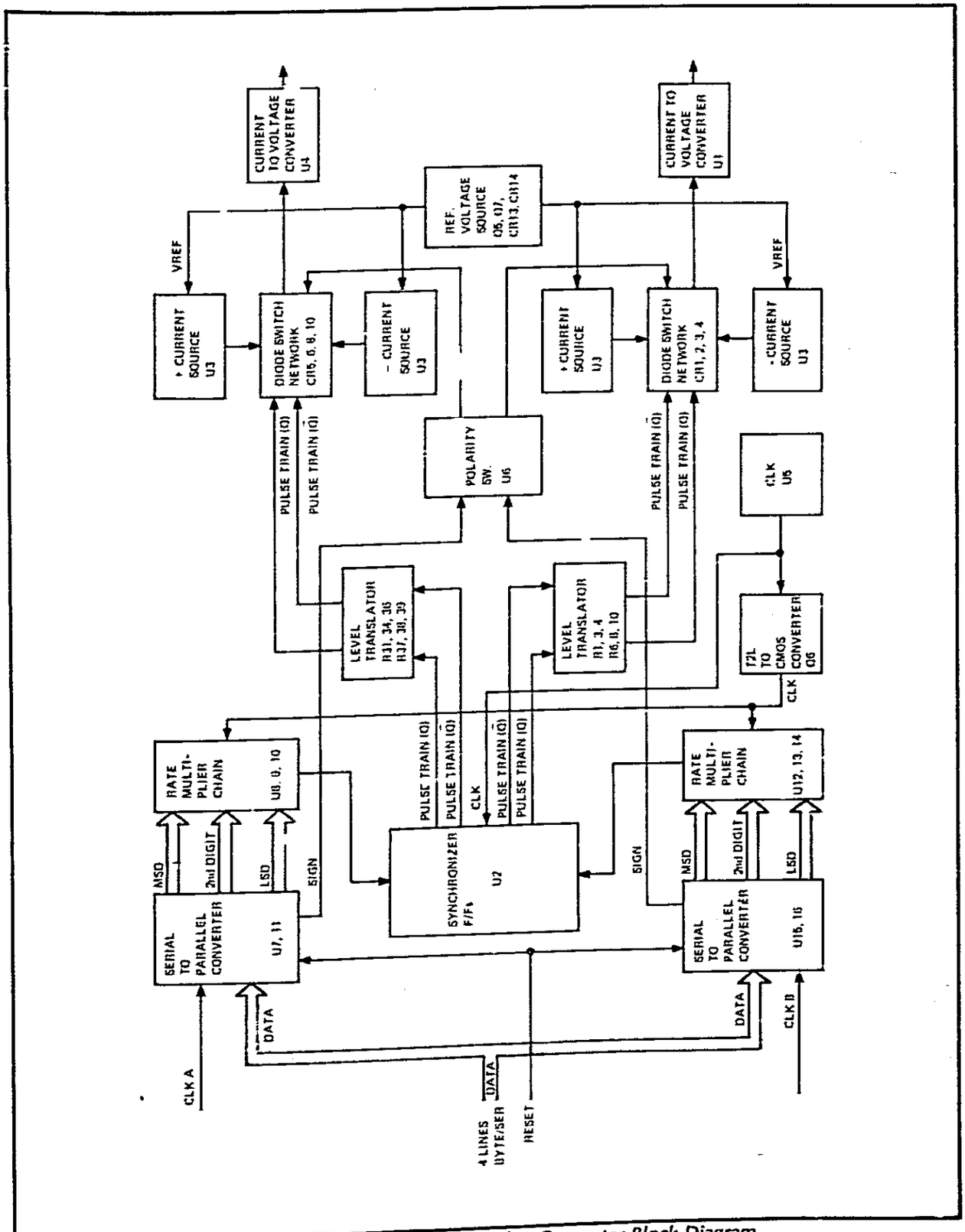
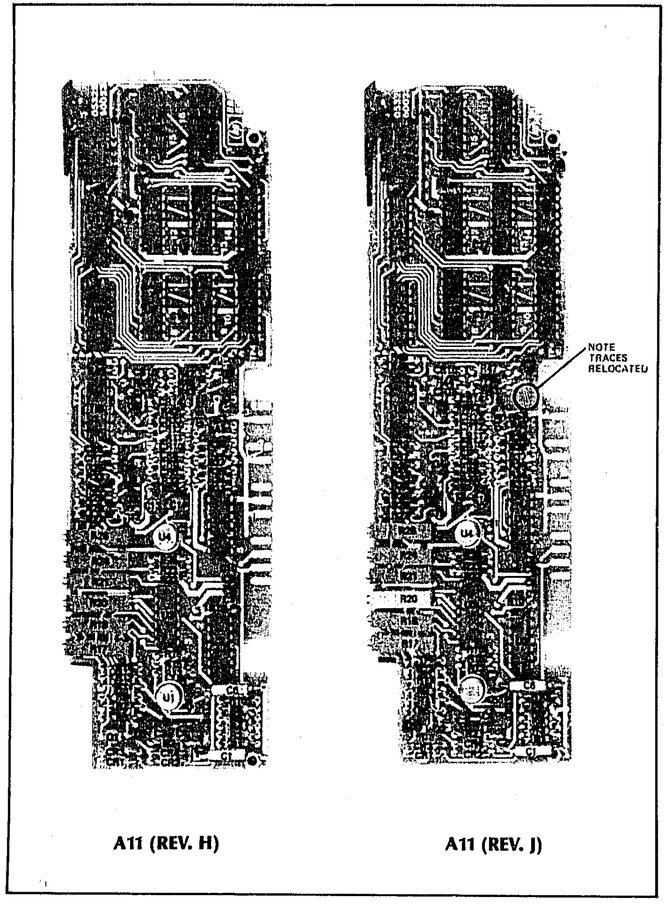


Figure 8-17. A11 Digital-to-Analog Converter Block Diagram



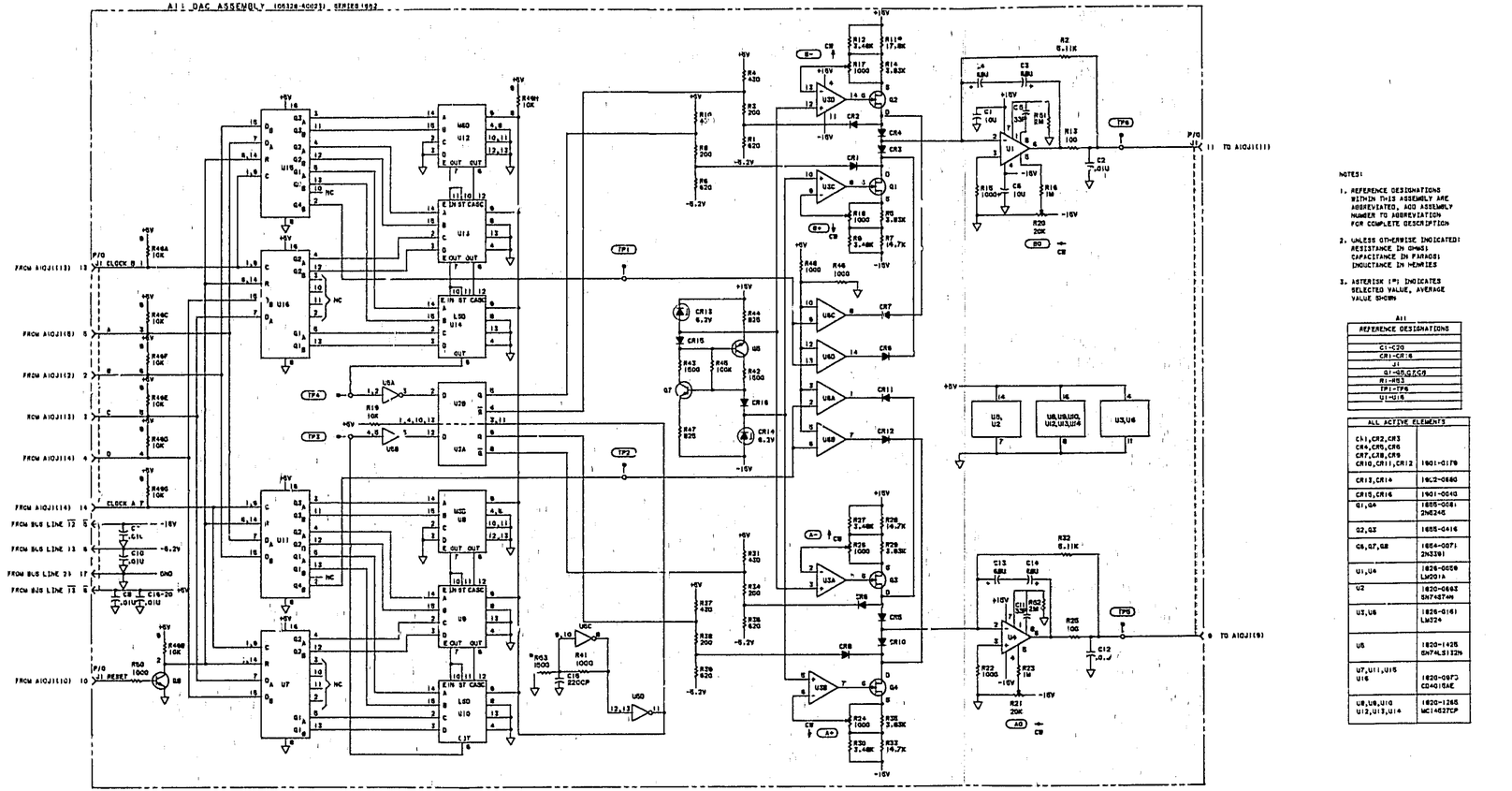


Figure 8-18. A11 Digital-to-Analog Converter Schematic Diagram

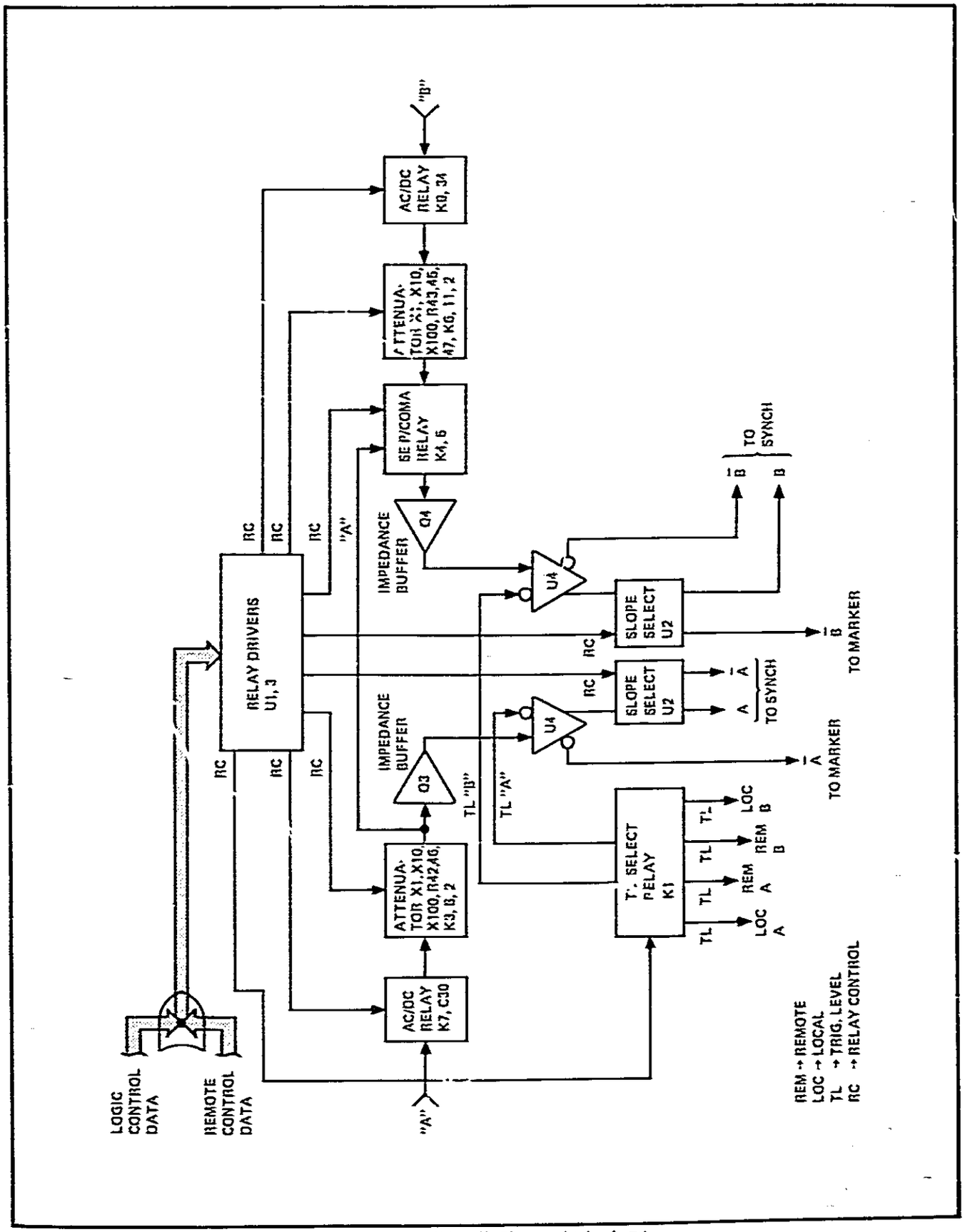
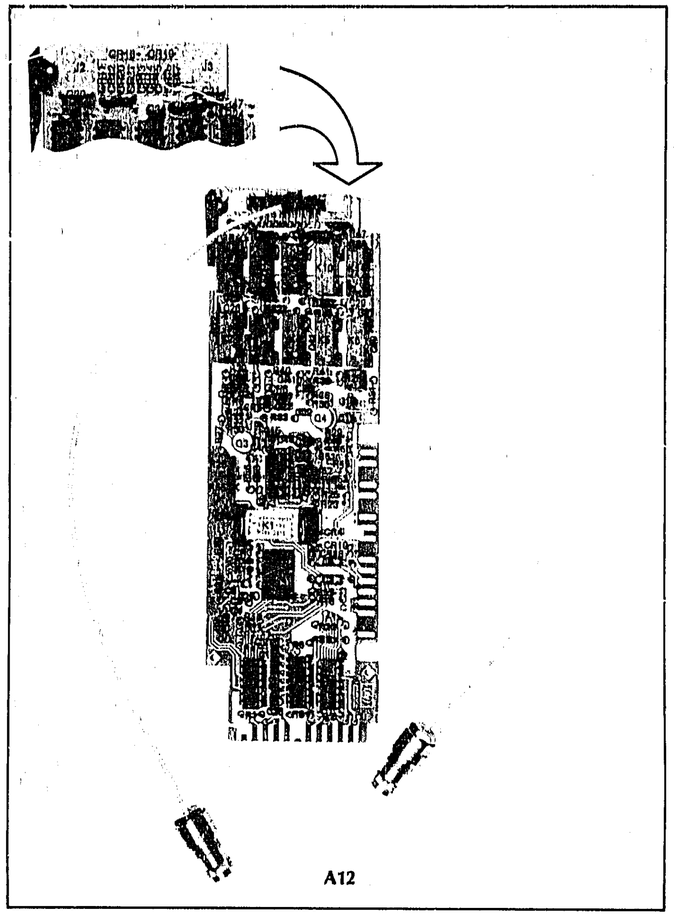


Figure 8-19. A12 "A-B" Channel Block Diagram



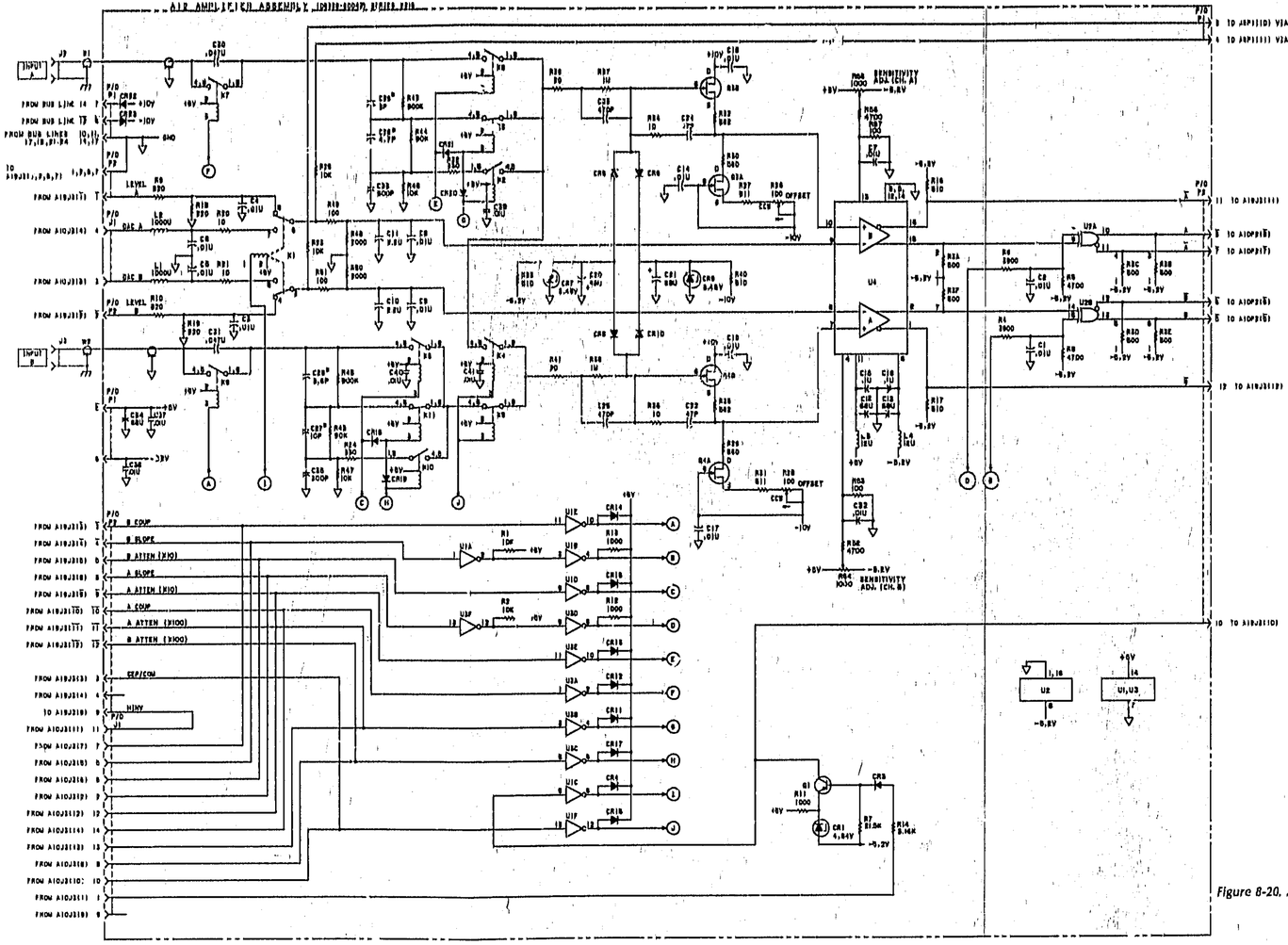
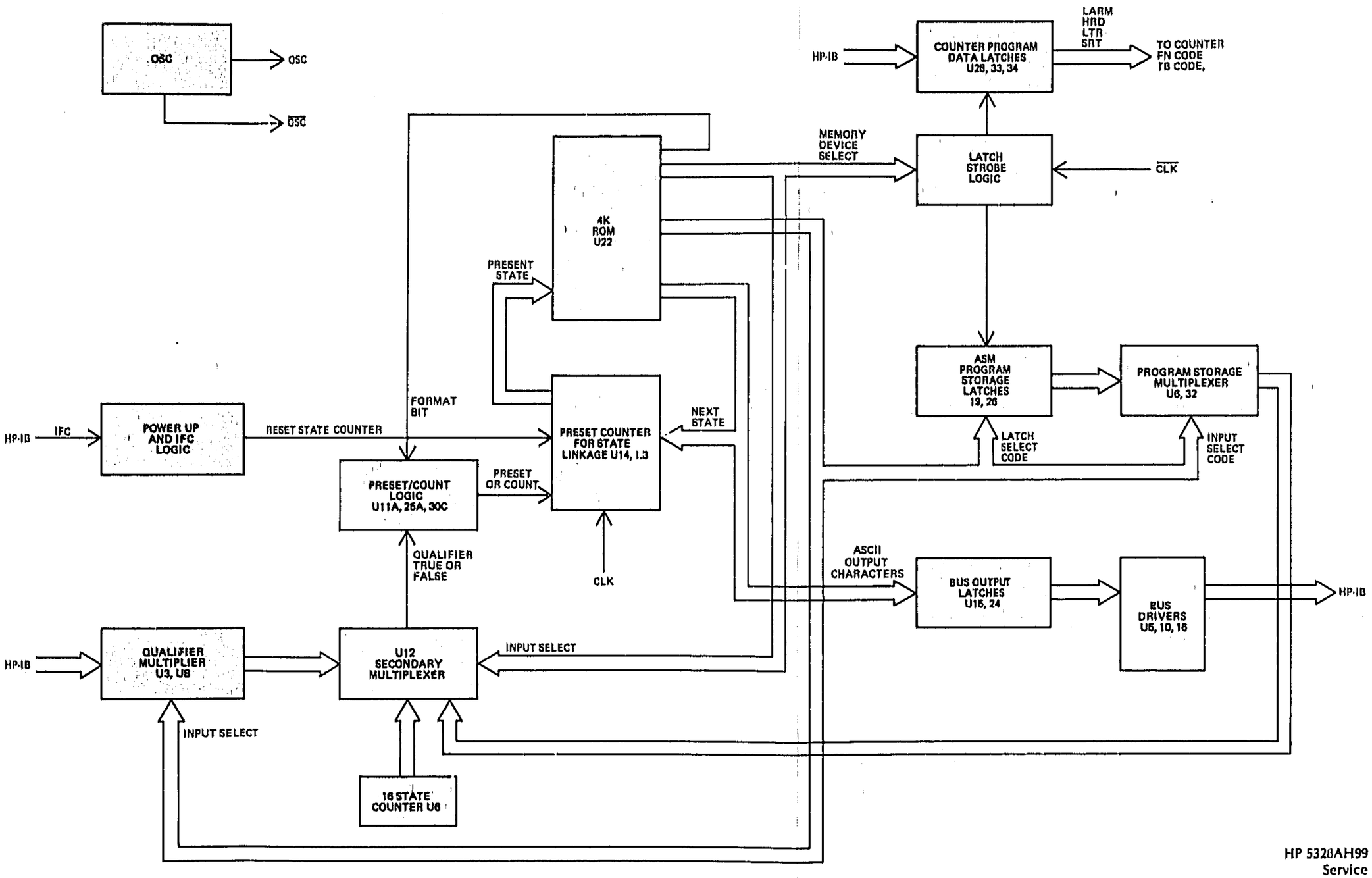
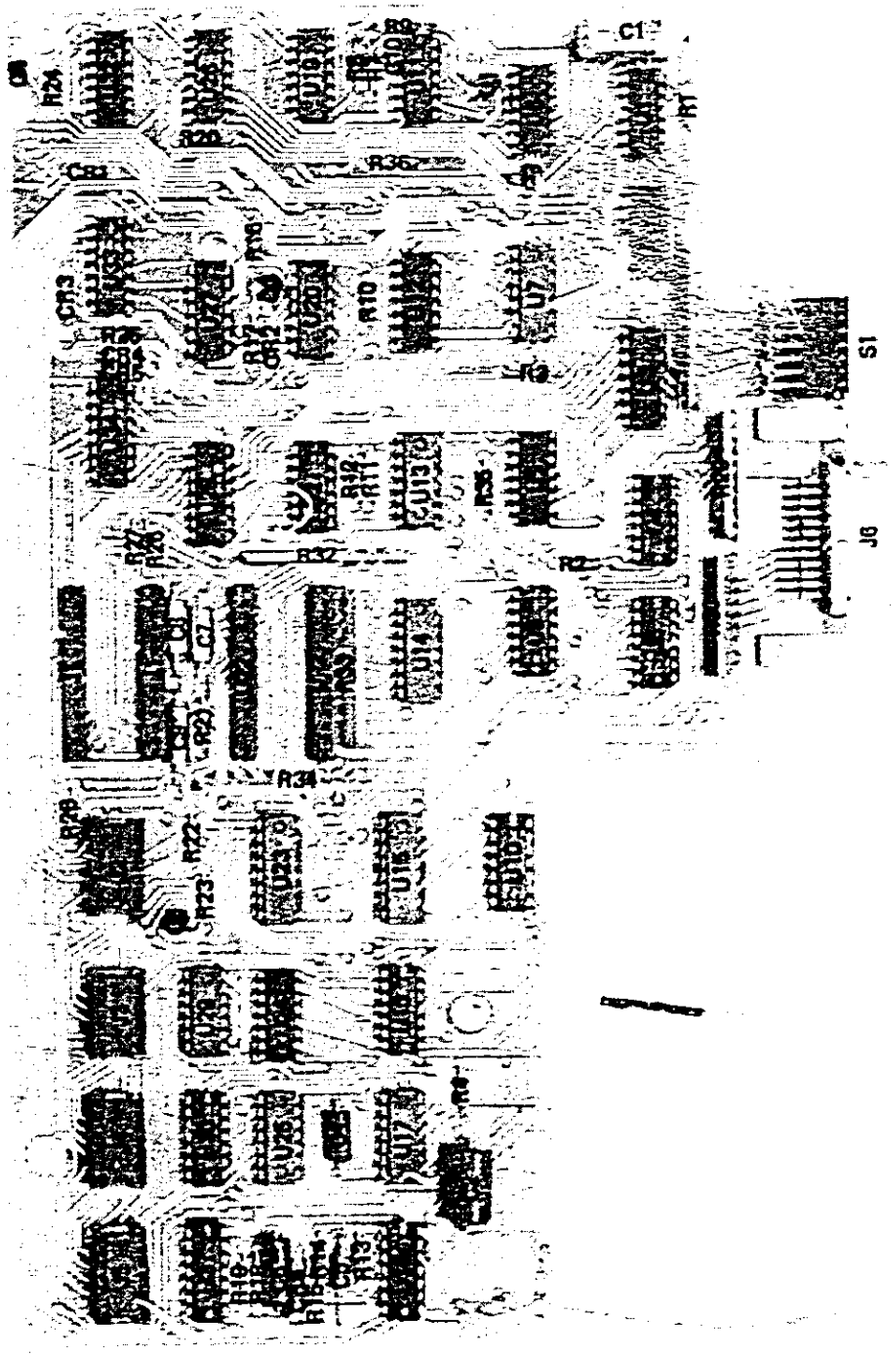


Figure 8-20. A12 A-B Channel Schematic Diagram



HP 5328AH99
Service

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) → XA16(24)
20 HDS → XA4A(4) → BUS (14)
21 +15V
22 DC → XA4(B15) → BUS (42)
23 DD → XA4(B16) → BUS (42)
24 +5V
25 DA → XA4(B17) → BUS (43)
26 DB → XA4(B18) → BUS (43)
27 GND
28 -5V

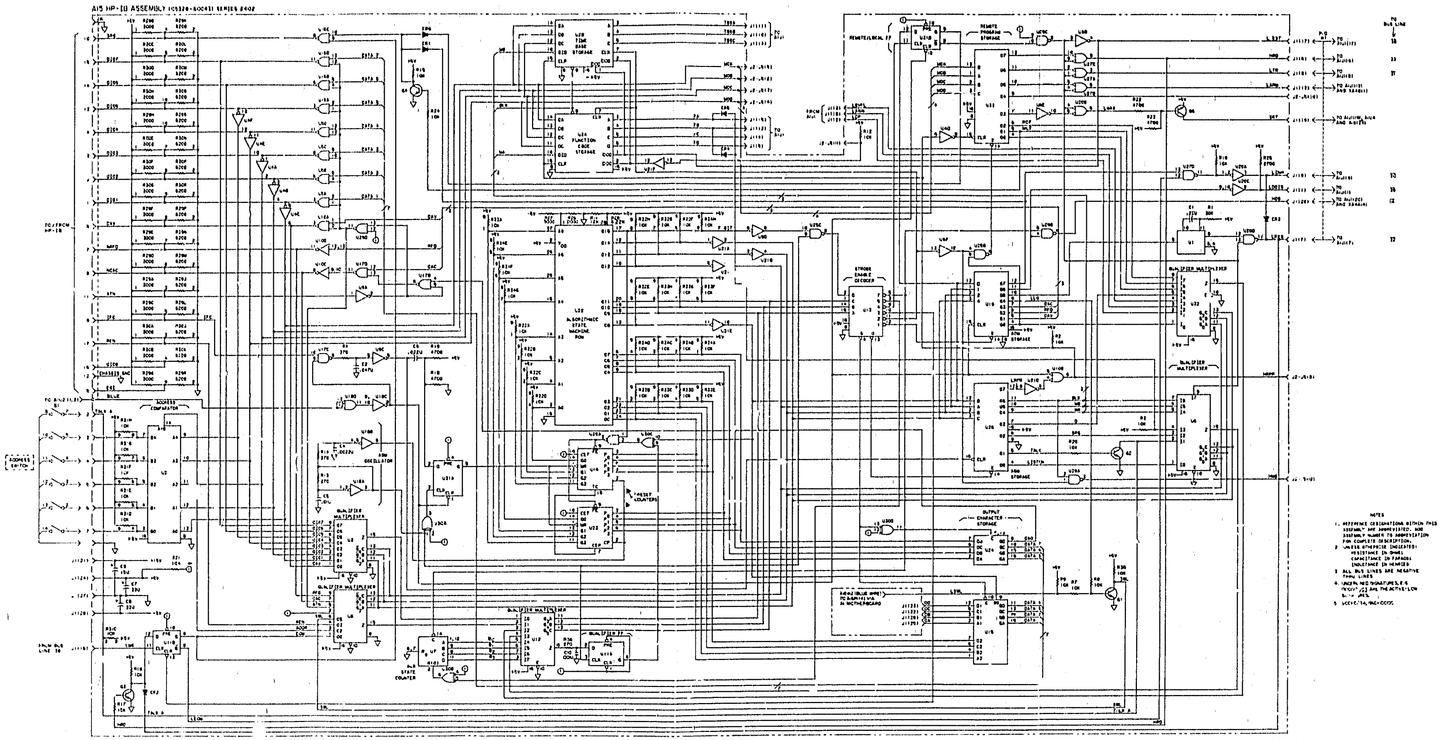


Figure 8-22. A15 A15 HP-IB Interface Schematic Diagram

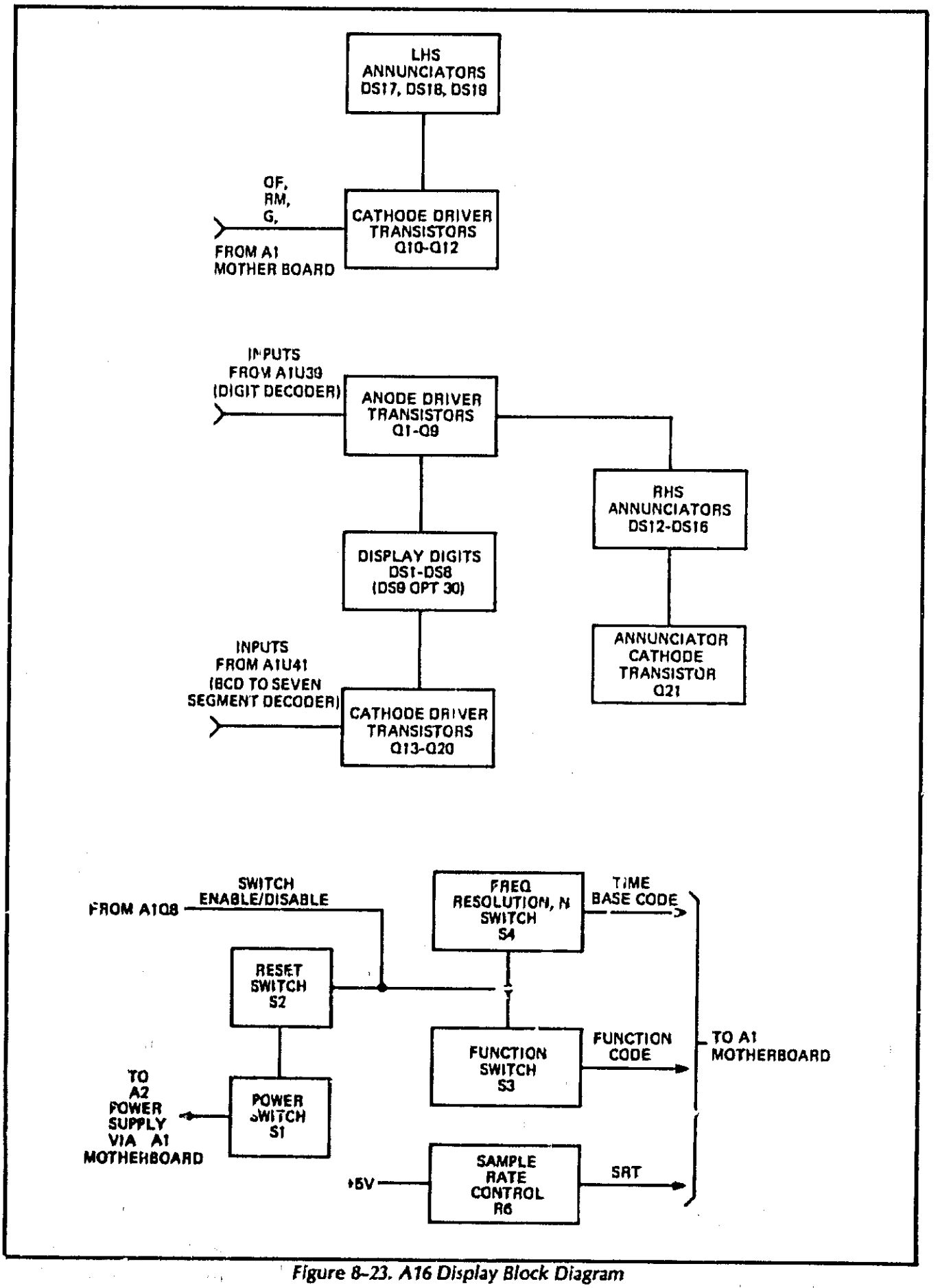
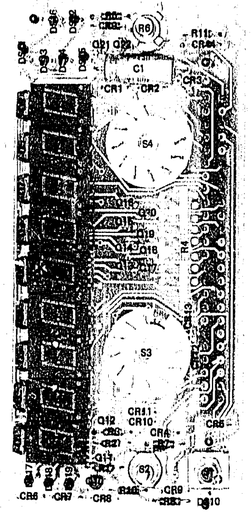


Figure 8-23. A16 Display Block Diagram

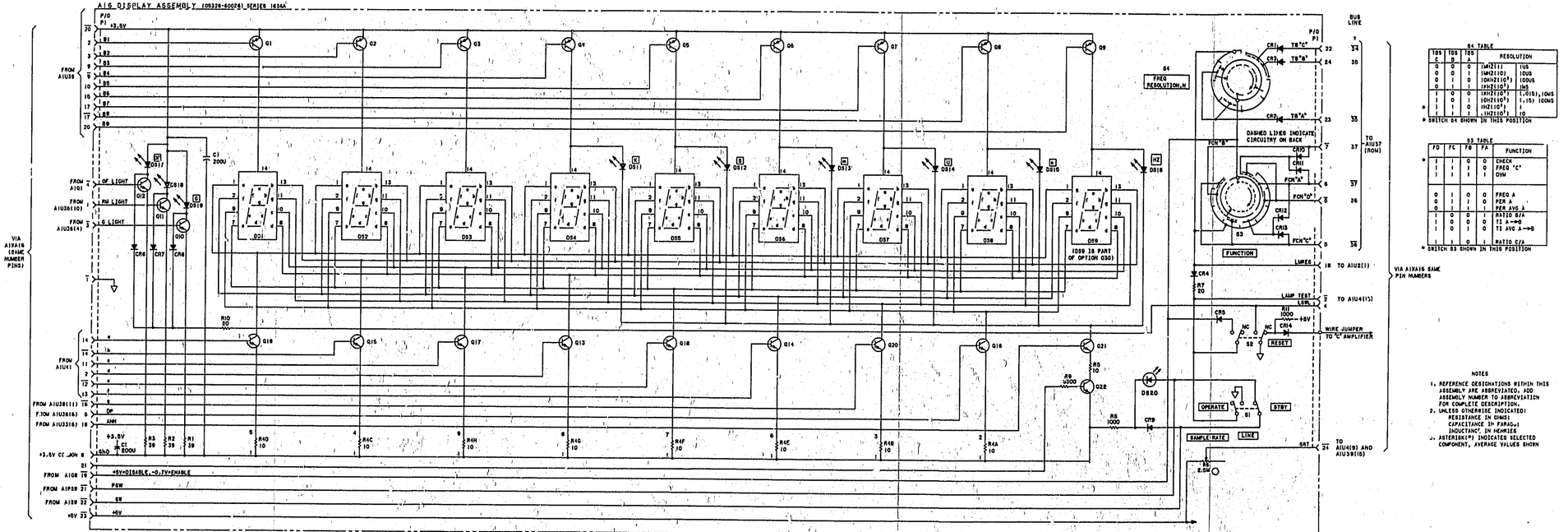
P1 PINS

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	–	+3.6V
21	–	LSLO NC	21	–	} POWER SWITCH
22	–	TBS C	22	–	
23	–	TBS A	23	–	+5V
24	–	TBS C	24	–	GND

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



A16



B5 C	B4 B	B3 A	RESOLUTION
0	0	0	1MHZ(1) 1US
0	0	1	1MHZ(10) 10US
0	1	0	10KHZ(10^2) 100US
0	1	1	1KHZ(10^3) 1MS
1	0	0	100HZ(10^4) 1.015),10MS
1	0	1	10HZ(10^5) 1.15) 10MS
1	1	0	1HZ(10^6) 1
1	1	1	.1HZ(10^7) 10

* SWITCH S4 SHOWN IN THIS POSITION

S3 TABLE

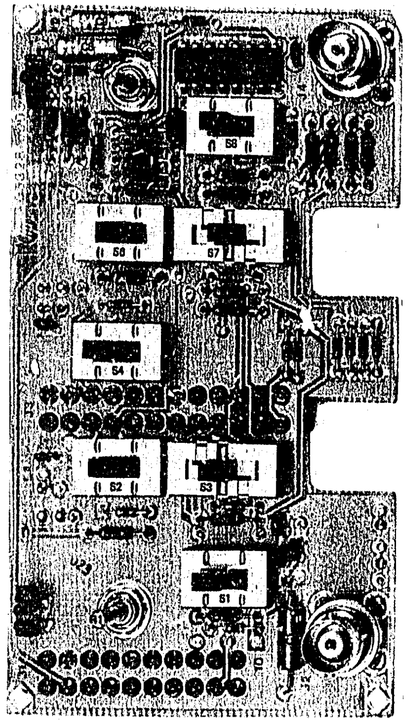
FD	FC	FB	FA	FUNCTION
*	1	1	0	0 CHECK
	1	1	0	1 FREQ "C"
	1	1	1	0 DVM
	0	1	0	0 FREQ A
	0	1	0	1 PER A
	0	1	1	0 PER AVG A
	1	0	0	1 RATIO B/A
	1	0	0	0 T1 A→B
	1	0	1	0 T1 AVG A→B
	1	0	1	1 RATIO C/A

* SWITCH S3 SHOWN IN THIS POSITION

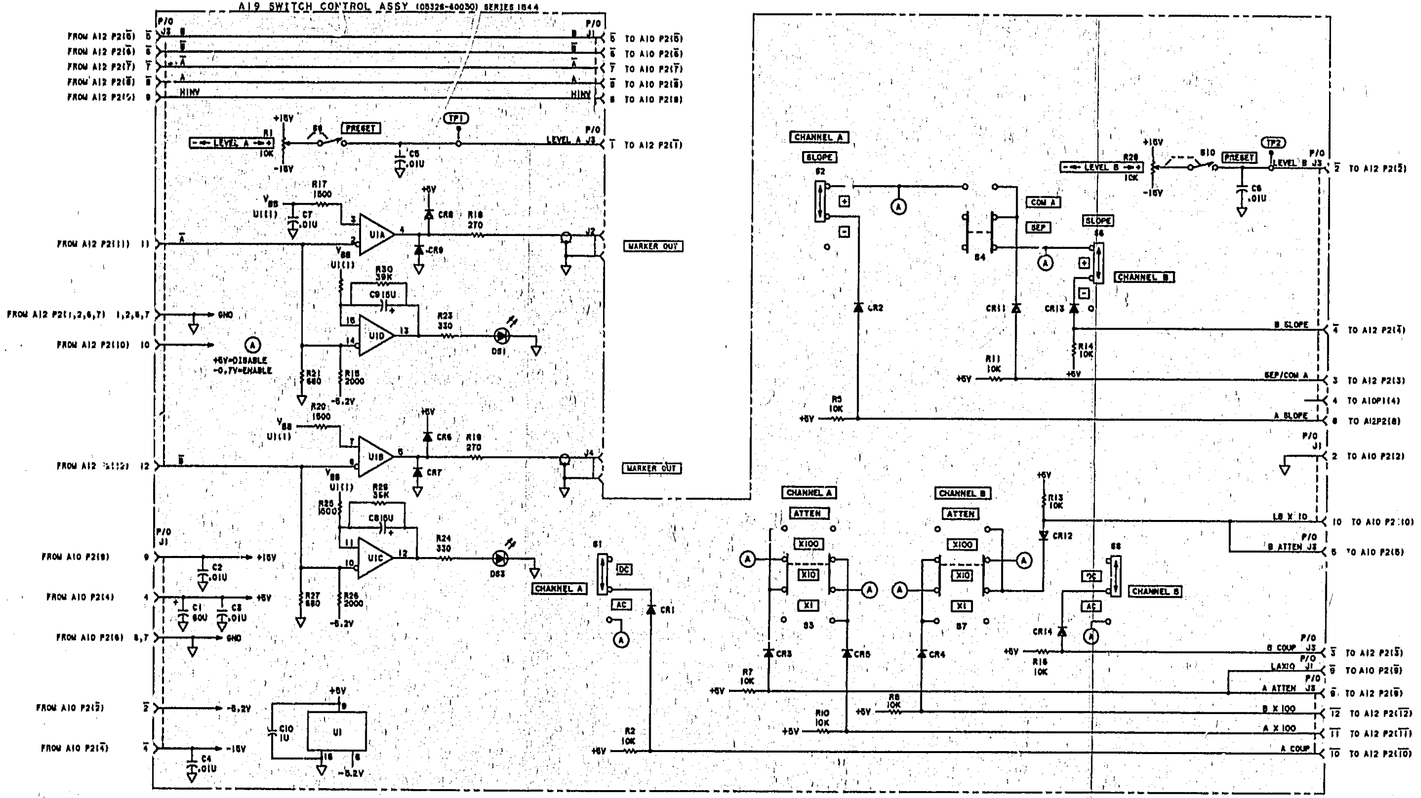
NOTES

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

Figure 8-24. A16 Display Schematic Diagram



A19



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/Attentuator Schematic Diagram

MANUAL CHANGES

MANUAL UPDATING CHANGES

CHANGE DATE: October 4, 1984

*** * * * MANUAL UPDATING COVERAGE * * * ***

This supplement adapts your manual to instruments with serial numbers prefixed through 2444.

*** * * * MANUAL IDENTIFICATION * * * ***

Instrument: HP 5328A/1199 Universal Counter Operating & Service Manual

Manual Part No: 05328-90101
Manual Microfiche: 05328-90102
Manual Print Date: June 1984

ABOUT THIS SUPPLEMENT

The information in this supplement is provided to correct manual errors and to update the manual to instruments containing changes after the manual print date.

Change and correction information in this supplement is itemized by page numbers corresponding to the original manual pages. The pages in this supplement are organized in numerical order by manual page number.

Manual updating supplements are revised as often as necessary to keep manuals as accurate as possible. Hewlett-Packard recommends that you periodically request the latest edition of this supplement. Free copies are available from all HP offices. When requesting copies quote the model number, print date, and part number listed at the top of this page.

HOW TO USE THIS SUPPLEMENT

Insert this title page in front of the title page in your manual.

Perform all changes specified for "All Serials", and all changes through the Series Prefix of your instrument or board.

Insert any complete replacement pages provided into your manual in the proper location.

If your manual has been updated according to the last edition of this supplement, you need only perform those changes pertaining to the new series prefix. See List of Effective Pages on the reverse side of this page. New information affecting "All Serials" will be indicated by a "#" in front of the page number.

HEWLETT PACKARD

LIST OF EFFECTIVE PAGES

SERIAL PREFIX OR SERIAL NUMBER	PAGES
All Serials	5-1, 6-5/6-7, 6-12, 6-23, 7-12
2424	The following Series 2424 instruments also have changes indicated for Series 2444. 2424A56902 2424A56958 56909 56960 thru 56911 56972 56922 56981 thru 56934 57001 56946 57003 and above
2444	6-12, 8-29

SERIAL PREFIX OR SERIES NUMBER	CHANGES

Page 5-1. Maintenance

All Serials — Table 5-1. HP 5328A Assembly Identification
>Change A8 from 05328-60045 to 05328-60046.

Pages 6-5/6-7, Table 6-2. A1 Motherboard Replaceable Parts:

All Serials
>Change A1CR7 from 1901-0040 to 1901-0535 DIODE-SM SIG SCHOTTKY, 28480, 1901-0535.
>Add A1CR17 1901-0040 DIODE-SWITCHING 30V 50MA, 28480, 1901-0040.
>Add A1CR18 1901-0016 DIODE-GE 60V 60MA, 28480, 1901-0016.
>A1CR19 and A1CR20 are Not Assigned.
>Change A1U10 from 1820-0633 to 1820-2316 IC-DIG HEX DEC.
>Change A1XU22 from 1200-0549 to 1200-0567 SOCKET-IC 28-CONT DIP DIP-SOLDER.

Page 6-12, Table 6-2. A8 Frequency C Board Replaceable Parts:

All Serials
>Change A8 (05328-60046) SERIES to 2424.
>Change A8C2 from 0160-3879 to 0160-4704.
>Delete A8C2 0160-4040.

2444
>Change A8 (05328-60046) SERIES to 2444.
>Add L5, L6 9170-0029 INDUC FXD BEAD.

Page 6-23, Table 6-2. Chassis Parts:

All Serials — >Add 2110-0301 FUSE-12A MIN-AX.

Page 7-12, Table 7-2. A8 "C" Channel Input Replaceable Parts:

All Serials — >Change A8 (05328-60032) SERIES from 2424 to 2105.

Page 8-29, Figure 8-13. A8 Channel C Schematic Diagram:

All Serials
>Change A8 (05328-60046) SERIES to 2444.
>Add L5, L6 Ferrite beads to leads of A8C5.

NOTE

L5, L6 Ferrite beads are factory-selected parts and may not be used in all instruments.