Errata

Title & Document Type: 5316B Operating and Service Manual

Manual Part Number: 05316-90014

Revision Date: September 1987

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, semiconductor products and chemical analysis businesses are now part of Agilent Technologies. We have made no changes to this manual copy. The HP XXXX referred to in this document is now the Agilent XXXX. For example, model number HP8648A is now model number Agilent 8648A.

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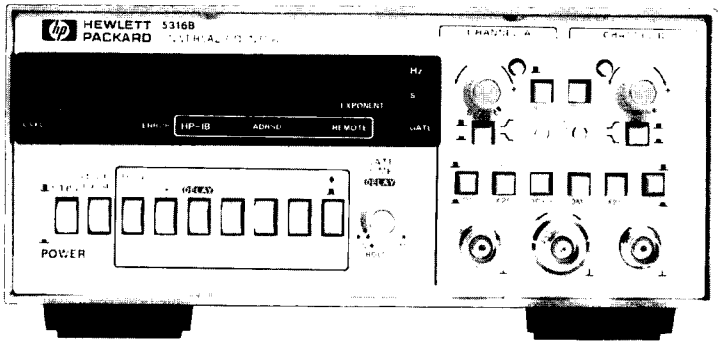
Agilent Technologies

OPERATING AND SERVICE MANUAL

DESIGNED FOR HP-IB SYSTEMS

5316B
100 MHz Universal Counter



HEWLETT PACKARD

HP 5316B

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 instrument 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. 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.

HP warrants that its software and firmware designated by HP for use with an instrument will execute its programming instructions when properly installed on that instrument. HP does not warrant that the operation of the instrument, or software, or firmware will be uninterrupted or error free.

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.

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

4/81 PG1-8WOC 19/79

OPERATING AND SERVICE MANUAL

5316B
100 MHz Universal Counter

Serial Prefix: 2708A

This manual applies to Serial Prefix 2708A, unless accompanied by a Manual Change Sheet indicating otherwise.

5301 Stevens Creek Blvd., Santa Clara, California 95051-7299

MANUAL PART NUMBER 05316-90014
Microfiche Part Number 05316-90015

Printed SEPTEMBER 1987

SAFETY CONSIDERATIONS

GENERAL

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

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

BEFORE APPLYING POWER

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

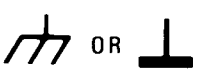
SAFETY EARTH GROUND

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

SAFETY SYMBOLS

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

Indicates hazardous voltages.



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

Alternating current.

Direct current.

WARNING

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

CAUTION

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

SAFETY INFORMATION

WARNING

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

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

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

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

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

When measuring power line signals, be extremely careful and always use a step-down isolation transformer whose output voltage is compatible with the input measurement capabilities of this product. This product's front and rear panels are typically at earth ground, so **NEVER TRY TO MEASURE AC POWER LINE SIGNALS WITHOUT AN ISOLATION TRANSFORMER.**

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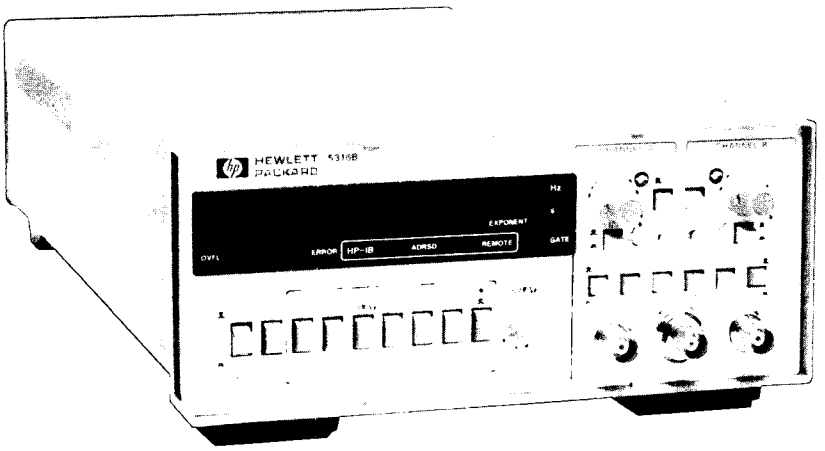
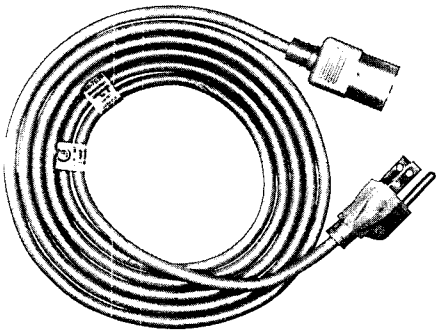


5316B UNIVERSAL COUNTER



POWER CORD
PART NO. 8120-1378

Figure 1-1. HP 5316B Universal Counter and Power Cable

SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION

1-2. This manual provides information pertaining to the installation, operation, programming, testing, adjustments, and maintenance of the HP 5316B Universal Counter, shown in *Figure 1-1.*

1-3. This manual is divided into eight sections, each covering a particular topic for the operation of the HP 5316B Universal Counter. The topics by section number are:

Section	Topic
I	General Information
II	Installation
III	Operation and Programming
IV	Performance Tests
V	Adjustments
VI	Replaceable Parts
VII	Manual Changes
VIII	Service

A three-section users manual is provided with the HP 5316B. These three sections duplicate the first three sections of the eight-section manual. We suggest that you keep the users manual with the HP 5316B.

1-4. DESCRIPTION

1-5. The Hewlett-Packard Model 5316B is a universal counter, measuring signals over a range of DC to 100 MHz. The HP 5316B measures Frequency, Period, Time Interval, Time Interval Average, Time Interval Holdoff (delay), and Ratio. A Totalize function with manual or external gating is also provided. All measurements except Totalize are displayed in engineering notation with up to eight digits of resolution. In addition, the HP 5316B may be programmed via the Hewlett Packard Interface Bus (HP-IB).

1-6. Two independent input channels are provided for time interval measurements. Each input channel has an Attenuator (X1, X20), Trigger Slope selector, Trigger Level/Sensitivity control, three-state trigger lamps, and front panel Trigger Level Monitoring jacks. A front panel selectable Low-Pass Filter is provided for Channel A.

1-7. Four options extend the capabilities of the HP 5316B. Option 001 TCXO and Option 004 Oven Oscillator offer improved time base stability. Option 003 Channel C allows frequency measurements in the range of 50 MHz to 1 GHz. Complete specifications are given in *Table 1-1.*

1-8. The HP 5316B is designed for rack mounting or stacking.

1-9. SPECIFICATIONS

1-10. The instrument specifications are listed in *Table 1-1.* These specifications are the performance standards or limits against which the instrument may be tested.

Table 1-1. Model 5316B Specifications

INPUT CHARACTERISTICS (Channel A and Channel B)

Range:
DC coupled, 0 to 100 MHz.
AC coupled, 30 Hz to 100 MHz.

Sensitivity:
10 mV rms sine wave to 10 MHz.
25 mV rms sine wave to 100 MHz.
75 mV peak-to-peak pulse at minimum pulse width of 5 ns.
Sensitivity can be varied continuously up to 500 mV rms NOMINAL by adjusting sensitivity control. In sensitivity mode, trigger level is automatically set to 0V NOMINAL.

Dynamic Range:
30 mV to 5V peak-to-peak, 0 to 10 MHz.
75 mV to 5V peak-to-peak, 10 to 100 MHz.

Signal Operating Range: +2.5V dc to -2.5V dc.

Coupling: AC or DC, switchable.

Filter: Low pass, switchable in or out of Channel A.
3 dB point of NOMINALLY 100 kHz.

Impedance:
1 MΩ NOMINAL shunted by less than 40 pF.

Attenuator: X1 or X20 NOMINAL.

Trigger Level: Variable between +2.5V dc and -2.5V dc.

Slope: Independent selection of + or - slope.

Common Input: All specifications are the same for Common A except the following:
Sensitivity: 20 mV rms sine wave to 10 MHz.
50 mV rms sine wave to 100 MHz, 150 mV peak-to-peak.
Dynamic Range: 60 mV to 5V peak-to-peak 0–10 MHz,
150 mV to 5V peak-to-peak 10–100 MHz.
Impedance: 500 kΩ NOMINAL shunted by less than 70 pF.

Damage Level:

AC & DC × 1:	
DC to 2.4 kHz	250V (DC + AC rms)
2.4 kHz to 100 kHz	(6 × 10⁵V rms × Hz)/FREQ
>100 kHz	6V rms
AC & DC × 20:	
DC to 28 kHz	500V (DC + AC peak)
28 kHz to 100 kHz	(1 × 10⁷V rms × Hz)/FREQ
>100 kHz	100V rms

FREQUENCY (Channel A)

Range: .1 Hz to 100 MHz.

LSD Displayed: 10 Hz to 1 nHz depending upon gate time and input signal. At least 7 digits displayed per second of gate time.

†Resolution:
For FREQ <10 MHz;

$$\pm LSD\dagger\dagger \pm 1.4 \times \frac{\text{Trigger Error}}{\text{Gate Time}} \times FREQ.$$

For FREQ ≥10 MHz; ±LSD††

Accuracy: ± Resolution ± (time base error) × FREQ.

RATIO

Range: .1 Hz to 100 MHz, both channels.

LSD:

$$\frac{2.5 \times \text{Period}}{\text{Gate Time}} \times \text{Ratio (rounded to nearest decade).}$$

where "Period" is the period of the highest frequency input signal.

Resolution:
FREQ A > FREQ B

$$\pm LSD \pm \frac{\text{B Trigger Error}}{\text{Gate Time}} \times \text{Ratio.}$$

FREQ B > FREQ A

$$A = \frac{2.5 \times \text{Period A}}{\text{Gate Time}} \times \text{Ratio}$$

(Rounded to nearest decade)

$$\pm A \pm \frac{\text{B Trigger Error}}{\text{Gate Time}} \times \text{Ratio}$$

Accuracy:
Same as resolution. Highest frequency input is connected to Channel A to achieve specified accuracy.

TOTALIZE

Manual:
Range: 0 to 100 MHz.

A Gated By B:
Totalizes input A between two events of B. Instrument must be reset to make new measurement. Gate opens on A slope, closes on B slope.

Range: 0 to 100 MHz.

Resolution: ±1 count.

Accuracy: ±1 count ± B Trigger Error × Frequency A.

PERIOD

Range: 10 ns to 10^5 s.

LSD Displayed: 100 ns to 1 fs depending upon gate time and input signal. At least 7 digits displayed per second of gate time.

Resolution:
For PER >100 ns;

$$\pm LSD\dagger\dagger \pm 1.4 \times \frac{\text{Trigger Error}}{\text{Gate Time}} \times PER.$$

For PER ≤100 ns; ± LSD††

Accuracy: ± Resolution ± (time base error) × PER.

†Best Case Resolution for 1 Second Gate

	100 Hz	1 kHz	10 kHz	100 kHz	1 MHz	10 MHz	100 MHz
50 mV rms	±.0004 Hz	±.00048 Hz	±.0014 Hz	±.01 Hz	±.1 Hz	±1 Hz	±10 Hz
100 mV rms	±.0002 Hz	±.00029 Hz	±.0012 Hz	±.01 Hz	±.1 Hz	±1 Hz	±10 Hz
500 mV rms	±.00005 Hz	±.00014 Hz	±.0011 Hz	±.01 Hz	±.1 Hz	±1 Hz	±10 Hz
1V rms	±.00003 Hz	±.00012 Hz	±.0010 Hz	±.01 Hz	±.1 Hz	±1 Hz	±10 Hz

This chart shows best case frequency resolution versus input sine wave rms amplitude. This is best case because noise from the signal source is assumed to be zero; the trigger error is produced only by the counter's noise (i.e., 120 μV rms).

††Due to arithmetic truncation, quantization error will be ±1 or ±2 counts of the LSD (Least Significant Digit) as follows:

±2 counts of LSD if $\frac{\text{LSD}}{\text{FREQ or PER}} < 1 \times 10^{-7}$, FREQ <10 MHz.

±2 counts of LSD if $\frac{\text{LSD}}{\text{FREQ or PER}} < \frac{1/(\text{Gate Time})}{\text{FREQ}}$, FREQ ≥10 MHz.

±1 count of LSD for all other cases.

Table 1-1. Model 5316B Specifications (Continued)

TIME INTERVAL

Range: 100 ns to 10^5 s.
LSD Displayed: 100 ns.
Resolution: ± LSD ± Start Trigger Error ± Stop Trigger Error.
Accuracy: ± Resolution ± (time base error) × T.I.

TIME INTERVAL AVERAGE

Range: 0 ns to 10^5 s.
LSD Displayed: 100 ns to 10 ps depending upon gate time and input signal. See table in Definitions section.
Resolution:

$$\pm \text{LSD} \pm \frac{\text{Start Trigger Error}}{\sqrt{N}} \pm \frac{\text{Stop Trigger Error}}{\sqrt{N}}$$

Accuracy: ± Resolution ± (time base error) × T.I. ±4 ns.
Number of Intervals Averaged (N): N = Gate Time × FREQ
Minimum Dead Time (stop to start): 200 ns.

TIME INTERVAL DELAY (Holdoff)

Front panel gate time knob inserts a variable delay of **NOMINALLY** 500 μs to 20 ms between START (Channel A) and enabling of STOP (Channel B). Electrical inputs during delay time are ignored. Delay time may be measured by simultaneously pressing T.I. Average, T.I. Delay, and Blue Shift key. Other specifications of T.I. Delay are identical to Time Interval.

TIME BASE

Frequency: 10 MHz.
Aging Rate: $<3 \times 10^{-7}$/mo.
Temperature: $\leq 5 \times 10^{-6}$, 0 to 50°C.
Line Voltage: $\leq 1 \times 10^{-7}$ for ±10% variation.
Oscillator Output: 10 MHz, 50 mV p-p into 50Ω.
External Frequency Standard Input: 1, 5, 10 MHz, 1V rms into 500Ω, on rear panel; 6V rms maximum.

GENERAL

Trigger Level Output: ±5% ±15 mV, over ±2.0V dc range at front panel test connectors.
Check: Counts internal 10 MHz reference frequency over gate time range NOMINALLY 500 μs to 30 ms.
Error Light: LED warning light activated if logic error is found during instrument turn-on self-check.
Display: 8-digit LED display, with engineering units annunciator.
Overflow: Only frequency and totalize measurements will overflow. In case of overflow, eight least significant digits will be displayed and front panel overflow LED will be actuated. All other measurements which would theoretically cause a display of more than eight digits will result in the display of the eight most significant digits.
Gate Time: Continuously variable, NOMINALLY from 60 ms to 10 s or 1 period of the input, whichever is longer. For FREQ A, a shorter gate time of 500 μs–30 ms is selectable by simultaneously pressing T.I. Delay and Totalize keys.
Sample Rate: Up to seven readings per second NOMINAL except in time interval mode, where it is continuously variable NOMINALLY from four readings per second to 1 reading every 10 seconds via Gate Time control.
Operating Temperature: 0° to 50°C.
Power Requirements: Selectable 100, 120, 220, or 240V (+5%, -10%) 48–66 Hz; 30 VA maximum.
Dimensions: 215 mm W × 86 mm H × 425 mm D (8½ × 3⅜ × 16¾ in.).
Weight: Net, 3.7 kg (8 lbs. 2 oz.); Shipping, 6.3 kg (14 lbs.). Rack and stack metal case with rear panel, switchable AC power line module.
Rack Mount Kit: 5061-9672 recommended.

HP INTERFACE BUS (HP-IB)

Data Output
Format: (alpha character) ± (Reading) (Exponent) ± (2 digits).
Data Output Rate: ~7 Readings/second max. (10 in short G.T.)
Talk Only Mode: Selectable by rear panel switch.
Operating Commands
5316B: Reset, Initialize (to FREQ A), Wait State ON/OFF, Service Request Enabled/Disabled, Gate Time Range.
HP-IB: Group Execute Trigger, Device Clear, Selected Device Clear, Interface Clear, Local, Remote, Local Lockout, Read Status (Serial Poll Enable).
Programmable Controls and Functions
Frequency Functions: FREQUENCY A, FREQ A ARMED BY B, TOTALIZE, A GATED BY B, RATIO A/B, and FREQ C.
Period Function: Period A.
Time Interval Functions: Time Interval A→B, Time Interval Average A→B, Time Interval Delay.
Trigger Level Commands: Set Channel A Slope (±), set Channel B Slope (±), A Trigger Level: ±X.XX, B Trigger Level: ±X.XX.
Gate Time Command: Sets Gate Time Range.
Miscellaneous Functions: Gate Time Check, Display Test, 10 MHz Check, Interface Test.

OPTIONS

OPTION 001: High Stability Time Base (TCXO)
Frequency: 10 MHz.
Aging Rate: $<1 \times 10^{-7}$/mo.
Temperature: $\pm 1 \times 10^{-6}$, 0° to 40°C referenced to 25°C if offset frequency is used.
Line Voltage: $<1 \times 10^{-8}$ for ±10% variation.

OPTION 003: C Channel
Input Characteristics
Range: 50 to 1000 MHz, prescaled by 10.
Sensitivity: 15 mV rms sine wave (-23.5 dBm) to 650 MHz. 75 mV rms sine wave (-9.5 dBm) to 1000 MHz. Sensitivity can be decreased continuously by up to 20 dB NOMINAL, 50 to 500 MHz and 10 dB NOMINAL, 500 to 1000 MHz by adjusting sensitivity control. Trigger level is fixed at 0V NOMINAL.
Dynamic Range:
15 mV to 1V rms (36 dB), 50 to 650 MHz.
75 mV to 1V rms (20 dB), 650 to 1000 MHz.
Signal Operating Range: +5V dc to -5V dc.
Coupling: AC
Impedance: 50Ω **NOMINAL (VSWR, ⩽2.5:1 TYPICAL).**
Damage Level: ±8V (DC + AC peak), fuse protected. Fuse located in BNC connector.
Frequency
Range: 50 to 1000 MHz.
LSD Displayed: 100 Hz to 1 Hz depending upon gate time. At least 7 digits per second of gate time.
LSD, Resolution and Accuracy: Same formulas as for Frequency A except "Gate Time" term becomes "(Gate Time)/10".

Table 1-1. Model 5316B Specificatons (Continued)

OPTIONS (Continued)

OPTION 004: Oven Oscillator
Frequency: 10 MHz.
Aging Rate: $<5 \times 10^{-8}$/month after 7 days of continuous operation. $<3 \times 10^{-7}$/year after 180 days continuous operation.
Warm-up: $\pm 5 \times 10^{-8}$ of final value after 20 minutes.
Temperature; $\pm 2 \times 10^{-8}$, 0° to 50°C.
Oscillator Output: 50 mV p-p into 50Ω.

DEFINITIONS:

Resolution: Smallest discernible change of measurement result due to a minimum change in the input.
Accuracy: Deviation from the actual value as fixed by universally accepted standards of frequency and time.
Least Significant Digit (LSD) Displayed:

Frequency:

$$\frac{2.5 \times 10^{-7}}{\text{Gate Time}} \times \text{FREQ, for FREQ} < 10 \text{ MHz.}$$

$$\frac{2.5}{\text{Gate Time}} \quad \text{for FREQ} \geq 10 \text{ MHz.}$$

Period:

$$\frac{2.5 \times 10^{-7}}{\text{Gate Time}} \times \text{PER, for PER} > 100 \text{ ns.}$$

$$\frac{2.5}{\text{Gate Time}} \times \text{PER}^2\text{, for PER} \leq 100 \text{ ns.}$$

All above calculations should be rounded to nearest decade (i.e., 5 Hz will become 10 Hz and .4 ns will be .1 ns).

NOTE

Time Interval Average is a statistical process. LSD displayed is calculated for 1 standard deviation (σ) confidence level.

Trigger Error:

$$\frac{\sqrt{(120 \times 10^{-6}\text{V})^2 + e_n^2}}{\text{(Input slew rate in V/s at trigger point)}} \text{ seconds rms,}$$

Typical where e_n is the rms noise voltage of the input for a 100 MHz bandwidth.

Time Interval Average:

	LSD
1 to 25 intervals	100 ns
25 to 2500 intervals	10 ns
2500 to 250,000	1 ns
250,000 to 25,000,000 intervals	100 ps
>25,000,000 intervals	10 ps

1-11. OPTIONS

1-12. The options available for the HP 5316B are listed below. There are no field retrofit kits available for these options. All options should be requested at the time of the initial order. However, Section II contains the necessary information required to install Option 001 TCXO, Option 004 Oven Oscillator, and Option 003, Channel C. Options 001 and 004 require the standard A7 assembly be replaced by the appropriate option (Option 004 adds an A13 assembly). Option 003 requires the addition of the A9 assembly and a new front panel. All parts must be ordered as separate items and then installed as described in Section II. Full descriptions of Options 001, 003, and 004 are in Section III.

Option	Description
001	High Stability Time Base (TCXO)
003	Channel C 1 GHz
004	Oven Oscillator

1-13. Option 001 TCXO is a Temperature Compensated Crystal Oscillator that directly replaces the standard A7 oscillator assembly. Option 004 Oven Oscillator provides increased temperature stability over the TCXO. Specifications are listed in *Table 1-1.*

1-14. Option 003 Channel C allows frequency measurements to 1 GHz. Specifications are listed in *Table 1-1.*

1-14a. Option W30 (Extended Hardware Support) provides two additional years of return-to-HP hardware-service support. Option W30 is available only at time of purchase. Service contracts are available from Hewlett-Packard for instruments which did not include Option W30 at time of purchase. For more information, contact your nearest Hewlett-Packard Sales and Support office (offices are listed at the back of this manual).

1-15. SAFETY CONSIDERATIONS

1-16. The HP 5316B Universal Counter is a Safety Class I instrument, designed according to International Safety Standards. This operating manual contains information, cautions, and warnings which must be followed by the user to ensure safe operation and keep the instrument in safe condition.

1-17. INSTRUMENT IDENTIFICATION

1-18. Hewlett-Packard instruments have a 2-section, 10-character serial number (0000A00000), which is located on the rear panel. The four-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. If the change sheet is missing, contact the nearest Hewlett-Packard Sales and Service Office listed at the back of this manual. Instruments having a lower serial prefix than that listed on the title page are covered in Section VII.

1-19. ACCESSORIES

1-20. *Table 1-2* lists accessory equipment supplied and *Table 1-3* lists accessories available.

Table 1-2. Accessories Supplied

Description	HP Part Number
Detachable Power Cord, 229 cm (7½ feet)	8120-1378

Table 1-3. Accessories Available

Description	HP Part Number
Rack Mount Kit	5061-0072

1-21. RECOMMENDED TEST EQUIPMENT

1-22. The test equipment listed in *Table 1-4* is recommended for use during performance tests, adjustments, and troubleshooting. Substitute test equipment may be used if it meets the required characteristics listed in the table.

Table 1-4. Recommended Test Equipment

Instrument	Critical Specifications	Recommended Model	Use*
Oscilloscope	100 MHz Bandwidth	54201A	A,T
Synthesizer/Generator	0.1—10 MHz	HP 3325A	P,A,T
Signal Generator	10—100 MHz	HP 8656B	P,A,T
Synthesized Generator	1000 MHz	HP 8660C/86602A	P,A,T
DC Voltmeter	20V Range, 0.05V Resolution	HP 3468A	A,T
Counter	10 MHz, .1 Hz Resolution	HP 5384A	A
50Ω Feedthrough	BNC Type	HP 10100C	P,A,T
Tee Connector	BNC Type	HP 1250-0781	P,A,T
Power Splitter	DC—18 GHz	HP 11667A	P
Cables (3)	4 BNC 50Ω	HP 11170C	P,A,T
Controller	IEEE 488-1978	HP 85B	P,A,T,
Signature Analyzer		HP 5005A	T

*P = Performance Tests, A = Adjustments, T = Troubleshooting.

SECTION II
INSTALLATION

2-1. INTRODUCTION

2-2. This section contains information for unpacking, inspection, storage, and installation.

2-3. UNPACKING AND INSPECTION

2-4. If the shipping carton is damaged, inspect the instrument for visible damage (scratches, dents, etc.). If the instrument 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. The Hewlett-Packard Sales and Service Office will arrange for repair or replacement of your instrument without waiting for the claim against the carrier to be settled.

2-5. PREPARATION FOR USE

2-6. Power Requirements

2-7. The HP 5316B requires a power source of 100-, 120-, 220-, or 240-volt ac, +5%, −10%, 48 to 66 Hz single phase. Power consumption is approximately 15 watts. See Section I, Specifications for description.

2-8. Line Voltage Selection

CAUTION

Before connecting the instrument to ac power lines, be sure that the voltage selector is properly positioned as described below.

2-9. The HP 5316B is equipped with a power connector module that has a plug-in printed-circuit card line voltage selector to choose 100-, 120-, 220-, or 240-volt ac operation (see *Figure 2-1*). Before applying power, the selector card must be set to the correct position and the correct fuse must be installed as described below.

2-10. Power line connections are selected by the position of the plug-in card in the module. When the card is plugged into the module, the only visible markings on the card indicate the line voltage to be used. The correct value of line fuse, with 250-volt rating, must be installed after the card is inserted.

2-11. To convert from one line voltage to another, the power cord must be disconnected from the power module before the sliding window covering the fuse and card compartment can be moved to expose the fuse and circuit card.

2-12. Pull on the fuse lever to remove the fuse and then pull the card out of the module. The fuse lever must be held to one side to remove and insert the card. Insert the card so the marking that agrees with the line voltage to be used is visible.

2-13. Return fuse lever to normal position, insert correct fuse, slide plastic window over the compartment, and connect the power cord to complete the conversion.

NOTE

For operation from 100V ac or 120V ac use a .3A slo-blo fuse. For 220V ac or 240V ac operation, use a .15A slo-blo fuse.

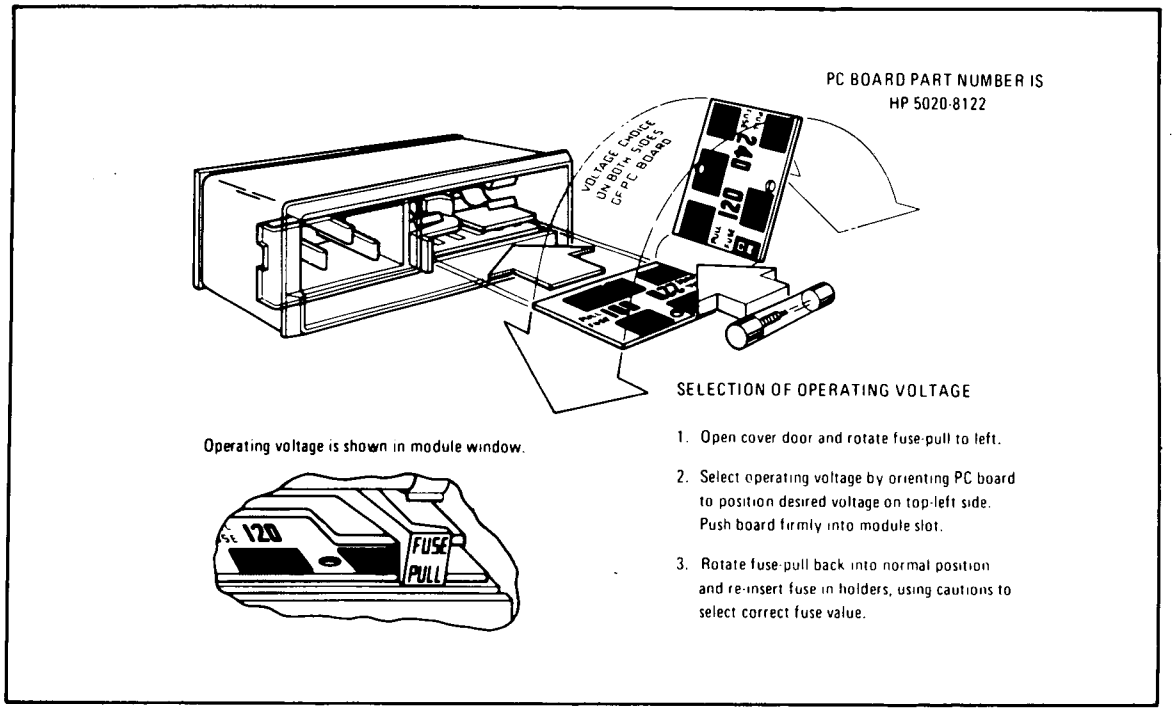


Figure 2-1. 5316B Line Voltage Selection

2-14. Power Cable

WARNING

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

2-15. The HP 5316B is shipped with a three-wire power cable. When the cable is connected to an appropriate ac power source, this cable connects the chassis to earth ground. The type of power cable plug shipped with each instrument depends on the country of destination. Refer to *Figure 2-2* for the part numbers of the power cable and plug configurations available.

2-16. Operating Environment

2-17. TEMPERATURE. The HP 5316B may be operated in temperatures from 0°C to 50°C.

2-18. ALTITUDE. The HP 5316B may be operated at altitudes up to 4,600 metres (15,000 feet).

2-19. STORAGE AND SHIPMENT

2-20. Environment

2-21. The instrument may be stored or shipped in environments with the following limits:

Temperature ..... -40°C to +75°C
Altitude ..... 7,620 metres (25,000 feet)

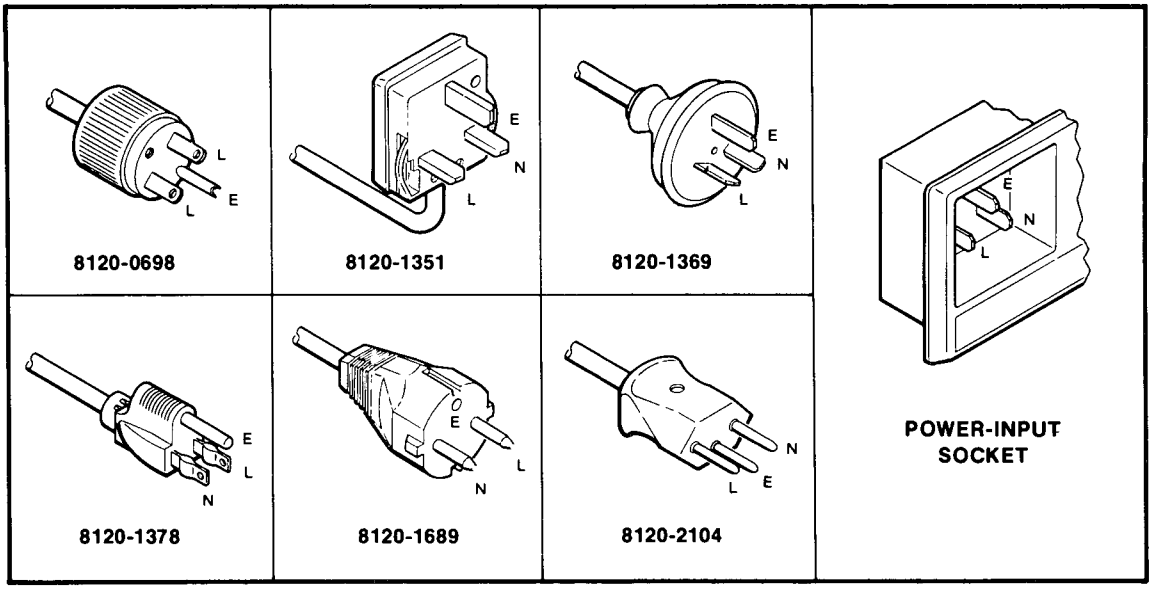


Figure 2-2. Power Cable HP Part Numbers versus Main Plugs Available

2-22. The instrument should also be protected from temperature extremes which cause condensation within the instrument.

2-23. Packaging

2-24. ORIGINAL PACKAGING. Containers and materials identical to those used in factory packaging are available through Hewlett-Packard offices. If the instrument is being returned to Hewlett-Packard for servicing, attach a tag indicating the type of service required, return address, model number, and full serial number. Also, mark the container FRAGILE to ensure careful handling. In any correspondence, refer to the instrument by model number and full serial number.

2-25. OTHER PACKAGING. The following general instruction should be used for repacking with commercially available materials:

a. Wrap instrument in heavy paper or plastic. (If shipping to Hewlett-Packard office or service center, attach a tag indicating type of service required, return address, model number, and full serial number.)

b. Use strong shipping container. A double-wall carton made of 350-pound test material is adequate.

c. Use a layer of shock-absorbing material 70 to 100 mm (3- to 4-inch) thick around all sides of the instrument to provide firm cushioning and prevent movement inside container. Protect control panel with cardboard.

d. Seal shipping container securely.

e. Mark shipping container FRAGILE to ensure careful handling.

f. In any correspondence, refer to instrument by model number and full serial number.

2-26. FIELD INSTALLATION OF OPTIONS

2-27. The following paragraphs provide instructions for the installation of Option 001 (TCXO), Option 004 (Oven Oscillator), and Option 003 (Channel C). Any of the options may be installed after the purchase of the HP 5316B by ordering the appropriate parts in *Table 2-1* and performing the installation procedure listed in paragraphs 2-30 through 2-35.

2-28. Part Numbers for Ordering Option Kits

2-29. To obtain the necessary parts for installation of an option, order by part number as listed in *Table 2-1* (refer to Section VI for ordering information):

Table 2-1. Options 001, 004, and 003 Parts Lists

OPTON 001 TCXO	
A7 TCXO ASSEMBLY	05316-60007
OPTION 004 OVEN OSCILLATOR	
4-40 × .187" Pan Head Posidrive Screws (3 ea.)	2200-0179
M3.0 LK 4.0 L Screw (3 ea.)	0515-1508
6-32 × .250" Screw (2 ea.)	2360-0113
A7 Regulator Board (1 ea.)	05316-60013
Cable Assembly (1 ea.)	05316-60103
Bracket (1 ea.)	05316-00015
Oven Oscillator (1 ea.)	0960-0603
Inductor (Ferrite Beads) (2 ea.)	9170-0029
Capacitor 1000 pf (1 ea.)	0160-4556
OPTION 003 CHANNEL C	
Special BNC Connector	1250-1899
Hex Nut	2950-0054
Lockwasher	2190-0068
Front Panel	05316-00016
Channel C Assembly A9	05315-60009
Screws 6-32 × .250" Pan Head Pozidriv (4 ea.)	2360-0113

WARNING

TO PREVENT ELECTRICAL SHOCK, REMOVE ALL POWER FROM THE INSTRUMENT BEFORE REMOVING COVER.

2-30. Option 001 TCXO Installation

2-31. Option 001 Temperature Compensated Crystal Oscillator (TCXO) replaces the standard reference oscillator which plugs into a connector (J2) on the A1 motherboard. To install Option 001, proceed as follows:

a. Remove AC power cord.

b. Remove rear bezel (the two screws are captive).

c. Remove screw on bottom rear of instrument (between rear feet).

d. Slide cover off rear of instrument.

e. Remove A7 standard reference oscillator.

f. Insert Option 001 TCXO into J2 located on motherboard. This is same jack previously occupied by standard reference oscillator.

g. Secure Option 001 TCXO using two 6/32 × 1.4 inch screws.

CAUTION

Do not operate the HP 5316B unless the Q11 and Q12 heat sink is securely fastened to the side frame of the instrument. Otherwise, the transistors will be damaged from overheating.

h. Perform "Operator's Checks" listed in *Figure 3-12.*

i. Go to Section V, A7 Option 001 TCXO Adjustment.

j. Replace cover.

2-32. Option 004 Installation

2-33. Option 004 Oven oscillator consists of two sections, a voltage regulator assembly that replaces the standard A7 assembly and an oven oscillator module (A13). A cable connects the regulator assembly and the module to supply power to the oscillator and route the 10 MHz output back to the A1 Motherboard via the A7 regulator assembly. To install Option 004 Oven oscillator, proceed as follows:

a. Remove AC power cord.

b. Remove rear bezel (the two screws are captive).

c. Remove screw on bottom rear of instrument (between rear feet).

d. Slide cover off rear of instrument.

e. Remove two Pozidriv screws securing the standard A7 assembly to the A1 Motherboard.

f. Remove A7 assembly.

g. Insert A7 regulator assembly into J2 on A1 Motherboard. This is same jack previously occupied by standard oscillator.

h. Secure A7 regulator assembly with two 6/32 × 1/4 screws.

i. Orient oscillator module so label is facing front of the HP 5316A, power supply and output pins are facing rear, and portion of bracket that wraps around module is against the left frame.

j. Looking at left side HP 5316B, (as you face instrument), position oscillator/bracket so holes of bracket align with three holes in middle of frame. Secure bracket to side frame with three (3) metric screws.

k. Solder 1000 pf capacitor to pins 1 and 2 of oven oscillator module. Leave room on pins to attach an additional wire.

l. Thread a ferrite bead on red wire of cable from A7 Regulator Board.

m. Solder red wire of cable to pin 1 of oven oscillator module.

n. Thread a ferrite bead on white wire of cable from A7 Regulator Board.

o. Solder white wire to pin 3 of oven oscillator.

p. Solder black wire of cable to pin 2 of oven oscillator.

q. Center trimmer A7R2 (located at top of regulator assembly).

r. Apply power to HP 5316B. Select CHECK mode. Set Gate Time control fully counter-clockwise, but not HOLD.

s. The HP 5316B should display 10 MHz with Gate Lamp flashing. If this does not occur, remove power and check all connections. The most likely place for mistakes are connections to oscillator module. If all connections are correct, but oscillator still does not operate, go to Section VIII, Troubleshooting, for Option 004 Oven Oscillator.

t. If HP 5316B is operating properly, go to Section V Adjustments, for Option 004 Oven Oscillator.

u. Installation of Option 004 Oven Oscillator is complete.

2-34. Option 003 Channel C Installation

2-35. To install Option 003 proceed as follows:

a. Remove AC power cord.

b. Remove rear bezel (the two screws are captive).

c. Remove screw on bottom rear of instrument (between rear feet).

d. Slide cover off rear of instrument.

e. Remove two screws securing heat sink/support bracket to right side frame.

f. Disconnect REF IN/OUT cable (W3) from A1 Motherboard at rear of instrument.

g. Remove two HP-IB connector screws located on rear panel of instrument.

h. Disconnect cable from transformer to A1J9 on motherboard.

i. Remove two 6/32 screws securing A7 board to A1 Motherboard if A7 board installed.

j. Unplug A7 board from A1J2.

k. Remove 3 screws securing oven oscillator bracket if oven oscillator is installed.

l. Remove oven oscillator assembly.

m. Remove A1 Motherboard and front panel assembly from cabinet frame by gently pushing at rear of A2 front panel assembly and pressing up on top of front frame to release top of front panel; then press down on bottom of front frame to release bottom of front panel.

n. Pull front panel and motherboard assembly out of frame several inches.

o. Remove two LEVEL/SENS knobs and GATE TIME knob, and hex nuts behind knobs and on Channel A and B BNC connectors, from front panel.

p. Disconnect ribbon cable W1 from A1J4.

q. Disconnect W2 from A2J2 and A1J6.

r. Remove two hex nuts securing CHANNEL A and CHANNEL B BNC's to front panel.

s. Remove ¼-inch hex nut on left side (back) of A2 assembly, and pull front panel straight forward, until clear. Note spacer between front panel and A2 assembly. Disconnect two front panel trigger level slide-on connectors from A2.

t. Unsolder two wires from TRIGGER LEVEL OUT pins on rear of front panel.

u. Remove four Pozidriv screws securing A4 assembly to A1 Motherboard. Remove combination A2/A4 assembly by gently lifting on rear edge of A4, until pins come free of A1 Motherboard Connector A1J8.

v. Position A9 Channel C assembly, component side up and protruding pins toward rear of instrument, over A1 Motherboard Connector A1J7. Install by gently pressing row of pins into connector A1J7 until assembly rests on spacers mounted on A1. Secure A9 assembly with four Pozidriv screws (6-32 × .250").

w. Install special input BNC in INPUT C position (center) of 5316B replacement front panel as illustrated in Section III, *Figure 3-9*.

x. Connect brass SMC connector on A9W1 to INPUT C BNC and tighten.

y. Go to A9 Option 003 Channel C Adjustment for adjustment procedures.

z. Reassemble instrument by essentially performing steps a through t in reverse order.

SECTION III
OPERATION

3-1. INTRODUCTION

3-2. This section provides operating information for the HP 5316B Universal Counter. Descriptions of all front panel controls, connectors, and indicators, as well as an operator's check, operating instructions, and operator's maintenance, are provided.

3-3. OPERATING CHARACTERISTICS

3-4. The HP 5316B is a 100 MHz/100 ns full universal counter, capable of Frequency, Period, Time Interval, Ratio, and Totalize measurements. To maximize resolution, the HP 5316B uses a reciprocal counting technique for frequencies below 10 MHz, automatically switching to conventional frequency counting for frequencies above 10 MHz. The gate time is continuously adjustable from 60 ms to 10 s, via the front panel. The internal microprocessor performs the calculations, and automatically takes into account the selected gate time. The display is given in engineering notation (i.e., exponents of blank, ±3, ±6, or ±9, except in totalize modes). The input amplifiers are optimized for both time interval and frequency measurements. In addition, the HP 5316B may be programmed via the HP-IB. The rear panel external reference input can accept 1, 5, or 10 MHz as the reference due to a time base multiplier (injection-lock-multiplier). With the addition of Option 001 TCXO or Option 004 Oven Oscillator, increased temperature stability is gained, and this increased stability allows extended calibration periods.

3-5. When Option 003 Channel C is installed, the frequency counting range of the counter is extended to 1 GHz. Signals on Input C are prescaled by 10, then routed to the Channel C input of the MRC (Multiple Register Counter) integrated circuit on the HP 5316B motherboard. The input sensitivity can be decreased, continuously, up to 20 dB nominally (in the range of 50 to 500 MHz) and 10 dB nominally (in the range of 500 to 1000 MHz).

3-6. MODES OF OPERATION

3-7. The HP 5316B provides 10 modes of operation and two CHECK functions. The resolution and accuracy for each mode except A Armed by B is provided in *Table 1-1*. The modes of operation are described in the following paragraphs:

FREQ A	A BY B (Gated Totalize)
PER A	FREQ A ARMED BY B
T.I. A→B	FREQ C (Option 003)
T.I. AVG. A→B	TOT (Manual Totalize START/STOP)
T.I. DELAY (Holdoff)	CHECK
RATIO A/B	Display Check

3-8. FREQ A

3-9. Frequency measurements are made by connecting a signal (up to 100 MHz) to INPUT A, and pressing the FREQ A function (with the Blue Shift key OUT). Select the appropriate input signal conditioning and adjust the LEVEL/SENS control (with TRIGGER LEVEL/SENSITIVITY key to TRIGGER LEVEL) to the optimum trigger point. The optimum trigger point may be determined by centering the LEVEL/SENS control within the triggering range, and triggering is indicated by the flashing TRIGGER light. The actual trigger voltage may be determined by monitoring the TRIGGER LEVEL OUT on the front panel. The voltage at these points will be within ±5% ±15 mV of the actual trigger voltage over a ±2.0 volt range. The GATE TIME control determines the resolution of the measurement, and may be

displayed by pressing the GATE TIME function key and Blue Shift key. The gate time range when FREQ A is pressed is 60 ms to 10 s, typical. However a gate time range of 500 μs to 30 ms is available by pressing T.I. DELAY and TOT STOP/START simultaneously. When the Blue Shift key is OUT, the HP 5316B will be in FREQ A. When the Blue Shift key is IN, the HP 5316B will be in PER A. PER A is discussed in the following paragraph.

3-10. PER A

3-11. The Period A mode allows signal period measurements to be made over a range of 10^5 s to 10 ns into INPUT A. Select the appropriate input signal conditioning, and Trigger Level/Sensitivity. The gate time range is 60 ms to 10 s, typical, when PER A is pressed. However, a shorter gate time is also available for PER A (500 μs to 30 ms) as described in FREQ A, paragraph 3-9.

3-12. T.I. A→B

3-13. T.I. A→B measures the time interval between a START signal at INPUT A and a STOP signal at INPUT B. If both the START and STOP signals are derived from the same signal, connect the signal to INPUT A and set the SEP/COM A key to the COM A position (IN). Separate Slope and Level/Sensitivity controls for each channel allow variable triggering on either positive or negative going slope. A single-shot time interval measurement may be made over a range of 100 ns to 10^5 s.

3-14. T.I. AVG A→B

3-15. The T.I. Average mode provides greater resolution of time interval measurements than single-shot T.I. mode provides. In the T.I. AVG mode, the gate time control varies the number of events of time intervals averaged (approximately GATE TIME × REP RATE). The resolution of the measurement is improved by the $\sqrt{N}$, where N is the number of time intervals averaged. A limited range of negative T.I. measurements (i.e., B triggers before A) are possible in T.I. AVG mode.

3-16. In the T.I. AVG mode, there must be at least 200 ns dead time. Dead time is the time between the preceding time interval stop event and the current time interval start event, as shown in *Figure 3-1.* This means that in T.I. AVG mode, the repetition rate must be less than 5 MHz. Also time interval averaging of high stability (synthesized) sources is not recommended because the displayed result may not be accurate. Proper averaging requires that there be no coherence between the source and the counter time base oscillator.

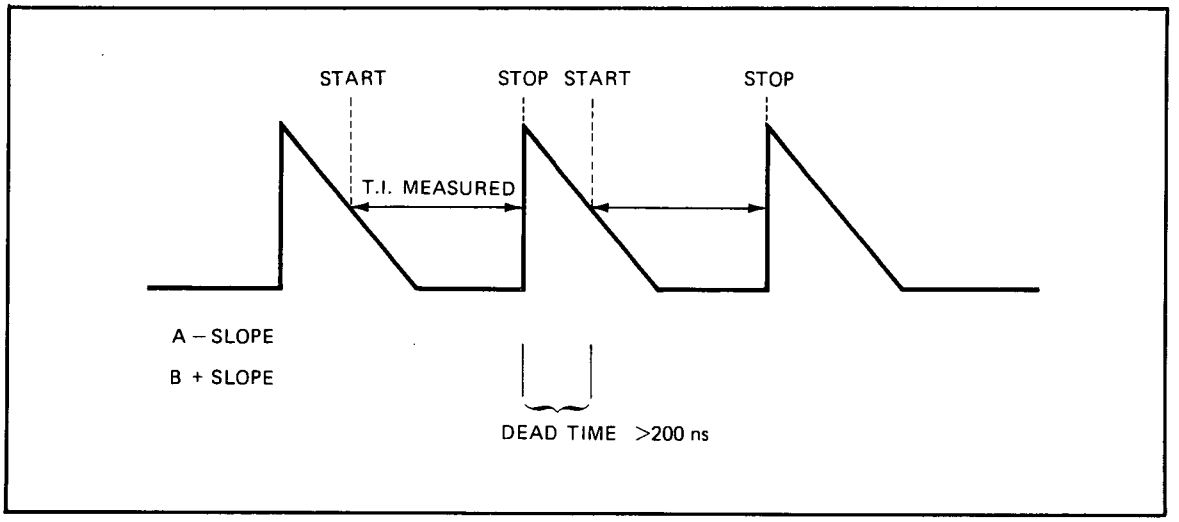


Figure 3-1. T.I. Average Dead Time

3-17. T.I. DELAY (HOLD OFF)

3-18. The T.I. DELAY mode of operation is similar to T.I. A→B, but with the following additional control: The front panel GATE TIME control inserts a variable delay (from 500 μs to 30 ms nominal) between the START (INPUT A) event and the enabling of the STOP (INPUT B) event. Potential STOP events are ignored during the specified delay or holdoff. The amount of delay time may be continuously measured and displayed by simultaneously pressing the T.I. A→B, T.I. DELAY, and Blue Shift keys. *Figure 3-2* illustrates the T.I. DELAY function. It should be noted that both START and STOP Slopes are positive in this illustration.

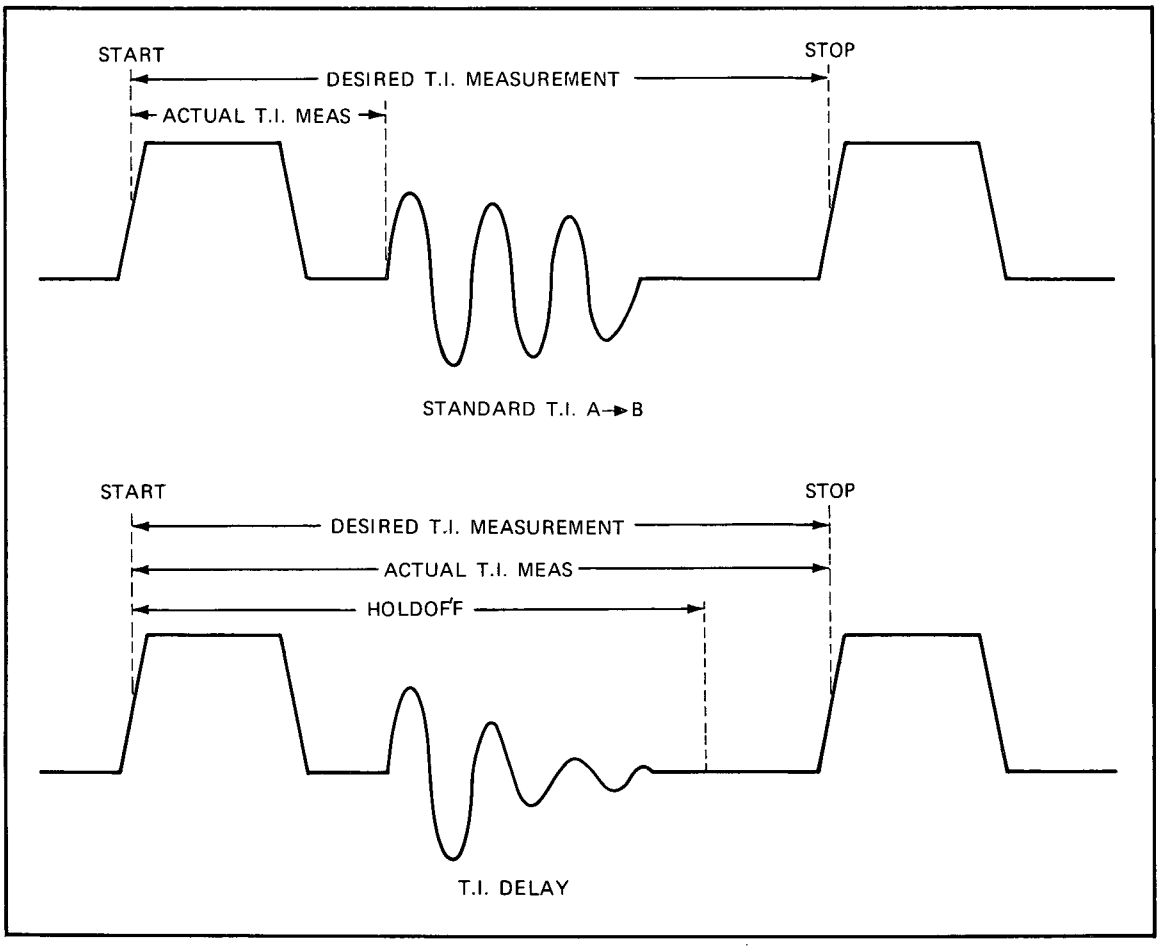


Figure 3-2. Timing of Time Interval Delay Mode

3-19. RATIO A/B

3-20. The RATIO A/B mode of operation measures and displays the frequency ratio of signals on INPUT A to signals on INPUT B. The GATE TIME control determines the resolution by selecting the number of cycles of the INPUT B signal over which the ratio A/B is measured. Increasing the gate time (towards MAX) or increasing the frequency of INPUT A results in an increased resolution of the measurement. Frequencies up to 100 MHz are allowed on both channels.

3-21. A BY B

3-22. A BY B (A gated by B) is a totalize mode of operation (see *Figure 3-3*) in which events on INPUT A (up to 100 MHz) are counted for a duration determined by INPUT B. The gate is "OPENED" on the slope of Input B selected by the Channel A Slope switch, and "CLOSED" on the

slope of Input B selected by the Channel B Slope switch. This allows any one of four discrete gate durations from a given signal on Input B. The Channel A Slope switch also determines which slope of the events signal (on INPUT A) is counted. A BY B is a single-shot mode of operation. The RESET button must be pressed to clear the display and allow the initiation of a new measurement.

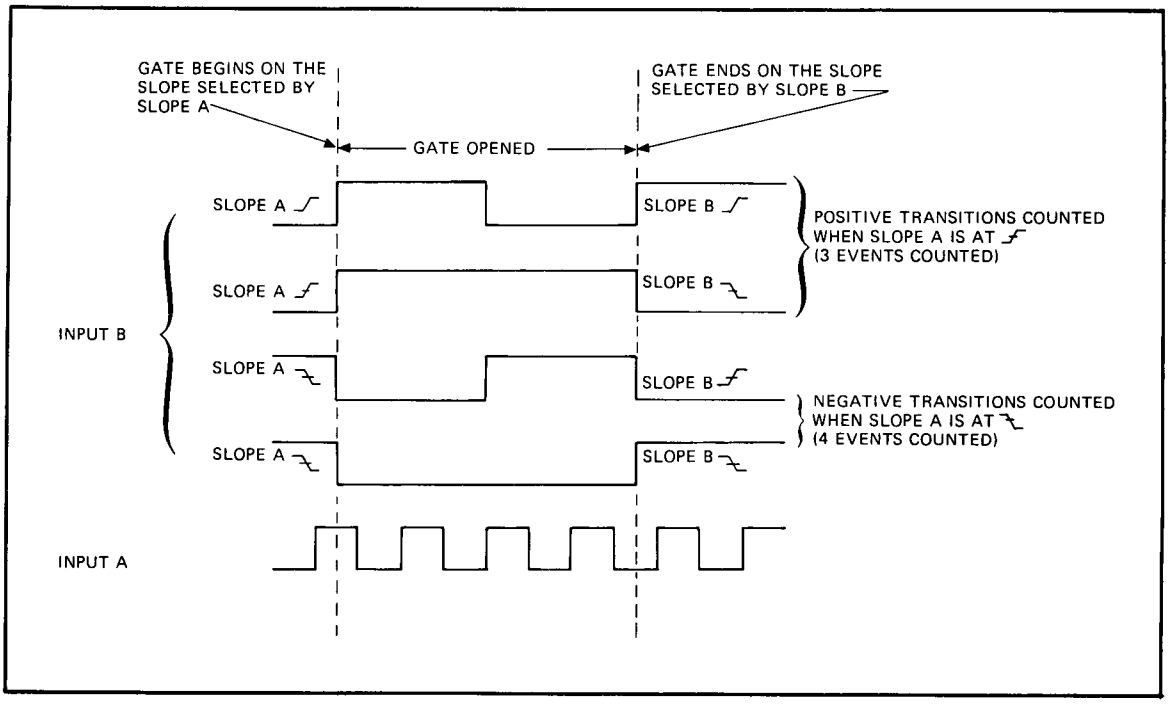


Figure 3-3. Timing of Totalize A by B Mode

3-23. A ARMED BY B

3-24. The HP 5316B has a measurement function, Frequency A, Averaged, Armed By B, for frequency averaging. Called "A ARMED BY B", this function allows the HP 5316B to average together multiple frequency measurements. To do this a sampling signal synchronized with and of pulse width less than the frequency bursts must be applied to the Channel B input. This signal performs two functions: one, it tells the the HP 5316B when to count the incoming bursts and when to ignore the dead time between bursts; and two, it opens the HP 5316B gate. The measurement interval is set from the front panel and its length determines the number of bursts to be averaged. *Figure 3-4* shows an example of function A Armed By B. In this example, 1MHz bursts, 10 μs wide, at a 10 kHz repetition rate are applied to Channel A input. A sampling signal of equal repetition rate and shorter pulse width is applied to Channel B. This sampling signal must be synchronized with the Channel A frequency burst signal. When the first burst occurs, the sampling signal at Channel B opens the gate, and tells the HP 5316B to begin counting the events at Channel A. When the sampling signal disappears, the HP 5316B stops counting the events at Channel A. If the gate is still open and another burst occurs, the HP 5316B will add these "new" events to the previous events counted. This will continue until the measurement interval runs out. On the next sampling pulse, after the gate closes, the HP 5316B will compute the average frequency of the signal during the burst (in this example 1 MHz). A final sampling pulse **must** occur after the measurement interval ends to terminate the measurement. The events that occurred during this final pulse are not averaged in.

3-25. The length of the measurement interval and signal repetition rate determine how many bursts will be averaged. Faster burst repetition rates allow shorter measurement intervals for a given number of averages. The main limit is that no more than 100 million "events" can be counted (either input frequency cycles or time base counts). In the case of *Figure 3-4*, each burst contains 10 "events", with 10

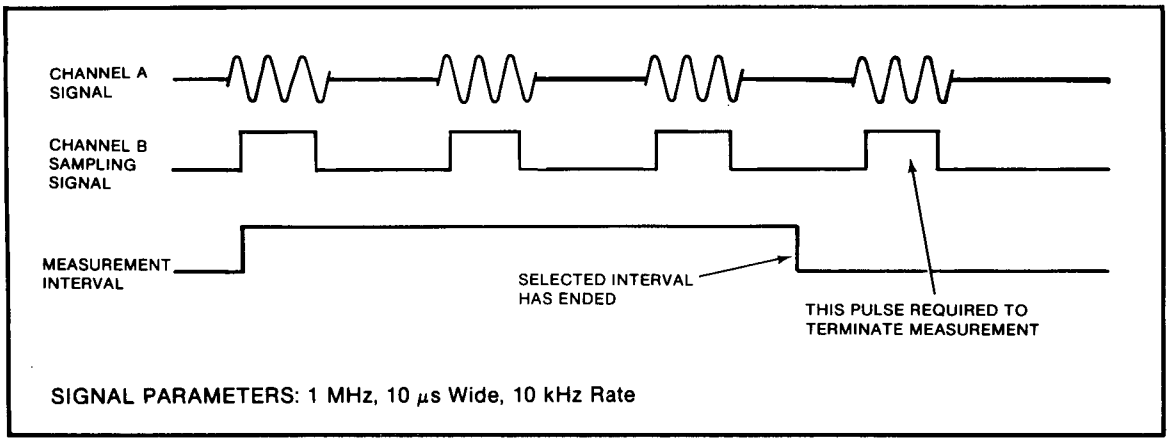


Figure 3-4. A ARMED BY B

thousand occurring in 1 second for 100 thousand "events" per second. Since 100 million events is the limit, the HP 5316B could average for 1000 seconds before the events counter would overflow. And, since the measurement interval determines the number of averages, a 1000-second measurement interval would be necessary before the events count or time base count would overflow. This, of course, is longer than that obtainable from the HP 5316B (maximum measurement interval of ~10 seconds). A specific case where the HP 5316B would overflow would be a 50 MHz signal pulsed for 200 ns at a 2 MHz rate. In this case 10 "events" occur during each burst, with 2 million bursts per second, or 20 million "events" in 1-second. So, the HP 5316B would overflow in 5 seconds, thus the gate time must be less than 5 seconds, and 10 million bursts would be averaged. If the 100 million events limit is exceeded the displayed answer will be inaccurate.

3-26. A ARMED BY B has two modes (two different measurement interval ranges) and is not labeled on the front panel. For a measurement interval range of 500 μs-30 ms, press T.I. DELAY and RATIO A/B together. The measurement interval may be displayed by selecting the GATE TIME mode for the LONG interval or by pressing T.I. A→B, T.I. DELAY, and Blue Shift key simultaneously for the SHORT interval. For a measurement interval range of 60 ms to 10 seconds, press FREQ A and TOT STOP together. The Channel A Trigger Slope is set by the front panel Channel A Slope switch. The sampling signal enable slope (begin counting) is determined by the Blue Shift key. In the OUT position the counting will be enabled on the sampling signal positive slope. In the IN position, the counting will be enabled on the sampling signal negative slope. The gate will also be opened on the same slope as determined by the Blue Shift key. The disable slope is determined by the Channel B front panel slope switch. The measurement interval is controlled, as normal, by the front panel GATE TIME control. The gate will close once the selected time has passed. There is no problem if the gate should close in the middle of counting a burst. The following limits do exist in this mode.

1. 200 ns minimum dead time between bursts.
2. 100 ns minimum burst width.
3. The enable slope can only be negative when using the short measurement interval (500 μs–30 ms), but can be positive or negative when under remote control.

Resolution increases with the square root of the number of samples averaged, N.

$$\textbf{Resolution} \sim \frac{(10^{-7}) \times (\text{INPUT FREQ})}{(\text{Sampling Signal Width}) \times (\sqrt{N})} \text{ Hz}$$

$$N \sim \frac{\text{Measurement Interval}}{\text{Gate signal repetition rate}}$$

From *Figure 3-4*, the sampling signal is 10 μs wide at a 10 kHz repetition rate with a measurement interval of 1-second. With a single-shot measurement:

$$\text{resolution} = \frac{100 \times 10^{-9}}{10 \times 10^{-6}} \times \frac{1 \times 10^{6}}{\sqrt{N}} = 10^{4} \text{ or } 10 \text{ kHz resolution}$$

but with average N = 10000 (1 s measurement interval):

$$\text{resolution} = \frac{100 \times 10^{-9}}{10 \times 10^{-6}} \times \frac{10^{6}}{\sqrt{10000}} = 100 \text{ Hz (100 times better)}$$

Accuracy: The actual measurement interval is shorter than the correct value by about 1 ns. With short sample pulse widths and large N values the displayed answer will not be perfectly accurate:

$$\text{Ultimate accuracy} = \frac{10^{-9}}{\text{measurement interval}} \times (\text{Input FREQ})$$

With a 10 μs sample pulse width, accuracy can be as good as 100 Hz if enough events are averaged.

3-27. FREQ C (Option 003)

3-28. To make a frequency measurement on a CW signal in the range of 50 MHz to 1 GHz, select FREQ C function and apply the signal to INPUT C.

CAUTION

Make sure that the amplitude of the signal does not exceed the 1V rms dynamic range.

Set the GATE TIME control to MIN (but not hold). Set the SENS C control to MIN. Slowly move the SENS C control in a clockwise direction (toward MAX) until the counter begins to gate. This represents the optimum trigger sensitivity. To increase the displayed resolution, move the GATE TIME control toward MAX.

NOTE

The Trigger Lights for INPUT A and INPUT B are inoperative and extinguished when functions FREQ C or GATE TIME are selected. This is normal. *However* pressing either Channel A or B Slope switches will reset the counter.

3-29. TOT STOP/START

3-30. Totalize STOP/START is a manually gated, Totalize mode of operation. Pressing the Blue Shift key (IN position) opens the main gate, allowing INPUT A events to be counted. Pressing the Blue Shift key again (OUT position) closes the gate, stopping the count. The count is continuously displayed, and cumulative from gate cycle to gate cycle. The RESET button clears the counter and resets the display to zero.

3-31. CHECK

3-32. The Check function applies 10 MHz from the internal (or external) reference oscillator to the Multiple Register Counter (MRC). It is used to verify the basic operation of the counter, GATE light and GATE TIME control.

3-33. Display Check

3-34. The Display Check is an unlabeled function, which cycles the display through a routine that exercises all digits and most annunciators. With the POWER switch to ON, and all function switches to the "OUT" position, a rolling display, corresponding to *Table 3-1*, will result.

Table 3-1. Display Check

Digit Displays (7-segment)	OVFL	ERROR	-	Hz	S	GATE	Decimal Point Position 1	2	3
0							*		
1	*		*					*	
2	*				*				*
3	*		*		*				
4	*			*					
5	*	*	*	*					
6	*			*	*				
7	*		*	*	*				
8	*					*			
9	*		*			*			
BLANK	*		*	*	*	*			

3-35. PANEL FEATURES AND CONTROLS

3-36. The following paragraphs describe the features and controls of function selection, signal conditioning, and display sections of the front panel. Front and rear panel controls are individually located and described in *Figures 3-10* and *3-11*.

3-37. FUNCTION SELECTION CONTROLS

3-38. The function selection controls section of the front panel contains the POWER (STBY/ON), and RESET/LOCAL keys, the "Function" keys group (within the border outline) and Gate Time/Delay control.

3-39. The POWER key sets the HP 5316B either to ON or STBY (standby). In the ON position (IN) power is supplied to the entire instrument. In the STBY position (OUT) the unregulated voltages are disconnected from the power supply voltage regulators. The RESET/LOCAL key clears and updates the display for continuous measurement modes, and resets the counter in Totalize modes. Also see Remote Programming via the HP-IB paragraph 3-73.

3-40. Each of the keys within the outlined function group can select one of two functions, as follows: With the Blue Shift key in the "OUT" position, the keys select the function labeled above (e.g., FREQ A, T.I. A→B, etc.). With the Blue Shift key in the IN position, the keys select the function labeled in blue below (e.g., PER A, T.I. AVG A→B, etc.).

3-41. The GATE TIME/DELAY control determines the amount of gate time per measurement, continuously adjustable over a range of 60 ms to 10 s. The selected gate time may be displayed by pressing the GATE TIME function key, and the Blue Shift keys. In the T.I. DELAY mode of operation, the control determines the amount of time the start channel is held off or "delayed" (see paragraph 3-17). The amount of "delay" may be displayed by pressing the T.I. A→B, T.I. DELAY, and Blue Shift key simultaneously. In the T.I. A→B mode of operation, the GATE TIME/DELAY control determines the "sample rate".

3-42. SIGNAL CONDITIONING CONTROLS

3-43. A full complement of signal conditioning controls are provided for each channel (A and B) input (see *Figure 3-6*). These controls allow the selection of Attenuation (X1, X20), Slope (positive or negative) and input coupling (AC or DC). The SEP/COM A switch allows the selection of separate Channel A and B input in the SEP position. The COM A position disconnects the Channel B Input BNC, and connects both Channel A and Channel B input amplifiers to the Channel A input.

3-44. A low pass filter for Channel A input is provided. With the FILTER NORM key in the 100 kHz (IN) position, frequencies above 100 kHz are effectively attenuated. With the FILTER NORM key in the Normal (OUT) position there is no effect.

3-45. TRIGGER LEVEL/SENSITIVITY CONTROLS

3-46. The Trigger Level/Sensitivity controls provided for each channel operate as follows: With the TRIGGER LEVEL/SENSITIVITY key in the "OUT" position, the LEVEL/SENS control adjusts the trigger level, (over a range of ±2.5 volts dc in ATTN X1, or ±50 volts dc in ATTN X20). With the TRIGGER LEVEL/SENSITIVITY key in the "IN" position, the LEVEL/SENS control adjusts the input sensitivity from MAX (10 mV up to 10 MHz, 25 mV up to 100 MHz) with control fully clockwise to MIN (greater than 500 mV) with control fully counterclockwise (see *Figure 3-5*). The trigger levels may be monitored at the front panel TRIGGER LEVEL jacks. The voltage at this point is ±5% ±15 mV of the actual voltage over the range of ±2.0V.

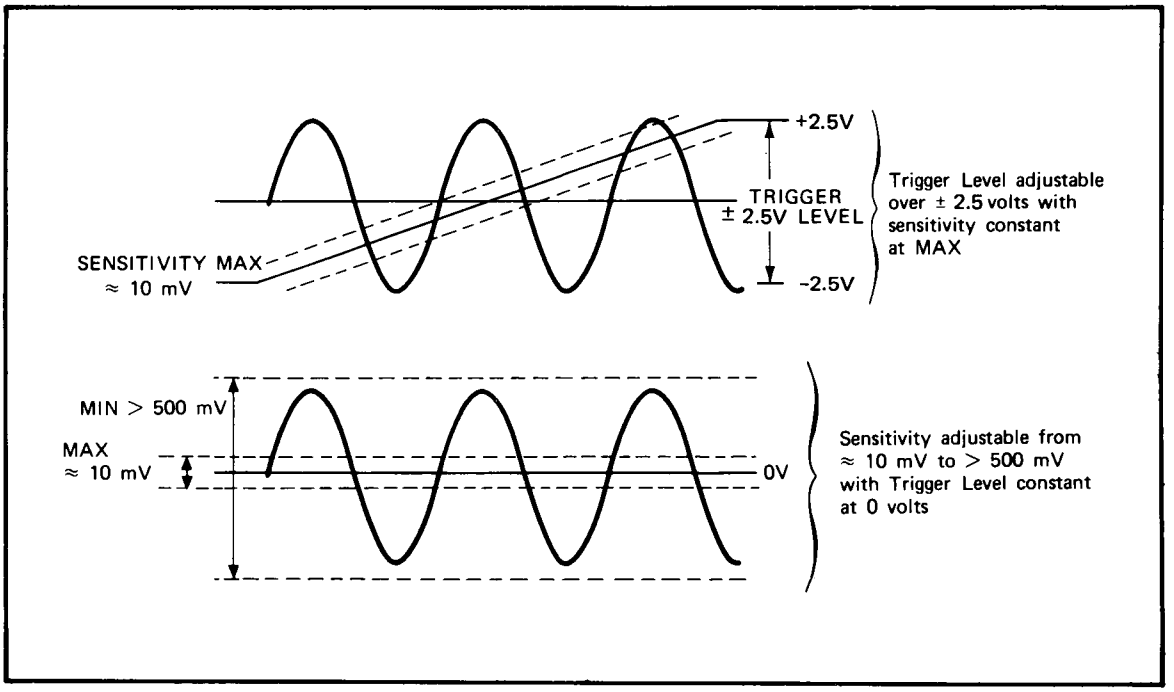


Figure 3-5. Trigger Level/Sensitivity Controls

3-47. DISPLAY

3-48. The HP 5316B counter display consists of nine LEDs, providing eight digits of resolution and a one-digit exponent. All measurements (except Totalize modes) are displayed in engineering notation [i.e., exponents of blank (none), ±3, ±6, or ±9 (+ is not displayed)] with automatic decimal point location. Annunciators for indicating the measurement units Hz, for Hertz, and s, for seconds are provided. The OVFL annunciator indicates that the leftmost significant digits have overflowed

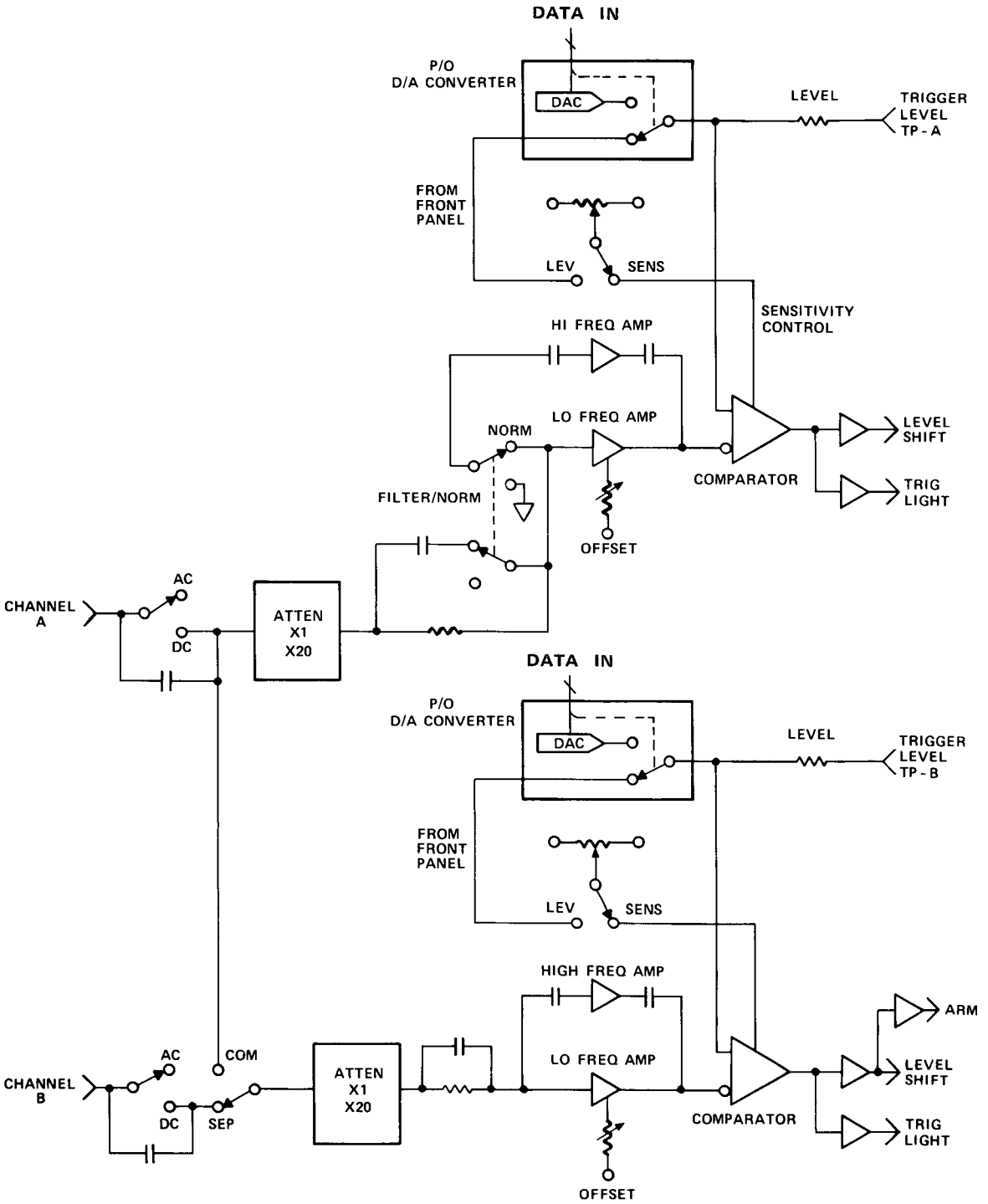


Figure 3-6. Input Amplifier Block Diagram

the display. The GATE annunciator indicates the counter has been triggered and a measurement is in progress. The ERROR annunciator indicates a failure during power-up self-check (see paragraph 3-59). The ADRSD and REMOTE lamps annunciators indicate the instrument's status during remote control (see Paragraph 3-86).

3-49. OPERATOR'S CHECKS

3-50. A procedure for verifying the basic operation of the HP 5316B is provided in *Figure 3-12*. This check utilizes the instrument's self-calibration cycle and visual verification of front panel controls by front panel indicators. No additional equipment is required.

NOTE

This check is not intended to verify the accuracy or performance specifications of the instrument.

3-51. OPERATING INSTRUCTIONS

WARNING

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

WARNING

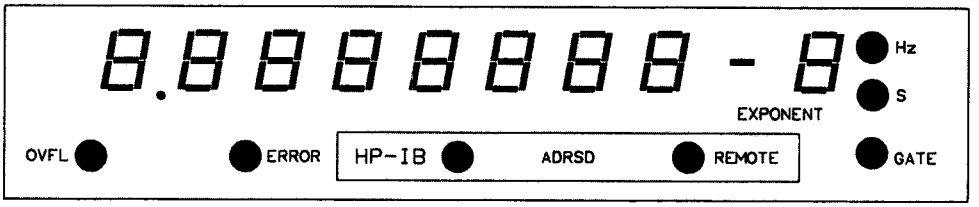
ONLY FUSES WITH THE REQUIRED RATED CURRENT AND SPECIFIED TYPE SHOULD BE USED. DO NOT USE REPAIRED FUSES OR SHORT CIRCUITED FUSE-HOLDERS. TO DO SO COULD CAUSE A SHOCK OR FIRE HAZARD.

CAUTION

Before the instrument is turned on, it must be set to the voltage of the power source, or damage to the instrument could result.

3-52. POWER-UP SELF-CHECK

3-53. When the HP 5316B is turned on, a power-up reset and self-check cycle is automatically initiated. This is approximately a 2-second cycle, indicated by the following display:



NOTE: Error LED may or may not light during Power-Up Self-Check

3-54. During this cycle, the microprocessor performs a check sum of the internal program in ROM and a bit pattern is written into RAM. Then it performs a partial check of the MRC and I/O ports, and performs a link test between the microprocessors. Any failure during the cycle will produce a numbered error (for a U7 microprocessor, MRC or I/O failure), or a flashing of the HP-IB status LEDs (for a microprocessor link test failure). If a numbered error occurs, the ERROR LED will remain lit. Refer to Error Messages, paragraph 3-59. If the HP 5316B is placed into STANDBY and then immediately placed in ON again, the display will illuminate random segments during the power-up cycle. This is normal.

3-55. MEASUREMENT PROCEDURES

3-56. *Figures 3-13* through *3-21* show general operating procedures with the HP Model HP 5316B Universal Counter in typical measurement setups. Description numbers match the locator illustrations. The following paragraphs provide recommended operating guidelines, to assist in making the most accurate measurement possible.

3-57. Frequency, Period, and Ratio Measurements

1. For cw sine wave or symmetrical waveforms (triangle, square, etc.) use ac coupling and the sensitivity mode.
2. For asymmetrical waveforms (pulse trains, TTL, ECL signals, ramps, etc.) use a combination of dc coupling, Trigger Level, and fixed attenuator. AC coupling these types of signals tends to distort them slightly, due to the charging of the capacitor. More important, the position of the signal on the zero preset trigger level is determined by the average dc level of the input. Depending on the pulse width and duty cycle, this dc average may be low enough to allow the base line noise to trigger the counter, producing false counts (see *Figure 3-7*). DC coupling fixes the dc level of the input signal, which allows the adjustable Trigger Level to be positioned at the optimum point. Set the Trigger Level control to the approximate center of the triggering range indicated by the trigger light (see *Figure 3-8*) The actual dc trigger level may be monitored at the front panel test point. When programming via the HP-IB, it may be set directly.

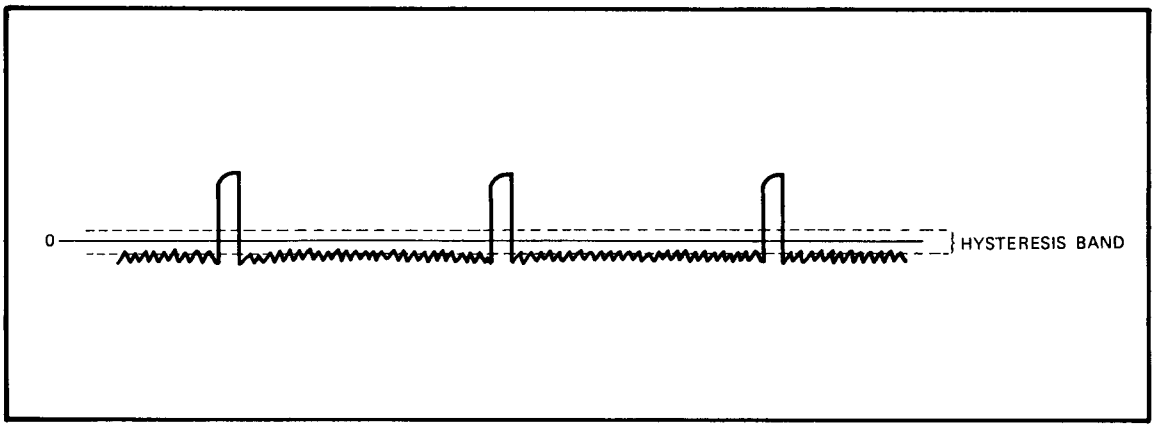


Figure 3-7. AC Coupled Measurements

3. When input loading is a problem (i.e., 1 MΩ load or cable capacitance) or when a more convenient method of probing is desirable, use a 10:1 oscilloscope probe. A probe is recommended for all logic applications.
4. For sine wave measurements <100 kHz, always use the low pass filter, selectable on the front panel. Normally the input signal is integrated over the entire 100 MHz bandwidth. Use of the Filter effectively removes noise and harmonics (above 100 kHz), that may affect the correct measurement.

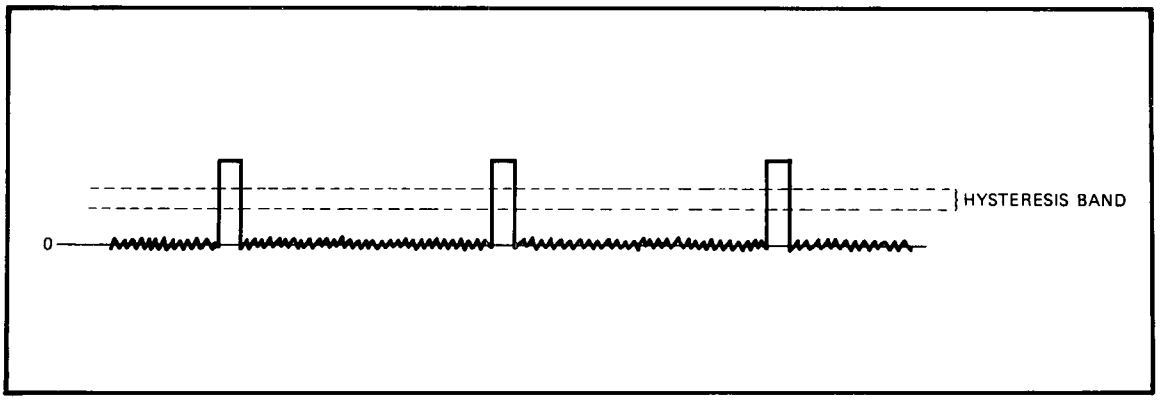


Figure 3-8. DC Coupled Measurements

5. Be very careful with input levels at higher frequencies (greater than 5 MHz). The counter front end is protected to 6 volts rms at these frequencies.

WARNING

WHEN MEASURING POWER LINE FREQUENCIES, BE EXTREMELY CAREFUL AND ALWAYS USE A STEP-DOWN ISOLATION TRANSFORMER (WITH ≈10V OUTPUT). THE COUNTER'S PANEL IS TYPICALLY AT SIGNAL GROUND, SO NEVER TRY TO MEASURE THE 50 OR 60 Hz LINE WITHOUT AN ISOLATION TRANSFORMER.

3-58. Time Interval Measurements

1. To insure waveform fidelity during T.I. measurements, always use dc coupling.
2. Measurements of pulse width, and time between pulses, are more conveniently made in the COM A (common) position.
3. T.I. Average measurements of high stability (synthesized) sources are not recommended The displayed result may not be accurate. Proper averaging requires that there be no coherence between the source and the counter time base oscillator. (See Application Note 162-1, Time Interval Averaging.)
4. In general, use the GATE TIME control to vary the amount of resolution displayed. This control does not affect accuracy. It basically trades off longer measurement time for more resolution.

3-59. TROUBLESHOOTING/ERROR MESSAGES

3-60. Two different type error messages exist in the HP 5316B. First is the numbered errors. Failures in the power-up self-check will result in the momentary display of one of these messages. The ERROR LED will remain on until the error is cleared and the instrument reset. The three error messages are:

ERROR	MESSAGE
E1	Possible failure in microprocessor A1U7
E2	Possible failure in I/O ports
E3	Possible failure in A1U2 (MRC); rear panel oscillator switch in the EXT position with no external signal; or a failure in the A7 oscillator assembly.

If the ERROR annunciator is lit, verify the error number (1, 2, or 3) by repeating the power-up self-check, and refer to Section VIII, Troubleshooting. Power-up self-check is initiated when the POWER switch is placed from STBY to ON.

3-61. The two HP-IB status annunciators indicate a failure in the following ways:

Flashing in-phase ..... Possible failure in the HP-IB microprocessor A1U10.
Flashing out-of-phase ..... Possible link failure or defective HP-IB microprocessor.

If one of these failures occur when the POWER switch is placed in ON from STBY, refer to Section VIII, Troubleshooting.

3-62. OPTIONS

3-63. The operating characteristics of the HP 5316B are affected by the addition of any of the options described in the following paragraphs.

3-64. Time Base Options

3-65. Option 001 provides a Temperature Compensated Crystal Oscillator (TCXO) which results in higher accuracy. The TCXO is a 10 MHz oscillator, capable of making minor frequency corrections to compensate for offsets due to temperature variations. Option 004 Oven Oscillator provides increased temperature stability and accuracy over Option 001. See *Table 1-1* for complete specifications of Options 001 and 004.

3-66. Channel C Option 003

3-67. Option 003 extends the frequency counting range of the HP 5316B from 100 MHz (in Channel A) to 1 GHz (in Channel C). The input sensitivity and gate time are adjustable via front panel controls. See *Table 1-1* for complete specifications of Option 003.

3-68. OPERATOR'S MAINTENANCE

3-69. The only maintenance the operator should normally perform is the replacement of the primary power fuse. This fuse is located within the Line Module Assembly. For instructions on how to change the fuse, refer to paragraph 2-8, Line Voltage Selection.

CAUTION

Make sure that only fuses with the required rated current and of the slow-blow type are used for replacement. The use of repaired fuses and the short-circuiting of fuse-holders must be avoided.

3-70. When Option 003 Channel C is installed, the operator may be required to replace the input BNC fuse. This is a 1/8A fuse which is located within the INPUT C BNC connector (see *Figure 3-9* for details). To replace the fuse, disconnect the power cord, unscrew the special BNC barrel and, with needle-nose pliers, remove and replace the fuse. Reinstall the BNC barrel, and tighten using a BNC cable connector. Be careful not to overtighten.

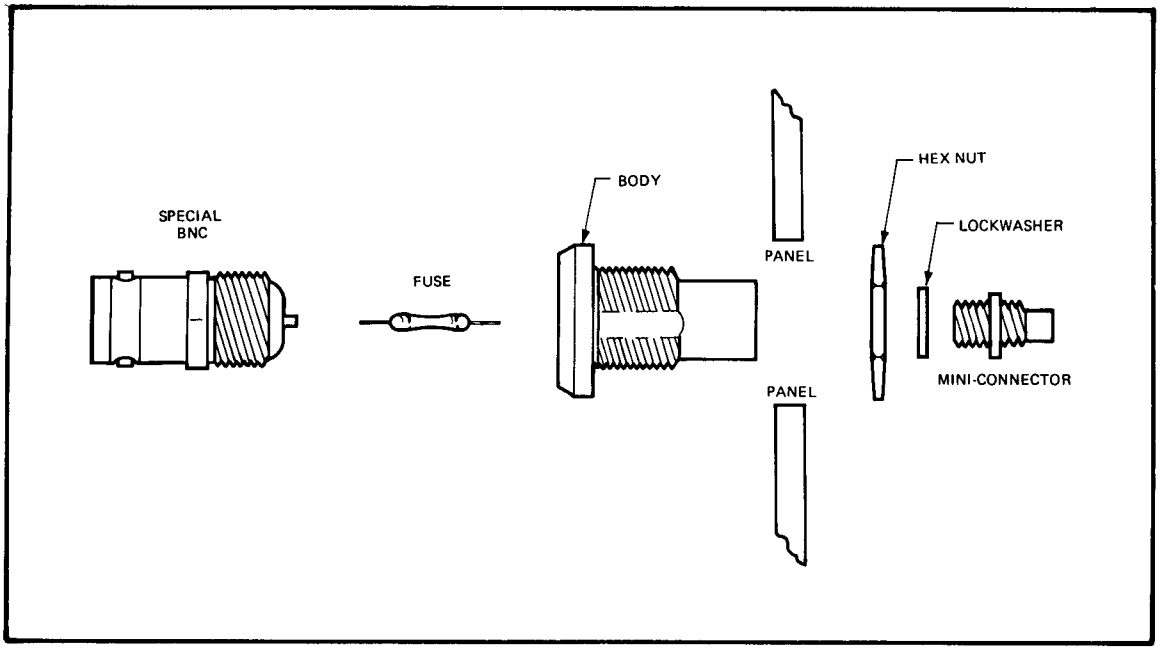


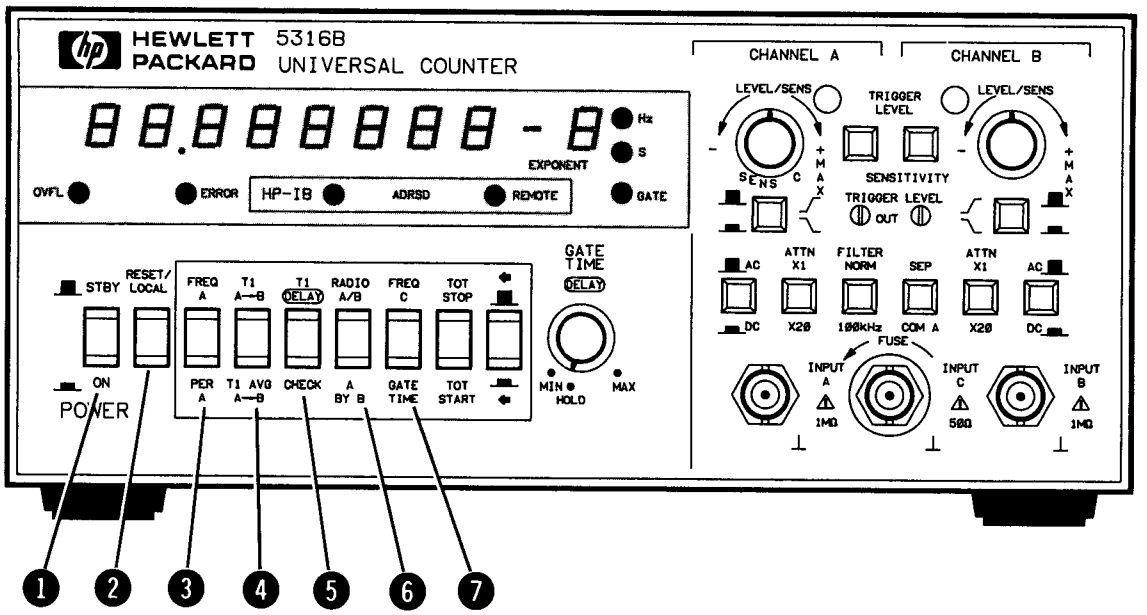
Figure 3-9. Details of Option 003 Input Connector and Fuse Mounting

3-71. POWER/WARM UP

3-72. The HP Model HP 5316B requires a power source of 100-, 120-, 220-, or 240-volt ac, +5%, -10%, 48 to 66 Hz single phase. The selection of line voltage and input power fuse is described in Section II, paragraph 2-8, Line Voltage Selection.

WARNING

POWER IS ALWAYS PRESENT AT THE LINE SWITCH AND TRANSFORMER, AND UNREGULATED DC IS PRESENT WHENEVER THE LINE CORD IS ATTACHED. UNPLUGGING THE POWER CORD IS NECESSARY TO REMOVE ALL POWER FROM THE INSTRUMENT.



1. **STBY/ON.** Supplies power to entire machine in the ON position. Removes power from the voltage regulators when in the STBY (Standby) position.

2. **RESET.** Clears and updates display in continuous measurement modes, resets counter to zero in Totalize modes. Also returns operation to Local control.

3. **FREQ A.** Selects Frequency modes of operation (with Blue Shift key out), for signals on Input A.

   PER A. Selects Period mode of operation (with Blue Shift key in), for signal on Input A.

4. **T.I. A→B.** Selects Time Interval mode of operation (with Blue Shift key out) measuring time differences from Start signal on INPUT A to Stop signal on INPUT B (when in SEP).

   T.I. AVG A→B. Selects Time Interval Average mode of operation (with Blue Shift key in), measuring time difference from Start signal on INPUT A to Stop signal on INPUT B (when in SEP).

5. **T.I. DELAY.** Selects Time Interval mode of operation (with Blue Shift key out), measuring time differences from Start signal on INPUT A to Stop signal on INPUT B (when in SEP) with the triggering of the Stop signal DELAYED (held off) for a period of time determined by GATE TIME DELAY control.

   CHECK. Applies 10 MHz from reference oscillator to MRC (with Blue Shift key in), to verify operation of MRC, display and GATE TIME control, microcomputer, etc.

6. **RATIO A/B.** Selects Ratio mode of operation (with Blue Shift key out), measuring the ratio of the signal frequency at INPUT A to the signal frequency at INPUT B.

   A BY B. Selects a "gated" Totalize mode of operation (with Blue Shift key in), in which the signal frequency of INPUT A is totalized for a gate duration determined by the signal on on INPUT B.

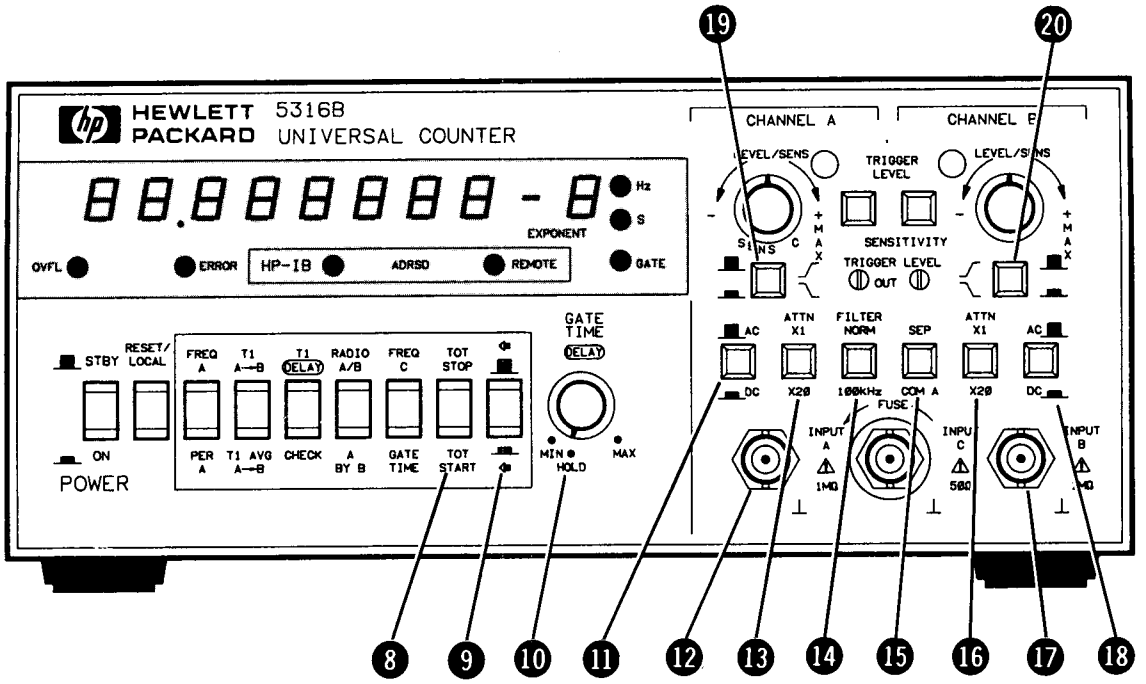
7. **FREQ C.** Enables the Frequency C INPUT (Option 003) module (with the Blue Shift key out).

   GATE TIME. Continuously measures and displays the gate time determined by the GATE TIME control (with Blue Shift key in).

NOTE

The trigger lights are disabled and extinguished when either FREQ C or GATE TIME is selected.

Figure 3-10. Front Panel Features



8 **TOT, STOP/START.** Selects Totalize mode of operation, manually controlled by the Blue Shift key. With the Blue Shift key in, totalizing of signal frequency on INPUT A starts. With the Blue Shift key out, Totalize accumulation stops and holds. RESET must be pressed to zero the display.

9 **Blue Shift.** Used in conjunction with six dual purpose function keys (3, 4, 5, 6, 7, 8) to select the function labeled above or below the key. With the Blue Shift key out, functions labeled above the keys are enabled, with the Blue Shift key in, functions labeled below the keys are enabled.

10 **GATE TIME/DELAY.** For FREQUENCY, PERIOD, RATIO AND T.I. AVERAGE modes, provides continuously variable measurement time from, nominally, 60 ms to 10 s (minimum = 1 period of the input signal). For T.I. mode, varies the time between measurements. For T.I. DELAY mode, provides continuously variable delay time between START and STOP enable.

HOLD. Single measurement with minimum gate time. Requires pushing RESET key to initiate new measurement.

11, 18 **AC/DC.** Selects ac or dc coupling for corresponding input signal. When in COM A, only Channel A determines coupling.

12, 17 **INPUT A, B.** Input BNC's for channels A and B.

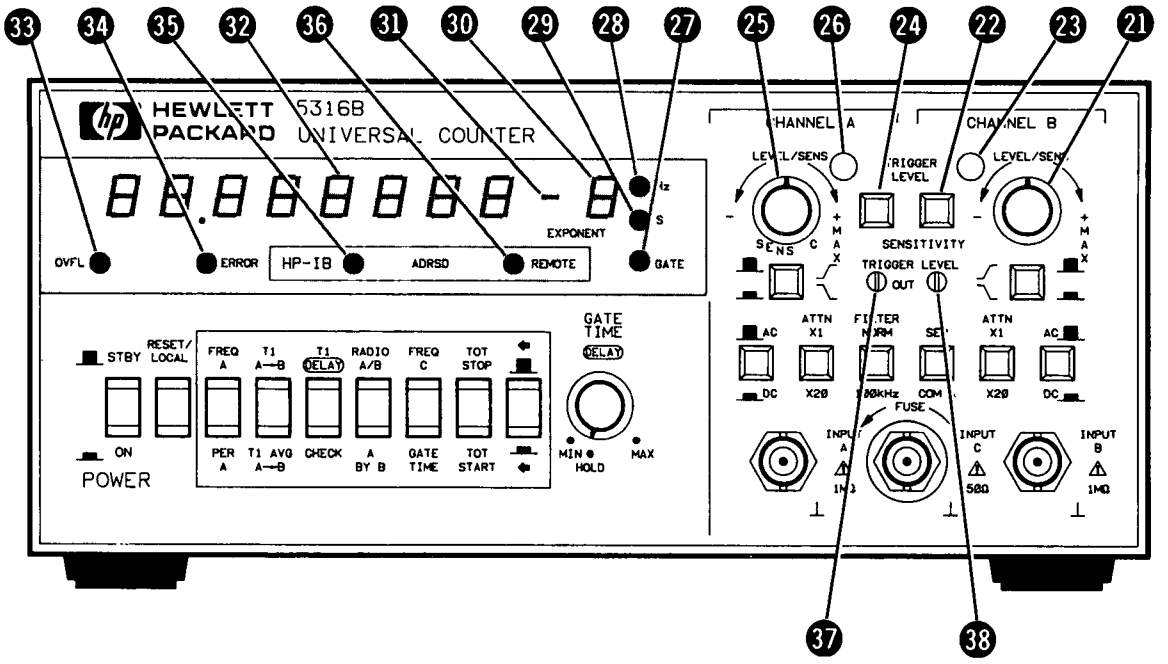
13, 16 **ATTN, X1/X20.** Selects attenuation of signal on corresponding input channels. X1 position connects input signal directly to input amplifiers; X20 position attenuates input signal by a factor of 20 (nominal).

14 **FILTER, NORM/100 kHz.** Inserts a low pass filter configuration into the INPUT A channel, attenuating frequencies above 100 kHz.

15 **SEP/COM A.** Input amplifier control, selects independent operation of inputs A and B in SEP (separate) position. In COM A (Common A) position, the signal at Input A is also applied to Input B, with the B input BNC disconnected from input circuitry. Input B coupling is the same as Input A.

19, 20 **SLOPE.** Selects triggering on either positive ⨍ or negative ⨍ slope of the corresponding input channel.

Figure 3-10. Front Panel Features (Continued)



25 **LEVEL/SENS.** When in TRIGGER LEVEL, controls the voltage at which CHANNEL A input will trigger, variable over ±2.5 volts X ATTN setting. When in SENSITIVITY, varies the sensitivity from MAX (≈10 mV) up to 500 mV. In FREQ C, controls the input sensitivity for INPUT C from MAX (≈15 mV up to 650 MHz, 75 mV up to 1 GHz) up to MIN (20 dB NOMINAL).

21 **LEVEL/SENS.** When in TRIGGER LEVEL, controls the voltage at which corresponding CHANNEL B input will trigger, variable over ±2.5 volt X ATTN setting. When in SENSITIVITY, varies the sensitivity from MAX (≈10 mV) up to 500 mV.

22, 24 **TRIGGER LEVEL/SENSITIVITY.** Sets the function of corresponding LEVEL/SENS control to either Trigger Level or Sensitivity mode. In TRIGGER LEVEL mode, sensitivity is preset to maximum. In SENSITIVITY mode, trigger level is preset to 0 volts.

23, 26 **TRIGGER LIGHT.** 3-state trigger lights; blinks when channel is triggering; OFF when input signal is below trigger level setting; ON when input signal is above trigger level setting.

27 **GATE.** Gate light (when ON), indicates the counter's main gate is open and a measurement is in progress.

28 **Hz.** Hz (Hertz) annunciator, indicates displayed data is in frequency domain, in units of Hertz.

29 **S.** (seconds) annunciator, indicates displayed data is in time domain, in units of seconds.

30 **EXPONENT.** Displays the value of the exponent of the measurement. Measurements are displayed in engineering notation, with exponents of blank (Ø), ±3, ±6, ±9.

31 **EXPONENT SIGN.** Indicates the polarity of the displayed exponent; ON (-) if negative, OFF if positive.

32 **DISPLAY.** Eight-digit red LED display.

33 **OVFL.** OVFL (Overflow) annunciator indicates that one of more of the most significant digits are not displayed.

34 **ERROR.** Lights and remains lit when an error is detected during power-up.

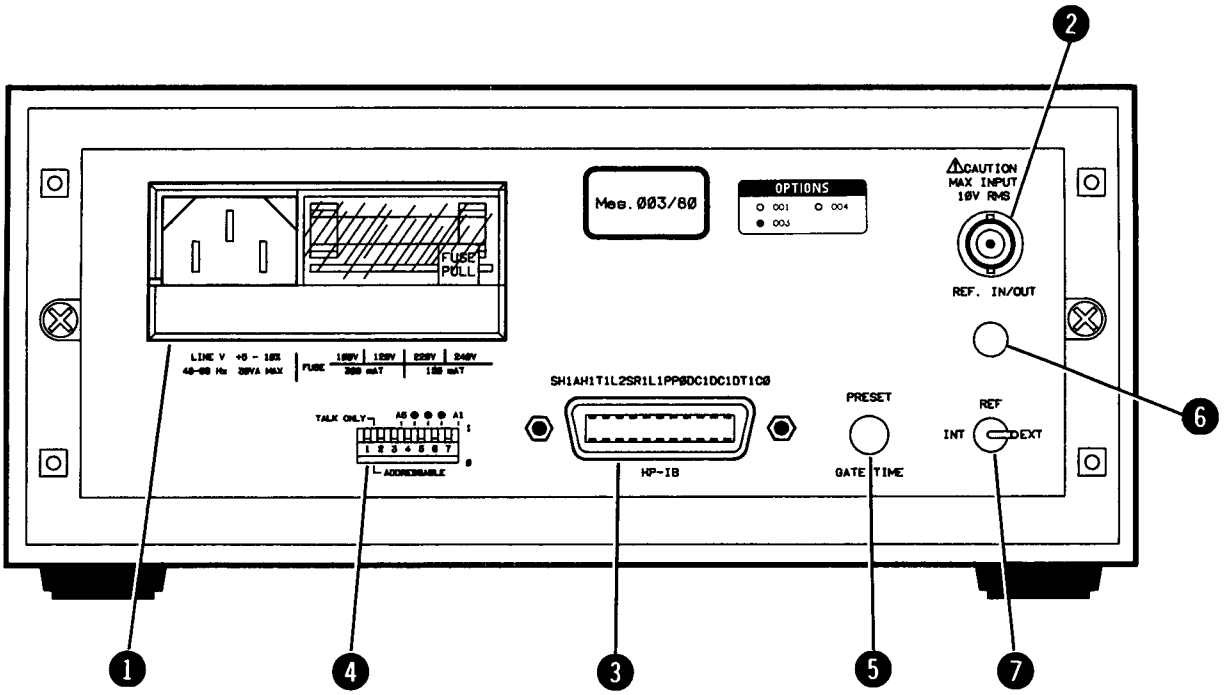
35 **ADRSD.** Lights when the HP 5316B is addressed to Talk or Listen. See Paragraph 3-87.

36 **REMOTE.** Lights when the HP 5316B is under remote control. See Paragraph 3-87.

37 **TRIGGER LEVEL OUT CHANNEL A.** This allows the monitoring of the Channel A trigger level. The dc voltage is equal to the Channel A trigger level.

38 **TRIGGER LEVEL OUT CHANNEL B.** This allows the monitoring of the Channel B trigger level. The dc voltage is equal to the Channel B trigger level.

Figure 3-10. Front Panel Features (Continued)



1 AC power input module permits operation from 100, 120, 220, or 240 volts ac. The number visible in the window indicates nominal line voltage to which instrument must be connected (see *Figure 2-1*). Protective grounding conductor connects to the instrument through this module.

WARNING

ANY INTERRUPTION OF THE PROTECTIVE (GROUNDING) CONDUCTOR INSIDE OR OUTSIDE THE INSTRUMENT OR DISCONNECTING OF THE PROTECTIVE EARTH TERMINAL IS LIKELY TO MAKE THE INSTRUMENT DANGEROUS. (See Section II.)

2 **REFERENCE INPUT/OUTPUT JACK (J3).** When **7**, in the EXT position this allows the HP 5316B to be operated with an external frequency reference. The HP 5316B does not actually use the external input signal for a time base but locks-on to the signal with an injection-lock-multiplier. The external signal must be 1, 5, or 10 MHz at 500 mV rms across 500 ohms. When **7** in the INT position, the internal 10 MHz standard operates the counter, and the jack is the internal 10 MHz standard output signal at 50 mV p-p.

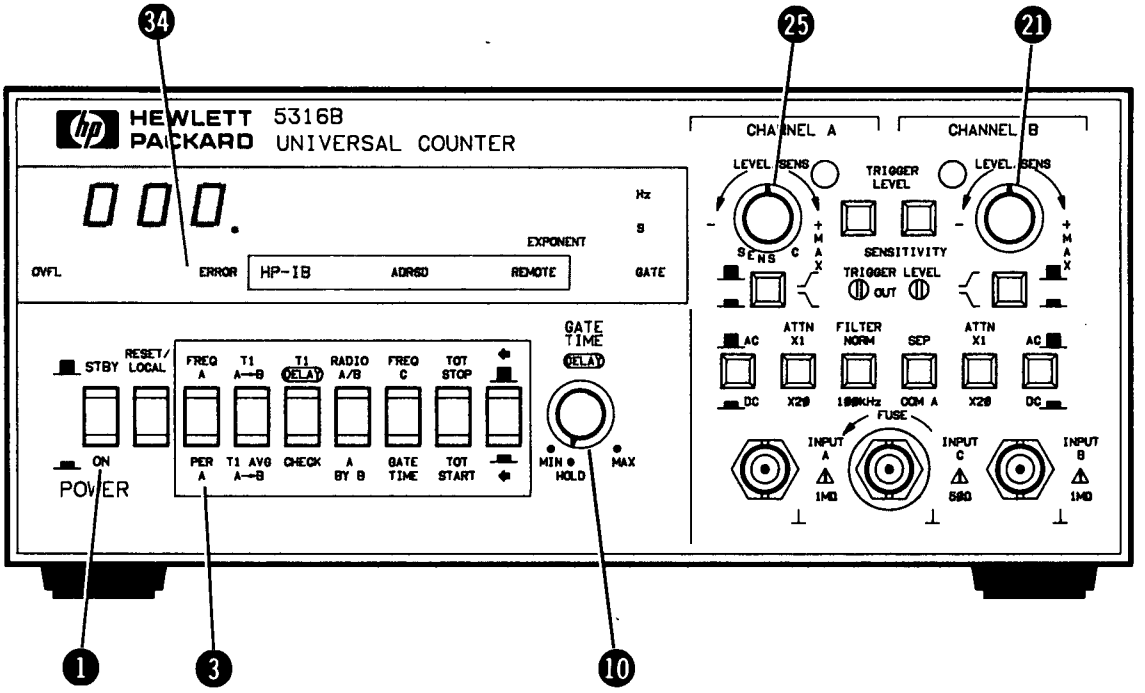
3 **HP-IB INTERFACE CONNECTOR (24 pin).** Used to convey data and programming information. IEEE-1978 compatible. See paragraph 3-73.

4 **HP-IB ADDRESS SWITCHES.** Selects the LISTEN/TALK address and ADDRESSABLE/TALK ONLY mode for remote control. See paragraph 3-83.

5 **PRESET GATE TIME.** Essentially the same as the front panel GATE TIME control without the HOLD position. Selectable only during remote programming. See paragraph 3-92c.

6 **OSCILLATOR ADJ.** This allows the adjustment of the internal reference oscillator.

Figure 3-11. HP 5316B Rear Panel Features



1. Before switching on the instrument, ensure that the power transformer primary is matched to the available line voltage, the correct fuse is installed and the safety precautions are taken. Refer to Power Requirements, Line Voltage Selection, Power Cables, and associated warnings and cautions in Section II of this manual.
2. Press FREQ A/PER A switch (3), and adjust LEVEL/SENS controls (21) (25) fully ccw. Set All other switches to the OUT position.
3. Adjust GATE TIME control (10) to minimum.
4. Set POWER switch (1) to the ON position and observe the power-up self-check. Verify all segments of the display; decimal point after MSD; and the OVFL, Hz, S, and GATE annunciators light momentarily, followed by a display of 000. Verify both trigger lights are lit.

NOTE

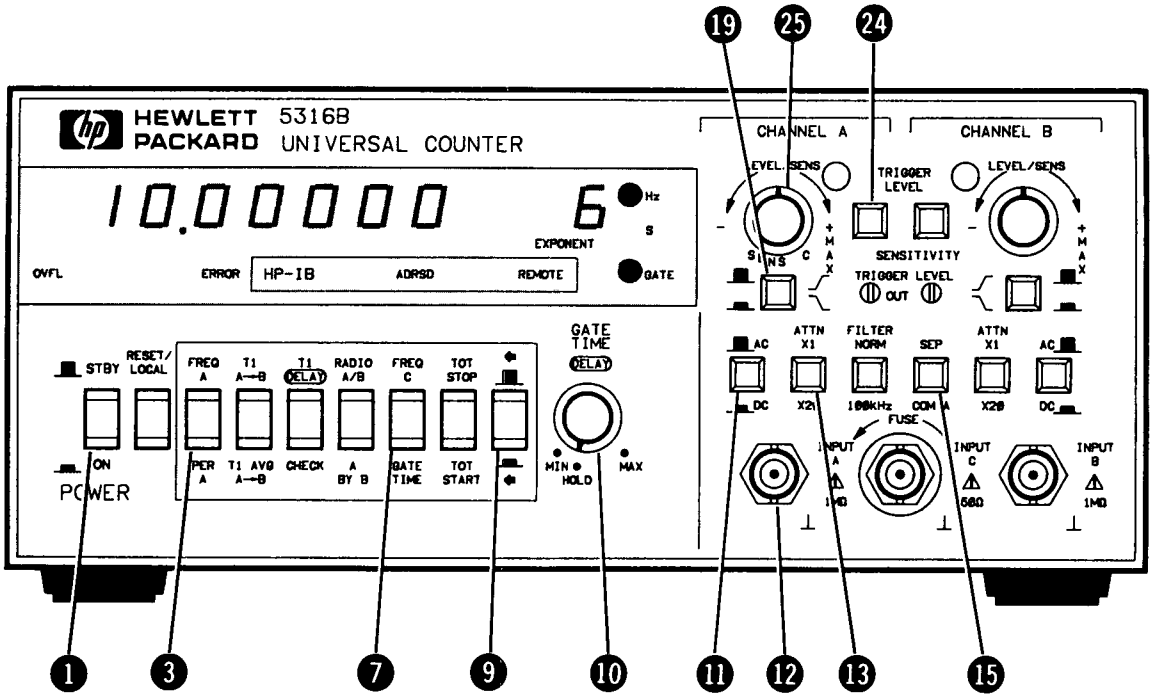
When the instrument is first turned on, the microcomputer performs a self-check. If, during the self-check, an error is detected, a numbered error message will be displayed and will light the ERROR LED, or the HP-IB status LEDs will flash. Verify the error, by repeating the power-up self-check and referring to paragraph 3-59, Error Messages.

5. Verify the Display Check routine by placing all function select switches in the OUT position. This may be accomplished by pressing any gray colored function switch partially in, thus releasing a function switch that is locked in. Observe the cycling of the display from all zero's to all one's, two's, three's. . . . etc., to all blank. Refer to paragraph 3-33.

NOTE

The Display Check routine is an unlabeled function, used to verify the operation, digits and most annunicators in the Display assembly.

Figure 3-12. Operator's Check

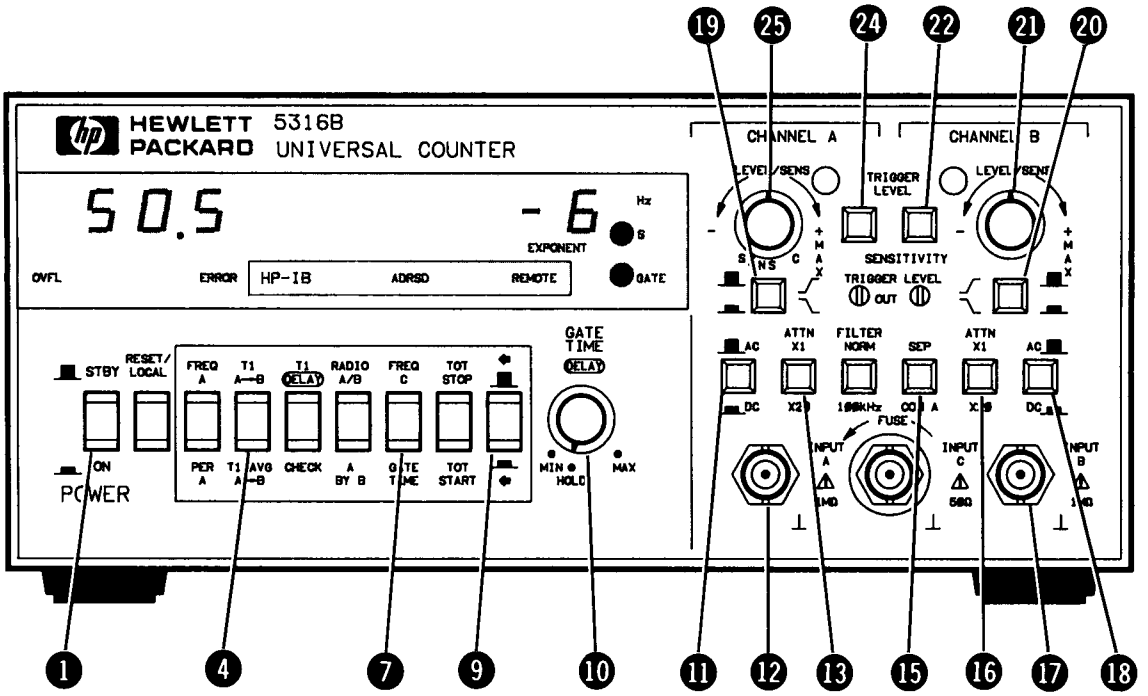


NOTE

For specifications concerning bandwidth, accuracy, and amplitude on input signals, refer to *Table 1-1*.

1. Set POWER switch (1) to the ON position.
2. Set SEP/COM A switch (15) to SEP position.
3. Connect the input signal to INPUT A jack (12).
4. Press FREQ A/PER A switch (3), and set the Blue Shift key (9) in the out position for FREQ A, or the in position for Period A.
5. Set AC/DC (11), ATTN (13) and Slope (19) switches to appropriate positions.
6. Set GATE TIME control (10) to MIN.
7. Set TRIGGER LEVEL/SENSITIVITY switch (24) to SENSITIVITY position, and LEVEL/SENS control (25) fully ccw. This sets the trigger level at Ø volts (nominally) and sensitivity to minimum.
8. Adjust the LEVEL/SENS control (25) in a clockwise direction until a stable reading is obtained.
9. Adjust the GATE TIME control (10) for desired resolution. The gate time may be displayed by pressing the GATE TIME switch (7) and the Blue Shift key (9).

Figure 3-13. Frequency A/Period A Measurements



NOTE

For specifications concerning bandwidth, accuracy, and amplitude on input signals, refer to *Table 1-1*.

1. Set POWER switch (1) to the ON position.
2. Set GATE TIME control (10) to min.
3. If the Start and Stop signals are from separate sources, connect the Start signal to INPUT A jack (12), the Stop signal to INPUT B jack (17), and set the SEP/COM A switch (15) to SEP position. If the Start and Stop signals are from a common source, connect to INPUT A jack (12) and set the SEP/COM A switch (15) to COM A position.
4. Press T.I. A→B switch (4), and insure the Blue Shift key (9) is in the out position, to select Time Interval function.
5. Set AC/DC (11) (18), ATTN (13) (16), and Slope (19) (20) switches to desired positions.

NOTE

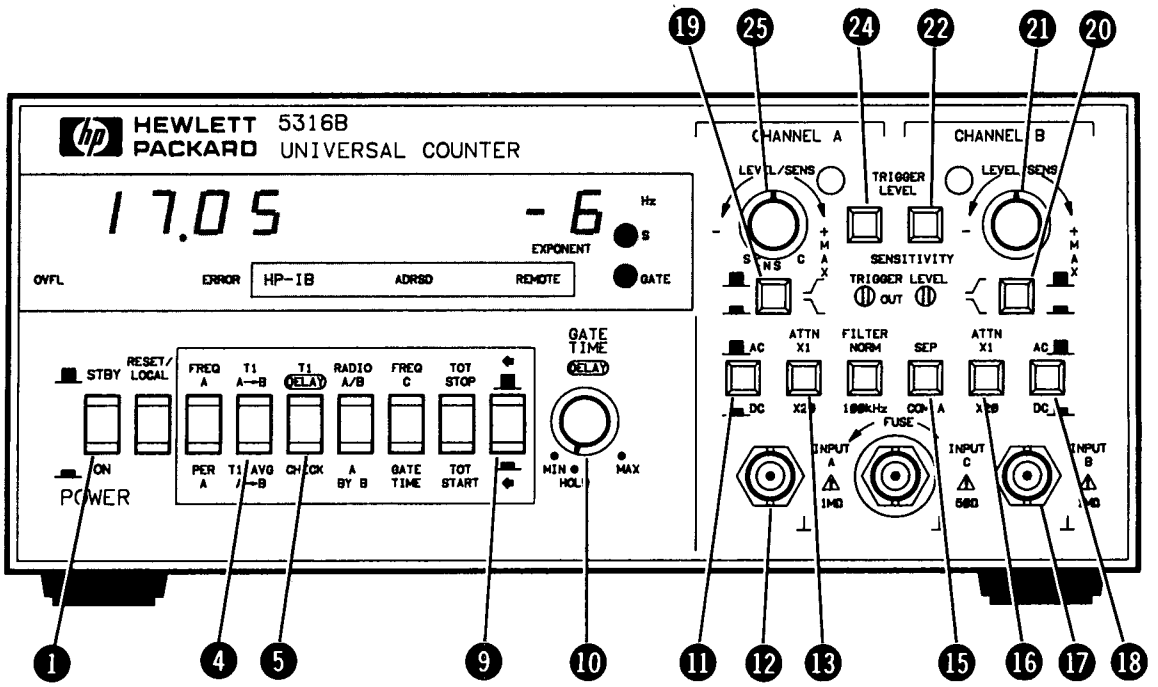
When the SEP/COM A switch is set to COM A, only the CHANNEL A AC/DC switch (11) is effective. However, all Attenuator, Slope, and LEVEL/SENS controls are effective.

6. Set TRIGGER LEVEL/SENSITIVITY switches (22) (24) to TRIGGER LEVEL position. This sets the sensitivity to maximum (≤10 mV for frequencies ≤10 MHz) and allows variable selection of trigger levels.
7. Adjust the LEVEL/SENS controls (21) (25) for optimum triggering, usually the middle of the range over which the trigger light flashes.
8. Adjust the GATE TIME control (10) for the desired sample rate, variable nominally from 60 ms to 10 s. The selected gate time may be displayed by pressing the GATE TIME switch (7) and the Blue Shift key (9).

NOTE

The first measurement is not displayed until the gate time delay is up. For slow sample rates, use HOLD and the RESET switch.

Figure 3-14. Time Interval Measurement



NOTE

For specifications concerning bandwidth, accuracy, and amplitude on input signals, refer to *Table 1-1*.

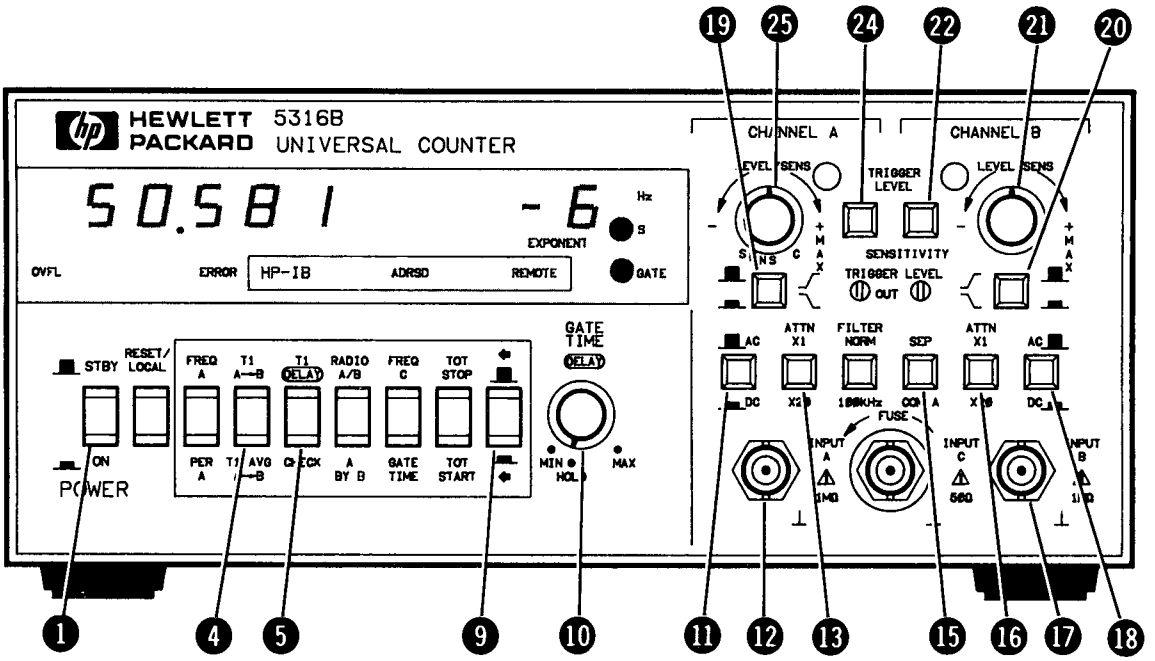
1. Set POWER switch (1) to the ON position.
2. If the Start and Stop signals are from separate sources, connect the Start signal to INPUT A jack (12), the Stop signal to INPUT B jack (17), and set the SEP/COM A switch (15) to SEP position. If the Start and Stop signals are from a common source, connect that source to INPUT A jack (12) and set the SEP/COM A switch (15) to COM A position.
3. Press T.I. DELAY switch (5), and insure the Blue Shift key (9) is in the out position, to select Time Interval function.
4. Set AC/DC (11) (18), ATTN (13) (16), and Slope (19) (20) switches to desired positions.

NOTE

When the SEP/COM A switch is set to COM A, only Channel A AC/DC switch (11) is effective. However, all ATTENUATOR, SLOPE, and LEVEL/SENS controls are effective.

5. Set TRIGGER LEVEL/SENSITIVITY switches (22) (24) to TRIGGER LEVEL position. This sets the sensitivity to maximum (≤10 mV) and allows variable selection of trigger levels.
6. Adjust the LEVEL/SENS controls (21) (25) for optimum triggering (i.e., the middle of the range over which the trigger light flashes).
7. Adjust the GATE TIME/DELAY control (10), for the desired holdoff, (variable nominally from 500 μs to 30 ms) between the Start on Channel A and the enabling of Stop on Channel B. Inputs during the delay time are ignored. The selected delay time may be displayed by pressing T.I. A→B (4), T.I. DELAY (5) and Blue Shift key (9).

Figure 3-15. Time Interval Delay Measurement



NOTE

For specifications concerning bandwidth, accuracy, and amplitude on input signals, refer to *Table 1-1*.

1. Set POWER switch (1) to the ON position.

NOTE

There must be at least 200 ns between the Stop pulse and the next Start pulse. When measuring the time interval between the same polarity slope of two pulses from a single source, the PER A mode should be used.

2. If the Start and Stop signals are from separate sources, connect the Start signal to INPUT A jack (12), the Stop signal to INPUT B jack (17), and set the SEP/COM A switch (15) to SEP position. If the Start and Stop signals are from a common source, connect to that source INPUT A jack (12) and set the SEP/COM A switch (15) to COM A position.
3. Press T.I. A→B switch (4), and the Blue Shift key (9), to select time interval average function.
4. Set AC/DC (11) (18), ATTN (13) (16), and Slope (19) (20) switches to desired positions.

NOTE

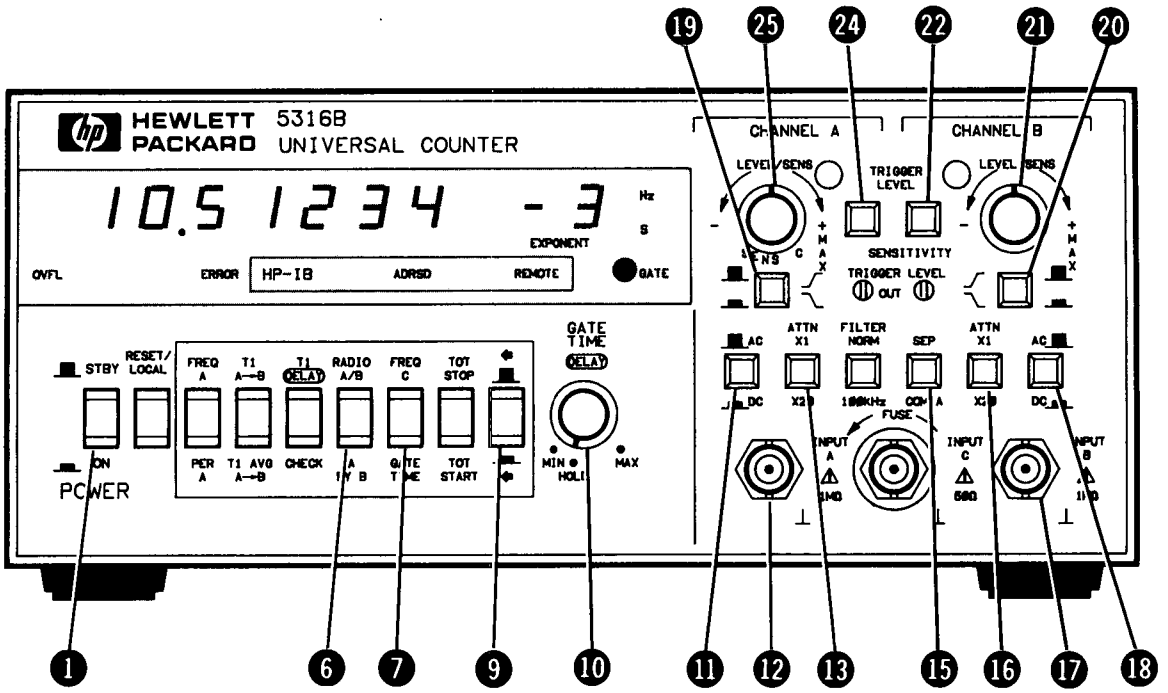
When the SEP/COM A switch is set to COM A, only the Channel A AC/DC switch (11) is effective. However, all ATTENUATOR, SLOPE, and LEVEL/SENS controls are effective.

5. Set TRIGGER LEVEL/SENSITIVITY switches (22) (24) to TRIGGER LEVEL position. This sets the sensitivity to maximum (≤10 mV) and allows variable selection of trigger levels.
6. Adjust the LEVEL/SENS controls (21) (25) for optimum triggering (i.e., the middle of the range over which the trigger light flashes).
7. Adjust the GATE TIME control (10) for the desired resolution. The selected gate time may be displayed by pressing the GATE TIME switch (7) and the Blue Shift key (9).

NOTE

The T.I. Average A→B mode of operation will measure time intervals from 10^5 seconds to 0 ns, with up to 10 ps resolution. A display of up to "–" 1 or 2 ns, indicating a negative time interval (i.e., Channel B event occurred before Channel A event) is possible.

Figure 3-16. Time Interval Average A→B

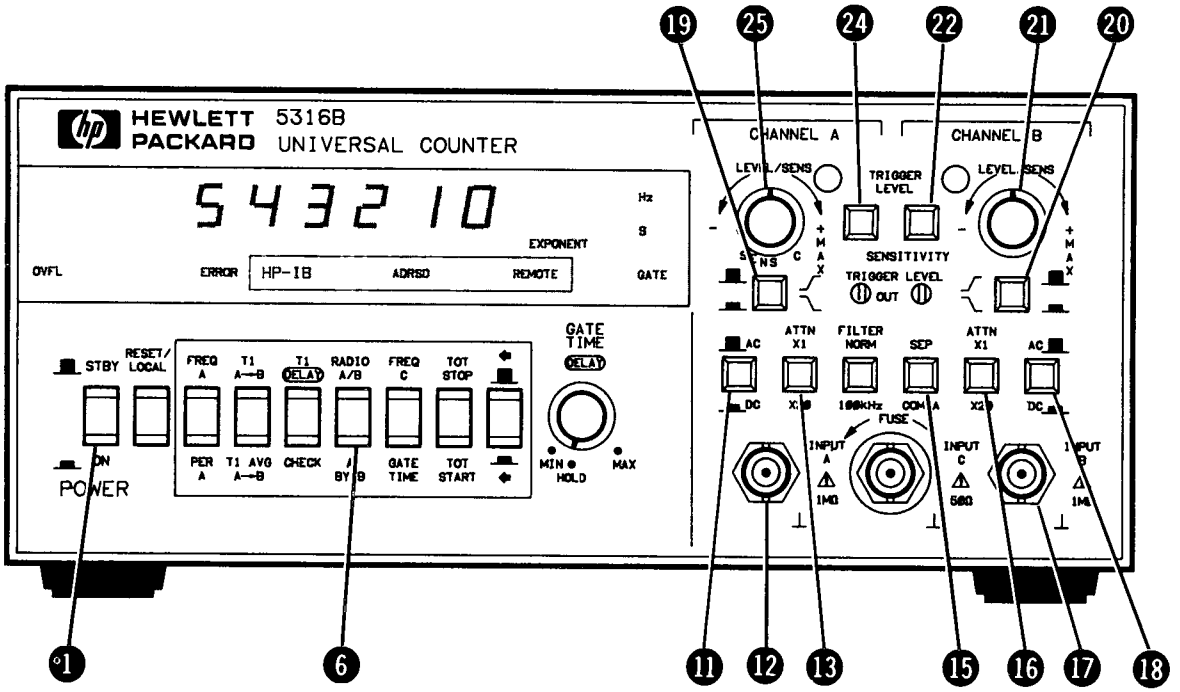


NOTE

For specifications concerning bandwidth, accuracy, and amplitude on input signals, refer to *Table 1-1*.

1. Set POWER switch (1) to the ON position.
2. Set SEP/COM A switch (15) to SEP position.
3. Connect the input signals to INPUT A (12) and INPUT B (17). Connect the higher frequency signal to INPUT A. Connect the lower frequency signal to INPUT B. The ratio displayed will be greater than 1.
4. Press RATIO A/B (6), and insure the Blue Shift key (9) is in the out position.
5. Set AC/DC (11) (18), ATTN (13) (16), and Slope (19) (20) switches to desired positions.
6. Set TRIGGER LEVEL/SENSITIVITY switches (22) (24) to SENSITIVITY position and LEVEL/SENS controls (21) (25) fully ccw. This sets the trigger level at Ø volts (nominally) and sensitivity to minimum (>500 mV).
7. Adjust each LEVEL/SENS control (21) (25) in a clockwise direction slightly beyond the point the corresponding trigger light flashes. If signals are less than 250 mV rms, the LEVEL/SENS controls may be fully cw.
8. Adjust the GATE TIME control (10) for desired resolution. The selected gate time, variable nominally from 60 ms to 10 s, may be displayed by pressing the GATE TIME switch (7) and the Blue Shift key (9).

Figure 3-17. Ratio A/B Measurements



NOTE

For specifications concerning bandwidth, accuracy, and amplitude on input signals, refer to *Table 1-1*.

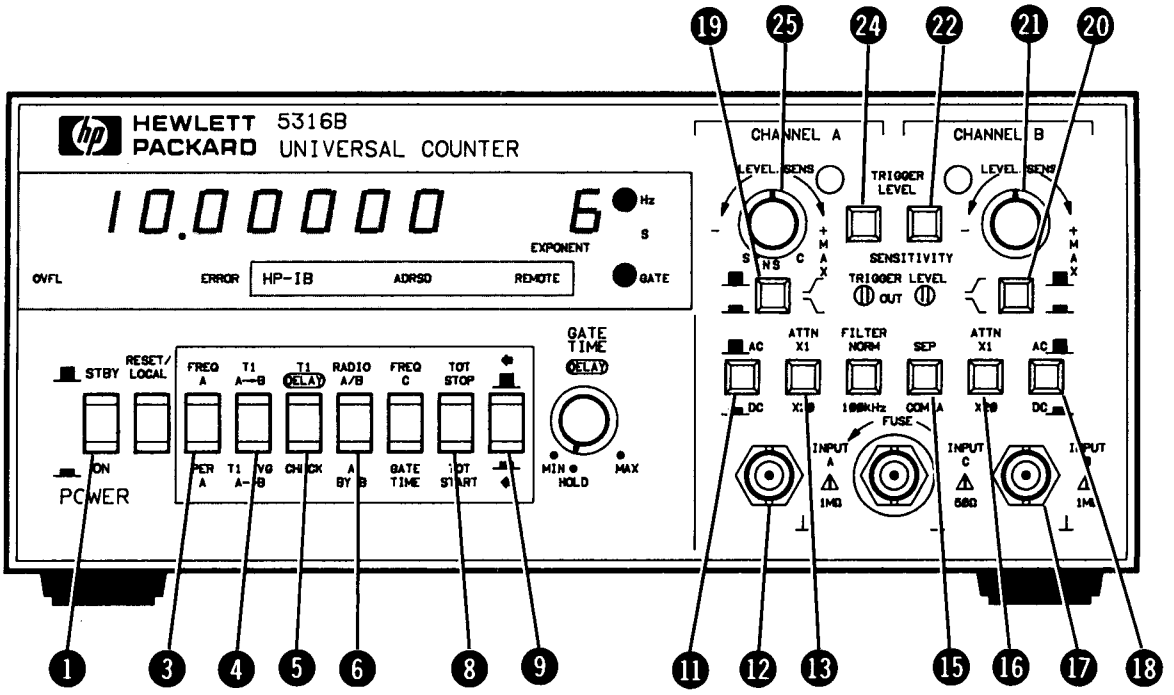
1. Set POWER switch (1) to the ON position.
2. Set SEP/COM A switch (15) to SEP position.
3. Connect the signal, either sine wave or pulses, to be totalized to INPUT A jack (12) and the gate control signal to INPUT B jack (17)

NOTE

This mode will totalize inputs on Channel A for the time between two events on Channel B. The Gate will open on the A Slope setting and close on the B Slope setting. A reset is required to make a new measurement.

4. Press A BY B switch (6) and the Blue Shift key (9) to select the Totalize A BY B function.
5. Set AC/DC (11) (18), ATTN (13) (16) and Slope (19) (20) switches to desired positions.
6. Set TRIGGER LEVEL/SENSITIVITY switches (22) (24) to SENSITIVITY position and LEVEL/SENS (21) (25) fully ccw. This sets the trigger level at Ø volts (nominally) and sensitivity to minimum (500 mV).
7. Adjust each LEVEL/SENS (21) (25) in a clockwise direction slightly beyond the point the corresponding trigger light flashers. If signals are less than 250 mV rms, the LEVEL/SENS controls may be fully cw.
8. This function operates in a single-shot mode. The RESET key must be pressed to initiate a new measurement.

Figure 3-18. A BY B Measurements



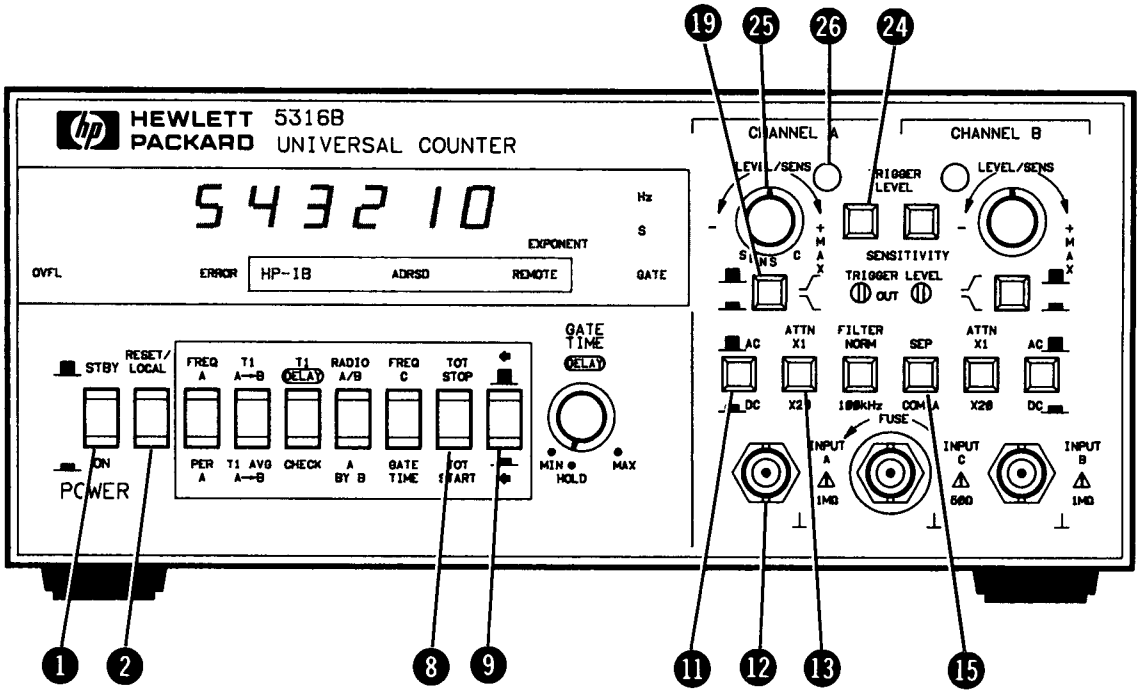
1. Set POWER switch (1) to the ON position.
2. Set SEP/COM A switch (15) to SEP position.
3. Connect the frequency burst signal to be averaged to INPUT A jack (12) and the sampling signal to INPUT B jack (17) . The sampling signal must be synchronized with, and of pulse width less than the burst.

NOTE

This mode will average together multiple frequency bursts and display the average frequency of the signal within the burst. *Due to the complexity of this function it is recommended that the user thoroughly read paragraph 3-23 before attempting to use this function.*

4. Press T.I. DELAY, CHECK switch (4) and RATIO A/B, A BY B switch (6) together for a gate time of 500 μs-30 ms or FREQ A, PER A switch (3) and TOT STOP, TOT START switch (8) for a gate time of 60 ms-10 s.
5. Set AC/DC (11) (18) , ATTN (13) (16) to the desired positions.
6. Set the Blue Shift key (9) for the desired sampling/measurement interval enable slope: OUT for a positive enable slope, IN for a negative enable slope (negative slope only using SHORT measurement interval).
7. Set the A Channel SLOPE switch (19) to the desired trigger slope. Set the B Channel SLOPE switch (20) for the desired disable slope.
8. Set the TRIGGER/SENSITIVITY switches (22) (24) to SENSITIVITY position and LEVEL/SENS controls (21) (25) fully ccw. This sets the trigger level at 0 volts (nominally) and sensitivity to minimum (500 mV).
9. Adjust each LEVEL/SENS (21) (25) in a clockwise direction slightly beyond the point the corresponding trigger light flashes. If the signals are less than 250 mV, the LEVEL/SENS controls may be fully cw.

Figure 3-19. FREQ A Armed by B Measurements



NOTE

For specifications concerning bandwidth, accuracy, and amplitude on input signals, refer to *Table 1-1*.

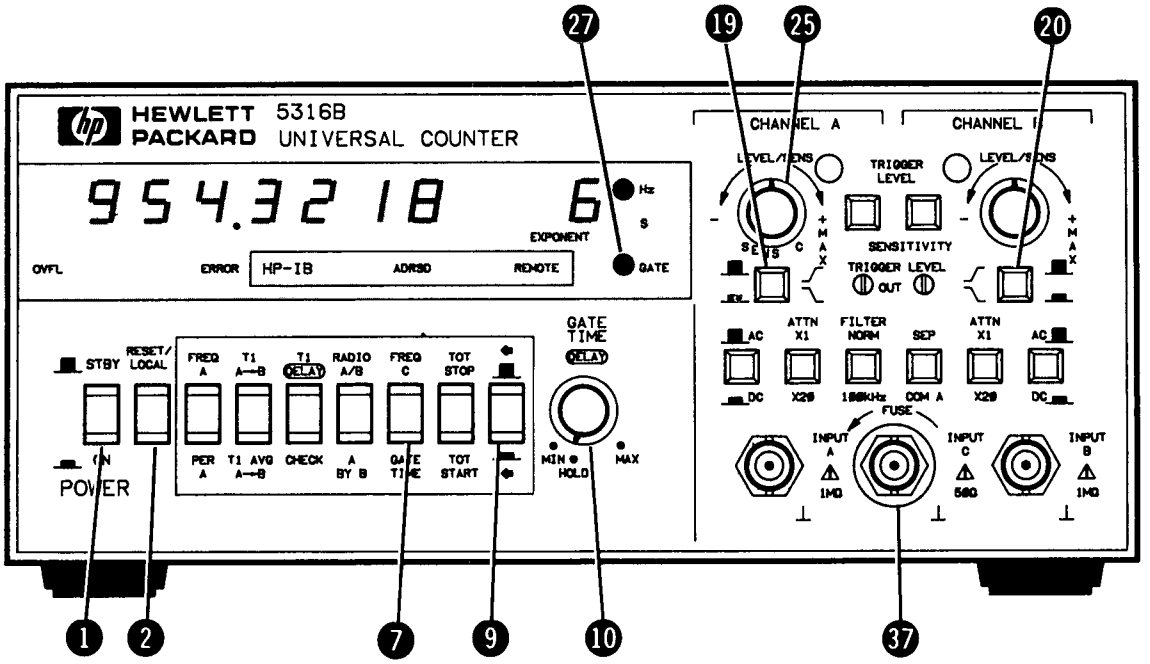
1. Set POWER switch (1) to the ON position.
2. Set SEP/COM A switch (15) to SEP position.
3. Connect the signal to be totalized to INPUT A jack (12)

NOTE

This mode will totalize inputs on Channel A for the period of time manually selected using front panel switches.

4. Press TOT switch (8). The Blue Shift key (9) must be in the out position.
5. Set AC/DC (11), ATTN (13) and Slope (19) switches to desired positions.
6. Set TRIGGER LEVEL/SENSITIVITY switch (24) to SENSITIVITY position and LEVEL/SENS (25) fully ccw. This sets the trigger level at Ø volts (nominally) and sensitivity to minimum (500 mV).
7. Adjust the LEVEL/SENS control (25) in a clockwise direction slightly beyond the point the Channel A trigger light (26) flashes.
8. Press RESET (2) to clear display.
9. Press Blue Shift key (9) IN to START totalize measurement, and press again (OUT position) to STOP totalize. Repeat this procedure to accumulate counts, press RESET (2) to clear display and enable a new measurement.

Figure 3-20. Totalize Measurements



CAUTION

Make sure that the amplitude of the signal does not exceed the 1V rms dynamic range.

NOTE

For specifications concerning bandwidth, accuracy, and amplitude on input signals, refer to *Table 1-1*.

1. Set POWER switch (1) to the ON position, and press FREQ C/GATE TIME (7).
2. Set GATE TIME control (10) to MIN.
3. Connect the input signal to INPUT C jack (37).
4. Set SENS C control (25) to MIN. Slowly rotate the control in a cw direction until the GATE light (27) just turns on.
5. Adjust the GATE TIME control (10) for the desired resolution. The actual gate time may be displayed by pressing the GATE TIME function switch (7) and the Blue SHIFT (9). Moving the GATE TIME control (10) fully ccw into detent will HOLD the measurement display. In HOLD, single-shot measurements with minimum gate time can be made by pressing the RESET (2) key.

NOTE

The only controls active in FREQ C function mode are GATE TIME (10), RESET (2), and SENS C (25). However, pressing either Channel A (19) or B (20) scope switches will reset the counter.

6. The input connector for INPUT C (37) is a special fused BNC. The in-line fuse within the connector is accessible from the front panel. Refer to the Operator's Maintenance, paragraph 3-70, for replacement of fuse.

Figure 3-21. Frequency C Measurement

3-73. REMOTE PROGRAMMING VIA THE HP-IB

3-74. Introduction

3-75. The HP 5316B Universal Counter is compatible with the Hewlett-Packard Interface Bus (HP-IB). Remote programming is installed as standard equipment and allows the counter to respond to remote control instructions and to output measurement data via the HP-IB. At the simplest level, with no system controller, the HP 5316B can output data, in the talk only mode, to other devices such as a printer or a digital-to-analog converter. In more sophisticated systems, a computing or other type of controller can remotely program the HP 5316B to perform a specific type of measurement, trigger the measurement, and output the results.

NOTE

HP-IB is Hewlett-Packard's implementation of IEEE Std. 488-1978, *"Standard Digital Interface for Programmable Instrumentation"*.

3-76. The operator must be familiar with the selected controller, the HP-IB, and the manual operation and functional capabilities of the HP 5316B. The following HP manuals should provide useful background information:

HP-85 Owners Manual and Programming Guide (P/N 00085-90002)
Condensed Description of the Hewlett-Packard Interface Bus (P/N 59401-90030)
HP-IB Programming Hints For Selected Instruments (P/N 59300-90005)

3-77. BUS COMPATIBILITY

3-78. Interface Function

3-79. The capability of a device connected to the bus is specified by its interface functions. These functions provide the means for a device to receive, process, and send messages over the bus. *Table 3-2* lists the HP 5316B interface functions using the terminology of the IEEE 488-1978 standard. These functions are also listed below the rear panel HP-IB connector, as follows:

SH1, AH1, T1, L2, SR1, RL1, PPØ, DC1, DT1, CØ

The number following the interface function code indicates the particular capability of that function.

Table 3-2. HP-IB Interface Functions

INTERFACE FUNCTION SUBSET IDENTIFIER	INTERFACE FUNCTION DESCRIPTION
SH1	Complete source handshake capability.
AH1	Complete acceptor handshake capability.
T1	Talker (basic talker, serial poll, and talk only mode capabilities)
L2	Listener (basic listener without listen only)
SR1	Service request capability.
RL1	Complete remote/local capability.
PPØ	No parallel poll capability.
DC1	Complete device clear capability.
DT1	Device trigger capability.
CØ	No controller capability.

3-80. The HP 5316B operates (as listed in *Table 3-2*) as both a talker and listener. The HP 5316B output format is the same regardless of the mode (talk only/addressable).

a. TALK: The HP 5316B can be addressed to Talk by a controller or by the TALK ONLY switch for use in system without a controller. When addressed as a Talker, the HP 5316B will send data out to other devices on the bus. This data is the result of a measurement in progress when addressed, or the next measurement, depending on the function selected. The Talk Only switch and the HP-IB address switches are located on the rear panel. (See *Figure 3-11*).

NOTE

To remove the HP 5316B from the TALK ONLY mode, set the ADDRESSABLE/TALK ONLY switch to ADDRESSABLE and press RESET (front panel). When RESET is pressed the HP 5316B will exit the TALK ONLY mode.

b. LISTEN: When addressed as a Listener, the instrument can accept any number of commands from the controller via the bus. These commands are used to program the instrument operation.

c. SERVICE REQUEST (SRQ): SRQ can be sent active on the bus at the end of the measurement. The HP 5316B has the capability to request service asynchronously from the controller in charge of the bus. See "SR" described in Binary Command section, paragraph 3-91.

d. REMOTE/LOCAL: Normally the HP 5316B is under front panel (local) control. In order to program the HP 5316B, it must be placed into Remote. Once in Remote, the programmable functions cannot be affected by front panel control, except the RESET/LOCAL key, which may be used manually to return the HP 5316B to local control. The RESET/LOCAL key may be disabled with Local-Lockout (LLO). In LLO, the bus command GTL (Go To Local) must be sent to disable LLO.

e. PARALLEL POLL: The HP 5316B does not respond to a parallel poll.

f. DEVICE CLEAR: When a group or selected device clear is received, the instrument resets and makes a new measurement.

h. DEVICE TRIGGER: When a device trigger is received, the HP 5316B will reset and make a new measurement.

i. CONTROLLER: The HP 5316B cannot act as a controller.

3-81. BUS MESSAGES

3-82. Through bus messages, devices on the bus can exchange control and measurement information. There are 12 basic messages which can be sent over the interface. *Table 3-3* lists each bus message, giving a description of the HP 5316B response, and examples of the various controllers' implementations of the messages.

Table 3-3. Bus Messages

HP-IB MESSAGE	DESCRIPTION/RESPONSE	HP 85 (address = 20)
DATA	A WAY TO SEND COMMANDS TO HP 5316B AND RECEIVE MEASUREMENT DATA.	OUTPUT 720; "FN1" ENTER 720; A
TRIGGER	STARTS NEW MEASUREMENT. IF THE HP 5316B IS IN LOCAL, IT WILL REMAIN IN LOCAL AND NO TRIGGER OCCURS.	TRIGGER 7
	STARTS NEW MEASUREMENT.IF THE HP 5316B IS IN LOCAL, THE HP 5316B WILL GO INTO REMOTE.	TRIGGER 720
CLEAR	STARTS NEW MEASUREMENT (ACTS AS RESET).	CLEAR 7 CLEAR 720
REMOTE	FRONT PANEL FUNCTION AND SLOPE SWITCHES ARE DISABLED; COUNTER DEFAULTS TO FREQUENCY A, ALL SLOPES TO POSITIVE UNLESS PREVIOUSLY PROGRAMMED.	REMOTE 720
LOCAL	RETURNS TO LOCAL (FRONT PANEL) OPERATION.	LOCAL 7 LOCAL 720
LOCAL LOCKOUT	DISABLES FRONT PANEL RESET; ONLY CONTROLLER CAN RETURN HP 5316B TO LOCAL. NOTE: IF IN REMOTE, FRONT PANEL FUNCTION AND SLOPE SWITCHES ARE ALSO DISABLED.	LOCAL LOCKOUT 7
GOTO LOCAL AND CLEAR LOCAL LOCKOUT	HP 5316B RETURNS TO LOCAL (FRONT PANEL) CONTROL; LOCAL LOCKOUT CLEARED.	LOCAL 7
SERVICE REQUEST	HP 5316B WILL REQUEST SERVICE AT END OF MEASUREMENT IF SRQ AND WAIT STATE THIS COMMAND CHECKS THE HP-IB STATUS REGISTER INSIDE THE CONTROLLER TO SEE IF THE SRQ LINE IS ACTIVE.	STATUS 7, 2; A
STATUS BYTE	PRESENTS STATUS INFORMATION. BIT 7 IS SET IF SERVICE IS REQUESTED. (IN THIS CASE, THE VARIABLE A WILL BE 64.)	A = SPOLL (720)
STATUS BIT	NOT APPLICABLE.	
PASS CONTROL	NOT APPLICABLE.	
ABORT	TERMINATES THE BUS COMMUNICATIONS; TELLS ALL DEVICES TO UNLISTEN; HP 5316B ADRSD LIGHT WILL GO OFF.	ABORTIO 7

3-83. Address Selection

3-84. To use the HP 5316B in an HP-IB system, first set the rear panel address switches to the desired address. The leftmost switch sets the counter to the ADDRESSABLE mode or the TALK ONLY mode. The ADDRESSABLE mode is used whenever a calculator or other controller is used within the system. TALK ONLY mode is used when the counter is operating under its own control (no controller on bus) and sends its measured result to another device on the bus, such as a printer set to LISTEN ALWAYS.

3-85. The five rightmost switches, A_5 through A_1, set the TALK and LISTEN addresses of the HP 5316B when it is used in the ADDRESSABLE mode. *Table 3-4* shows all possible address settings and the corresponding ASCII codes for talk and listen. The HP 5316B is factory set to address 20 as shown in *Figure 3-22.*

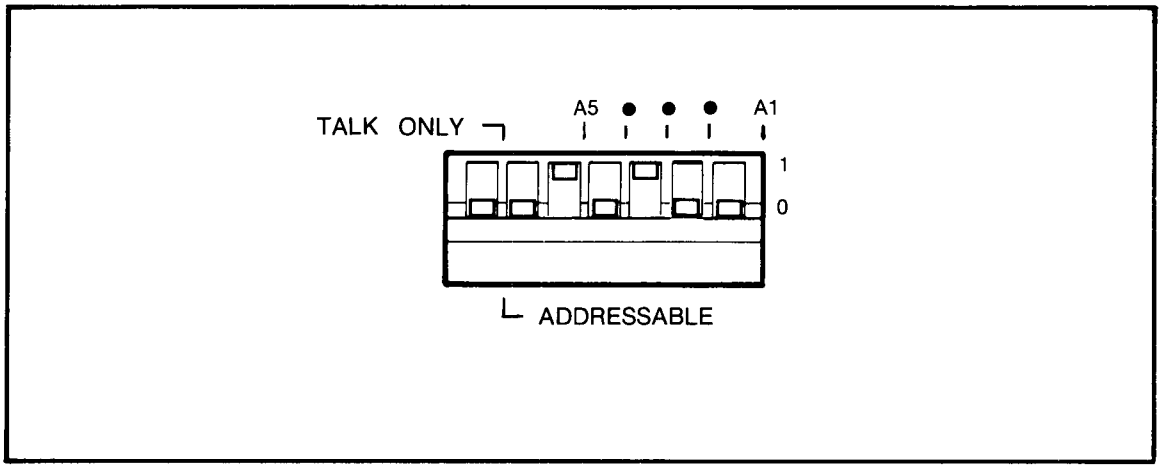


Figure 3-22. HP 5316B Address Switches (20)

3-86. Front Panel HP-IB Status LEDs.

3-87. The two HP-IB Status LEDs on the front panel are to indicate if the counter is in REMOTE and/or ADDRESSED. The REMOTE light is on when the HP 5316B is in the remote mode. The ADRSD light is on when the HP 5316B is addressed to talk or listen. When the HP 5316B goes to local mode, the front panel REMOTE indicator goes off. The ADRSD indicator stays illuminated if the HP 5316B is still addressed. When in the TALK ONLY mode the ADRSD LED is always illuminated.

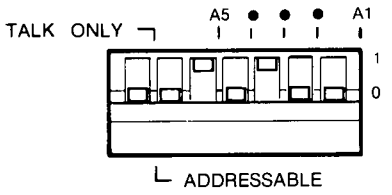
NOTE

The TALK ONLY mode may be entered by the rear panel switch, but can be exited only by setting the switch to ADDRESSABLE and pressing the front panel RESET key.

3-88. Device Command D

3-89. A device command is a string or sequence of two or more ASCII-coded bytes (upper or lower case), ending with a delimiter. (A delimiter is either a comma, semicolon, space, carriage return, or linefeed.) This command causes the counter to perform a specific function. For the HP 5316B these commands can be classified as either Terse, Binary, or Numeric commands.

Table 3-4. Address Selection



NOTE

Select the listen address from the table below and set the address switches to the corresponding positions.

ASCII CODE CHARACTER	ADDRESS SWITCHES					5-BIT DECIMAL CODE
LISTEN	A_5	A_4	A_3	A_2	A_1	
SP	0	0	0	0	0	00
!	0	0	0	0	1	01
"	0	0	0	1	0	02
#	0	0	0	1	1	03
$	0	0	1	0	0	04
%	0	0	1	0	1	05
&	0	0	1	1	0	06
'	0	0	1	1	1	07
(	0	1	0	0	0	08
)	0	1	0	0	1	09
*	0	1	0	1	0	10
+	0	1	0	1	1	11
,	0	1	1	0	0	12
—	0	1	1	0	1	13
.	0	1	1	1	0	14
/	0	1	1	1	1	15
Ø	1	0	0	0	0	16
1	1	0	0	0	1	17
2	1	0	0	1	0	18
3	1	0	0	1	1	19
4	1	0	1	0	0	20
➔ **5**	**1**	**0**	**1**	**0**	**1**	**21**
6	1	0	1	1	0	22
7	1	0	1	1	1	23
8	1	1	0	0	0	24
9	1	1	0	0	1	25
:	1	1	0	1	0	26
;	1	1	0	1	1	27
<	1	1	1	0	0	28
=	1	1	1	0	1	29
>	1	1	1	1	0	30

***Address "21" is address for controller and cannot be used.**

3-90. TERSE COMMANDS: A sequence of two ASCII-coded alphabetic characters NOT followed by a numeric or binary number.

RE Reset — Causes display to blank and a new measurement to be made. All functions and parameters remain the same. RESET (RE) also occurs after the HP 5316B is placed into Remote. The "RE" command is equivalent to the bus Device Clear and Trigger commands. The RESET (RE) command may be used to initiate a new measurement.

IN Initialize — Causes the HP 5316B to go to the default state: Function goes to FREQUENCY A, A and B slopes go to +, and all of the Binary commands go to the Ø state. For example, Initialize (IN) sets the following codes:

FN1ASØBSØTRØWAØSRØGAØ

The HP 5316B will blank the display and make a new measurement in FREQ A. (NOTE: Even if the HP 5316B was in FREQ A already, "IN" will still set the Binary commands to Ø and make a new measurement. Initialize is commonly sent as the leading code in a command string. This will clear all functions (to default states) and then only the codes following in the command string change the operating mode from the default states..

3-91. BINARY COMMANDS: A sequence of two ASCII-coded alphabetic characters followed by either a 'Ø' or a "1". **Bold** indicates the default state.

ASØ Channel A triggers on POSITIVE slope of signal.

AS1 Channel A triggers on NEGATIVE slope of signal.

BSØ Channel B triggers on POSITIVE slope of signal.

BS1 Channel B triggers on NEGATIVE slope of signal.

TRØ The A and B trigger levels are set by front panel controls.

TR1 The A and B trigger levels are set by the internal D-to-A Converters. If no numeric values are specified after a TR1 the DACs go to nominal zero volts DC. (See Numeric Commands paragraph 3-92b).

WAØ Continuous gating mode; output only if addressed to talk.

WA1 Gate once, wait for talk address; output data; then make new measurement.

In the Wait state (WA1), the HP 5316B will make a measurement and hold the data until it has been addressed to talk. At that time, it will output the data and then make a new measurement. None of the functions or parameters are changed. Note that WA1 allows you to make a measurement and then get the data from that measurement. Simply addressing it to Talk, in WAØ, will send you the results of the next measurement completed. WAØ will continue gating and not hold the measurement.

SRØ HP 5316B WILL NOT pull SRQ at end of measurement.

SR1 HP 5316B WILL pull SRQ at end of measurement.

The HP 5316B will request service only to indicate that a measurement is complete and the data is available. Service Request will occur only if:

1. the "SR1" command has been sent.
2. the WAIT state (WA1) has been enabled.

Reading a device status will return the value 64 (seventh bit active) indicating that service has been requested. The service request line is cleared when the

HP 5316B is addressed to TALK or when the status is read. Even though SRQ is cleared during a read device status, the status will remain "64" until the data is read or a front panel RESET is sent.

Once the data is read (when service has been requested) SRQ will go inactive and the HP 5316B will start a new measurement. The service request can only be cleared by reading the measurement data.

3-92. NUMERIC COMMANDS: A sequence of two ASCII-coded alphabetic characters followed by a sequence of bytes representing a decimal number and a delimiter. **Bold** indicates the default states.

a. Measurement Functions:

FNØ ROLLING DISPLAY TEST
FN1 FREQUENCY A
FN2 TIME INTERVAL A→B
FN3 TI DELAY
FN4 RATIO A/B
FN5 FREQUENCY C
FN6 TOTALIZE STOP
FN7 PERIOD A
FN8 TIME INTERVAL AVERAGE A→B
FN9 CHECK 10.00 MHz
FN1Ø A GATED BY B (trigger slope controlled by front panel or by commands AS and BS).
FN11 READ GATE TIME
FN12 TOTALIZE START
FN13 FREQUENCY A, AVERAGED, ARMED BY B
FN13 sets the Channel B START arming slope to positive trigger. The STOP slope is determined by sending BSØ or BS1. The Channel A slope is determined by ASØ or AS1. See paragraph 3-23 for a detailed description of this function.
FN14 FREQUENCY A, AVERAGED, ARMED BY B
Same as FN13 except the B START arming slope is negative. The B STOP arming slope and Channel A slopes are still determined by BSØ or BS1 and ASØ or AS1, respectively. See paragraph 3-23.

FUNCTION 13 AND 14 A ARMED BY B CODE TABLE

TRIGGER ON A SLOPE	BEGIN ON B SLOPE	END ON B SLOPE	CODE STRING
POS	POS	POS	FN13ASØBSØ
NEG	POS	POS	FN13AS1BSØ
POS	NEG	POS	FN14ASØBSØ
NEG	NEG	POS	FN14AS1BSØ
POS	POS	NEG	FN13ASØBS1
NEG	POS	NEG	FN13AS1BS1
POS	NEG	NEG	FN14ASØBS1
NEG	NEG	NEG	FN14AS1BS1

FN16 HP-IB INTERFACE TEST (Used only in the HP-IB verification in Section IV)

b. Programming Trigger Levels:
Commands of the form AT [value] and BT [value] set the D-to-A converters to DC voltages such that the trigger levels of the A (and B) channels are the value (in volts) specified. Note that TR1 must also be sent at the beginning of the DAC programming sequence. (TR1 enables the AT/BT command and need be sent only once.) The trigger level voltage range is +2.50V dc to -2.50V dc, in steps of

0.01V dc. The trigger level voltages may be monitored at the front panel TRIGGER LEVEL jacks. The measurement error at these points is ±5% of the actual voltage ±15 mV over the range of ±2.0V dc. For example all three of the following formats set the Channel A trigger level to 0V dc:

```
AT 0 (Here the space is ignored)
AT0.00
AT +00
```

Channel B is exactly the same. To set Channel B to -1.53V:

```
BT-1.53
```

Unless specified as negative, the polarity is assumed to be positive.

Sending trigger level commands (AT and/or BT) will cause the HP 5316B to reset.

c. Programming Gate Time:

GA There are 2 gate time ranges available. The LONG gate time range is 60 ms–10 s, typical. The SHORT gate time range is 500 μs–30 ms, typical. These two gate time ranges can be controlled by either the front knob or rear panel adjustment (see *Figure 3-11*). The rear panel gate time control is essentially the same as the front panel GATE TIME control WITHOUT the HOLD position. Commands for the gate time ranges are as follows. **Bold** indicates the default states.

GAØ Gate time range is LONG, controlled by front knob.
GA1 Gate time range is SHORT, controlled by front knob.
GA2 Gate time range is LONG, controlled by rear panel adjustment.
GA3 Gate time range is SHORT, controlled by rear panel adjustment.

NOTE

Placing the GATE TIME/DELAY control in the HOLD position will cause the bus to stop all operations whenever an attempt is made to read data from the HP 5316B. When a read data statement is sent, the HP 5316B cannot send out its data until the GATE TIME/DELAY control is removed from the HOLD position.

3-93. INPUT CODE FORMAT

3-94. The HP 5316B will accept the program codes in either upper case or lower case. For example:

```
output 720,"INFN7WA1SR1"      OR      output 720,"infn7wa1sr1"
```

Either way will produce the same results. Depending on the controller, this feature can help speed the writing of programs.

3-95. OUTPUT FORMAT

3-96. After a measurement is complete, the HP 5316B will output the data to the HP-IB. The output string contains 19 characters, followed by a carriage return and line feed. *Table 3-5* shows the output format of the string.

Table 3-5. Output String Format

1	2	3 through 15	16	17	18	19	20	21
F	+	X spaces, 1 digit, dp, 11-X digits	E	+	D	D	CR	LF
T	-			-				
O								
X								
SP								

Position 1 (ALPHA CHARACTER):

a. F for frequency measurement (FN1, 5, 9, 13, and 14)
b. T for time measurement (FN2, 3, 7, 8 and 11)
c. O for overflow
d. X for error (indicates the same error as front panel ERROR LED). See Section VIII, Troubleshooting.
e. SP (space) for all other modes and functions (FN4, 6, 10, and 12)

Positions 3 through 15:

In these positions, X spaces followed by a single digit, a decimal point, and 11-X digits (depending on the resolution). The decimal point may appear at any position between 4 and 15.

Position 16 through 21:

The "E" to signify EXPONENT followed by the exponent polarity (+ or -), two exponent digits, and carriage return and linefeed.

3-97. The measurement data output speed for the HP 5316B is approximately:

a. Seven measurements/second in the LONG gate time mode with the GATE TIME control fully counterclockwise (shortest LONG gate time), but not in HOLD.

b. Ten measurements/second in the SHORT gate time mode with the GATE TIME control in the fully counterclockwise position (shortest SHORT gate time), but not HOLD.

3-98. PROGRAMMING EXAMPLES

3-99. The examples listed in this section assume a HP 5316B address setting of 10100. The HP 5316B is addressed to talk and listen by using the code 720, where 20 is the HP 5316B address and 7 is the interface select code of the 82937A HP-IB for the HP-85.

3-100. The following programs demonstrate the programming of the HP 5316B using the HP-85.

EXAMPLE 1 SIMPLE FREQUENCY MEASUREMENT HP-85

```
10:   output 720;"FN1"          SET THE HP 5316B TO FREQUENCY A MODE
20:   enter 720; A              READ DATA INTO A
30:   disp A @ wait 500         DISPLAY CONTENTS OF A, WAIT 500 ms
40:   goto 10                   GO TO LINE 10
50:   end                       END PROGRAM
```

EXAMPLE 2 PERIOD MEASUREMENT USING REMOTE TRIGGER LEVELS HP-85

```
10:   dim A$[19]                DIMENSION A$ TO 19 CHARACTER LONG
20:   output 720;"fn7wa1tr1at-.25"  SET THE HP 5316B TO: PERIOD, WAIT TO OUTPUT,
                                TRIGGER LEVEL SET BY D/A CONVERTER,
                                CHANNEL A TRIGGER LEVEL SET TO -.25V dc
30:   enter 720; A$             READ DATA INTO A$
40:   dsp A$ @  wait 1000       DISPLAY A$;WAIT 1 SECOND
50:   goto 30                   GOTO LINE 30
60:   end                       END PROGRAM
```

3-101. Special Programming Considerations

3-102. To clarify the programming of the HP 5316B, the following considerations should be noted:

1. If the HP 5316B is currently in REMOTE and new commands are sent, the HP 5316B will reset and begin a new measurement.
2. If the HP 5316B is sent back to local from remote and then returned to remote again, all previous remote functions (slopes, trigger levels, output mode, etc.) will be retained and reactivated. The gate time, however, is dominated by the locally selected range and must be programmed again if different.
3. If a trigger command (group or select) is sent to the HP 5316B while under remote control, and the HP 5316B is currently making a measurement, a new measurement will begin but the gate time is shortened. The gate time will be *approximately* the amount of time remaining from the interupted measurement. The resolution obtained will be correct for the shortened gate time.
4. If a slope command is sent to the HP 5316B and no previous function command was sent, the HP 5316B will default to Frequency A.
5. If new commands are sent to the HP 5316B while it is waiting to output data (WA1 is active), the new commands will not become active until the data is read from the counter (HP 5316B addressed to talk).
6. The HP 5316B will remember the trigger level values set during remote control when sent to local. However, if the front panel Reset is pressed while in Local, the trigger level values stored will default to nominal zero and the Trigger Level/DAC selection will default to TRØ (front panel control).
7. When writing instructions, the HP 5316B will generally ignore the delimiters in the instruction string, as long as they occur BETWEEN complete instructions.
8. To enable Service Request, BOTH WA1 and SR1 must be sent. WA1 can be used alone if Service Request is not desired.

Table 3-6. HP-IB Program Code Set

RE Reset — Display blanks and a new measurement is made.

IN Initialize — HP 5316B goes to default state, which is the same as sending the following codes:
FN1 ASØ BSØ TRØ WAØ SRØ GAØ
(noted in **bold**)

ASØ A channel triggers on POSITIVE slope of signal.
AS1 A channel triggers on NEGATIVE slope of signal.
BSØ B channel triggers on POSITIVE slope of signal.
BS1 B channel triggers on NEGATIVE slope of signal.
WAØ Continuous gating mode, output only if addressed.
WA1 Gate once, wait for talk address to output data, then make new measurement.
SRØ HP 5316B WILL NOT pull SRQ at end of measurement.
SR1 HP 5316B WILL pull SRQ at end of measurement (must be in wait state *WA1*).
GAØ Gate time range is LONG, controlled by front knob.
GA1 Gate time range is SHORT, controlled by front knob.
GA2 Gate time range is LONG, controlled by rear panel adjustment.
GA3 Gate time range is SHORT, controlled by rear panel adjustment.
Long gate time range — 60 ms to 10 s, typical.
Short gate time range — 500 μs to 30 ms, typical.
TRØ The A and B trigger levels are set by front panel controls.
TR1 Enables the A and B trigger levels to be set remotely via HP-IB. If no numeric AT or BT comman is sent, trigger level is zero volts DC nominal.

AT (value) A Channel Trigger Level
BT (value) B Channel Trigger Level
Trigger levels can be set from -2.50V dc to +2.50V dc in steps of 0.01V dc. Format for the voltage value can be any of

X	+X.XX
X.XX	-X.XX
+X.X	X.X
-X	+X
-X.X	

Measurement Functions:
FNØ ROLLING DISPLAY TEST -- other panel.
FN1 FREQUENCY A
FN2 T.I. A→B
FN3 T.I. DELAY
FN4 RATIO A/B
FN5 FREQUENCY C
FN6 TOTALIZE STOP
FN7 PERIOD A
FN8 T.I. AVERAGE A→B
FN9 CHECK 10.00 MHz — other panel
FN1Ø A GATED BY B (trigger slope controlled by commands AS and BS or by front panel).
FN11 GATE TIME — other panel
FN12 TOTALIZE START
FN13 FREQUENCY A, AVERAGED, ARMED BY B
FN13 sets the B channel START arming slope to positive trigger. The STOP slope is determined by sending BSØ or BS1. The A channel slope is determined by ASØ or AS1.
FN14 FREQUENCY A, AVERAGED, ARMED BY B
Same as FN13 except the B channel START arming slope is negative.
FN16 HP-IB INTERFACE TEST (Used in the HP-IB verification in Section IV). other panel

DATA OUTPUT SPEED:
7 readings/second maximum — Long Gate Time.
10 readings/second maximum — Short Gate Time.

Note: As soon as a command is sent to the HP 5316B a new measurement is triggered.

Placing the GATE TIME/DELAY control in the HOLD position will cause the bus to stop all operations whenever an attempt is made to read data from the HP 5316B.

SECTION IV
PERFORMANCE TESTS

4-1. INTRODUCTION

4-2. The procedure in this section tests the electrical performance of the HP 5316B using the specifications in *Table 1-1* as the performance standards. The complete performance tests are given in *Tables 4-1* and *4-2*. All tests can be performed without access to the inside of the instrument.

4-3. OPERATIONAL VERIFICATION

4-4. The abbreviated checks given in *Table 4-1* can be performed to give a high degree of confidence that the HP 5316B is operating properly without performing the complete performance tests. The operational verification should be useful for incoming QA, routine maintenance, and after instrument repair. *Table 4-1* consists of the following:

I. Self-Check
II. Channel A Frequency Response/Sensitivity
III. Channel B Frequency Response/Sensitivity and Ratio A/B
IV. Time Interval and Time Interval Average
V. Totalize

NOTE

The set-up conditions listed in **BOLD** indicate only those controls have changed position from the previous test.

4-5. PERFORMANCE TESTS

4-6. The performance tests consist of all the tests given in this section as listed below and in *Table 4-2*. These tests verify the specifications in *Table 1-1*. All tests can be performed without access to the interior of the instrument.

I. Display Test
II. Self-Check
III. Channel A Frequency Response/Sensitivity
IV. Channel B Frequency Response/Sensitivity and Ratio A/B
V. Period A
VI. A By B
VII. Time Interval and Time Interval Average
VIII. Totalize
IX. Gate Time
X. External Reference Oscillator
XI. Time Interval Delay
XII. Channel C Frequency Response/Sensitivity

4-7. EQUIPMENT REQUIRED

4-8. Equipment required for the complete test and operational verification is listed in *Table 1-4*. Any equipment which satisfies the critical specification given in the table may be substituted for recommended model numbers.

4-9. TEST RECORD

4-10. Results of the operational verification and performance test may be tabulated on the test cards located at the end of the procedure.

Table 4-1. Operational Verification

The following tests will be performed:

I. SELF-CHECK
II. CHANNEL A FREQUENCY RESPONSE/SENSITIVITY
III. CHANNEL B FREQUENCY RESPONSE/SENSITIVITY AND RATIO A/B
IV. TIME INTERVAL AND TIME INTERVAL AVERAGE
V. TOTALIZE

I. SELF-CHECK

a. Set-Up:

POWER SWITCH ..... ON (IN)
FUNCTION SELECT ..... T.I. DELAY/CHECK
FUNCTION SET (Blue Shift Key) ..... IN

b. Verify the HP 5316B displays 10 MHz, with display resolution controlled by the Gate Time control knob. Resolution should increase with gate time.

c. Record the results on the test card (PASS/FAIL).

II. CHANNEL A FREQUENCY RESPONSE/SENSITIVITY

a. Specifications: 0.1 Hz to 100 MHz.

1. 10 mV rms, sine wave 0.1 Hz–10 MHz, dc coupled.
2. 10 mV rms, sine wave 30 Hz–10 MHz, ac coupled.
3. 25 mV rms, sine wave 10–100 MHz, ac or dc coupled.

b. Set-Up:

FUNCTION SELECT ..... **FREQ A/PER A**
FUNCTION SET (Blue Shift Key) ..... **OUT**
GATE TIME/DELAY control ..... fully CCW, but not in HOLD
CHANNELS A&B TRIG LVL/SENS controls ..... MAX (CW)
CHANNELS A&B TRIGGER LEVEL/SENSITIVITY ..... SENS (IN)
CHANNELS A&B SLOPES ..... POS (OUT)
CHANNELS A&B AC/DC ..... DC (IN)
CHANNELS A&B ATTN X1/X20 ..... X1 (OUT)
FILTER NORM/100 kHz ..... FILTER NORM (OUT)
SEP/COM A ..... SEP (OUT)

c. Connect an HP 3325A Synthesizer/Function Generator, through a 50-ohm feedthrough, to the HP 5316B Channel A Input BNC connector.

d. Set the HP 3325A for 1 Hz, and then 10 MHz at 10 mV rms. Verify the HP 5316B displays the correct frequencies.

e. Replace the HP 3325A with an HP 8656B Signal Generator. Set the HP 8656B to 50 MHz and then 100 MHz at 25 mV rms. Verify the HP 5316B displays the correct frequencies.

f. Record the results on the test card (PASS/FAIL).

III. CHANNEL B FREQUENCY RESPONSE/SENSITIVITY AND RATIO A/B

a. Specifications: 0.1 Hz to 100 MHz.

1. 10 mV rms, sine wave 0.1 Hz–10 MHz, dc coupled.
2. 10 mV rms, sine wave 30 Hz–10 MHz, ac coupled.
3. 25 mV rms, sine wave 10–100 MHz, ac or dc coupled.

b. Set-Up:

FUNCTION SELECT ..... **RATIO A/B — A BY B**
FUNCTION SET (Blue Shift Key) ..... OUT
GATE TIME/DELAY control ..... fully CCW, but not in HOLD
CHANNELS A&B TRIG LVL/SENS controls ..... MAX (CW)
CHANNELS A&B TRIGGER LEVEL/SENSITIVITY ..... SENS (IN)
CHANNELS A&B SLOPES ..... POS (OUT)
CHANNEL A AC/DC ..... **AC (OUT)**
CHANNEL B AC/DC ..... DC (IN)
CHANNELS A&B ATTN X1/X20 ..... X1 (OUT)
FILTER NORM/100 kHz ..... FILTER NORM (OUT)
SEP/COM A ..... SEP (OUT)

Table 4-1. Operational Verification (Continued)

c. Connect an HP 3325A Synthesizer/Function Generator, through a 50-ohm feedthrough, to the HP 5316B Channel B Input BNC. Connect the HP 3325A front panel SYNC OUT, through a 50-ohm feedthrough, to the HP 5316B Channel A Input BNC.

d. Set the HP 3325A to 30 Hz at 10 mV rms. Verify the HP 5316B displays: 1.

e. Set the HP 3325A to 10 MHz at 10 mV rms. Verify the HP 5316B displays: 1.000000.

f. Replace the HP 3325A with an HP 8656B Signal Generator. Connect the HP 8656B front panel RF OUT, through a 50-ohm feedthrough, to the HP 5316B Channel B Input BNC. Connect the HP 8656B rear panel AUX OUTPUT, through a 50-ohm feedthrough, to the HP 5316B Channel A Input BNC.

g. Set the HP 8656B to 100 MHz at 25 mV rms. The HP 5316B should have a stable display of: 1.0000000.

h. Record the results on the test card (PASS/FAIL).

IV. TIME INTERVAL AND TIME INTERVAL AVERAGE

NOTE

The HP 5316B and 3325A time bases shall be locked together. Connect the HP 5316B rear panel REF IN/OUT to the 3325A EXT REF IN. The HP 5316B INT/EXT switch remains in INT. If the 3325A has Option 001 Hight Stability Frequency Reference, the rear panel external jumper between the 10 MHz OUT and the EXT REF IN must be removed before connecting the HP 5316B reference signal.

a. Specifications:

1. Time Interval 100 ns to 10^5 seconds.
2. Time Interval Average 0 ns to 10^5 seconds.

b. Set-Up:

FUNCTION SELECT ..... **T.I. A-B/T.I. AVG A-B**
FUNCTION SET (Blue Shift Key) ..... OUT
GATE TIME/DELAY control ..... fully CCW, but not in HOLD
CHANNELS A&B TRIG LVL/SENS controls ..... MAX (CW)
CHANNELS A&B TRIGGER LEVEL/SENSITIVITY ..... SENS (IN)
CHANNEL A SLOPE ..... POS (OUT)
CHANNEL B SLOPE ..... **NEG (IN)**
CHANNEL A&B AC/DC ..... **DC (IN)**
CHANNEL A ATTN X1/X20 ..... X1 (OUT)
FILTER NORM/100 kHz ..... FILTER NORM (OUT)
SEP/COM A ..... **COM A (IN)**

c. Connect an HP 3325A Synthesizer/Function Generator, through a 50-ohm feedthrough, to the HP 5316B Channel A Input BNC.

d. Set the HP 3325A to 500.013 kHz square wave at 300 mV p-p. The HP 5316B display should read 1.0 E-6s ±1 count.

e. Press Function Set (Blue Shift Key) IN. The HP 5316B display should read 1.000 E-6s ±5 ns.

f. Change the Channel B Slope to Positive (OUT). The display should read either 2.000 E-6s ±5 ns or 0 E-9s ±5 ns.

g. Change the Channel A Slope to Negative (IN). The HP 5316B display should read 1.000 E-6s ±5 ns.

h. Change the Channel B Slope to Negative (IN). The HP 5316B display should read 0. E-9 ±5 ns or 2.000 E-6s ±5 ns.

i. Record the results on the test card (PASS/FAIL).

Table 4-1. Operational Verification (Continued)

V. TOTALIZE

a. Specification: 0 to 100 MHz.

b. Set-Up:

FUNCTION SELECT ..... **TOT STOP/TOT START**
FUNCTION SET (Blue Shift Key) ..... **OUT**
GATE TIME/DELAY control ..... fully CCW, but not in HOLD
CHANNELS A&B TRIG LVL/SENS controls ..... MAX (CW)
CHANNELS A&B TRIGGER LEVEL/SENSITIVITY ..... SENS (IN)
CHANNELS A&B SLOPES ..... **POS (OUT)**
CHANNELS A&B AC/DC ..... DC (IN)
CHANNELS A&B ATTN X1/X20 ..... X1 (OUT)
FILTER NORM/200 kHz ..... FILTER NORM (OUT)
SEP/COM A ..... **SEP (OUT)**

c. Connect an HP 3325A Synthesizer/Function Generator, through a 50-ohm feedthrough, to the HP 5316B Channel A Input BNC.

d. Set the HP 3325A to 1 Hz at 100 mV rms. The HP 5316B display should read 0.

e. Press the Function Set (Blue Shift Key) IN. Verify the HP 5316B is counting at a 1-count/second rate. The trigger LED will also flash at this rate.

f. Release the Function Set (Blue Shift Key). The HP 5316B should display the total number of pulses counted. The GATE light should be off.

g. Record the results on the test card (PASS/FAIL).

OPERATIONAL VERIFICATION TEST CARD

HEWLETT-PACKARD MODEL 5316B
UNIVERSAL COUNTER

Test Performed By _____

Serial Number _____ Date _____

DESCRIPTION	CHECK
I. SELF-CHECK	_____
II. CHANNEL A FREQUENCY RESPONSE/SENSITIVITY	_____
III. CHANNEL B FREQUENCY RESPONSE/SENSITIVITY/RATIO	_____
IV. TIME INTERVAL AND TIME INTERVAL AVERAGE	_____
V. TOTALIZE	_____

Table 4-2. HP 5316B In-Cabinet Performance Test

The following tests will be included:

I. DISPLAY TEST
II. SELF-CHECK
III. GATE TIME
IV. CHANNEL A FREQUENCY RESPONSE/SENSITIVITY
V. CHANNEL B FREQUENCY RESPONSE/SENSITIVITY AND RATIO A/B
VI. PERIOD A
VII. A BY B
VIII. TIME INTERVAL AND TIME INTERVAL AVERAGE
IX. TOTALIZE
X. EXTERNAL REFERENCE OSCILLATOR
XI. TIME INTERVAL DELAY
XII. CHANNEL C FREQUENCY RESPONSE/SENSITIVITY

I. DISPLAY TEST

a. Turn the HP 5316B power ON. Place all FUNCTION SELECT switches in the OUT position, including the Function Set (Blue Shift Key).

b. Refer to paragraph 3-33 and verify that rolling display is correct.

c. Record the results on the test card (PASS/FAIL).

II. SELF-CHECK

a. Set-Up:

FUNCTION SELECT ..... **T.I. DELAY/CHECK**
FUNCTION SET (Blue Shift Key) ..... **IN**

b. Verify the HP 5316B displays 10 MHz, with display resolution controlled by the GATE TIME control knob. The resolution should increase with Gate Time.

c. Record results on the test card (PASS/FAIL).

III. CHANNEL A FREQUENCY RESPONSE AND SENSITIVITY

a. Specifications: 0.1 Hz to 100 MHz.

1. 10 mV rms, sine wave 0.1 Hz–10 MHz, dc coupled.
2. 10 mV rms, sine wave 30 Hz-10 MHz, ac coupled.
3. 25 mV rms, sine wave 10–100 MHz, ac and dc coupled.

b. Set-Up:

FUNCTION SELECT ..... **FREQ A/PER A**
FUNCTION SET (Blue Shift Key) ..... **OUT**
GATE TIME/DELAY control ..... fully CCW, but not in HOLD
CHANNELS A&B TRIG LVL/SENS controls ..... MAX (CW)
CHANNELS A&B TRIGGER LEVEL/SENSITIVITY ..... SENS (IN)
CHANNELS A&B SLOPES ..... POS (OUT)
CHANNELS A&B AC/DC ..... DC (IN)
CHANNELS A&B ATTN X1/X20 ..... X1 (OUT)
FILTER NORM/100 kHz ..... FILTER NORM (OUT)
SEP/COM A ..... SEP (OUT)

c. Connect an HP 3325A Synthesizer/Function Generator, through a 50-ohm feedthrough, to the HP 5316B Channel A Input BNC.

d. Set the HP 3325A to the following frequencies at 10 mV rms: 0.1 Hz, 10 Hz, 30 Hz, and 100 Hz.

e. The HP 5316B should correctly display all frequencies in this range. (For the readings of 0.1 Hz to 0.141 Hz, the OVFL light will be ON and the most significant digit "1" will not be displayed).

f. Set the Channel A AC/DC switch to AC (OUT). While maintaining a 10 mV amplitude, set the 3325A to 30 Hz, 100 Hz, 500 kHz, and 10 MHz. Verify the HP 5316B displays the proper frequencies.

g. Set the HP 3325A to 30 Hz at 1 mV rms. Increase the amplitude of the input signal until the HP 5316B displays a stable count of 30 Hz.

Table 4-2. HP 5316B In-Cabinet Performance Test (Continued)

h. Record on the test card the minimum amplitude at which the HP 5316B displays a stable count (VALUE).

i. Set Channel A to DC coupled (IN).

j. Replace the 3325A with the HP 8656B Signal Generator. Set the 8656B to 50 MHz, 75 MHz, and 100 MHz. Maintain an amplitude of 25 mV rms. The HP 5316B should correctly display all frequencies in this range.

k. Set the HP 8656B to 100 MHz to 5 mV rms. Increase the amplitude of the HP 8656B until the HP 5316B displays a stable count of 100 MHz.

l. Record on the test card the minimum amplitude at which the HP 5316B displays a stable count (VALUE).

IV. CHANNEL B FREQUENCY RESPONSE/SENSITIVITY AND RATIO A/B

a. Specifications: 0.1 Hz to 100 MHz.

1. 10 mV rms, sine wave 0.1 Hz–10 MHz, dc coupled.
2. 10 mV rms, sine wave 30 Hz–10 MHz, ac coupled.
3. 25 mV rms, sine wave 10–100 MHz.

b. Set-Up:

FUNCTION SELECT ..... **RATIO A/B — A BY B**
FUNCTION SET (Blue Shift Key) ..... OUT
GATE TIME/DELAY control ..... fully CCW, but not in HOLD
CHANNELS A&B TRIG LVL/SENS controls ..... MAX (CW)
CHANNELS A&B TRIGGER LEVEL/SENSITIVITY ..... SENS (IN)
CHANNELS A&B SLOPES ..... POS (OUT)
CHANNEL A AC/DC ..... AC (OUT)
CHANNEL B AC/DC ..... DC (IN)
CHANNEL A ATTN X1/X20 ..... X1 (OUT)
FILTER NORM/100 kHz ..... FILTER NORM (OUT)
SEP/COM A ..... SEP (OUT)

c. Connect an HP 3325A Synthesizer/Function Generator, through a 50-ohm feedthrough to the HP 5316B Channel B Input BNC. Connect the HP 3325A front panel SYNC OUT, through a 50-ohm feedthrough, to the HP 5316B Channel A Input BNC.

d. Set the HP 3325A to 10 Hz, 30 Hz, and 10 MHz at 10 mV rms. The HP 5316B should display a stable ratio of 1. to 1.000000 through the frequency range.

e. Change Channel B to AC coupled (OUT). Maintaining the 10 mV rms amplitude, set the HP 3325A to 30 Hz, 100 Hz, 500 kHz, and 10 MHz. Verify the HP 5316B displays: 1. to 1.000000.

f. Replace the HP 3325A with an HP 8656B Signal Generator. Connect the HP 8656B front panel RF OUT, through a 50-ohm feedthrough, to the HP 5316B Channel B input BNC. Connect the HP 8656B rear panel AUX OUT, through a 50-ohm feedthrough, to the HP 5316B Channel A Input BNC.

g. Set Channel B to DC coupled (IN).

h. While maintaining a 25 mV amplitude, set the HP 8656B to 50 MHz, 75 MHz, and 100 MHz. The HP 5316B should display a stable ratio from 1.000000 to 1.0000000 throughout this frequency range.

i. Record the results on the test card (PASS/FAIL).

V. PERIOD A

a. Specification: 10 ns–10^5 seconds.

b. Set-Up:

FUNCTION SELECT ..... **FREQ A/PER A**
FUNCTION SET (Blue Shift Key) ..... **IN**
GATE TIME/DELAY control ..... fully CCW, but not in HOLD
CHANNELS A&B TRIG LVL/SENS controls ..... MAX (CW)
CHANNELS A&B TRIGGER LEVEL/SENSITIVITY ..... SENS (IN)
CHANNELS A&B SLOPES ..... POS (OUT)
CHANNELS A&B AC/DC ..... **AC (OUT)**
CHANNEL A ATTN X1/X20 ..... X1 (OUT)
FILTER NORM/100 kHz ..... FILTER NORM (OUT)
SEP/COM A ..... SEP (OUT)

Table 4-2. HP 5316B In-Cabinet Performance Test (Continued)

c. Connect an HP 8656B to HP 5316B Channel A Input BNC with a 50-ohm feedthrough. Set the HP 8656B to 10 MHz and 100 MHz at 100 mV rms. The HP 5316B should display: 100 ns at 10 MHz and 10 ns at 100 MHz.

d. Record the results on the test card (PASS/FAIL).

VI. A BY B

a. Set-Up:

FUNCTION SELECT ..... **RATIO A/B — A BY B**
FUNCTION SET (Blue Shift Key) ..... IN
GATE TIME/DELAY control ..... fully CCW, but not in HOLD
CHANNELS A&B TRIG LVL/SENS controls ..... MAX (CW)
CHANNELS A&B TRIGGER LEVEL/SENSITIVITY ..... SENS (IN)
CHANNELS A&B SLOPES ..... POS (OUT)
CHANNELS A&B AC/DC ..... **DC (IN)**
CHANNELS A&B ATTN X1/X20 ..... X1 (OUT)
FILTER NORM/100 kHz ..... FILTER NORM (OUT)
SEP/COM A ..... SEP (OUT)

b. Connect the HP 3325A rear panel 1 MHz REF OUT, through a 50-ohm feedthrough to the Channel A Input BNC.

c. Set the HP 3325A Synthesizer/Function Generator to 10 kHz square wave at 1.00 mV p-p. Connect the output of the HP 3325A to the CHANNEL B input BNC through a 50-ohm feedthrough.

d. Verify the Channel A and B Trigger lights are flashing.

e. Press the HP 5316B front panel RESET. The HP 5316B should display 100 ±1 count.

f. Record the results on the test card (PASS/FAIL).

VII. TIME INTERVAL AND TIME INTERVAL AVERAGE

NOTE

The HP 5316B and 3325A time bases shall be locked together. Connect the HP 5316B rear panel REF IN/OUT to the 3325A EXT REF IN. The HP 5316B INT/EXT switch remains in INT. If the 3325A has Option 001 High Stability Frequency Reference, the rear panel external jumper between the 10 MHz OUT and the EXT REF IN must be removed before connecting the HP 5316B reference signal.

a. Specifications:

1. Time Interval: 100 ns to 10^5 seconds.
2. Time Interval Average: 0 ns to 10^5 seconds.

b. Set-Up:

FUNCTION SELECT ..... **T.I. A-B/T.I. AVG A-B**
FUNCTION SET (Blue Shift Key) ..... **OUT**
GATE TIME/DELAY control ..... fully CCW, but not in HOLD
CHANNELS A&B TRIG LVL/SENS controls ..... MAX (CW)
CHANNELS A&B TRIGGER LEVEL/SENSITIVITY ..... SENS (IN)
CHANNEL A SLOPE ..... POS (OUT)
CHANNEL B SLOPE ..... **NEG (IN)**
CHANNELS A&B AC/DC ..... DC (IN)
CHANNELS A&B ATTN X1/X20 ..... X1 (OUT)
FILTER NORM/100 kHz ..... FILTER NORM (OUT)
SEP/COM A ..... **COM A (IN)**

c. Connect an HP 3325A Synthesizer/Function Generator, through a 50-ohm feedthrough, to the HP 5316B Channel A Input BNC.

d. Set the HP 3325A to 500.013 kHz square wave at 300 mV p-p. The HP 5316B should display 1.0 E-6s ±1 count.

e. Press Function Set (Blue Shift Key) IN. The HP 5316B should display 1.000 E-6s ±5 ns.

f. Change the Channel B Slope to Positive (OUT). The HP 5316B should display either 2.000 E-6s ±5 ns or 0.E-9s ±5 ns.

Table 4-2. HP 5316B In-Cabinet Performance Test (Continued)

g. Change the Channel A Slope to Negative (IN). The HP 5316B should display 1.000 E-6s ±5 ns.

h. Change the Channel B Slope to Negative (IN). The HP 5316B should display 0 E-9 ±5 ns, or 2.000 E-6 ±5 ns.

i. Record the results on the test card (PASS/FAIL).

VIII. TOTALIZE

a. Specification: 0 to 100 MHz.

b. Set-Up:

FUNCTION SELECT ..... **TOT STOP/TOT START**
FUNCTION SET (Blue Shift Key) ..... **OUT**
GATE TIME/DELAY control ..... fully CCW, but not in HOLD
CHANNELS A&B TRIG LVL/SENS controls ..... MAX (CW)
CHANNELS A&B TRIGGER LEVEL/SENSITIVITY ..... SENS (IN)
CHANNELS A&B SLOPES ..... POS (OUT)
CHANNELS A&B AC/DC ..... DC (IN)
CHANNELS A&B ATTN X1/X20 ..... X1 (OUT)
FILTER NORM/100 kHz ..... FILTER NORM (OUT)
SEP/COM A ..... **SEP (OUT)**

c. Connect an HP 3325A Synthesizer/Function Generator, through a 50-ohm feedthrough, to the HP 5316B Channel A Input BNC.

d. Set the HP 3325A to 1 Hz at 100 mV rms. The HP 5316B should display 0.

e. Press the Function Set (Blue Shift Key) IN. Verify the HP 5316B is counting at a 1 count/second rate. The trigger LED will also flash at this rate.

f. Release the Function Set (Blue Shift Key) OUT. The HP 5316B should display the total number of pulses counted. The GATE light should be OFF.

g. Record the results on the test card (PASS/FAIL).

IX. GATE TIME

a. Set the Function Select to FREQ C/GATE TIME, and the Function Set (Blue Shift Key) IN. Vary Gate time pot from Min (CCW but not HOLD) to MAX (CW). The HP 5316B should display:

60 ms to 10 seconds nominal

b. Set the Gate Time control to HOLD (detent). The HP 5316B should stop gating and hold the last measurement. The Gate Light should be OFF.

c. Record the results on the test card (PASS/FAIL).

X. EXTERNAL REFERENCE OSCILLATOR

a. Set-Up:

FUNCTION SELECT ..... **FREQ A/PER A**
FUNCTION SET (Blue Shift Key) ..... **OUT**
GATE TIME/DELAY control ..... **fully CCW, but not in HOLD**
CHANNELS A&B TRIG LVL/SENS controls ..... MAX (CW)
CHANNELS A&B SLOPE ..... POS (OUT)
CHANNELS A&B TRIGGER LEVEL/SENSITIVITY ..... SENS (IN)
CHANNELS A&B AC/DC ..... **AC (OUT)**
CHANNELS A&B ATTN X1/X20 ..... X1 (OUT)
FILTER NORM/100 kHz ..... FILTER NORM (OUT)
SEP/COM A ..... SEP (OUT)

b. Connect the HP 3325A through a 50-ohm feedthrough to HP 5316B rear panel REF IN/OUT BNC. Connect HP 3325A front panel SYNC OUT, through a 50-ohm feedthrough, to the Channel A Input BNC. Set the HP 5316B rear panel REFERENCE INT/EXT switch to EXT.

c. Adjust the HP 3325A for 10 MHz at 1 volt rms.

d. Verify the HP 5316B display reads EXACTLY 10 MHz.

Table 4-2. HP 5316B In-Cabinet Performance Test (Continued)

e. Repeat steps c and d for 5 MHz and 1 MHz. The display should read EXACTLY 5 MHz and 1 MHz, respectively.

f. Record the results on the test card (PASS/FAIL).

g. Set the HP 5316B rear panel REFERENCE INT/EXT switch back to INT.

XI. TIME INTERVAL DELAY

a. Specification:

Variable delay: 500 μs to 20 ms (nominal) between Channel A START and the enabling of Channel B STOP.

b. Set-Up:

FUNCTION SELECT ..... **T.I. DELAY/CHECK**
FUNCTION SET (Blue Shift Key) ..... OUT
GATE TIME/DELAY control ..... fully CCW, but not in HOLD
CHANNELS A&B TRIG LVL/SENS ..... MAX (CW)
CHANNELS A&B TRIGGER LEVEL/SENSITIVITY ..... SENS (IN)
CHANNELS A&B AC/DC COUPLING ..... AC (OUT)
CHANNEL A SLOPE ..... POS (OUT)
CHANNEL B SLOPE ..... **NEG (IN)**
CHANNELS A&B ATTN X1/X20 ..... X1 (OUT)
FILTER NORM/100 kHz ..... FILTER NORM (OUT)
SEP/COM A ..... **COM A (IN)**

c. Connect an HP 3325A Synthesizer/Function Generator, through a 50-ohm feedthrough, to the HP 5316B Channel A Input BNC.

d. Set the HP 3325A to 250 Hz at 100 mV rms. Verify the Channels A and B Trigger Lights are flashing.

e. The HP 5316B should display: 2 E-3.

f. Slowly increase the GATE TIME control CW. The HP 5316B should jump from 2 E-3s to 6 E-3s and continue to increase in 4 ms steps to greater than 20 ms.

g. Record the results on the test card (PASS/FAIL).

XII. CHANNEL C FREQUENCY RESPONSE AND SENSITIVITY

a. Specifications:

1. 15 mV rms (-23.5 dBm), 50-650 MHz.
2. 75 mV rms (-9.5 dBm), 650 MHz-1 GHz.

b. Set the HP 5316B front panel controls as follows:

FUNCTION SELECT ..... **FREQ C/GATE TIME (IN)**
FUNCTION SET (Blue Shift Key) ..... (OUT)
GATE TIME/DELAY control ..... **fully CCW, but not in HOLD**
CHANNEL A TRIGGER LVL/SENS C ..... fully CW

c. Connect the HP 8660C/86602A Synthesized Signal Generator, the HP 436A Power Meter, and the HP 5316B as shown in *Figure 4-1*.

d. Set the HP 8660C Signal Generator to 50 MHz. Set output level for -13.5 dBm on the HP 436A Power Meter. Verify the HP 5316B gates and displays the 50 MHz. Repeat for 150 MHz, 350 MHz, and 650 MHz.

e. Increase the HP 8660C output level for +.5 dBm on the HP 436A Power Meter. Verify the HP 5316B gates and displays the proper frequency. Repeat for 900 MHz and 1000 MHz.

f. Record the results on the test card (PASS/FAIL).

PERFORMANCE TEST RECORD (Page 1 of 4)

HEWLETT-PACKARD MODEL 5316B
UNIVERSAL COUNTER

Serial Number: _____ **Repair/Work Order No.** _____

Test Performed By: _____ **Temperature:** _____

Date: _____ **Relative Humidity:** _____

Notes: _____ **Post Calibration Test:** ☐

Pre Calibration Test: ☐

PARA. NO.	TEST	CORRECT DISPLAY	RESULTS PASS	RESULTS FAIL	RESULTS ACTUAL
I.	**DISPLAY TEST**				
		Rolling Display	_____	_____	
II.	**SELF-CHECK**				
		10 MHz Resolution	_____	_____	
		Increases with Gate Time	_____	_____	
III.	**CHANNEL A FREQUENCY RESPONSE AND SENSITIVITY**				
	DC Coupled:				
	.1 Hz @ 10 mV rms	Stable Count	_____	_____	
	10 Hz @ 10 mV rms	Stable Count	_____	_____	
	30 Hz @ 10 mV rms	Stable Count	_____	_____	
	100 Hz @ 10 mV rms	Stable Count	_____	_____	
	AC Coupled:				
	30 Hz @ 10 mV rms	Stable Count	_____	_____	
	100 Hz @ 10 mV rms	Stable Count	_____	_____	
	500 kHz @ 10 mV rms	Stable Count	_____	_____	
	10 MHz @ 10 mV rms	Stable Count	_____	_____	
				MINIMUM	
	30 Hz @ Minimum Amplitude AC Coupled			≥10 mV rms	_____
				FAIL	
	DC Coupled:				
	50 MHz @ 25 mV rms	Stable Count	_____	_____	
	75 MHz @ 25 mV rms	Stable Count	_____	_____	
	100 MHz @ 25 mV rms	Stable Count	_____	_____	
				MINIMUM	
	100 Hz @ Minimum Amplitude			≥10 mV rms	_____

HP 5316B PERFORMANCE TEST RECORD (Page 2 of 4)

PARA. NO.	TEST	CORRECT DISPLAY	RESULTS PASS	RESULTS FAIL	
IV.	**CHANNEL B FREQUENCY RESPONSE/SENSITIVITY AND RATIO A/B**				
	DC Coupled:				
	10 Hz @ 10 mV rms	Stable Count	_____	_____	
	30 Hz @ 10 mV rms	Stable Count	_____	_____	
	10 MHz @ 10 mV rms	Stable Count	_____	_____	
	AC Coupled:				
	30 Hz @ 10 mV rms	Stable Count	_____	_____	
	100 Hz @ 10 mV rms	Stable Count	_____	_____	
	500 kHz @ 10 mV rms	Stable Count	_____	_____	
	10 MHz @ 10 mV rms	Stable Count	_____	_____	
	DC Coupled:				
	50 MHz @ 25 mV rms	Stable Count	_____	_____	
	75 MHz @ 25 mV rms	Stable Count	_____	_____	
	100 MHz @ 25 mV rms	Stable Count	_____	_____	
V.	**PERIOD A**				
	10 MHz @ 100 mV rms	100 ns	_____	_____	
	100 MHz @ 100 mV rms	10 ns	_____	_____	
VI.	**A BY B**				
	Channel A and B Trigger Lights Flashing	Trigger Lights Flashing	_____	_____	
			MINIMUM	**ACTUAL**	**MAXIMUM**
	10 kHz Square Wave @ 100 mV p-p	100	99	_____	101
VII.	**TIME INTERVAL AND TIME INTERVAL AVERAGE**				
	500.013 kHz Square Wave @ 300 mV p-p	1.0 E-6 s	.99 E-6	_____	1.1 E-6
	Display Count	1.000 E-6 s	.995 E-6	_____	1.005 E-6
	Channel B, Positive Slope:				
		2.000 E-6 s	1.995 E-6	_____	2.005 E-6
		0 E-9 s	or 0 E-9	_____	5 E-9
	Channel A, Negative Slope,		.995 E-6	_____	1.005 E-6
	Channel B, Negative Slope:				
		0 E-9	0 E-9	_____	5 E-9
		2.00 E-6 s	or 1.995 E-6	_____	2.005 E-6

HP 5316B PERFORMANCE TEST RECORD (Page 3 of 4)

PARA. NO.	TEST	CORRECT DISPLAY	RESULTS		
					YES/NO
VIII.	**TOTALIZE**				
	Display is 0	0			_____
	Gate Open	Display Upcounts			_____
	Gate Closed	Count Held			_____
			MINIMUM	**ACTUAL**	**MAXIMUM**
IX.	**GATE TIME**				
	Minimum Nominal	60 ms	≤60 ms	_____	
	Maximum Nominal		_____	10 Seconds	
			PASS	**FAIL**	
	Hold	No Gating	_____	_____	
		Display Held	_____	_____	
X.	**EXTERNAL REFERENCE OSCILLATOR**				
	10 MHz	Exactly 10 MHz	_____	_____	
	5 MHz	Exactly 5.000 MHz	_____	_____	
	1 MHz	Exactly 1.0000 MHz	_____	_____	
				ACTUAL	**YES/NO**
XI.	**TIME INTERVAL DELAY**				
	Channel A Trigger Lights	Lights Flashing			_____
	Channel B Trigger Lights	Lights Flashing			_____
	Minimum Delay Displayed	2 E-3		_____	_____
	Display Increments 4 ms Steps			_____	_____
	Maximum Delay, ≤20 ms	≤20 E-3		_____	_____
			PASS	**FAIL**	
XII.	**CHANNEL C FREQUENCY RESPONSE AND SENSITIVITY**				
	50 MHz @ -13.5 dBm	Stable Count	_____	_____	
	150 MHz @ -13.5 dBm	Stable Count	_____	_____	
	350 MHz @ -13.5 dBm	Stable Count	_____	_____	
	650 MHz @ -13.5 dBm	Stable Count	_____	_____	
	900 MHz @ +.5 dBm	Stable Count	_____	_____	
	1000 MHz @ +.5 dBm	Stable Count	_____	_____	

HP 5316B PERFORMANCE TEST RECORD (Page 4 of 4)

PARA. NO.	TEST	CORRECT DISPLAY	RESULTS	
			PASS	FAIL
VIII.	**TOTALIZE (Continued)**			
	Checkpoint 1 HP-IB Interface Test		_____	_____
	Checkpoint 2 Remote Test		_____	_____
	Local Lock Out		_____	_____
	Local		_____	_____
	Checkpoint 3 Frequency A and Ratio A/B Measurement		_____	_____
	Checkpoint 4 Wait State and Service Request		_____	_____
	Checkpoint 5 Remote Trigger Levels		_____	_____
	Checkpoint 6 Gate Time Test		_____	_____
	Checkpoint 7 Channel C Test Option 003		_____	_____

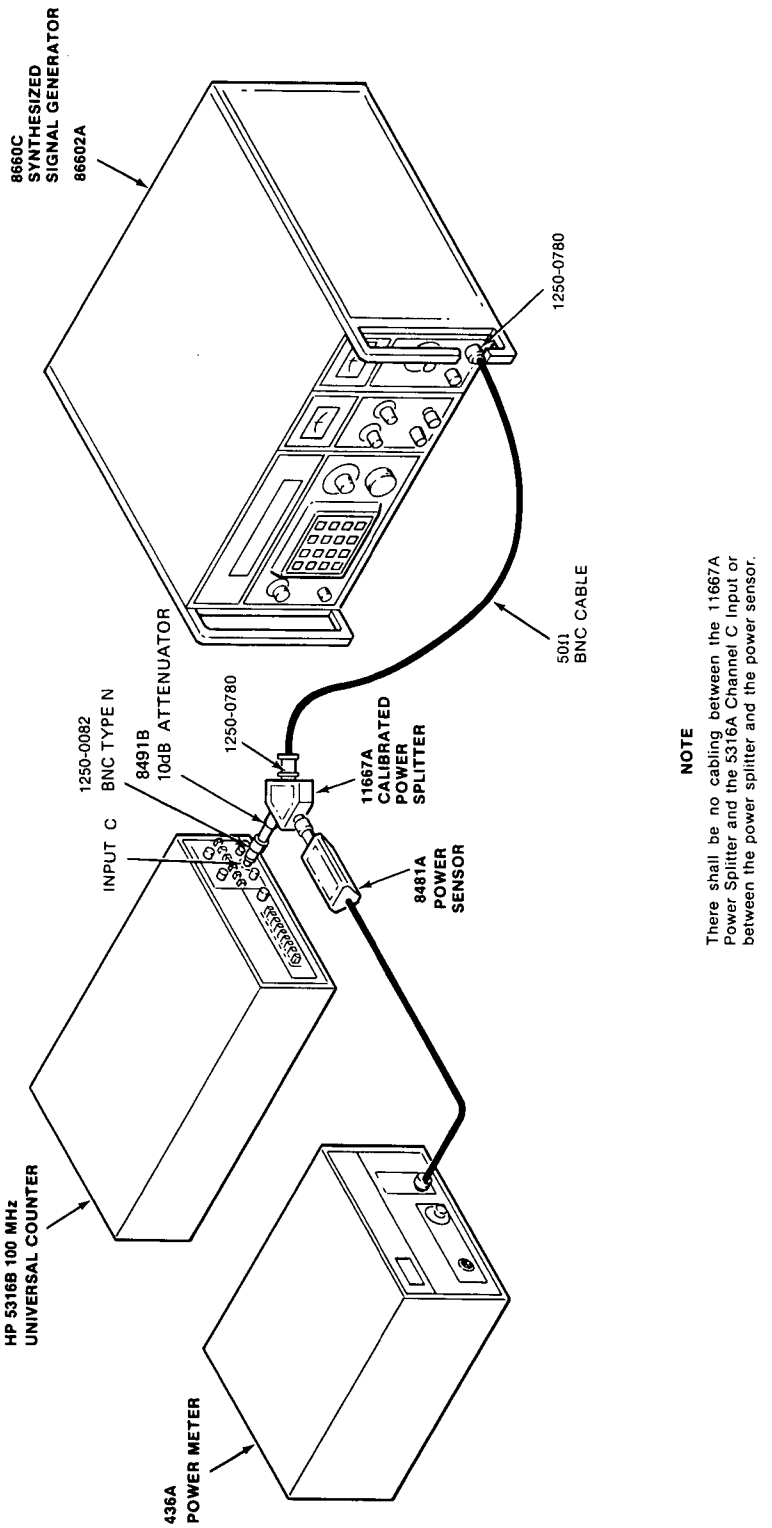


Figure 4-1. Channel C Test Setup

4-11. HP-IB VERIFICATION

4-12. The HP-85 program listed in *Table 4-3* exercises the HP 5316B through its various operating modes via the HP-IB. A checkpoint is also provided for Option 003 C Channel.

NOTE

The HP-IB verification requires an HP-85 controller, 82937A HP-IB Interface Card, 82936A ROM Drawer, and the following ROMs:

00085-1505 Advanced Programming ROM
00085-1503 Input/Output ROM
00085-1502 Plotter/Printer ROM

4-13. Checkpoint 1 is an internal software test between the HP-IB microcomputer, the HP-IB interface, and the HP-85. If the HP 5316B passes this test, there is a high probability that the total HP-IB link is operating properly. (It does not check the Digital-to-Analog Converter, only the capability of the HP 5316B to accept trigger commands.) If Checkpoint 1 is failed, the 82937A Interface may be defective. If the 82937A appears to be operating correctly, suspect A1U4 and/or A1U5. See paragraph 8-56.

4-14. To perform the HP-IB verification, connect the HP 5316B and HP-85 as shown in *Figure 4-2.*

4-15. The program listed in *Table 4-4* may be keyed into the HP-85 or may be loaded from an HP-IB verification cassette, HP Part No. 59300-10002 (Revision H or later) which also contains other HP-IB verification programs for other HP instruments. To run the program, insert the cassette into the HP-85. Turn the power ON. The HP-85 will auto-start and show a menu of available programs. Select HP 5316A/B and proceed as directed by the program messages shown on the HP-85 display screen. The program contains instructions on repeating a program.

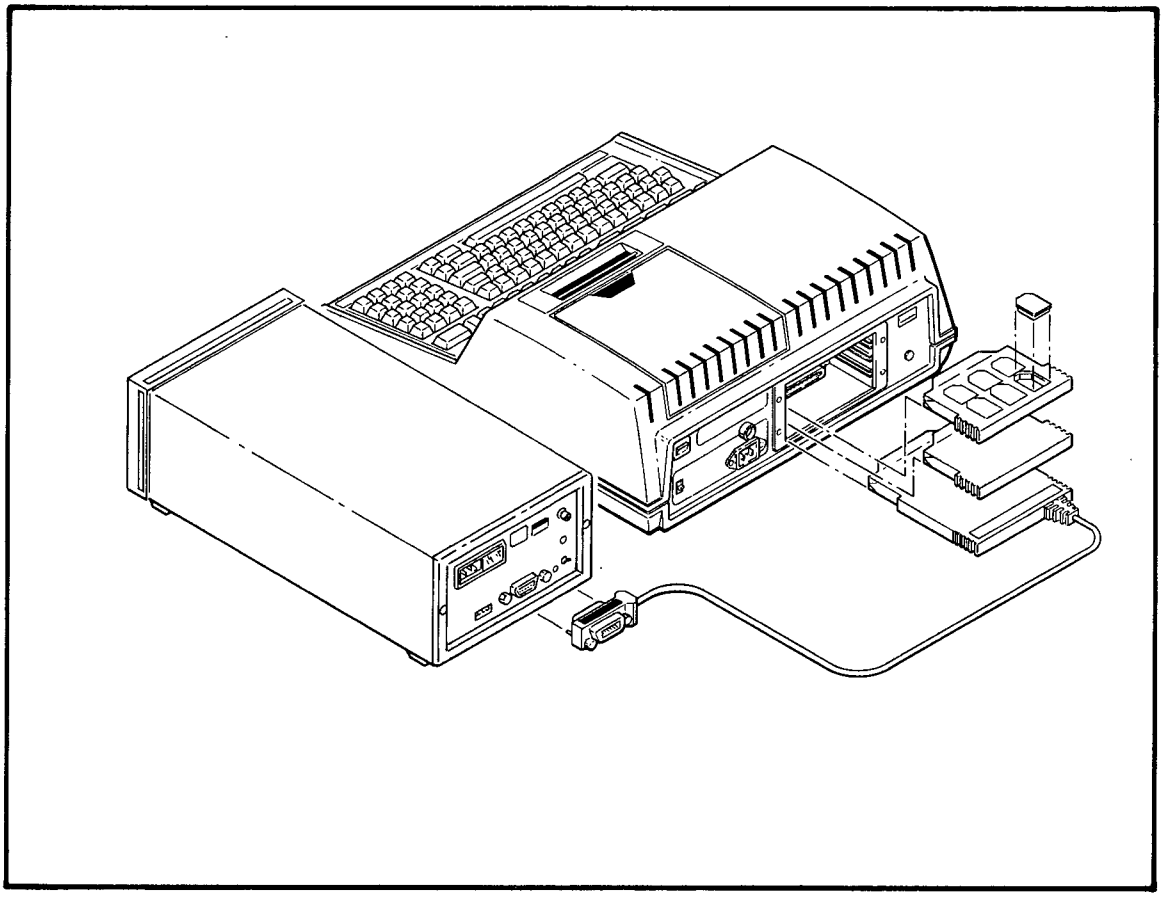


Figure 4-2. HP 5316B and HP85 Connections

Table 4-3. HP-IB Verification

1. Set-Up: Connect the rear panel REF IN/OUT to the Channel A input.

   Set rear panel REF switch to INT.

   SEP/COM A ..... COM (IN)
   FUNCTION SELECT ..... FREQ A/PER A
   CHANNELS A&B TRIG LVL/SENS control ..... MAX (CW)
   GATE TIME/DELAY control ..... fully CCW, but not in HOLD
   CHANNELS A&B TRIGGER LEVEL/SENSITIVITY ..... SENS (IN)
   FUNCTION SET (Blue Shift Key) ..... OUT
   CHANNELS A&B SLOPES ..... POS (OUT)
   CHANNELS A&B AC/DC ..... AC (OUT)
   CHANNEL A ATTN X1/X20 ..... X1 (OUT)
   FILTER NORM/100 kHz ..... FILTER NORM (OUT)

2. Verify the HP 5316B is gating and displaying 10 MHz. Both A and B Channel Trigger lights should be flashing.
3. Press RESET on the HP-85, and then press RUN.
4. Enter the three digit select code (7XX), where 7 is the interface select code and XX is the HP-IB address of the HP 5316B.
5. Press SCRATCH CONT on the HP-85 and check the set-up conditions.

NOTE

Any one of the following conditions could cause the HP-85 to display; *check address/interface*:

1. Wrong address entered on the HP-85
2. 5316A/B is not turned on.
3. Interfacing between the HP-85 and the 5316A/B is defective.

CP#	TEST	PROCEDURE
Checkpoint 1 INTERNAL LINK TEST PASS	HP-IB INTERFACE TEST	None (see paragraph 4-11)

Table 4-3. HP-IB Verification (Continued)

CP#	TEST	PROCEDURE
Checkpoint 2 REMOTE TEST Verify the following HP-IB status lights: ADRSD: on REMOTE: on	REMOTE	A. HP 5316B Remote and Address Lamps should light.
LOCAL LOCKOUT TEST Verify front panel reset does not return counter to local.	LOCAL LOCKOUT	B. HP 5316B Remote and Address Lamps should remain lit. Verify the front panel reset has no effect.
LOCAL TEST Verify the following HP-IB stauts lights: ADRSD: on REMOTE: off	LOCAL	C. HP 5316B should return to LOCAL. Address Lamp should remain lit. Remote Lamp should go OFF. Before continuing, verify the A and B Channel Trigger Lamps are flashing.
Checkpoint 3 BASIC MEASUREMENTS TEST FREQUENCY= F 1.000000E+07 RATIO= 1 PASS	FREQUENCY A AND RATIO A/B MEASUREMENT	Commands sent to the HP 5316B; measurement data is read and printed by the HP-85.
Checkpoint 4 SERVICE REQUEST TEST sra1 = 64 PERIOD = +1.00000000E-07 sra2 = 0 PASS	WAIT STATE AND SERVICE REQUEST	Set gate time control to maximum (cw). A period measurement is made; service is requested; data is read by the HP-85. The status is read before and after each measurement. ADRSD lamp should be on. GATE lamp is on during the measurement. After the measurement is complete, set gate time control to minimum (ccw), but not in HOLD.

Table 4-3. HP-IB Verification (Continued)

CP#	TEST	PROCEDURE
Checkpoint 5 DAC TEST Verify DVM ramps from -2.0V to +2.0V in .2V steps (typical) Verify HP5316A/B has resumed gating and measuring reference signal.	REMOTE TRIGGER LEVELS	Channel A — Connect A DVM to the Channel A Trigger Level monitor jack. Observe the DVM. When CONTINUE is pressed, the DVM should begin at -2.0V and then increment in 200 mV steps (typical) until +2.0V is reached. When cycling, the HP 5316B will display 000. Address and remote lamps will be on. A 10 MHz reading will flash momentarily on the HP 5316B display in the middle of the trigger level range. Channel B — Move the DVM to the Channel B Trigger Level Monitor jack. Observe the DVM as in Channel A above. At the end of the test, the HP-85 will beep. Press CONTINUE and verify the HP 5316B resumes gating and displaying 10 MHz.
Checkpoint 6 GATE TIME TEST PASS	GATE TIME TEST	Two gate time range commands are sent to the HP 5316B for both front and rear panel controls. The gate times are then measured. Depending on the rear panel gate time setting, this measurement may take up to 30 seconds.
Checkpoint 7 OPTION 003 TEST Verify that the controller displays frequencies of 50MHz to 1GHz during this test. End of tests.	CHANNEL C TEST OPTION 003	Connect an HP 8660 (or equivalent), to the C Channel input. Slowly vary the frequency from 1 GHz down to 50 MHz and verify the HP 5316B displays the proper frequency. The HP-85 should have the same display as the HP 5316B. The program will loop, allowing 30 seconds to sweep the oscillator. This test point may be repeated if more time is necessary.

Table 4-4. HP-IB Verification Program Listing

```
10 REM HP5316A/B HP-IB Verification Program
20 REM Rev. A, Dated: February 19, 1987, EJS
30 OPTION BASE 1
40 CLEAR
50 RESET 7
60 DISP "HP5316A/B Frequency Counter"
70 DISP "HP-IB Verification program."
80 DISP "------------------------------"
90 DISP ""
100 DIM A$[21],C$[21],A(9),B(9),Q(4)
110 ON ERROR GOTO 150
120 STATUS 7,0 ; I
130 OFF ERROR
140 IF I=1 THEN 220
150 DISP "No HP-IB interface, (HP82937A),"
160 DISP "found installed in controller."
170 DISP ""
180 DISP "Program stopped.  Correct"
190 DISP "problem and re-RUN program."
200 BEEP
210 STOP
220 CONTROL 7,2 ; 16
230 STATUS 7,2 ; I
240 STATUS 7,2 ; I
250 IF BIT(I,1) THEN 490
260 DISP "Is the HP5316A/B connected to"
270 DISP "HP-IB and power applied"
280 DISP "(YES or NO)";
290 BEEP
300 INPUT A$
310 IF A$<"Y" THEN 420
320 CLEAR
330 DISP "Active device not found on"
340 DISP "HP-IB.  (HP-IB control line"
350 DISP "NDAC false when it should be"
360 DISP "true)."
370 DISP ""
380 DISP "Program stopped.  Correct"
390 DISP "problem and re-RUN program."
400 BEEP
410 STOP
420 CLEAR
430 DISP "Connect HP5316A/B to HP-IB and"
440 DISP "turn on power."
450 DISP ""
460 DISP "When ready, press continue."
470 PAUSE
480 GOTO 220
490 CONTROL 7,2 ; 64
500 STATUS 7,2 ; I
510 DISP "Enter 3 digit HP-IB address     (Example: 720)";
520 INPUT S
530 IF S<>721 THEN 570
540 CLEAR
550 DISP "721 is the controller's address."
560 DISP "Please select another address." @ BEEP @ GOTO 510
570 IF S<700 OR S>730 THEN 580 ELSE 620
580 CLEAR
590 DISP "Address must be >=700 and <=730."
600 BEEP
```

Table 4-4. HP-IB Verification Program Listing (Continued)

```
610 GOTO 510
620 ! *****  TEST 0  *****
630 SET TIMEOUT 7;20000
640 ON TIMEOUT 7 GOTO 4310
650 C=0
660 PRINT "HP5316A/B HP-IB TEST"
670 CLEAR
680 DISP "Connect rear panel REF IN/OUT to"
690 DISP " INPUT A."
700 DISP "Press continue."
710 PAUSE
720 CLEAR
730 DISP "Set rear panel REF switch to"
740 DISP " INT."
750 DISP "Press continue."
760 PAUSE
770 CLEAR
780 DISP "Set SEP/COM switch to COM A(in)."
790 DISP "Press continue."
800 PAUSE
810 CLEAR
820 DISP "Set FREQ A/PER A to FREQ A(in)."
830 DISP "Press continue."
840 PAUSE
850 CLEAR
860 DISP "Turn LEVEL/SENS knobs to"
870 DISP " MAX(cw)."
880 DISP "Press continue."
890 PAUSE
900 CLEAR
910 DISP "Turn GATE TIME knob to MIN(ccw)"
920 DISP " but not to HOLD."
930 DISP "Press continue."
940 PAUSE
950 CLEAR
960 DISP "Set TRIG LEV/SENS buttons to"
970 DISP " SENSITIVITY(in)."
980 DISP "Press continue."
990 PAUSE
1000 CLEAR
1010 DISP "Set all other buttons out."
1020 DISP ""
1030 DISP "SET-UP SUMMARY"
1040 DISP "=============="
1050 DISP "REF IN/OUT to INPUT A"
1060 DISP "REF switch to INT"
1070 DISP "SEP/COM switch to COM A(in)"
1080 DISP "FREQ A/PER A to FREQ A(in)"
1090 DISP "LEVEL/SENS knob to MAX(cw)"
1100 DISP "GATE TIME knob to MIN(ccw)"
1110 DISP "TRIG LEV/SENS to SENS(in)"
1120 DISP "========================="
1130 DISP "When ready, press continue."
1140 PAUSE
1150 GOTO 3990
1160 ! *****  TEST 1  *****
1170 CLEAR
1180 PRINT
1190 PRINT "____________"
1200 PRINT "Checkpoint 1"
```

Table 4-4. HP-IB Verification Program Listing (Continued)

```
1210 PRINT "INTERNAL LINK TEST"
1220 CLEAR
1230 FOR I=1 TO 9
1240 READ B(I)
1250 NEXT I
1260 DATA 0,85,64,255,240,79,64,64,64
1270 RESTORE
1280 REMOTE S
1290 CLEAR S
1300 LOCAL 7
1310 OUTPUT S ;"fn16"
1320 A(1)=SPOLL(S)
1330 REMOTE S
1340 GOSUB 1670
1350 A(2)=SPOLL(S)
1360 LOCAL LOCKOUT 7
1370 GOSUB 1670
1380 A(3)=SPOLL(S)
1390 CLEAR S
1400 GOSUB 1670
1410 A(4)=SPOLL(S)
1420 LOCAL 7
1430 GOSUB 1670
1440 A(5)=SPOLL(S)
1450 CLEAR 7
1460 GOSUB 1670
1470 A(6)=SPOLL(S)
1480 OUTPUT S ;"*U"
1490 GOSUB 1670
1500 A(7)=SPOLL(S)
1510 OUTPUT S ;"ow"
1520 GOSUB 1670
1530 A(8)=SPOLL(S)
1540 OUTPUT S ;"@0"
1550 GOSUB 1670
1560 A(9)=SPOLL(S)
1570 OUTPUT S ;"?0"
1580 GOSUB 1670
1590 ENTER S ; A$
1600 TRIGGER S
1610 FOR I=1 TO 9
1620 IF A(I)<>B(I) THEN PRINT "FAIL" @ GOTO 1740
1630 NEXT I
1640 IF A$[1,8]<>"*Uow@0?0" THEN PRINT "FAIL" @ GOTO 1740
1650 PRINT "PASS"
1660 GOTO 1740
1670 I=0
1680 STATUS 7,2 ; A
1690 IF BIT(A,5) THEN RETURN
1700 I=I+1
1710 IF I<500 THEN 1680
1720 PRINT "FAIL"
1730 RETURN
1740 GOTO 3990
1750 ! *****  TEST 2  *****
1760 CLEAR
1770 PRINT "_____"
1780 PRINT "Checkpoint 2"
1790 PRINT "REMOTE TEST"
1800 REMOTE S
```

Table 4-4. HP-IB Verification Program Listing (Continued)

```
1810 PRINT "Verify the following HP-IB"
1820 PRINT "status lights:"
1830 PRINT "ADRSD:  on"
1840 PRINT "REMOTE: on"
1850 DISP "Once verified, press continue."
1860 PAUSE
1870 CLEAR
1880 PRINT
1890 PRINT "LOCAL LOCKOUT TEST"
1900 LOCAL LOCKOUT 7
1910 PRINT "Verify front panel reset does"
1920 PRINT "not return counter to local."
1930 DISP "Once verified, press continue."
1940 PAUSE
1950 CLEAR
1960 PRINT
1970 PRINT "LOCAL TEST"
1980 LOCAL S
1990 PRINT "Verify the following HP-IB"
2000 PRINT "stauts lights:"
2010 PRINT "ADRSD:   on"
2020 PRINT "REMOTE: off"
2030 DISP "Once verified, press continue."
2040 PAUSE
2050 GOTO 3990
2060 ! *****  TEST 3  *****
2070 CLEAR
2080 PRINT
2090 PRINT "____________"
2100 PRINT "Checkpoint 3"
2110 PRINT "BASIC MEASUREMENTS TEST"
2120 DISP "Turn GATE TIME knob to MIN(ccw),"
2130 DISP "but not to HOLD."
2140 DISP "Press continue."
2150 PAUSE
2160 CLEAR
2170 OUTPUT S ;"in"
2180 ENTER S ; A$
2190 PRINT "FREQUENCY=",A$[1,4]&A$[8,19]
2200 OUTPUT S ;"fn4"
2210 ENTER S ; A
2220 PRINT "RATIO=";A
2230 I=POS(A$,"E")
2240 IF I<>0 THEN A$[I,I]="e" @ GOTO 2230
2250 IF VAL(A$[2])<>10000000 THEN 2260 ELSE 2280
2260 PRINT "FAIL.  Freq should be = 10 MHz."
2270 GOTO 2310
2280 IF A<>1 THEN PRINT "FAIL.  Ratio should = 1." @ GOTO 2310
2290 ENTER S ; A
2300 PRINT "PASS"
2310 GOTO 3990
2320 ! *****  TEST 4  *****
2330 CLEAR
2340 PRINT
2350 PRINT "____________"
2360 PRINT "Checkpoint 4"
2370 PRINT "SERVICE REQUEST TEST"
2380 DISP "Turn GATE TIME to MAX(cw)."
2390 DISP "Press continue."
2400 PAUSE
```

Table 4-4. HP-IB Verification Program Listing (Continued)

```
2410 CLEAR
2420 F=0 @ I=0
2430 OUTPUT S ;"infn7srlwa1"
2440 ON INTR 7 GOSUB 2510
2450 ENABLE INTR 7;8
2460 DISP "Waiting for a service request."
2470 IF F=1 THEN 2620
2480 I=I+1
2490 IF I>=200 THEN 4310
2500 GOTO 2460
2510 OFF INTR 7
2520 CLEAR
2530 STATUS 7,1 ; I
2540 I1=SPOLL(S)
2550 PRINT "srq1 =";I1
2560 ENTER S ; A$
2570 I2=SPOLL(S)
2580 PRINT "PERIOD =";A$[4,19]
2590 PRINT "srq2 =";I2
2600 F=1
2610 RETURN
2620 IF VAL(A$[2])<>.0000001 THEN PRINT "FAIL.  PERIOD SHOULD = 100ns" @ F=2
2630 IF I1<>64 THEN PRINT "FAIL.  srq1 SHOULD = 64" @ F=2
2640 IF I2<>0 THEN PRINT "FAIL.  srq2 SHOULD = 0" @ F=2
2650 IF F<>2 THEN PRINT "PASS"
2660 GOTO 3990
2670 ! *****  TEST 5  *****
2680 CLEAR
2690 PRINT
2700 PRINT "____________"
2710 PRINT "Checkpoint 5"
2720 PRINT "DAC TEST"
2730 DISP "Turn GATE TIME knob to MIN(ccw),"
2740 DISP "but not to HOLD."
2750 DISP "Press continue."
2760 PAUSE
2770 PRINT "Verify DVM ramps from -2.0V"
2780 PRINT "to +2.0V in .2V steps (typical)."
2790 CLEAR
2800 DISP "Connect DVM to CHAN A TRIGGER"
2810 DISP "LEVEL OUT test point."
2820 DISP "Press continue."
2830 PAUSE
2840 CLEAR
2850 DISP "DAC test in process."
2860 FOR I=-2 TO 2 STEP .2
2870 OUTPUT S ;"intrlat";I
2880 WAIT 1250
2890 NEXT I
2900 BEEP
2910 CLEAR
2920 DISP "Connect DVM to CHAN B TRIGGER"
2930 DISP "LEVEL OUT test point."
2940 DISP "Press continue."
2950 PAUSE
2960 CLEAR
2970 DISP "DAC TEST in process."
2980 FOR I=-2 TO 2 STEP .2
2990 OUTPUT S ;"bt";I
3000 WAIT 1250
```

Table 4-4. HP-IB Verification Program Listing (Continued)

```
3010 NEXT I
3020 BEEP
3030 CLEAR
3040 DISP "DAC test done."
3050 DISP "Press continue."
3060 PAUSE
3070 OUTPUT S ;"at0"
3080 PRINT "Verify HP5316A/B has resumed"
3090 PRINT "gating and measuring reference"
3100 PRINT "signal."
3110 CLEAR
3120 DISP "Once verified, press continue."
3130 PAUSE
3140 CLEAR
3150 DISP "Press continue."
3160 GOTO 3990
3170 ! *****  TEST 6  *****
3180 CLEAR
3190 PRINT
3200 PRINT "____________"
3210 PRINT "Checkpoint 6"
3220 PRINT "GATE TIME TEST"
3230 DISP "Turn GATE TIME knob to MIN(ccw),"
3240 DISP "but not to HOLD."
3250 DISP "Press continue."
3260 PAUSE
3270 CLEAR
3280 REMOTE S
3290 OUTPUT S ;"infn!1"
3300 CLEAR
3310 DISP "Gate time test in process."
3320 FOR I=0 TO 3
3330 OUTPUT S ;"ga";I
3340 WAIT 100
3350 Y=I+1
3360 C$="Ee"
3370 CONVERT IN 7 PAIRS ; C$
3380 ENTER S ; A$
3390 WAIT 500
3400 ENTER S ; A$
3410 Q(Y)=VAL(A$[2])
3420 NEXT I
3430 R4=Q(2)
3440 R1=MAX(Q(1),Q(2))
3450 R2=MAX(Q(3),Q(4))
3460 IF R1=R4 THEN 3520
3470 FOR I=1 TO 4
3480 IF R1=Q(I) THEN R3=I
3490 IF R2=Q(I) THEN R3=R3+I
3500 NEXT I
3510 IF R3=4 THEN 3600
3520 PRINT "FAIL"
3530 PRINT "LONG.  FP GT=";Q(1)
3540 PRINT "SHORT. FP GT=";Q(2)
3550 PRINT "LONG.  RP GT=";Q(3)
3560 PRINT "SHORT. RP GT=";Q(4)
3570 CLEAR
3580 DISP "Once verified, press continue."
3590 GOTO 3990
3600 PRINT "PASS"
```

Table 4-4. HP-IB Verification Program Listing (Continued)

```
3610 GOTO 3570
3620 ! *****  TEST 7  *****
3630 CLEAR
3640 DISP "Does the HP5316A/B have OPTION"
3650 DISP "003 C channel installed"
3660 DISP "(YES or NO)";
3670 INPUT C$
3680 IF C$>="Y" THEN 3740
3690 CLEAR
3700 DISP "No test performed."
3710 DISP "Press continue."
3720 PAUSE
3730 GOTO 3990
3740 CLEAR
3750 PRINT
3760 PRINT "___________"
3770 PRINT "Checkpoint 7"
3780 PRINT "OPTION 003 TEST"
3790 PRINT "Verify that the controller"
3800 PRINT "displays frequencies of"
3810 PRINT "50MHz to 1GHz during this test."
3820 DISP "Turn GATE TIME knob to MIN(ccw),"
3830 DISP "but not to HOLD."
3840 DISP "Press continue."
3850 PAUSE
3860 CLEAR
3870 CLEAR
3880 DISP "Connect source of 1 GHz @75 mv"
3890 DISP " rms to CHANNEL C input."
3900 DISP "Press continue."
3910 PAUSE
3920 CLEAR
3930 OUTPUT S ;"inga0fn5"
3940 FOR I=1 TO 200
3950 ENTER S ; A$
3960 CLEAR
3970 DISP A$
3980 NEXT I
3990 CLEAR
4000 DISP "Checkpoint";C;"complete."
4010 DISP "Please choose next checkpoint."
4020 DISP "========================"
4030 DISP "Choose 0 to start again."
4040 DISP "Checkpt 1, INTERNAL LINK TEST"
4050 DISP "Checkpt 2, REMOTE TEST"
4060 DISP "Checkpt 3, BASIC MEASUREMENTS"
4070 DISP "Checkpt 4, SERVICE REQUEST TEST"
4080 DISP "Checkpt 5, DAC TEST"
4090 DISP "Checkpt 6, GATE TIME TEST"
4100 DISP "Checkpt 7, OPTION 003 TEST"
4110 DISP "Choose 8 to stop program."
4120 DISP "============================="
4130 C=C+1
4140 DISP "Your choice (end line for";C;")";
4150 ON ERROR GOTO 4170
4160 INPUT C
4170 OFF ERROR
4180 IF C=0 THEN 40
4190 IF C=1 THEN 1160
4200 IF C=2 THEN 1750
```

Table 4-4. HP-IB Verification Program Listing (Continued)

```
4210 IF C=3 THEN 2060
4220 IF C=4 THEN 2320
4230 IF C=5 THEN 2670
4240 IF C=6 THEN 3170
4250 IF C=7 THEN 3620
4260 CLEAR
4270 PRINT
4280 PRINT "End of tests."
4290 DISP "Program stopped."
4300 STOP
4310 ! **** TIMEOUT ERRORS  ****
4320 CLEAR
4330 PRINT "FAIL"
4340 DISP "No response from counter."
4350 DISP "Check power, HP-IB cable and"
4360 DISP "input connection, setup (incl"
4370 DISP "sep/com switch, trigger level"
4380 DISP "switch and knob), HP-IB address"
4390 DISP "switch (rear panel) set for"
4400 DISP S;".  Also check that input"
4410 DISP "signal is present by making"
4420 DISP "a manual frequency measurement."
4430 DISP ""
4440 DISP "Program stopped.  Correct"
4450 DISP "problem, press RUN to re-start."
4460 BEEP
4470 END
```

SECTION V
ADJUSTMENTS

5-1. INTRODUCTION

5-2. This section describes the adjustments required to maintain the HP 5316B operating characteristics within specifications. Adjustments should be made when required, such as after a performance test failure or when components have been replaced that may affect an adjustment. If the adjustment cannot be made to the value specified, refer to Section VIII, Troubleshooting.

5-3. *Table 5-1* is a list of all adjustable components in the HP 5316B. The table includes the paragraph for a particular adjustment, the figure showing the adjustment's location, the label of the adjustment, and the order in which the adjustments should be performed.

Table 5-1. Adjustments

PROCEDURE	ADJUSTMENT	COMMENTS
1. Input Offset Adjustments Paragraph 5-10, Figure 5-1	A4R32 A4R1	Channel A Channel B
2. D/A Converter Adjustments Paragraph 5-12, Figure 5-2	A1R35 A1R34 A1R33 A1R32	Channel A Amplitude Channel A Offset Channel B Amplitude Channel B Offset
3. Trigger Level Adjustments Paragraph 5-14, Figure 5-3	A2R27 A2R28	Channel A Channel B
4. Injection-Locked Multiplier Paragraph 5-16, Figure 5-4	A1C24 A1C19	Coarse Adjust Fine Adjust
5. Reference Oscillator Paragraph 5-18, Figure 5-5	A1R14	Freq. Adjust
6. Option 001 TCXO Adjustment Paragraph 5-22, Figure 5-6	A7 ADJ	Frequency Adjust Use at 25°C
7. Option 001 TCXO Adjustment Paragraph 5-23, Figure 5-6	A7 ADJ	Frequency Adjust Use from 0 to 40°C
8. Option 004 Oven Oscillator Paragraph 5-24, Figure 5-7	A7R2	Voltage Adjust
9. Option 003 Channel C Paragraph 5-26, Figure 5-8	A9L, HY, H, CL	A2/A4 must be removed prior to the Adjustment

5-4. EQUIPMENT REQUIRED

5-5. The test equipment required for the adjustment procedure is listed in *Table 1-4*, Recommended Test Equipment. Substitute instruments may be used if they meet the critical specifications.

5-6. FACTORY SELECTED COMPONENTS

5-7. There are no factory selected components in the HP 5316B.

5-8. ADJUSTMENT LOCATIONS

5-9. *Figures 5-1* through *5-8* illustrate the location of all adjustments and test points used in the HP 5316B adjustment procedure.

WARNING

MAINTENANCE DESCRIBED HEREIN IS PERFORMED WITH POWER SUPPLIED TO THE INSTRUMENT, AND PROTECTIVE COVERS REMOVED. SUCH MAINTENANCE SHOULD BE PERFORMED ONLY BY SERVICE-TRAINED PERSONNEL WHO ARE AWARE OF THE HAZARDS INVOLVED (FOR EXAMPLE, FIRE AND ELECTRICAL SHOCK). WHERE MAINTENANCE CAN BE PERFORMED WITHOUT POWER APPLIED, THE POWER CORD SHOULD BE REMOVED.

BEFORE ANY REPAIR IS COMPLETED, ENSURE THAT ALL SAFETY FEATURES ARE INTACT AND FUNCTIONING, AND THAT ALL NECESSARY PARTS ARE CONNECTED TO THEIR PROTECTIVE GROUNDING MEANS.

5-10. A4 Input Offset Adjustments

5-11. The input offset adjustments are made to the A4 assembly as follows (see *Figure 5-1*):

a. Remove AC power cord.

b. Remove rear bezel (the two screws are captive).

c. Remove screw on bottom rear of instrument (between rear feet).

d. Slide cover off rear of instrument.

e. Connect an HP 54201A oscilloscope to Pin 5 of A4P2 (not labeled on the assembly).

f. Connect a 3325A Synthesizer/Function Generator, through a 50-ohm feedthrough, to Channel A Input BNC. Set the 3325A to 10 MHz at 100 mV rms.

g. Set the Channel A Trigger Level/Sensitivity switch to SENS with the control fully clockwise. The Attenuator and Filter switches should be in the OUT Position; the AC/DC switchs should be in DC (IN).

h. Adjust the 1740A oscilloscope for a stable display and then decrease the amplitude of the 10 MHz input signal to the lowest amplitude that maintains a stable display (typically 10 mV rms). If more than 10 mV rms is required, repeat this process following, steps h. and i. until less than 10 mV rms is required for a stable display.

i. Adjust HP 54201A for a 50% duty cycle on the HP 54201A oscilloscope display. A4R32 may require some minor adjustment during the A6 Digital-to-Analog Converter adjustment following in paragraph 5-13.

j. Connect the HP 54201A oscilloscope to pin 6 of A4P2 and connect the 10 MHz signal to the Channel B Input (through the 50-ohm feedthrough).

k. Set the Channel B Trigger Level/Sensitivity switch to SENS with the control fully clockwise. The Attenuator should be in the OUT position.

l. Adjust the HP 54201A osilloscope for a stable display and then decrease the amplitude of the 10 MHz input signal to the lowest amplitude that maintains a stable display (typically 10 mV rms).

m. Adjust A4R1 for a 50% duty cycle on the HP 54201Aoscilloscope display. A4R1 may require some minor adjustment during the Digital-to-Analog Converter adjustment following in paragraph 5-13.

n. This completes the offset adjustments for the A4 assembly. The Digital-to-Analog Converter adjustment described in the following paragraphs should now be performed.

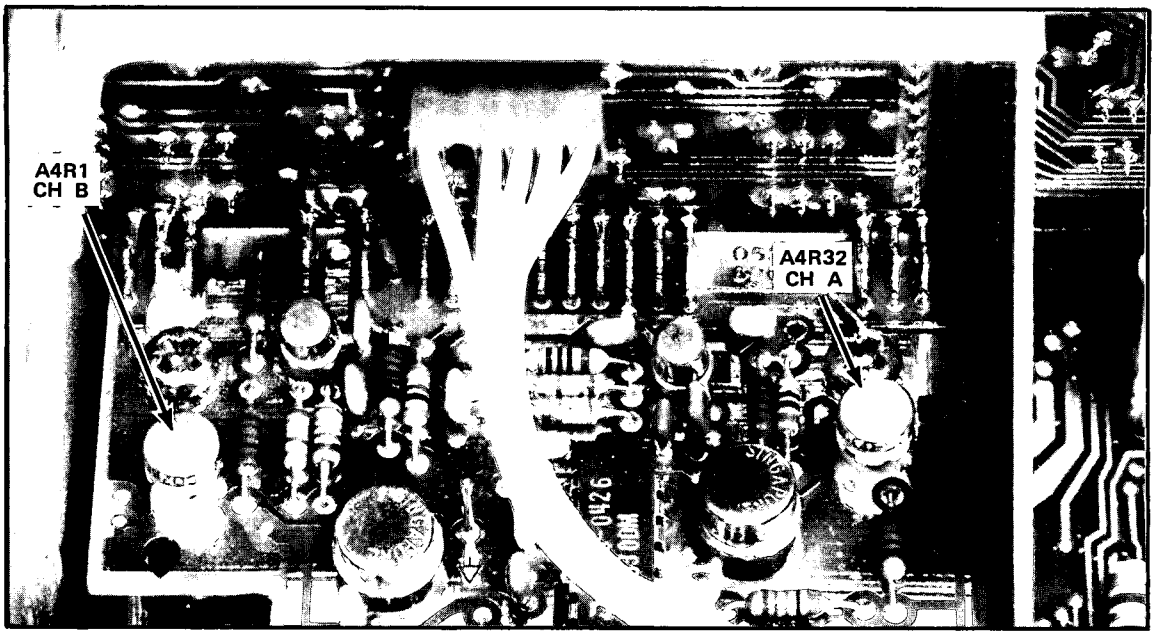


Figure 5-1. A4 Offset Adjustment Location

5-12. A1 Digital-to-Analog Converter Adjustments (Remote Trigger Levels)

5-13. The following D/A Converter adjustment procedure requires an HP-85. Any suitable controller conforming to IEEE 488-1978 may be substituted for the HP-85A system described above (see *Figure 5-2*).

a. Remove AC power cord.

b. Remove rear bezel (the two screws are captive).

c. Remove screw on bottom rear of instrument (between rear feet).

d. Slide cover off rear of instrument.

e. Connect a 3468A DMM to the Channel A Trigger Level Out jack on the front panel.

f. Set both Channels A and B Trigger Level/Sensitivity switches to SENS. Adjust both controls fully clockwise.

g. Connect the HP-85 Interface Cable to the HP 5316B. Set the HP 5316B rear panel address switches to Address *ØØ* and ADDRESSABLE (ALL switches in the down position).

h. Type into the HP-85 the following: *output 7ØØ; "TR1ATØ"* ..... press END LINE. Adjust A1R34 (A OS) for 0.000V ±.001V on the HP 3468A DMM display.

i. Type into the HP-85 the following: *output 7ØØ; "TR1AT2.55"* ..... press END LINE. Adjust A1R35 (A AMP) for 2.550V ±.001V on the HP 3468A DMM display.

j. Type into the HP-85A the following: *output 7ØØ; "TR1ATØ"* ..... press END LINE. The HP 3468A DMM should display 0.000V ±.001V. If not, repeat steps h., i., and j. until it does.

k. Type into the HP-85 the following: *output 7ØØ; "TR1AT-2.55"* ..... press END LINE. The HP 3468A DMM should now display -2.550V ±.005. If it does not, adjust A1R35 (A AMP) until it does, and repeat steps h. through k.

l. Connect a 3325A Synthesizer/Function Generator set to 10 MHz at 10 mV rms, through a 50-ohm feedthrough, to the Channel A Input BNC. Connect a HP 54201A oscilloscope to A4P2 pin 5. Adjust A1R34 (A OS) for a 50% duty cycle on the HP 54201A oscilloscope. The HP 3468A should display 0.000V ±0.005V. Press the HP 5316B front panel RESET. Verify the 50% duty cycle does not change. If the duty cycle does change, adjust A4R32 for a 50% duty cycle after RESET on the HP 5316B has been pressed. A4R32 should require only minor adjustments. Repeat to verify the duty cycle remains 50%.

m. Connect the 3468A DMM to the Channel B Trigger Level Out jack on the front panel.

n. Type into the HP-85 the following: *output 700; "TR1BT0"* ..... press END LINE. Adjust A1R32 (B OS) for 0.000V ±.001V on the 3468A DMM display.

o. Type into the HP-85 the following: *output 700; "TR1BT2.55"* ..... press END LINE. Adjust A1R33 (B AMP) for 2.550V ±.001V on the 3468A DMM display.

p. Type into the HP-85 the following: *output 700; "TR1BT0"* ..... press END LINE. The 3468A DMM should display 0.000V ±.001V. If not, repeat steps n, o, and p until it does.

q. Type into the HP-85 the following: *output 700; "TR1BT-2.55"* ..... press END LINE. The 3468A DMM should now display -2.550V ±.005. If it does not, adjust A1R33 (B AMP) until it does, and repeat steps n. through q.

r. Connect a 3325A Synthesizer/Function Generator set to 10 MHz at 10 mV rms, through a 50-ohm feedthrough, to the Channel B Input BNC. Connect an HP 54201A oscilloscope to A4P2 pin 6. Adjust A6R4 (B OS) for a 50% duty cycle on the HP 54201A oscilloscope. The 3468A should display 0.000V ±0.005V. Press the HP 5316B front panel RESET. Verify the 50% duty cycle does not change. If the duty cycle does change, adjust A4R1 for a 50% duty cycle after RESET on the HP 5316B has been pressed. A4R1 should require only minor adjustment. Repeat to verify the duty cycle remains 50%.

s. This completes the D/A Converter adjustments.

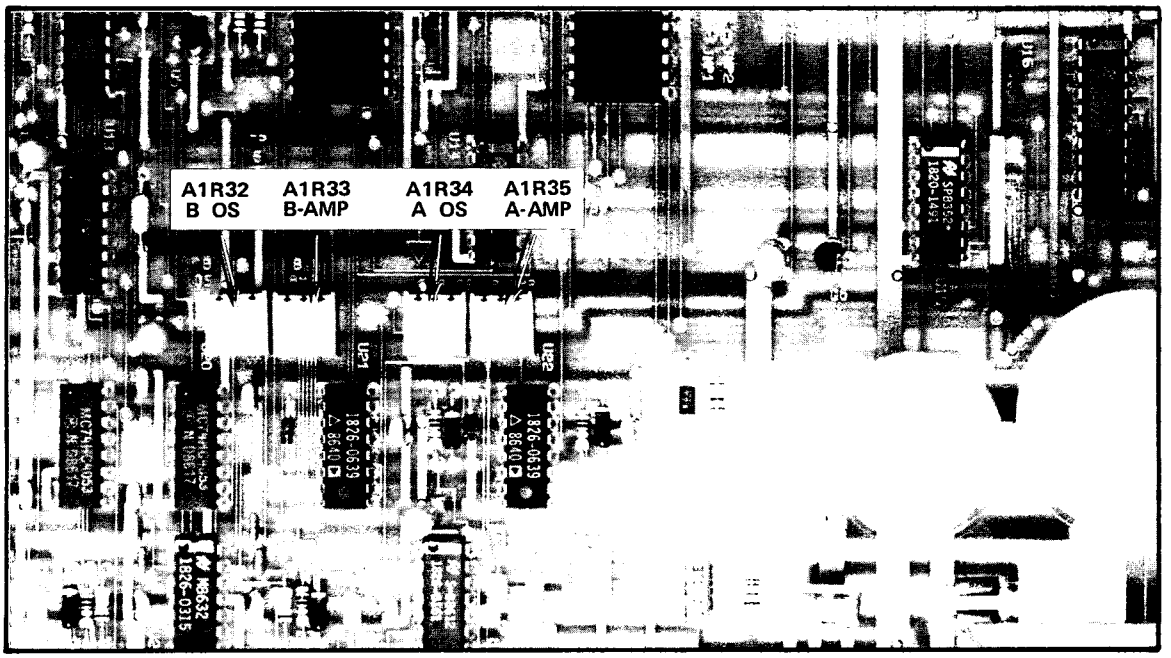


Figure 5-2. Digital-to-Analog Converter Adjustment Location

5-14. A2 Trigger Level Gain Compensation

5-15. The following A2 Input Amplifier Gain Compensation procedure requires an HP-85A/B Controller and an HP 82937A HP-IB Interface. Any suitable controller conforming to IEEE 488-1978 may be substituted for the HP-85 system described above.

NOTE

Adjustment of the trigger level gain compensation should be performed any time the dual FETs on A4 (Q2 and Q4) are replaced, as this adjustment compensates for their dc gain. Repair or replacement of the DAC circuitry, or adjustment of the A4 assembly or DAC Offset Controls, will *generally* not require gain compensation adjustment.

a. Remove AC power cord.

b. Remove rear bezel (the two screws are captive).

c. Remove screw on bottom rear of instrument (between rear feet).

d. Slide cover off rear of instrument.

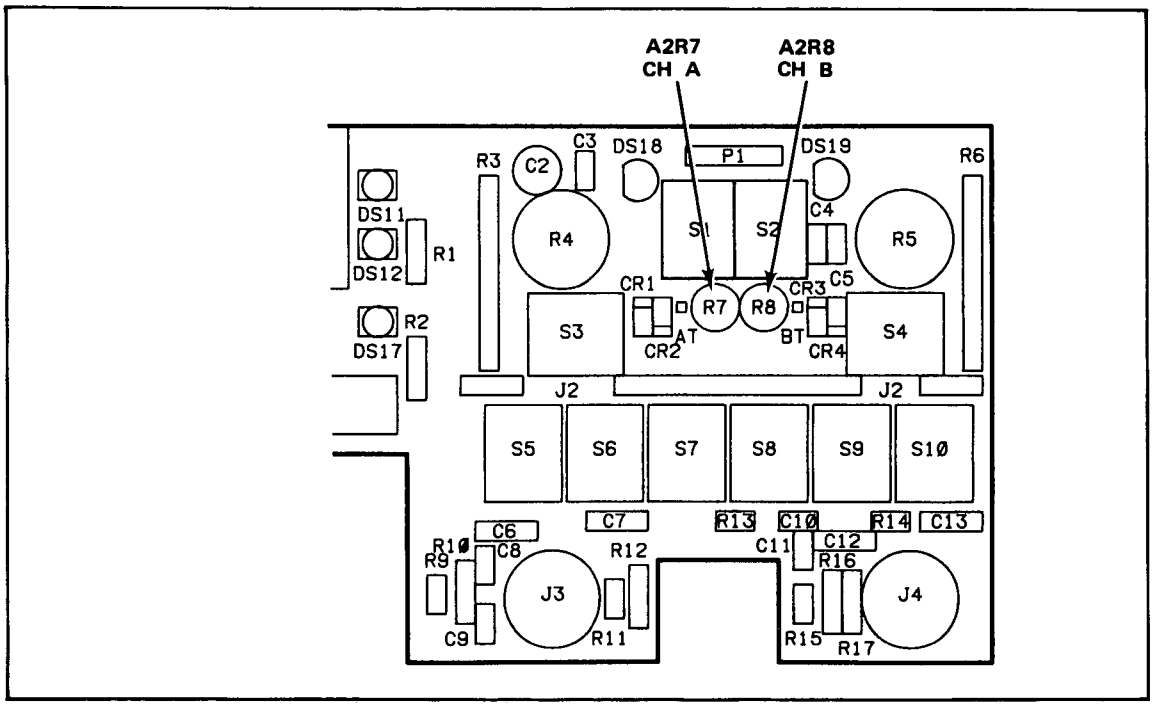


Figure 5-3. Trigger Level Gain Compensation Adjustment Location

e. Connect the HP 82937A Interface Cable to the HP 5316B rear panel HP-IB Connector.

f. Set the HP 5316B rear panel Address switches to address ØØ and ADDRESSABLE (ALL switches in the DOWN position). Set the TRIGGER LEVEL/SENSITIVITY switches to SENS (IN). Set the Trigger Level pots fully CCW.

g. Using a suitable jumper, connect A1J6 pin 5 to the Channel A Input BNC. Do not disconnect the cable from the DC circuitry. Set Channel A to dc coupled (IN).

h. Connect a 16-pin IC Test Clip to A4U2.

i. Connect the PLUS test lead to a floating input 3468A DMM to A4U2 pin 7 and the NEGATIVE test lead to A4U2 pin 8.

j. Apply power to the HP 5316B and the HP-85.

k. Type into the HP-85A: *output 700; "TR1AT-2.00"* ..... Press END LINE.

l. Adjust A2R7 for 0.000V ±0.001 (zero volts differential between A4U2 pins 7 and 8). See *Figure 5-3* for adjustment location.

m. Repeat step k, but program the trigger level for -1.00, 0.00, +1.00, and +2.00 volts. To do this, change the code string *"TR1AT-2.00"* to *"TR1AT-1.00"*, etc. Verify the 3465A DMM displays 0.000V ±5% of the programmed voltage ±15 mV, for the above voltages. For example, if the programmed voltage is -2.00 volts, then ±5% of -2.00 volts is ±10 mV. Then adding ±15 mV yields ±115 mV. Thus the HP 3468A DMM should display 0.000V ±115 mV. Listed below are the tolerance limits for the above programmed voltages.

PROGRAMMED VOLTAGES	TOLERANCE
-2.00 Volts	0.000V ±115 mV
-1.00 Volts	0.000V ±65 mV
0.00 Volts	0.000V ±15 mV
+1.00 Volts	0.000V ±65 mV
+2.00 Volts	0.000V ±115 mV

n. Move the jumper to connect A1J6 pin 4 to the Channel B Input BNC. Set Channel B to dc coupling (IN).

o. Move the PLUS test lead of a floating input 3468A DMM to A4U2 pin 10 and the NEGATIVE test lead to A4U2 pin 9.

p. Type into the HP-85: *wrt 700, "TR1BT-2.00"* ..... press EXECUTE.

q. Adjust A2R8 for 0.000V ±0.001 (zero volts differential between A4U2 pin 9 and 10). See *Figure 5-3* for adjustment location.

r. Repeat step p, but program the trigger level for -1.00, 0.00, +1.00, and +2.00 volts. To do this, change the code string *"TR1BT-2.00"* to *"TR1BT-1.00"*, etc. Verify the HP 3468A DMM displays 0.000V ±5% of the programmed voltage ±15 mV, for the above voltages. For example, if the programmed voltage is -2.00 volts, then ±5% of -2.00 volts is ±115 mV. Then adding ±15 mV yields ±115 mV. Thus the HP 3468A DMM should display 0.000V ±115 mV. Listed below are the tolerance limits for the above programmed voltages.

PROGRAMMED VOLTAGES	TOLERANCE
-2.00 Volts	0.000V ±115 mV
-1.00 Volts	0.000V ±65 mV
0.00 Volts	0.000V ±15 mV
+1.00 Volts	0.000V ±65 mV
+2.00 Volts	0.000V ±115 mV

s. Remove the power from the HP 5316B and disconnect the jumper.

t. This completes the A2 Trigger Level Gain adjustments.

5-16. A1 Injection-Locked Multiplier Adjustment

5-17. The following adjustments set the lock range of the external reference input (see *Figure 5-4*).

a. Remove AC power cord.

b. Remove rear bezel (the two screws are captive).

c. Remove screw on bottom rear of instrument (between rear feet).

d. Slide cover off rear of instrument.

e. Set the HP 5316B rear panel REFERENCE switch to EXT.

f. Using a BNC "T" and 50-ohm feedthrough, connect the output of a 3325A Synthesizer/Function Generator to the Channel A Input BNC and to the rear panel External Reference Input.

g. Set the 3325A Synthesizer/Function Generator to 10.000000 MHz at 500 mV rms (sine wave).

h. Press FREQ A on the HP 5316B front panel. Set the Channel A Trigger Level/Sensitivity switch to SENS and set the control fully clockwise.

i. Adjust the HP 5316B GATE TIME control until all eight digits of resolution are displayed (about the 12 o'clock position).

j. Adjust A1C24 until the HP 5316B displays 10.000000 E6 ±2 counts. Set A1C24 to the center of the adjustment range in which the HP 5316B displays the correct count.

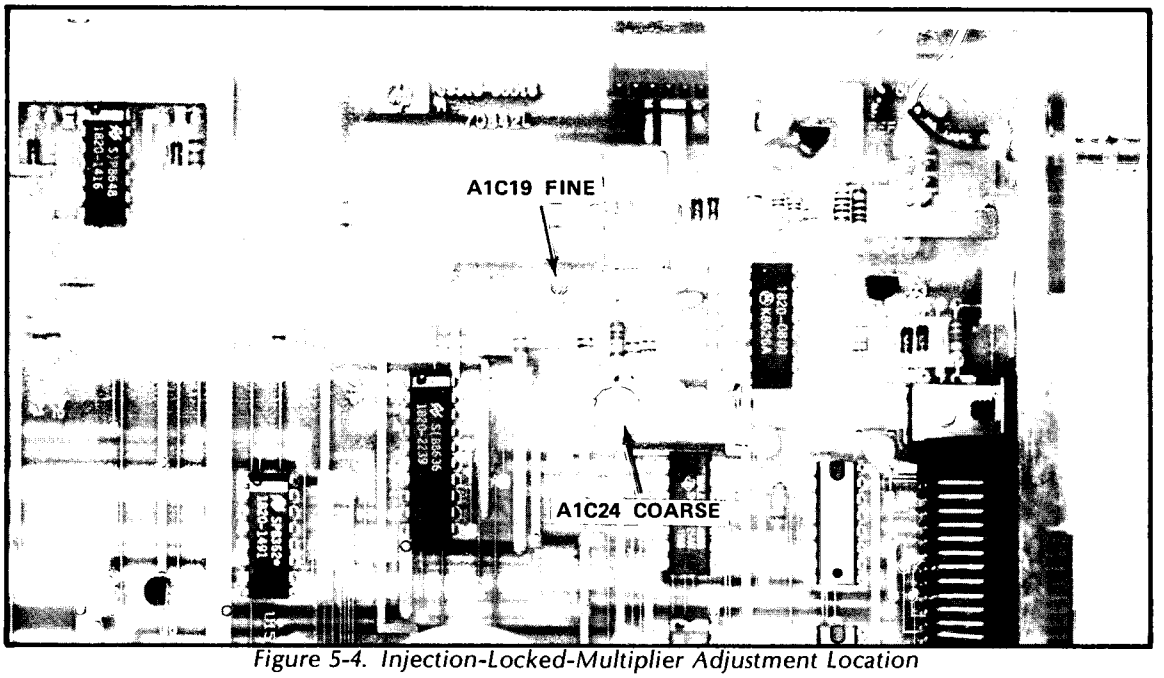


Figure 5-4. Injection-Locked-Multiplier Adjustment Location

k. Set the 3325A Synthesizer/Function Generator to 1.000000 MHz at 500 mV rms (sine wave).

l. The HP 5316B should display 1.000000 E6 ±2 counts. If the reading is outside these limits, adjust A1C24 until the display is close to the required value and adjust A1C19 until it is correct. Center A1C19 so that the same amount of adjustment in either direction is possible before the display unlocks from 1.000000 E6 ±2 counts.

NOTE

If finding the lock-in point is difficult, set the 3325A to 5.000000 MHz at 500 mV rms (sine wave). Adjust A1C24 for a balanced lock-in with a display of 5.000000 E6 ±2 counts, then repeat for 1.000000 MHz.

m. Set the 3325A Synthesizer/Function Generator to 1.001400 MHz at 500 mV rms (sine wave). The HP 5316B should still display 1.000000 E6 ±2 counts. If the display is outside these limits, carefully adjust A1C19 until the display just locks at 1.000000 E6 ±2 counts.

n. Set the 3325A Synthesizer/Function Generator to 0.998600 MHz at 500 mV rms (sine wave). The HP 5316B should still display 1.000000 E6 ±2 counts. If the display is outside these limits, carefully adjust A1C19 until the display just locks at 1.000000 E6 ±2 counts.

o. Repeat steps f. through l. until the HP 5316B displays the correct count in all cases.

p. Set the 3325A Synthesizer/Function Generator to 1.000000 MHz, 5.000000 MHz, and 10.000000 MHz. Verify the HP 5316B displays the respective frequency and the display remains stable.

q. This completes the adjustment of the Injection-Locked Multiplier.

5-19. A7 Time Base Reference Adjustment — Standard Instrument

5-20. The following adjustment sets the frequency of the standard internal time base (see *Figure 5-5*).

a. Remove AC power cord.

b. Remove rear bezel (the two screws are captive).

c. Remove screw on bottom rear of instrument (between rear feet).

d. Slide cover off rear of instrument.

e. Press GATE TIME on the HP 5316B front panel. Adjust the GATE TIME/DELAY control for a gate time of 1 to 2 seconds (not critical).

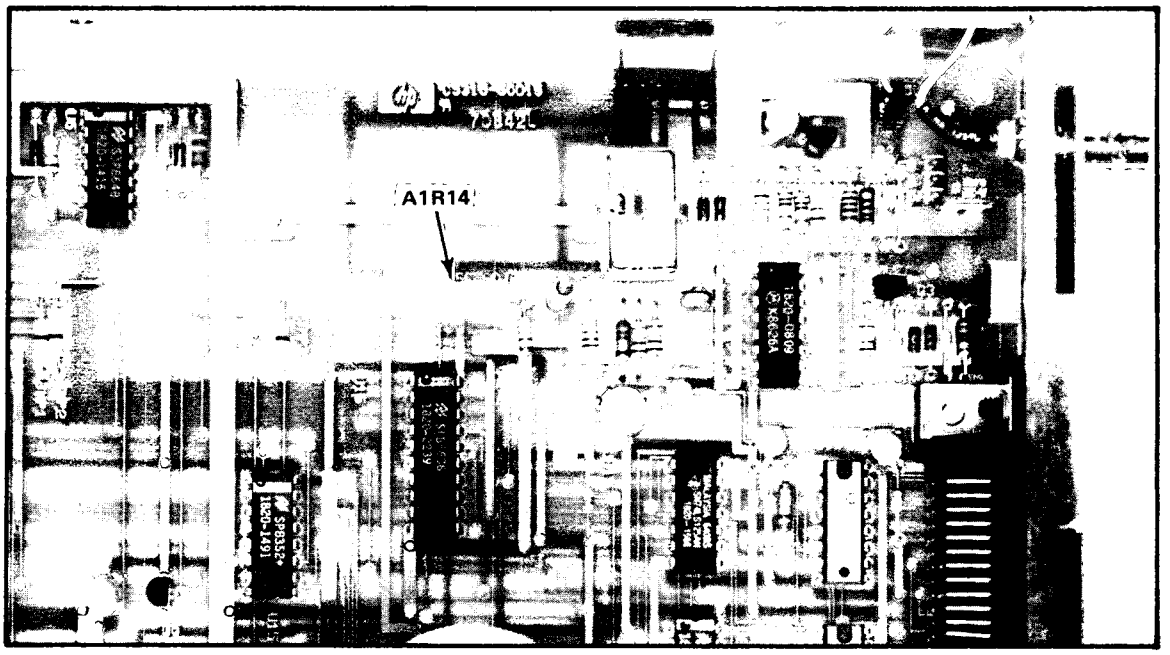


Figure 5-5. Internal Time Base Adjustment Location

f. Set the HP 5316B to the FREQ A. Set the Channel A Trigger Level/Sensitivity switch to SENS and set the control fully clockwise.

g. Set the 3325A Synthesizer/Function Generator to 10.000000 MHz at 100 mV rms. The 3325A should be locked to the house standard, if available.

h. Connect the output of the 3325A Synthesizer/Function Generator, through a 50-ohm feedthrough to the HP 5316B Channel A Input BNC.

i. Adjust A1R14 until the HP 5316B displays 10.000000 E6 ±2 counts.

j. This completes the Standard Time Base adjustment.

5-20. A7 Option 001 TCXO Adjustment

5-21. Two procedures are given for the adjustment of Opton 001 (TCXO). If the operation of the counter will be solely at 25°C (78°C), then adjust the oscillator frequency as close as possible to 10 MHz using the procedure in paragraph 5-22. If the operation of the counter will be over the full temperature range (0° to 40°C), then the TCXO must be offset by the amount labeled on its cover. This is to keep the TCXO frequency within the manufacturers temperature specifications. In this case, use the procedure in paragraph 5-23. Option 001 TCXO is factory set for use at 25°C.

5-22. Adjustment of Option 001 for use at 25°C.

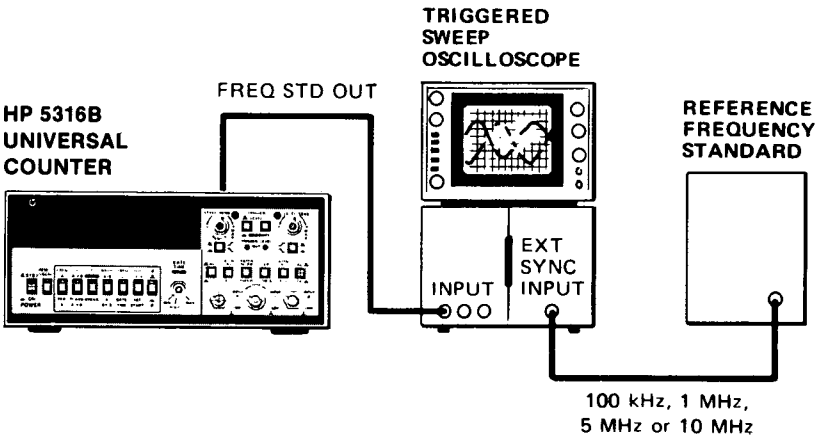
a. Remove AC power cord.

b. Remove rear bezel (the two screws are captive).

c. Remove screw on bottom rear of instrument (between rear feet).

d. Slide cover off rear of instrument.

e. Connect a house standard (reference frequency) to the external SYNC input of an HP 54201A oscilloscope as shown below. Set the HP 54201A oscilloscope to External SYNC.



MOVEMENT	SWEEP SPEED			NOTES
	1 μs/cm	0.1 μs/cm	0.01 μs/cm	
1 cm/s 1 cm/10 s 1 cm/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}	TIME SCOPE TRACE MOVEMENT WITH SECONDHAND OF WATCH OR CLOCK

For example, if the trace moves 1 centimeter in 10 seconds and the sweep speed is 0.01 μs/cm, the oscillator signal is within 1×10^{-9} of the reference frequency.

f. Connect the HP 5316B rear panel REF IN/OUT to the Channel A input of the HP 54201A oscilloscope.

g. Adjust the TCXO frequency for minimum sideways movement of the 10 MHz signal with ADJ on the TCXO. See *Figure 5-6.*

h. By timing the sideways movement (in cm/second), the approximate offset can be determined based on the HP 54201A oscilloscope sweep speed as shown in the following table.

i. This completes the adjustment of Option 001 TCXO for use at 25°C.

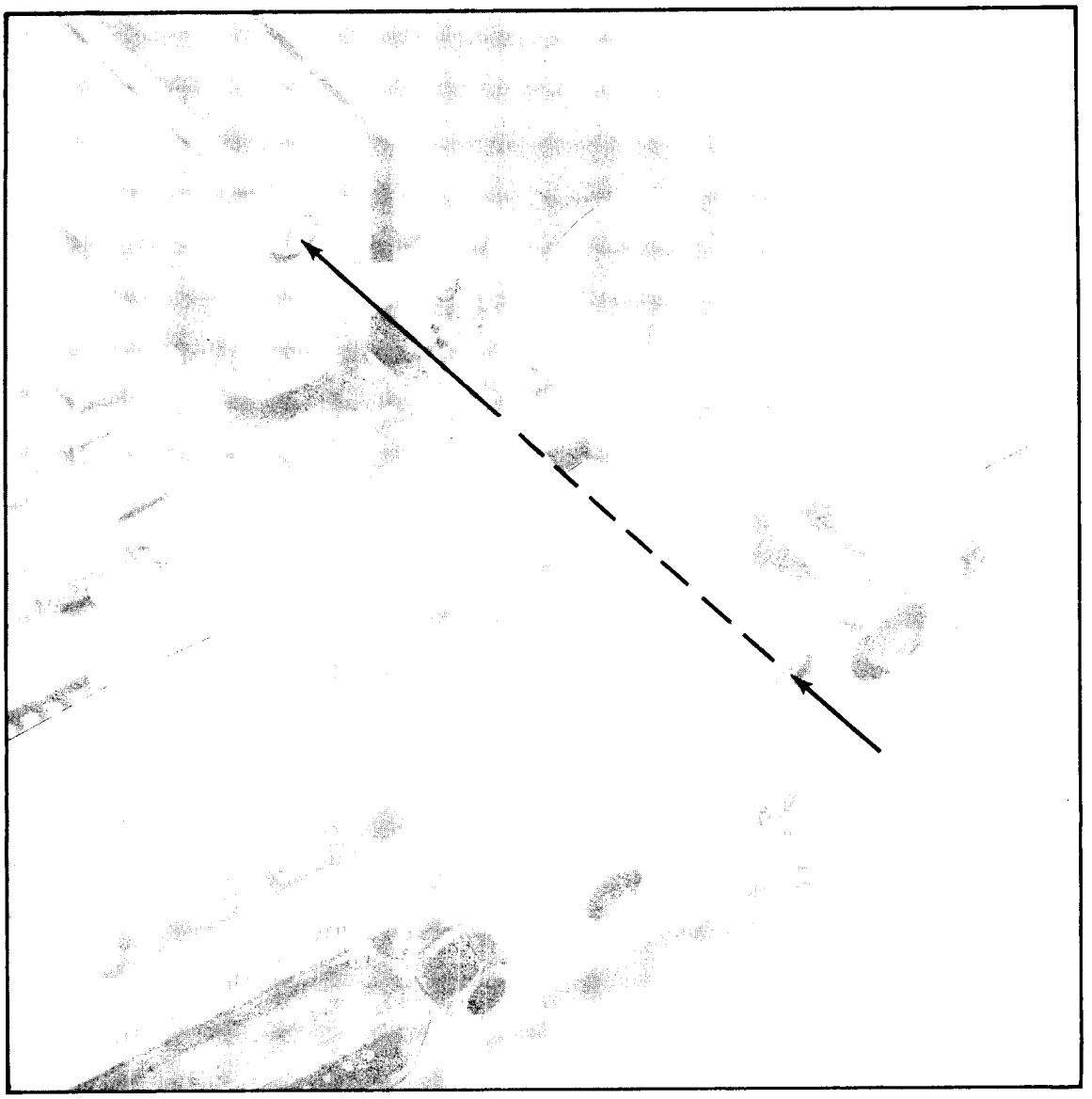


Figure 5-6. TCXO Option 001 Adjustment Location

5-23. Adjustment of Option 001 With Offset (0 to 40°C).

a. Remove AC power cord.

b. Remove rear bezel (the two screws are captive).

c. Remove screw on bottom rear of instrument (between rear feet).

d. Slide cover off rear of instrument.

e. Connect a house standard (reference frequency) to the EXT FREQ STD INPUT of a high resolution counter such as an HP 5384A Electronic Counter.

f. Connect the HP 5316B rear panel REF IN/OUT to the HP 5384A Channel A Input BNC.

g. Set the HP 5384A to FREQUENCY A, GATE TIME to 1 second, AUTO DSIPLAY, and SEP.

h. Adjust the TCXO frequency to 10 MHz±the offset labeled on the TCXO cover. For example, if the offset is labeled +3.5 Hz, then the TCXO should be adjusted to a frequency of 10.0000035 MHz on the HP 5384A display at a room temperature of +25°C.

5-24. A7 Option 004 Oscillator

5-25. The following procedure describes the adjustment of the Option 004 (*Figure 5-7*).

a. Remove AC power cord.

b. Remove rear bezel (the two screws are captive).

c. Remove screw on bottom rear of instrument (between rear feet).

d. Slide cover off rear of instrument.

e. Connect the NEGATIVE lead of an HP 3468A DMM to the HP 5316B chassis and the PLUS lead to the terminal pin on the A13 module furthest from the left chassis frame. This pin also has a red wire connecting it to the A7 module.

f. Adjust A7R2 for +5.00V±.01V dc.

g. The HP 5316B should now be allowed to operate for at least 30 minutes before proceeding with the oscillator adjustment.

h. Connect the output of an 8660C to the HP 5316B Channel A input BNC through a 50-ohm feedthrough.

i. Set the 8660C Synthesizer/Generator to 100.000000 MHz at 100 mV rms. The 8660C must be referenced to a house standard.

j. Set the HP 5316B front panel controls to the following:

GATE TIME ..... 1 TO 2 SECONDS
FUNCTION ..... FREQ A
ATTENUATOR ..... X1 (OUT)
FILTER ..... NORMAL (OFF)
SEP/COM ..... SEPARATE (OUT)
TRIGGER LEVEL/SENSITIVITY ..... SENSITIVITY (IN)
LEVEL/SENSITIVITY CONTROL ..... FULLY CLOCKWISE

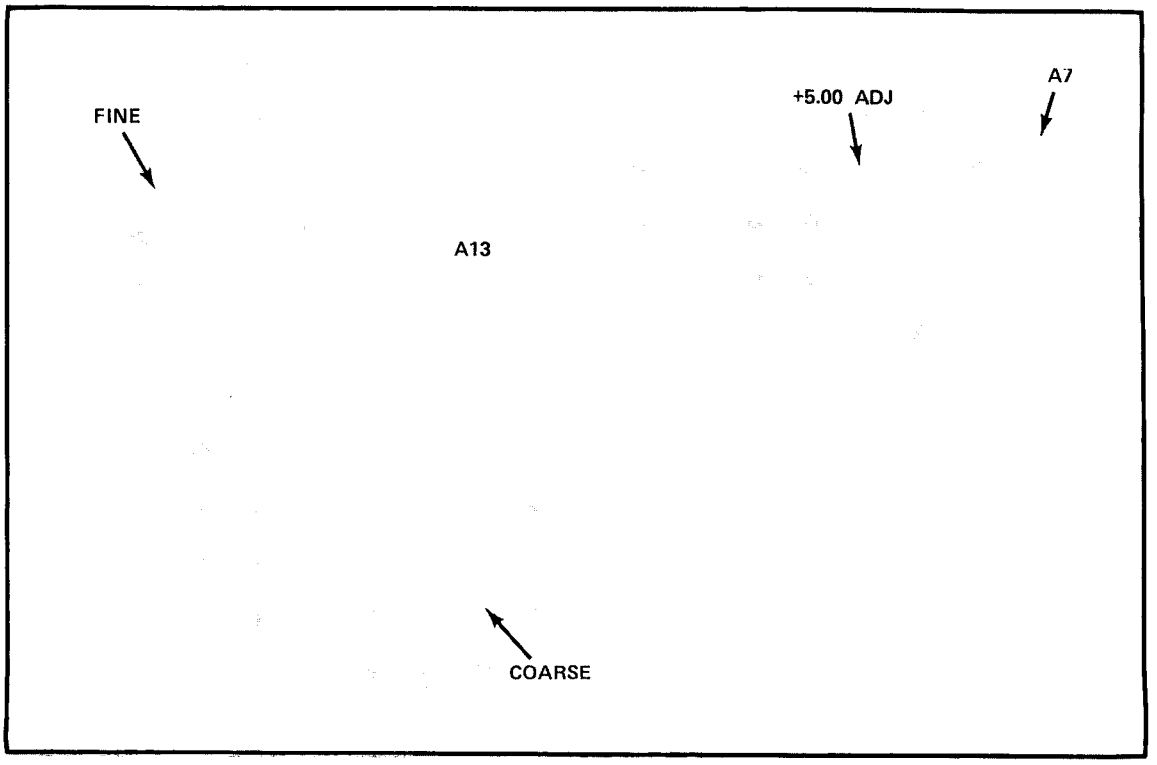


Figure 5-7. Option 004 Oven Oscillator Adjustment Location

k. Remove the threaded caps labeled COARSE and FINE from the A13 oscillator module.

l. Adjust the COARSE control until the HP 5316B displays 100.000000 MHz ±1 count. Use the COARSE control to bring the display as close to 100.000000 MHz as possible, then adjust the FINE control for 100.000000 MHz ±1 count.

NOTE

Overflow LED will turn on; all display digits will show zeros, except the LSB, which shows offset from 10 MHz and should reach 0 ±1 as FINE control is adjusted.

m. Replace the adjustment caps and the top cover. The HP 5316B should continue displaying 100.000000 MHz ±1 count.

5-26. A9 Option 003 Channel C Adjustment

5-27. The following procedure describes the adjustments required to maintain the Option 003 Channel C operating characteristics within specifications. To access the adjustment of A9 Channel C, the A2/A4 assemblies must be removed as described in the following procedure (see *Figure 5-8*).

a. Remove AC power cord.

b. Remove rear bezel (the two screws are captive).

c. Remove screw on bottom rear of instrument (between rear feet).

d. Slide cover off rear of instrument.

e. Remove two screws securing heat sink/support bracket to the right side frame.

f. Disconnect REF IN/OUT cable (W3) from A1 Motherboard at rear of instrument.

g. Remove two HP-IB connector screws located on rear panel of instrument.

h. Disconnect cable from transformer to A1J9 on motherboard.

i. Remove two 6/32 screws securing A7 board to A1 Motherboard if A7 board installed.

j. Unplug A7 board from A1J2.

k. Remove 3 screws securing oven oscillator bracket if oven oscillator is installed.

l. Remove oven oscillator assembly.

m. Remove A1 Motherboard and front panel assembly from cabinet frame by gently pushing at rear of A2 front panel assembly and pressing up on top of front frame to release top of front panel; then press down on bottom of front frame to release bottom of front panel.

n. Pull front panel and motherboard assembly out of frame several inches.

o. Remove two LEVEL/SENS knobs, GATE TIME knob, and hex nuts behind knobs and on Channel A and B BNC connections from front panel.

p. Looking at back of A2 Display assembly, remove hex nut located to right of assembly (just above Power STBY/ON switch). Located between front panel and A2 Display assembly is a spacer. When front panel is removed in step r., be sure not to lose spacer.

q. Channel A and B Trigger Level Monitor jacks are secured to front panel. Two wires with push-on clips connect them to A2 Input Amplifier assembly. Pull front panel forward about 1" and, using long-tipped needle-nose pliers, disconnect two clips from the A2 assembly.

r. Carefully remove brass SMC connector from A9 Input C BNC assembly. Remove front panel. Note space between front panel and A2 assembly.

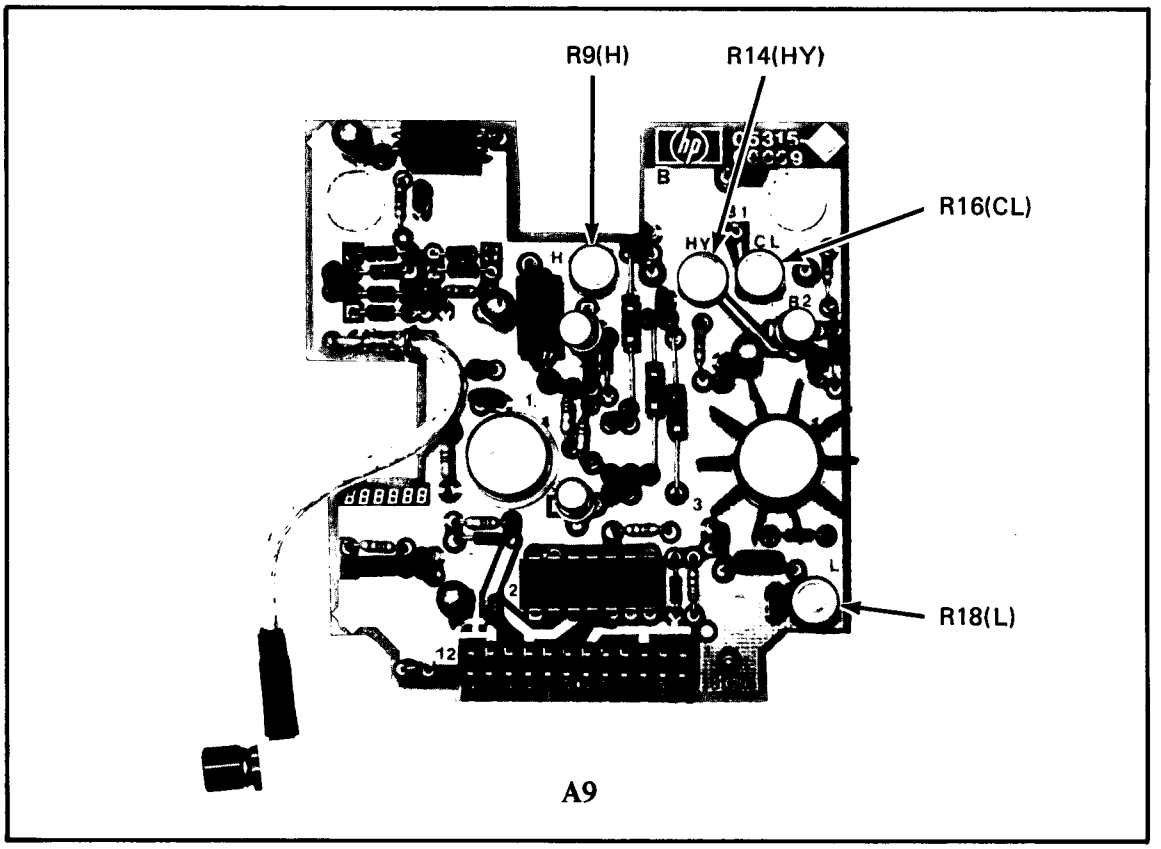


Figure 5-8. Channel C Adjustment Location

s. Remove four screws securing A2/A4 assembly. Remove combination A2/A4 assembly by gently lifting on rear edge of A4, until pins come free of A1 Motherboard connector A1J8.

t. Slide HP 5316B back into chassis and reconnect secondary of transformer T1 to A1J9 located just in front of transformer.

u. Securely fasten Q11 and Q12 heat sink/support bracket to right side frame.

v. Reconnect brass SMC connector to Input C BNC assembly and loosely replace front panel.

CAUTION

Do not operate the HP 5316B unless the Q11 and Q12 heat sink is securely fastened to the side frame of the instrument. Otherwise, the transistors will be damaged from overheating.

w. Reconnect power cord to rear panel.

x. Connect a jumper wire between Test Points labeled SCV and TP+5.

y. Connect an HP 8660C Synthesized Signal Generator to Input C BNC.

z. Set 8660C to 10.000 MHz at 500 mV rms.

NOTE

The HP 3468A DMM to be used in the following step MUST have floating inputs.

aa. Using a suitable IC clip, connect an HP 3468A DMM between A9U2 pin 8 and ground. Adjust trimmer "L" (A9R18) for a reading of 2.6V ±5 mV on HP 3468A DMM.

ab. Reduce 8660C output level to 500 μV (.5 mV) rms.) Connect HP 3468A DMM positive lead to TP "B1" and commen lead to TP "B2". Adjust trimmer "HY" (A9R14) for a reading of 110 mV ±1 mV on HP 3468A DMM.

ac. Increase 8660C output level to 50 mV rms. Adjust trimmer labeled "H" (A9R9) for a reading of 75 mV .1 mV (differential between TPB1 and TPB2) on HP 3468A DMM.

ad. Connect HP 3468A DMM positive lead to TP "C". Adjust trimmer "CL" (A9R16) for a reading of 37 mV +1/–0 mV.

ae. Connect 8660C rear panel REFERENCE OUT to HP 5316B rear panel REF IN. Set HP 5316B rear panel REFERENCE EXT/INT to EXT position.

af. Verify HP 5316B displays 100.0000 MHz ±1 count. If a generator other than 8660C is used and/or no reference out is available, then display should be 100.0000 MHz ± time base error ±1 count.

ag. Recheck steps ab. through ae. to verify all voltages. Repeat steps until all voltages are within tolerance.

ah. Vary 8660C frequency from 50 MHz to 650 MHz at 15 mV rms, and 650 MHz to 1000 MHz at 75 mV and verify HP 5316A displays proper frequency.

ai. Reassemble HP 5316B by performing steps a. through t. in reverse order.

aj. This completes A9 Channel C adjustments.

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION

6-2. This section contains information for ordering replacement parts. *Table 6-1* lists the abbreviations used in the parts list and throughout this manual. *Table 6-2* lists all of the replaceable parts for the HP 5316B including the options. The parts list is set-up in order of the assembly reference designators (A1, A2, A3, etc.). *Table 6-3* contains the names and addresses that correspond with the manufacturers' code numbers.

6-3. ABBREVIATIONS

6-4. *Table 6-1* lists the abbreviations used in the parts list, schematics, and throughout the manual. In some cases, two forms of the abbreviations may appear, one in all capital letters, and one in partial or no capital letters. This occurs because the abbreviations in the parts lists are always capitals. However, in the schematics and other parts of the manual, other abbreviation forms are used with lower case and upper case letters.

6-5. REPLACEABLE PARTS

6-6. *Tables 6-2* and *6-3* are the lists of replaceable parts and are organized as follows:

a. Electrical assemblies and their components in alphanumerical order by reference designation.

b. Chassis-mounted parts in alphanumerical order by reference designation.

c. Miscellaneous parts.

6-7. The information given for each part consists of the following:

a. The Hewlett-Packard part number.

b. The part number check digit (CD).

c. The total quantity (Qty) used in the assembly.

d. The description of the part.

e. A typical manufacturer of the part in a five-digit code.

f. The manufacturers number for the part.

6-8. The total quantity of each part used within each assembly is given only once at the first appearance of the part number in the lists.

6-9. ORDERING INFORMATION

6-10. To order a part listed from the replaceable parts table, quote the Hewlett-Packard part number, indicate the quantity required, and address the order to the nearest Hewlett-Packard Office.

6-11. To order a part that is not listed in the replaceable parts table, include the model number, serial number, the description and function of the part, and the number of parts required. Address the order to the nearest Hewlett-Packard Office.

Table 6-1. Reference Designations and Abbreviations

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 = metre
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 transistor 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 (centrigrade)
°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 transistor 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
FOL 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 = logarithm(ic)
LPF = low pass filter
LV = low voltage
m = metre (distance)
mA = milliampere
MAX = maximum
MΩ = megohm
MEG = meg (10^6) (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(s) (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 = timed (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
VDCW = volts, dc, working (used in parts list)
V(F) = 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 ratic
VTO = voltage-tuned oscillator
VTVM = vacuum-tube voltmeter
V(X) = volts, switched
W = watt
W/ = with
WIV = 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}

6-12. DIRECT MAIL ORDER SYSTEM

6-13. Within the USA, Hewlett-Packard can supply parts through a direct mail order system. The advantages of using this system are:

a. Direct ordering and shipment from the HP Parts Center in Mountain View, California.

b. No maximum or minimum on any mail order (there is a minimum order amount for parts ordered through a local HP office when the order requires billing and invoicing).

c. Prepaid transportation (there is a small handling charge for each order).

d. No invoicing to provide these advantages, a check or money order must accompany each order.

6-14. Mail order forms and specific ordering information is available through your local HP office. Addresses and phone numbers are located at the back of this manual.

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1	05316-60015	0	1	BD AY-MAIN	28480	05316-60015
A1C1	0160-4557	0	7	CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A1C2	0160-4786	7	2	CAPACITOR-FXD 27PF +-5% 100VDC CER 0+-30	28480	0160-4786
A1C3	0160-4786	7		CAPACITOR-FXD 27PF +-5% 100VDC CER 0+-30	28480	0160-4786
A1C4	0160-4554	7	23	CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C5	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C6	0180-3834	6	11	CAPACITOR-FXD 33UF+-20% 10VDC TA	28480	0180-3834
A1C7	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C8	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C9	0160-4556	9	1	CAPACITOR-FXD 1000PF +-20% 100VDC CER	16299	CAC02X7R102M100A
A1C10	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C11	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C12	0180-3834	6		CAPACITOR-FXD 33UF+-20% 10VDC TA	28480	0180-3834
A1C13	0160-3879	7	15	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A1C14	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A1C15	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C16	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C17	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C18	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C19	0121-0168	9	1	CAPACITOR-V TRMR-PSTN .2-1.5PF 600V	28480	0121-0168
A1C20	0160-4386	3	1	CAPACITOR-FXD 33PF +-5% 200VDC CER 0+-30	28480	0160-4386
A1C21	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C22	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C23	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C24	0121-0475	1	1	CAPACITOR-V TRMR-POLYP 2-22PF 100V	D2540	2222 808 11229
A1C25	0160-4481	9	1	CAPACITOR-FXD 270PF +-5% 100VDC CER	51642	150-100-NP0-271J
A1C26	0180-3834	6		CAPACITOR-FXD 33UF+-20% 10VDC TA	28480	0180-3834
A1C27	0180-3834	6		CAPACITOR-FXD 33UF+-20% 10VDC TA	28480	0180-3834
A1C28	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C29	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C30	0180-3834	6		CAPACITOR-FXD 33UF+-20% 10VDC TA	28480	0180-3834
A1C31	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A1C32	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A1C33	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C34	0180-3834	6		CAPACITOR-FXD 33UF+-20% 10VDC TA	28480	0180-3834
A1C35	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A1C36	0180-3834	6		CAPACITOR-FXD 33UF+-20% 10VDC TA	28480	0180-3834
A1C37	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C38	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	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C41	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A1C42	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A1C43	0180-3834	6		CAPACITOR-FXD 33UF+-20% 10VDC TA	28480	0180-3834
A1C44	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C45	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C46	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A1C47	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A1C48	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A1C49	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A1C50	0180-2991	4	1	CAPACITOR-FXD 3900UF+100-10% 20VDC AL	56289	674D398H020JL5A
A1C51	0180-3484	2	1	CAPACITOR-FXD .017F+75-10% 15VDC AL	28480	0180-3484
A1C52	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A1C53	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A1C54	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A1C55	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A1C56	0160-4040	6	2	CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A1C57	0160-4521	8	2	CAPACITOR-FXD 12PF +-5% 200VDC CER 0+-30	28480	0160-4521
A1C58	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A1C59	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A1C60	0160-4521	8		CAPACITOR-FXD 12PF +-5% 200VDC CER 0+-30	28480	0160-4521
A1C61	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A1C62	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A1C63	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A1C64	0180-3834	6		CAPACITOR-FXD 33UF+-20% 10VDC TA	28480	0180-3834
A1C65	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A

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
A1C66	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A1C67	0180-2929	8	3	CAPACITOR-FXD 68UF+-10% 10VDC TA	28480	0180-2929
A1C68	0180-2929	8		CAPACITOR-FXD 68UF+-10% 10VDC TA	28480	0180-2929
A1C69	0180-2929	8		CAPACITOR-FXD 68UF+-10% 10VDC TA	28480	0180-2929
A1C70	0160-4814	2	3	CAPACITOR-FXD 150PF +-5% 100VDC CER	28480	0160-4814
A1C71	0180-3834	6		CAPACITOR-FXD 33UF+-20% 10VDC TA	28480	0180-3834
A1C72	0160-4814	2		CAPACITOR-FXD 150PF +-5% 100VDC CER	28480	0160-4814
A1C73	0180-3834	6		CAPACITOR-FXD 33UF+-20% 10VDC TA	28480	0180-3834
A1C74	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C75	0160-4814	2		CAPACITOR-FXD 150PF +-5% 100VDC CER	28480	0160-4814
A1CR1	1901-0518	8	5	DIODE-SM SIG SCHOTTKY	28480	1901-0518
A1CR2	1901-0050	3	7	DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A1CR3	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A1CR4	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A1CR5	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A1CR6	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A1CR7	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A1CR8	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A1CR9	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A1CR10	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A1CR11	1906-0286	7	1	DIODE-CT-S-BARR 35V 20A	04713	MBR2035CT
A1CR12	1901-0734	0	3	DIODE-PWR RECT 1N5818 30V 1A	04713	1N5818
A1CR13	1901-0734	0		DIODE-PWR RECT 1N5818 30V 1A	04713	1N5818
A1CR14	1902-0953	7	1	DIODE-ZNR 6.2V 5% DO-35 PD=.4W TC=+.053%	28480	1902-0953
A1CR15	1901-0734	0		DIODE-PWR RECT 1N5818 30V 1A	04713	1N5818
A1CR16	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A1CR17	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A1H1	0340-0620	2	2	INSULATOR-XSTR THRM-CNDCT	28480	0340-0620
A1H2	0515-0886	3	3	SCREW-MACH M3 X 0.5 6MM-LG PAN-HD	28480	0515-0886
A1H3	3050-0960	1	2	WASHER-SHLDR 3.0 MM 3.1-MM-ID 3.5-MM-OD	28480	3050-0960
A1J1	1251-4787	2	1	SHUNT-DIP 8 POSITION; DUAL INLINE PKG	28480	1251-4787
A1J2	1251-4215	1	1	CONNECTOR 6-PIN F POST TYPE	28480	1251-4215
A1J3	1251-0600	0	3	CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A1J4	1200-0639	8	1	SOCKET-IC 20-CONT DIP DIP-SLDR	28480	1200-0639
A1J5	1252-0268	8	1	CONN-RECT MICRORBN 24-CKT 24-CONT	28480	1252-0268
A1J6	1251-5063	9	1	CONNECTOR 6-PIN M POST TYPE	28480	1251-5063
A1J7	1251-5237	9	1	CONNECTOR 11-PIN M POST TYPE	28480	1251-5237
A1J8	1251-5281	3	1	CONN-POST TYPE .100-PIN-SPCG 12-CONT	28480	1251-5281
A1J9	1251-3638	0	1	CONNECTOR 6-PIN M POST TYPE	28480	1251-3638
A1JMP1	8159-0005	4	3	RESISTOR, ZERO OHMS	28480	8159-0005
A1JMP2	8159-0005	4		RESISTOR, ZERO OHMS	28480	8159-0005
A1JMP3	8159-0005	4		RESISTOR, ZERO OHMS	28480	8159-0005
A1L1	9140-0238	3	1	INDUCTOR RF-CH-MLD 82UH 5%	28480	9140-0238
A1L2	9140-0181	9	1	INDUCTOR RF-CH-MLD 22UH 5% .105DX.26LG	28480	9140-0604
A1L3	9100-1637	4	1	INDUCTOR RF-CH-MLD 120UH 5%	28480	9100-1637
A1L4	9140-0551	3	1	INDUCTOR RF-CH-MLD 10UH 5% .105DX.26LG	28480	9140-0551
A1MP1	0370-2486	5	7	PUSHBUTTON .230 X .390 X .397 IN H; JADE	28480	0370-2486
A1MP2	0370-2625	4	1	PUSHBUTTON .230 X .390 X .397 IN H	28480	0370-2625
A1MP3	0370-2917	7	1	PUSHBUTTON .230 X .390 X .397 IN H	28480	0370-2917
A1MP4	05316-00014	3	1	BRKT: HEATSINK	28480	05316-00014
A1MP5	1205-0318	0	1	HEAT SINK SGL TO-220-CS	28480	1205-0318
A1Q1	1853-0036	2	2	TRANSISTOR PNP SI PD=310MW FT=250MHZ	27014	2N3906
A1Q2	1854-0560	9		TRANSISTOR NPN SI DARL PD=310MW	04713	MPS A12
A1Q2	1854-0560	9	4	TRANSISTOR NPN SI DARL PD=310MW	04713	MPS A12
A1Q3	1854-0215	1	5	TRANSISTOR NPN SI TO-92 PD=350MW	04713	2N3904
A1Q4	1854-0215	1		TRANSISTOR NPN SI TO-92 PD=350MW	04713	2N3904
A1Q5	1854-0215	1		TRANSISTOR NPN SI TO-92 PD=350MW	04713	2N3904
A1Q6	1854-0560	9		TRANSISTOR NPN SI DARL PD=310MW	04713	MPS A12
A1Q6	1854-0560	9		TRANSISTOR NPN SI DARL PD=310MW	04713	MPS A12
A1Q7	1854-0215	1		TRANSISTOR NPN SI TO-92 PD=350MW	04713	2N3904
A1Q8	1853-0036	2		TRANSISTOR PNP SI PD=310MW FT=250MHZ	27014	2N3906
A1Q9	1854-0215	1		TRANSISTOR NPN SI TO-92 PD=350MW	04713	2N3904
A1Q10	1853-0363	8	2	TRANSISTOR PNP SI PD=50W FT=20MHZ	03508	X45H281
A1Q11	1854-0635	9	1	TRANSISTOR NPN SI PD=50W FT=20MHZ	03508	D44H5
A1Q12	1853-0363	8		TRANSISTOR PNP SI PD=50W FT=20MHZ	03508	X45H281

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
A1R1	0698-3442	9	3	RESISTOR 237 1% .125W F TC=0+-100	24546	CT4-1/8-T0-237R-F
A1R2	0757-0401	0	6	RESISTOR 100 1% .125W F TC=0+-100	24546	CT4-1/8-T0-101-F
A1R3	1810-0365	0	1	NETWORK-RES 6-SIP 2.2K OHM X 5	11236	750-61-R2.2K
A1R4	1810-0369	4	1	NETWORK-RES 6-SIP 100.0K OHM X 5	11236	750-61-R100K
A1R5	1810-0367	2	1	NETWORK-RES 6-SIP 4.7K OHM X 5	11236	750-61-R4.7K
A1R6	0698-0082	7	2	RESISTOR 464 1% .125W F TC=0+-100	24546	CT4-1/8-T0-4640-F
A1R7	0757-0288	1	1	RESISTOR 9.09K 1% .125W F TC=0+-100	19701	5033R-1/8-T0-9091-F
A1R8	0698-0082	7		RESISTOR 464 1% .125W F TC=0+-100	24546	CT4-1/8-T0-4640-F
A1R9	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	CT4-1/8-T0-101-F
A1R10	0698-3440	7	3	RESISTOR 196 1% .125W F TC=0+-100	24546	CT4-1/8-T0-196R-F
A1R11	0757-0465	6	3	RESISTOR 100K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1003-F
A1R12	0698-3442	9		RESISTOR 237 1% .125W F TC=0+-100	24546	CT4-1/8-T0-237R-F
A1R13	0698-3442	9		RESISTOR 237 1% .125W F TC=0+-100	24546	CT4-1/8-T0-237R-F
A1R14	2100-3789	4	1	RESISTOR-TRMR 20K 10% C TOP-ADJ 17-TRN	28480	2100-3789
A1R15	0698-3162	0	1	RESISTOR 46.4K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-4642-F
A1R16	0757-0394	0	1	RESISTOR 51.1 1% .125W F TC=0+-100	24546	CT4-1/8-T0-51R1-F
A1R17	0698-3440	7		RESISTOR 196 1% .125W F TC=0+-100	24546	CT4-1/8-T0-196R-F
A1R18	0698-3440	7		RESISTOR 196 1% .125W F TC=0+-100	24546	CT4-1/8-T0-196R-F
A1R19	1810-0405	9	1	NETWORK-RES 8-SIP 470.0 OHM X 4	11236	750-83-R470
A1R20	1810-0374	1	1	NETWORK-RES 8-SIP 1.0K OHM X 4	11236	750-83-R1K
A1R21	0698-3156	2	1	RESISTOR 14.7K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1472-F
A1R22	0698-0084	9	2	RESISTOR 2.15K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2151-F
A1R23	2100-3357	2	1	RESISTOR-TRMR 500K 10% C SIDE-ADJ 1-TRN	28480	2100-3357
A1R24	0757-0199	3	1	RESISTOR 21.5K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2152-F
A1R25	0698-7218	5	2	RESISTOR 178 1% .05W F TC=0+-100	24546	C3-1/8-T0-178R-F
A1R26	0698-7218	5		RESISTOR 178 1% .05W F TC=0+-100	24546	C3-1/8-T0-178R-F
A1R28	1810-0205	7	1	NETWORK-RES 8-SIP 4.7K OHM X 7	11236	750-81-R4.7K
A1R29	1810-0136	3	1	NETWORK-RES 10-SIP MULTI-VALUE	28480	1810-0136
A1R30	0698-3431	6	2	RESISTOR 23.7 1% .125W F TC=0+-100	03888	PME55-1/8-T0-23R7-F
A1R31	2100-3905	6	1	RESISTOR-VAR W/SW 500K 20% 10CW SPDT-NC	28480	2100-3905
A1R32	2100-3253	7	2	RESISTOR-TRMR 50K 10% C TOP-ADJ 1-TRN	28480	2100-3253
A1R33	2100-0567	0	2	RESISTOR-TRMR 2K 10% C TOP-ADJ 1-TRN	28480	2100-0567
A1R34	2100-3253	7		RESISTOR-TRMR 50K 10% C TOP-ADJ 1-TRN	28480	2100-3253
A1R35	2100-0567	0		RESISTOR-TRMR 2K 10% C TOP-ADJ 1-TRN	28480	2100-0567
A1R36	0757-0280	3	8	RESISTOR 1K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1001-F
A1R37	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1001-F
A1R38	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1001-F
A1R39	0698-6624	5	4	RESISTOR 2K .1% .125W F TC=0+-25	28480	0698-6624
A1R40	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1001-F
A1R41	0698-6624	5		RESISTOR 2K .1% .125W F TC=0+-25	28480	0698-6624
A1R42	0757-0279	0	1	RESISTOR 3.16K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-3161-F
A1R43	0698-6624	5		RESISTOR 2K .1% .125W F TC=0+-25	28480	0698-6624
A1R44	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1001-F
A1R45	0698-3260	9	2	RESISTOR 464K 1% .125W F TC=0+-100	28480	0698-3260
A1R46	0698-3260	9		RESISTOR 464K 1% .125W F TC=0+-100	28480	0698-3260
A1R47	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1001-F
A1R48	0698-6624	5		RESISTOR 2K .1% .125W F TC=0+-25	28480	0698-6624
A1R49	0698-3447	4	2	RESISTOR 422 1% .125W F TC=0+-100	24546	CT4-1/8-T0-422R-F
A1R50	0698-6360	6	5	RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A1R51	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A1R52	1810-0406	0	1	NETWORK-RES 8-SIP 10.0K OHM X 4	11236	750-83-R10K
A1R53	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1001-F
A1R54	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	CT4-1/8-T0-101-F
A1R55	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	CT4-1/8-T0-101-F
A1R56	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A1R57	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A1R58	0698-3441	8	1	RESISTOR 215 1% .125W F TC=0+-100	24546	CT4-1/8-T0-215R-F
A1R59	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A1R60	0757-0417	8	1	RESISTOR 562 1% .125W F TC=0+-100	24546	CT4-1/8-T0-562R-F
A1R61	0698-3447	4		RESISTOR 422 1% .125W F TC=0+-100	24546	CT4-1/8-T0-422R-F
A1R62	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1001-F
A1R63	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1003-F
A1R64	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1003-F
A1R65	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	CT4-1/8-T0-101-F
A1R66	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	CT4-1/8-T0-101-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
A1R67	0698-3431	6		RESISTOR 23.7 1% .125W F TC=0+-100	03888	PME55-1/8-T0-23R7-F
A1R68	0698-0084	9		RESISTOR 2.15K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2151-F
A1S1	3101-2922	8	1	SW PB DPDT 9POS	28480	3101-2922
A1S3	3101-2921	7	1	SW DPDT PC 90 DEG	28480	3101-2921
A1S4	3101-2215	2	1	SWITCH-RKR DIP-RKR-ASSY 7-1A .05A 30VDC	28480	3101-2215
A1TP1	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A1TP6	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A1U1	1820-1199	1	1	IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A1U2	1820-2922	0	1	IC GATE CMOS/74HC NAND QUAD 2-INP	04713	MC74HC00N
A1U3	1820-2228	9	1	IC LCH CMOS NAND R-S QUAD	04713	MC14044BCP
A1U4	1820-2333	7	1	IC-MCU;CLOCK=1MHZ;ROM;RAM;I/O;TIMER;UART	04713	MC6801P
A1U5	1820-2219	8	1	IC MICPROC-ACCESS NMOS 8-BIT	04713	MC68488P
A1U6	1820-1416	5	1	IC SCHMITT-TRIG TTL LS INV HEX 1-INP	01295	SN74LS14N
A1U7	1820-2131	3	1	IC-MCU; CLK FREQ=4 MHZ,W/ROM/RAM/4 I/O	50088	MK3870/20N MASKED
A1U8	1820-2312	2	1	IC MISC	28480	1DA9-2902
A1U9	1820-1266	3	2	IC BFR CMOS NON-INV HEX	27014	MM80C97N
A1U10	1820-3058	5	1	IC FF CMOS/74HC D-M/S POS-EDGE-TRIG COM	27014	MM74HC174N
A1U11	1820-0809	8	1	IC RCVR ECL LINE RCVR QUAD 2-INP	04713	MC10115P
A1U12	1820-1266	3		IC BFR CMOS NON-INV HEX	27014	MM80C97N
A1U13	1820-3692	3	3	IC ANLG-MUXR/DEMUXR CMOS/74HC 2-CHANNEL	27014	MM74HC4053N
A1U14	1820-1216	3	1	IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A1U15	1820-1491	6	1	IC BFR TTL LS NON-INV HEX 1-INP	01295	SN74LS367AN
A1U16	1820-2239	2	1	IC TRANSCEIVER TTL S BUS	27014	DP8304BN
A1U17	1820-1568	8	1	IC BFR TTL LS BUS QUAD	01295	SN74LS125AN
A1U18	1820-3329	3	2	IC TRANSCEIVER TTL INSTR-BUS IEEE-488	01295	MC3446N
A1U19	1820-3692	3		IC ANLG-MUXR/DEMUXR CMOS/74HC 2-CHANNEL	27014	MM74HC4053N
A1U20	1820-3692	3		IC ANLG-MUXR/DEMUXR CMOS/74HC 2-CHANNEL	27014	MM74HC4053N
A1U21	1826-0639	4	2	D/A 8-BIT 16-PLASTIC CMOS	24355	AD7524JN
A1U22	1826-0639	4		D/A 8-BIT 16-PLASTIC CMOS	24355	AD7524JN
A1U23	1820-1144	6	1	IC GATE TTL LS NOR QUAD 2-INP	01295	SN74LS02N
A1U24	1820-3329	3		IC TRANSCEIVER TTL INSTR-BUS IEEE-488	01295	MC3446N
A1U25	1826-0139	9	1	IC OP AMP GP DUAL 8-DIP-P PKG	3L585	CA1458G
A1U26	1826-0315	3	1	IC OP AMP GP QUAD 14-DIP-P PKG	27014	LM348N
A1U27	1826-0161	7	1	IC OP AMP GP QUAD 14-DIP-P PKG	04713	MLM324P
A1U28	1826-0544	0	1	IC V RGLTR-V-REF-FXD 2.5V 8-DIP-C PKG	28480	1826-0544
A1XJ1	1200-0607	0	1	SOCKET-IC 16-CONT DIP DIP-SLDR	28480	1200-0607
A1XU8	1200-0552	4	1	SOCKET-IC 40-CONT DIP-SLDR	28480	1200-0552
A1XY1	1251-1556	7	4	CONNECTOR-SGL CONT SKT .018-IN-BSC-SZ	28480	1251-1556
A1Y1	1813-0552	3	1	TCXO-10MHZ CMOS	28480	1813-0552

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
				NOTE: IF A2 OR A4 IS TO BE REPLACED, BOTH ASSEMBLIES MUST BE REPLACED AS A PAIR. ORDER HP PART NUMBER 05316-60105.		
A2	05316-60016	1	1	BD AY-DISP/INPUT	28480	05316-60016
A2C1	0180-3775	4	1	CAPACITOR-FXD 68UF-+20% 10VDC TA	28480	0180-3775
A2C2	0180-3834	6	1	CAPACITOR-FXD 33UF+-20% 10VDC TA	28480	0180-3834
A2C3	0160-3879	7	3	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C4	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C5	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C6	0160-5108	9	4	CAPACITOR-FXD .01UF +-10% 500VDC CER	28480	0160-5108
A2C7	0160-5108	9		CAPACITOR-FXD .01UF +-10% 500VDC CER	28480	0160-5108
A2C8	0160-4705	0	2	CAPACITOR-FXD 2.2PF +-.25PF 500VDC CER	28480	0160-4705
A2C9	0160-4527	4	1	CAPACITOR-FXD 56PF +-5% 200VDC CER 0+-30	28480	0160-4527
A2C10	0160-4705	0		CAPACITOR-FXD 2.2PF +-.25PF 500VDC CER	28480	0160-4705
A2C11	0160-4497	7	1	CAPACITOR-FXD 82PF +-5% 200VDC CER 0+-30	28480	0160-4497
A2C12	0160-5108	9		CAPACITOR-FXD .01UF +-10% 500VDC CER	28480	0160-5108
A2C13	0160-5108	9		CAPACITOR-FXD .01UF +-10% 500VDC CER	28480	0160-5108
A2CR1	1901-0376	6	4	DIODE-GEN PRP 35V 50MA DO-35	9N171	1N3595
A2CR2	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	9N171	1N3595
A2CR3	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	9N171	1N3595
A2CR4	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	9N171	1N3595
A2DS1	1990-0730	3	9	DISPLAY-NUM-SEG 1-CHAR .3-H RED	28480	5082-7611
A2DS2	1990-0730	3		DISPLAY-NUM-SEG 1-CHAR .3-H RED	28480	5082-7611
A2DS3	1990-0730	3		DISPLAY-NUM-SEG 1-CHAR .3-H RED	28480	5082-7611
A2DS4	1990-0730	3		DISPLAY-NUM-SEG 1-CHAR .3-H RED	28480	5082-7611
A2DS5	1990-0730	3		DISPLAY-NUM-SEG 1-CHAR .3-H RED	28480	5082-7611
A2DS6	1990-0730	3		DISPLAY-NUM-SEG 1-CHAR .3-H RED	28480	5082-7611
A2DS7	1990-0730	3		DISPLAY-NUM-SEG 1-CHAR .3-H RED	28480	5082-7611
A2DS8	1990-0730	3		DISPLAY-NUM-SEG 1-CHAR .3-H RED	28480	5082-7611
A2DS9	1990-0730	3		DISPLAY-NUM-SEG 1-CHAR .3-H RED	28480	5082-7611
A2DS10	1990-0757	4	1	LED-LAMP LUM-INT=1MCD IF=35MA-MAX BVR=5V	50522	MV57124
A2DS11	1990-0517	4	7	LED-LAMP LUM-INT=3MCD IF=20MA-MAX BVR=5V	28480	5082-4655
A2DS12	1990-0517	4		LED-LAMP LUM-INT=3MCD IF=20MA-MAX BVR=5V	28480	5082-4655
A2DS13	1990-0517	4		LED-LAMP LUM-INT=3MCD IF=20MA-MAX BVR=5V	28480	5082-4655
A2DS14	1990-0517	4		LED-LAMP LUM-INT=3MCD IF=20MA-MAX BVR=5V	28480	5082-4655
A2DS15	1990-0517	4		LED-LAMP LUM-INT=3MCD IF=20MA-MAX BVR=5V	28480	5082-4655
A2DS16	1990-0517	4		LED-LAMP LUM-INT=3MCD IF=20MA-MAX BVR=5V	28480	5082-4655
A2DS17	1990-0517	4		LED-LAMP LUM-INT=3MCD IF=20MA-MAX BVR=5V	28480	5082-4655
A2DS18	1990-0660	8	2	LED-LAMP LUM-INT=8MCD IF=20MA-MAX BVR=5V	28480	5082-4597
A2DS19	1990-0660	8		LED-LAMP LUM-INT=8MCD IF=20MA-MAX BVR=5V	28480	5082-4597
A2H1	05315-20201	1	2	SPACER-POTS	28480	05315-20201
A2H2	05315-20201	1		SPACER-POTS	28480	05315-20201
A2J3	1250-1594	1	2	CONNECTOR-RF BNC FEM SGL-HOLE-RR 50-OHM	28480	1250-1594
A2J4	1250-1594	1		CONNECTOR-RF BNC FEM SGL-HOLE-RR 50-OHM	28480	1250-1594
A2L1	9100-1618	1	1	INDUCTOR RF-CH-MLD 5.6UH 10%	28480	9100-1618
A2MP1	5040-8816	3	10	SWITCH CAP-IVORY	28480	5040-8816
A2MP2	8120-4920	5	1	CBL AY-20P DP 6'	28480	8120-4920
A2P1	1251-5063	9	1	CONNECTOR 6-PIN M POST TYPE	28480	1251-5063
A2R1	0757-0398	4	1	RESISTOR 75 1% .125W F TC=0+-100	24546	CT4-1/8-T0-75R0-F
A2R2	0698-3438	3	1	RESISTOR 147 1% .125W F TC=0+-100	24546	CT4-1/8-T0-147R-F
A2R3	1810-0452	6	2	NETWORK-RES 10-SIP MULTI-VALUE	28480	1810-0452
A2R4	2100-3729	2	2	RESISTOR-VAR CONTROL CCP 20K 10% LIN	01121	WP4H048P203UA
A2R5	2100-3729	2		RESISTOR-VAR CONTROL CCP 20K 10% LIN	01121	WP4H048P203UA
A2R6	1810-0452	6		NETWORK-RES 10-SIP MULTI-VALUE	28480	1810-0452
A2R7	2100-1788	9	2	RESISTOR-TRMR 500 10% C TOP-ADJ 1-TRN	73138	82PR500
A2R8	2100-1788	9		RESISTOR-TRMR 500 10% C TOP-ADJ 1-TRN	73138	82PR500
A2R9	0698-7277	6	2	RESISTOR 51.1K 1% .05W F TC=0+-100	24546	C3-1/8-T0-5112-F
A2R10	0698-8827	4	2	RESISTOR 1M 1% .125W F TC=0+-100	28480	0698-8827

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
A2R11	0698-7194	6	2	RESISTOR 17.8 1% .05W F TC=0+-100	24546	C3-1/8-T0-17R8-F
A2R12	0757-0472	5	2	RESISTOR 200K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2003-F
A2R13	0698-7277	6		RESISTOR 51.1K 1% .05W F TC=0+-100	24546	C3-1/8-T0-5112-F
A2R14	0698-7194	6		RESISTOR 17.8 1% .05W F TC=0+-100	24546	C3-1/8-T0-17R8-F
A2R15	0698-7188	8	1	RESISTOR 10 1% .05W F TC=0+-100	24546	C3-1/8-T0-10R-F
A2R16	0698-8827	4		RESISTOR 1M 1% .125W F TC=0+-100	28480	0698-8827
A2R17	0757-0472	5		RESISTOR 200K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2003-F
A2SW1	3101-2124	2	10	SWITCH-PB DPDT ALTNG .25A 115 VAC	28480	3101-2124
A2SW2	3101-2124	2		SWITCH-PB DPDT ALTNG .25A 115 VAC	28480	3101-2124
A2SW3	3101-2124	2		SWITCH-PB DPDT ALTNG .25A 115 VAC	28480	3101-2124
A2SW4	3101-2124	2		SWITCH-PB DPDT ALTNG .25A 115 VAC	28480	3101-2124
A2SW5	3101-2124	2		SWITCH-PB DPDT ALTNG .25A 115 VAC	28480	3101-2124
A2SW6	3101-2124	2		SWITCH-PB DPDT ALTNG .25A 115 VAC	28480	3101-2124
A2SW7	3101-2124	2		SWITCH-PB DPDT ALTNG .25A 115 VAC	28480	3101-2124
A2SW8	3101-2124	2		SWITCH-PB DPDT ALTNG .25A 115 VAC	28480	3101-2124
A2SW9	3101-2124	2		SWITCH-PB DPDT ALTNG .25A 115 VAC	28480	3101-2124
A2SW10	3101-2124	2		SWITCH-PB DPDT ALTNG .25A 115 VAC	28480	3101-2124
A2TPA	1251-0600	0	2	CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A2TPB	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A2U1	1820-4688	9	1	IC DRVR CMOS DSPL LED	11307	ICM7218AIPI
A2U2	1820-1688	3	1	IC DCDR TTL LS BCD-TO-7-SEG	01295	SN74LS247N
A2XDS1	1200-0805	0	9	SOCKET-DSPL 14-CONT DIP DIP-SLDR	28480	1200-0805
A2XDS2	1200-0805	0		SOCKET-DSPL 14-CONT DIP DIP-SLDR	28480	1200-0805
A2XDS3	1200-0805	0		SOCKET-DSPL 14-CONT DIP DIP-SLDR	28480	1200-0805
A2XDS4	1200-0805	0		SOCKET-DSPL 14-CONT DIP DIP-SLDR	28480	1200-0805
A2XDS5	1200-0805	0		SOCKET-DSPL 14-CONT DIP DIP-SLDR	28480	1200-0805
A2XDS6	1200-0805	0		SOCKET-DSPL 14-CONT DIP DIP-SLDR	28480	1200-0805
A2XDS7	1200-0805	0		SOCKET-DSPL 14-CONT DIP DIP-SLDR	28480	1200-0805
A2XDS8	1200-0805	0		SOCKET-DSPL 14-CONT DIP DIP-SLDR	28480	1200-0805
A2XDS9	1200-0805	0		SOCKET-DSPL 14-CONT DIP DIP-SLDR	28480	1200-0805
A2XDS10	4040-1615	5	8	STANDOFF-LED .196-IN-WD .196-IN-LG BLK	28480	4040-1615
A2XDS11	4040-1615	5		STANDOFF-LED .196-IN-WD .196-IN-LG BLK	28480	4040-1615
A2XDS12	4040-1615	5		STANDOFF-LED .196-IN-WD .196-IN-LG BLK	28480	4040-1615
A2XDS13	4040-1615	5		STANDOFF-LED .196-IN-WD .196-IN-LG BLK	28480	4040-1615
A2XDS14	4040-1615	5		STANDOFF-LED .196-IN-WD .196-IN-LG BLK	28480	4040-1615
A2XDS15	4040-1615	5		STANDOFF-LED .196-IN-WD .196-IN-LG BLK	28480	4040-1615
A2XDS16	4040-1615	5		STANDOFF-LED .196-IN-WD .196-IN-LG BLK	28480	4040-1615
A2XDS17	4040-1615	5		STANDOFF-LED .196-IN-WD .196-IN-LG BLK	28480	4040-1615
A2XDS18	4040-1616	6	2	STANDOFF-LED .196-IN-WD .196-IN-LG BLK	28480	4040-1616
A2XDS19	4040-1616	6		STANDOFF-LED .196-IN-WD .196-IN-LG BLK	28480	4040-1616
A3				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
				NOTE: IF A2 OR A4 IS TO BE REPLACED, BOTH ASSEMBLIES MUST BE REPLACED AS A PAIR. ORDER HP PART NUMBER 05316-60105.		
A4	05315-60004	6	1	BD AY-INPUT AMP	28480	05315-60004
A4C1	0180-2815	1	2	CAPACITOR-FXD 100UF+-20% 10VDC TA	28480	0180-2815
A4C2	0160-3875	3	2	CAPACITOR-FXD 22PF +-5% 200VDC CER 0+-30	28480	0160-3875
A4C3	0180-2815	1		CAPACITOR-FXD 100UF+-20% 10VDC TA	28480	0180-2815
A4C4	0180-0418	6	1	CAPACITOR-FXD 1UF+-20% 35VDC TA	28480	0180-0418
A4C5	0160-3877	5	2	CAPACITOR-FXD 100PF +-20% 200VDC CER	28480	0160-3877
A4C6	0160-3879	7	13	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A4C7	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A4C8	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A4C9	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A4C10	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A4C11	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A4C12	0160-3875	3		CAPACITOR-FXD 22PF +-5% 200VDC CER 0+-30	28480	0160-3875
A4C13	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A4C14	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A4C15	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A4C16	0180-2662	6	2	CAPACITOR-FXD 10UF+-10% 10VDC TA	25088	D4R7GS1A10K
A4C17	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A4C18	0160-3877	5		CAPACITOR-FXD 100PF +-20% 200VDC CER	28480	0160-3877
A4C19	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A4C20	0180-2662	6		CAPACITOR-FXD 10UF+-10% 10VDC TA	25088	D4R7GS1A10K
A4C21	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A4C22	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A4CR1	1901-0518	8	2	DIODE-SM SIG SCHOTTKY	28480	1901-0518
A4CR2	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A4H1	2360-0113	2	4	SCREW-MACH 6-32 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A4P1A	1251-3768	7	2	CONTACT-CONN U/W-POST-TYPE MALE DPSLDR	28480	1251-3768
A4P1B	1252-0112	1	1	CONN-POST TYPE .100-PIN-SPCG 36-CONT	28480	1252-0112
A4P2	1251-5282	4	1	CONN-POST TYPE .100-PIN-SPCG 12-CONT	28480	1251-5282
A4Q1	1854-0345	8	2	TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW	04713	2N5179
A4Q2	1855-0213	1	2	TRANSISTOR-JFET DUAL N-CHAN D-MODE TO-78	28480	1855-0213
A4Q3	1854-0345	8		TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW	04713	2N5179
A4Q4	1855-0213	1		TRANSISTOR-JFET DUAL N-CHAN D-MODE TO-78	28480	1855-0213
A4R1	2100-1984	7	2	RESISTOR-TRMR 100 10% C TOP-ADJ 1-TRN	73138	82PR100
A4R2	0698-3441	8	3	RESISTOR 215 1% .125W F TC=0+-100	24546	CT4-1/8-T0-215R-F
A4R3	0757-0416	7	4	RESISTOR 511 1% .125W F TC=0+-100	24546	CT4-1/8-T0-511R-F
A4R4	0698-3449	6	2	RESISTOR 28.7K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2872-F
A4R5	0757-0278	9	2	RESISTOR 1.78K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1781-F
A4R6	0698-7218	5	2	RESISTOR 178 1% .05W F TC=0+-100	24546	C3-1/8-T0-178R-F
A4R7	0698-7228	7	2	RESISTOR 464 1% .05W F TC=0+-100	24546	C3-1/8-T0-464R-F
A4R9	0698-7228	7		RESISTOR 464 1% .05W F TC=0+-100	24546	C3-1/8-T0-464R-F
A4R10	0698-7209	4	1	RESISTOR 75 1% .05W F TC=0+-100	24546	C3-1/8-T0-75R0-F
A4R11	0698-3441	8		RESISTOR 215 1% .125W F TC=0+-100	24546	CT4-1/8-T0-215R-F
A4R12	0757-0417	8	2	RESISTOR 562 1% .125W F TC=0+-100	24546	CT4-1/8-T0-562R-F
A4R13	0698-7227	6	1	RESISTOR 422 1% .05W F TC=0+-100	24546	C3-1/8-T0-422R-F
A4R14	0757-0401	0	1	RESISTOR 100 1% .125W F TC=0+-100	24546	CT4-1/8-T0-101-F
A4R15	0698-3449	6		RESISTOR 28.7K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2872-F
A4R16	0757-0278	9		RESISTOR 1.78K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1781-F
A4R17	1810-0219	3	1	NETWORK-RES 8-SIP 220.0 OHM X 4	11236	750-83-R220
A4R19	0698-7218	5		RESISTOR 178 1% .05W F TC=0+-100	24546	C3-1/8-T0-178R-F
A4R20	1810-0203	5	1	NETWORK-RES 8-SIP 470.0 OHM X 7	11236	750-81-R470
A4R21	0757-0439	4	2	RESISTOR 6.81K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-6811-F
A4R22	0757-0418	9	2	RESISTOR 619 1% .125W F TC=0+-100	24546	CT4-1/8-T0-619R-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
A4R23	0757-0418	9		RESISTOR 619 1% .125W F TC=0+-100	24546	CT4-1/8-T0-619R-F
A4R24	0757-0283	6	2	RESISTOR 2K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2001-F
A4R25	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	CT4-1/8-T0-511R-F
A4R26	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	CT4-1/8-T0-511R-F
A4R27	0757-0421	4	2	RESISTOR 825 1% .125W F TC=0+-100	24546	CT4-1/8-T0-825R-F
A4R28	0698-3441	8		RESISTOR 215 1% .125W F TC=0+-100	24546	CT4-1/8-T0-215R-F
A4R29	0757-0439	4		RESISTOR 6.81K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-6811-F
A4R30	0757-0417	8		RESISTOR 562 1% .125W F TC=0+-100	24546	CT4-1/8-T0-562R-F
A4R31	0757-0421	4		RESISTOR 825 1% .125W F TC=0+-100	24546	CT4-1/8-T0-825R-F
A4R32	2100-1984	7		RESISTOR-TRMR 100 10% C TOP-ADJ 1-TRN	73138	82PR100
A4R33	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	CT4-1/8-T0-511R-F
A4R34	0757-0283	6		RESISTOR 2K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2001-F
A4TP1	0360-0124	3	1	CONNECTOR-SGL CONT PIN .04-IN-BSC-SZ RND	28480	0360-0124
A4U1	1858-0040	8	1	TRANSISTOR ARRAY 16-PIN PLSTC DIP	3L585	CA3127E
A4U2	1826-0426	7	1	IC COMPARATOR HS DUAL 16-DIP-C PKG	34335	AM687ADL
A4U3	1821-0001	4	1	TRANSISTOR ARRAY 14-PIN PLSTC DIP	3L585	CA3046
A5				NOT ASSIGNED		
A6				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
A7	05316-60007	0	1	BD AY-TCXO OPTION 001	28480	05316-60007
A7C1	0180-0562	1	1	CAPACITOR-FXD 33UF+-20% 10VDC TA	56289	199D1120
A7H1	2360-0113	2	2	SCREW-MACH 6-32 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A7P1	1251-4510	9	1	CONNECTOR 6-PIN M POST TYPE	28480	1251-4510
A7R1	0757-0416	7	2	RESISTOR 511 1% .125W F TC=0+-100	24546	CT4-1/8-T0-511R-F
A7R2	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	CT4-1/8-T0-511R-F
A7Y1	0960-0612	6	1	CRYSTAL-OSCILLATOR 10.0 MHZ; 0-55 DEG C	28480	0960-0612

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
A7	05316-60013	8	1	BRD ASSY-REGULATOR	28480	05316-60013
A7C1	0180-2662	6	1	CAPACITOR-FXD 10UF+-10% 10VDC TA	25088	D4R7GS1A10K
A7C2	0160-4554	7	2	CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A7C3	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A7C4	0180-0418	6	1	CAPACITOR-FXD 1UF+-20% 35VDC TA	28480	0180-0418
A7C5	0160-4511	6	1	CAPACITOR-FXD 220PF +-5% 200VDC CER	28480	0160-4511
A7CR1	1902-3059	0	1	DIODE-ZNR 3.83V 5% DO-35 PD=.4W	28480	1902-3059
A7H1	2360-0113	2	2	SCREW-MACH 6-32 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A7P1	1205-0219	0	1	HEAT SINK SGL TO-66-CS	28480	1205-0219
A7PA	1251-4510	9	1	CONNECTOR 6-PIN M POST TYPE	28480	1251-4510
A7Q1	1853-0363	8	1	TRANSISTOR PNP SI PD=50W FT=20MHZ	03508	X45H281
A7R1	0757-0428	1	2	RESISTOR 1.62K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1621-F
A7R2	2100-3349	2	1	RESISTOR-TRMR 100 10% C SIDE-ADJ 1-TRN	28480	2100-3349
A7R3	0757-0280	3	2	RESISTOR 1K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1001-F
A7R4	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1001-F
A7R5	0757-0428	1		RESISTOR 1.62K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1621-F
A7R6	0757-0401	0	1	RESISTOR 100 1% .125W F TC=0+-100	24546	CT4-1/8-T0-101-F
A7U1	1820-0493	6	1	IC OP AMP GP 8-DIP-P PKG	27014	LM307N
A7U2	1826-0544	0	1	IC V RGLTR-V-REF-FXD 2.5V 8-DIP-C PKG	28480	1826-0544
A7W1	05316-60103	7	1	CBL AY- OSC	28480	05316-60103
	0340-0468	6	1	INSULATOR-XSTR NYLON	28480	0340-0468
	0340-0620	2	1	INSULATOR-XSTR THRM-CNDCT	28480	0340-0620
A13	0960-0603	5	1	OVEN OSCILLATOR OPTION 004	28480	0960-0603
				NOTE:		
				A13 PART NUMBER 0960-0603 DOES NOT INCLUDE A13C1, E1 OR E2.		
A13C1	0160-4556	9	1	CAPACITOR-FXD 1000PF +-20% 100VDC CER	16299	CAC02X7R102M100A
A13E1	9170-0029	3	2	CORE-SHIELDING BEAD	28480	9170-0029
A13E2	9170-0029	3		CORE-SHIELDING BEAD	28480	9170-0029
A13H1	2200-0101	0	3	SCREW-MACH 4-40 .188-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A13H2	0515-1508	8	3	SCREW-MACH M3 X 0.5 4MM-LG PAN-HD	28480	0515-1508
A13MP1	05316-00015	4	1	BRKT: OVEN OSC	28480	05316-00015

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
A9	05315-60009	1	1	BD AY-FREQ C OPTION 003	28480	05315-60009
A9C1	0160-0576	5	19	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A9C2	0180-2662	6	3	CAPACITOR-FXD 10UF+-10% 10VDC TA	25088	D4R7GS1A10K
A9C4	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A9C4	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A9C5	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A9C5	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A9C6	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A9C6	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A9C7	0180-2662	6		CAPACITOR-FXD 10UF+-10% 10VDC TA	25088	D4R7GS1A10K
A9C9	0160-3878	6	1	CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A9C10	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A9C11	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A9C12	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A9C13	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A9C14	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A9C15	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A9C16	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A9C17	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A9C18	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A9C19	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A9C20	0180-2662	6		CAPACITOR-FXD 10UF+-10% 10VDC TA	25088	D4R7GS1A10K
A9C21	0160-0127	2	1	CAPACITOR-FXD 1UF +-20% 50VDC CER	28480	0160-0127
A9C22	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A9C23	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A9CR1	1901-0535	9	4	DIODE-SM SIG SCHOTTKY	28480	1901-0535
A9CR2	1901-0535	9		DIODE-SM SIG SCHOTTKY	28480	1901-0535
A9CR3	1901-0050	3	2	DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A9CR4	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A9CR5	1902-0041	4	1	DIODE-ZNR 5.11V 5% DO-35 PD=.4W	07263	1N751A
A9CR6	1901-0535	9		DIODE-SM SIG SCHOTTKY	28480	1901-0535
A9CR7	1901-0535	9		DIODE-SM SIG SCHOTTKY	28480	1901-0535
A9CR8	1902-0551	1	1	DIODE-ZNR 6.2V 5% PD=1W IR=10UA	28480	1902-0551
A9H1	2360-0113	2	4	SCREW-MACH 6-32 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A9H2	2190-0068	5	1	WASHER-LK INTL T 1/2 IN .505-IN-ID	28480	2190-0068
A9H3	2950-0054	1	1	NUT-HEX-DBL-CHAM 1/2-28-THD .125-IN-THK	00000	ORDER BY DESCRIPTION
A9H4	2190-0577	1	1	WASHER-LK HLCL NO. 10 .194-IN-ID	28480	2190-0577
A9J1	1250-1899	9	1	ADAPTER-COAX STR F-BNC M-SMC	28480	1250-1899
A9L1	9100-1788	6	2	CORE-FERRITE CHOKE-WIDEBAND;IMP:>680	28480	9100-1788
A9L2	9100-1788	6		CORE-FERRITE CHOKE-WIDEBAND;IMP:>680	28480	9100-1788
A9L3	9100-2272	5	3	INDUCTOR RF-CH-MLD 47UH 10%	28480	9100-2272
A9L4	9100-2272	5		INDUCTOR RF-CH-MLD 47UH 10%	28480	9100-2272
A9L5	9100-2272	5		INDUCTOR RF-CH-MLD 47UH 10%	28480	9100-2272
A9P1A	1251-1556	7	24	CONNECTOR-SGL CONT SKT .018-IN-BSC-SZ	28480	1251-1556
A9P1B	1251-5621	5	1	CONNECTOR 12-PIN F POST TYPE	28480	1251-5621
A9Q1	1853-0281	9	1	TRANSISTOR PNP 2N2907A SI TO-18 PD=400MW	04713	2N2907A
A9Q2	1855-0420	2	2	TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A9Q3	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A9R1	0698-7234	5	5	RESISTOR 825 1% .05W F TC=0+-100	24546	C3-1/8-TO-825R-F
A9R2	0698-7234	5		RESISTOR 825 1% .05W F TC=0+-100	24546	C3-1/8-TO-825R-F
A9R3	0698-7205	0	3	RESISTOR 51.1 1% .05W F TC=0+-100	24546	C3-1/8-TO-51R1-F
A9R4	0698-7234	5		RESISTOR 825 1% .05W F TC=0+-100	24546	C3-1/8-TO-825R-F
A9R5	0698-7205	0		RESISTOR 51.1 1% .05W F TC=0+-100	24546	C3-1/8-TO-51R1-F
A9R5	0698-7205	0		RESISTOR 51.1 1% .05W F TC=0+-100	24546	C3-1/8-TO-51R1-F
A9R6	0698-7258	3	1	RESISTOR 8.25K 1% .05W F TC=0+-100	24546	C3-1/8-TO-8251-F
A9R7	0698-7199	1	2	RESISTOR 28.7 1% .05W F TC=0+-100	24546	C3-1/8-TO-28R7-F
A9R8	0698-7199	1		RESISTOR 28.7 1% .05W F TC=0+-100	24546	C3-1/8-TO-28R7-F
A9R9	2100-2061	3	3	RESISTOR-TRMR 200 10% C TOP-ADJ 1-TRN	73138	82PR200
A9R10	0698-7276	5	2	RESISTOR 46.4K 1% .05W F TC=0+-100	24546	C3-1/8-TO-4642-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
A9R11	0698-7250	5	1	RESISTOR 3.83K 1% .05W F TC=0+-100	24546	C3-1/8-T0-3831-F
A9R12	0698-7269	6	1	RESISTOR 23.7K 1% .05W F TC=0+-100	24546	C3-1/8-T0-2372-F
A9R13	0698-7243	6	1	RESISTOR 1.96K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1961-F
A9R14	2100-2060	2	1	RESISTOR-TRMR 50 20% C TOP-ADJ 1-TRN	73138	82PR50
A9R15	0698-7234	5		RESISTOR 825 1% .05W F TC=0+-100	24546	C3-1/8-T0-825R-F
A9R16	2100-2061	3		RESISTOR-TRMR 200 10% C TOP-ADJ 1-TRN	73138	82PR200
A9R17	0698-7212	9	1	RESISTOR 100 1% .05W F TC=0+-100	24546	C3-1/8-T0-100R-F
A9R18	2100-2061	3		RESISTOR-TRMR 200 10% C TOP-ADJ 1-TRN	73138	82PR200
A9R19	0698-7234	5		RESISTOR 825 1% .05W F TC=0+-100	24546	C3-1/8-T0-825R-F
A9R20	0698-7276	5		RESISTOR 46.4K 1% .05W F TC=0+-100	24546	C3-1/8-T0-4642-F
A9U1	1826-0589	3	1	IC MISC TO-8 PKG	28480	1826-0589
A9U2	1826-0138	8	1	IC COMPARATOR GP QUAD 14-DIP-P PKG	01295	LM339N
A9U3	1820-2382	6	1	IC DIVR ECL DECD	28480	1DC2A
A9W1	05315-60104	7	1	CBL AY-FREQ C	28480	05315-60104
A9XU3	1205-0375	9	1	HEAT SINK SGL TO-8-CS	05820	211-CB
	0360-0124	3	5	CONNECTOR-SGL CONT PIN .04-IN-BSC-SZ RND	28480	0360-0124
	05316-00016	5	1	PANEL: FRT #003	28480	05316-00016

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
				5316B MISCELLANEOUS PARTS		
F1	2110-0044	9	1	FUSE .3A 250V TD 1.25X.25 UL	28480	2110-0044
F1	2110-0320	4	1	FUSE .15A 250V TD 1.25X.25 UL	75915	313.150
H1	0380-1332	9	2	STANDOFF-HEX .18-IN-LG 6-32-THD	28480	0380-1332
H1	2950-0035	8	2	NUT-HEX-DBL-CHAM 15/32-32-THD	00000	ORDER BY DESCRIPTION
H2	2950-0072	3	4	NUT-HEX-DBL-CHAM 1/4-32-THD .062-IN-THK	00000	ORDER BY DESCRIPTION
H3	0515-0886	3	4	SCREW-MACH M3.0 X 0.6 6MM-LG PAN-HD	28480	0515-0886
H4	0515-0898	1	2	SCREW-MACH M4 X 0.5 6MM-LG PAN-HD	28480	0515-0898
H5	0515-0898	7	2	SCREW-MACH M4 X 0.7 6MM-LG PAN-HD	28480	0515-0898
H6	0535-0031	2	1	NUT-HEX W/LKWR M3 X 0.5 2.4MM-THK	00000	ORDER BY DESCRIPTION
J9	0380-1332	9		STANDOFF-HEX .18-IN-LG 6-32-THD	28480	0380-1332
J8H1	2950-0001	8	1	NUT-HEX-DBL-CHAM 3/8-32-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
J8H2	2190-0016	3	1	WASHER-LK INTL T 3/8 IN .377-IN-ID	28480	2190-0016
MP1	03478-88301	6	1	BEZEL-FRONT	28480	03478-88301
MP2	03478-88302	7	1	BEZEL-REAR	28480	03478-88302
MP3	05316-00011	0	1	CHASSIS	28480	05316-00011
MP4	05316-00012	1	1	COVER	28480	05316-00012
MP5	05316-00013	2	1	PANEL FRONT STD	28480	05316-00013
MP6	05316-00016	5	1	PANEL: FRT #003	28480	05316-00016
MP7	1460-1345	5	2	TILT STAND SST	28480	1460-1345
MP8	05316-40003	4	1	WINDOW	28480	05316-40003
MP9	5001-0438	7	2	TRIM-SIDE	28480	5001-0438
MP10	5040-7201	8	4	FOOT	28480	5040-7201
MP11	0370-1005	2	3	KNOB-BASE-PTR 3/8 JGK .125-IN-ID	28480	0370-1005
T1	9100-4647	2	1	TRANSFORMER-PWR	28480	9100-4647
W1	8120-1378	1	1	CABLE ASSY 18AWG 3-CNDCT JGK-JKT	28480	8120-1378
W2	05316-60101	5	1	CBL AY-DAC	28480	05316-60101
W3	05315-60114	9	1	CBL AY-EXT OSC	28480	05315-60114
W4	05316-60102	6	2	CBL AY-TRIG LEV	28480	05316-60102
W5	05316-60102	6		CBL AY-TRIG LEV	28480	05316-60102
	0960-0444	2	1	LINE MODULE-UNFILTERED	28480	0960-0444

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

Table 6-3. Manufacturers Code List

Mfr Code	Manufacturer Name	Address	Zip Code
D2540	VALVO GMBH	HAMBURG GM	2000
00000	ANY SATISFACTORY SUPPLIER		
01121	ALLEN-BRADLEY CO INC	EL PASO TX US	79935
01295	TEXAS INSTRUMENTS INC	DALLAS TX US	75265
03508	GE CO SEMICONDUCTOR PROD DEPT	AUBURN NY US	13201
03888	K D I PYROFILM CORP	WHIPPANY NJ	07981
04713	MOTOROLA INC SEMI-COND PROD	PHOENIX AZ US	85008
05820	EG & G WAKEFIELD ENGR INC	WAKEFIELD MA US	01880
07263	FAIRCHILD CORP	MOUNTAIN VIEW CA US	94042
11236	CTS CORP BERNE DIV	BERNE IN US	46711
11307	DELTA COILS	PHILADELPHIA PA	19127
16299	CORNING ELECTRONICS	RALEIGH NC US	27604
19701	MEPCO/CENTRALAB INC	WEST PALM BEACH FL US	33407
24355	ANALOG DEVICES INC	NORWOOD MA US	02062
24546	CORNING ELECTRONICS	SANTA CLARA CA US	95050
25088	SIEMENS CORP	ISELIN NJ US	08830
27014	NATIONAL SEMICONDUCTOR CORP	SANTA CLARA CA US	95052
28480	HEWLETT-PACKARD CO CORPORATE HQ	PALO ALTO CA	94304
3L585	RCA CORP SOLID STATE DIV	SOMERVILLE NJ	
34335	ADVANCED MICRO DEVICES INC	SUNNYVALE CA US	94086
50088	MOSTEK CORP	CARROLLTON TX US	75006
50522	GENERAL INSTR CORP OPTO DIV	PALO ALTO CA	94304
51642	CENTRE ENGINEERING INC	STATE COLLEGE PA	16801
56289	SPRAGUE ELECTRIC CO	NORTH ADAMS MA	01247
73138	BECKMAN INDUSTRIAL CORP	FULLERTON CA US	92632
75915	LITTELFUSE INC	DES PLAINES IL US	60016
9N171	UNITRODE CORP	LEXINGTON MA US	02173

SECTION VII
MANUAL CHANGES

7-1. INTRODUCTION

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

7-3. MANUAL CHANGES

7-4. Newer Instruments

7-5. As engineering changes are made, newer instruments have serial numbers higher than those listed on the title page of this manual. Instruments having serial number prefixes higher than those listed on the title page of this manual are covered with a "Manual Changes" sheet included with this manual. If this change sheet is missing, the information can be supplied by any Hewlett-Packard Sales and Service Office listed at the back of this manual.

SECTION VIII
SERVICE

WARNING

IF THE POWER MODULE COVER IS REMOVED, LINE VOLTAGE IS EXPOSED WITHIN THE HP 5316B EVEN WHEN THE POWER SWITCH IS IN THE STBY POSITION.

8-1. INTRODUCTION

8-2. This section contains the information required to service the HP 5316B Universal Counter. The information includes theory of operation, troubleshooting, safety considerations, service aids, block diagram, and schematic diagrams. This section also includes a cross-reference table, *Table 8-1*, to aid the correlation of assembly reference designations with their HP part numbers.

8-3. THEORY OF OPERATION

8-4. The overall theory of operation begins with paragraph 8-28 and references the overall block diagram, *Figure 8-2*. The detailed theory of operation for each assembly is located adjacent to the schematic diagram for that particular assembly.

8-5. TROUBLESHOOTING

8-6. Troubleshooting for the HP 5316B is performed by isolating the defective block as described in troubleshooting, paragraph 8-40, and then referring to that particular schematic. Each schematic section contains the detailed theory of operation, detailed troubleshooting information, schematic diagram, and repair considerations.

8-7. The schematic diagrams for all the assemblies are located at the end of this section.

8-8. RECOMMENDED TEST EQUIPMENT

8-9. The test equipment required to service the HP 5316B is listed in *Table 1-4*. Equipment other than that listed may be substituted if it meets or exceeds the critical specifications.

8-10. SCHEMATIC DIAGRAM NOTES

8-11. *Figure 8-1* shows the symbols used on the schematic diagrams. *Figure 8-1* also shows the method of assigning reference designators, assembly numbers, and subassembly numbers.

8-12. Reference Designations

8-13. Assemblies such as printed circuit boards are assigned numbers in sequence, A1, A2, etc., as shown in *Table 8-1*. Reference designators for individual components are determined by adding the assembly number with the component number. For example, CR1 on assembly A1 is designated A1CR1.

SYMBOLS

DANGEROUS VOLTAGE, EXCEEDS 1000 VOLTS

FRONT PANEL LABEL

REAR PANEL LABEL

INTERIOR AND PC BOARDS LABEL

WIPER MOVES TOWARD "CW" WHEN CONTROL IS ROTATED CLOCKWISE

OR PROTECTIVE CONDUCTOR TERMINAL

CIRCUIT COMMON

IDENTIFIED COMMON

OR CHASSIS TERMINAL

KNOB CONTROL

SCREWDRIVER ADJUST

MAIN SIGNAL PATH

FEEDBACK PATH

OR OR TEST POINT

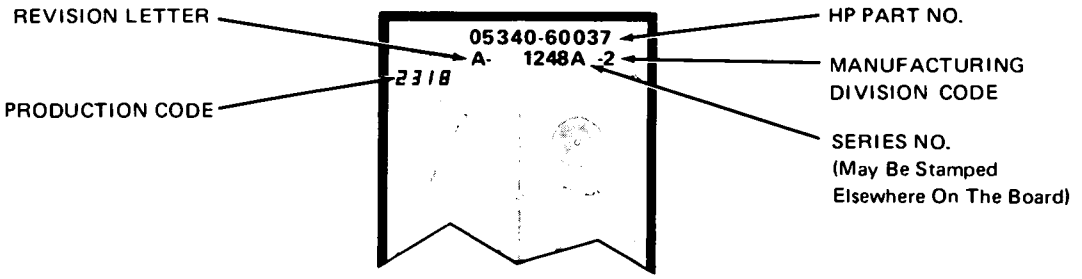
INSTRUCTION MANUAL REFERENCE

ALTERNATING CURRENT

DIRECT CURRENT

ALTERNATING OR DIRECT CURRENT

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

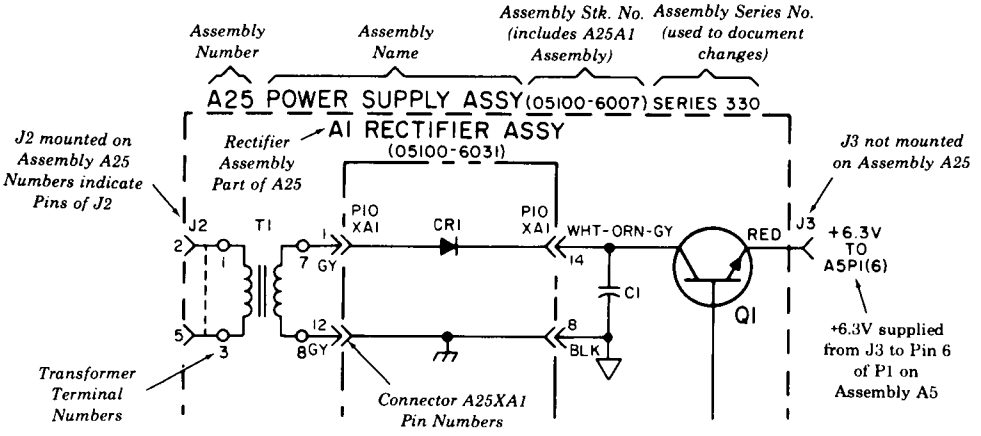


Figure 8-1. Schematic Diagrams Notes

8-14. Identification Markings on Printed Circuit Boards

8-15. HP printed circuit boards (see *Figure 8-1*) have four identification numbers; an assembly number, a series number, a revision letter, and a production code. The assembly part number has 10 digits, such as 05316-60015, and is the primary identification. All assemblies with the same part number are interchangeable. When a production change is made to an assembly that makes it incompatible with the previous assembly, the part number is changed. The series number, such as 2120, is used to document minor electrical changes. As changes are made, the series number is incremented. When replacement assemblies are ordered, you may receive a replacement with a different series number. If a difference is found between the series number marked on the assembly and the number on the schematic, then minor electrical difference exist. If the series number on the assembly is lower than that on the schematic, then refer to Section VII, Manual Changes. Section VII contains documentation of the lower series assemblies. If the number is higher, then refer to the yellow looseleaf manual change sheets for this manual. If the manual change sheets are missing, contact your local HP Sales and Service Office. See the listings at the back of this manual.

8-16. Revision letters (A, B, etc.) denote changes in the printed circuit layout. For example, if a capacitor type is changed (the electrical value may remain the same) and requires different lead spacing, then the layout is changed and the revision letter is incremented. When the revision letter changes, then the series number usually changes. The production code is the seven-segment number used for production purposes.

8-17. SAFETY CONSIDERATIONS

8-18. Although the HP 5316B has been designed in accordance with international safety standards, this manual contains information, cautions, and warnings which must be followed to insure safe operation (also see Sections II, III, and V). Service and adjustments should be performed only by qualified personnel.

WARNING

ANY INTERRUPTION OF THE PROTECTIVE (GROUNDING) CONDUCTOR (INSIDE OR OUTSIDE THE HP 5316B) OR DISCONNECTION OF THE PROTECTIVE EARTH TERMINAL IS LIKELY TO MAKE THE HP 5316B DANGEROUS.

8-19. Opening the HP 5316B while power is connected should be avoided as much as possible, and when necessary, should be carried out only by a skilled person who is aware of the hazards involved. Capacitors inside the HP 5316B may still be charged even if the HP 5316B has been disconnected from its source of power.

WARNING

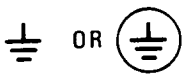
LINE VOLTAGE IS EXPOSED AT THE HP 5316B POWER MODULE EVEN WHEN THE POWER SWITCH IS IN STBY. REMOVAL OF THE POWER CORD IS NECESSARY TO REMOVE THE LINE VOLTAGE FROM THE HP 5316B.

8-20. Make sure that only fuses with the required rated current and of the type specified (.15 or .30 AMP SLO-BLO) are used for replacement. The use of repaired fuses or short circuiting of fuseholders **MUST** be avoided. Whenever it is likely that the protection has been impaired, the HP 5316B must be rendered inoperative and secured against any operation until repaired.

8-21. The following safety symbols are used on equipment and in manuals:

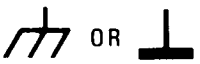
Instruction manual symbol. The product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect against damage to the instrument.

Indicates dangerous voltage (terminals feed from the interior by voltage exceeding 1000 volts must be so marked).



Protective conductor terminal. For protection against electrical shock in case of a fault. Used with field wiring terminals to indicate the terminal which must be connected to ground before operating equipment.

Low-noise or noiseless, clean ground (earth) terminal. Used for a signal common, as well as providing protection against electrical shock in case of a fault. A terminal marked with the symbol must be connected to ground in the manner described in the installation (operating) manual, and before operating the equipment.



Frame and chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.

Alternating current (power line).

Direct current (power line).

Alternating or direct current (power line).

The **WARNING** signal 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.

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.

8-22. SERVICE AIDS

8-23. Pozidriv Screwdrivers

8-24. The screws in the HP 5316B which appear to be Phillips type are not. They are Pozidriv. Although the two types are similar, damage to the screw or screwdriver will result if the correct driver is not used. Phillips screwdrivers will not seat into the Pozidriv screw-head properly. So Pozidriv screwdrivers must be used.

8-25. Service Aids on Printed Circuit Boards

8-26. The servicing aids include test points, transistor and integrated circuit designations, adjustment callouts, and assembly stock numbers.

8-27. The assembly number, name, and Hewlett-Packard part number of the HP 5316B assemblies are listed in *Table 8-1.*

Table 8-1. HP 5316B Assembly Reference Designators

REFERENCE DESIGNATION	DESCRIPTION	HP PART NUMBER
A1	Motherboard/Power Supply	05316-60015
A2	Input/Display Assembly	05315-60016
A3	Not Assigned	—
A4	*Input A&B Amplifiers	05315-60004
A5	Not Assigned	—
A6	Not Assigned	—
A7	Standard Oscillator	05316-60008
A7	TCXO 001	05316-60007
A7	Regulator Assembly 004	05316-60013
A8	Not Assigned	—
A9	Channel C Input 003	05315-60009
A10	Not Assigned	—
A11	Not Assigned	—
A12	Not Assigned	—
A13	Oven Oscillator 004	0960-0603

*If A2 or A4 are to be replaced, both assemblies must be ordered as a pair.

8-28. THEORY OF OPERATION

8-29. Signal Mnemonics

8-30. *Table 8-2* lists the signal mnemonics used in the HP 5316B for the primary control lines.

8-31. Introduction

8-32. The HP 5316B is a Universal Counter with frequency, period, time interval, time interval average, ratio, and totalizing capabilities. The HP 5316B utilizes five LSI circuits. A Microprocessor (A1U7) controls a Multiple-Register-Counter (MRC A1U8) to form the basic counter system. A Microprocessor (A1U4) controls the HP-IB Interface (A1U5) to handle all bus operations. (A1U4) exchanges data with (A1U7). In addition, a Display Decoder/Driver (A2U1) formats that display data for the eight 7-segment LEDs. The following paragraphs describe the overall functional operation and reference *Figure 8-2*, Overall Block Diagram. The detailed theory of operation is located adjacent to the corresponding schematic diagrams.

8-33. Block Theory

8-34. The HP 5316B is divided into the following assemblies (listed in relative order of signal flow):

1. A4 Input Amplifier Assembly.
2. A9 Channel C Assembly (Option 003).
3. A1 Motherboard Assembly.
4. A2 Input/Display Assembly.
5. A7 Time Base Assembly.
   a. Standard Time Base Oscillator.
   b. TCXO (Option 001).
   c. A7 and A13 Oven Oscillator (Option 004).
6. Digital-to-Analog Converter (Remote Trigger Levels).

8-35. Theory

8-36. There are two essentially identical input channels, which condition and shape the input signals. Front panel controls allow individual selection of AC/DC coupling, Attenuation (X1/X20). Trigger Slope, and Separate/Common A signal source selection. The input amplifier assembly buffers and shapes the signals, and sets the desired trigger level or sensitivity. The signals are then level-shifted and sent to the MRC (A1U8) as Channel A and Channel B. An arming signal is also generated from Channel B (used only in A armed by B). A1U8 receives the input signals from Channel A, B, and sometimes B Arming, and the Reference Oscillator (A7). Under control of the (U7), it processes the data for the function specified by the function switches.

In addition to the Channel A and B input, Option 003 Channel C (A9) allows frequency measurements up to 1 GHz. For increased measurement accuracy, a Temperature Compensated Crystal Oscillator (Option 001 TCXO), or Oven Oscillator (Option 004) may be used in place of the standard reference oscillator (A7). When using an external time base as the reference, an injection-locked multiplier located on the A1 Motherboard detects the presence of an external input and buffers the incoming external signal (1, 5, or 10 MHz) and multiplies it, if necessary, up to the 10 MHz reference frequency.

8-37. To make measurements, U7 routinely scans and stores the position of the Function Switches, S1-3 through S1-9, and then configures U8, via the Address Command bus to the desired measurement mode (frequency, period, time interval, totalize, etc.). U7 then "arms" U8, which allows the measurement to begin. The input signal to U8 starts the measurement, and when the Gate Time One-Shot times out, U8 signals U7 (via its IRQ) that the measurement is complete. U7 will then read the measurement data from U8, manipulate it mathematically and direct it to the Display Driver (A2U1). The Display Driver receives, decodes, and displays the data. The exponent, exponent sign, units annunciator, and decimal point are computed within U7 at the same time as the measurement data. U7 will then repeat the cycle, until the Function switches are changed, at which time it will reconfigure U8.

8-38. The power supply provides four dc voltages to the HP 5316B circuitry: +5V, +3V, -5.2V, and a 2.5V reference. The Power Module contains a pc card that, depending on its orientation, determines the line voltage to be used by configuring the primary windings of T1 as necessary (see paragraph 2-8). The secondary of T1 is then routed to the A1 Motherboard which contains the rectifiers and regulators.

8-39. For remote control via the HP-IB, (A1U4) and U5 HP-IB Interface Adapter (A1U5) are located on the A1 Motherboard. U5 can communicate with U7 and U8 (via U7). U4 always controls power-up reset, and selection of Time Interval Delay and Channel C functions. The HP-IB Interface circuitry contains the bus transceivers, address selection switches, and buffers.

Table 8-2. Mnemonics

MNEMONIC	DESCRIPTION	FROM	TO
a-d	Data lines for exponent digit to the display	A1U7(30-33)	A2U2(7,1,2,6)
ADDRESSED	Lights ADRSD LED. The 5316A has been addressed via the HP-IB	A1U4(18)	A2DS15
ATN	HP-IB Attention	A1U5(26)	A1U18(9)
$\overline{\text{ASE}}$	Address Switch Enable	A1U5(4)	A1U15(1,15)
$\overline{\text{A1-A5}}$	Address switch data lines	A1S4(1-5)	A1U5(7-11)
A/$\overline{\text{TO}}$	Addressable/$\overline{\text{Talk}}$ Only to A1U5	A1S4(7)	A1U5(13)
CHAN A LOW FREQ	Low frequency path for Channel A amplifier		
CHAN A HIGH FREQ	High frequency path for Channel A amplifier		
CHAN A TO MRC	Channel A signal to A1U8	A4U7(11)	A1U8(30)
CHAN B TO A1U8	Channel B signal to A1U8	A4U7(2)	A1U8(28)
CHANNEL B ARM	Channel B external arm to A1U8	A4U7(2)	A1U8(17)
CE1	Enables display for update	A1U7(19)	A2U1(9)
CE2	Measurement gating signal from A1U7 to Channel C	A1U7(18)	A9U2(4)
CE3	Enables Offset/Normalizer data to be placed on the A1U7 data bus	A1U7(17)	A1U2(12), U9(14) A11U13(4,5)
CH A	A1U8 Channel A Input		A1U8(30)
CH B	A1U8 Channel B Input		A1U8(28)
CH C	A1U8 Channel C Input		A1U8(26)
CHANNEL C GAIN	Gain control for Channel C	A4R2 WIPER	A9Q3(GATE)
CONTROL VOLTAGE	Sensitivity control voltage to Channel C		
$\overline{\text{CHAN C SWITCH}}$	Front panel function switch logic level to A1U4 to select Channel C	A1S1-S7	A1U4(11)
$\overline{\text{CLEAR 3870 I/O}}$	End of an A1U7-A1U4 interaction	A1U14(7)	A1U2(8), U4(6)
ΔCE	CE line-previous state changed	A1U3(9)	A1U12(14)
DATA 0-7	Port 3 of A1U4 (data bus)	A1U4(30-37) A1U9(3,5,7,9,11,13)	A1U5(7-14)
D0-D3	Data lines for display (mantissa)	A1U7(12-15)	A2U1(5,6,10-14)
D0-D3	Data lines between A1U7 and A1U4	A1U12(3,5,7,9)	A1U8(32-35)
D0-D3			A1U5(2,4,6,10)
DP	Decimal point position for the display	A1U7(11)	A2U1(7)
DAC A SIGN	Select trigger level polarity for DAC A (Channel A)	A1U10(10)	A1U20(10)
DAC B SIGN	Select trigger level polarity for DAC B (Channel B)	A1U10(7)	A1U20(9)
DAC A NEW DATA	Enables DAC A for new data	A1U14(12)	A1U22(13)

Table 8-2. Mnemonics (Continued)

MNEMONIC	DESCRIPTION	FROM	TO
DAC B NEW DATA	Enables DAC B for new data	A1U14(13)	A1U21(13)
DAC	HP-IB Data Accepted		
DAV	HP-IB Data Valid		
EOI	HP-IB End or Identify		
FPGT	Front panel control for gate time	A1R31 WIPER	A1U13(1)
GATE	Lights Gate LED; MRC is gating	A1U7(26)	A1U1(1,3,)
GATE TIME	Line from analog switch to MRC from gate time control	A1U13(15)	A1U8(6)
GATE TIME LOCAL/$\overline{\text{PRESET}}$	From U8; selects front or rear panel gate time control	A1U10(5)	A1U13(10)
GAIN	Channel C sensitivity control		
IFC	HP-IB Interface Clear		
IRQ	Interrupt request from MRC	A1U4(5)	A1U12(40)
IB0-7	HP-IB DIO lines (after transceivers)		
Hz	Lights Hertz LED; measurement is a frequency	A1U7(27)	A1U1(9)
$\overline{\text{IOS}}$	A1U4 I/O strobe; a Read or Write involving data transfer by A1U4, from or to an external circuit	A1U4(39)	A1U7(5)
LATCH MISC FUNC	Latchs data from port 1 of A1U4 at U10	A1U14(10)	A1U10(9)
$\overline{\text{MRC GO}}$	MRC Gate Open (not used)	A1U8(15)	
$\overline{\text{MRC ESR}}$	External Sequencer Reset (not used)	A1U8(27)	
Minus (-)	Lights "minus" sign	A1U7(29)	A1U1(11,13)
MULTIPLIER TURNOFF	Disables the Injection-Locked Multiplier when no external reference is present	A1Q3(C)	A1U11(5)
NS0-NS2	Nibble select lines to MRC	A1U7(8,9,10)	A1U8(9,10,11)
$\overline{\text{POWER-UP RESET}}$	Hardware Reset during power-up initialization	A1U6(8)	A1U4(6), A1U5(19), A1U7(39)
$\overline{\text{REMOTE/LOCAL}}$	Lights "REMOTE" LED; 5316B is under remote (HP-IB) control from A1U4	A1U4(17)	A2DS16
$\overline{\text{RESET COUNTER}}$	Front panel reset has been implemented; A1U4 Resets the A1U7	A1U4(20)	A1U7(38) A1U3(11)
RPGT	Rear panel control for gate time	A1R23	A1U13(2)
R/$\overline{\text{W}}$	Read/$\overline{\text{Write}}$ to MRC registers	A1U7(5)	A1U8(40)
RG0-RG1	Register select lines to/from MRC	A1U7(3,4)	A1U8(1,2)
RST	Reset counters		
R/$\overline{\text{W}}$	A1U4 Read/Write	A1U4(38)	A1U5(5)
RFD	HP-IB Ready for Data		
REN	HP-IB Remote Enable		
REF VOLTAGE	+2.5V dc voltage reference line	A1U28(2)	A1U27(3,10), U2(15)

Table 8-2. Mnemonics (Continued)

MNEMONIC	DESCRIPTION	FROM	TO
REF OSC	10 MHz clock to the MRC	A1S3	A1U8(21)
SEC	Lights Seconds LED	A1U7(28)	A2U7(5)
$\overline{\text{STR}}$	Indicates an address or command is valid	A1U7(7)	A1U8(8), A1U3(3), A2U1(8)
SLOPE A	Channel A Slope line to A1U7	A2S3	A1U7(34)
SLOPE B	Channel B Slope line to A1U71	A2S4	A1U7(35)
SENSITIVITY A	Channel A Sensitivity control voltage	A2S1	A4U2(4)
SENSITIVITY B	Channel B Sensitivity control voltage	A2S2	A4U2(13)
$\overline{\text{SELECT C CHANNEL}}$	From A1U4		
TRIGGER LIGHT SUPPLY	Isolated +5V for trigger LEDs		
TRIGGER LIGHT A&B	Lights Channel A&B trigger lights	A4U3(1,8)	A2DS18,19
T.I. DELAY	From front panel to A1U4 shortens gate time; removes C34 at U13	A1S1-5	A1U4(9)
$\overline{\text{TRIGGER LEVEL POT/DACS}}$	Selects local/$\overline{\text{remote}}$ trigger levels		A1U19(9,10)
TRIGGER LEVEL POT A	Voltage from the wiper of the Channel A trigger level control	A2S1	A1U19(1)
TRIGGER LEVEL POT B	Voltage from the wiper of the Channel B trigger level control	A2S2	A1U19(3)
TRIGGER LEVEL A	Channel A trigger level control voltage	A1U25(1)	A4U2(8)
TRIGGER LEVEL B	Channel B trigger level control voltage	A1U25(7)	A4U2(9)
$\overline{\text{33M/OUT}}$	Removes A1C34 to enable shorter gate times	A1U10(15)	A1U13(9)
$\overline{\text{3870 DATA IN}}$	Enables A1U7 data onto A1U4 data bus	A1U14(9)	A1U9(1,15), A1U12(15)
-5.2	-5.2V dc line to input amplifiers.	A1Q11	
+7.5 UNREGULATED	Unregulated dc from transformer T1 secondary and rectifiers		
-7.5 UNREGULATED	Unregulated dc from transformer T1 secondary and rectifiers		
+4 UNREGULATED	Unregulated dc from transformer T1 secondary and rectifiers		

Figure 8-2
OVERALL BLOCK DIAGRAM

(See Page 8-11)

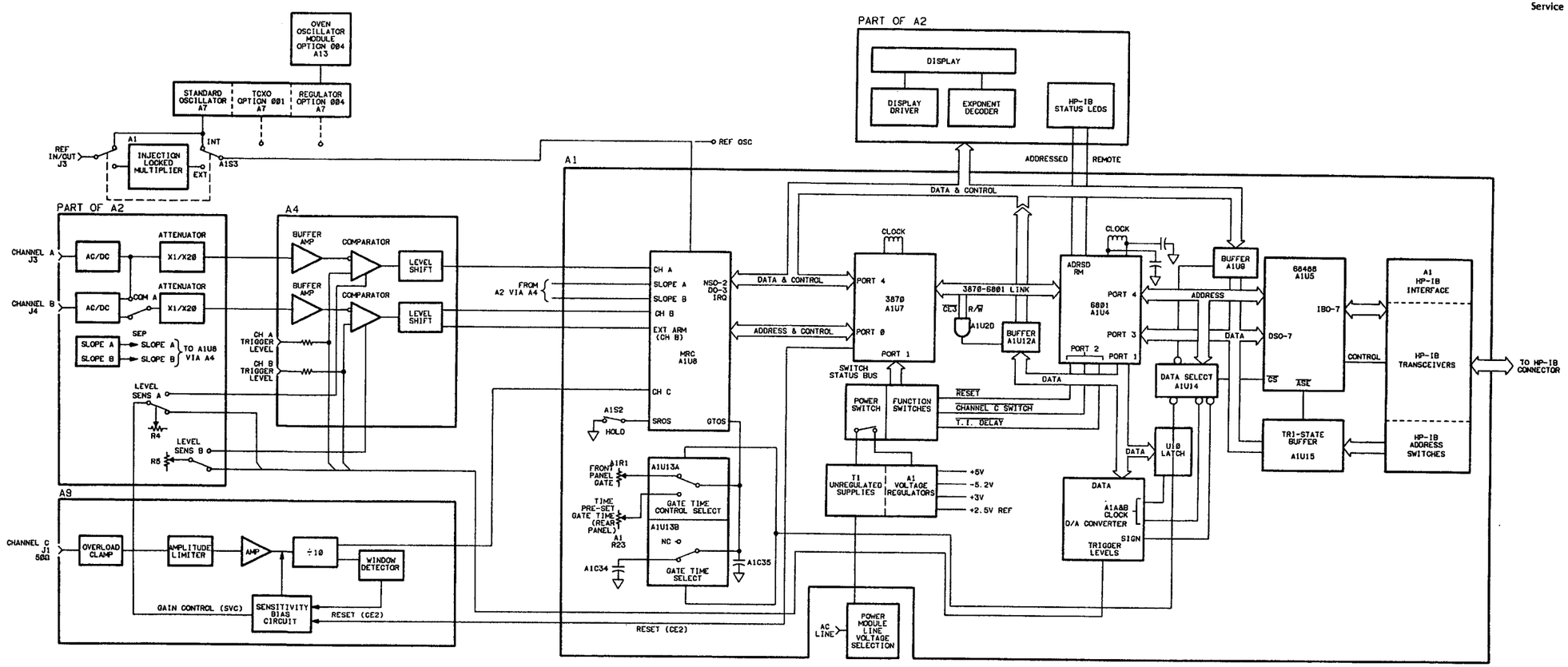


Figure 8-2. Overall Block Diagram

8-40. TROUBLESHOOTING

CAUTION

Proper static handling techniques must be employed when servicing semiconductor products. The voltage susceptibility of all IC and transistor families are well below levels commonly found in service environments. Exercise care and observe standard static precautions.

8-41. When one of the LSI ICs are removed they should be placed in conductive foam to avoid static damage. If conductive foam is not available, handle them by the ends of the packages.

8-42. The troubleshooting philosophy for the HP 5316B is to break the counter down into five main blocks so that the defective block can quickly be found. Once the defective circuit is identified, then go to the schematic diagram for that block as listed below. If the repaired circuit contains any adjustments to be set after repair, then refer to Section V and make the adjustments as described. For quick reference, *Figure 8-3,* Troubleshooting Flowchart, parallels the procedures beginning with paragraph 8-45.

8-43. Prelimiary Troubleshooting

8-44. DEFECTIVE BLOCK ISOLATION. For troubleshooting purposes the HP 5316B can be divided into the following sections (see *Figure 8-4,* Troubleshooting Block Diagram):

a. Three input amplifiers (A, B, and C).

1. A2/A4 Channel A and B.
2. A9 Channel C Option 003.

b. Main Counter A1 Motherboard.

1. A1 Motherboard (A1U7 3870-A1U8 RC).
2. A2 Display.

c. HP-IB Remote Control.

1. A1 Motherboard. (A1U4 6801-A1U5 68488).
2. A1 Digital-to-Analog Converter (A1U20, U21, U22, U26).
3. A1 HP-IB Interface (A1U16, U17, U18, U24).

d. Time Base.

1. A7 Standard Oscillator.
2. A7 TCXO Option 001.
3. A7 and A13 Oven Oscillator Option 004.
4. Injection-locked multiplier (located on the A1 Motherboard).

e. Power supplies (on the A1 Motherboard).

+5 volt supply
-5.2 volt supply
+3 volt supply

8-45. The following procedure will determine the defective block.

a. Check for a blown line fuse in the Power Module. If it has blown, check transformer T1, the rectifier components, and the +5 volt power supply line for short circuits (only the +5V supply will blow the fuse if shorted). The -5.2V and +3V supplies should also be checked for short circuits. The following resistance values are typical and variations can be expected. However, a short circuit will show dramatic differences from these values.

1. +5 volt supply ~300 ohms
2. -5.2 volt supply ~500 ohms
3. +3 volt supply ~350 ohms

b. A short on the -5.2V or +3V supplies will cause the regulator transistor in that supply to become very warm. The heat sink on which the transistors are mounted should feel only slightly warm and not painful to the touch. If a short is found, the following table lists the supplies and the assemblies or circuits they power.

SUPPLY	CIRCUITS
+5V	All assemblies except A1U11
-5.2V	A1U11, A4, A9
+3V	A1U8 (MRC), A4, A9

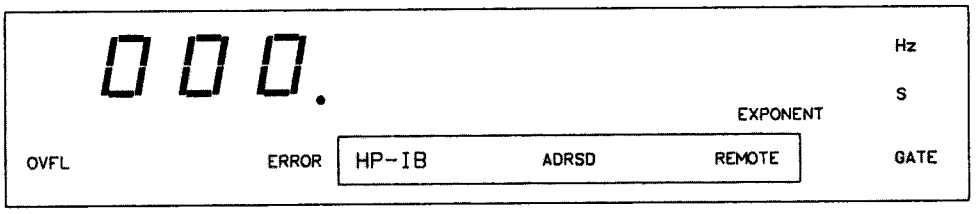
c. If no short can be found, apply power to the HP 5316B through a variable line transformer (Variac®) and monitor the +5V supply. The ac line current should be ~300 mA at 115V ac.

d. Measure the three main power supplies. All supplies should be within the values specified below.

VOLTAGE	TOLERANCE
+5V dc	±50 mV
-5.2V dc	±50 mV
+3V dc	±50 mV

e. Operation of the +3 volt and -5.2 volt power supplies is depdendent upon proper operation of the +5 volt power supply. If *all* supplies are found to be low, then verify +2.5V is present at A1U12 pin 2. The +2.5V reference is used on all supplies. If at least *one* supply is operating, then repair those supplies found faulty.

f. Once the power supplies are operating, press FREQ A. Turn the power off then back on again. The display should show all "8's" for about 1-second and then display zero (with no input signal).



Note: If the HP 5316B is rapidly switched on/off then back on, it may display random segments, then all "8's", etc.

®Variac is a Registered Trademark of General Radio.

g. If, on power-up, instead all 8's the HP 5316B displays:

E1 — This indicates a possible problem in the Microprocessor A1U7. Verify the failure by substituting a known good Microprocessor.

E2 — This indicates a possible short on the U8-U7-display driver interconnect bus, or a defective U8.

E3 — If this is displayed, put the HP 5316B into the Display Check mode (all function switches out and Blue Shift key out). Turn the power off and then back on. If E2 is now displayed, the problem is a short on one of the U7 I/O pins. If E2 is NOT displayed, then the problem may be U8. Next verify the INT/EXT oscillator switch on the rear panel is in the INT position. Error E3 WILL be displayed if the INT/EXT oscillator switch is in the EXT position, or if there is no signal (or insufficient) at the REF OSC test point. If it is in INT, verify that there is 10 MHz present at the REF OSC test point (this is the same point as A7P1 pin 2). See A7 Output Waveform, A7 Troubleshooting.

If the signal is correct, place the HP 5316B into the CHECK mode. If the number displayed does not read exactly 10 MHz, the problem is probably U8. Verify by substituting a known good U8.

h. If the HP-IB status LEDs (ADRSD and REMOTE) are flashing, then go to step l. for a description of this failure indication. Note the failure then return to Step i.

i. Once again, release all of the Function switches and the Blue Shift key. Verify the display sequentially displays the numbers Ø through 9 and blank (see *Table 3-1*, Display Check). This verifies the display (A2) and indicates U7 is operating, although a problem may still exist.

j. Place the HP 5316B in the CHECK mode. The HP 5316B should display exactly 10 MHz. Apply a 10 MHz signal at 100 mV rms to Channel A Input BNC or connect the rear panel REF IN/OUT to the Channel A Input BNC. Press FREQ A. Adjust the input controls for a stable trigger. If the HP 5316B displays exactly 10 MHz in CHECK, but fails to count the 10 MHz input signal, then apply 50 MHz at 50 mV to the Channel C Input BNC and press FREQ C. The intent of this procedure is to determine if at least one input operates. If Channel C is not installed, then go the step k. If Channel C input operates, then the A2/A4 assembly is defective. In this case go to A2/A4 Input Amplifier Troubleshooting. If Channel A operates and Channel C does not, go to A9 Channel C Troubleshooting. If neither input operates, then continue to step k.

k. If the problem cannot be located from the above tests, remove A1J1P1 (the 8-pin dip test jumper) and repeat tests f. and g. Ignore the flashing of the HP-IB status LED's. With the test jumper removed the LEDs will flash. If the HP 5316B functions correctly with the jumper removed, the failure is in the HP-IB portion, so go to step l. If the HP 5316B fails this test, the failure is in the counter portion. Substitute first, U7 and then U8 with known good IC's since one is probably dead. Listed below are the circuits that are affected when jumper A1J1P1 is removed.

1. A1J1P1 pins 1 and 16, NO CONNECTION.
2. A1J1P1 pins 2 and 15 breaks the RG1 line (disabled) so U7 can continue to operate without U4 response. Grounding pin 2 will pull RG1 down causing U7 to halt.
3. A1J1P1 pins 3 and 14 breaks the TRIGGER LEVEL POTS/$\overline{\text{DAC}}$ line disabling the analog switches in the DAC circuitry (which select either the front panel Trigger Level controls, or the DAC) and returns Trigger Level control to the front panel potentiometers. Grounding pin 3 will cause the DAC to be selected. Ground pin 3, press FREQ A and vary the front panel Trigger Level controls. They should have no effect.
4. A1J1P1 pins 4 and 13 breaks the $\overline{\text{RESET COUNTER}}$ line. Thus U4, during power-up or when the front panel RESET button is pressed, does not reset U7. Grounding pin 4 should cause the counter to reset.
5. A1J1P1 pins 5 and 12 breaks the $\overline{\text{SELECT CHANNEL C}}$ line disabling Channel C. Press FREQ C. A signal applied to the Channel C input BNC should now cause the HP 5316B to gate.

6. A1J1P1 pins 6 and 11 breaks the 33 μF IN/$\overline{\text{OUT}}$ line, reinserting C34. This causes the Gate Time to go into the long range (60 ms—10 s). C34 is normally connected through U13 to the GATE TIME line for long gate time range except when T.I. DELAY or CHECK is selected. C34 is also removed when the Short Gate Time range (500 μs—30 ms) is selected under remote control or by multiple key function select (see Section III, Operation). Grounding pin 6 should cause the gate time to go from long to short. Select the Gate Time mode to verify if this occurs.
7. A1J1P1 pins 7 and 10 breaks the GATE TIME LOCAL/$\overline{\text{PRESET}}$ line so that front panel Gate Time control is always selected. Grounding pin 7 should cause the Gate Time control to be switched from the front panel Gate Time control to the rear panel Preset Gate Time.
8. A1J1P1 pins 8 and 9 breaks the enable line to U12A removing U4 from the 4-bit data bus. U4 cannot then put data on the U7/U8 data bus. If U7 is removed from its socket, grounding pin 9 of the test connector will enable U12A. The input to U12A can then be pulsed and monitored at the output with a logic probe.
9. Pins 10, 11, 12, 13, and 14 when under HP-IB control; should go to their proper logic level when that particular lines function is selected. If not, look for shorts or opens on the lines or in their driver IC.

NOTE

With the test jumper removed, Channel C, T.I. Delay, and front panel Reset will not operate. These functions are selected through U4 Microprocessor A1U4. The jumper must be in place to operate these circuits. They can be selected, however, by grounding the appropriate pins on the jumper socket as described above.

l. If the HP 5316B operates correctly with the test jumper removed, replace the test jumper, and repeat the rolling display test. Note the action of the HP-IB status LED's.

If they:

Flash in phase —This indicates a failure in A1U4. Go to the A1 Motherboard Signature Analysis Troubleshooting, paragraph 8-69.

Flash out of phase — And the HP 5316B operates correctly with the test jumper removed, this indicates U8 and U7 are good. The problem is a U7-U4 link failure or a defective U4. In this case, go to the A1 Motherboard Signature Analysis Troubleshooting, paragraph 8-69.

NOTE

An error E3 and "out-of-phase" flashing usually means a bad reference signal. Check the INT/EXT REF switch and the signal level of the reference driving U8 at test point REF OSC and U8 pin 21 (500 mV-1.2 V p-p).

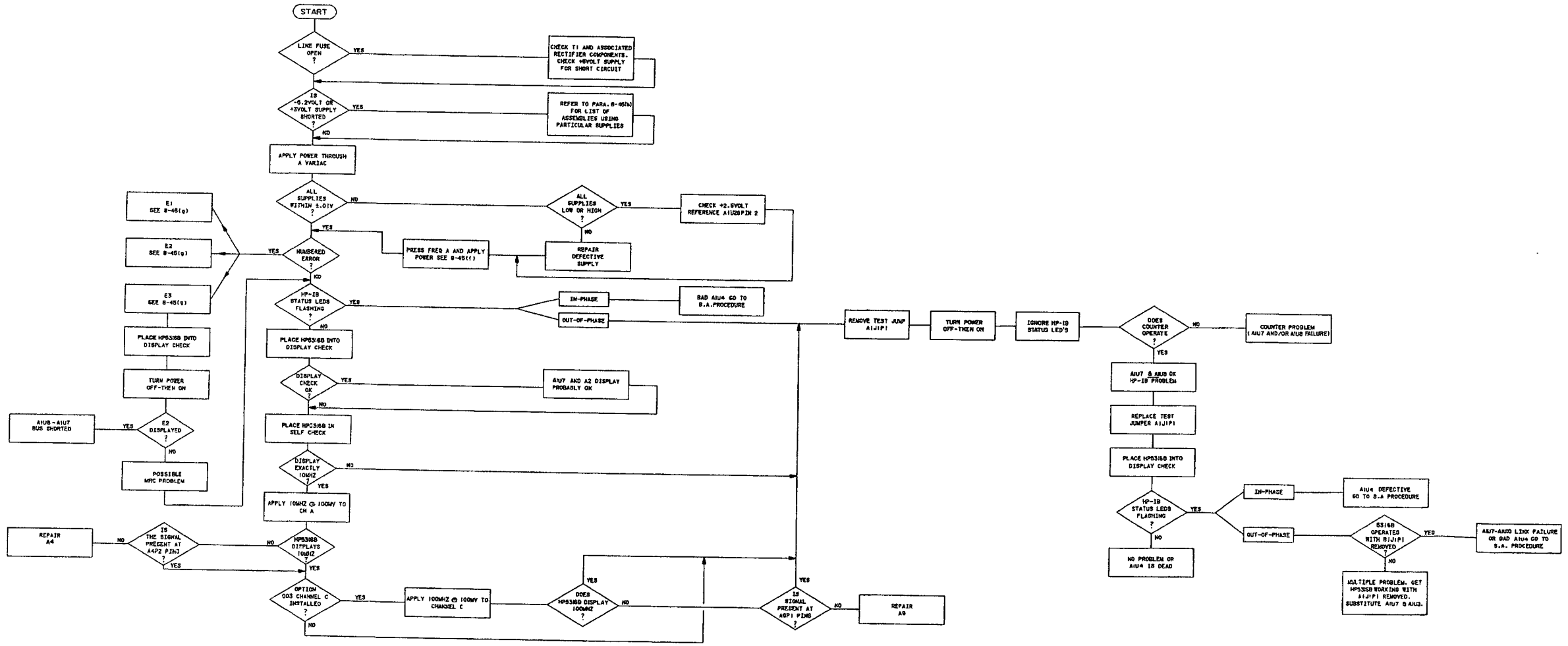


Figure 8-3. Troubleshooting Flowchart

Figure 8-3
TROUBLESHOOTING FLOWCHART

(See Page 8-17)

NOTES

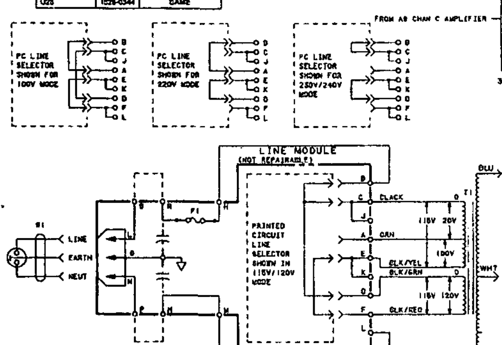
1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.
2. UNLESS OTHERWISE INDICATED:
   RESISTANCE IN OHMS;
   CAPACITANCE IN FARADS;
   INDUCTANCE IN HENRIES.
3. ASTERISK (*) INDICATES SELECTED COMPONENT, AVERAGE VALUES SHOWN.
4. C11 REMOVED WHEN OPTION 001 (TCXO) OR OPTION 004 (OVEN OSCILLATOR) IS INSTALLED.
5. R27 NOT INSTALLED. RESERVED AS COMPENSATION FOR ANY POSSIBLE CHANGES IN U8 (MRC) CHARACTERISTICS.

REFERENCE DESIGNATIONS

A1
C1-C78
CR1-CR17
H1-3
J-J9
JMP1-3
L1-L4
Q1-Q12
R1-R25, R29-R58
S1, S3-S4
S2 (PART OF R1)
TP1-TP8
U1-U28

TABLE OF ACTIVE COMPONENTS

REFERENCE DESIGNATION	HP PART NUMBER	MFR OR INDUSTRY PART NUMBER
CR1, 7-10	1901-0518	SAME
CR2-6, 16, 17	1901-0050	1N4150
CR11	1906-0285	MSR2025CT
CR12, 13, 15	1901-0734	1N5818
CR14	1902-0953	SAME
Q1, 6	1853-0039	SAME
Q2, 8	1854-0560	MPSA12
Q3, 4, 5, 7, 9	1854-0215	2N3904
Q10, 12	1853-0363	X4GM281
Q11	1854-0635	D44H5
U1	1820-1199	SN74LS04N
U2	1820-2922	MC74HC00N
U3	1820-2228	MC14044BCP
U4	1820-2333	MC6801P
U5	1820-2219	MC68488P
U6	1820-1416	SN74LS14N
U7	1820-2131	MK3870/30N MASKED
U8	1820-2312	10AS-2502
U9, 12	1820-1296	MM80C97N
U10	1820-3058	MM74HC174N
U11	1820-0309	MC10115P
U12	1820-1268	MM80C97N
U13	1820-3592	MM74HC4053N
U14	1820-1216	SN74LS138N
U15	1820-1491	SN74LS367AN
U16	1820-2239	DP8304BN
U17	1820-1568	SN74LS125AN
U18, U24	1820-3329	MC3446N
U19, U20	1820-3632	MM74HC4053N
U21, U22	1820-0639	AD7524JN
U23	1820-1144	SN74LS02N
U26	1826-0315	LM348N
U27	1826-0161	MLM324P
U28	1826-0344	SAME



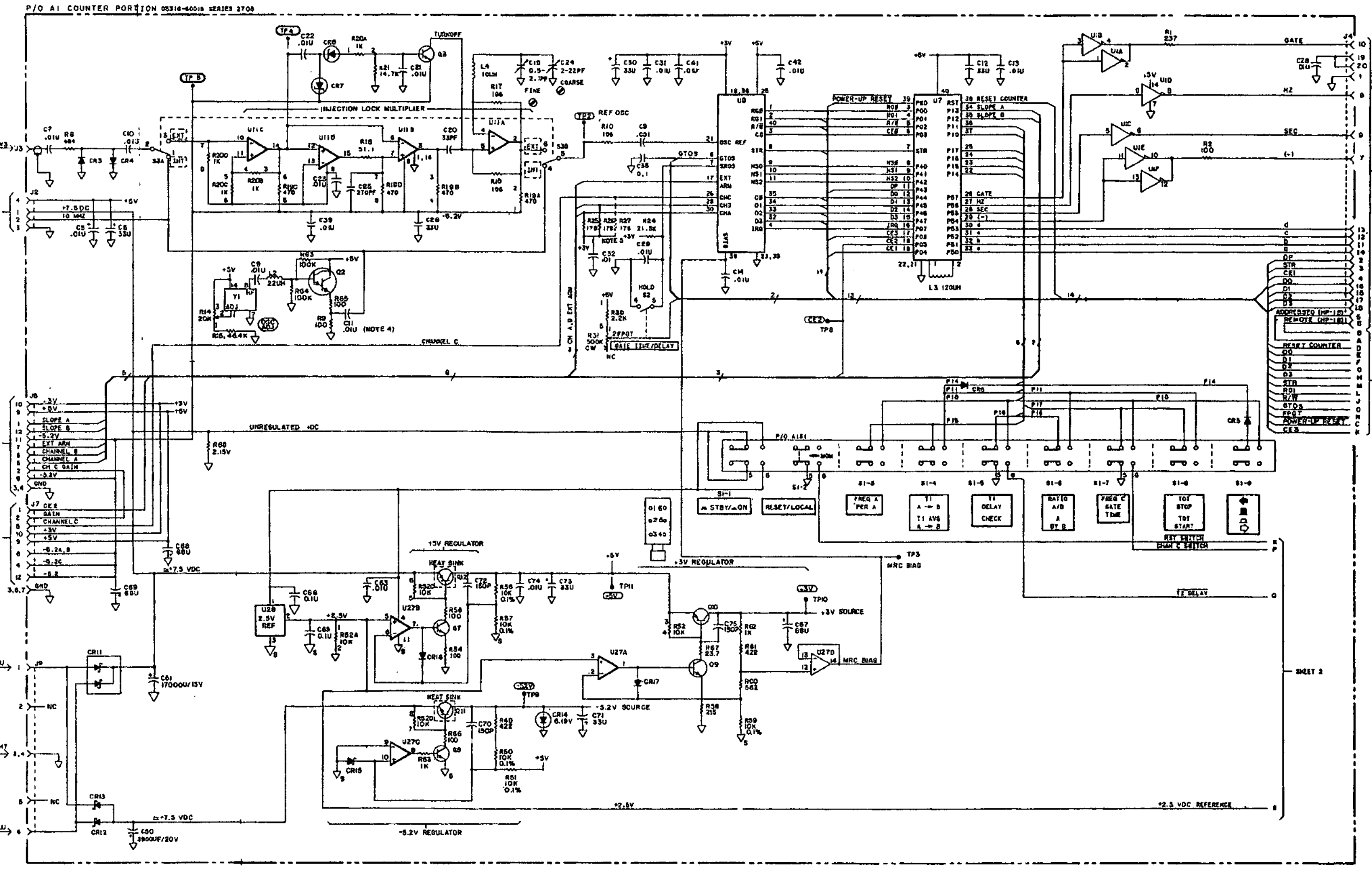


Figure 8-4. Troubleshooting Block Diagram

Figure 8-4
TROUBLESHOOTING BLOCK DIAGRAM

(See Page 8-19)

8-46. MAIN COUNTER THEORY (A1 MOTHERBOARD)

8-47. The A1 Motherboard assembly contains the counter microprocessor A1U7, multiple register counter A1U8, HP-IB Microprocessor A1U4, HP-IB Interface Adapter A1U5, power supplies, and external time base circuitry. The U7 Microprocessor runs at an internal clock rate of ~3.5 MHz, as set by L3. It continually cycles through programmed routines, which are stored in ROM within the IC. The block of function switches are routinely polled, via the Switch Status bus, and the status image is stored in internal RAM. Any change in the image is detected and verified. A new function switch setting must remain stable for 32 scans to be accepted.

8-48. U7 controls the operation of U8 via the Address/Control bus. Address lines RG0 and RG1 select one of four internal registers of U8. NS0, NS1, and NS2 are nibble select lines, (nibble = 4 bits) which address data within the various registers. The chip select line, CS, allows or disallows the chip to respond to addresses. IRQ (Interrupt Request) signals U7 that U8 requires service (i.e., when a measurement is complete). Command line R/$\overline{W}$ (Read/$\overline{Write}$) controls the direction of data transfer on the bidirectional Data/Control Bus.

8-49. The Data/Strobe bus contains four bidirectional data lines, DØ-D3, and the command line STR which indicates an address or command is valid, between U7, U8, and the Display assembly A2.

8-50. The Exponent/Annunciator bus controls the operation of the Gate, Hz, s, "–", and decimal point annunciator lines going to the A2 Display assembly. The four-line binary addresses on lines a, b, c, and d select the exponent to be displayed. CE1 enables the display driver IC.

8-51. The Multiplier Register Counter U7, a universal counter on a chip, is an LSI bipolar IC utilizing both EFL and I^2L circuitry. The reference oscillator (A7) drives the MRC via pin 21 and its output can be monitored at the REF OSC test point located on the A1 Motherboard near the A7 assembly. Inputs from the Channel A and B amplifier assembly (A2/A4) are fed into U8 at pins 30 and 28. An External Arm line (used only in FREQ A Armed by B), also from the input amplifier assembly, is connected to pin 17. The Channel C signal, if Option 003 is installed, is connected to pin 26 of U8.

8-52. In addition to the Address/Control and Data/Control buses from the counter microprocessor U7, two other control lines, GTOS and SROS are routed to pins 6 and 7. GTOS is the Gate-Time-One-Shot timing node. The gate time operates over one of two ranges, as set by the Function switch S1-5. The gate time is determined by the time constant formed by R31 or R23 (front or rear panel, respectively), and the capacitor(s), C35 with or without C34, connected to GTOS through analog switch U13B. Short gate times are obtained with R31 (or R23) and C35 (500 μs–30 ms), and longer gate times (60 ms-10 s) when C34 is added in parallel through U7B. SROS is the Sample-Rate-One-Shot timing node. One of two sample rates is selected: a short minimal sample rate, determined by the time constant of R24 and C29, or one time only in HOLD, via S2 (part of R31). With SROS Low (HOLD), the measurement will be made and displayed, but no more measurements will be made until the SROS line goes High.

8-53. Within U8 are four addressable registers. The Events Register and Time Register are counting registers; thus they are Read Only. The Status Register monitors the operation of U8, and the Control Register receives the commands from the U7 and determines U8's configuration.

8-54. Main Counter Troubleshooting

8-55. The preliminary troubleshooting procedure beginning with paragraph 8-45, step g., is the most effective way of finding a fault in the counter section. If U7 or U8 are suspected as being at fault, substitute known good ICs.

8-56. HP-IB Theory (Remote Control)

8-57. The HP-IB Microprocessor is U4. It operates independently of U7, and all data and control information has to be exchanged between these microprocessors on a handshake basis. This is done in the following manner:

8-58. When U7 begins a measurement cycle, it signals U4, via the CE3 and R/W lines that it is ready for control codes from U4. The interface latch circuitry, consisting of U2 and U3, presents these signals to U4, which pull down on RG1, keeping U7 from moving on to the next step until U4 can respond. U4 can send codes to U7 which tell it to: 1.) ignore U4; 2.) send U4 the results of the current measurement; 3.) ignore the front panel function switches and perform the function U4 wants it to perform; or 4.) perform the function U4 wants it to perform and return the measurement results to U4.

8-59. The control codes from U4 are sent to U7 through a three-state buffer, (U12A), which puts the data on the four-bit data bus shared by U7 and U8 (D0-D3). The data from U7 and the handshake latch circuitry is presented to U4 on its own data bus (8 bits) through three-state buffers U9 and U12B. These buffers are enabled by a control signal, $\overline{\text{U7 DATA IN}}$, from Data Selector U11 (3- to 8-line decoder), and this in turn goes active when U4 writes to address $0130 (all addresses in HEXADECIMAL unless otherwise noted). When this happens, it causes $\overline{\text{U7 DATA IN}}$ enable line to go Low (active low), in turn sending the three-state buffers to the active state and putting U7 data on U4 data bus. Note that the codes come from U4 static port (Port 1), rather than U4 data bus. These codes are held available at all times to U7, so U7 can read them whenever ready by enabling its three-state buffers onto its own 4-bit data bus.

8-60. The Data Selector, U14, also generates enable and reset signals for other parts of U4 Microprocessor circuitry. Addresses $0108-$010F enable the U5 HP-IB Interface. Addresses $0110 and $0118 clock data into the Digital-to-Analog Converters for the trigger level of Channel A and B, respectively. Address $0128 clocks data (from Port 1) into a 6-bit CMOS latch, U10. The output lines from this latch control several other functions in the HP 5316B.

8-61. Address $0138 causes a reset pulse to be sent to the handshake latch, freeing U7 to continue its original function.

8-62. Port 1 has several functions; 1.) the 4-lower bits (0-3) send data to U7. The next 2 bits (4 and 5) provide the logic levels for the "ADRSD" (addressed via the HP-IB) and "REMOTE" (in the remote control state) LED's on the front panel; 2.) these six lines are also used to send control codes to the CMOS latch U10. The MSB is used as described to reset U7; 3.) additionally, all eight lines are used as data lines for the Digital-to-Analog Converter; data is presented to the DAC's, and is clocked in by writing to addresses $0110 or $0118. The pins of Port 1 then resume their normal functions.

8-63. Port 2 of U4 (pins 8-12) has two functions. The Power-Up Reset is generated by Q6 and formed into a clean short rise-time, no-bounce TTL signal by the Schmitt inverter U6A and U6D. The resulting signal is sent to the Power-Up Reset input pins of U7 (U7-39), U4 (U4-6), and U5 (U5-19) interface. U7 initializes its programs, and the U5 clears its registers; but U4, during this power-up period, reads in Mode-Select codes from the logic levels on pins 8, 9, and 10. This tells U4 how to configure its internal structure. In this application the mode is Expanded Nonmultiplexed; U4 uses its internal RAM and ROM. Port 1 is static and always defined as outputs. Port 2 is defined (by the program) as inputs. Port 3 is the bidirectional data bus, and Port 4 the lower 8 bits of the address bus. A special line, $\overline{\text{IOS}}$, also becomes available in this mode, and is used as one of the qualifiers on U14. A low logic level on the $\overline{\text{IOS}}$ line means that the seven-most significant bits of the 16-bit address are all zeros, and the eighth is a "one". Hence, $\overline{\text{IOS}}$ and the lower 8 bits of address (Port 4) defines addresses $0100-$01FF.

8-64. After the mode is defined, on Port 2, these same pins now serve as inputs to U4. The program tests their logic levels on a regular basis, and varies its operation accordingly. Pin 8 is connected to a test point, TP1; gounding this test point during program execution will send U4 into its signature analysis routine (power must be turned off or front panel reset depressed to exit this routine.) Pin 9 is connected to the T.I. DELAY/CHECK switch, and by selecting T.I. DELAY, a low logic level will cause the U4 to send a low logic level through latch U10, to analog switch U13B, removing capacitor C34 from the Gate-Time-One-Shot circuit, dramatically decreasing the gate time period. Pin 12 looks at the state of latch, U3C, which is set anytime the front panel RESET button is pressed. The reset results (and the latch is cleared) whenever U4 puts a logic low on the line $\overline{\text{RESET COUNTER}}$ by writing a zero to pin 20, the MSB of Port 1. This is held Low long enough to reset U7 to its restart position.

8-65. Port 3 is used only as a data bus. It inputs the results of the measurement from U7 via buffers U9 and U12. It exchanges data with U5, HP-IB Interface Adapter. (Note that U15 three-state buffer is also tied to this data bus; it is enabled by U5, and U4 does not read its data into itself; rather, U5, under U4 control, enables U15 to read in its HP-IB address switches so it will know what its address is.)

8-66. Port 4 is the lower 8 bits of the address bus. The lower six address lines select individual registers in U5.

8-67. Other pins on U4 are NMI (NonMaskable Interrupt — not used), Read/$\overline{\text{Write}}$, E, (U4 clock = 1 MHz), the Power-Up Reset line, and $\overline{\text{IRQ}}$. $\overline{\text{IRQ}}$ is the maskable interrupt line, which is pulled down by U5 whenever it has been addressed to listen to the HP-IB.

8-68. The U5 HP-IB Interface IC (U5) is not a processor or a computer; it operates under U4 control. The HP-IB control lines (RFD, DAC, DAV, EOI, ATN, REN, SRQ, and IFC) cause various bits in U5 internal registers to go to the TRUE or FALSE state. U4 can read these registers to monitor the state of the bus. The eight data lines IBØ-IB7 (pins 29-36) tie to the HP-IB data lines through bidirectional receiver A1U16 and can be read into U4 through U4 data bus, from pins 7-14 of U5. Register select RSØ-RS2, tied to the three LSB address lines of U4, ANDed internally with Chip Select ($\overline{\text{CS}}$), determine which of the registers in U5 will be read from, or written to, by U4.

8-69. Signature Analysis Troubleshooting

8-70. The following signatuare analysis tests can be used to troubleshoot U4-U7 link and the operation of U4 HP-IB interface and associated components. Failures in U7 or U8 can only be verified by substitution.

Procedure:

1. Set the signature analyzer as follows:

START	NEGATIVE SLOPE (IN)
STOP	NEGATIVE SLOPE (IN)
CLOCK	NEGATIVE SLOPE (IN)
HOLD	OFF (OUT)
SELF TEST (5004A only)	OFF (OUT)
NORMAL (5005A only)	

2. Connect the analyzer to the following points:

CLOCK	U14 PIN 6
STOP	U10 PIN 10
START	U10 PIN 7
GROUND	U14 PIN 8

3. Set all the rear panel address switches to the down position (address 00/ADDRESSABLE). Release all the front panel function switches (OUT) including the Blue Shift key.

4. Ground TP1 for a short time. Instrument will now be in the signature analysis mode. The display will be blank with some flickering. If this does not occur, U4 is defective. Touch the 5004A probe to +5V and press the analyzer Reset button. The 5004A should display 483C. The UNSTABLE SIGNATURE lamp should be off and the GATE lamp flashing. If this does not occur, check all connections and repeat the procedure from the beginning.

   In the following table:

   PULSE — This means the probe lamp will be flashing.

   LOW — This means the signature will be 0000 and the probe lamp will be OFF.

   HIGH — This means the signature will be 483C and the probe lamp will be ON.

Signature Analysis Table

PIN	A1U10	A1U4	A1U14	A1U5
1	DO NOT MEASURE	LOW	3AU8	
2	2FU8	PULSE	80FF	
3	3PCF	PULSE	AH42	147U
4	7336	HIGH	LOW	91H4
5	95H0	HIGH	A39P	
6	A411	HIGH	PULSE	
7	FF89	HIGH	HIGH	
8	LOW	HIGH	LOW	
9	H54H	HIGH	HIGH	
10	35AA	HIGH	H54H	
11	0998	HIGH	HIGH	
12	8H94	HIGH	5H49	
13	C897	3PCF	77HP	
14	P671	7336	147U	
15	PAAC	A411	HIGH	
16	HIGH	0998	HIGH	
17		C897		
18		P671		
19		94H3		
20		P01F		
21		HIGH		
22		HIGH		
23		HIGH		
24		AH42		
25		80FF		
26		3AU8		
27		8H4A		
28		1262		
29		A7P7		
30		F79U		
31		A5H2		
32		A680		
33		7F57		
34		753U		
35		9HA8		
36		U754		
37		5200		
38		550P		
39		A39P		
40		PULSE		

8-71. Time Base Support and Injection-Locked Multiplier Theory

8-72. A 6-pin socket, J2, located near the rear of the instrument, will support either the Optional TCXO (Option 001), or the Oven Oscillator Regulator assembly (Option 004). The INT/EXT REF OSC switch is wired in such a way that the internal reference oscillator is fed to the rear panel through BNC connector J3 when the switch is in the INT position. This output is ac coupled through C7 and C10 and isolated by R8; its output amplitude is nominally 50 mV p-p into 50 ohms.

8-73. When the switch is in the EXT position, the internal reference oscillator output is disconnected and an external input signal (connected to J3 REF IN/OUT) is connected to pin 10 of ECL line receiver, U11. Q3 detects the presence of an incoming EXT REF signal, activating the injection-lock buffer oscillator. External frequencies of 1.0, 5.0, or 10.0 MHz at 1V rms amplitude fed into J3 are amplified, level-shifted by U11C and applied to a one-shot formed by U11B and D. The resulting narrow pulses (1, 5, or 10 MHz) are applied through a capacitor C20 to one of the input nodes of tank-LC oscillator U11A, whose oscillation frequency (~10 MHz) is determined by L4 and C19 and C24. (C24 allows coarse adjustment and C19 allows fine adjustments.) The nominal 10 MHz frequency of U11A is locked to the incoming pulses from U11B, such that the reference frequency used in the HP 5316B is now a tracking multiple of the EXT input reference.

8-74. For a 1.0 MHz input reference, the injection locked oscillator will track the input frequency for at least a variation of ±.01% (i.e., 1.000100 to .9999000 MHz). For 5 and 10 MHz the lock range is wider.

8-75. Injection-Locked Multiplier Troubleshooting

8-76. To troubleshoot the Injection-Lock Multiplier, verify -5.2V is present at U11 pin 8, then trace the external input signal through the multiplier. The four figures below show the typical waveforms to be found at U11 pins 10, 15, 3, and 2 (listed in order of signal flow) with a 1 MHz input signal at 1V rms).

8-77. The tank oscillator formed around U11A may be enabled to oscillate by connecting the base of Q13 (turn-off control) to the -5.2V supply. No external input is required. The tank circuit should oscillate very close to 10 MHz, depending on the settings of C19 and C24. If making this connection causes the circuit to oscillate but it does not function under normal conditions, then suspect CR7 or CR8.

8-78. Power Supplies

8-79. The HP 5316B power supplies provide three voltages; +5, +3, and -5.2V. A +2.5V supply (derived separately), is used only as a reference for the three main supplies and the Digital-to-Analog Converter circuit.

8-80. The Power Module contains a connector for an ac power cord, fuse, and a PC card. The PC card can be inserted in any one of four positions to select 100-, 120-, 200-, 240-volt operation. The schematic diagram of the module is shown in *Figure 8-5*. A detailed description, including instructions for changing the fuse or voltage selection is given in paragraph 2-8.

8-81. Once the proper line voltage has been selected by the Line Module, this voltage is applied to the primary of transformer T1. The secondary winding of T1 is connected to the A1 Motherboard through connector J9. T1 has one secondary winding with a grounded center tap.

8-82. When ac power is applied to the HP 5316B through the line cord and the STANDBY/ON switch is in either the STANDBY or ON position, rectifier CR11 and filter capacitor C51 develops an unregulated +7.5 volts dc. Rectifiers CR12 and CR13, and filter capacitor C50 develops an unregulated -7.5 volts.

8-83. The unregulated +7.5 volts is connected to the Option 004 Oven Oscillator regulator board (if installed) through A1J2 pin 1. Continous power is thereby applied to the oven whenever ac power is applied to the counter.

8-84. When the HP 5316B is turned on, unregulated +7.5 volts is connected through the STANDBY/ON switch to the voltage regulator operational amplifier U27 and the 2.5 volt reference voltage IC, U28.

8-85. U27 is a quad operational amplifier with three sections providing the individual controls for the +5 volt, -5.2 volt and +3 volt regulators. The fourth section, U27D, is configured as a voltage follower to provide a fixed voltage bias for MRC, U8.

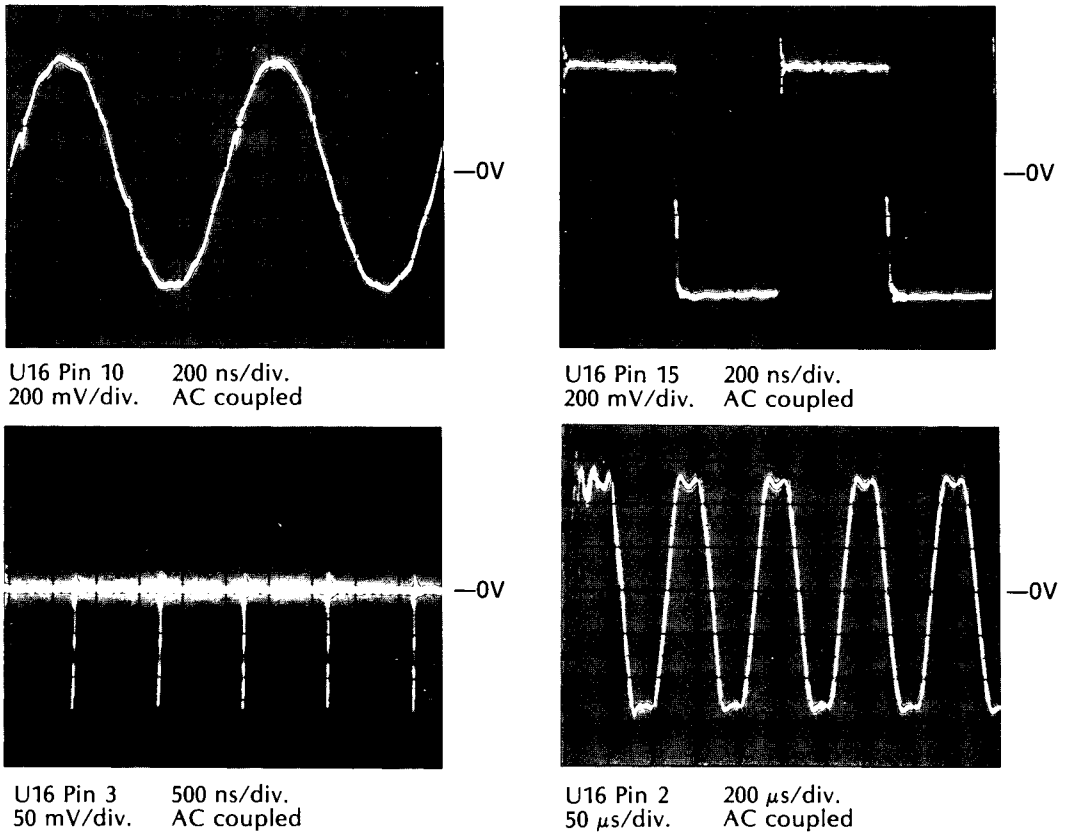
8-86. U28 provides a +2.5 volt reference for +5 volt and +3 volt regulators and for the two DACs in the Digital-to-Analog Converter circuitry.

8-87. The +5 volt regulator consists of series pass transistor Q12, driver Q7, U28B, and associated components. The voltage is fixed at +5 volts with no adjustment capabilites. Precision resistors R56 and R57 form a voltage divider that compares exactly one half of the output voltage with the +2.5 volt reference voltage inputs of U27B.

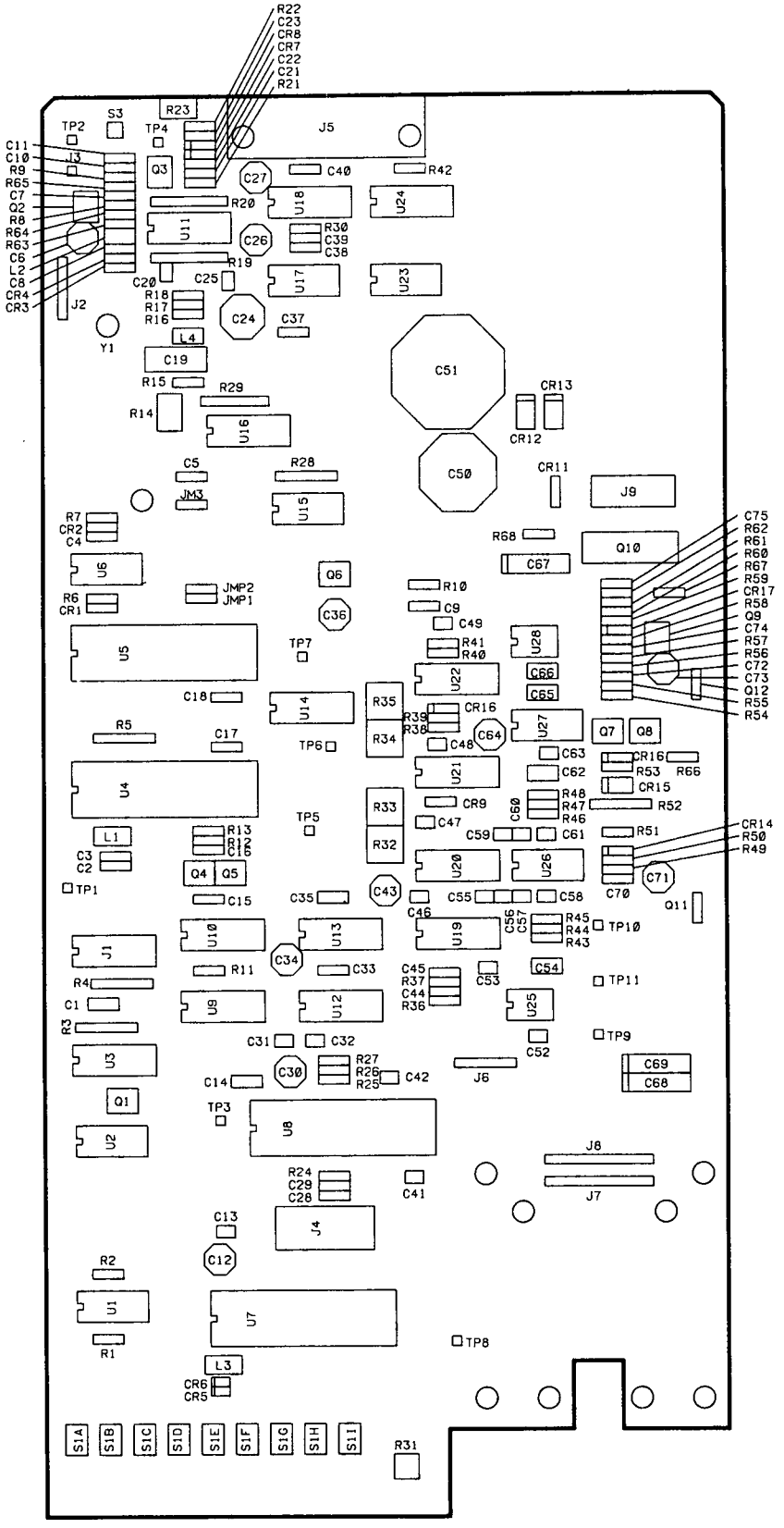
8-88. The +3 volt regulator consists of series pass transistor Q10, driver Q9, U27 and associated components. Operation is similiar to the +5 volt regulator, except that the +3 volt regulator input voltage is supplied by the +5 volt source. Voltage divider R59, R60, R61 and R62 is used to drive a sensing voltage of approximately +2.5 volts for comparison with the +2.5 volt reference voltage at U27A. This same voltage divider also provides a voltage of approximately 2.65 volts to the input of voltage follower U27D, which in turn is applied to pin 39 of MRC, U8.

8-89. The -5.2 volt regulator consists of series pass transistor Q11, driver Q8, U27C, and associated components. Resistors R49, R50 and R51 form a voltage divider between the -5.2 volt regulated output and the +5 volt supply. At proper output levels, the voltage at the junction of R50 and R51 is 0 volts. The voltage at junction R50 and R51 is applied to the non-inverting input of U27C. This (sensed) voltage is compared with pin 9 of U27C, which is at ground reference. Any change in the level of the -5.2 volt output will cause a corresponding correction voltage to be developed at pin 8 of U27C. CR15 is a schottky diode that prevents pin 10 of U27 from going negative by more than 0.3 volts which could cause U27C to latch up in a full on condition.

8-90. The troubleshooting for the power supplies can be found under Preliminary Troubleshooting, paragraph 8-45.



Part of Figure 8-5. A1 Counter Portion Assembly



Part of Figure 8-5. A1 Counter Portion Assembly

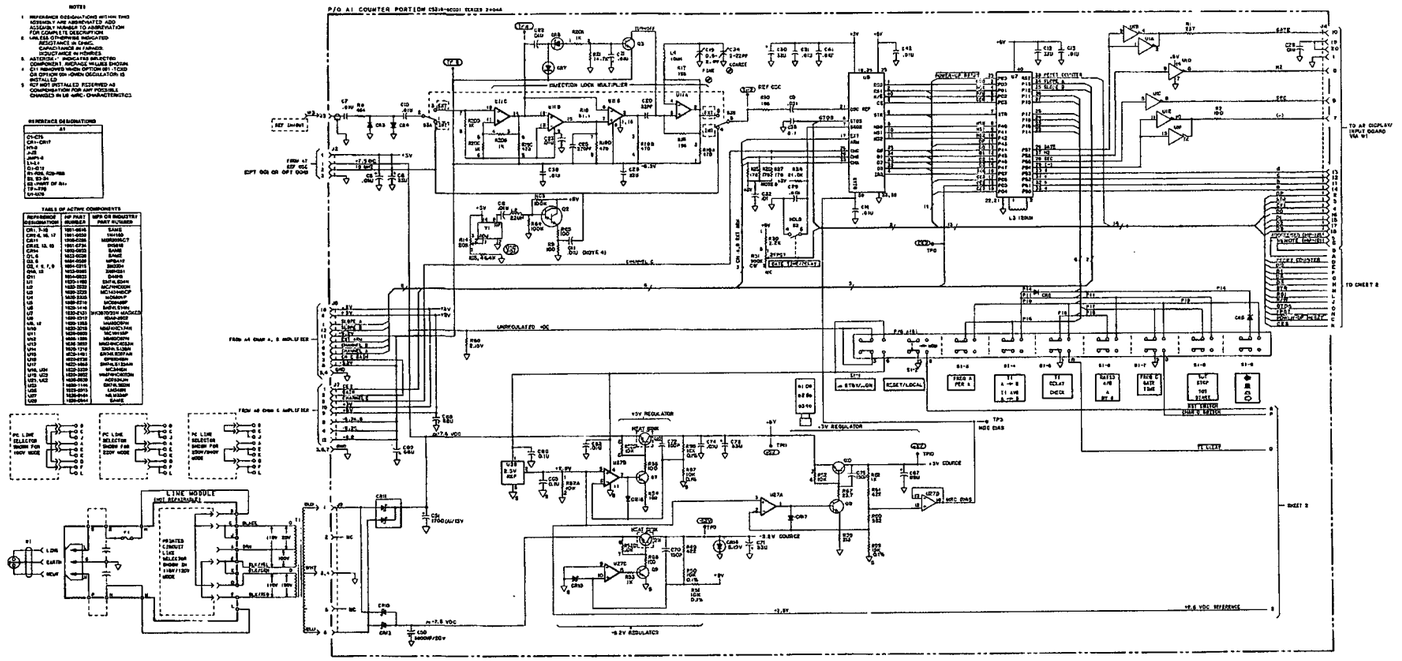
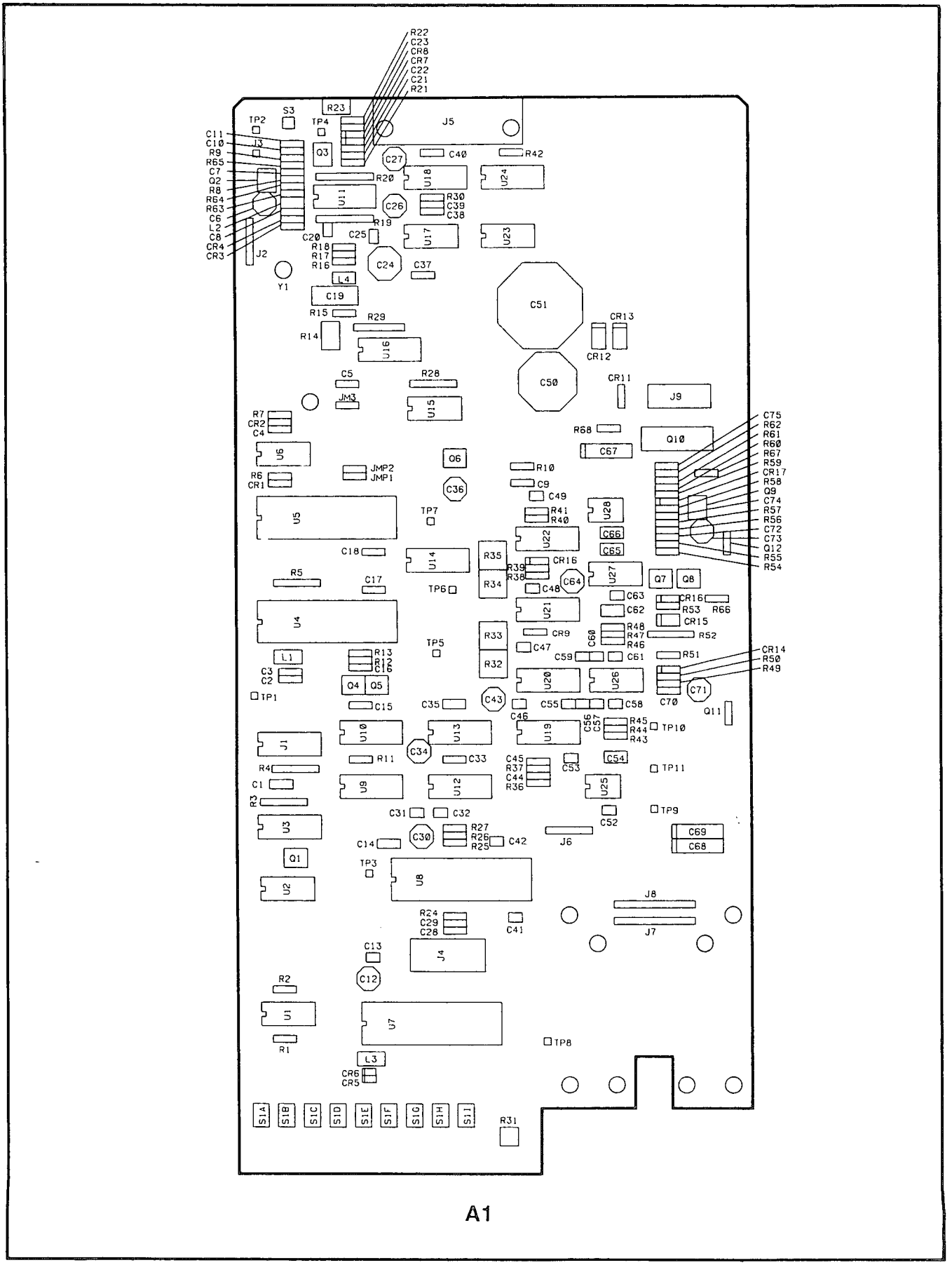


Figure 8-5. A1 Motherboard (Counter Portion)
(Sheet 1 of 2)

Figure 8-5
A1 MOTHERBOARD (COUNTER PORTION)
(Sheet 1 of 2)

(See Page 8-29)



Part of Figure 8-5. A1 Motherboard Counter Portion Assembly

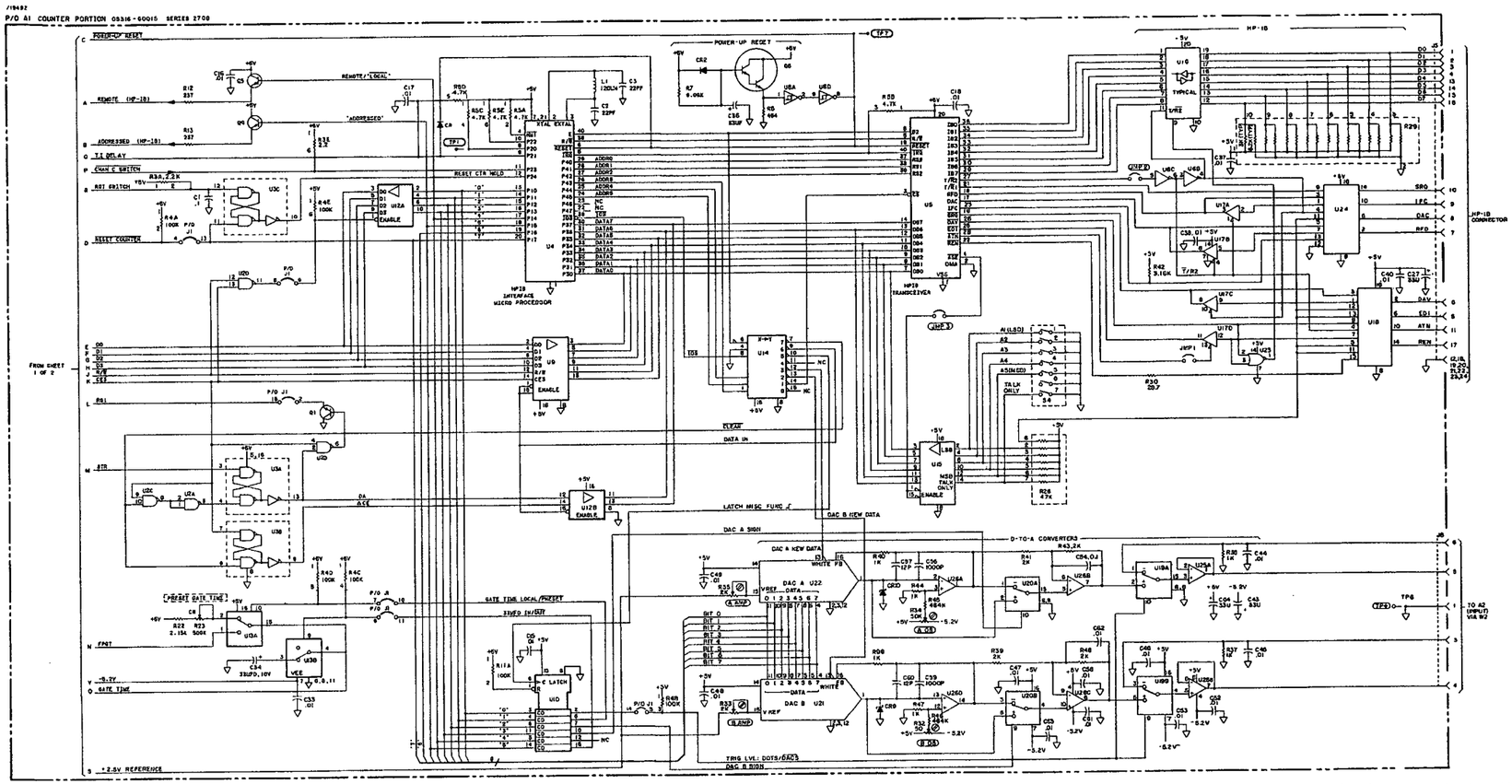
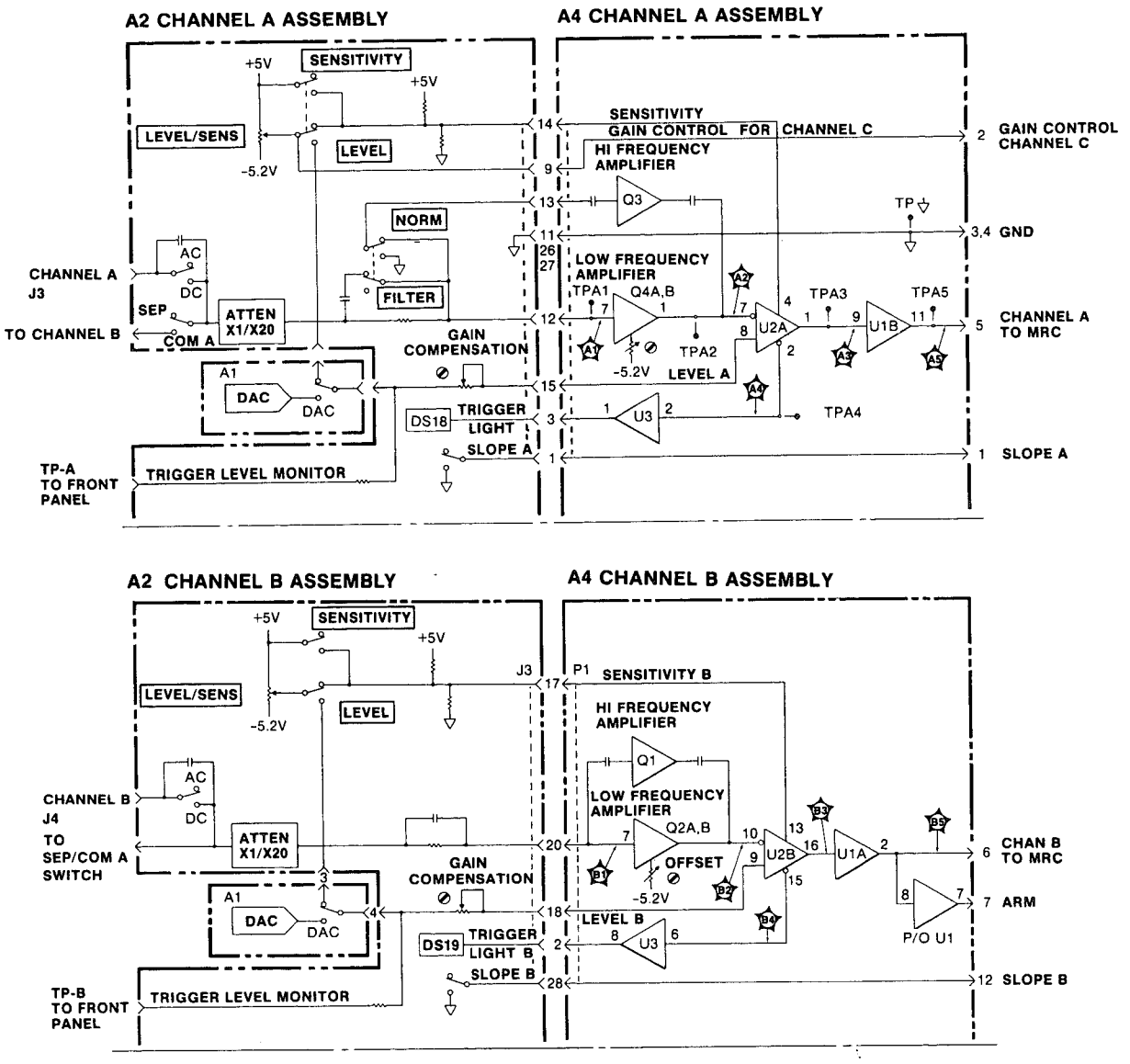


Figure 8-5. A1 Motherboard Counter Portion Assembly
(Sheet 2 of 2)

Figure 8-5
A1 MOTHERBOARD COUNTER PORTION ASSEMBLY
(Sheet 2 of 2)

(See Page 8-31)



8-91. CHANNEL A AND B THEORY

8-92. The A2/A4 assembly may be divided into the following sections:

A2 INPUT SWITCH ASSEMBLY

a. AC/DC coupling.

b. Separate/Common switch.

c. Attenuator X1/X20.

d. 100 kHz Low-Pass Filter (Channel A only).

e. Trigger Level/Sensitivity Controls.

f. Slope Switches.

g. Trigger Level LEDs.

h. Trigger Level Monitor Jacks.

A4 INPUT AMPLIFIER ASSEMBLY

a. High impedance buffer stage.

b. Schmitt trigger stage.

c. Level shifters.

d. Trigger LED drivers.

e. Various input switch assembly interconnect to the A1 Motherboard.

8-93. A2 Input Switch Assembly

8-94. The A2 Input Switch Assembly contains the Channel A and B signal conditioning switches, the Trigger Level/Sensitivity controls, and trigger lights. S5 and S10 select either ac or dc coupling. S8 is the SEP/COM A which allows the Channel B amplifier to be driven by either the Channel B BNC (J4), or the Channel A BNC (J3) in COM A. S6 (Ch A) and S9 (Ch B) select X1 and X20 attenuation by switching in or out the voltage dividers R9, R10, C8, C9 (Ch A), and R13, R16, C10, C11 (Ch B). C8, C9, C10, and C11 compensate for stray coupling at high frequencies. R11, R12, C7, and R14, R17, C12 form current limiting networks. CR1, CR2, and CR3, CR4 are voltage limiters.

8-95. S7 selects normal or low-pass filter configuration for Channel A. In the low-pass filter mode, C7 is disconnected, and high frequency input on pin 13 is connected to ground. The combination of R12, stray capacitance and the input capacitance of the amplifier on A4, roll off the frequencies above 100 kHz.

8-96. The LEVEL/SENS controls R4 and R5 provide adjustable dc levels, from +5V to -5.2V for use with either the LEVEL or SENSITIVITY outputs. With S1 or S2 in the SENSITIVITY position, the voltage swing is applied to the divider networks R7, R3F, and R8, R6F providing a voltage swing of ~+44 to -70 mV to the sensitivity node of the A4 comparators. The LEVEL outputs default to 0V dc. With the switches set to the TRIGGER LEVEL position, the SENSITIVITY outputs are tied high (to +5V; this applies +44 mV to the sensitivity port (pin 4) of the Schmitt trigger on A4U2), and the trigger level potentiometer voltage swing is divided in half via resistor networks in R3 and R6. A voltage swing of ~±2.5V is output to the Trigger Level inputs of A4 comparators. The wiper of R4 is also routed to A9 to be used as the sensitivity control for Option 003, Channel C. The trigger voltage is set either by the front panel Trigger Level control or Digital-to-Analog Converter, and can be monitored at the front panel Trigger Level Out jacks. These voltages are taken through R3E and R6E for Channels A and B, respectively.

8-97. S3 and S4 are the Slope switches which pull to ground, or allow to float high, the Slope A and/or Slope B lines. These lines are routed through A4 to A1U7. DS18 and DS19 are the Channel A and Channel B Trigger Lights, which are driven by a transistor array (U3) on A4.

8-98. A4 Input Amplifiers

8-99. A4 contains two essentially identical amplifier channels. The only differences are: 1.) the Low frequency and High frequency amplifiers have separate inputs for Channel A and are connected together for Channel B; 2.) Channel B has one additional output stage which drives the EXTERNAL ARM line. For simplification, only Channel A will be described.

8-100. The amplifier provides separate Low and High frequency buffer amplifiers. The Low frequency path is through a dual FET in a totem-pole configuration made up of Q4A, B, and associated circuitry. The High frequency buffer amplifier comprising of C8, C12, C18, R14, R15, R16, and Q3 is a simple ac coupled emitter-follower with dc biasing. Its output is combined with a Low frequency amplifier and applied to one side of comparator U2. The dc level from the Trigger Level control is applied to the other input. The complementary ECL outputs of the comparator are input to a differential amplifier, within transistor array U1. The differential amplifier shift the level of the Channel A signal, to the logic level of ~+2.4V (logic Low), to +3.0V (logic High) required by U8.

8-101. An additional differential pair, within U3, forms a one-shot. This circuit monitors the complementary outputs of U2, and drives the Trigger Lights on A2, causing the one-shot to trigger and the LED to flash. CR1 keeps U3 from saturating, which allows it to capture narrow pulses from the comparator. When the outputs of U2 are a steady logic state (High or Low), the LED's will stay fully on or off depending on whether the input signal's dc level is above or below the trigger level.

8-102. A2/A4 Input Amplifier Troubleshooting

NOTE

The Channel A and B Trigger Levels are routed through the Digital-to-Analog Converter, then back to A2. To troubleshoot A2 and A4 disconnect W2, and connect a jumper between A2P1 pins 3 and 4 and between pins 5 and 6. This removes the DAC from the circuit. Special shorting clips for this purpose are available by ordering HP Part Number 1258-0141 (2 required).

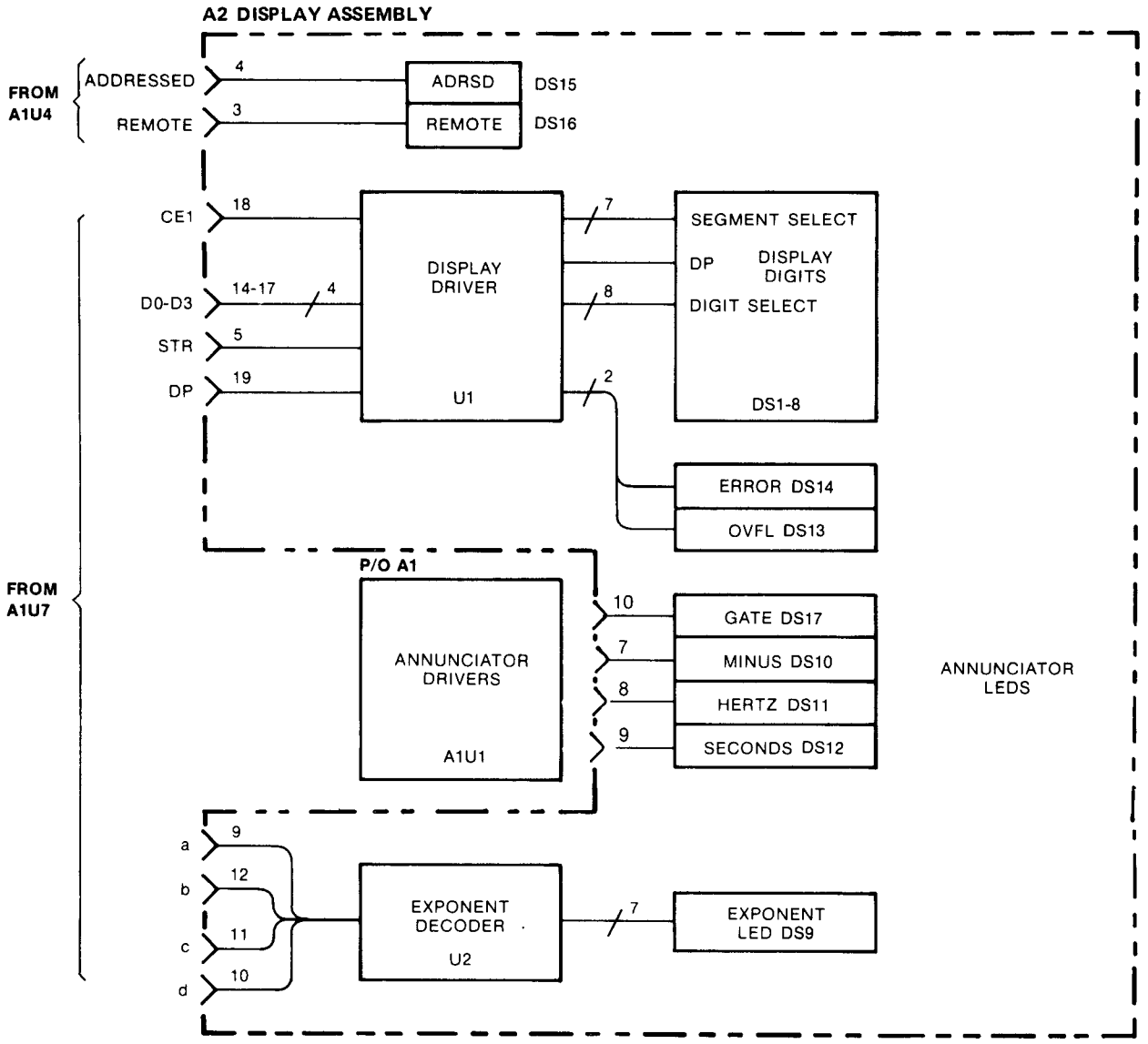
8-103. To troubleshoot the A2/A4 Input Amplifiers, apply a 10 MHz signal at 25 mV rms (70 mV p-p) to Input A, with the HP 5316B in COM A. Referring to the A2/A4 schematic diagram, *Figure 8-7*, check that the proper waveforms exist at each channel output (test points A5 and B5) as shown in the following examples. If either is not present, use the example waveforms to trace the signal back through each respective stage.

TEST POINT:

A1 Channel A signal conditioning output A4Q4(7)
A2 Channel A Schmitt trigger input A4U2(7)
A3 Channel A Schmitt trigger output A4U2(1)
A4 Channel A trigger amplifier one-shot input A4U3(2)
A5 Channel A to U8 P2(5)

B1 Channel B signal conditioning output A4Q2(7)
B2 Channel B Schmitt trigger input A4U2(10)
B3 Channel B Schmitt trigger output A4U2(16)
B4 Channel B trigger amplifier one-shot input A4U3(6)
B5 Channel B to U8 P2(6)
B6 Channel B arm P2(7)

After the repair, perform the A2 Trigger Level Compensation Adjustments as described in paragraph 5-16 and A4 Input Offset Adjustments as described in paragraph 5-12 in Section V.



8-104. A2 Display Assembly

8-105. The A2 Display assembly may be divided into the following sections:

a. LED digit displays.

b. Display decoder driver.

c. Annunciator drivers.

d. Exponent decoder.

e. Status and annunciator LEDs.

8-106. The Display assembly provides 8 digits of resolution with seven-segment LEDs, D1 through D8. The displays are controlled by display driver U1. The display driver contains complete decoding, memory, and scan circuitry as well as power drivers for the LED's.

8-107. The exponent digit is decoded by U2 and is displayed by DS8. U1 drives the annunciator LEDs for GATE, "-" (minus), Hz, and s (seconds).

8-108. A2 Display Troubleshooting

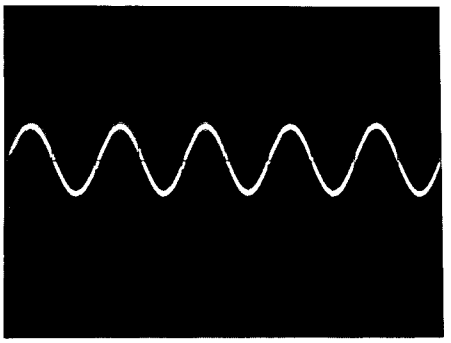
8-109. Release all of the Function Switches including the Blue Shift key (OUT). Refer to paragraph 3-33 Display Check and verify the appropriate LEDs light as shown in *Table 3-1.*

The failures now can be divided into three sections:

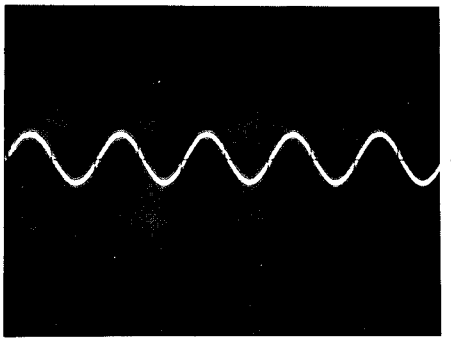
1. Failure in the main display LEDs DS1-DS8. If all LEDs display incorrect segments, then suspect U1 Display Driver. If only one LED is incorrect, swap the suspected display with one of the good displays.
2. Failure in the exponent LED. The exponent LED should display the same number as the main display LED's DS1-DS8 during the display check. If the display is blank, suspect U2. If one segment fails to light but it appears as though the correct number as being displayed, then swap the LED with another that is known to be good. If more than one segment fails to light then suspect U2.
3. Failure in the Hertz, Seconds, Minus, or Gate LED's: A failure in this area is more easily determined by connecting the rear panel REF IN/OUT to the Channel A Input BNC and switching between FREQ A (to verify Hertz and Gate) and PER A (to verify Seconds). Verify the input to the appropriate inverter A1U1 is High and the corresponding output is Low. If these lines are not being pulled when the corresponding function is selected, then the problem may be A1U7. Go to Preliminary Troubleshooting, paragraph 8-42.

NOTE

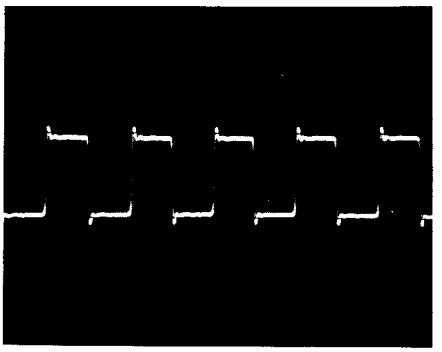
The Addressed & Remote LED's are from A1U4. These lines should go High when the 5316B is addressed and/or in remote.



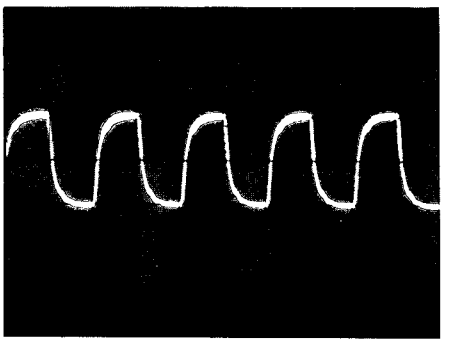
A1 B1 .01 V/div. .05 μs/div. DC coupled



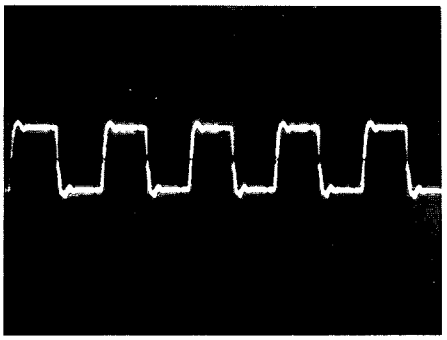
A2 B2 .01 V/div. .05 μs/div. DC coupled



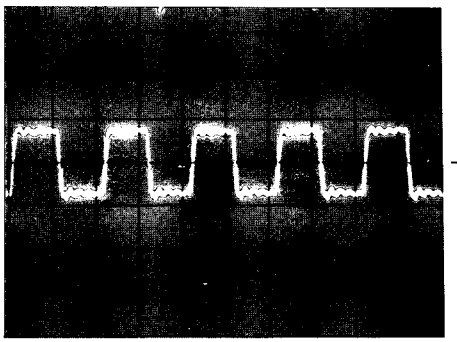
A3 B3 .05 V/div. .05 μs/div. AC coupled



A4 B4 .05 V/div. .05 μs/div. AC coupled

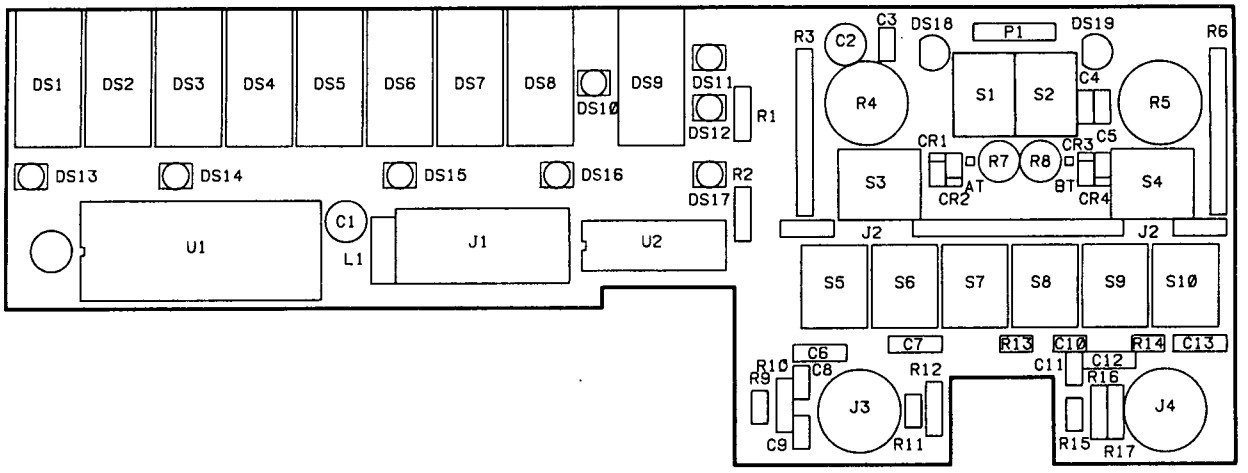


A5 B5 .05 V/div. .05 μs/div. AC coupled

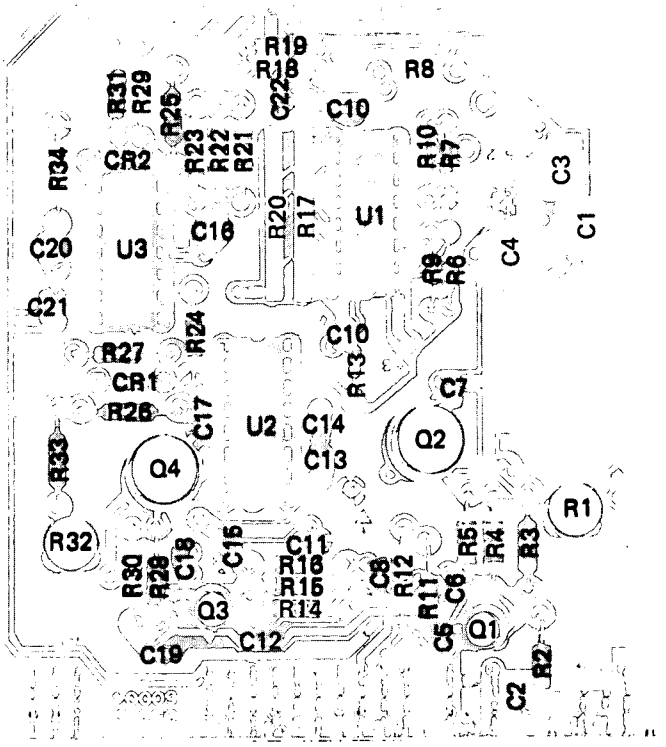


Channel B Arm
.05 V/div.
.05 μs/div.
AC coupled

Part of Figure 8-6. A2/A4 Input Assembly

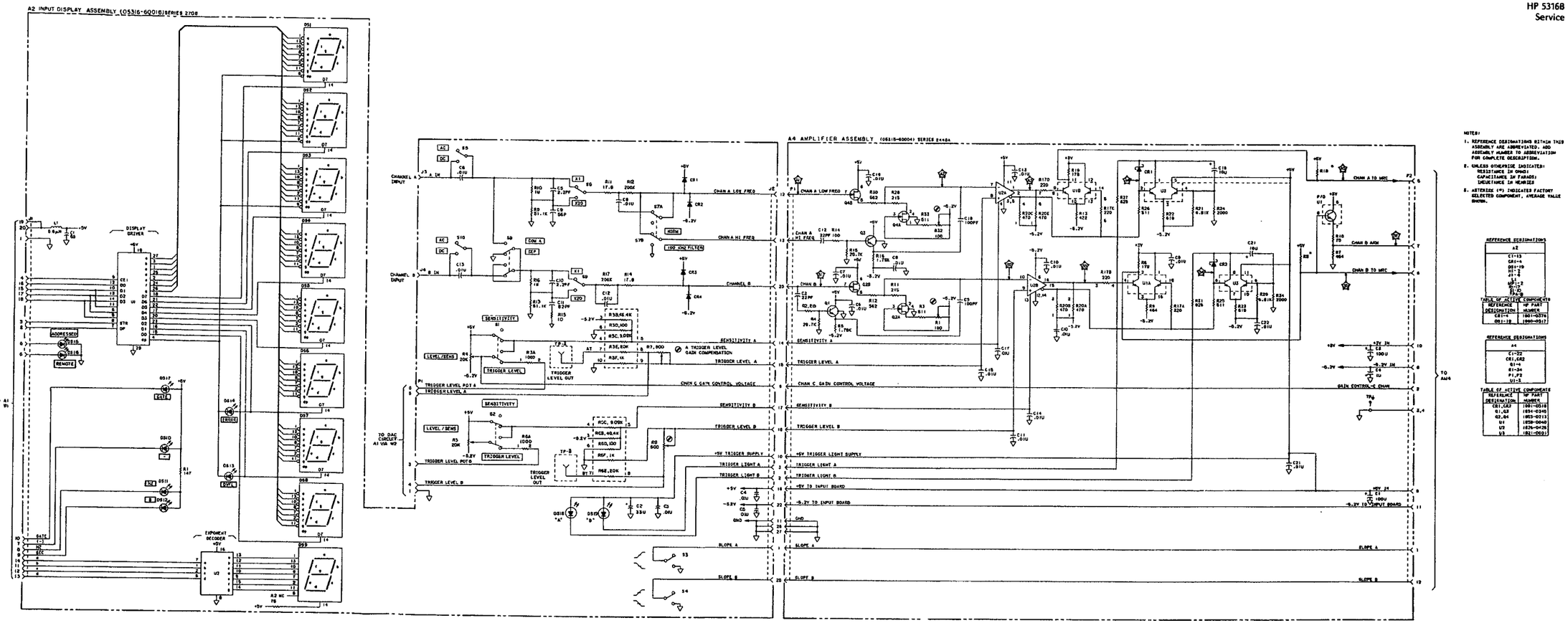


A2



A4

Part of Figure 8-6. A2/A4 Input Display Assembly



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 FACTORY SELECTED COMPONENT, AVERAGE VALUE SHOWN.

REFERENCE DESIGNATIONS

A2
C1-13
CR1-4
DS1-19
J1-3
L1
P1-2
R1-10
U1-8
TP4-8

TABLE OF ACTIVE COMPONENTS

REFERENCE DESIGNATION	HP PART NUMBER
U1-7	1901-0376
DS1-19	1990-0517

REFERENCE DESIGNATIONS

A4
C1-22
CR1,CR2
Q1-4
R1-34
P1,P2
U1-5

TABLE OF ACTIVE COMPONENTS

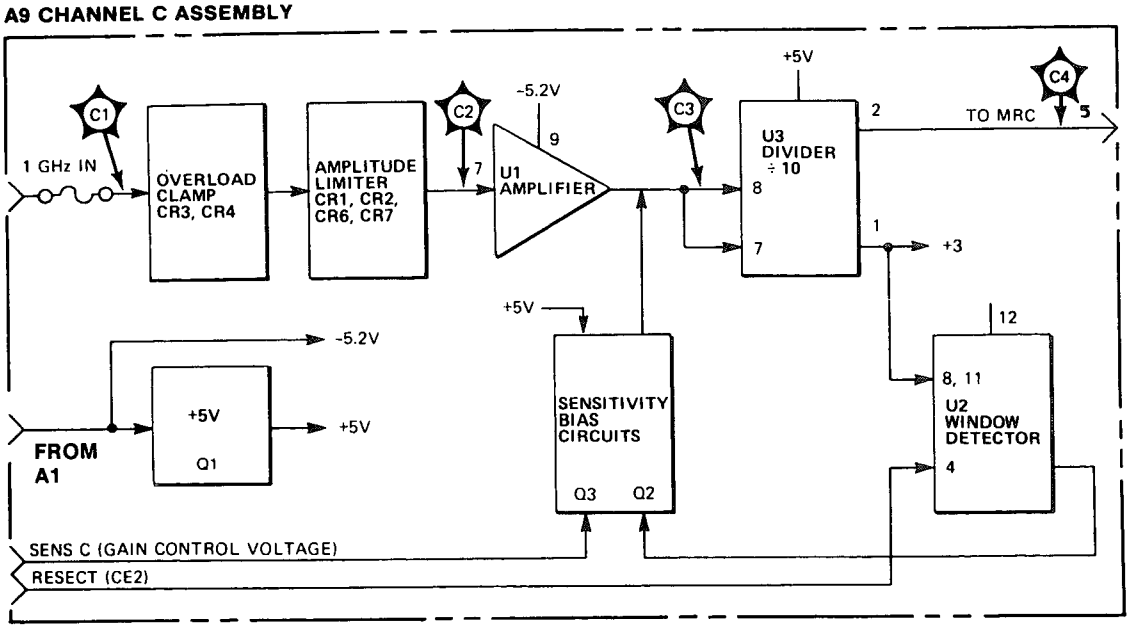
REFERENCE DESIGNATION	HP PART NUMBER
CR1,CR2	1901-0518
Q1,Q3	1854-0345
Q2,Q4	1853-0213
U1	1820-0040
U2	1826-0426
U3	1821-0901

Figure 8-6. A3/A4 Input Display Assembly

Figure 8-6
A3/A4 INPUT DISPLAY ASSEMBLY

(See Page 8-39)

A9 CHANNEL C ASSEMBLY



8-110. A9 CHANNEL C THEORY OF OPERATION

8-111. The A9 Channel C assembly may be divided into the following sections:

a. Input amplitude limiting circuit.

b. Complementary output buffer amplifier.

c. Divider biasing circuitry.

d. Complementary output divide-by-three circuit.

e. Window detect circuit.

8-112. The A9 Channel C assembly contains circuitry, to limit, amplify, and divide-by-10 an input signal from 50 to 1000 MHz. The overall sensitivity of the assembly is controlled by the dc bias applied to the inputs of the divider. This bias voltage can be manually varied via the front panel SENS C (also labelled Channel A LEVEL/SENS). A switch circuit monitors the divider output. If a marginal input signal level causes the divider output to move into a voltage window, this circuit feeds back a control voltage which increases the divider sensitivity. This in turn prevents any erroneous counts from the divider until the input signal is increased.

8-113. The input signal enters the front panel BNC J1, passes through fuse F1 and RF coax cable W1 to the A9 assembly. Input signals >±5V will forward bias the overload protection diodes CR3 and CR4, and the resultant current flow through the diodes will open the 125 mA fuse F1. The signal is ac coupled through C1, to the amplitude limiter circuit comprised of diodes CR1, CR2, CR6, and CR7, and associated circuitry. This circuit protects the differential amplifier in the following stages by limiting the amplitude of the input signal to ±300 mV maximum. CR1, CR2, CR6, and CR7 are fast switching Schottky diodes, in a balanced bridge configuration. R2 and R4 limit the current, while L1 and L2 and associated capacitors effectively isolate the limiter from power supply noise and transients. The signal is routed through C9 to differential amplifier U1. The input on pins 7 and 5 are balanced through 51.1 ohm resistors, R3 and R5, which provide a dc path to ground. The differential outputs of U1 (pins 1 and 2) are terminated to +5V through resistors R7 and R8. The outputs of U1 drive pins 7, 8, and 9 of divider U3. The divider is a biquinary (divide-by-2 and divide-by-5) resulting in a division by 10. The sensitivity of U3 is controlled by the differential dc voltage on pins 7 and 8. This dc voltage is controlled by FET Q3. The gate of Q3 is driven through R4 by the SCV (Sensitivity Control Voltage) line from the HP 5316B front panel

SENS C control. U3, pins 7 and 8 are normally offset approximately 75 mV, by HY adjustment R14 and H adjustment R9. Pin 9 is set halfway between TPB1 and TPB2 (approximately 37.5 mV above TP2) by CL adjustment R16. The SCV line swings between approximately +5V and -5V. The Channel C is most sensitive with SCV at +5V, which turns Q3 on hard. A the SCV voltage decreases, Q3 conducts less, dropping more voltage, and increasing the 75 mV offset, which decreases the divider sensitivity. The coupling capacitors C13, C14, and C15 isolate the dc levels of U1 from the dc bias levels of U3. The signal is shaped, squared, divided by 10, and output from U3 at pin 2. Pull-up resistor R17 references the output to +3V to match the HP 5316B U8 input level requirements.

8-114. The sensitivity switch circuit consisting of U2, Q2, and associated components prevents ambiguity in Channel C when the input signal has marginal strength. Adjustment of R14 is made such that TPB1 and TPB2 are biased to be 110 mV apart (differential), with the SCV line at +5V. At the beginning of each measurement cycle a reset pulse (positive TTL) is applied to U2 pin 4. This pulse causes pin 2 of U2 to pull the gate of FET Q2 to -5.2V, causing Q2 to shut off. Approximately 80 ms after the reset pulse A1U8 begins measurement of the A9 Channel C assembly output. If there is insufficient input signal, there will be no change of state on the outputs of U3 (pins 1 and 2), and the filtered voltage on pin 1 (U3) will be either 2 volts or 3 volts depending on the logical state of the U3 output. In either case this voltage is outside of the "window" of input voltages to U2 (pins 8 and 11) that could cause U2 to turn on (window = 2.4V to 2.8V). However, if the input signal is marginal but is sufficient to cause U3 to change states, the filtered voltage on pin 1, U3 will move into the window of U2. FET Q2 will turn on and the differential dc bias on TPB1 and TPB2 will decrease to 75 mV, as set by adjustment of R9. The sensitivity of U3 will increase by a small amount, such that the input signal strength which was marginal becomes adequate for a correct count. If the input strength drops below this level it will not be sufficient to trigger the hysteresis switch after the next pulse, and the Channel C will drop out.

8-115. Channel C Troubleshooting

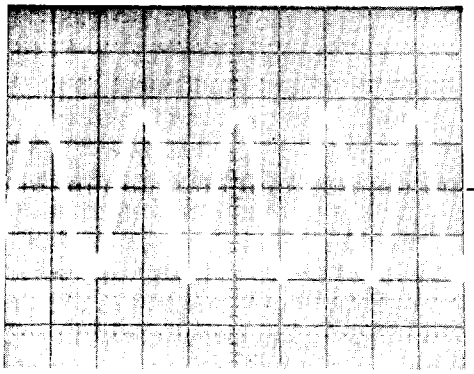
8-116. The Channel A and B Input Amplifiers (A2/A4) must be removed to access the A9 Channel C assembly. Refer to Section V, paragraph 5-28, A9 Option 003 Channel C Adjustment, and perform steps a. through w. Once the repair is completed, perform steps a. through w. in reverse order.

8-117. Refer to paragraph 3-70 and check for a blown input fuse. If so, replace the fuse and apply a 100 MHz signal at 100 mV rms to the Channel C Input BNC. Press FREQ C and set the SENS C (Channel A SENS/LEVEL) control fully clockwise. If the HP 5316B fails to count the input, the following procedure should help determine the defective stage. If the Channel C input has low sensitivity, there is a possibility that the protection diodes, CR3 and CR4, are damaged and must be replaced. Although when over-powered the input fuse will blow, damage to the junctions of the protection diodes may occur.

8-118. Press FREQ C. Verify +5 volts is present at U2 pin 3, and -5.2V is present at U2 pin 12. If NEITHER is present, verify -5.2 volts present at P1 pin 4. The -5.2V is used to turn on Q1, providing +5 volts.

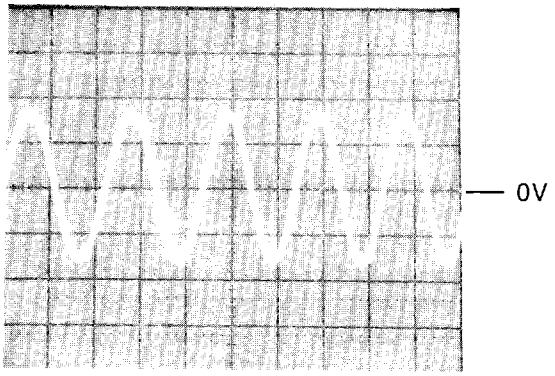
8-119. If both supplies are present, apply a 100 MHz sine wave at 100 mV rms (~280 mV p-p) to INPUT C with the HP 5316B in FREQ C mode. Place the SENS C front panel control to MAX. Refer to the A9 schematic diagram, *Figure 8-10,* and check that the proper waveforms exist at the indicated points. If the waveforms are not present, trace the signal to the defective stage.

LIMITER INPUT



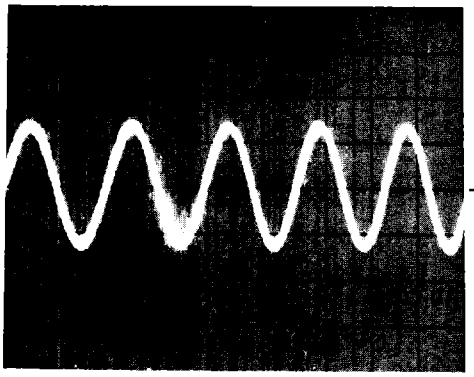
C1
A4CR3 (anode)
V = 0.1V/cm
H = 5 μs/cm
DC Coupled

LIMITER OUT



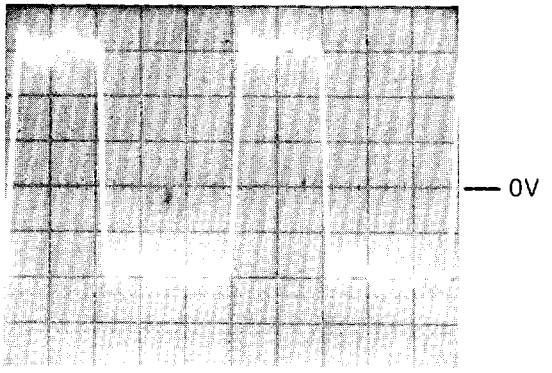
C2
A9U1(7)
V = 0.1V/cm
H = 5 μs/cm
AC Coupled

INPUT ÷10



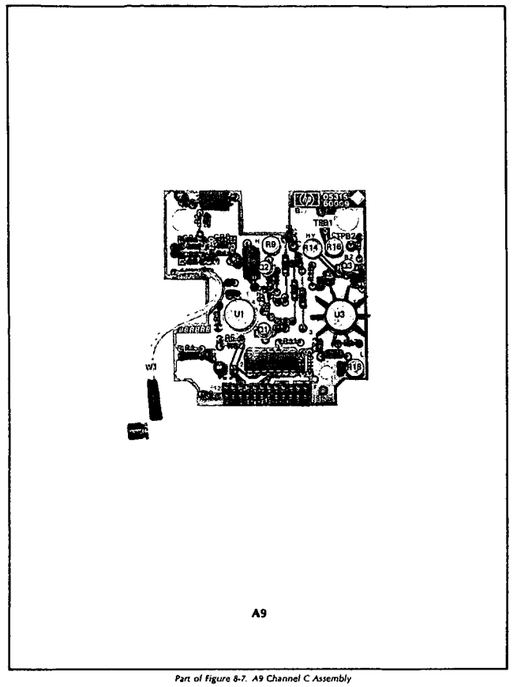
C3
U3(8)
V = 0.1V/cm
H = 5 μs/cm
AC Coupled

OUTPUT

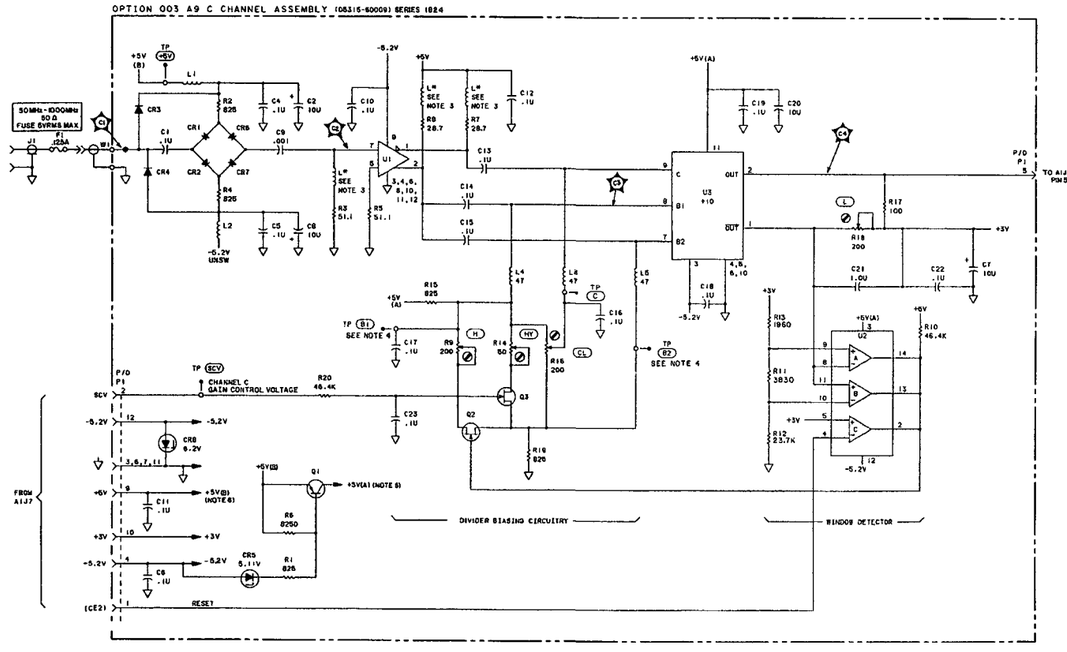


C4
U3(2)
V = 0.2V/cm
H = 20 ns/cm
AC Coupled

Part of Figure 8-7. A9 Channel C Assembly



Part of Figure 8-7. A9 Channel C Assembly



NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.
2. UNLESS OTHERWISE INDICATED:
   RESISTANCE IN OHMS
   CAPACITANCE IN PICOFARADS
   INDUCTANCE IN MICROHENRIES
3. L" = INDUCTANCE SHOWN IS NOT A DISCRETE PART, BUT IS DUE TO THE INTENTIONALLY LENGTHENED LEADS OF ASSOCIATED RESISTOR.
4. THE DIFFERENTIAL READING (B1-B2) IS:
   (10mV WITH NO SIGNAL APPLIED
   75mV WITH SIGNAL (AT SUFFICIENT LEVEL) APPLIED
5. +5V(A) SOURSED FROM Q1-5.2 VOLTS REQUIRED AT BASE OF Q1 FOR +5V(A) ON PC BOARD.
6. +5V(B) SOURCE DIRECTLY CONNECTED TO PIN 9 OF P1.

REFERENCE DESIGNATORS

A9
C1, C2, C4 - C20
CR1 - CR8
Q1 - Q3
R1 - R20
U1 - U3
L1 - L6

TABLE OF ACTIVE COMPONENTS

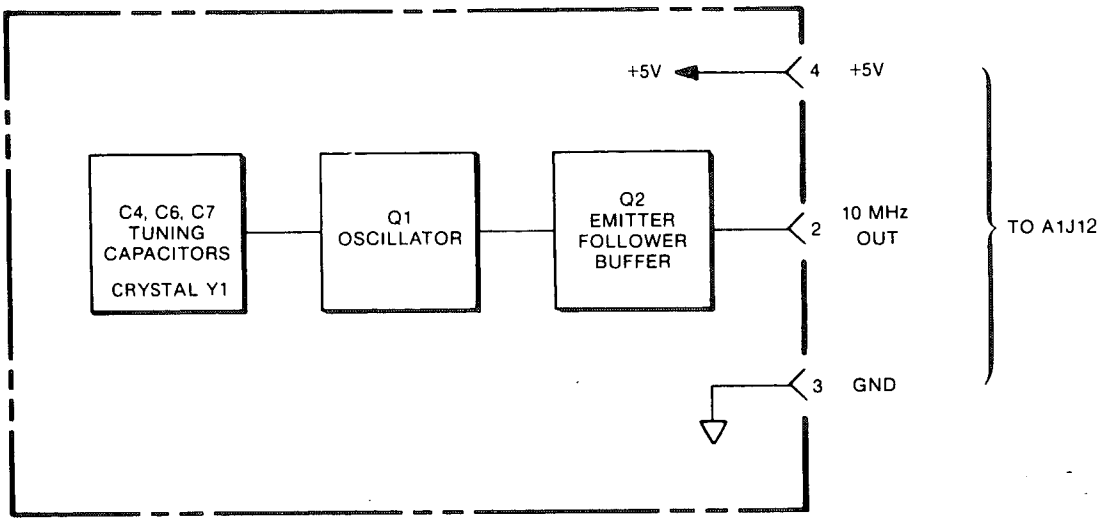
REFERENCE DESIGNATORS	HP PART NUMBER
CR1,2,6,7	1901 - 0535
CR3,4	1901 - 0050
CR5	1902 - 0041
CR8	1902 - 0051
Q1	1853 - 0281
Q2,3	1855 - 0420
U1	1826 - 0889
U2	1826 - 0138
U3	1820 - 2382

Figure 8-7. A9 Channel C Assembly

Figure 8-7
A9 CHANNEL C ASSEMBLY

(See Page 8-43)

A7 TIME BASE OSCILLATOR ASSEMBLY (STANDARD)



8-120. A7 TIME BASE OSCILLATOR

8-121. The Standard A7 Time Base Oscillator may be divided into the following sections:

a. Oscillator circuit.

b. Buffer amplifier.

8-122. The standard time base for the HP 5316B uses a 10 MHz Quartz Crystal, Y1. The circuit is formed around Q1, and uses feedback through divider C1 and C2. This stage then drives emitter follower Q2. The signal output at pin 2 is routed to S3 on A1. A1S3 selects whether the reference frequency will be derived from the on-board standard time base assembly (or the optional TCXO or Oven Oscillator) or from an external input frequency source connected to J3. An external reference connected to J3 is applied to the injection-lock-multiplier on A1. This circuit allows three different reference frequencies to be used (1, 5, 10 MHz). See A1 Theory of Operation, paragraph 8-75, Injection-Lock Multiplier.

8-123. Option 004 Oven Oscillator

8-124. The Oven Oscillator is made up of two sections: an assembly that replaces the Standard A7 assembly and an Oven Oscillator Module, A13. The A7 assembly is a voltage regulator circuit to supply +5 volts to the oscillator module, A13. The regulator consists of a series transistor Q1, a 2.5-volt reference U2, and amplifier U1. The 2.5V reference is applied to the inverting input of U1 at pin 2. The output of the voltage divider consisting of trimmer R2, R3, and R4 is applied to the noninverting input, pin 3. Since U1 wants to keep both of the inputs at the same voltage (2.5V due to reference U2), the current flowing into the noninverting input will reflect changes in the 5V output. U1 will increase or decrease the drive current to Q1 base as necessary. This changes Q1 emitter-collector voltage drop, restoring the proper output voltage. Zener diode CR1 provides a voltage shift to set Q1 base at the required 7.0V. Trimmer R2 is adjusted to compensate for offsets and tolerances in the components.

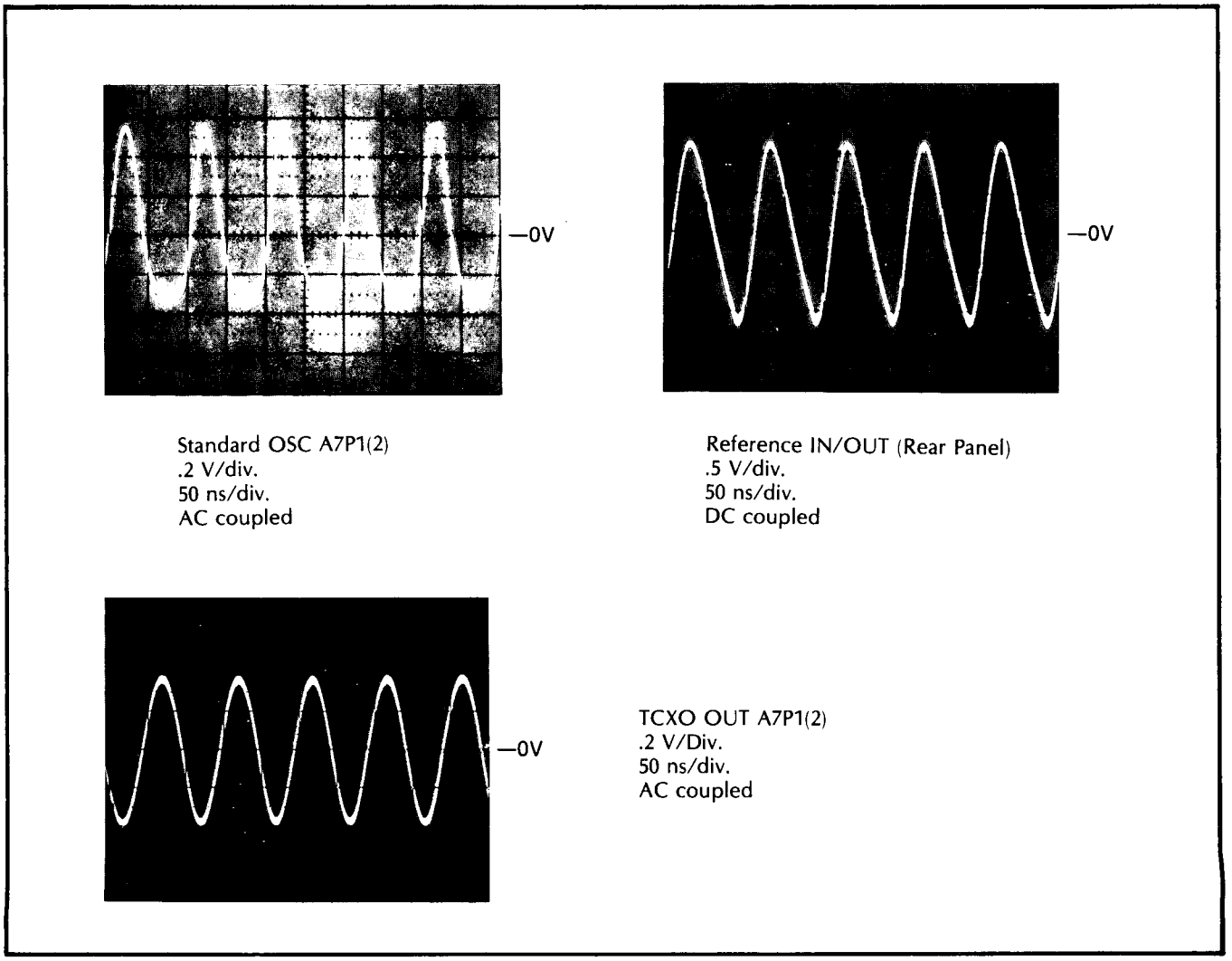
8-125. A7 Troubleshooting

8-126. STANDARD OSCILLATOR. To verify proper operation of the oscillator, check for the presence of the 10 MHz sine wave at the emitter of Q2. If the signal is not present, check Q1, Q2, and Y1. The following figures show the output waveforms for the standard oscillator and the Option 001 TCXO.

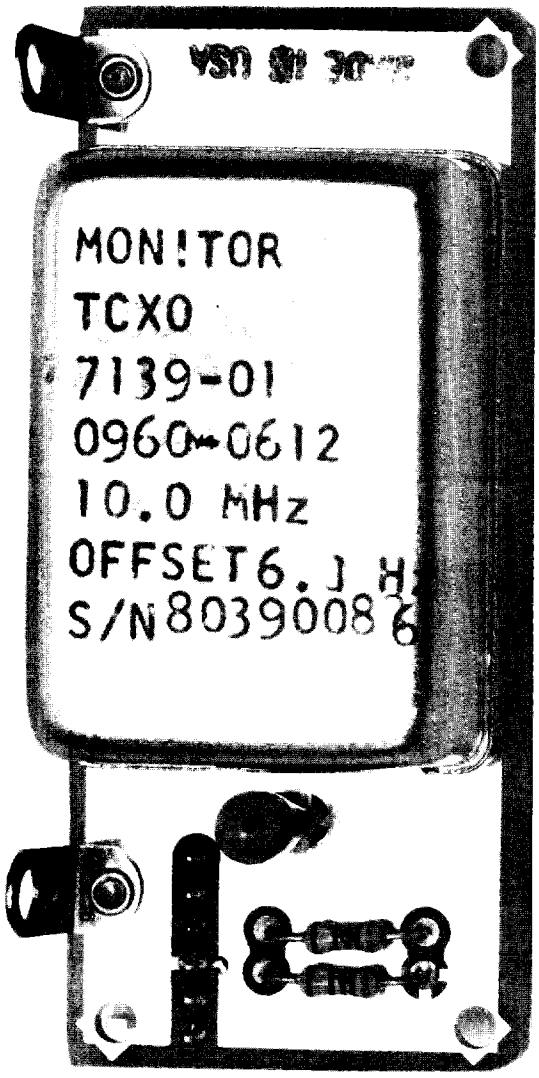
8-127. OPTION 001 (TCXO). If the HP 5316B has Option 001 (TCXO) and it has been found to be defective, then it must be replaced since it cannot be repaired.

8-128. OPTION 004 OVEN OSCILLATOR. If the output at A7P1 pin 2, is low or there is no output, verify there is +5V at the collector of Q1, (heat sink tab). If +5V is present, then the oscillator module is defective and must be replaced. It is not repairable.

8-129. If +5V is not present (0V or low), verify there is +2.5V at U2 pin 2. The output of U1 at pin 6 should be ~4.2V. If Q1 were to short emitter to collector, this would place 3.75V to the noninverting input of U1 at pin 3, probably damaging U1. Since R5 will limit the current from U2, U2 is subject mainly to internal failures.

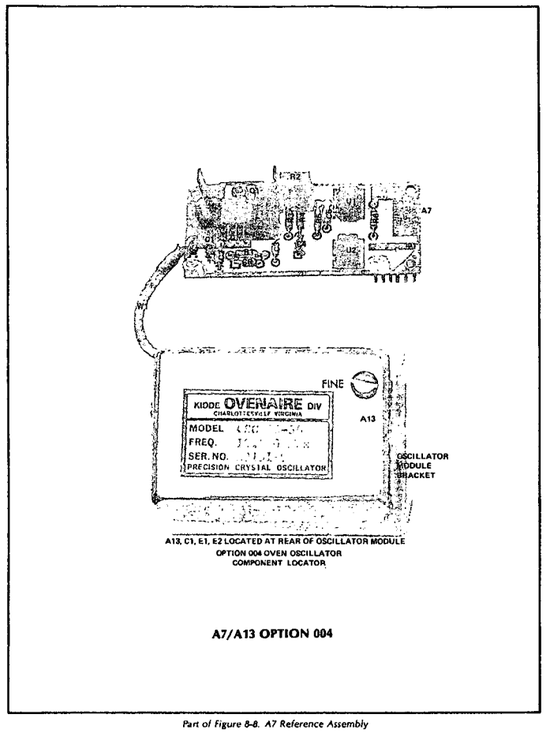


Part of Figure 8-8. A7 Reference Assembly

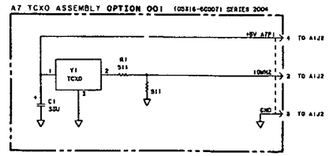


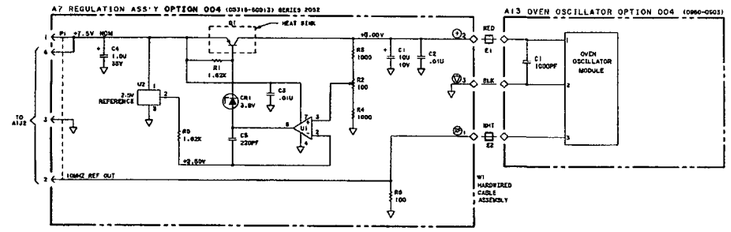
A7 OPTION 001

Part of Figure 8-8. A7 Reference Assembly



Part of Figure 8-8. A7 Reference Assembly





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 FACTORY SELECTED COMPONENT, AVERAGE VALUE SHOWN.

REFERENCE DESIGNATIONS (05316-60008)

A7
C1-7 Q1,2 R1-9

TABLE OF ACTIVE COMPONENTS

REFERENCE DESIGNATION	HP PART NUMBER
Q1,2	1854-0477
U1	0410-0412

REFERENCE DESIGNATIONS (05316-60007)

A7 TCXO OPTION 001
C1 R1,2 Y1

TABLE OF ACTIVE COMPONENTS

REFERENCE DESIGNATION	HP PART NUMBER
Y1	0960-0503

REFERENCE DESIGNATIONS (05316-60013)

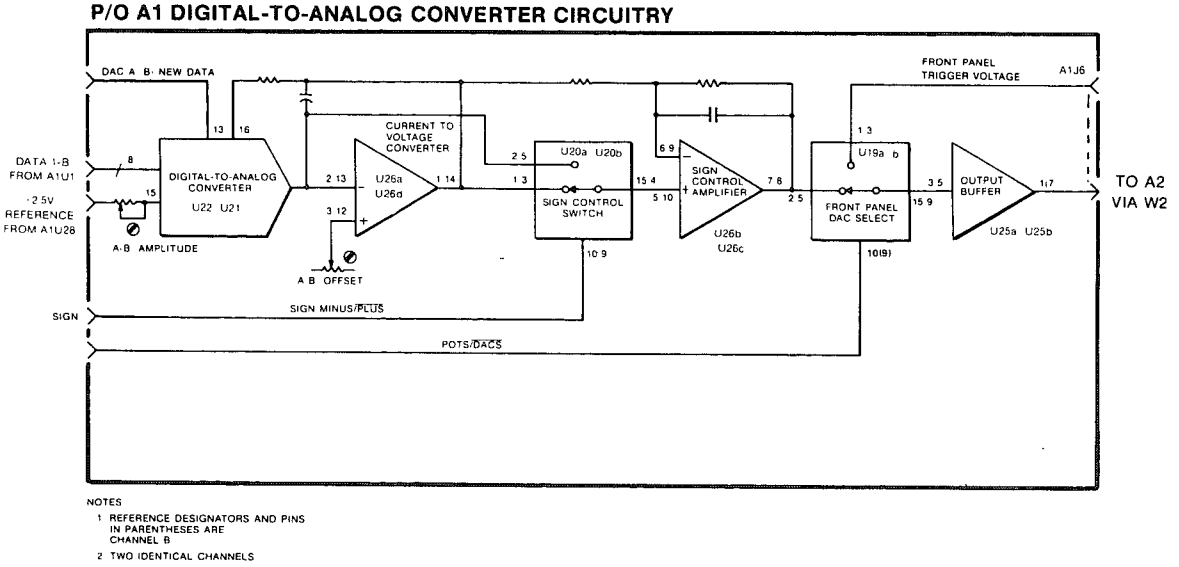
REGULATOR OPTION 004
C1-4 CR1 Q1 R1-6 U1,2

Figure 8-8. A7 Time Base Assemblies

Figure 8-8
A7 TIME BASE ASSEMBLIES

(See Page 8-47)

P/O A1 DIGITAL-TO-ANALOG CONVERTER CIRCUITRY



NOTES
1 REFERENCE DESIGNATORS AND PINS IN PARENTHESES ARE CHANNEL B
2 TWO IDENTICAL CHANNELS

8-130. DIGITAL-TO-ANALOG CONVERTER

8-131. The Digital-to-Analog Converter may be divided into the following sections:

a. DAC current-to-voltage converter.

b. Polarity inverting stage.

c. Polarity select analog switch.

d. DAC assembly buffer output stage.

e. Analog switch to select DAC or front panel trigger level controls.

8-132. The Digital-to-Analog Converter assembly controls the trigger level circuitry, allowing the 6801 to select Local or Remote Trigger Level control, and to set the value of the trigger level voltage when it is being controlled remotely.

8-133. The assembly has two identical circuits, one for the Channel A and one for the Channel B. The following description is for the Channel A. The Channel B is identical.

8-134. The variable voltage from the front panel trigger level control on A2 goes either to the 6-pin connector on the rear of the assemby (when the Trigger Level/Sensitivity switch is in the Trigger Level position) or to the sensitivity control network on A4.

8-135. A five-conductor cable takes the voltage from the trigger level control, through cable W2, through J6, to one of the inputs of a triple SPDT CMOS analog multiplexer, U19A. The control line (pin 10 of U19A), determines whether this voltage, or the voltage from the Digital-to-Analog Converter, will be routed back to the input amplifier assembly to be used as the trigger level voltage. The control line is driven by U10 pin 2 of a CMOS 6-bit latch on the A1 Motherboard. U10 latches data from U4, port 1, by a pulse on "LATCH MISC FUNC".

8-136. TRIGGER LEVEL POTS/$\overline{\text{DACS}}$ initializes (during power-up and when the IN instruction has been received) in the high state, so that the trigger level is set by the front panel trigger level controls. When a TR1 instruction is received, the control line goes Low, connecting the trigger level lines to the outputs of the Digital-to-Analog Converters for remote setting of the trigger levels. A TRØ command will return control back to the front panel trigger level controls by setting the control line High.

8-137. The Digital-to-Analog Converter consists of three major blocks: the D/A Converter U22, Current-to-Voltage Converter U26A, and Sign Control Amplifier U26B.

8-138. The D/A Converters are 8-bit CMOS circuits with an internal data latch and current mode output. Data is clocked into the latch on the rising edge of the "DAC A NEW DATA" pulse derived from the A1 Motherboard U14 pin 12 and pin 13 (Channel A or B). The data bits come from Port 1 of U4. When it is necessary to change the trigger level, U4 will remove the current data from the port and store it internally. (Port 1 of U4 is shared between several circuits; thus it is necessary for U4 to store the current data at Port 1 whenever it is requested to send new data to a different circuit. Once the data has been sent and received by the other circuit, the original data is returned to Port 1 so it can continue its original function.) U4 will place the new 8-bit data representing the new trigger level voltage at Port 1. U4 will then follow with a pulse on the "DAC A NEW DATA" line to latch this data into the DAC U22. Once this is accomplished, U4 will remove the 8-bit data from Port 1 and replace it with the original data present before U4 was ordered to send the DAC data. A similar process sets the Channel B DAC, U21.

8-139. The DAC reference current is defined by the +2.5V reference located on the A1 Motherboard. This reference is passed through R31 to the DAC.

8-140. The output of the DAC is fed to the inverting input of U26A. U26A has a feedback path through R40 to U22 pin 16. U25A is acting as an inverting current-to-voltage converter, with component values selected so that each bit represents a 10 mV change in the output of U26A. U26A output ranges from 0 to -2.55V. To obtain a negative trigger voltage, the output of U26A is fed to U26B. In this configuration, U26B is acting as a summing differential amplifier. For any voltage at the output of U26A, the voltage applied to the inverting input of U26B will have a gain of -(R41/R43) or -1. For any voltage at the output of U26A, the voltage applied to the noninverting input of U26B will have a gain of 1 + R41/R43 = +2. Since the same voltage is being applied to both inputs, the resulting output gain is +1 and the output is from 0 to -2.55V.

8-141. To obtain a positive trigger level, U20A connects the noninverting input of U26B directly to the output of the DAC. Since the DAC's output is current, the current through R41 will cause a positive voltage from 0 to +2.55V to appear at the output of U26B.

8-142. R34 offset adjustment is provided to null out the offset voltages of U26A and U26B and voltage buffer U20A.

8-143. U19A selects either the front panel trigger voltage set by A2R4 or the output of A1U26B, whenever the "POTS/$\overline{\text{DACS}}$" line goes Low. U25A acts as a voltage follower to buffer the output voltage and provide a low output impedance necessary to drive the 1K ohm resistor on the A2 assembly.

8-144. A1 Digital-to-Analog Converter Troubleshooting

8-145. The following troubleshooting assumes the HP 5316B will pass Checkpoint 1 of the HP-IB Verification in Section IV and that the failure of the DAC circuitry assembly to program trigger levels is not due to a failure in the HP-IB portion of the A1 Motherboard.

8-146. Connect a DVM to the front panel Trigger Level Out jacks. Set Channel A and B Trigger Level/Sensitivity switches to the TRIGGER LEVEL position (OUT). Vary the A and B Trigger Level controls and verify the DVM displays approximately -2.50V to +2.50V. This verifies that cable W2 is connected from the A2 assembly to the A1 assembly, the front panel TRIGGER LEVEL OUT jacks are connected to the front panel, and the analog switches (U19) on the A1 assembly are selecting the front panel controls.

8-147. Connect, through a 10:1 probe, an oscilloscope to the Channel A front panel TRIGGER LEVEL OUT on the front panel. Set the oscilloscope to:

.1 volt/div. .05 s/div. dc coupled + slope

8-148. Ground TP1 on the A1 Motherboard. This places the HP 5316B in the signature analysis mode. The display will flicker (see paragraph 8-70, step 4.) The Digital-to-Analog Converter is now being programmed to increment through its full voltage range. *Figure 1, 2,* and *3* show the output of U26 at pins 1(14) and 7(8), and the front panel TRIGGER LEVEL OUT. Both A and B Channels should be the same.

8-149. If the sawtooth wave is not present at U26 pins 1 and 14, verify U19 pins 9 and 10 are Low. This is the POTS/$\overline{\text{DACS}}$ line which selects the front panel controls when High or the D/A when Low. If the POTS/$\overline{\text{DACS}}$ line is High, connect U19 pins 9 and 10 to ground for a short time. If the sawtooth wave is now present, then the problem is associated with the HP-IB portion of the HP 5316B. Refer to paragraph 8-45, step f., and follow the procedure to isolate the problem.

8-150. If the AOS and BOS controls appear ineffective during adjustment of the DAC suspect U22 or U21 D/A Converters or U26 voltage-to-current converters. If the offset controls have an effect but do not have the necessary range, then suspect U22 or U21 D/A converters.

8-151. If the A AMP and B AMP controls appear ineffective during adjustment, then suspect U22 or U21. If the controls have an effect but do not have the necessary range, AND 2.5V is present at U22 and U21 pin 15, then suspect U22 or U21.

NOTE

After repair, adjust the A1 assembly as described in Section V.

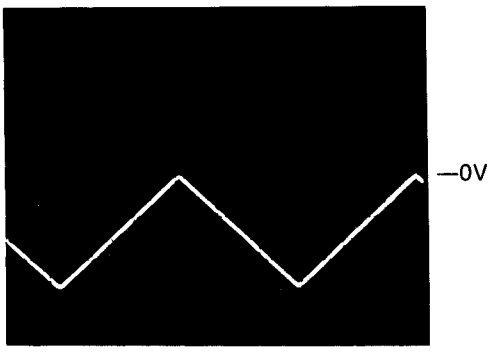
8-152. HP-IB INTERFACE

8-153. The HP-IB Interface circuitry may be divided into the following sections:

1. Address switches. S4 1-7
2. Three-state bidirectional DIO line drivers. U23, U16
3. Bus management logic and drivers. U18, U24

8-154. The HP-IB Interface circuitry is the hardware interface between (U5) and the HP-IB bus. The interface circuitry also contains the HP-IB address switches and pull-up resistors.

8-155. The 7PST switch (mounted in J4), sets the HP-IB address for the instrument. The five-rightmost switches set this address, while the leftmost switch sets Addressable or Talk only. Resistor network R28 and the ground side of the switches define the TTL logic levels fed to U5. The switches are read during the power-up sequence, and at regular intervals during the program, whenever U5 (under U4 control) sends $\overline{\text{ASE}}$ (Address Switch Enable) to a Low state (active Low). This puts the contents of the switches onto the 8-bit data bus shared by U5 and U4.

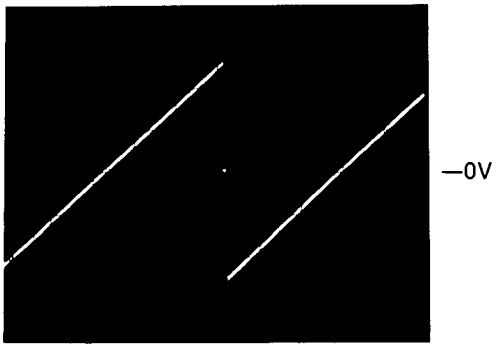


D1 D3

U26 Pin 1
.1 V/div.
.05 s/div.
DC coupled

D2 D4

U26 Pin 7
.1 V/div.
.05 s/div.
DC coupled



D1

Trigger Level Out
.1 V/div.
.05 s/div.
DC coupled

Figure 8-9. Digital-to-Analog Converter U26

8-156. IC U16 is an octal transceiver. Pins 1 through 8 connect to the data lines of U5, and pins 12 through 19 go to the data lines of the HP-IB. Each of the HP-IB data lines are biased by the resistor network R29. The Transmit/$\overline{\text{Receive}}$ Line, pin 11 of U16 is driven by T/R2, one of the control lines of U5. Pin 2 is the Enable Line (active Low), which is driven by gate U23A. This disables the data lines drivers when a system controller puts the HP-IB bus into Parallel Poll (the HP 5316B does not respond to a Parallel Poll). U18 and U24 are quad bus transceivers, and U17 is a quad three-state buffer. The buffers of U17 enable data to be sent to U5 when enabled by the driver control lines T/$\overline{\text{R1}}$, $\overline{\text{T}}$/R2, T/$\overline{\text{R2}}$. They go into the high impedance state when U5 wants to send signals over DAC, DAV, and RFD, the HP-IB control lines. The SRQ line is sent active by the HP 5316B when the SR1 command has been programmed and U4 determines that service is needed (a measurement has been completed and the HP 5316B has data to output).

8-157. The EOI line is received by U5, but U4 does not respond to it; rather, external input of instructions terminates with Carriage Return/Line Feed, and this is what U4 looks for. Remote Enable (REN) is sent by the controller to the HP 5316B, as is Interface Clear (IFC). U4 and U5 follow IEEE 488-1978 rules for these lines. Attention (ATN) is received by U5 and is used as an internal qualifier.

8-158. A1 HP-IB Troubleshooting

8-159. Divide into 3 sections:

a. HP-IB address switches, A1-A5, and Addressable/talk only may be checked as follows:

1. Remove test jumper JMP1.
2. Install a DIP clip on U15.
3. Ground pin 1 or 15 to enable U15.
4. Place all address switches in the down (open) position.
5. Apply power to the HP 5316B.
6. Using a logic probe (or an oscilloscope), check the input and output pins of U15 as shown in *Table 8-3.*

   — with all the input pins high, the output pins should be low, and visa versa.

7. Close one address switch at a time and verify that the logic levels change on the output pins of U15 and input pins of U5.
8. If proper indications are not apparent, look for a bad U15, broken traces, or a bad address switch.

NOTE

Re-install JMP1 when testing is complete.

Table 8-3. HP-IB Address Switches Test

BIT	SWITCH	A1U15 IN/OUT	A1U5 PIN
A1	S1-1	2/3	7
A2	S1-2	4/5	8
A3	S1-3	6/7	9
A4	S1-4	10/9	10
A5	A1-5	12/11	11
A6	NOT USED		
ADD/TLK	S1-7	14/13	13

b. The data I/O lines, the bi-directional transceiver U16, and associated components may be checked as follows:

1. Remove test jumper JMP2. (This isolates the T/R2bar line from U5. . . logic level high for transmit, low for receive.)
2. To test the receive direction, do the following:
   a) Install a DIP clip on U6.
   b) Ground pin U6, pin 5.
   c) Hook up a logic pulser and logic probe (or an oscilloscope).
   d) Using the information in *Table 8-4*, apply pulses to the data lines at the HP-IB connector.
   e) Verify that the corresponding pins at U5 pulse.
3. To test the send direction, do the following:
   a) connect u5, pin 6 to +5V.
   b) Using the logic pulser, logic probe, and *Table 8-4*, apply pulses at U5 data lines.
   c) Verify that the corresponding pins at the HP-IB connector pulse.

NOTE

Re-install JMP2 when testing is complete.

Table 8-4. U16 Transceiver

DIO LINE	HP-IB CONN	A1U16 IN/OUT	A1U5 PIN
0	1	19/1	36
1	2	18/2	35
2	3	17/3	34
3	4	16/4	33
4	13	15/5	32
5	14	14/6	31
6	15	13/7	30
7	16	12/8	29

c. The bus management lines can be checked as follows:

1. Remove test jumper JMP2 (if not already done in step b. above), and JMP3.
2. Using a logic pulser, logic probe (or an oscilloscope), and information listed in *Table 8-5*, pulse the appropriate pins on the HP-IB connector.
3. Ground only the IC pins indicated in *Table 8-5*.
4. Verify that the corresponding pins at U5 pulse.

NOTE

Re-install JMP2 and JMP3 when testing is complete.

Table 8-5. Bus Management Lines

BUS LINE	APPLY PULSE HP-IB CONN (A1J5)	TEST PROBE A1U5	
REN	17	22	
ATN	11	26	
EOI	5	25	GND A1U17(13)
DAV	6	16	GND A1U6(5)
IFC	9	21	
DAC	8	17	
RFD	7	18	
BUS LINE	**APPLY PULSE A1U5**	**TEST PROBE HP-IB CONN (A1J5)**	
SRQ	23	10	
DAC	17	8	GND A1U6(5)
RFD	18	7	GND A1U6(5)

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