OPERATING AND SERVICE MANUAL

5335A Universal Frequency Counter

General Information
Installation
Operation and Programming
Performance Tests
Adjustments
Replaceable Parts
Manual Changes
Service

HEWLETT PACKARD

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OPERATING AND SERVICE MANUAL

5335A
UNIVERSAL FREQUENCY COUNTER

SERIAL PREFIX: 2232A

This manual applies to Serial Prefix 2224A, unless accompanied by a Manual Change Sheet indicating otherwise.

OLDER INSTRUMENTS

For serial prefix below 2232A, refer to Section VII for manual backdating.

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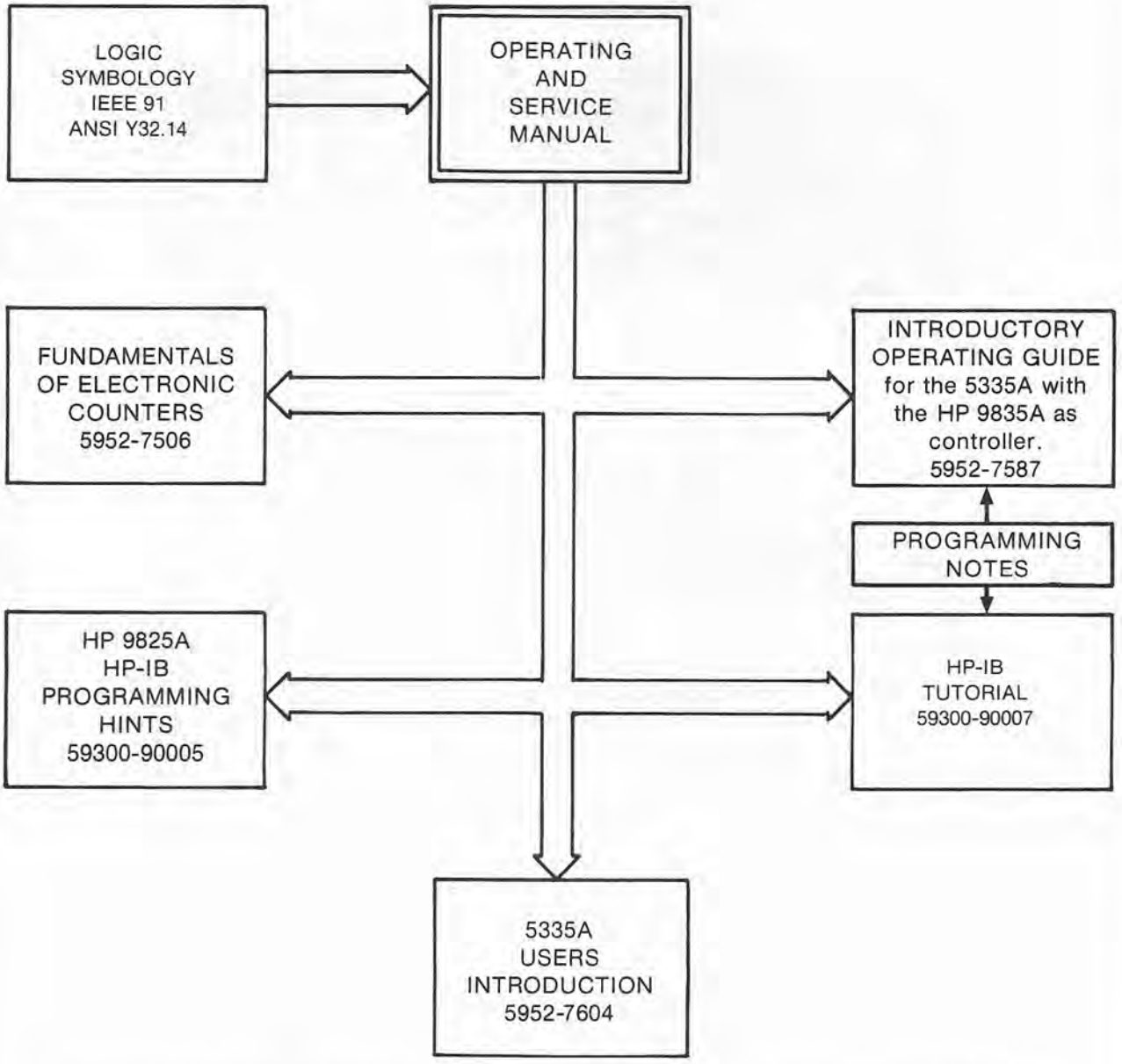
PREFACE

This manual is designed to present the information required by the user to effectively operate and maintain the 5335A Universal Counter.

It is divided into sections, each relating to a specific topic. As much as possible the sections are self-contained. It is the intention of this manual to allow for the quick location of desired information, while still providing the overall depth of detail required. Some sections provide the learning and working information, and will be used frequently. Other sections are dedicated to general and introductory types of information, and are intended to be used only for reference. Where applicable, photos, illustrations, and diagrams foldout allowing the user access to related information throughout the manual.

In limiting the depth of coverage in this manual, a certain amount of previous knowledge on the part of the reader must be assumed. A variety of additional related documentation is available. These materials address in depth the specific areas of interest, and should be used, whenever necessary, to supplement this manual. Users unfamiliar with HP-IB or Logic Symbology, for example, may want to refer to the 5335A Documentation Map to find additional sources of information.



5335A/9835A INTRODUCYTORY OPERATING GUIDE — Provides basic HP-IB interconnection information, remote programming examples and applications; specifically for the HP 5335A Universal Counter, using the HP 9835A as controller.

5335A OPERATING AND SERVICE MANUAL — Provides primary operating instructions and service information.

5335A USER'S GUIDE — Provides expanded operating instruction and instrument specific applications.

FUNDAMENTALS OF ELECTRONIC COUNTERS (AN 200) — Provides the basic concepts, techniques, and underlying principles of electronic counters.

HP 8725A HP-IB PROGRAMMING HINTS — Includes a variety of HP-IB related documents, including general bus theory and instrument specific programming examples.

5335A PROGRAM NOTES — Supplemental HP-IB programming information, provided in simple step-by-step format. Written for a specific instrument and specific controller.

IEEE 91 (ANSI Y32.14) — Describes logic symbols used in this manual.

HP-IB Tutorial — Describes fundamentals of Hewlett-Packard Interface Bus.

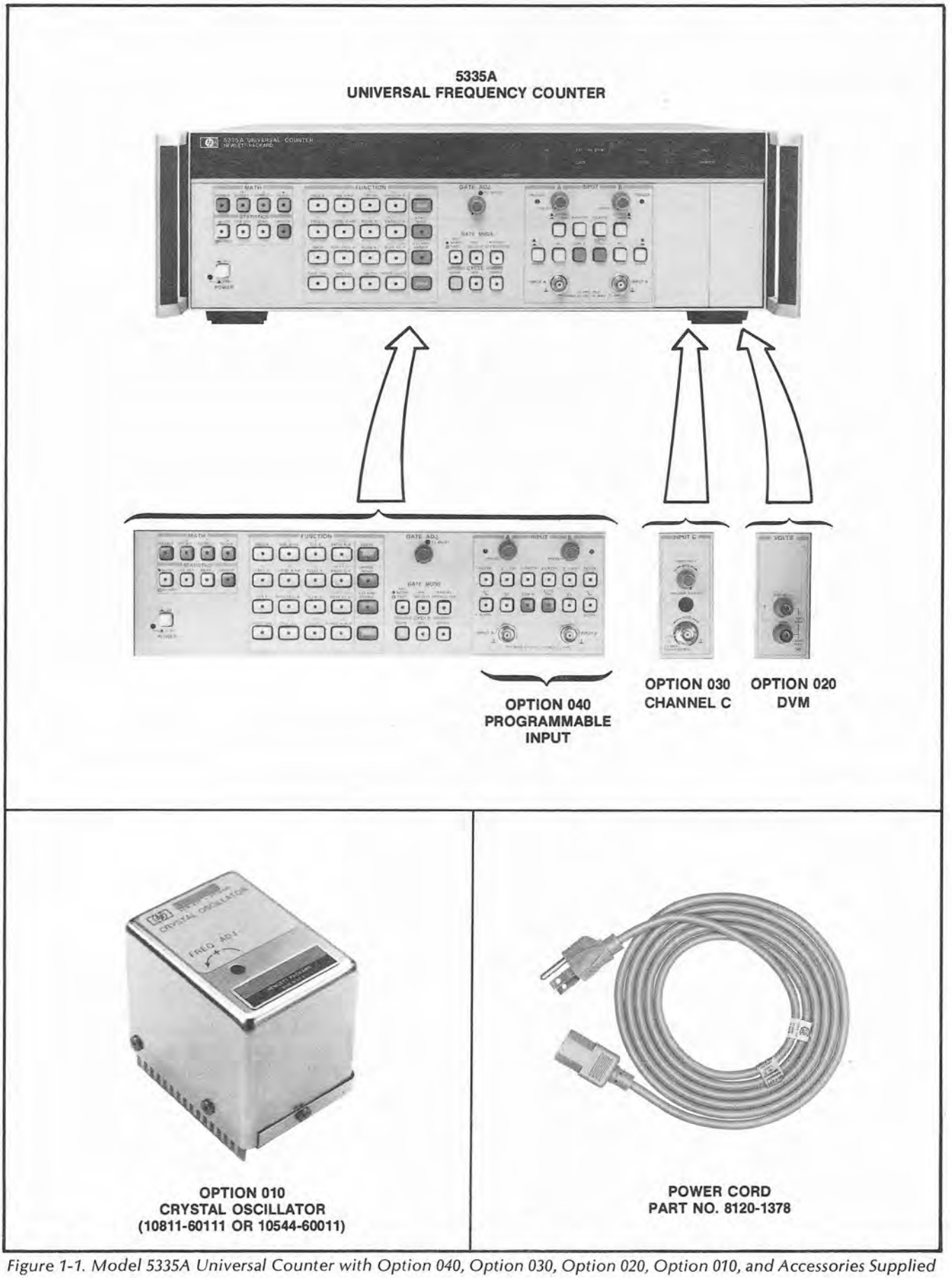


Figure 1-1. Model 5335A Universal Counter with Option 040, Option 030, Option 020, Option 010, and Accessories Supplied

SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION

1-2. This Operating and Service Manual contains the information required to install, operate, test, adjust, and service the Hewlett-Packard Model 5335A Universal Frequency Counter. *Figure 1-1* shows two examples of the 5335A counter. One instrument is a standard unit with no options. The other instrument has the optional digital voltmeter (Option 20), the third input amplifier or "C" channel (Option 30), and the programmable input amplifiers (Option 40).

1-3. MANUAL SUMMARY

1-4. This manual is divided into eight sections, each covering a particular topic for the operation and service of the HP 5335A. The topics by section number are:

SECTION I, GENERAL INFORMATION. Provides the instrument specifications, instrument identification, description of options, accessories and recommended test equipment.

SECTION II, INSTALLATION. Provides information about initial inspection, preparation for use, storage and shipment, field installation of options, and HP-IB interconnections.

SECTION III, OPERATION AND PROGRAMMING. Provides information about operating characteristics, panel features, local and remote operating instructions, operator's maintenance, and programming. The operation of Options 020, 030 and 040 is included in this section.

SECTION IV, OPERATIONAL VERIFICATION. Provides abbreviated procedures for operational verification which give the operator a high degree of confidence that the 5335A is operating properly.

SECTION V, ADJUSTMENTS. Provides the procedures required to properly maintain the instrument operating characteristics within specifications.

SECTION VI, REPLACEABLE PARTS. Provides ordering information for all replaceable parts and assemblies within the instrument.

SECTION VII, MANUAL CHANGES. This section contains manual change information which effectively "backdates" the technical areas of the manual to apply to older instruments.

SECTION VIII, SERVICE. This section provides the instrument theory of operation, troubleshooting information, repair techniques, and schematic diagrams.

1-5. SPECIFICATIONS

1-6. The instrument specifications are listed in *Table 1-1.* These specifications are the performance standards or limits against which the instrument may be tested.

1-7. SAFETY CONSIDERATIONS

1-8. The 5335A Universal Counter is a Safety Class I instrument (provided with a protective earth terminal), designed according to international safety standards. This operating and service manual contains information, cautions, and warnings which must be followed by the user to ensure safe operation and keep the instrument in safe condition.

1-9. INSTRUMENT IDENTIFICATION

1-10. Hewlett-Packard instruments have a two-section, ten-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 described in Section VII.

1-11. ACCESSORIES

1-12. *Table 1-2* lists accessory equipment supplied and *Table 1-3* lists accessories available.

Table 1-1. Model 5335A Specifications

INPUT CHARACTERISTICS (Channel A and B)

Range:
DC coupled, 0 to 100 MHz.
AC 1 MΩ, 30 Hz to 100 MHz.
AC 50 Ω, 200 KHz to 100 MHz.
NOTE: Channel A range 200 MHz when in Frequency A and Ratio modes.

Sensitivity (X1):
25 mV rms sine wave.
75 mV peak-to-peak pulse at minimum pulse width of 5 ns.

Dynamic Range (X1):
75 mV to 5V peak-to-peak, to 100 MHz.
75 mV to 2.5V peak-to-peak, > 100 MHz.

Signal Operating Range (X1, DC):
−5V dc to +5V dc.

Crosstalk (X1): <500 mV rms, 0 to 100 MHz, or <250 mV rms, 100 to 200 MHz, sine wave in either channel will not affect other channel.

Trigger Level Range (X1):
Auto Trigger OFF:
Preset: Set to 0V dc NOMINAL.
Adjustable: −5V dc to +5V dc.
Auto Trigger ON:
Preset: Set to NOMINAL 50% point of input signal.
Adjustable: NOMINALLY between + and − peaks of input signal.

Auto Trigger (X1):
Range (50% duty cycle):
DC coupled, 30 Hz to 200 MHz.
AC 1 MΩ, 30 Hz to 200 MHz.
AC 50 Ω, 200 kHz to 200 MHz.
Minimum Signal: 100 mV rms.
Duty Cycle Range: 10% to 90%.
Response Time: 3 seconds TYPICAL.
NOTE: Auto Trigger requires a repetitive signal.

Coupling: AC or DC, switchable.

Impedance: 1 MΩ NOMINAL shunted by <35 pf, or 50 Ω NOMINAL, switchable. In COMMON A, 1 MΩ is shunted by <50 pf.

Attenuator: X1 or X10 NOMINAL, switchable.

Slope: Independent selection of + or − slope.

Channel Input: SEPARATE or COMMON A, switchable.

Damage Level (AC or DC):
1 MΩ X 1:
DC to 2 kHz .... 250V (DC + AC rms)
2 to 100 kHz (5 X 10^5V rms Hz) /FREQ
>100 kHz ..... 5V rms
1 MΩ X 10:
DC to 20 kHz ... 250V (DC + AC rms)
20 to 100 kHz (5 X 10^6V rms Hz) /FREQ
>100 kHz ..... 50V rms
50Ω:
DC to 200 MHz ..... 5V rms

FREQUENCY A

Range: 0 to 200 MHz, prescaled by 2.

LSD Displayed:**

$$\frac{1\text{ ns}}{\text{Gate Time}} \times \text{FREQ.}$$ (e.g., 9 digits in a second)

Resolution:

$$\pm (2 \times \text{LSD}) \pm 1.4 \times \frac{\text{Trigger Error}^{**}}{\text{Gate Time}} \times \text{FREQ.}$$

Accuracy: ± (Resolution) ± (Time Base Error) X FREQ.

PERIOD A

Range: 10 ns to 10^7s.

LSD Displayed:**

$$\frac{1\text{ ns}}{\text{Gate Time}} \times \text{PER.}$$ (e.g., 9 digits in a second)

Resolution:

$$\pm (2 \times \text{LSD}) \pm 1.4 \times \frac{\text{Trigger Error}^{**}}{\text{Gate Time}} \times \text{PER.}$$

Accuracy: ± (Resolution) ± (Time Base Error) X PER.

Period Average: User selects MEAN function, and n = 100, or n = 1,000.

TIME INTERVAL A→B

Range: 0 ns to 10^7s.

LSD Displayed:** 1 ns (100 ps using MEAN).

Resolution: ± (2XLSD) ± (START Trigger Error**) ± (STOP Trigger Error**).

Accuracy: ± (Resolution) ± (Time Base Error) X TI ± (Trigger Level Timing Error**) ± (2 ns).

Gate Mode: MIN only.

Time Interval Average: User selects MEAN function, n = 100 or n = 1,000.

TIME INTERVAL DELAY (Holdoff)

For Time A→B, 1/Time A→B, Pulse A, (Time B→A, Pulse B), front panel Gate Adjust control inserts a variable delay between START and enabling of STOP. Electrical inputs during delay are ignored. Delay ranges are same as gate time ranges (100 µs to 4s NOMINAL) for gate modes of Fast, Norm, and Manual. Delay measured by pressing Gate Time key. All other specifications are same as Time Interval A→B.

INVERSE TIME INTERVAL A → B

Range: 10^{-7} to 10^9 units/second.

LSD Displayed, Resolution, and **Accuracy** are inverse of Time Interval A → B specifications. If Time Interval A → B is zero, display will be zero.

RISE AND FALL TIME A

Range: 20 ns to 10 ms

Minimum Pulse Height: 500 mV peak-to-peak.

Minimum Width at Peak of Signal: 20 ns.

Duty Cycle Range: 20% to 80%.

LSD Displayed and **Resolution** are same as Time Interval A→B specifications.

Accuracy: ± (TI Accuracy) ± (Trigger Level Setting Error** at 10% point) ± (Trigger Level Setting Error** at 90% point).

Input Mode: Automatically set to COMMON A with 10% and 90% trigger levels.

Gate Mode: MIN only.

PULSE WIDTH A

Range: 5 ns to 10^7s.

Trigger Point Range: 40% to 60% of pulse height.

LSD Displayed and **Resolution** are same as Time Interval A → B specifications.

Accuracy: ± (Resolution) ± (Time Base Error) X PULSE ± (Trigger Level Timing Error**) ± 2ns.

DUTY CYCLE** A

Range: 1% to 99%, 0 to 100 MHz.

Trigger Point Range: 40% to 60% of pulse height.

LSD Displayed:**

$$\frac{1\text{ ns}}{\text{PER}} \times 100\%.$$

Resolution:

$$\pm \left(\frac{\text{PULSE} + |\text{PULSE Accuracy}|}{\text{PER} - |\text{PER Resolution}|} \times 100\% - \text{DUTY CY} \right)$$

Accuracy:

$$\pm \left(\frac{\text{PULSE} + |\text{PULSE Accuracy}|}{\text{PER} \times |\text{PER Accuracy}|} \times 100\% - \text{DUTY CY} \right)$$

Gate Mode: MIN only.

NOTE: Constant duty cycle required during measurement.

SLEW RATE** A

Range: 50 V/s to 10^8 V/s slew rate.

Minimum Pulse Height, Width, and **Duty Cycle Range** are same as Rise and Fall Time A.

LSD Displayed:**

$$\frac{1\text{ ns}}{|\text{RISE/FALL}|} \times \text{SLEW; three digits maximum.}$$

Resolution:

$$\pm \left(\frac{|\text{TRIG LVL B} - \text{TRIG LVL A}| + 20\text{ mV}}{|\text{RISE/FALL}| - |\text{RISE/FALL Resolution}| - |\text{SLEW}|} \right).$$

Accuracy:

$$\pm \left(\frac{|\text{TRIG LVL B} - \text{TRIG LVL A}| \times 1.003 + 40\text{ mV}}{|\text{RISE/FALL}| - |\text{RISE/FALL Accuracy}| - |\text{SLEW}|} \right).$$

Input Mode: Automatically set to COMMON A with 10% and 90% trigger levels.

Gate Mode: MIN only.

RATIO A/B

Range:
Channel A, 0 to 200 MHz (prescaled by 2).
Channel B, 0 to 100 MHz.

LSD Displayed:**

$$\frac{\text{RATIO}}{\text{FREQ} \times \text{Gate Time}},$$

where FREQ is higher frequency after prescaling.

Resolution:

$$\pm \text{LSD} \pm \frac{\text{Trigger Error}}{\text{Gate Time}} \times \text{RATIO},$$

where Trigger Error is on lower frequency after prescaling.

Accuracy: Same as Resolution.

TOTALIZE A

Range: 0 to 100 MHz.

LSD Displayed:** 1 count of input

HP-IB Output: At end of gate.

Manual:
Count Reset: Via RESET key.
HP-IB Output: Totalize data on-the-fly sent if Cycle mode set to Single. Input frequency range in this mode is 0 to 50 Hz NOMINAL.

Gated:
Count Reset: Automatic after measurement.
Resolution: ± LSD
Accuracy: Same as Resolution.

**See Definitions section for further information.

Table 1-1. Model 5335A Specifications (Continued)

PHASE** A rel B

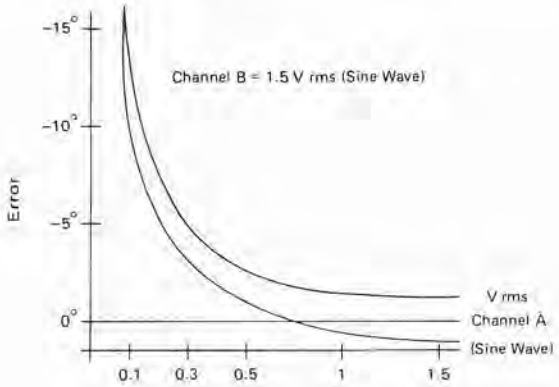
Range: -180° to 360°, Range Hold off, or 0° to 360°, Range Hold on, with signal repetition rates of 30 Hz to 1 MHz.
Minimum Signal: 100 mV rms.
LSD Displayed:** 0.1°.
Resolution:

$$\left[\pm \frac{TI_1 + |\ TI_1\ \text{Resolution}\ | + TI_2 + |\ TI_2\ \text{Resolution}\ |}{2\,[\ \text{PER A} - |\ \text{PER A Resolution}\ |\ ]} \times 360° - \text{PHASE (expressed in + degrees}\right]$$

Accuracy:

$$\left[\pm\text{Resolution} + \frac{TI_1 \pm TI_1\ \text{error}) + (TI_2 \pm TI_2\ \text{error})}{2\ (\text{PER A} + \text{PER error})} \times 360° - \text{PHASE (expressed in + degrees}\right]$$

Input Mode: Automatically set to 50% trigger level in A and B channels.
Gate Mode: MIN only.
NOTE: Constant phase required during measurement.



Typical phase uncertainty for PHASE A rel B measurements where channel B is 1.5 V RMS and channel A is varied in amplitude

NOTE: When signal B is **smaller** than signal A phase measurement uncertainty tends to be positive. TI_1 and TI_2 are times between 50% points of A and B as illustrated in the DEFINITIONS section.

TI_1 error and TI_2 error are the errors due to: 1) Trigger Level Timing Error, 2) Trigger Level Setting Error, and 3) Trigger Error due to noise.

GATE TIME

Range: 100 ns to 10^7s.
LSD Displayed:** Up to three digits with Ext. Arm Enable OFF, 100 ns when ON. MIN Gate Mode display zero.
NOTE: Time displayed and actual gate time may differ due to input signal synchronization of gate.

TRIGGER LEVEL

Range: X1, +5 to -5 volts.
X10, +50 to -50 volts.
Resolution: X1, 10 mV; X10, 100 mV.
Accuracy (X1): ±20 mV, ±0.5% of reading.
NOTE: Reading is center point of hysteresis band. When in X10, reading is multiplied by 10.

TIME BASE

Standard Crystal:
Frequency: 10 MHz.
Aging Rate: $<3 \times 10^{-7}$/month.
Temperature: $<4 \times 10^{-6}$, 0 to 50°C.
Line Voltage: $<1 \times 10^{-7}$ for 10% change.
High Stability Crystal: See Option 010.
External Time Base Input: Rear panel BNC accepts 5 or 10 MHz, 200 mV rms into 1 kΩ; 5V rms maximum.
Time Base Out: 10 MHz, >1V p-p into 50 Ω via rear panel.

STATISTICS

Sample Size: Selectable between either N = 100 or N = 1000 samples.
Std. Dev.: Displays a standard deviation of selected sample size.
Mean: Displays mean estimate of selected sample size.
Smooth: Performs a weighted running average and truncates unstable least significant digits from display.
NOTE: Statistics functions performed after Math functions.

MATH

All measurement functions with exception of GATE TIME, TOTALIZE in scale mode, and TRIG LVL, may be operated upon by Math functions. Offset, Normalize, and Scale may be used independently or together as follows:

$$\text{Display} = \frac{\text{Measurement} + \text{Offset}}{\text{Normalize}} \times \text{Scale}.$$

Numbers are entered via blue labeled keys.
DISABLE key will toggle off and on all active math keys.
Number Value Range: $\pm 1 \times 10^{-9}$ to $\pm 9 \times 10^{9}$.
Last Display: Causes value of previous display to Offset (negative value), Normalize, or Scale all subsequent measurements.
Measurement t-1: Causes each new measurement to be Offset (negative value), Normalized, or Scaled by each immediately preceding measurement.

HEWLETT-PACKARD INTERFACE BUS

Programmable Controls: All measurement functions, Math, Statistics, Reset, Range Hold, Ext. Arm Enable/Slope, Check, Gate Adj. (~1 ms to 1s), Gate Open/Close (gate time to ∞), Gate Mode, Cycle, Preset, Slope, Common A, Auto trigger.
Special Functions: FREQ B, PULSE B, TIME B→A, TOT A-B, LEARN, MIN, MAX, all internal diagnostic routines.
HP-IB Commands: Trigger, Clear, Remote, Local, Local Lockout, Require Service.
Data Output Rate: Fixed output format consisting of 19 characters plus CR and LF output in TYPICALLY 8 ms. Number of readings/second dependent on function, gate, and cycle used (~15 readings/second maximum).

GENERAL

Function Memory: Front panel settings for Math, Statistics, Range Hold, Ext. Arm Enable, Gate, and Cycle stored for current function and immediately preceding function. GATE TIME and TRIG LVL do not affect memory.
Gate: Minimum, manual, or continuously variable (NORM/FAST) via Gate Adj. control.
NORM: 20 ms to 4s NOMINAL.
FAST: 100 μs to 20 ms NOMINAL.
MIN: Minimum gate time. Actual time depends on function. For FREQ A, (FREQ B), FREQ C, and PER A, minimum gate = (one period of input) × (prescale factor).
MANUAL: Each press opens or closes gate.
Cycle: Determines delay between measurements.
NORM: No more than 4 readings per second NOMINAL.
MIN: Updates display as rapidly as possible (~15 readings per second, depending on function).
SINGLE: One measurement taken with each press of button.
Arming: Ext. Arm Enable key allows rear panel input to determine Start and/or Stop point of a measurement. External gate defined by both Start and Stop armed. All measurements are armable except Manual Totalize, Phase, and Trigger Level.
Start Arm: + or − slope of arm input signal starts measurement.
Stop Arm: + or − slope of arm input signal stops measurement. When used, Start arm must occur before Stop arm.
Ext. Arm Input: Rear panel BNC accepts TTL into 20 kΩ.
Minimum Start to Stop Time: 200 ns.
Trigger Level Out: DC output into 1 MΩ via rear panel BNC's for Channel A and B; not adjusted for attenuators.
Accuracy at DC (X1): ±15 mV ± 0.5% of TRIG LVL reading.
Gate Out: TTL level into 1 KΩ goes low when gate open; rear panel BNC.
Range Hold: Freezes decimal point and exponent of display.
Reset: Starts a new measurement cycle when pressed.
Check: Performs internal self test and lamp test.
Display: 12 digit LED display in engineering format; exponent range of +18 to −18.
Overflow: All measurements which would theoretically cause a display of more than 12 digits will display 12 most significant digits.
Operating Temperature: 0 to 50°C.
Power Requirements: 100, 120, 220, 240 VAC (+5%, -10%), 48-66 Hz; 130 VA max.
Weight: Net, 8.8 kg (19 lbs. 8 oz.); shipping, 13.6 kg (30 lbs.).
Dimensions: 425.5 mm W × 132.6 mm H × 345.4 mm D (16¾" × 5¼" × 13½"), not including removable handles.

**See Definitions section for further information.

Table 1-1. Model 5335A Specifications (Continued)

OPTIONS

Option 010: High Stability Time Base (Oven)
Frequency: 10 MHz.
Aging Rate: $< 5 \times 10^{-10}$/day after 24 hr. warm up.
Short Term: $< 1 \times 10^{-10}$rms for 1s average.
Temperature: $< 7 \times 10^{-9}$, 0 to 50°C.
Line Voltage: $< 1 \times 10^{-10}$ for 10% change.
Warm-Up: Within 5×10^{-9} of final value in 20 min.

Option 020: DC Digital Voltmeter
Range: 4 digits, autoranging, autopolarity, in ± 10, ± 100, ± 1000 V ranges.
Sensitivity: 100 µV, 1 mV, 10 mV, 100 mV for ± 1V, ± 10V, ± 100V, ± 1000V readings.
LSD Displayed:** Same as sensitivity.
Accuracy (10 min. warm-up): ±0.045% of reading ± 0.02% of range; for 1000V range, ± 0.06% of reading ± 0.02% of range. For 60 days at 24°C ± 5°C, RH < 80%, and gate > 100 ms.
Temperature Coefficient: ± (0.0055% of reading + 0.005% of range)/°C; for 1000V range, ± (0.008% of reading + 0.0005% of range)/°C.
Input Type: Floating pair.
Input Impedance: 10 MΩ ± 1%.
Maximum Input: Hi to Lo, ± 1000V all ranges. Low to chassis ground, ± 500V.
Response Time: 100 ms to within 1% of final value, within one range.
Normal Mode Rejection: 30 dB at 50/60 Hz.
Effective Common Mode Rejection (1 kΩ unbalanced): ≥ 110 dB at 50/60 Hz.
Filter: Single pole from 10 Hz NOMINAL.

Option 030: 1.3 GHz C Channel
Input Characteristics
Range: 150 MHz to 1.3 GHz, prescaled by 20.
Sensitivity:
10 mV rms sine wave (-27 dBm) to 1 GHz.
100 mV rms sine wave (-7 dBm) to 1.3 GHz.
Sensitivity can be decreased continuously by up to 20 dB NOMINAL, 150 to 1000 MHz and 14 dB NOMINAL, 1 to 1.3 GHz via sensitivity control. Trigger level is fixed at OV NOMINAL.

Dynamic Range:
10 mV to 1 V rms (40 dB), to 1 GHz.
100 mV to 1 V rms (20 dB), to 1.3 GHz.

Signal Operating Range: +5V dc to -5V dc.

Coupling: AC.

Impedance: 50 Ω NOMINAL (VSWR, < 2.5:1 TYPICAL).
Damage Level: ± 3V (DC + AC peak), fuse protected. Fuse located in BNC connector.

Frequency C
Range: 150 MHz to 1.3 GHz, prescaled by 20.
LSD Displayed, Resolution,** and **Accuracy** are same as Frequency A.

Ratio C/A
Range:
Channel A, 0 to 200 MHz (prescaled by 2.)
Channel C, 150 to 1300 MHz (prescaled by 20).
LSD Displayed, Resolution,** and **Accuracy** are same as Ratio A/B.

Option 040: Expanded HP-IB Control
Added Programmable Controls: Trigger level, input coupling, filter, input impedance, attenuation:
Trigger Level.
Range: ± 5 Vdc in 10 mV steps.
Accuracy: ± 30 mV of programmed level in X1; ± 300 mV in X10 NOMINAL.
Setup Time: < 50 ms from HP-IB command.

NOTE: Level programmed is center of hystersis band. When in X10, displayed level is 10 times entered value. Rear panel trigger level is not multiplied by 10 in X10 mode.

Input Coupling: AC or DC
Low Pass Filter: 150 kHz (Nom.), -30 dB down at 200 MHz (Nom.)
Input Impedance: 1M Ω NOMINAL shunted by < 45 pf, or 50 Ω NOMINAL. In Common A, 1 M Ω is shunted by < 55 pf.
Attenuator: X1 or X10 NOMINAL
Auto-Trigger: 50 mV rms sensitivity in PRESET, 30 Hz to 200 MHz (100 MHz in Channel B).

DEFINITIONS

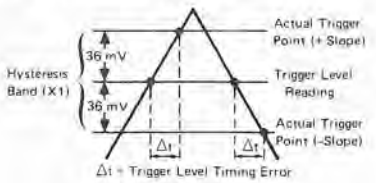
LSD Displayed: Unit value of Least Significant Digit displayed. Calculations should be rounded up to nearest decade, with a 12 digit mantissa maximum. If truncation required, most significant digits are kept.

Trigger Error:

$$\frac{\sqrt{(e_i^2 + e_n^2}}{\text{Input slew rate at trigger point}} \text{ sec rms}$$

where $e_i = 260\mu V$, typical, and is the effective rms noise of the 5335A input channel; e_n is the rms noise voltage of the signal input for a 200 MHz bandwidth.

Trigger Level and Trigger Point (X1):



Trigger Level Timing Error (X1): Applies to Time Interval measurements;

$$\frac{36 \text{ mV}}{|\text{Input slew rate at START trigger point}|}$$

minus

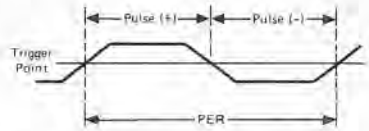
$$\frac{36 \text{ mV}}{|\text{Input slew rate at STOP trigger point}|}$$

Trigger Level Setting Error (X1): Applies to Rise/Fall, Slew, and Phase measurements:

$$\frac{\pm 2\% \text{ of input p-p voltage} \pm 40 \text{ mV}}{\text{Input slew rate at trigger point}}$$

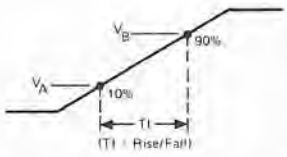
Duty Cycle: Percentage of time a signal is high or low, depending on Slope A setting. Trigger point is high/low dividing point.

$$\text{DUTY CY} = \frac{\text{PULSE}}{\text{PER}} \times 100\%;$$



Slew Rate: Effective slope between 10% and 90% points of rising or falling signal depending on Slope A setting.

$$\text{SLEW} = \frac{V_B - V_A}{TI};$$

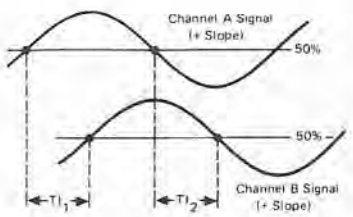


Phase: Angle, with respect to B signal, between 50% points of Channel A and B signals, trigger slopes selected by Channel A and B slope switches.

$$\text{PHASE} = \frac{\frac{TI_1 + TI_2}{2}}{\text{PER}} \times 360°,$$

TI_1 is time between 50% points of A then B signals using slopes defined during Phase measurement.

TI_2 is time between 50% points of A then B signals using complement slopes to TI_1.



*Specifications describe the instrument's warranted performance. Supplemental characteristics are intended to provide information useful in applying the instrument by giving TYPICAL or NOMINAL, but nonwarranted performance parameters. Definition of terms is provided at the end of the specification section. For a more detailed explanation, see Application Note 200-4 "Understanding Frequency Counter Specifications".

Table 1-2. Equipment Supplied

DESCRIPTION	HP PART NUMBER
Detachable Power Cord 229 cm (7 1/2 feet long)	8120-1378

Table 1-3. Accessories Available

DESCRIPTION	HP PART NUMBER
Option 910 Additional Manual	
Rack Mounting Adapter Kits: Rack Mount with Handles attached; Option 913	5060-0171
Rack Mount with Handles removed Option 908	5061-0077
Signature Analyzer	Model 5004A
2–1300 MHz Preamplifier	Model HP 10855A
Time Interval Probes	Model 5363B

1-13. DESCRIPTION

1-14. The HP Model 5335A is a Universal Counter capable of measuring signals in the 200 MHz range. The instrument's basic measurement functions include Frequency, Period, Time, Ratio, and Totalize. The resident microprocessor and multiple-register-counter expand the usefulness of the counter by allowing post-measurement data manipulation. This allows the additional power and convenience of user-defined measurement function keys for Statistical Data, Math Functions, Pulse Width, Rise/Fall Time, Slew Rate, Duty Cycle, and Phase Relationship. Interpolating oscillators, phaselocked to the instrument's time base, allow measurements to be resolved near a nanosecond.

1-15. The 5335A input provides two independent channels, featuring matched high performance 200 MHz input amplifiers. Each input channel includes a full complement of input signal conditioning controls. Additionally, the 5335A offers extensive control of triggerring and arming. Most measurements are displayed in scientific notation, with the digits grouped into three's for convenience. Four modes of gate selection are provided on the front panel.

1-16. HP-IB provides remote control of programming and data output.

1-17. OPTIONS

1-18. The following lists the options available for the 5335A. Specifications for the options are given in *Table 1-1*. If an option is included in the initial order, it will be installed at the factory and ready for operation upon receipt. For field installation of Options 010, 020, 030 and 040, refer to Section II for part numbers and instructions.

Option	Description
010	High Stability Time Base (Oven Oscillator)
020	DC Voltmeter Module
030	C Channel Input Module A/B
040	Programmable Input Amplifiers

1-19. RECOMMENDED TEST EQUIPMENT

1-20. 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	REQUIRED SPECIFICATION	QUANT.	RECOMMENDED HP MODEL	USE
Oscilloscope	200 MHz bandwidth, X-Y capability	1	1715A	T, A
Digital Voltmeter	20V range, 0.05V resolution	1	3456A/B	A, T
Signature Analyzer	5335A compatibility	1	5004A	T
Controller	HP-IB compatible	1	9825A	OV
	• HP-IB interface for 9825A	1	98034A	OV
	• String-Adv. Programming ROM	1	98210A	OV
	• Plotter-Gen I/O — Extended I/O	1	98214A	OV
	HP-IB compatible	1	HP-85	OV
	• Input/Output ROM	1	00085-15003	OV
	• ROM Drawer	1	82936A	OV
	• HP-IB Interface	1	82937A	OV
Function Generator			3312A	A, P, OV
Signal Generator	200 MHz bandwidth	1	8654A/B	OV, P
50Ω RF Termination	SMC type	2	1250-0839	T
Synthesized Signal Generator	1300 MHz, 150 mV rms	1	8660B/86603A	A, OV, P
Front Panel switch replacement tool (heat stacking tool)		1	5020-8160	T
Flat Ribbon assembly	26-AWG, 18-conductors	2	8120-2463	T
	50-ohm cable assembly	2	05335-60112	T
	SMC male-to-male adapter	2	1250-0827	T

* = See Additional Listing in User's Guide Manual!
T = Troubleshooting
A = Adjustments
P = Performance Tests
OV = Operation Verification

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 5335A requires a power source as listed in *Table 1-1*.

2-8. Line Voltage Selection

2-9. The HP 5335A Universal Frequency Counter is equipped with a power module that contains a printed circuit line voltage selector card to select 100-, 120-, 220-, or 240-volt ac operation. Before applying power, the pc selector card must be set to the correct position and the correct fuse must be installed as described below.

CAUTION

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

2-10. Power line connections are selected by the position of the plug-in pc selector 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, must be installed after the card is inserted. This instrument uses a power line fuse as listed in Section VI.

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. See *Figure 2-1*.

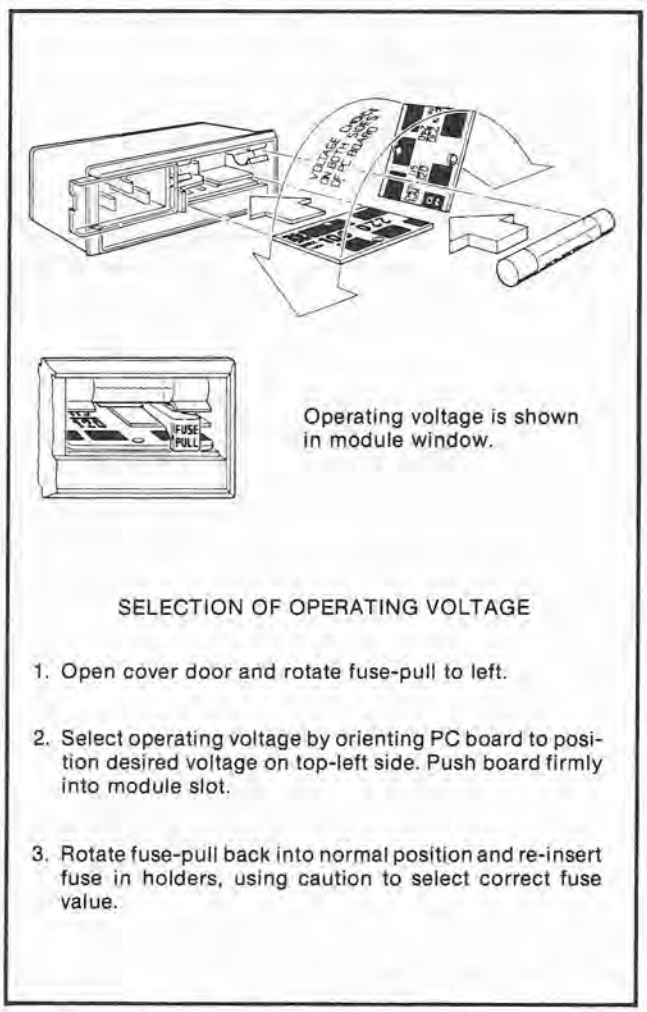


Figure 2-1. Line Voltage Selection

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 extract 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.

2-14. Power Cable

WARNING

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

2-15. The 5335A 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.

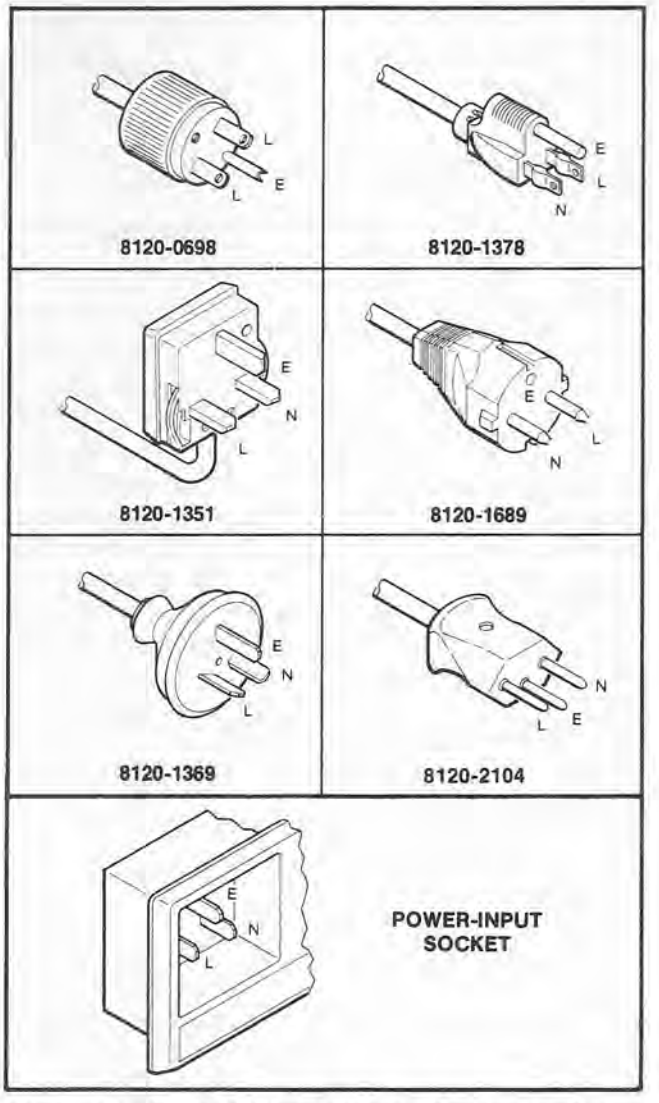


Figure 2-2. Power Cable HP Part Numbers versus Mains Plugs Available

2-16. Operating Environment

2-17. All environmental specifications are listed in *Table 1-1*.

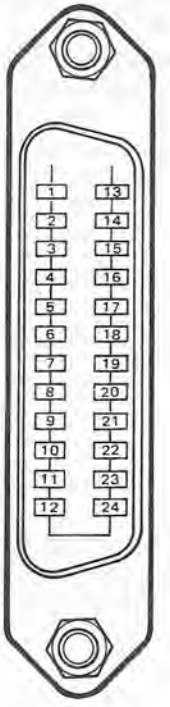
2-18. HUMIDITY. The 5335A may be operated in environments with humidity as listed in *Table 1-1*. However, it should be protected from temperature extremes which cause condensation in the instrument. Option 020, DVM, may be operated in environments with humidity up to 80%.

2-19. HP-IB INTERCONNECTIONS

2-20. HEWLETT-PACKARD INTERFACE BUS. Interconnection data concerning the rear panel HP-IB connector is provided in *Figure 2-3*. This connector is compatible with the HP 10631A/B/C/D HP-IB cables. The HP-IB system allows interconnection of up to 15 (including the controller) HP-IB compatible instruments. The HP-IB cables have identical "piggyback" connectors on both ends so that several cables can be connected to a single source without special adapters or switch boxes. System components and devices may be connected in virtually any configuration desired. There must, of course, be a path from the controller to every device operating on the bus. As a practical matter, avoid stacking more than three cables on any one connector. If the stack gets too large, the force on the stack produces great leverage which can damage the connector mounting. Be sure each connector is firmly (finger tight) screwed in place to keep it from working loose during use.

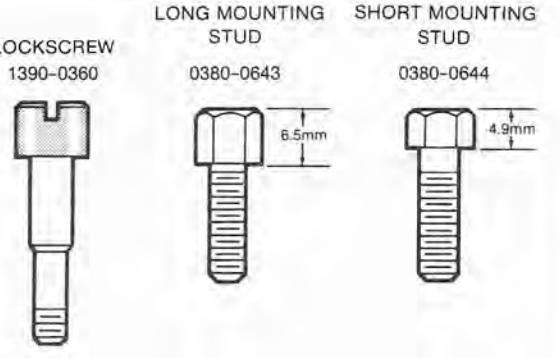
2-21. CABLE LENGTH RESTRICTIONS. To achieve design performance with the HP-IB, proper voltage levels and timing relationship must be maintained. If the system cable is too long, the lines cannot be driven properly and the system will fail to perform properly. therefore, when interconnecting an HP-IB system, it is important to observe the rules in *Figure 2-3*.

PIN	LINE	
1	DIO1	
2	DIO2	
3	DIO3	
4	DIO4	
13	DIO5	
14	DIO6	
15	DIO7	
16	DIO8	
5	EOI	
17	REN	
6	DAV	
7	NRFD	
8	NDAC	
9	IFC	
10	SRQ	
11	ATN	
12	SHIELD-CHASSIS GROUND	
18	P/O TWISTED PAIR WITH PIN 6	THESE PINS ARE INTERNALLY GROUNDED
19	P/O TWISTED PAIR WITH PIN 7	
20	P/O TWISTED PAIR WITH PIN 8	
21	P/O TWISTED PAIR WITH PIN 9	
22	P/O TWISTED PAIR WITH PIN 10	
23	P/O TWISTED PAIR WITH PIN 11	
24	ISOLATED DIGITAL GROUND	



CAUTION

The 5335A contains metric threaded HP-IB cable mounting studs as opposed to English threads. Metric threaded HP 10631A, B, C, or D HP-IB cable lockscrews must be used to secure the cable to the instrument. Identification of the two types of mounting studs and lockscrews is made by their color. English threaded fasteners are colored silver and metric threaded fasteners are colored black. DO NOT mate silver and black fasteners to each other or the threads of either or both will be destroyed. Metric threaded HP-IB cable hardware illustrations and part numbers follows.



Logic Levels

The Hewlett-Packard Interface Bus logic levels are TTL compatible, i.e., the true (1) state is 0.0V dc to 0.4V dc and the false (0) state is +2.5V dc to +5.0V dc.

Programming and Output Data Format

Refer to Section III, Operation

Mating Connector

HP 1251-0293; Amphenol 57-30240.

Mating Cables Available

HP 10631A, 1 metre (3.3 ft.), HP 10631B, 2 metres (6.6 ft.),
HP 10631C, 4 metres (13.2 ft.), HP 10631D, 1/2 metre (1.6 ft.).

Cabling Restrictions

1. A Hewlett-Packard Interface Bus System may contain no more than 2 metres (6.6 ft.) of connecting cable per instrument.
2. The maximum accumulative length of connecting cable for any Hewlett-Packard Interface Bus System is 20.0 metres (65.6 ft.).
3. The maximum number of instruments in one system is fifteen.

Figure 2-3. Hewlett Packard Interface Bus Connection

2-22. 5335A HP-IB Address

2-23. The 5335A contains a rear panel HP-IB instrument address selection switch. There are five switches, designated A_5, A_4, A_3, A_2, A_1 which are used to select the address. Instructions for setting and changing the address are provided in Section III of this manual along with programming codes. When the instrument is turned on, the setting of the address switches is momentarily displayed in decimal.

2-24. HP-IB Descriptions

2-25. A description of the HP-IB is provided in Section III of this manual. A study of this information is necessary if the user is not familiar with the HP-IB concept. Additional information concerning the design criteria and operation of the bus is available in IEEE Standard 488-1978, titled *"IEEE Standard Digital Interface for Programmable Instrumentation"*.

2-26. FIELD INSTALLATION OF OPTIONS

2-27. To obtain the necessary parts for installation of an option, order by part number as listed in *Table 2-1*.

2-28. Field Installation Procedure For Option 010

2-29. To install Option 010, first obtain parts listed in *Table 2-1*, then proceed as follows:

a. Disconnect the power cable from the 5335A (safety precaution).

WARNING

THE AC POWER CIRCUITS TO TRANSFORMER T1 AND THE UNREGULATED DC VOLTAGE ARE STILL ON EVEN WHEN THE POWER SWITCH IS OFF. CONTACT WITH THESE CIRCUITS CAN RESULT IN INJURY TO PERSONNEL OR DAMAGE TO EQUIPMENT.

b. Remove the top and bottom covers of the 5335A.

c. Remove electrical lead (jumper), P/N 8159-0005, that connects A4U1B(6) and U2B(6).

d. Apply power to the 5335A and check all voltages at A4XA15 connector per A4 schematic diagram, especially A4XA15 (14).

e. Disconnect the power cable from the 5335A.

f. Plug the oven oscillator (10544-60011 or 10811-60111) into A4XA15 and secure oven oscillator to A4 assembly from underneath, with two screws (6-32 × 5/16) and fiber washer provided (P/N 3050-0005).

g. Restore top and bottom covers to the 5335A.

h. Apply power to the 5335A and verify counter operation by performing the operational verification in Section IV.

2-30. Field Installation Procedures For Option 020

2-31. To install Option 020, order parts listed in *Table 2-1* or order Retrofit Kit P/N 05335-60220, then proceed as follows:

a. Disconnect power cable from the 5335A (safety precaution).

b. Remove the top and strapped-side cover (right side) of the 5335A.

c. Remove blank panel by removing the two 5/16 nuts that holds the blank panel to the front panel.

d. Install Positive cable assembly, P/N 05335-60110, through the upper hole of the DVM front panel (P/N 05335-00007) and the corresponding hole in the mainframe, and secure the cable and panel with 13 mm (3/8 inch) plastic nut, P/N 2950-0144, to the frame.

e. Install Negative cable assembly, P/N 05335-60111, through the lower hole of the DVM front panel and the corresponding hole in the mainframe, and secure it with plastic nut.

f. Use tie-wraps to bind the positive and negative cable assemblies together.

g. Connect the Positive cable (red/blue) assembly to terminal marked "INPUT" on the circuit side of the DVM board assembly; connect the Negative cable (black) assembly to terminal marked "COM" on same side of board.

h. Install DVM board into A2XA8 connector of the A2 amplifier support board (see assembly locator, *Figure 8-24*); secure A8 with two pozidriv screws to mainframe.

i. Perform Option 020 adjustment as described in paragraph 5-17.

j. Replace side and top covers.

Table 2-1. Field Installable Options

OPTION	DESCRIPTION	DESIGNATOR	PART NUMBER	QTY
010	A15 Oven Oscillator Assembly	A15	10811A	1
	6-32 × 5/16 Screw		2360-0115	2
	Fiber Washer		3050-0005	2
	Retrofit Kit Number (includes all parts in Option 020)		**05335-60220**	
020	A8 DVM Board Assembly	A8	05335-60008	1
	DVM Front Panel		05335-00007	1
	Positive Cable Assembly	A8W1	05335-60110	1
	Negative Cable Assembly	A8W2	05335-60111	1
	Plastic Nut (3/8 in. – 13 mm)		2950-0144	2
	Retrofit Kit Number (includes all parts in Option 030)		**05335-60230**	
030	A9 Channel C Board Assembly	A9	05335-60009	1
	Channel C Front Panel		05335-00008	1
	Channel C RF Cable Assembly	A9W1	05335-60105	1
	Channel C Sensitivity Cable Assembly	A9W2	05335-60106	1
	Pre-amp Power Cable Assembly	A9W3	05335-60109	1
	Fuse Holder		05305-20104	1
	Teflon insulator		05305-20105	1
	Special BNC		05305-60205	1
	SMC Connector		05305-60206	1
	Hex Nut		0590-0038	1
	0.12A Mini-Axial Fuse		2110-0301	1
	Lockwasher		2190-0068	1
	Plastic Nut (3/8 in. – 13 mm)		2950-0144	1
	Parts to Retrofit Option 040 include the following:		**05335-60240**	
040	Switch Panel	A10	05335-60010	1
	Support Assembly	A11	05335-60011	1
	Programmable Input	A12	05335-60012	1
	Shield	A16	05335-20203	1
	50-ohm Coaxial Cable	W7, W8	05335-60112	2
	Front Panel		05335-00013	1
	6-32 × 1/4" Screws		2360-0113	3

2-32. Field Installation Procedures For Option 030

2-33. To install Option 030, order parts listed in *Table 2-1* or order Retrofit Kit 05335-60230, then proceed as follows:

a. Disconnect power cable from the 5335A (safety precaution).

b. Remove top and strapped-sided cover of the 5335A.

c. Remove blank panel by removing the two 5/16 inch hex nuts that holds blank panel to the mainframe.

d. Install Special Input BNC (provided) through the lower hole of the Channel C front panel (P/N 05335-00008) and the corresponding hole in the mainframe, and secure the special BNC and panel with hex nut, P/N 0590-0038, to the frame as illustrated in *Figure 2-4*.

e. Connect the gold SMC connector on one end of A9W1 to the INPUT C BNC; connect the other end of A9W1 to A9J3.

f. Install Preamp Power Cable assembly (A9W3) through the middle hole of Channel C front panel, and secure it with plastic nut, P/N 2950-0144, to the frame; connect the other end of A9W3 red and white wires to A9J4 (to test pins marked "R" and "W").

g. Install Sensitivity cable assembly (A9W2) through the upper hold of Channel C front panel and secure it with a 5/16 hex nut; install the Channel C sensitivity control knob; connect the other end of A9W2 cable to A9J1.

h. Install A9 Channel C board into A2XA9 connector of the A2 amplifier support board (see assembly locator, *Figure ~~8-24~~*). Secure A9 with a posidriv screw to mainframe. 8-105

i. Perform Option 030 adjustment as described in paragraph ~~5-19~~. 5-17.

j. Replace side and top covers.

2-34. When Option 030 C Channel is installed, the operator may be required to replace the input BNC fuse. This is a 1/8A fuse (HP Part No. 2110-0301) which is located within the INPUT C BNC connector (see *Figure 2-4* 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 over-tighten.

2-35. Field Installation Procedures for Option 040

2-36. To install Option 040, first obtain parts listed in *Table 2-1*, then proceed as outlined in step b below (removal of the standard module is described in step a). If Option 020 (DVM) and/or Option 030 (C-channel) is installed, they **MUST** be removed before installing Option 040; reverse the steps of the option's installation procedures as outlined in previous paragraphs. Also, refer to *Figure 8-22* Assembly and Cable Locator, during this installation procedure.

a. Removal of standard module:

1. Disconnect the power cable from the 5335A (safety precaution).

WARNING

THE AC POWER CIRCUITS TO TRANSFORMER T1 AND THE UNREGULATED DC VOLTAGE ARE STILL ON WHEN AC POWER IS APPLIED TO THE INSTRUMENT AND THE POWER SWITCH IS OFF. CONTACT WITH THESE CIRCUITS CAN RESULT IN INJURY TO PERSONNEL OR DAMAGE TO EQUIPMENT.

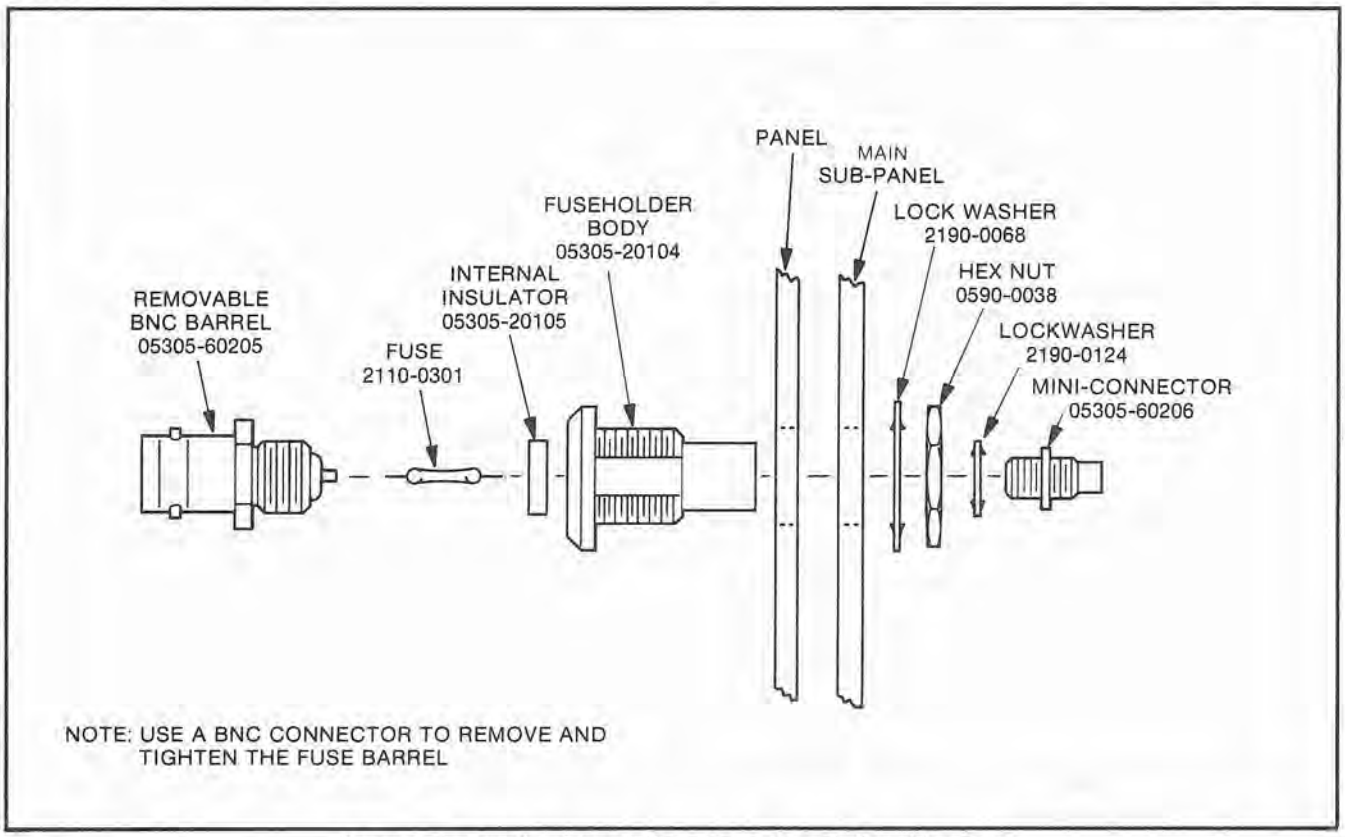


Figure 2-4. Details of Input Connector J1 and fuse Mounting

CAUTION

Static electricity can result in permanent degradation or catastrophic failure of the instrument or assemblies removed from the instrument. All work performed on instruments with covers removed or on assemblies, must be at static safe stations providing proper grounding for the operator.

2. Remove top, bottom, and both side covers of the 5335A.
3. Remove coaxial cables (P/N 05335-60103 or 05335-60112), that connect A3J6 and A2J3 (Channel A), and A3J1 to A2J4 (Channel B). Please see 5335A-13 Service Note for coaxial cable compatibility.
4. Remove multiribbon cables W5 (connects A3J5 to A2J1) and W6 (connects A3J2 to A2J2).
5. Remove W4 Cable Assembly Display which connects A5J1 to A4J3.
6. Remove A2 Amplifier Support Assembly by first unscrewing the four screws that attach the assembly to the mainframe, then sliding the assembly to the right.
7. Using a suitable allen wrench, remove channels A and B trigger level control knobs from standard module; also, remove the GATE ADJ control knob. With an appropriate nut driver, remove the hex nuts from A3R66, A3R22, and A5R3 (GATE ADJ).
8. Remove the two hex nuts from A3J4 (channel A) and A3J3 (channel B).
9. Remove standard A3 Amplifier Buffer Assembly, by gently pushing the assembly from the front panel inwards.
10. Remove the standard front panel by removing the hex nut, located on the rear of the A5 Display Assembly, above the ON/STBY switch.
11. Detach the 5335A front flange by removing the eight screws that affix it to the System II mainframe.
12. Remove the 13 retainer clips located on the back of the A5 Display assembly. Separate the A5 from the 5335A front flange.

b. Installation of Option 040:

1. Attach A10 keyboard assembly to the A5 display board by connecting A10J1 to A5J2.
2. Insert the A5/A10 assembly combination into the 5335A front flange and attach the thirteen retainer clips that fixes A5/A10 to the front flange.
3. Position the A10 assembly such that the momentary switches are centered with their respective subpanel openings. Attach the A17 shield, P/N 05335-20203, to the back of A10 keyboard assembly, with the part number of the shield facing the front of the instrument. Secure the shield and the keyboard to the front subpanel with three screws (P/N 2360-0113).
4. Attach and secure the 5335A front flange to the mainframe.
5. Install the Option 040 front panel and secure the rear left side of the panel with an 5/16" hex nut with lock (P/N 2420-0001). Secure the right side of panel with the same hex nut removed during disassembly, i.e., to A5R3 GATE ADJ.
6. Install the A12 Programmable Input Amplifier into the 5335A front panel from the rear; insure that the internal lock washers (P/N 2190-0102) are in place, between A12J6 and A12J3 and the front panel. Secure A12 with the appropriate hex nuts.
7. Install Channel A and B trigger level control knobs, and the GATE ADJ control knob.
8. Install A11 Option 040 Support Assembly, P/N 05335-60011, and secure to mainframe.
9. Connect A5J1 to A4J3 with W4 Cable Assembly Display.
10. Connect A12J7 to A11J1 with W5 and A12J2 to A11J2 with W6 (multiribbon cables, P/N 1820-2867).
11. Connect A12J8 to A11J5 with W7 and A12J4 with W8 (coaxial cables, P/N 05335-60112).
12. Perform Option 040 adjustments as described in Section V.
13. Replace top, bottom, and side covers on the 5335A.

2-37. STORAGE AND SHIPMENT

2-38. Environment

2-39. The instrument may be stored or shipped in environments within the following limits:

TEMPERATURE ..... -40°C to +75°
HUMIDITY ..... Up to 95%
ALTITUDE .. 7,620 metres (25,000 feet)

2-40. The instrument should also be protected from temperature extremes which cause condensation within the instrument.

2-41. Packaging

2-42. 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.

2-43. OTHER PACKAGING. The following general instructions 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 tag indicating type of service required, return address, model number, and full serial number.)

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

CAUTION

The instrument front handles must be left attached to avoid damage to controls.

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.

SECTION III
OPERATION AND PROGRAMMING

3-1. INTRODUCTION

3-2. This section provides the operating and remote programming information for the HP 5335A Universal Counter. It explains the operating characteristics, operating functions, controls, and all modes of operation.

3-3. Description, operating and programming instructions for Options 020, 030 and 040 are provided in this section.

3-4. OPERATING CHARACTERISTICS

3-5. The 5335A is a system and benchtop universal counter. Basic functions include frequency, period, time, ratio, totalize, and volts. Inputs enter two 200-MHz matched amplifiers and are measured by the multiple register counter IC. Raw data from the measurements are used by the counter microprocessor to compute and format the result for display. Extensive triggering and arming of the counter give the user great control over measurements. Math and statistical functions give the user flexibility over how the measurement is displayed. The operating range, resolution and accuracy for each individual functional mode of operation is given in the Specifications, *Table 1-1*.

3-6. Option 040 provides the same basic input circuitry and control as the standard instrument, with the following modifications:

- A digital-to-analog-converter is added to the trigger level circuitry, which allows remote programming of both channel input trigger levels between –5 and +5 volts, with 10 mV resolution.
- Relays have been added to the input signal conditioning circuitry, allowing remote programming of the attenuators, input coupling, impedance, trigger level, and low pass filter controls.
- Low Pass Filters have been added to the input buffer circuits. These are selectable via the front panel or the HP-IB.
- Front panel INPUT controls are momentary pushbutton keys, with inset LED indicators to represent status.

3-7. LOCAL OPERATION

3-8. The local operation (vice remote operation) of the HP 5335A is presented through the following subsections:

GENERAL OPERATION INFORMATION. The general operation information describes a variety of functionally nonspecific operating instructions, operating characteristics, and indications. It provides a general overview of the front panel operating controls and indicators.

FRONT AND REAR PANEL FEATURES. The front and rear panel features provides a complete functional description of all operator controls and indicators. This information compliments and expands on the front and rear panel foldouts, *Figures 3-12* and *3-13*.

DETAILED OPERATING INSTRUCTIONS. The detailed operating instructions (starting with paragraph 3-106) present the most comprehensive information about each specific measurement function. They are categorized by the labeled function mode (e.g., FREQ A, PER A), and provide simple keystroke examples.

3-9. Additionally, the top cover of the instrument provides an Operating Instructions label. This label summarizes the general operating instructions for most of the counter's functions. A copy of the Operating Instructions label is shown on a foldout at the end of this section.

3-10. REMOTE OPERATION

3-11. A description of remote programming operation begins with paragraph 3-167. A good working knowledge of local operation is essential for HP-IB programming, as most of the Data messages contain

the same keystroke-like sequences. Where applicable, throughout this section, program examples are provided. The information within the Remote Operation includes the following:

General HP-IB Information
Interface Function
Bus Messages
Address Selection
Device Command Definitions
Device Commands
Default and Power-up States
Learn Mode Programming
SRQ and Status
Program Execution/ Response Times
Output Format
Output Modes
Programming Examples

3-12. OPERATORS SELF-CHECK PROCEDURE

3-13. This section, beginning with paragraph 3-248, includes checks that allow the operator to make a quick evaluation of the counter's operation. These checks will fundamentally verify the following:

Keyboard
Display and Annunciators
Memory; RAM and ROM
HP-IB

3-14. GENERAL OPERATION INFORMATION

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.

ONLY 250V FUSES WITH THE REQUIRED RATED CURRENT AND SPECIFIED TYPE SHOULD BE USED. DO NOT USE REPAIRED FUSES OR SHORT CIRCUITED FUSEHOLDERS. TO DO SO COULD CAUSE A SHOCK OR FIRE HAZARD.

3-15. Power-Up/Self-Check

3-16. When the counter is turned on, an internal check is made of several major components in its circuitry. During this cycle, all front panel number display segments and indicators will light momentarily, followed by the momentary display of the instrument's decimal HP-IB address (e.g., HP-IB Addr 28).

3-17. After the power-up sequence, the counter will *initialize* itself. All math and statistics will be off, the function will be Frequency A, and the gate and cycle modes will be in Norm. All of the input controls will be set according to their switch positions.

3-18. Any failures during the power-up cycle will disable the counter and produce a display of numbered error or fail messages. Within the 5335A, fail messages generally indicate a hardware failure, and error messages indicate the user has attemped an improper operation. Refer to Error Messages, paragraph 3-252.

3-19. Display

3-20. The number to be displayed is formatted in engineering notation with the digits grouped into threes for convenient reading and an exponent. When displaying 11 and 12 digit numbers, the grouping is omitted. The number of digits displayed is determined by the FUNCTION and GATE time. In most cases, a longer gate time gives more digits.

3-21. When resolution calls for more than 12 digits no overflow results. Instead, the most significant digits are retained, and the display is reduced to 12 digits.

3-22. The exponent range of the display is ±18. If a number cannot be displayed the display will show one of these two numbers.

0. +19 ..... (0×10^{19})
if the number is too large.
0. –19 ..... (0×10^{-19})
if the number is too small.

NOTE

If you suddenly see two less digits in frequency, period, or time interval measurements, there may be a failure in the interpolators. If you press RESET you may get these digits back, or you may get a FAIL message. See the section on diagnostics in Section VIII.

3-23. Annunciators indicate the Hz (hertz), S (seconds), and V (volts) units. For some functions the units are not indicated, but assumed, such as degrees for phase measurements. For slew rate, both the Volts and Seconds annunciators are on to indicate Volt/second.

3-24. The GATE light shows the status of the counter gate. Before the measurement starts, this light is off, indicating that the gate is closed. During the measurement, the light is on, indicating that the gate is open.

3-25. The TALK, LISTEN, SRQ, and REMOTE lights monitor the status of the HP-IB. Refer to Programming, paragraph 3-167.

3-26. Keyboard

3-27. The keyboard is divided into several groups, according to the purpose of the keys. From the left, we have MATH/STATISTICS, FUNCTION, GATE ADJ/CYCLE MODE, INPUT, and if installed, INPUT C (Option 030), and VOLTS (Option 020). With exceptions, each group operates nearly independently of the others. The operation of each front panel key, within each keyboard group, is presented in Front Panel Features, beginning with paragraph 3-38.

3-28. Key Indicators

3-29. The operation of individual keys is relatively straightforward. Indicator LED's, in the center of many keys, represent that key status. A steady "on" LED indicates that the key labeled function is active or in-effect. An "off" LED indicates that the key's labeled function is not active or disabled. Many keys operate in a toggle on/off fashion. The blue colored keys in the MATH function group can be programmed. A "blinking" LED within a blue key is used as a "prompt" for the operator. It indicates that it is waiting for a data entry. Number entries are made from the keys labeled in blue. Refer to paragraph 3-82.

3-30. Keyboard Memory

3-31. To avoid having to reenter math constants, etc., whenever switching between two functions repetitively, the keyboard has one level of memory. This allows you to set up two functions modes, each with their own set-ups. The key set-ups for each of the keys in the MATH, STATISTICS, FUNCTION, GATE, and CYCLE groups are automatically memorized. Controls within the INPUT group are not memorized.

3-32. Reading the convenience functions GATE TIME or TRIG LVL will not affect the keyboard memory. Any changes to the key set-ups while in these functions will be carried back to the set-up of the function that was active before. GATE TIME and TRIG LVL are not affected by MATH and STATISTIC functions. For example:

1. Presently in FREQ A, we enter an OFFSET of 123.
2. Later we switch to PER A, where we see by the OFFSET key indicator, that the OFFSET is off.
3. Then later selecting FREQ A, we see that the OFFSET is again 123.
4. We then select TRIG LVL, and then GATE TIME.
5. While in GATE TIME we set the GATE MODE to FAST.
6. Returning to FREQ A, we still have an OFFSET 123, but also, the GATE MODE is now in FAST.
7. We select PER A, then PULSE A. Now, when we return to FREQ A, all set-ups go to the default positions.

3-33. Key Default

3-34. The initialized and/or default positions for all operator keys and controls are as follows:

Default:
- MATH .....OFF
- STATISTICS .....OFF
- RANGE HOLD .....OFF
- EXT ARM ENABLE ....OFF
- CYCLE .....NORM
- GATE MODE .....NORM
- GATE MODE .....MIN (for TIME, 1/TIME, RISE/FALL, SLEW, DUTY CYC, PHASE)

Initialize Power-Up:
- FREQ A
- GATE MODE .....NORM
- CYCLE .....NORM
- RANGE HOLD .....OFF
- EXT ARM ENABLE ...OFF
- MATH .....OFF
- STATISTICS .....OFF
- INPUT ... } As set by controls
- REAR .... } As set by controls

3-35. Special Function Mode

3-36. The front panel controls allow for a direct, key-per-function selection from 16 labeled function operations. A sequence of keystrokes will allow the operator to enter a *Special Function Mode*, in which the original 16 functions, plus 4 additional unlabeled functions and an extensive diagnostic mode can be accessed. The four unlabeled "phantom" functions are:

FREQ B
PULSE B
TIME A→B
TOTALIZE A-B

3-37. The diagnostic mode allows the user considerable flexibility during troubleshooting through a set of discrete, self-diagnostic test routines. A more complete description of the Special Function Mode and complete procedures using the diagnostic routines are provided in Section VIII.

3-38. FRONT PANEL FEATURES

NOTE

To enhance the descriptions of Front Panel features, fold out *Figure 3-12*, while reviewing these paragraphs.

3-39. The front panel controls, indicators, and connectors are located and briefly described in *Figure 3-12*. A good quick reference of the operating details for each function mode is provided in the Function Key Reference Summary, *Table 3-2*.

3-40. The following paragraphs describe the general purpose and use of the operator keys and controls. They are discussed by functional grouping, as follows:

FUNCTION GROUP
GATE CYCLE GROUP
INPUT GROUP
  Input Amplifier (Standard Instrument)
INPUT GROUP
  (Programmable Input Amplifier — Option 040)
TRIGGERING (MANUAL/AUTO)
MATH GROUP
STATISTICS GROUP
INPUT C (OPTION 030)
VOLTS (OPTION 020)

3-41. FUNCTION Group

3-42. Function selection for the HP 5335A is done via a simple key-per-function keyboard. Sixteen function modes (labeled in black) are directly accessible from the four leftmost columns of keys. The indicator LED within the key identifies which one of the functions is active. Several more functions are available, accessed through the HP-IB, and other means (see Special Function Mode, paragraph 3-35, and Diagnostics in Section VIII). During the programming sequence for the MATH group, the functions of these 16 keys (and CHECK) are reassigned to the numeric and special entry values labeled in blue.

3-43. Within the FUNCTION group, the rightmost column has four keys with functions that are described in the following four paragraphs. *Figure 3-1* shows the FUNCTION group keys.

3-44. The RESET key will reset the counter and start a new measurement. When pressed, all segments and decimal points in the display should light, momentarily. RESET will not affect any current function selection or key set-ups. If you are currently in GATE TIME or TRIG LEVELS, pressing RESET returns you to the function you were previously in.

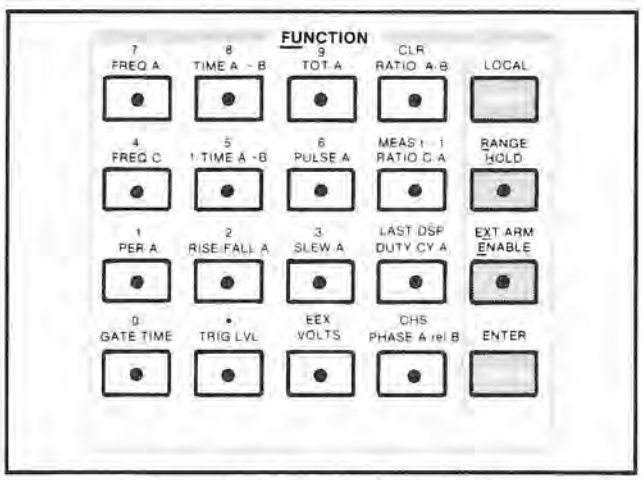


Figure 3-1. Function Group Keys

3-45. RANGE HOLD can be used to freeze the decimal point placement and exponent value of the display. Least significant digits are allowed to "fall off" the right of the display. However, the display is programmed to avoid a loss of the most significant digit. RANGE HOLD is useful when the value in the display is rapidly changing in magnitude. In the PHASE A rel B mode, RANGE HOLD will select and maintain the 0° to 360° measurement display range. RANGE HOLD toggles on and off with each press of the key.

3-46. The EXT ARM ENABLE key is used to enable or disable external arming of measurements. When it is on, the Start and/or Stop of the measurement can be armed by a signal connected to the rear panel. When EXT ARM ENABLE is off, the counter ignores the rear panel signal. EXT ARM ENABLE toggles on and off with each press of the key.

3-47. The CHECK key puts the instrument into one of two levels of internal self-check programs. Pressing the key once will enter a "lamp test loop" flashing all front panel annunciators, key indicators and segments, checking the MRC, and memory circuits. Pressing and holding the key (for approximately 3 seconds) will place the instrument into an extended diagnostic loop of several major circuits (i.e., amplifiers, time base, counting circuitry, and display). This extended test requires that the user connect the rear panel Time Base Out to the Channel A input, put both channels to 50Ω, and remove any signal to Channel B. See Operational Verification section for further details. Any failures during the diagnostic loop will result in the display of either a numbered FAIL or ERROR message. FAIL messages generally indicate a circuit failure. ERROR messages indicate the user has attempted an improper operation; for example, a misspelled HP-IB command. Refer to ERROR MESSAGES, paragraph 3-252. To exit either self-check routine, press any other function key.

3-48. GATE/CYCLE Group

3-49. The GATE ADJ control sets the length of the gate time, continuously adjustable through the ranges set by the GATE MODE keys. In certain time interval functions (i.e., TIME A→B, 1/TIME A→B, PULSE A), the actual gate time is automatically determined, dependent on the input signal. In these modes, the gate time controlled by GATE ADJ, can be used as a Hold-Off Delay for the Stop channel. If a T.I. DELAY mode is selected (any GATE MODE except MIN) the T.I. DELAY indicator will light. In these functions, the normal operation gate mode is MIN if no delay is desired. For more information about the GATE ADJ control during time domain measurements, refer to TIME A→B, paragraph 3-115. *Figure 3-2* shows the GATE and CYCLE controls.

3-50. Gate mode NORM and FAST are two ranges of adjustable gate times. NORM has a range of nominally 20 milliseconds to 4 seconds, and FAST has a range of nominally 100 microseconds to 20 milliseconds. The one key causes the mode to toggle between NORM and FAST.

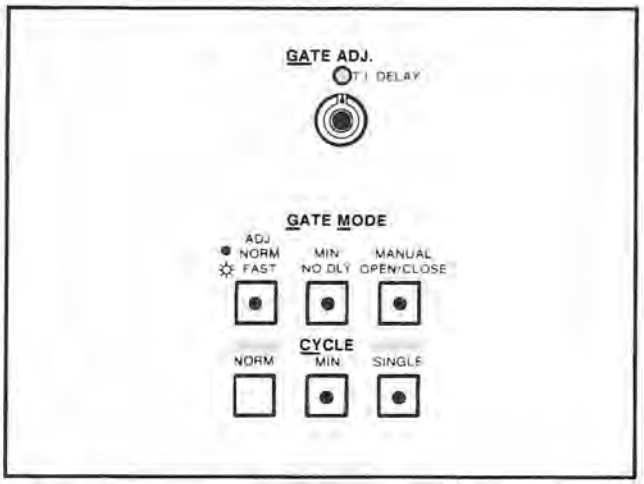


Figure 3-2. GATE and CYCLE Controls

3-51. Gate mode MIN (minimum) NO DLY (no delay) specifies the shortest possible gate time. This means that the signal itself usually determines the time. For example, the Frequency A measurement uses a divide-by-two prescaler. The gate time in this function would be determined by two periods of the input. MIN mode is usually the mode used when External Stop Arm is used.

3-52. The MANUAL OPEN/CLOSE key lets you specify the gate time manually. In the manual mode, each press of the key toggles the gate either open or closed. The status of the gate is indicated by the GATE annunciator. Manual mode allows very long gate times.

3-53. CYCLE mode NORM key specifies about a 250 milliseconds wait time between measurements. This slows the display down to a rate that is more convenient for viewing short gate time measurements.

3-54. CYCLE mode MIN (minimum) mode tells the counter to start the next measurement as soon as possible. This gives the most rapid updating of the display.

3-55. CYCLE mode SINGLE key lets you start measurements upon manual command. Each press of the key starts one measurement. This measurement stays on the display until the key is pressed again (RESET will also start a new measurement).

NOTE

Remember that this counter uses synchronized gating, and that the input signal also determines the length of the gate time. Additionally, several modes of Arming are available, see Rear Panel Features.

3-56. INPUT Group (Standard Instrument)

3-57. The INPUT group contains the A Channel and B Channel input BNC's, signal conditioning controls, and triggering controls. *Figure 3-3* shows the INPUT group controls.

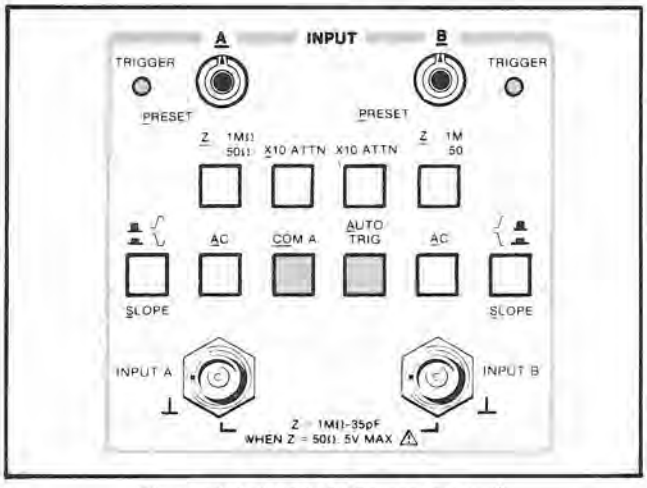


Figure 3-3. INPUT Group Controls

3-58. The SLOPE key determines which edge of the signal to trigger on. For some functions it also takes on other uses. For PULSE, the Slope A switch is used to specify the positive (⎍) or negative (⎏) pulse. For RISE/FALL, it is used to specify whether it is RISE or FALL time being measured. SLOPE A has a similar purpose for SLEW. For DUTY CYC, it determines whether to display the percentage high (⎍) or low (⎏).

NOTE

All keys in the INPUT group must be pressed to where they latch in to enable the operation of the key as it is labelled. To discontinue an operation the key must be pressed again so the key releases out.

3-59. The AC key, when pressed, makes the respective input amplifier ac (capacitor) coupled. This is useful for ignoring dc offsets on a signal.

3-60. The input impedance of each channel is selected by the Z = 1MΩ/50Ω key.

3-61. For inputs greater than the five volt dynamic range, or to reduce the sensitivity of the front end, the X10 ATTEN key lets you attenuate the signal by a factor of 10. The damage level still applies, however, when Z Z=50Ω. For convenience, the trigger level reading function will arithmetically multiply the display by ten when the attenuators are on.

3-62. INPUT Group (Option 040)

3-63. The addition of Option 040 affects only the INPUT section of the front panel controls. The INPUT group contains the A Channel and B Channel input BNC connectors, signal conditioning and triggering controls. The operation of all the pushbutton keys within this section is the same. The keys operate in a toggle on/toggle off fashion. An indicator LED in the center of each key represents the keys status. A steady "on" LED indicates that the keys labeled function is active or in-effect. An "off" LED indicates that the opposite or reciprocal function is active or in effect. For example, when the INPUT A FILTER key is pressed, that keys LED lights indicating the low pass filter is activated for INPUT A. Conversely, if the FILTER keys LED is disabled. The following paragraphs describe the operation and function of each control. *Figure 3-4* shows the Option 040 INPUT group controls.

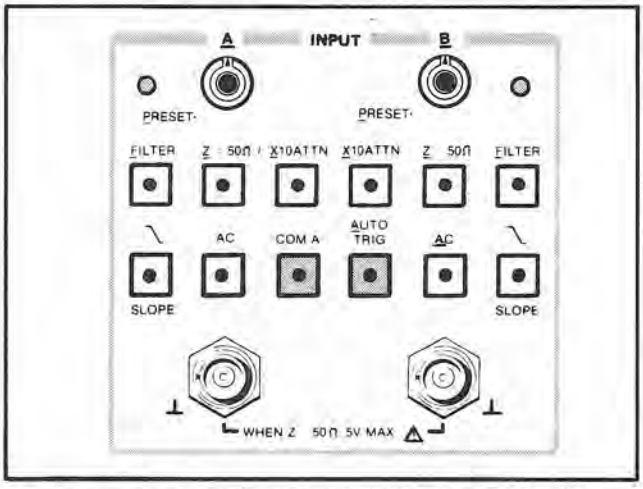


Figure 3-4. Option 040 INPUT Group Controls

3-64. The SLOPE key determines which edge of the input signal the channel will trigger on. For some functions it also takes on other uses. For PULSE, the SLOPE A key is used to specify the positive (LED off) or negative (LED on) pulse. For RISE/FALL, it is used to specify whether it is RISE or FALL time being measured. SLOPE A has a similar purpose for SLEW. For DUTY CYC, it determines whether to display the percentage high (LED off) or low (LED on).

3-65. When the positive slope is selected, the key indicator LED will be unlighted. When the negative slope is selected, the key indicator LED will be lighted.

3-66. The AC key selects either AC or DC coupling for the associated input amplifier. When DC coupling is selected, the key indicator LED will be unlighted.

When AC coupling is selected, the key indicator LED will be lighted.

3-67. The COM A key selects either the separate or common mode for the A and B INPUTS. INPUTS. When Separate is selected, the key indicator LED will be unlighted. When Common is selected, both inputs are directed through the INPUT A channel, and the key indicator LED will be lighted.

3-68. The AUTO TRIG key selects either the MANUAL or AUTO triggering modes. The MANUAL TRIG modes use the trigger adjustment control to set the trigger level between +5 and –5 volts, or to 0 volts when in PRESET. The AUTO TRIG modes reference the range of trigger level adjustability to the level of the input signal, with the peaks of the input signal nominally setting the control limits. The AUTO TRIG PRESET mode automatically sets the trigger level to the 50% point of the input signal, regardless of the dc offset of the input.

3-69. When MANUAL TRIG is selected, the key indicator LED will be unlighted. When AUTO TRIG is selected, the key indicator LED will be lighted.

3-70. The FILTER key activates a low pass filter for the associated channel. The filter attenuates frequencies above 100 kHz, with 175 kHz as NOMINAL cutoff (3 dB point) and >30 dB down at 200 MHz.

3-71. When FILTER is selected, the key indicator LED will be lighted. When FILTER is bypassed, the key indicator LED will be unlighted.

3-72. An input impedance of either 50Ω or 1 MΩ, for each channel, is selected by the Z=50Ω key. When 50Ω is selected, the key indicator will be lighted. When 1 MΩ is selected, the key indicator will be unlighted.

3-73. An attenuation factor of either X1 or X10, for each input channel, is selected by the X10 ATTN key. For inputs greater than the 5V dynamic range, or to reduce the sensitivity of the front end, an attenuation factor of X10 can be selected. For convenience, the trigger level reading function will arithmetically multiply the display by 10 when a X10 attenuator is on. When X1 is selected, the input signal not attenuated and the key indicator LED will be unlighted. When X10 is selected, the input signal is attenuated by ten and the key indicator LED will be lighted.

3-74. Triggering (MANUAL/AUTO)

3-75. The HP 5335A has an extensive set of triggering features which make accurate measurements on input signals easier for the user. Four modes of triggering, listed below, are directly accessible from the front panel or via the HP-IB. A fifth mode (see paragraph 3-80) is automatically selected when in the RISE/FALL A or SLEW A function modes.

Manual Adjustable
Manual PRESET
Auto Adjustable
Auto PRESET

3-76. The Manual Adjustable mode uses the trigger adjustment controls to set the trigger level anywhere between +5 and –5 volts. The actual trigger levels for both channels can be monitored by pressing the TRIG LVL function key. When the control is fully ccw (into detent) the Manual PRESET mode is selected, and the trigger level is set to zero volts.

3-77. When the Auto Trigger mode is selected, the trigger adjustment controls assume a wholly different meaning. Pressing the AUTO TRIG key selects the Auto Adjustable triggering mode. The range of adjustability for the control is now dependent on the amplitude of the input signal, with the peaks of the input signal nominally setting the control limits. See *Figure 3-5.*

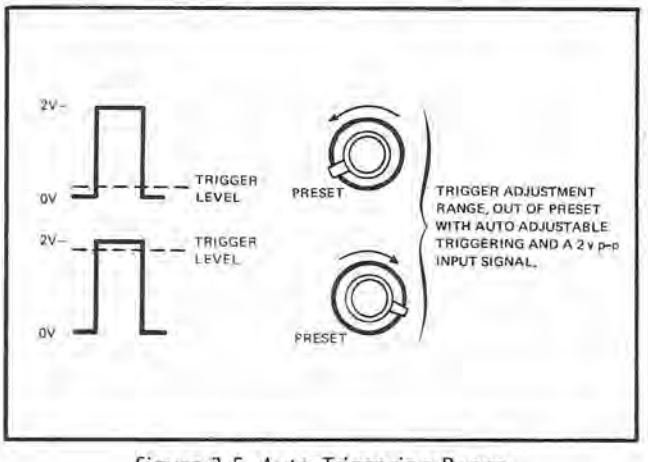


Figure 3-5. Auto-Triggering Range

3-78. Assume, for example, an input signal of two volts peak-to-peak, with Auto Adjustable triggering selected. The range of the trigger adjustment control outside of PRESET will automatically reduce from ±5 volts to ØV→+2V. This allows a much finer control over the trigger level setting. The actual trigger levels for both channels can be monitored by pressing the TRIG LVL function key.

3-79. Pressing the AUTO TRIG key, with the trigger adjustment control in PRESET, selects the Auto PRESET triggering mode. In this mode, peak detectors on both channels determine the peaks of the input signal. The trigger level is automatically set to the 50% point of the peaks, regardless of the dc offset of the input. *Figure 3-5* shows the AUTO triggering range without PRESET. *Figure 3-6* shows AUTO triggering with PRESET selected.

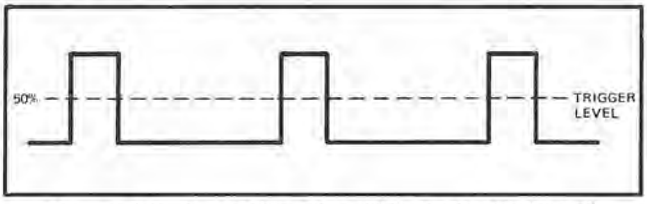


Figure 3-6. Auto Triggering With PRESET Selected

3-80. An additional mode of triggering is used by the functions RISE/FALL A and SLEW A. The peaks of the input signal are determined and the 10% and 90% points are found. These dc levels are assigned as trigger levels by the respective SLOPE keys, to Channels A and B. Pressing TRIG LVL will display the 10% and 90% levels determined.

3-81. The front panel three-state TRIGGER lights provide a visual indication of each channel triggering status. When the light is on, the trigger level is set too low (or the signal is too high). When the light is off, the trigger level is set too high (or the signal is too low). When the light is flashing, the trigger level is set within the peak limits of the input signal (± the hysteresis offset of the input amplifier) and the channel is triggering. *Figure 3-7* shows the INPUT TRIGGER indicator lights response to input signals at different trigger level settings.

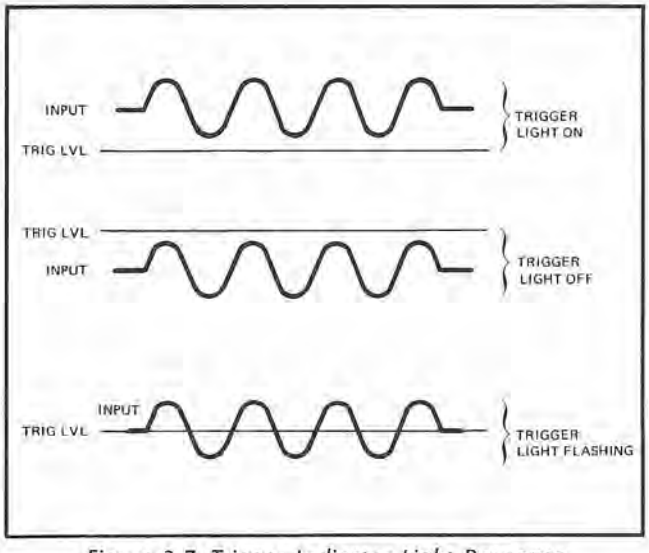


Figure 3-7. Trigger Indicator Light Response

3-82. MATH Group

3-83. The functions within the MATH group allow the user to perform a number of mathematical operations on the measurement before it is displayed. The OFFSET, NORMLZ, and SCALE keys allow for the addition, division, and multiplication, respectively, of the measurement by user specified constants. Modification of the display by the Math operations is represented by the following relationship:

$$\text{Display} = \frac{\text{Measurement} + \text{OFFSET}}{\text{NORMLZ}} \times \text{SCALE}$$

3-84. Notice that the OFFSET operation is performed before normalization and scaling. Any single or combination of these operations can be selected. This provides the user with extensive control over the resultant display. It can be used, for example, to subtract systematic errors or display the percentage difference. Additionally, the overall MATH operation can be disabled and then re-established without having to re-enter constants. *Figure 3-8* shows the MATH and FUNCTION keys.

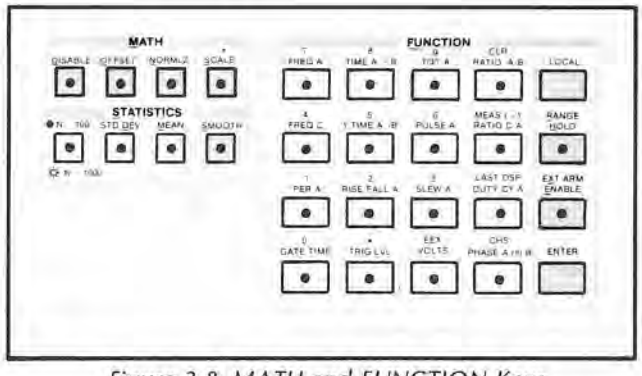


Figure 3-8. MATH and FUNCTION Keys

3-85. ENTERING CONSTANTS. The values for the three user specified constants are entered from the keyboard. Entry begins by pressing any one of three blue keys, OFFSET, NORMLZ, or SCALE. The selected indicator key light will start to flash, indicating that an entry is expected. During the number entry mode, the FUNCTION keys respond to the functions labled in blue (see *Table 3-1*). Any entry is completed by pressing the ENTER key, at which time the blue key light will turn on (steadily), indicating that a constant for that operation is stored and in effect. After pressing ENTER, the instrument will immediately begin making measurements, performing the MATH operation and displaying the result.

NOTE

Numbers greater than 9×10^{9} and less than 1×10^{-9} in magnitude can not be stored.

Table 3-1. Function Key Use During Number Entry

FUNCTION KEY	FUNCTION DURING NUMBER ENTRY
0-9, "."	Digit entry. Before EEX is pressed, these are used to enter the mantissa value. Up to 11 digits are allowed. After EEX is pressed, these are used to enter the exponent value.
EEX	Enter Exponent. Begins exponent entry when pressed.
CHS	CHange Sign. Toggles the sign of the mantissa or exponent, depending upon whether EEX was pressed.
CLR	CLeaRs entry.
ENTER	Completes entry of number. After ENTER is pressed, the instrument goes back to making measurements. If the value entered was zero, the specified constant is switched "off". This is indicated by turning the key's LED off. If the value entered was not zero, the specified constant is switched "on". This is indicated by the key LED on. When a constant is "off" it is ignored in the equation.
RESET	During number entry, RESET can be used to abort the entry and return to normal operation.
DISABLE (in MATH group)	During number entry, this key produces the same effect as entering zero as the value. The specified constant is switched off and normal operation begins. ENTER does not have to be pressed.
SPECIAL NUMBER ENTRY KEYS	
LAST DISP	This key will put on the display the value that was displayed from the last measurement. If you are presently entering a value to OFFSET, the last display value is negated. This lets you conveniently subtract errors or values based on measurements you've made. For NORMLZ and SCALE, the last display value is not negated.
MEAS t-1	This key does not specify any unique value, but instead specifies that as each measurement is made, the previous measurement value be used (before any mathematical manipulation). Previous measurement (t-1) — this measurement (t0) — display 1 2 3 4 5 — 1 2 3 4 6 — 1 This is an example of MEAS t-1 with OFFSET. As with LAST DISP, the value is negated for OFFSET, and not for NORMLZ and SCALE.

3-86. REVIEWING CONSTANTS. To review the constants, press any of the blue keys. The counter will cease taking measurements and the presently specified value of the constant will be displayed. The indicator light within the blue key specified will be flashing. At this time, either the value of the constant can be changed by keying in the new number and press ENTER, or all of the constants can be reviewed by pressing each blue key in succession. To return to the measurement mode, press either RESET or ENTER.

3-87. DISABLING MATH OPERATIONS. When not in the number entry mode (i.e., a blue key has not been pressed) the DISABLE key can be used to momentarily turn off all of the MATH functions. The DISABLE function toggles between on and off with each press of the key. The DISABLE key indicator light turns on when the MATH functions are disabled and off when the MATH functions are enabled. While disabled, the indicator lights within the individual MATH function keys are turned off.

3-88. During the number entry mode (i.e., pressing any blue key) the DISABLE key produces the same effect as entering zero (or one) as the value of the constant. The specified MATH function is turned off and the counter begins normal measurements. The ENTER key does not have to be pressed and the remaining MATH functions (if previously loaded) are reinstated.

3-89. If DISABLE is on and a blue key is pressed (number entry mode) the disable condition is defeated for the specified MATH function *only*. A new constant can be entered, and when ENTER is pressed, the measurement is displayed with only that specified MATH function activated. The remaining functions, though programmed with constants, are still DISABLED. To reactivate these stored functions, recall each (by pressing the blue key) and then press ENTER.

3-90. SAMPLE MATH OPERATIONS. The following examples illustrate the operation of the MATH GROUP functions.

a. With an input frequency of 10.001 MHz, enter an an offset of -10 MHz:

Keystrokes: OFFSET CHS 1 EEX 7 ENTER
Measured value: 10.001 MHz
Displayed value: 1 kHz

b. Suppose you are currently measuring a 3.56 MHz color TV crystal. To set -3.56 MHz as the offset:

Keystrokes: OFFSET LAST DISP ENTER

-3.56 E6 will be displayed

Measured value: 3.56 MHz
Displayed value: Ø Hz

c. Suppose in the above example you wished to display percentage error instead:

Keystrokes: OFFSET LAST DISP ENTER

-3.56 E6 will be displayed

DISABLE (lets 3.56 MHz be displayed without the offset)
NORMLZ LAST DISP ENTER

3.56 E6 is now in NORMLZ

SCALE 1 0 0 ENTER (100 is now in SCALE)
OFFSET ENTER (turns OFFSET on again)
Measured value: 3.61 MHz
Displayed value: 1.4045 (percent error from 3.56 MHz)

d. To display an measurement in rpm (revolutions per minute):

Keystrokes: SCALE 6 0 ENTER
Measured value: 100
Displayed value: 6.000 E3

e. To show change in frequency per second (approximately, averaged over 1-second gate times):

Set Gate Adjust to a 1-second gate time, and CYCLE Mode to MIN.

Keystrokes: OFFSET MEAS t-1 ENTER

A "t-1" will be displayed

Measured value: 1000 Hz
Measured value: 1002 Hz
Displayed value: 2 Hz
Measured value: 1005 Hz
Displayed value: 3 Hz

More precise timing of the gate can be achieved by arming.

3-91. STATISTICS Group

3-92. The functions within the STATISTICS group allow the user to automatically accumulate and sample 100 (or 1000) measurements and then determine and display either the standard deviation or the mean (average) of the sampling. These functions are selected by the STD DEV and MEAN keys, respectively, which toggle on and off with each press of the key. The indicator light will light when the function is activated. The sample size is initially set (default state) to 100. Pressing the N=100/N=1000 key will alternately toggle the sample size between 100 and 1000. The indicator light within the key will be on for a sample size of 1000, and off for 100. *Figure 3-9* shows the STATISTICS group keys.

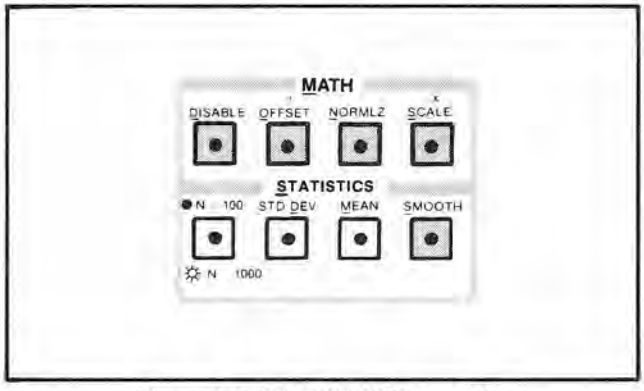


Figure 3-9. STATISTICS Group Keys

NOTE

MATH calculations are done *before* statistics when both are activated.

3-93. Selecting MEAN produces one additional digit of resolution. Selecting STD DEV will display three digits for either sample size. Both the Standard Deviation and the Mean can be displayed for a single sample. To do this the measurements must be made with STD DEV on and the CYCLE MODE set to SINGLE. At the end of the N measurements (100 or 1000) the standard deviation is displayed. Then press MEAN to display the mean of the sample. The mean value is displayed with a resolution based on the standard deviation.

NOTE

Statistical calculations sometimes use data from the measurement that is not displayed, from the resolution lost when a number has to be rounded to the best decade.

3-94. The SMOOTH key selects a unique function which "smooths" the display for easier reading. When SMOOTH is on, the counter looks at the resultant measurement and displays only the digits that are relatively stable. In addition, as the measurements continue to cycle, a running average is made to remove small deviations. The running average is made by assigning each new measurement a weight of 1/10, and the last display 9/10.

Smooth Display = 1/10 New Measurement + 9/10 Last Display

3-95. This allows for slow drift in the signal, but filters out small transients. The SMOOTH function provides a simple visual way to monitor the stability of a signal. If the stability of the signal decreases, the LSD's of the display will correspondingly begin to blank out. As stability increases, the lost digits of resolution will reappear. The SMOOTH key toggles on and off, and operates independently of all other functions.

NOTE

Because Phase measurements require a steady signal input, the use of Statistics is not valid (i.e., the STD DEV of a steady signal should be 0, and MEAN should be the same as any one measurement). Therefore, the use of STATISTICS for PHASE measurements is not recommended.

3-96. INPUT C (Option 030)

3-97. The INPUT C group contains the C Channel input BNC, SENSITIVITY control and PREAMP POWER receptacle. The input connector is a special fused BNC. Refer to paragraph 3-221 for replacement instructions. The SENSITIVITY control varies the input sensitivity from MAX (10 mV for 150 MHz to 1.0 GHz, 100 mV for 1.0 GHz to 1.3 GHz), refer to Specifications, *Table 1-1* to greater than 500 mV. The PREAMP POWER jack allows the use of an optional high frequency broadband preamplifier, such as the HP 10855A. The GATE ADJ and GATE MODE controls operate as with A Channel. *Figure 3-10* shows the Input control panel.

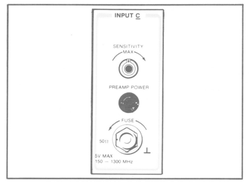


Figure 3-10. INPUT C Control Panel

NOTE

The PREAMP POWER jack supplies +15 Vdc and a ground output. This connector will not support a three-wire type power probe.

3-98. VOLTS (Option 020)

3-99. The VOLTS section contains the DCV (Red) and COM (Black) input connectors for the fully floating, autoranging Digital Voltmeter. The voltmeter measures dc inputs up to ±1000 volts. It automatically selects the ±10V, ±100V, or ±1000V range, depending on the input voltage. The sensitivity is 100 μV to 100 mV (depending on the range). *Figure 3-11* shows the VOLTS (digital voltmeter) control panel.

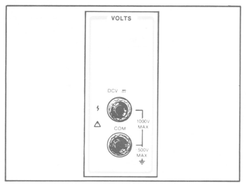


Figure 3-11. VOLTS Panel

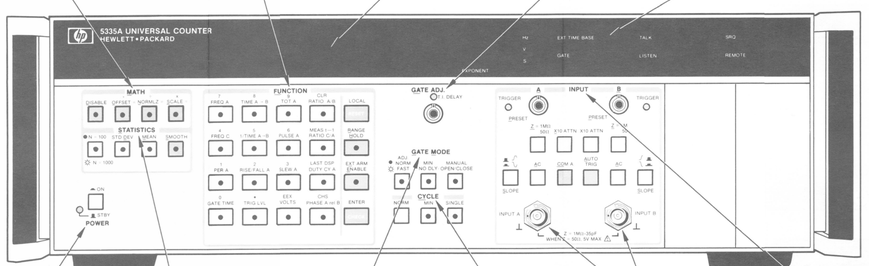
The MATH keys provide for post-measurement manipulation of the display, by the mathematical operations of OFFSET (±), NORMALIZE (÷), and SCALE (×). Values for constants are programmed in via the numeric values of the FUNCTION keys.

The Function keys provides the key-per-function selection of 16 basic function modes, as well as RESET, RANGE HOLD, EXT ARM, and CHECK.

The counter numeric display, providing 12 possible digits of mantissa, an exponent sign (±), and an engineering notation exponent (0, ±3, ±6, ±9 etc.) Mantissa digits are grouped into threes for convenience, whenever possible.

The GATE ADJ control provides the adjustability for the GATE MODES, and for adjustment of the T.I. Delay holdoff.

The display ANNUNCIATOR group provides LED indicators for monitoring the status of the Gate, HP-IB, and units of the measurement.



The POWER key applies power to the instrument when in the ON position (pressed in). In the STBY position (out), power is applied only to the high stability reference oscillator oven, Option 010.

The STATISTIC keys allow for the calculation of standard deviation or mean (average) of either 100 or 1000 measurement samples. The SMOOTH function performs a running average of ongoing measurements, and displays only the digits which are relatively stable.

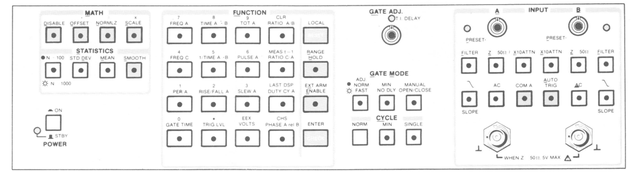
The GATE MODE keys selects the ranges of gate time. NORM and FAST are adjustable (via GATE ADJ) modes, providing ranges of 20 ms to 4 s and 100 μs to 20 ms, respectively, MIN specifies the shortest possible gate time, dependent on the input signal. MANUAL opens and closes the gate with each successive press.

The CYCLE keys determine the length of time between measurement cycles. The NORM mode specifies about 250 ms wait time, the MIN mode rearms the measurement as soon as possible. The SINGLE mode manually starts one measurement.

The A and B Channel input BNC connectors.

The INPUT group keys and controls determine how the input signals are conditioned (with attenuation, impedance, slope, coupling, and common controls) and how the counter is triggered (AUTO TRIG or normal).

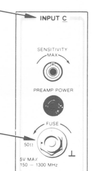
OPTION 040
PROGRAMMABLE INPUT



OPTION 030
CHANNEL C

The INPUT C module, Option 030, provides for FREQUENCY measurements from 150 MHz up to 1.3 GHz. Controls are provided for adjustable SENSITIVITY and PREAMP POWER.

The C Channel input BNC is a special fused connector. The fuse (HP Part No. 2110-0301) is 1/8A, and is accessible (for replacement) from the front panel.



OPTION 020
DVM

The VOLTS module, Option 020, provides a fully floating auto-ranging DC voltmeter. Input DC voltage range up to 1000V.

The input connectors for the Option 020 Voltmeter. Input voltage 1000V DC max. COM is floating.

Figure 3-12. Front Panel Features

5335A REAR PANEL

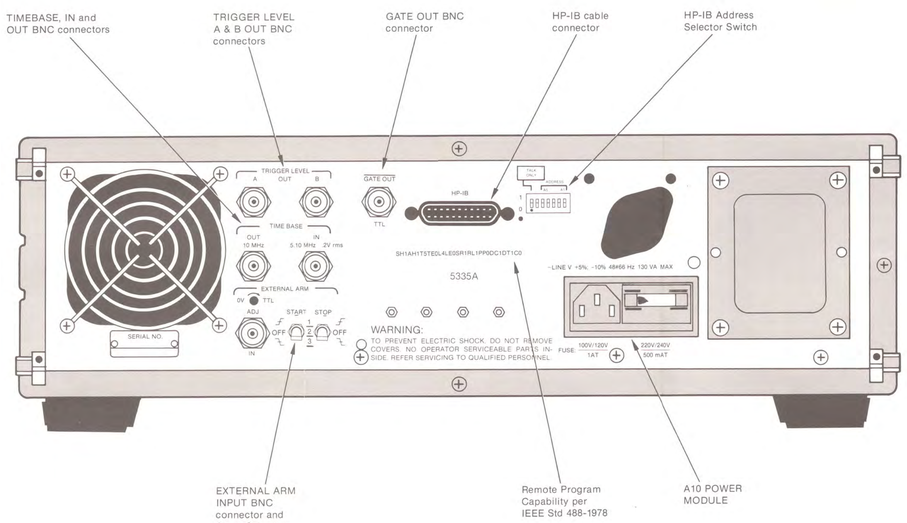


Figure 3-13. Rear Panel Features

3-100. REAR PANEL FEATURES

3-101. A number of signal inputs and outputs are provided on the rear panel. See *Figure 3-13*. TIME BASE OUT provides a 10 MHz signal that may be used as a reference for other instruments. If the reference to the HP 5335A is to be provided from another source, connect it to TIME BASE IN. This input accepts either 5 or 10 MHz signals and internally multiplies it up to 10 MHz. Whenever a reference is applied to the TIME BASE IN connector, the presence of that signal is sensed by internal circuitry, and the HP 5335A will automatically switch from the internal reference mode to the external reference mode of operation. This switchover is indicated by the lighting of the OSC annunciator on the front panel display. If the reference is removed, the OSC annunciator will not automatically turn off. Pressing the RESET key will update the status of the reference OSC annunciator. Do not connect TIME BASE IN to OUT. No damage will occur but the reference frequency will be incorrect.

NOTE

Always press RESET after connecting or disconnecting a signal to the TIME BASE IN. Do not connect or disconnect a signal to the TIME BASE IN during measurements. FAIL 5.1 may be indicated, or the measurement may give a false reading. If FAIL 5.1 is indicated in this situation, pressing RESET clears the condition.

3-102. TRIGGER LEVEL OUT provides A and B Channel DC trigger levels for display on scopes. These signals are useful for a visual verification of proper triggering.

3-103. GATE OUT provides a logic low signal when the gate is open (see specifications). This can be used in many cases as a visual indication of when the measurement occurs, or the duration of the measurement.

3-104. The EXTERNAL ARM input can be used to specify the start and/or stop of a measurement. The various modes of arming are determined by the two, three-position switches. Refer to ARMING MODES Timing Diagram, *Figure 3-14*.

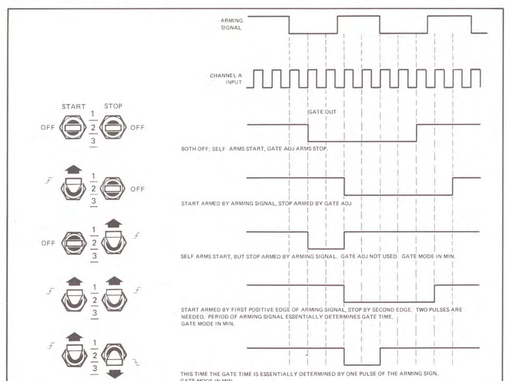


Figure 3-14. ARMING MODES Timing Diagram

Figure 3-12
FRONT PANEL FEATURES

(See Page 3-11)

OPEN FOLDOUT FOR FIGURE 3-13

NOTE

When STOP ARM is used the GATE MODE is usually used in MIN. To aid the user in this condition the 5335A will automatically set the GATE MODE to MIN when the STOP ARM is activated. However, the user can override this feature by simply selecting any other GATE MODE after setting up the ARMING modes.

3-105. When the GATE MODE is set to NORM, FAST, or MANUAL, and EXTernal ARM ENABLE is on, the "Gate Adj Timer" can be used to hold off the STOP ARM. Refer to *Figure 3-15* for example.

Example:

a. The rising edge of the ARMING signal enables the START of the gate and starts the Gate Adj Timer (1).

b. The ARMING signal is then ignored until the Gate Adj timer times out (2).

c. The next falling edge of the ARM signal (3) then arms the STOP.

In this way, multiples of the ARMING SIGNAL period can be used to arm the measurement.

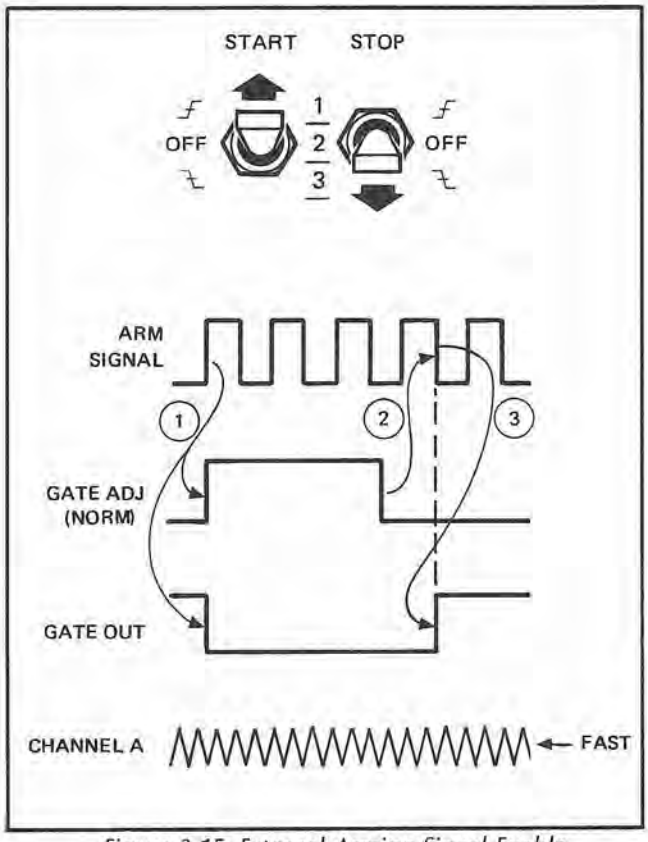


Figure 3-15. External Arming Signal Enable

3-106. DETAILED OPERATING INSTRUCTIONS

3-107. The following paragraphs provide detailed operating information. Within a specific function mode, (e.g., FREQ A, PER) a considerable amount of flexibility is present for both the type of input signal and measurement technique. The intent of the following paragraphs is to provide an instructional discussion, which demonstrates the *user control flexibility* for each major function mode. These operating guidelines should assist in making the most useful and accurate measurement possible.

3-108. FREQ A (Channel A Frequency)

3-109. The FREQ A mode makes measurements on frequencies up to 200 MHz through the Channel A INPUT. In this function the input is prescaled by two, however, there is no loss of resolution. On power-up, the 5335A assumes the FREQ A function with the GATE MODE in NORM. For a cw signal connected to INPUT A (and within the restrictions set by the input signal conditioning controls) the counter is self-arming, and measurements begin immediately. The displayed resolution is adjusted with the GATE ADJ control.

3-110. Suppose you need to measure a pulsed CW signal. Assuming no transients occur before the pulse, the frequency of this signal is measured by setting the GATE MODE to FAST, and adjusting for a gate time just under 200 μs. The INPUT A controls are set to ac coupling, separate, with the trigger level control at PRESET. The counter is armed by the signal, and the gate opens automatically just after the start of the pulse. *Figure 3-16* shows details of pulsed CW signal measurement.

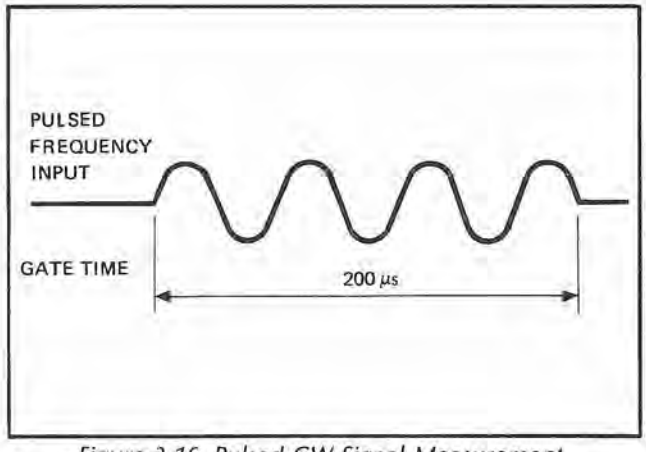


Figure 3-16. Pulsed CW Signal Measurement

3-111. To measure the frequency at various points along a chirp, use the 5335As arming capability. By setting the START ARM slope to positive and the STOP ARM slope to negative, and then turning EXT ARM ENABLE on, the frequency at various points can be measured. Use an external timing generator to produce the external arm signal. *Figure 3-17* shows details of chirp signal measurement.

3-112. If the timing generator cannot provide a pulse width of the appropriate width, the STOP ARM can be turned off, which lets the counter stop arm itself. With this setup, you can specify any gate time from 100 μs on up. With GATE MODE in MIN, the counter will measure the frequency based on two periods of the input.

3-113. To measure the frequency of a pulse stream or pulse repetition frequency (prf), use the AUTO TRIG mode and dc coupling. AC coupling these types of signals tends to distort them slightly, due to the charging of the coupling capacitor. Additionally, 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 extra counts. *Figure 3-18* shows AC coupling distortion of pulses.

3-114. DC coupling "fixes" the dc level of the input signal. Using AUTO TRIG in Preset or Adjustable allows the trigger level to be easily positioned at an optimum point. *Figure 3-19* shows advantage of DC coupling.

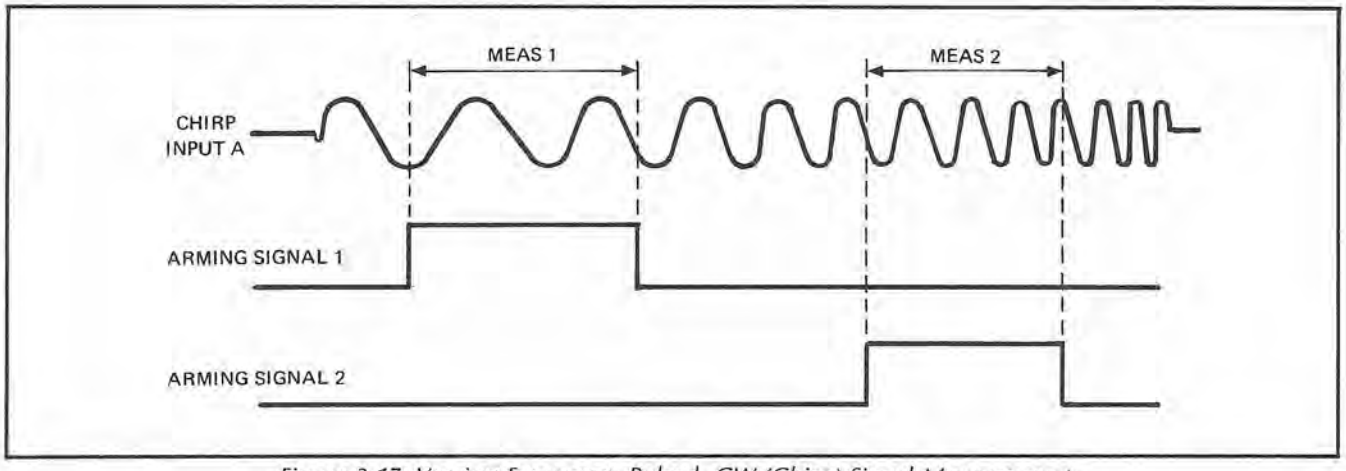


Figure 3-17. Varying Frequency Pulsed CW (Chirp) Signal Measurement

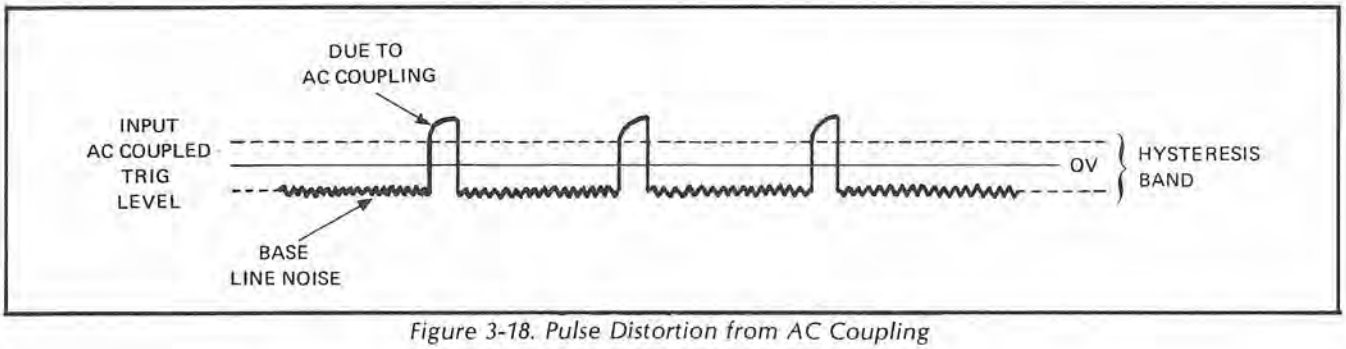


Figure 3-18. Pulse Distortion from AC Coupling

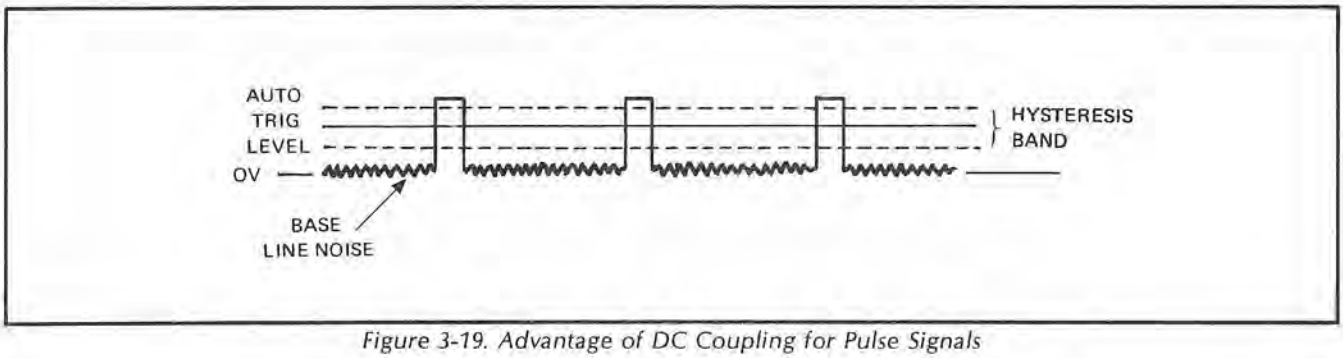


Figure 3-19. Advantage of DC Coupling for Pulse Signals

3-115. TIME A→B (Time Interval A to B)

3-116. The TIME A→B mode measures the time interval between a start signal at Channel A and a stop signal at Channel B. The START and STOP slopes, as well as trigger levels, are individually selectable. If the START and STOP signals are to be derived from a single signal, set the INPUT COM A (SEPARATE/COMMON) key to COM A (key in).

3-117. When TIME A→B is selected, the 5335A automatically shifts the GATE MODE from NORM to MIN (NO DELAY). If a "delay" (stop channel prevented from triggering for a specific period of time) is desired, the NORM, FAST, or MANUAL gate modes may be selected. When the delay is active, the red DELAY indicator will light.

3-118. For a simple time interval measurement with both slopes set to positive, the counter will display the time period illustrated. If the signals are not repetitive, be sure that AUTO TRIG is off. *Figure 3-20* shows time interval measurement relationships.

3-119. To measure a specific rise time manually, set both slopes to positive and set the INPUT SEPARATE/COMMON key to COM A. Setting the trigger levels to the desired points is simplified by using AUTO TRIG, however, the input signal to Channel A should be continuous. The selected trigger levels may be viewed by pressing the TRIG LVL key, or monitoring the rear panel trigger level outputs. For rise time measurements using the 10% and 90% points, see RISE TIME A. *Figure 3-21* shows voltage rise time measurement.

3-120. The T.I. DELAY (time interval delayed) mode is useful for making time interval measurements on signals, where false triggering (due to settling time, relay contact bounce, etc.) must be avoided. To insert a delay, set the GATE MODE to FAST (for a delay range of 100 μs to 20 ms) or NORM (for a delay range of 20 ms to 4 s) and use the GATE ADJ control to select the required delay. *Figure 3-22* shows time interval delayed measurement.

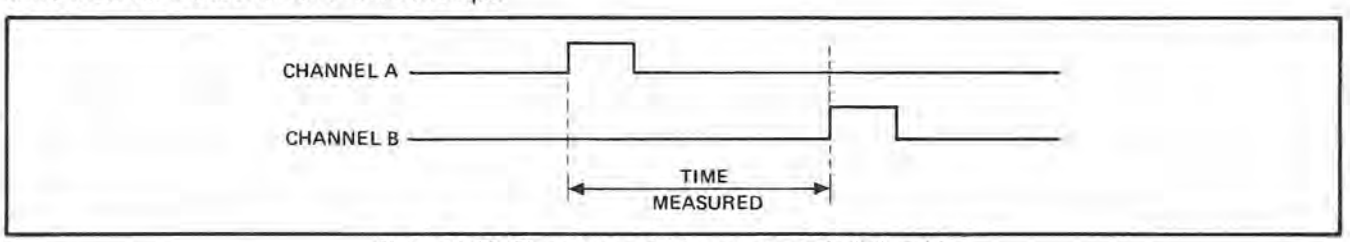


Figure 3-20. Time Interval Measurement Relationships

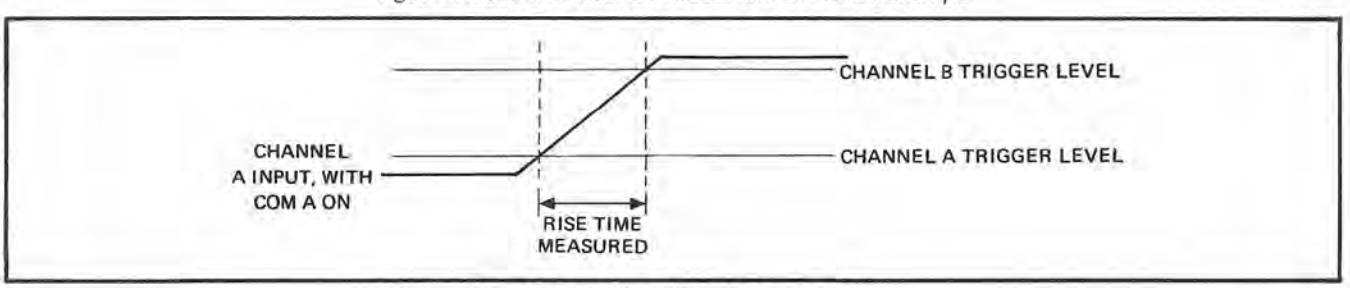


Figure 3-21. Rise Time Measurement

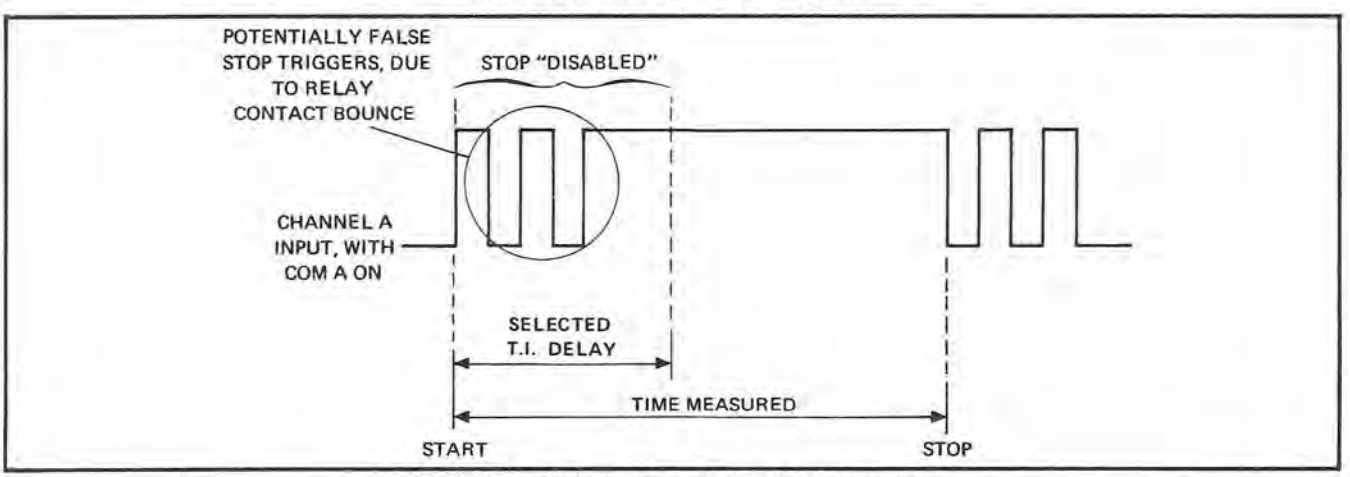


Figure 3-22. Delayed Time Interval Measurement

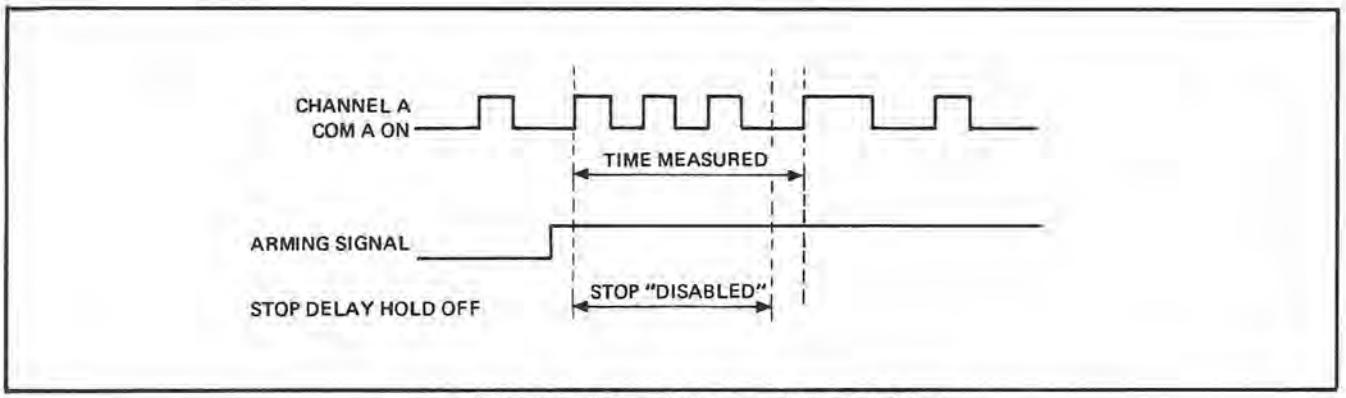


Figure 3-23. Time Interval Between Selected Pulses

3-121. To measure the time interval between two arbitrary pulses in a pulse train, use the counters external arming capability. Set the External Arm Start switch to select the starting pulse. Generate the arming signal from a timing generator. If the pulse width of the generator is programmable, you can also use this signal to specify the second pulse. If not, you may be able to use the stop hold-off delay feature described in the previous example. *Figure 3-23* shows measurement of time interval between selected pulses.

3-122. TOT A (A Channel Events Totalized)

3-123. The TOT A mode will display the number of counts (events) received in Channel A. When TOT A is selected, the 5335A will automatically shift the GATE MODE from NORM to MANUAL, with the Gate initially closed. Pressing the MANUAL key opens the Gate and allows counts to accumulate. To stop counting, press the MANUAL key again. Pressing the MANUAL key once more allows counting to continue without resetting the previous total. To zero the count, press RESET. To begin a new measurement, close the gate and then press RESET. RESET is independent of the Gate.

NOTE

SMOOTH and MATH operations using "MEASt-1" will not operate in manual totalize.

3-124. In other gate modes TOT A behaves slightly differently. With GATE MODE set to NORM or FAST, the totalize acts somewhat like a frequency measurement. Based on the CYCLE and ARM modes, the totalizing will start and stop without the need for manual operation. Also, between measurements, the count will automatically reset itself.

3-125. To totalize the number of events in a burst of pulses which occur at one second intervals, set the GATE MODE to NORM. Adjust the GATE ADJ control for a gate time of just under one-second (≈0.8 s). Set CYCLE to MIN. At a one second rate, the counter will update the display by the number of counts in each burst. The counter will reset and arm itself automatically for each cycle. *Figure 3-24* shows counting a burst or group of pulses.

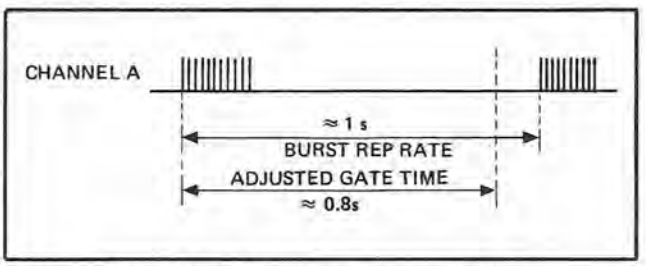


Figure 3-24. Counting Groups of Pulses

3-126. To totalize the number of events within a specified window, connect an externally generated arming signal to the rear panel ARM input. Set the START SLOPE switch to negative and the STOP to positive. Press EXT ARM ENABLE, and the counter will display the number of events within the window. If only the start point is specified by the ARMING signal, you may set the STOP SLOPE switch to OFF, and specify the stop point by putting the GATE MODE into FAST or NORM and setting the GATE ADJ control (as in paragraph 3-120). The SMOOTH and MATH operations can also be used for any totalize GATE MODE except MANUAL. *Figure 3-25* shows counting groups of pulses in a specific time interval.

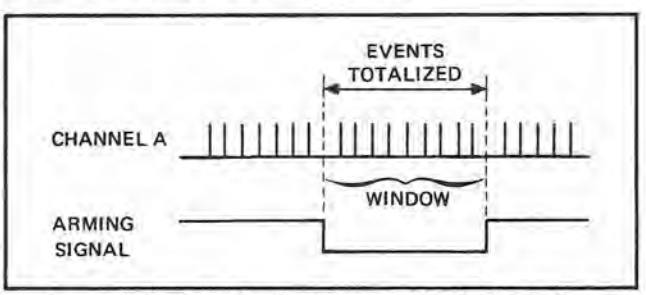


Figure 3-25. Specific Time Interval/Pulse Counting

3-127. Normally, the total is not sent to the HP-IB until the gate is closed. Some applications call for the total to be sent while the gate is still open and allowing counts. This is called totalize on the fly. To totalize on the fly put the counter in Totalize and set the GATE MODE to MANUAL and the CYCLE MODE to SINGLE. Start the count by pressing the MANUAL key. Data will then be sent on the fly during counting and once after the gate is closed. Data is sent only if two successive readings of the counting registers are equal, thus assuring an accurate reading. If the gate is reopened, data will once again be sent. The output data byte sent while the gate is open is *not* preceded by the Alpha Character "T", while the data sent after the gate is closed is. For further information on the data output format, refer to paragraph 3-211.

NOTE

Totalizing on the fly should be performed only on signals below 50 Hz.

3-128. RATIO A/B (Ratio of Frequencies of Channel A Signal to Channel B Signal)

3-129. The RATIO A/B mode allows the measuring of the ratio between two signal frequencies. The maximum frequency allowable to Channel A is 200 MHz, and to Channel B it is 100 MHz. The ratio is measured by connecting the original frequency into Channel B and the multiplied frequency into Channel A. The counter will display the multiplying factor "N". The number of digits of resolution is determined by the input frequencies and the Gate Time. *Figure 3-26* shows how to measure the ratio between two signal frequencies.

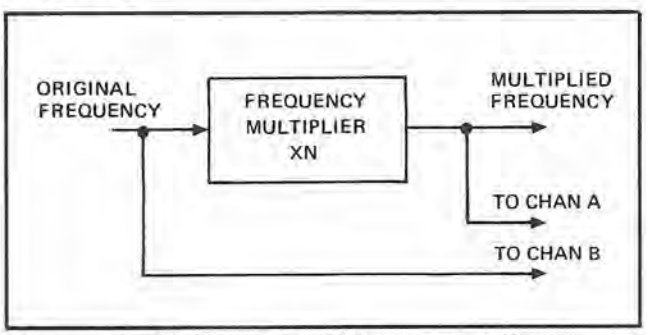


Figure 3-26. Frequency Ratio Measurement Connections

3-130. FREQ C

3-131. The FREQ C mode requires the optional C Channel Input Module. Input signals to INPUT C are prescaled by a-factor-of-20, however, as with FREQ A, there is no loss of resolution. When FREQ C is selected, the Channel A and B INPUT section is disabled. Measurements through C Channel respond to all other controls the same as FREQ A measurement.

3-132. 1/TIME A→B

3-133. The 1/TIME A→B mode performs the standard TIME A→B measurement, mathematically computes the reciprocal value and displays it as units-per-second. This allows measurement configurations with a direct display of velocity. This mode can also utilize the stop channel delay holdoff (T.I. DELAY) feature, described for TIME A→B.

3-134. To determine the velocity of a moving object, connect the START electric eye to Channel A, and the STOP electric eye to Channel B. Select the 1/TIME A→B function. In this example the two electric eyes are 10 metres apart, so compensate by setting SCALE to 10. This will produce a measurement readout in metres/per second. If the object takes 0.25 seconds to travel between the electric eyes, the answer displayed will be 40 (metres per second). If a Ø ns time is measured, a "Ø" result will be displayed. *Figure 3-27* shows how to measure velocity of moving objects.

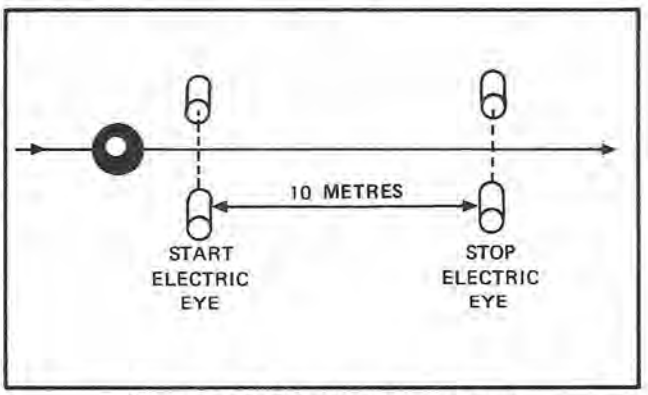


Figure 3-27. Velocity Measurement

3-135. PULSE A

3-136. The PULSE A mode measures the width of pulses input into Channel A. With the SLOPE A switch set to ⨍, positive pulses will be measured. With the SLOPE A switch set to ⨍̄, negative pulses will be measured. This mode can also utilize the stop channel delay holdoff (T.I. DELAY) feature, described for TIME A→B.

3-137. For continuous pulse streams, set the trigger level for AUTO PRESET. For single-shot pulses or special applications, use the manual modes of triggering. To locate and measure a selected pulse within a data stream use external arming. Set the START ARMING SLOPE to positive or negative, when measuring a

pulse on Channel A. Position the edge of the Arming Signal just ahead of the leading edge of the desired pulse and set EXT ARM ENABLE to on. Set the trigger level for AUTO PRESET (for most continuous signals) to automatically trigger at the 50% point. The GATE MODE will automatically switch to MIN and a single pulse measurement will be made. *Figure 3-28* shows pulse with measurement.

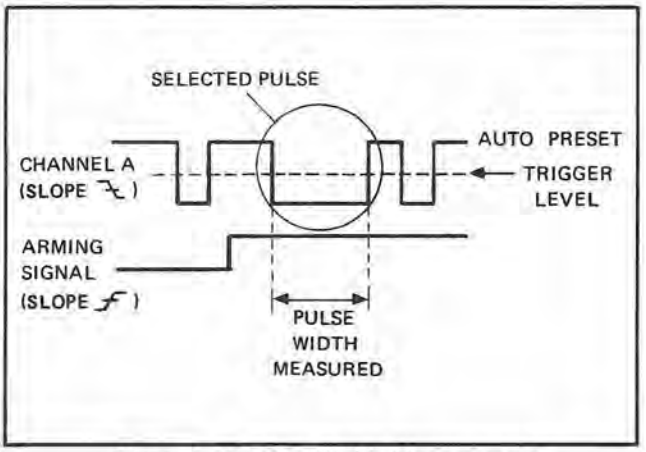


Figure 3-28. Pulse Width Measurement

NOTE

Pulse measurements are specified for trigger levels between the 40% and 60% points of the signal.

3-138. RATIO C/A

3-139. The RATIO C/A mode is similar to the RATIO A/B mode (paragraph 3-128), with the advantage of an extended frequency range for ratio measurements. The maximum frequency into Channel A is 200 MHz, and into C Channel it is 1300 MHz. Connect the higher of the two frequencies to the C Channel Input and select the RATIO C/A mode. The ratio will be displayed with the resolution being determined by the higher frequency and the selected Gate Time.

3-140. PER A (Channel A Period Measurement)

3-141. The PER A mode allows single period measurements or multiple period averages to be made on input signals into Channel A. In this mode, the input is not prescaled so the maximum frequency is 100 MHz. In NORM/FAST GATE MODES, a period average measurement is made where the number of periods averaged is determined by the setting of the GATE ADJ control and the period of the signal. For single period measurements, set the GATE MODE to MIN.

3-142. RISE/FALL A (Channel A Rise and Fall Time Measurement)

3-143. The RISE/FALL A mode automatically configures the counter to perform either rise or fall time measurements. The input is automatically set to COM A and triggering to AUTO TRIG. In this mode, AUTO TRIG automatically locates and sets the trigger levels at the 10% and 90% points of the input signal. Rise time measurements are made when the SLOPE A control is set to . Fall time measurements are made when the SLOPE A control is set to . For rise and fall measurements, the input signal must be continuous. To measure the rise time on a selected slope of a signal, use external arming. Set the Start Arming Slope to positive and using an oscilloscope, position the leading edge just ahead of the selected slope of the signal. With SLOPE A positive, the counter will display the rise time; with SLOPE A to negative, the counter will display the fall time. Measurements are displayed in units of seconds. *Figure 3-29* shows relationships in measurement of waveform rise and fall time measurement.

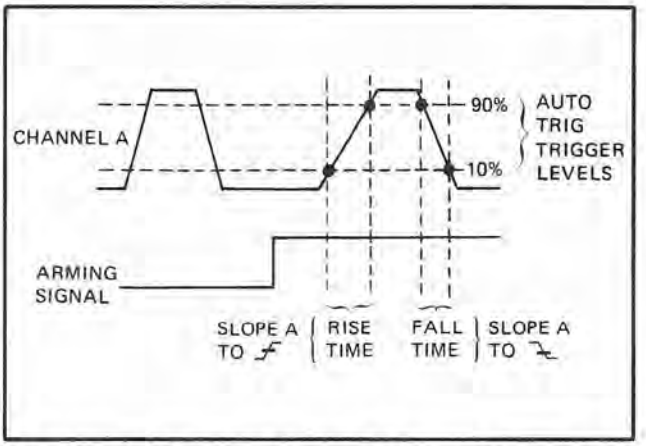


Figure 3-29. Waveform Rise and Fall Time Measurement

3-144. SLEW A

3-145. The SLEW A mode is similar to the RISE/FALL A mode, with the counter automatically selecting COM A and AUTO TRIG. However, to more easily accommodate analog signals, the measurement is displayed in units of Volts/seconds. Additionally, the MATH operations may also be selected to achieve a direct readout of the desired units. For example, programming the NORMLZ function with values of 10^3 or 10^6 will produce slew rates in units of volts/millisecond and volts/microsecond, respectively. As with RISE/FALL A, the measurements with SLEW A are with respect to the 10% and 90% points of the input

and the input must be continuous. Also, slew rates on selected slopes may be made, using the external arm method.

3-146. DUTY CYC A (Channel A Duty Cycle Measurement)

3-147. The DUTY CYC A mode measures and displays the proportional percentage of either the positive or negative durations of a given input digital waveform. The percentage of the positive pulse is given when the SLOPE A control is set to ⨍. The percentage of the negative pulse is given with the control set to ⨍̄. In this mode, the counter automatically sets the GATE MODE to MIN.

3-148. Duty cycle is actually measured indirectly through two measurements, Period and Pulse. Therefore, the signal should have a constant duty cycle in order to be accurately measured. If a particular place in a pulse stream needs to be examined in a changing duty cycle environment, be sure that the characteristics are repetitive.

3-149. To measure the positive duty cycle of a continuous asymmetrical waveform, select DUTY CYC A, set the SLOPE A control to ⨍ and set triggering to Auto Preset. The counter will display a value, typically between 1 and 99 ("25" in this example) representing the duty cycle. No unit annunciators will light, as duty cycle is assumed as "percentage". *Figure 3-30* shows waveform duty cycle measurement relationships.

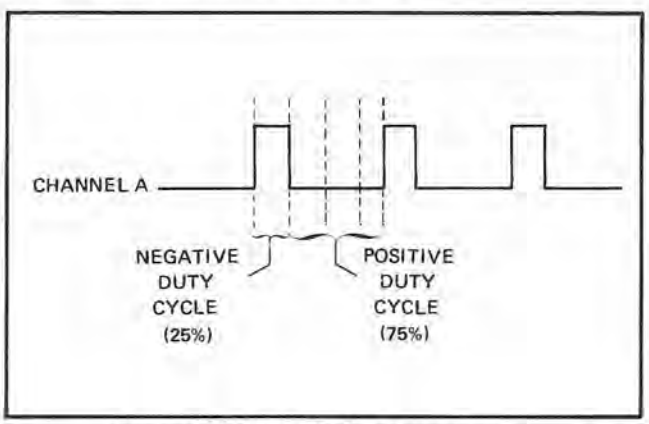


Figure 3-30. Duty Cycle Measurements

NOTE

Duty Cycle should be measured with the trigger level set between the 40% and 60% points of the signal peaks.

3-150. GATE TIME

3-151. The GATE TIME mode provides an indication of the duration of the gate time, displayed to three significant digits. When EXT ARM ENABLE is on, gate time resolution to 100 ns is displayed. The gate time is controlled (except in MIN) by the GATE ADJ control.

NOTE

As the gate is synchronized to the input signal, the actual gate time may be different from the displayed gate.

3-152. When in a TIME domain function mode (e.g., TIME A→B, PULSE A), the GATE TIME mode provides an indication of the amount of stop delay time selected. This time is set by the GATE ADJ control. When in a TIME domain function, with the GATE MODE in NORM or FAST, the T.I. DELAY indicator will be lighted.

3-153. Pressing GATE TIME does not affect the function set-up memory of the operating mode. Press the operating mode function key or RESET to resume measurements.

3-154. TRIG LVL (Trigger Level)

3-155. The TRIG LVL mode displays both the Channel A and B trigger levels. The display grouping on the left is Level A and the right is Level B. If the operating function mode, prior to the TRIG LVL, was RISE/FALL or SLEW, the levels displayed will be the 10% and 90% points of the input signal. For PHASE A rel B, the levels will be the 50% points. Pressing TRIG LVL does not affect the function set-up memory of the operating mode. Press the operating mode function key or RESET to resume measurements.

3-156. When outputting the Channel A and B Trigger Levels, via the HP-IB, two complete numbers are sent, prefixed with the letters A and B.

3-157. VOLTS

3-158. The VOLTS mode requires the option 020 DVM input module. The DVM is fully floating and autoranging. A unique feature is that there is no need for predetermined gate times. This means that, like frequency, you may set gate time to most any setting desired. Also, this means that you can arm both the start *and* the stop of a voltage measurement.

3-159. To measure the voltage of a signal at a specified point, use external arming. Set the start arm

switch to positive and the stop arm switch to negative. Position the arming signal to allow for the step response time of the voltmeter (t_1). For environments with 50 or 60 Hz noise problems, gate times which are multiples of 100 ms will reduce error in the measurements. *Figure 3-31* shows the time relationship of the voltage measurement.

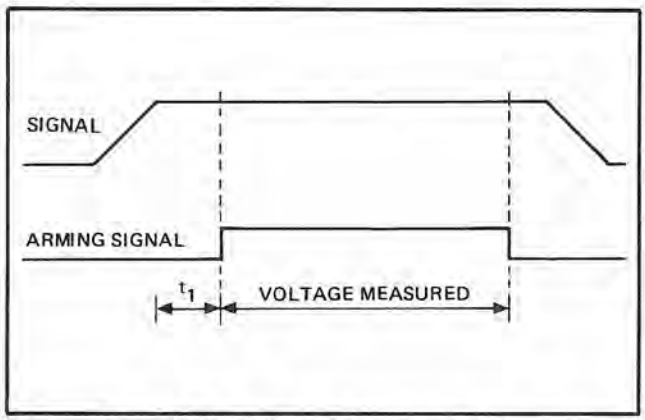


Figure 3-31. Voltage Measurement Time

- PHASE A rel B measurements should be made with the SEP/COM switch in SEP. If COM A is momentarily selected, the RESET key should be pressed.
- RESET should be pressed after any change to the INPUT controls, particularly for SLOPE and SEP/COM controls.

NOTE

Because phase requires a steady signal input, the use of statistics is not valid (i.e., the STD DEV of a steady signal should be Ø, and the MEAN should be the same as any one measurement). Therefore, the use of STATISTICS for PHASE measurements is not recommended.

3-160. PHASE A rel B

3-161. The PHASE mode measures the phase of the signal on Input A, relative to the signal on Input B. The phase difference is displayed in degrees. In this mode, Auto Preset triggering is automatically selected. The trigger points are set to the 50% points of each signal, regardless of either signals offset.

3-162. The overall display range is –180° to +360°. The display of a PHASE measurement is configured such that around 0°, the operating range is –180° to +180°, but around +180° the operating range is 0° to 360°. If RANGE HOLD is on, the range is fixed to 0° to 360°. The PHASE mode cannot be externally armed. *Figure 3-32* shows waveform phase relationships.

3-163. Phase measurements are made through a series of individual measurements, therefore certain input and operational restrictions apply:

- The frequency and phase angle of the signals should be constant.
- Frequencies can be measured up to 1 MHz.

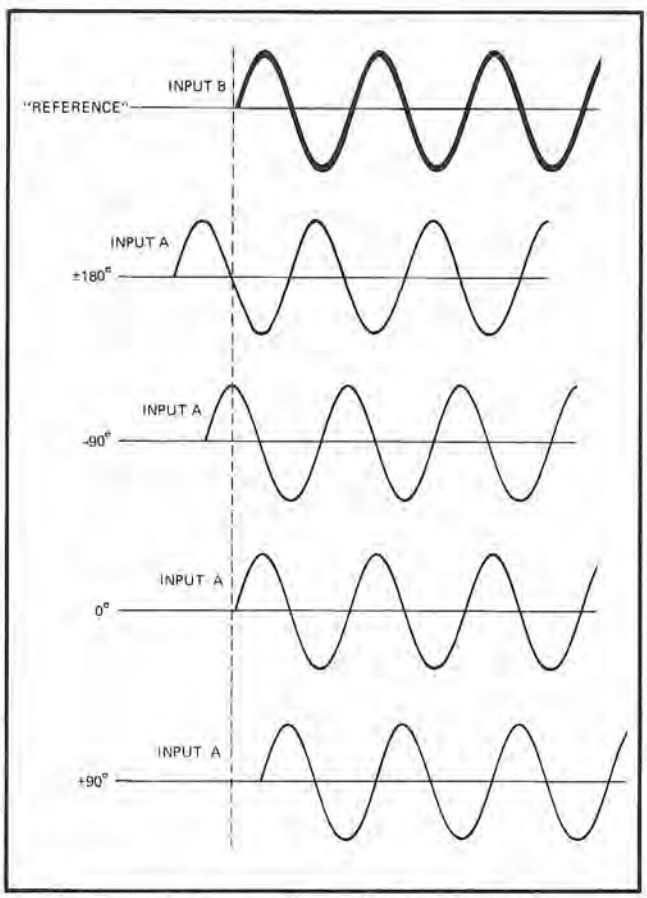


Figure 3-32. Waveform Phase Relationships

Table 3-2. Function Key Reference Summary

FUNCTION KEY	UNITS	TRIG MODE	SLOPE A USAGE	ARMING	GATE ADJ	COMMENTS
FREQ A	Hz	Any		Yes	Gate	Prescaled-by-2
TIME A→B	s	Any		Yes	Stop Delay	
TOT A	——	Any		If not in manual	Gate	Smooth and $MEAS_{t-1}$ will not operate when in MANUAL
RATIO A/B	——	Any		Yes	Gate	
FREQ C	Hz	N.A.	N.A.	Yes	Gate	Prescaled-by-20
1/TIME A→B	1/s	Any		Yes	Stop Delay	
PULSE A	s	Any	ƒ = Positive Pulse ɻ= Negative Pulse	Yes	Stop Delay	
RATIO C/A	——	Any		Yes	Gate	"A" prescaled-by-2, "C" prescaled-by-20
PER A	s	Any		Yes	Gate	
RISE/FALL A	s	10%, 90%	ƒ = Rise Time ɻ = Fall Time	Yes	MIN only	Signal should be >50 Hz and <25 MHz.
SLEW A	V/s	10%, 90%	ƒ = Rising Slope ɻ= Falling Slope	Yes	MIN only	Signal should be >50 Hz and <25 MHz.
DUTY CYC A	s	Any	ƒ = % High ɻ = % Low	No	MIN only	Needs constant signal
GATE TIME	s	N.A.		Yes	Shows Gate or Stop Delay	Will not affect function memory
TRIG LVL	V	Follows Last function	N.A.	N.A.	N.A.	Will not affect Function memory, sends 2 numbers on HP-IB
VOLTS	V	N.A.	N.A.	Yes	Gate	
PHASE A rel B	°	50%		No arming	MIN only	Needs constant signal. Range 0° to 360° if RANGE HOLD on >30 Hz

3-164. SPECIAL FUNCTIONS

3-165. Functions 17, 18, 19, and 20 are additional functions that are available in the 5335A.

17 FREQ B
18 TIME B→A
19 TOT A–B
20 PULSE B

These functions are accessed via the HP-IB through the normal FN or FU command, however, they may also be accessed manually through the keyboard. This is an example of invoking FREQ B, function 17:

Press: SCALE, SMOOTH, 1, 7, ENTER

3-166. After pressing SMOOTH the display will show the word "SPECIAL". After pressing ENTER the counter will be in FREQ B. No function lamp indication is given for these special functions.

- When using TOTALIZE A–B output is given only after the gate is closed. To start the totalizing, a pulse from B must first be received. Closing the gate is also synchronized with a pulse from Channel B.

- Diagnostics are programmed by sending FN99, followed by a diagnostic code that is programmed into the SCALE register. For example, FN99 MS12, calls up diagnostic 12. (See Section VIII). Via the keyboard the diagnostics are called similarly. Press SCALE, SMOOTH, 9, 9, ENTER, then SCALE, 1, 2, ENTER.

3-167. PROGRAMMING

3-168. Introduction

3-169. The 5335A Universal Counter is fully compatible with the Hewlett-Packard Interface bus (HP-IB). The bus capability is installed as standard equipment and allows the counter to respond to remote control instructions and output measurement results via the HP-IB. At the simplest level, the 5335A can output data to other devices such as the 5150A Thermal Printer or the 59303A Digital-to-Analog Converter. In more sophisticated systems, a computing controller or other controllers can remotely program the 5335A to perform a specific type of measurement, trigger the measurement, and read the results.

NOTE

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

3-170. This section describes how to use the 5335A on the HP-IB. Before programming, the operator must be familiar with the selected computing controller (e.g., the 9825A, 9830A, or 9835/85A calculators), the capabilities of the HP-IB, and the manual operation and capabilities of the 5335A. The following HP manuals provide useful background information:

HP-IB User Guide, 9830A (P/N 59300-90002)
Hewlett-Packard 9825A Calculator General I/O Programming (P/N 09825-90024) Hewlett-Packard 9825A Calculator Extended I/O Programming (P/N 09825-90025)
Condensed Description of the Hewlett-Packard Interface Bus (P/N 59401-90030)
Abbreviated Description of Hewlett-Packard Interface Bus (P/N 5955-2903)
HP-IB Quick Reference (P/N 5955-2902)

3-171. Interface Function

3-172. The capability of a device connected to the bus is specified by its interface functions. *Table 3-3* lists the 5335A Interface Functions using the terminology of the IEEE 488-1978 standard. These features are also listed below the rear panel HP-IB connector, as follows:

SH1, AH1, T1, TE0, L2, LE0, SR1, RL1, PP0, DC1, DT1, C0

Table 3-3. HP-IB Interface Capability

INTERFACE FUNCTION SUBSET IDENTIFIER	INTERFACE FUNCTION DESCRIPTION
SH1	Complete source handshake capability.
AH1	Complete acceptor handshake capability.
T5	Talker (basic talker, serial poll, talk only mode)
TE0	No extended talker capability.
L4	Listener (basic listener, no listen only mode, does not unaddress to listen if addressed to talk).
LE0	No extended listener capability.
SR1	Service request capability.
RL1	Complete remote/local capability.
PP0	No parallel poll capability.
DC1	Device clear capability.
DT1	Device trigger capability.
C0	No controller capability.

3-173. The number following the interface function code indicates the particular capability of that function as listed in Appendix C of IEEE Std. 488-1978. Interface functions provide the means for a device to receive, process, and send messages over the bus.

3-174. Nearly all controls on the 5335A can be programmed remotely, and data from measurements can be sent to other devices through the HP-IB. The TALK, LISTEN, SRQ, and REMOTE annunciators in the display indicate the state of the instrument. The following paragraphs describe the basic programming capability of the 5335A Universal Counter.

TALK:
When addressed as a Talker, whether by a controller or by the TALK ONLY switch, the 5335A will try to send data out to other devices on the bus. Normally this data is the measurement data.

LISTEN:
When addressed as a Listener, the instrument can accept any number of commands from a controller on the bus. These commands will usually be used to program the instrument's operation.

SERVICE REQUEST:
SRQ can be sent out to the bus at the end of measurements and on error or failure messages. Normally SRQ is inhibited, but certain commands will enable this feature. See "WA" (WAIT) and "SR" (SERVICE REQUEST).

REMOTE/LOCAL:
Normally the 5335A is under local control. In order to program the instrument it must be in Remote. Once in Remote, all programmable controls are in remote and cannot be affected by manual command. The RESET key may be used to manually return to local control when Local Lockout is OFF. If Local Lockout is ON, the RESET key is ignored.

PARALLEL POLL:
No parallel poll capability in the 5335A.

DEVICE CLEAR:
When a universal or selected device clear is received, the instrument clears out all input buffers and resets the hardware for a new measurement. The display will flash momentarily. SRQ is also cleared. Device clear can be used to clear an ERROR message.

DEVICE TRIGGER:
When a device trigger is received, a new measurement is started.

CONTROLLER:
No controller capability in the 5335A.

3-175. Bus Messages

3-176. Messages are the means by which devices exchange control and measurement information. There are 12 basic messages which can be sent over the interface. *Table 3-4* lists each bus message, a description of the message, how the 5335A uses that message, and examples of the various controller's implementation of the messages.

Table 3-4. 5335A Bus Message Usage

Message	Description	5335A Use	Sample 9825 Statements (5335A Set to Address 03)	Sample 9835/45 Statements (5335A Set to Address 03)
Data	Transfers device-dependent information from one device to one or more devices on the bus.	Sends measurement data. See paragraph 3-211 for output format. Accepts program codes See *Table 3-6* for code set.	red 703, A wrt 703, "FN9"	ENTER 703, A OUTPUT 703, "FN9"
Trigger	Causes a group of selected devices to simultaneously initiate a set of device-dependent actions.	Starts a new measurement.	trg 7 or trg 703	TRIGGER 7 or TRIGGER 703
Clear	Causes an instrument to be set to a predefined state (a certain range, function, etc.).	Sames as front panel RESET. Clears internal count and starts new measurement. Clears any Error condition.	clr 7 or clr 703	CLEAR 7 or CLEAR 703
Remote	Permits selected devices to be set to remote operation, allowing parameters and device characteristics to be controlled by Bus Messages.	Causes counter to go to remote operation if REN is true and counter is addressed to listen. In absence of program data, remote operation is according to state of front panel settings just prior to going to remote. Locks out all push-pushbuttons except Local	rem 7 or rem 703	REMOTE 7 or REMOTE 703
Local	Causes selected devices to return to local (front panel) operation.	Goes to local front panel control. In absence of front panel data, local operation is according to the state of the remote data just prior to going to local. The following states are invoked; WA0, DR0, and SR0.	lcl 703	LOCAL 703
Local Lockout	Disables local (front panel) controls fo selected devices.	Disables front panel RESET. 5335A remains in remote.	llo 7	LOCAL LOCKOUT 7 or LOCAL LOCKOUT 703
Clear Lockout and Local	Returns all devices to local (front panel) control and simultaneously clears the Local Lockout Message.	Local Lockout cleared and returns to local front panel control.	lcl 7	LOCAL 7
Require Service	Indicates a device's need for interaction with the controller.	Used to flag an error or fail condition or indicate one of several instrument specific messages coded in status byte.	rds(703)→A if bit (7, A) (bit 7=1 if SRQ true)	STATUS 703; A
Status Byte	Presents status information of a particular device; one bit indicates whether or not the device currently requires service, the other 7 bits (optional) are used to indicate the type of service required.	Bit 7 is set if service is requested. Additionally, Bit 1, 2, 3, 4, 6, 7, or 8 may be set, indicating a specific instrument condition or status, see *Table 3-7*.		STATUS 703; A FOR I=7 TO 0 STEP - 1 PRINT I: BIT (A, I) NEXT I END (sample program prints status of Bits 1 through 8)
Status Bit	A single bit of device dependent status information which may be logically combined with status bit information from other devices by the controller.	Does not use	—	—
Pass Control	Passes bus controller responsibilities from the current controller to a device whic can assume the Bus supervisory role.	Does not use	—	—
Abort	Unconditionally terminates Bus communications and returns control to the system controller.	Clears Talk, Listen, Serial Poll Enable registers on 5335A HP-IB Interface. Front panel set-up does not change.	cli 7	ABORTIO 7

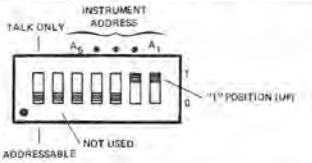
3-177. Address Selection

3-178. To use the 5335A in an HP-IB system, first set the rear panel address switches as shown in *Table 3-5*. The leftmost switch sets the counter to the ADDRESSABLE mode or the TALK ONLY mode. ADDRESSABLE mode is used whenever a calculator or other controller is used with the system. TALK ONLY mode is used when the counter is operating under its own control (no controller on bus) and outputs its measured result to another device on the bus, such as a printer.

3-179. The five righthand switches, A_5 through A_1, set the talk and listen addresses of the 5335A when it is used in the ADDRESSABLE mode. *Table 3-5* shows the possible address settings and the corresponding ASCII codes for talk and listen.

3-180. The examples listed in this section assume an address setting of 00011, which is a 5-bit binary code for the decimal number three. This number is important when using an HP 9825A, 9835A, or 9845A calculator, since the calculator addresses the 5335A to talk and listen by using the code 7Ø3. (The "Ø3" being the 5335A address.) The ASCII characters for this same switch setting are "C" for a talk address and "#" for a listen address. These characters are used when the computing controller is an HP 9830A calculator.

Table 3-5. HP-IB Address Switch Selections



NOTE

THE TALK ONLY SWITCH SHOULD BE CHANGED ONLY WHEN THE INSTRUMENT IS OFF.

ASCII CODE CHARACTER		ADDRESS SWITCHES					DECIMAL EQUIVALENT OF BINARY SWITCH SETTING
LISTEN	TALK	A_5	A_4	A_3	A_2	A_1	
SP	@	0	0	0	0	0	00
!	A	0	0	0	0	1	01
"	B	0	0	0	1	0	02
#	C	0	0	0	1	1	03
$	D	0	0	1	0	0	04
%	E	0	0	1	0	1	05
&	F	0	0	1	1	0	06
'	G	0	0	1	1	1	07
(	H	0	1	0	0	0	08
)	I	0	1	0	0	1	09
*	J	0	1	0	1	0	10
+	K	0	1	0	1	1	11
,	L	0	1	1	0	0	12
—	M	0	1	1	0	1	13
.	N	0	1	1	1	0	14
/	O	0	1	1	1	1	15
Ø	P	1	0	0	0	0	16
1	Q	1	0	0	0	1	17
2	R	1	0	0	1	0	18
3	S	1	0	0	1	1	19
4	T	1	0	1	0	0	20
5	U	1	0	1	0	1	21
6	V	1	0	1	1	0	22
7	W	1	0	1	1	1	23
8	X	1	1	0	0	0	24
9	Y	1	1	0	0	1	25
:	Z	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

3-181. Device Command Definitions

3-182. A device command is a sequence of two or more ASCII-coded bytes, sent to the 5335A over the HP-IB, that causes the counter to perform a specific function. Before discussing individual device commands, it is useful to classify these commands into five types:

1. **Numeric Command:** *Type N;* A sequence of two ASCII-coded bytes followed by a sequence of bytes representing a decimal number and a terminator. A terminator is either a comma, semicolon, space, carriage return, or line feed. A Termination may also be implied with the start of the next command. For a numeric command, the entry must follow the following format:

<N spaces> [sign] <J digits> [.<K digits>] [E [Sign] <L digits>]

where:

N=0 to any value
J=1 to 12
K=0 to 11
L=1 or 2

and:

J+K ≤12
Absolute value of number $<10^{10}$. If more than 12 digits are received, they are ignored.

The following commands are equivalent:

9825A	HP 85A
wrt 703, "RE, MS 123456"	OUTPUT 703; "RE, MS 123456"
wrt 703, ;"REMS+1.23456E+05"	OUTPUT 7,3;"REMS+1.23456E+05"
wrt 703, "RE, MS123.456E3"	OUTPUT 703; "RE, MS123.456E3"
	S = 123456
123456→A; wrt 703 "RE MS", A	OUTPUT 703; "RE MS", Scale
wrt 703, "RE, MS123.456E3"	OUTPUT 703; "RE, MS123.456E3"

2. **Binary Command:** *Type B;* A sequence of two ASCII-coded bytes followed by either a 0 or a 1. The 0 indicates the selected function if "OFF" or "FALSE", and the 1 (or any non-zero value) indicates "ON" or "TRUE". The binary command uses the same format as numeric commands. The following are binary commands:

wrt 703, "WA1"	TRUE	OUTPUT 703; "WA1"
wrt 703, "WA0"	FALSE	OUTPUT 7,3; "WA0"
wrt 703, "WA123"	TRUE	OUTPUT 703; "WA123"
		T = 1
1→A; wrt 703, "WA", A	TRUE	OUTPUT 703; "WA", True

3. **Integer Commands:** *Type I;* A sequence of two ASCII-coded bytes followed by a sequence of bytes representing a decimal number and a terminator. For integer commands, negative number are converted to their absolute values. If the number is outside the expected range, the parameter is converted to zero. The integer command uses the same format as numeric commands. The following commands are equivalent:

9825A	HP 85A
wrt 703, "CY2"	OUTPUT 703; "CY2"
wrt 703, "CY-2"	OUTPUT 703; "CY-2"
wrt 703, "CY 0.2E+1"	OUTPUT 703; "CY0.2E+1"

4. **Terse Commands:** *Type T;* A sequence of two ASCII-coded bytes not followed by a numeric or binary number. Requests a specific function or subroutine to be executed. For example, the characters "IN" will cause the counter to **IN**itialize all control settings to default status.

5. **Special Commands:** *Type *;* A sequence of two ASCII-coded bytes followed by a sequence of bytes representing some defined value. For example, the characters "MOD" will program the **M**ath **O**ffset to the value of the last **D**isplay.

3-183. PROGRAMMING 5335A OPTION 040

3-184. Option 040 enables signal conditioning controls, including trigger levels to be programmed remotely, via HP-IB. Programming is accomplished by addresssing the counter as a listener and sending it the desired device commands. *Table 3-6* shows the device commands for the Option 040 Programmable Input Amplifiers. The first section contains the standard device commands which remain unchanged, and the second section lists the added commands with Option 040.

3-185. Trigger Level Setting TR, AT, BT

3-186. The trigger levels may be set with a resolution of 10 mV over the ±5 volt range. The TR1 command may come at any time to put the trigger levels into remote. AT and BT preceed the programmed levels. An ERROR 1.1 will be displayed if a trigger level outside the specified rate (–5 to +5 volts) is programmed. The IN (Initialize) command does not affect the programmed trigger level values set by AT and BT.

NOTE

It is necessary to send the TR0 (TRIG REMOTE) command prior to an AU1 (AUTO TRIGGER) or AP1/BP1 (PRESET) command.

3-187. The 5335A DEVICE COMMANDS

3-188. Almost every control on the 5335A can be programmed via the HP-IB. Programming is accomplished by addressing the counter as a listener and sending it device commands. *Table 3-6* shows the complete set of device commands. The commands are organized into functional groups for ease of description and use.

Table 3-6. 5335A Device Commands

Command Group	Equivalent Key/Control	Description	Command Type	Device Command
	NOTE Bold print indicates the conditions set on power-up or initialization of the counter. Some of the Key/Controls are disabled or set to "off", as indicated in the Description column.			
MATH	**DISABLE**	**Disable Math group**	B	**MDØ**
		Enable Math group	B	MD1
	OFFSET	**Set OFFSET off**	N	**MOØ**
		Set OFFSET value	N	MO<#>
		Set OFFSET to last disp.	*	MOD
		Set OFFSET to $MEAS_{t-1}$	*	MOM
	NORMLZ	**Set NORMLZ off**	N	**MNØ**
		Set NORMLZ value	N	MN<#>
		Set NORMLZ to LAST Disp.	*	MND
		Set NORMLZ to $MEAS_{t-1}$	*	MNM
	SCALE	**Set SCALE off**	N	**MSØ**
		Set SCALE value	N	MS<#>
		Set SCALE to LAST Disp.	*	MSD
		Set SCALE to $MEAS_{t-1}$	*	MSM
STATISTIC	**N=100/1K**	**Set N=100**	B	**SNØ**
		Set N=1000	B	SN1
	STD DEV	**Disable Standard Deviation**	B	**SDØ**
		Enable Standard Deviation	B	SD1
	MEAN	**Disable Mean**	B	**SMØ**
		Enable Mean	B	SM1
	SMOOTH	**Disable Smooth**	B	**SSØ**
		Enable Smooth	B	SS1
	SPECIAL OUTPUT	**Special Output disable**	B	**SOØ**
		Special Output enable	B	SO1
FUNCTION	ALL FUNCT.	Select Function	I	FU<#>
			I	FN<#>
	FREQ A	**Standard Functions**		**FN1**
	TIME A→B			FN2
	TOT A			FN3
	RATIO A/B			FN4
	FREQ C			FN5
	1/TIME A→B			FN6
	PULSE A			FN7
	RATIO C/A			FN8
	PER A			FN9
	RISE/FALL A			FN10
	SLEW A			FN11
	DUTY CY A			FN12
	GATE TIME			FN13
	TRIG LVL			FN14
	VOLTS			FN15
	PHASE A rel B			FN16
	FREQ B	Special Functions		FN17
	TIME B→A			FN18
	TOT A-B			FN19
	PULSE B			FN20
	DIAGNOSTICS	See text		FN99

NOTE

An Error 1.0 will be displayed if an invalid HP IB Alpha command is sent to the 5335A.

An Error 1.1 will be displayed if an invalid HP-IB Numeric command is sent to the 5335A.

Table 3-6. 5335A Device Commands (Continued)

Command Group	Equivalent Key/Control	Description	Command Type	Device Command
GATE	GATE ADJ	Set GATE TIME 1 ms to one second	N	GA<#>
	GATE OPEN		T	GO
	GATE CLOSE		T	GC
	GATE MODE	**Set GATE MODE to NORM**	I	**GM0**
		Set GATE MODE to FAST	I	GM1
		Set GATE MODE to MIN	I	GM2
		Set GATE MODE to MANUAL	I	GM3
CYCLE	**CYCLE MODE**	**Set CYCLE to NORM**	I	**CY1**
		Set CYCLE to MIN	I	CY2
		Set CYCLE to SINGLE	I	CY3
INPUT	**SLOPE A**	**Set SLOPE A POSITIVE**	B	**AS0**
		Set SLOPE A NEGATIVE	B	AS1
	SLOPE B	**Set SLOPE B POSITIVE**	B	**BS0**
		Set SLOPE B NEGATIVE	B	BS1
	PRESET A	Set PRESET A off	B	AP0
		Set PRESET A on	B	**AP1**
	PRESET B	Set PRESET B off	B	BP0
		Set PRESET B on	B	**BP1**
	COM A	**Set COM A off**	B	**CO0**
		Set COM on	B	CO1
	AUTO TRIG	**Set AUTO TRIG off**	B	**AU0**
		Set AUTO TRIG on	B	AU1
REAR	**EXT START**	External START Arm Slope Positive	I	XA1
		External START Arm off	I	**XA2**
		External START arm Slope Negative	I	XA3
	EXT STOP	External STOP Arm Slope Positive	I	XO1
		External STOP Arm Off	I	**XO2**
		External STOP Arm Slope Negative	I	XO3
DISPLAY	**DISP REMOTE**	**Set display to NORMAL**	B	**DR0**
		Set Display to REMOTE (blank display)	B	DR1
	DISP DATA	Display data (with display in Remote)	N	DI<#>
BINARY	Request	Request 30 byte binary status	T	P?
		Request 30 byte binary status	T	PQ
	Program	Program with binary status	*	PB<*>
MISC	**Wait**	**WAIT to send mode off**	B	**WA0**
		WAIT to send mode on	B	WA1
	SRQ	**Service Request disabled**	B	**SR0**
		Service Request enabled	B	SR1
	INITIALIZE	Initialize everything to default	T	IN
	INTERPOLATOR	**Interpolator enable**	B	**ID0**
		Interpolator disabled	B	ID1
	RESET	Reset instrument for new measurement.	T	RE
	RANGE HOLD	**Set RANGE HOLD off**	B	**RH0**
		Set RANGE HOLD on	B	RH1
	EXT ARM EN	**Set EXT ARM EN off**	B	**XE0**
		Set EXT ARM EN on	B	XE1
	CHECK	Start CHECK*	T	CH

*When selecting the CHECK function via the HP-IB, the HP5335A must NOT be in the "GA" (Gate Adj) function or a "FAIL 4.4" will result.

Table 3-6. 5335A Device Commands (Continued)

OPTION 040 DEVICE COMMANDS				
COMMAND GROUP	**EQUIVALENT KEY/CONTROL**	**DESCRIPTION**	**COMMAND TYPE**	**DEVICE COMMAND**
INPUT	**SLOPE A**	**Set SLOPE A to POSITIVE**	B	**AS0**
		Set SLOPE A to NEGATIVE	B	AS1
	SLOPE B	**Set SLOPE B to POSITIVE**	B	**BS0**
		Set SLOPE B to NEGATIVE	B	BS1
	PRESET A	Set PRESET A off	B	AP0
		Set PRESET A on	B	**AP1**
	PRESET B	Set PRESET B off	B	BP0
		Set PRESET B on	B	**BP1**
	COM A	**Set COM A off**	B	**CO0**
		Set COM A on	B	CO1
	AUTO TRIG	**Set AUTO TRIG off**	B	**AU0**
		Set AUTO TRIG on	B	AU1
	X10 ATTN	**Set ATTN A to X1**	B	**AX0**
		Set ATTN A to X10	B	AX1
		Set ATTN B to X1	B	**BX0**
		Set ATTN B to X10	B	BX1
	FILTER	**Set FILTER A to off**	B	**AF0**
		Set FILTER A to on	B	AF1
		Set FILTER B to off	B	**BF0**
		Set FILTER B to on	B	BF1
	Z=50Ω	**Set A Z to 1 MΩ**	B	**AZ0**
		Set A Z to 50Ω	B	AZ1
		Set B Z to 1 MΩ	B	**BZ0**
		Set B Z to 50Ω	B	BZ1
	AC	**Set A to DC**	B	**AA0**
		Set A to AC	B	AA1
		Set B to DC	B	**BA0**
		Set B to AC	B	BA1
	TRIG ADJ	Set TRIGGER LEVEL A	N	AT<#>*
		Set TRIGGER LEVEL B	N	BT<#>*
	TRIG REMOTE	Set TRIGGER LEVELS to LOCAL	B	**TR0**
		Set TRIGGER LEVELS to REMOTE	B	TR1

*Where <#> is the trigger level value, from -5.00 to +5.00, programmed in the format: "AT(+/-)X.XX". For example, a plus two volt trigger level can be: "AT2", "AT2.", "AT+2.", "AT+2.0", or "AT+2.00".

3-189. Commands may be sent upper or lower case. To separate commands, you may use nothing at all or you may use any combination of spaces, commas, semicolons, carriage returns, and line feeds. Spaces are not allowed within a command name. At least one of the separation characters must follow the end of command strings. Usually this is the carriage return and line feed characters sent automatically by a write statement. For example, the command:

Controller	**9825A**	**85A**
Command	wrt 703, "RE"	OUTPUT 703; "RE"

addresses the counter as a listener and sends it the command to reset. The "wrt" (and OUTPUT) instruction automatically follows the "RE" with a carriage return and a line feed. The one exception to most of

these rules is binary programming, which uses the "wtb" (or WRITE BIN) instruction. For further information on binary programming refer to Learn Mode Programming, paragraph 3-181.

3-190. Function Selection FU, FN

3-191. This selects the function. Functions 1 through 16 are the normal functions found on the front panel. Functions above 16 are special functions (see Special Functions). These are provided to enhance system measurements. **FU99** accesses the diagnostic mode. Diagnostics are covered in Section VIII.

3-192. Gate Time Setting GA, GO, GC

3-193. This GA command is used to set the gate time remotely. The range of times is from about 1 ms to about one second. Resolution of the setting is about 2 ms, and accuracy is about 2% ±2 ms. For programmed gate times greater than one second, use GO and GC, to open and close the gate "manually":

Controller	9825A	HP 85A
Commands	wrt 703. "GO" wait 30000 wrt 703; "GC"	OUTPUT 703; "GO" WAIT 30,000 OUTPUT 703;"GC"

This can be useful for totalizing and for extremely long gate times.

NOTE

The 5335A makes no distinction between the GO and GC command. Each time either of these two are received the 5335A interprets it like the pressing of MANUAL Gate Mode key.

3-194. Remote Display DR0, DR1, DI

3-195. This command lets you write to the display remotely. When DR1 is sent, the display can be written to by the DI command. For example, the command:

9825A	HP 85A
wrt 703, "DR1, DI12345"	OUTPUT 703; "DR1, DI12345"

causes the number given by the DI command (12345) to be formatted into engineering notation and displayed. With the display in remote, normal measurements can still be programmed, executed and output through the HP-IB, but the results will not be displayed.

3-196. Default States

3-197. The default state is equivalent to sending all commands with a parameter of zero. This may be different from the power-up state for controls that are found on the rear panel and for the INPUT section on the standard front end, due to the use of detented not momentary, switches.

3-198. For integer type commands (Type I) the default states are as follows:

FUNCTION	(FU0 is ignored)			
CYCLE	CY0	equivalent to	CY1	NORM
EXT START	XA0	equivalent to	XA2	OFF
EXT STOP	XO0	equivalent to	XO2	OFF

3-199. Initialize

3-200. When INitialize is executed, the following states are NOT affected: DR, WA, SR, SO, AT & BT. The following states will be set:

CHAN A & B PRESET ... ON
CHAN A & B .....
SEP/COM ..... SEP
AUTO TRIG ..... OFF
EXT ARM ..... OFF
RANGE HOLD ..... OFF

FUNCTION ..... FREQ A
MATH ..... OFF
STATISTICS ..... OFF
GATE MODE ..... NORM
CYCLE MODE ..... NORM
CHAN A & B 1MΩ
CHAN A & B X1/X10 ... X1
CHAN A & B AC ..... DC
} Option 040

NOTE

Do not initialize ("IN") the counter when the display is in remote ("DR1"). Whenever the display is in remote, follow the initialize command with "FU1" (or any other function command). For example: wrt "5335A", "IN, FU1, DR1".

3-201. Learn Mode Programming P?, PQ, PB

3-202. The front panel can be used as the medium to tell the controller how to program the counter. This is commonly referred to as Learn Mode programming, or Binary Programming.

3-203. With the instrument in Local, the user is allowed to set up the controls in the MATH, STATISTICS, FUNCTION, GATE MODE and cycle groups in any way desired. The controller then sends a PQ command and follows this by receiving 30 bytes of binary program data. Later, when the set up is to be duplicated by the controller, the instrument is sent PB followed by the same 30 bytes of binary data.

3-204. If the data contained in the OFFSET, NORMLZ, and SCALE registers is not needed, the 30 bytes can be shortened to just 7 bytes, thus speeding the programming time. Refer to the Programming Examples beginning with paragraph 3-227.

3-205. SRQ and Status SR

3-206. The 5335A has the ability to send a request service (SRQ) message. To enable this feature, the controller must send the SR1 command.

3-207. Request service may be sent upon any error or fail message, and may be sent at the end of a measurement. When request service is sent the seventh bit (bit 7) is set. In addition to this bit, one other bit is also set, representing the status or type of service requested. If service request is not enabled, this second bit is still set, even though bit 7 is not. *Table 3-7* gives the effect of each of the status bits on the service request message. When SRQ is asserted, the 5335A will turn on the "SRQ" annunciator.

3-208. The 5335A will only send SRQ if a measurement is ready for sending, and it is in the WAIT mode, and it is not addressed to TALK or RFD is false.

SRQ if: (Measurement done) AND (in WAIT mode) AND [(if not addressed to TALK) or (RFD is false)]

NOTE

Constant reading of the status byte is not recommended. This may slow down the measurement processor time.

3-209. Program Execution/Response Times

3-210. Program speed is dependent upon the 5335A HP-IB response time. *Table 3-8* provides some NOMINAL response times for various types of commands, using the 9825A calculator. The examples use the "wrt" instruction. Times are rounded up to 5 ms resolution.

3-211. Output Format

3-212. After a measurement, the 5335A outputs the data to the HP-IB. The output byte contains 19 characters which are arranged in the following format:

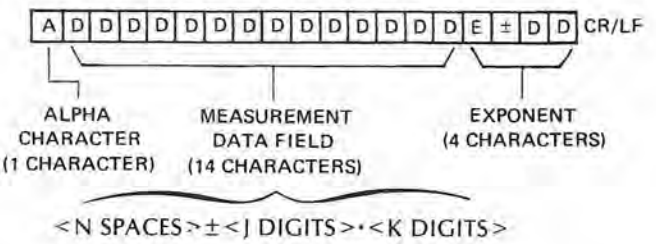


Table 3-7. Status Bits Usage with SRQ

Bit Weight	SR Status Bits	Usage
1	BIT 1 (LSB)	Set when measurement is done; and 1) 5335A is in WAIT mode and it is not yet addressed to talk, or 2) 5335A is in WAIT mode and is addressed to talk, but listening device on bus is not yet ready for data (RFD is false).
2	BIT 2	Set when external time base used.
4	BIT 3	Set if an ERROR has happened.
8	BIT 4	Set if a FAIL has happened.
32	BIT 6	Set when GATE is open.
64	BIT 7	Set if requesting service.
128	BIT 8	Set if in diagnostic monitor

Table 3-8. HP-IB Response Times

Command Mode	Device Command Code	Nominal Response Time
Function Select	FU1	50 ms
	NOTE	
	For RISE/FALL A, SLEW A, and PHASE allow for AUTO TRIG response time).	
Math Set	MS-123456789e-9	75 ms
	MD1	45 ms
Statistics Set	SN1	45 ms
	SD1	45 ms
	SM1	45 ms
	SS1	45 ms
Reset	RE	30 ms
Range Hold	RH1	45 ms
Ext Arm Enable	XE1	45 ms
	XA2	45 ms
Gate Set	GM1	45 ms
	GA 29.111	60 ms
Cycle Set	CY1	45 ms
Input Set	AS1 and AP1	45 ms
	CO1	45 ms
	AU1	45 ms
Display	DR1	25 ms
	DI-123456789e-9	70 ms
	DRØ	45 ms
Initialize	IN	30 ms
Miscellaneous	WA1	45 ms
	SR1	45 ms
	clr (HP-IB clear)	240 ms
	trg (HP-IB trigger)	30 ms
	rds (HP-IB read status)	30 ms
Program Binary	P?	30 ms
	PB (30 bytes)	90 ms
	PB (7 bytes)	40 ms

3-213. ALPHABET CHARACTER. One of eight single characters which specify the type of measurement. It is generally used to indicate the type of units. The alpha characters are:

F - precedes Frequency measurements; units of Hz (Hertz)

S - precedes Time measurement; units of s (seconds)

V - precedes Voltage measurements; units of V (Volts)

R - precedes Ratio measurement; no units

T - precedes Totalize measurements; no units

sp - precedes 1/TIME, DUTY CYCLE, PHASE; units as specified

A - precedes A Channel TRIG LVL; units of V (Volts)

B - precedes B Channel TRIG LVL; units of V (Volts)

M - precedes MEAN output with SO1

N - precedes MIN output with SO1

X - precedes MAX output with SO1

NOTE

For Trigger Level, two complete 19 character output bytes are sent in succession. Each Channel requires a complete output sequence.

3-214. MEASUREMENT DATA FIELD. The data field consists of a 14-character string. The number begins with the sign (+ or –), followed by the digits in descending order or significance. The number,

however, is right-justified within the data field. To keep the number of characters constant within the total string, spaces (up to 10) will be inserted preceding the sign.

3-215. EXPONENT. Preceded by an "E" and the sign (+ or –), the exponent will be a multiple of 3, similar to the display which is in scientific format. On some occasions, it is possible that the format of the HP-IB output and the display will differ. Nonsignificant zeros in the display are converted to real zeros, and the output is such that there is always a significant digit left of the decimal point.

3-216. The following string illustrates a typical output byte for a FREQ A measurement of 12.3456789 MHz. The output byte is followed by a (CR) carriage return and a (LF) line feed.

F (sp) (sp) +1 2 . 3 4 5 6 7 8 9 0 E + 0 6 (CR) (LF)

NOTE

The Data Output Rate for a complete output string consisting of 19 characters plus a CR and LF is typically 8 ms.

3-217. Output Modes

3-218. The 5335A powers up with the following output modes: WAØ, SRØ, SOØ.

3-219. When the Wait to be Addressed mode is OFF (WAØ) the 5335A will output only if it is addressed to talk and RFD is true and measurement data is ready. If at the end of a measurement the 5335A finds that it is NOT addressed to talk or that RFD is false the measurement data is not sent and a new measurement is started.

3-220. When the Wait to be Addressed mode is ON (WA1) the 5335A will wait to be addressed and for RFD to be true. In this mode, new measurements are not started until the data from the previous measurement is sent, or if a command is sent.

3-221. The Wait to be Addressed mode must be active if you want an SRQ generated at the end of the measurement. Status Bit 1 can be used to monitor the 5335A for the end of measurement occurrence. This bit is effective only if the WAIT mode is ON.

3-222. When receiving trigger level data it is recommended that the WAIT mode be ON. This will assure no loss of data. However, the TRIG LVL function is unique in that it does not show a display until *after* it outputs to the HP-IB. Therefore, the WAIT mode should be turned OFF if you want the display to update.

3-223. Output of Statistics

3-224. For measurements using statistics the individual measurements are not sent out. Only the result of the statistical calculation is output. The prefix alpha character will be the same as the normal measurement.

3-225. The Special Output command "SO" can be sent to tell the 5335A to send additional secondary data when statistics are enabled:

- When STD DEV is on and SO1 has been sent the following data is given in two complete strings:

  STD DEV
  MEAN (of the same sample, preceded with the letter "M")

- When MEAN is on and SO1 has been sent the following data is given in three complete strings:

  MEAN
  MIN (of the same sample, preceded with the letter "N")
  MAX (of the same sample, preceded with the letter "X")

NOTE

Secondary statistical data will wait for RFD to be true if the listening device is not able to receive the data immediately.

3-226. PROGRAMMING ANOMALIES

3-227. The following items describe particular programming requirements or operations which are normal conditions, but may not be obvious or expected by the user.

- When programming Option 040, the use of REMOTE TRIGGER LEVELS and the AUTO TRIGGER mode are mutually exclusive. Sending a "TR1" (Set TRIGGER LEVELS to REMOTE) effectively prevents (or disables) the "AU1" (AUTO TRIGGER) mode from being invoked. If REMOTE TRIGGER LEVELS ("TR1") is active, and the AUTO TRIGGER ("AU1") command is sent, the AUTO TRIG key indicator will light, but the AUTO TRIG-

GER mode will not be activated. To invoke the AUTO TRIGGER mode, from the TRIGGER LEVEL REMOTE mode, the "TR0" command (Set TRIGGER LEVELS to LOCAL) must be sent first.

- When Input A has been programmed to 50Ω and Input B has not (B defaults to 1 MΩ), sending a "CO1" (COMA) command will set Input B to 50Ω also. However, if a "CO0" (SEP) command is then sent, Input B will remain in the 50Ω setting. This is also true for Channel B's AC/DC coupling and X10/X1 attenuator.

- After a "DR1" (DISP REMOTE) command, if an "IN" (INITIALIZE) command is sent it must be followed by a "FN<#>" (FUNCTION) command, or the counter will appear to hang up or freeze the display.

- The INPUT B SLOPE key indicator does not correctly reflect the slope of the B channel input during functions where the INPUT A slope controls both channels.

3-228. PROGRAMMING EXAMPLES

3-229. The following HP-IB programming examples are provided for information and illustration only. Sample programs are provided for both 9825A and HP 85 Computing Controllers, and assume a 5335A address of decimal "3".

EXAMPLE 1. A) TYPICAL MEASUREMENT FORMAT

This program first dimensions a string variable in the controller for the incoming data and then sets the 5335A to its default mode (Initialize) with a gate time of 500 ms (.5 seconds). The counter will then make a simple Frequency A measurement. In step 2 the controller will read the measurement into string A, and then step 3 displays the information. After waiting for 1 second (1000 milliseconds), the program loops back into reading a "new measurement" and the cycle is repeated.

9825A EXAMPLE

```
0: dim A$[21]
1: wrt 703,"in,ga.5"
2: red 703,A$
3: dsp A$
4: wait 1000
5: gto -3
6: end
*24362
```

HP 85 EXAMPLE

```
10 DIM A$[21]
20 OUTPUT 703 ;"in,ga.5"
30 ENTER 703 ; A$
40 DISP A$
50 WAIT 1000
60 GOTO 30
70 END
```

EXAMPLE 1. B) TYPICAL MEASUREMENT FORMAT

This is an example of how the controller can be used to display a measurement once every 5 seconds. After a measurement is accepted in step 2, the HP-IBs RFD (Ready For Data) line is held false until another read instruction is executed. This means that during the wait statement in step 4, the RFD line is false. The 5335A will check the RFD line whenever it is addressed to talk to make sure that the listening device is ready for data. If it finds RFD false and the wait mode is off, the counter will skip trying to output the data and start a new measurement.

In this example the 5335A will continue to make measurements without sending data until five seconds have passed. After five seconds, the next measurement that comes is sent.

Note that this check of the RFD line is done for the first character of a measurement data string only. Subsequent characters are sent normally.

9825A EXAMPLE

```
0: dim A$[21]
1: wrt 703,"in"
2: red 703,A$
3: dsp A$
4: wait 5000
5: gto -3
6: end
*12686
```

HP 85A EXAMPLE

```
10 DIM A$[21]
20 OUTPUT 703 ;"in"
30 ENTER 703 ; A$
40 DISP A$
50 WAIT 5000
60 GOTO 30
70 END
```

EXAMPLE 2. WAIT MODE

The wa1 command tells the 5335A to wait at the end of each measurement to output data, even if not presently addressed to talk. During the 5 second wait period in step 4 if a measurement ends the counter will wait until it can send its data before starting the next measurement.

Note that if the gate time of the measurement is very short, the data that gets displayed in this example is about 5 seconds old.

9825A EXAMPLE

```
0: dim A$[21]
1: wrt 703,"in,wa1"
2: red 703,A$
3: dsp A$
4: wait 5000
5: gto -3
6: end
*22874
```

HP 85 EXAMPLE

```
10 DIM A$[21]
20 OUTPUT 703 ;"in,wa1"
30 ENTER 703 ; A$
40 DISP A$
50 WAIT 5000
60 GOTO 30
70 END
```

EXAMPLE 3. TIME INTERVAL AND PULSE WIDTH

This program will set the 5335A for a Time Interval measurement (fu2), com A (co1) and channel B slope to negative (bs1), in step 0. Step 1 causes the counter to read into the simple variable A and step 2 sets up the controller for a specific floating format. Step 3 displays the contents of the simple variable A; format: "T.I.= _____s". After waiting for 3 seconds in step 4, the controller will set up the 5335A for a Pulse A measurement (fu7) in step 5. In step 6, the 5335A will read into the simple variable B. Step 7 will display the contents of variable B formatted as follows: "PULSE A=_____s". Following 3 seconds of waiting, the whole process is repeated.

9825A EXAMPLE

```
0: wrt 703,"in,fu2,co1,bs1"
1: red 703,A
2: flt 5
3: dsp "T.I.=",A,"sec."
4: wait 3000
5: wrt 703,"infu7"
6: red 703,B
7: dsp "PULSE A=",B,"sec."
8: wait 3000
9: gto 0
10: end
*6527
```

HP 85 EXAMPLE

```
10 CLEAR @ DISP USING "4/"
30 OUTPUT 703 ;"in,fu2,co1,bs1"
50 WAIT 100
70 ENTER 703 ; A
90 IMAGE "T.I.= ",D.4DE," sec."
110 DISP USING 90 ; A @ DISP
130 WAIT 1000
150 OUTPUT 703 ;"infu7"
170 ENTER 703 ; B
190 IMAGE "PULSE A= ",D.4DE," sec."
210 DISP USING 190 ; B
230 WAIT 2000
240 GOTO 10
250 END
```

EXAMPLE 4. RISE/FALL TIME AND SLEW RATE

In this example, step 0 sets the 5335A for Rise Time (in, fu10). After a pause of 3 seconds in step 1, (this pause is recommended to allow the Auto trigger circuitry to settle down). Step 2 will force the counter to read into simple variable A. Step 3 sets up the 9825A for a given floating format. In step 4, the 9825A will display: "RISE TIME=_____s.", showing the contents of simple register A. The controller sets up the counter for Positive Slew Rate A (fu11) in step 6, and in step 7, the 5335A reads into simple variable B. In step 8 the controller will display: "POS. SLEW RATE=_____V/S"

showing the contents of variable B. The controller sets up the counter for Fall Time (fu10 as 1) and waits for 3 seconds in steps 9 and 10. In step 11, the information from the 5335A is read into the simple variable A. The controller will display: "FALL TIME=_____s." and the contents of variable A in step 12. The 5335A is set up for a Negative Slew Rate A in step 14, and the controller reads this information into variable B in step 15; then the 9825A will show the contents of B along with the display: "NEG. SLEW RATE=_____V/S" in step 16, after which the whole process is repeated.

9825A EXAMPLE

```
0: wrt 703,"in,fu10"
1: wait 3000
2: red 703,A
3: flt 5
4: dsp "RISE TIME=",A,"sec."
5: wait 2000
6: wrt 703,"infu11"
7: red 703,B
8: dsp "POS. SLEW RATE=",B,"V/s"
9: wrt 703,"fu10,as1"
10: wait 3000
11: red 703,A
12: dsp "FALL TIME=",A,"sec."
13: wait 2000
14: wrt 703,"fu11"
15: red 703,B
16: dsp "NEG. SLEW RATE=",B,"V/s"
17: gto 0
18: end
*28502
```

HP 85 EXAMPLE

```
10 CLEAR @ OUTPUT 703 ;"in,fu10"
20 WAIT 3000
30 ENTER 703 ; A
40 IMAGE "RISE TIME= ",D.4DE," sec."
50 DISP USING 40 ; A @ DISP
60 WAIT 2000
70 OUTPUT 703 ;"infu11"
80 ENTER 703 ; B
85 IMAGE "POS. SLEW RATE= ",D.2DE," V/sec."
90 DISP USING 85 ; B @ DISP
100 OUTPUT 703 ;"fu10,as1"
110 WAIT 3000
120 ENTER 703 ; A
125 IMAGE "FALL TIME= ",D.4DE," sec."
130 DISP USING 125 ; A @ DISP
140 WAIT 2000
150 OUTPUT 703 ;"fu11"
160 ENTER 703 ; B
165 IMAGE "NEG. SLEW RATE= ",D.2DE," V/sec."
170 DISP USING 165 ; B
175 WAIT 2000
180 GOTO 10
190 END
```

EXAMPLE 5. DUTY CYCLE

This program will set up the 5335A for a Duty Cycle measurement (positive portion of waveform, in fu12) in step 0; then , in step 2, forces the counter to read into simple variable A. Step 3 displays the contents of variable A, format: "'UP' Duty Cycle=_____%" and maintains the display for 3 seconds (step 4). In step 5, the 5335A is programmed for a Duty Cycle measurement of the negative portion of the waveform (as1) and in step 7, the 9825A will display: "'DOWN' Duty Cycle=_____%"; after waiting for 3 seconds, the total cycle is repeated.

9825A EXAMPLE

```
0: wrt 703,"in,fu12"
1: fxd 4
2: red 703,A
3: dsp "'UP' Duty Cycle=",A,"%"
4: wait 3000
5: wrt 703,"as1"
6: red 703,B
7: dsp "'DOWN' Duty Cycle=",B,"%"
8: wait 3000
9: gto 0
10: end
*8772
```

HP 85 EXAMPLE

```
10 CLEAR @ DISP USING "4/"
20 OUTPUT 703 ;"in,fu12"
30 IMAGE "'UP' Duty Cycle= ",2D.2D," %"
40 ENTER 703 ; A
50 DISP USING 30 ; A @ DISP
60 WAIT 3000
70 OUTPUT 703 ;"as1"
80 ENTER 703 ; B
90 IMAGE "'DOWN' Duty Cycle= ",2D.2D," %"
100 DISP USING 90 ; B @ DISP
110 WAIT 3000
120 GOTO 10
130 END
```

EXAMPLE 6. MATH PROGRAMMING EXAMPLE

To demonstrate the 5335A flexibility in mathematical manipulations, apply a signal to INPUT A of different frequencies. Step 2 will request the Offset, Normalize, and Scale factors which are used to program the 5335A in step 3. The manipulated measurement is read into string variable A (step 4). Steps 5 through 10 will print the Offset, Normalize, and Scale factors, respectively; steps 11 and 12 will print the final result.

9825A EXAMPLE

```
0: dim A$[21]
1: fxd 0
2: ent "OFFSET ?",O,"NORMALIZE ?",N,"SCALE ?",S
3: wrt 703,"in,mo",O,"mn",N,"ms",S
4: red 703,A$
5: prt "OFFSET=",O
6: spc
7: prt "NORMALIZE=",N
8: spc
9: prt "SCALE=",S
10: spc 2
11: wrt 16,"RESULT="
12: wrt 16,A$[1,1],A$[5,19]
13: end
*25419
```

9825A PRINTED RESULTS:

```
OFFSET=    100000

NORMALIZE=     50

SCALE=         25


RESULT=
F+50.5014734E+03
```

HP 85 EXAMPLE

```
10 DIM A$[21]
20 CLEAR
30 IMAGE "OFFSET=",6D.3D
40 IMAGE "NORMALIZE=",6D.3D
50 IMAGE "SCALE=",6D.3D
60 DISP "ENTER OFFSET FACTOR ?" @ INPUT O@ DISP
70 DISP "ENTER NORMALIZE FACTOR ?" @ INPUT N@ DISP
80 DISP "ENTER SCALE FACTOR ?" @ INPUT S
90 CLEAR @ DISP USING "4/"
100 OUTPUT 703 ;"in,mo";O;"mn";N;"ms";S
110 ENTER 703 ; A$
120 DISP USING 30 ; O @ DISP
130 DISP USING 40 ; N @ DISP
140 DISP USING 50 ; S @ DISP
150 DISP "RESULT=     ";A$[1,1];A$[5,19]
160 END
```

EXAMPLE 7. REMOTE DISPLAY

This program will set up the 5335A for the remote display function, to acquire a measurement, modify and format the measurement into engineering notation, and send the result to the display of the counter.

Step 0 programs the counter for Frequency A and Remote Display (fu1 dr1); the unmodified measurement then is read into simple variable A in step 1. This measurement is modified and stored in variable B (step 2), then sent to the 5335A display in step 3. The cycle is again repeated in step 4.

9825A EXAMPLE

```
0: wrt 703,"fu1dr1"
1: red 703,A
2: A+1e6 → B
3: wrt 703,"di",B
4: gto 1
5: end
*27213
```

HP 85 EXAMPLE

```
10 OUTPUT 703 ;"fu1dr1"
20 ENTER 703 ; A
30 B=A+1000000
40 OUTPUT 703 ;"di";B
45 WAIT 2000
50 GOTO 10
60 END
```

EXAMPLE 8. TEACH—LEARN

The following program serves as an example of the TEACH—mode (Binary Program mode). It will allow you to manually set-up the 5335A front panel, after which the 9825A will read into column matrix A, 30 bytes of binary programming data (steps 4 through 7), after which the controller will beep indicating the end of data transfer. (Information recorded: MATH, STATISTICS, FUNCTION, GATE MODE and CYCLE). Then the controller will allow the user to change the front panel settings of the counter (steps 10 and 11). Also, it will allow the user to suppress the MATH information and thereby speeding up the transfer of data (steps 12, 13, and 14). Note however, that the OFFSET, NORMALIZE and SCALE LED will be ON although no information was transferred into their registers. In step 15 the controller will transfer all 30 bytes of binary programming data that it recorded earlier, to the 5335A; at the end of data transfer, the controller will beep twice. The counter is returned to local control in step 19, completing the exercise.

9825A EXAMPLE

Press CONTINUE TO RESUME

0 = SHORT DATA TRANSFER
1 = LONG DATA TRANSFER

```
0: dim A[30]
1: lcl 703
2: dsp "Manually set-up 5335A controls"
3: stp
4: wrt 703,"pq"
5: for I=1 to 30
6: rdb(703)}A[I]
7: next I
8: beep
9: lcl 703
10: dsp "Now, change the 5335A controls"
11: stp
12: ent "Do you need MATH functions ?",B
13: if B;gto "LONG"
14: wtb 703,"pb"
15: wtb 703,A[1],A[2],A[3],A[4],A[5],A[6],255
```

EXAMPLE 8 (Continued)

9825A EXAMPLE (Continued)

```
16: beep
17: wait 500
18: beep
19: gto 27
20: "LONG":wtb 703,"pb"
21: for I=1 to 30
22: wtb 703,AII
23: next I
24: beep
25: wait 500
26: beep
27: lcl 703
28: end
*28738
```

HP 85 EXAMPLE

```
10 DIM A$[30]
20 LOCAL 703
30 CLEAR @ DISP "MANUALLY SET-UP 5335A CONTROLS. PRESS 'CONT' WHEN READY."
40 PAUSE
50 OUTPUT 703 ;"pq"
60 ENTER 703 USING "#,30A" ; A$
61 LOCAL 703
62 BEEP
80 DISP "NOW, CHANGE THE 5335A CONTROLS. PRESS 'CONT' WHEN READY."
90 PAUSE
100 DISP "DO YOU NEED MATH FUNCTIONS      (Y=1 ,'N=0) ";
105 INPUT B
110 IF B<0 OR B>1 THEN 100
115 IF B THEN 170
120 OUTPUT 703 USING "#,2A,6A,B" ; "pb",A$,255
130 BEEP
140 WAIT 500
150 BEEP
160 GOTO 210
170 OUTPUT 703 USING "#,2A,30A" ; "pb",A$
180 BEEP
190 WAIT 500
200 BEEP
210 LOCAL 703
220 END
```

EXAMPLE 9. STATISTICS OUTPUT EXAMPLE

This is an example of the use of Statistic Output Format. The controller will request from the user the sample size, either 100 or 1000 (step 1); it will then program the 5335A for a Frequency A measurement with the selected sample size, and special statistics output for MEAN computation (SM1, SO1) in step 2. Step 3 causes the counter to read into the three string variables; the contents of the strings with appropriate leader information will be printed in steps 4 through 10.

The controller will then set up the 5335A for a Standard Deviation measurement and it will store the result in the two string variables (step 11); in steps 12 through 25, the 9825A will print the contents of the variables with appropriate identification.

9825A EXAMPLE

```
0: dim A$[21],B$[21],C$[21]
1: ent "Sample size: 100/1000 (N=0/1) ?",N
2: wrt 703,"insn",N,"sm1,so1"
3: red 703,A$,B$,C$
4: prt "FRECUENCY A"
5: prt "STATISTICS"
6: spc 2
7: prt "MEAN="
8: wrt 16,A$[1,1],A$[5,19]
9: spc
10: prt "MIN="
11: wrt 16,B$[1,1],B$[5,19]
12: spc
13: prt "MAX="
14: wrt 16,C$[1,1],C$[5,19]
15: spc 3
16: beep
17: wrt 703,"sd1"
18: red 703,A$,B$
19: prt "STANDARD DEV.="
20: wrt 16,A$[1,1],A$[5,19]
21: spc
22: prt "MEAN="
23: wrt 16,B$[1,1],B$[5,19]
24: spc 3
25: beep
26: lcl 703
27: end
*32154
```

EXAMPLE 9 (Continued)

9825A PRINTED RESULTS:

```
FREQUENCY A
STATICTICS


MEAN=
F+107.009501E+03

MIN=
N+106.999793E+03

MAX=
X+107.018802E+03


STANDARD DEV.=
F       +3.34E+00

MEAN=
M   +107.0020E+03
```

HP 85 EXAMPLE

```
10 DIM A$[21],B$[21],C$[21]
20 CLEAR @ DISP "Sample size: 100/1000 (N=0/1)  ";
25 INPUT N
30 OUTPUT 703 ;"insn";N;"sm1,so1"
40 ENTER 703 ; A$,B$,C$
50 CLEAR @ DISP "**  FREQUENCY  A  STATISTICS  **"
70 DISP USING "2/"
80 DISP "   MEAN= ";A$ @ DISP
110 DISP "    MIN= ";B$ @ DISP
140 DISP "    MAX= ";C$
160 DISP USING "3/"
161 BEEP
170 OUTPUT 703 ;"sd1"
180 ENTER 703 ; A$,B$
190 DISP "STD. DEV.= ";A$ @ DISP
220 DISP "     MEAN= ";B$
270 BEEP
280 LOCAL 703
290 END
```

EXAMPLE 10. HIGH SPEED MEASUREMENT (COMPUTER DUMP)

This following program will illustrate how the 5335A can be set-up to perform a high speed transfer of data with the 9825A controller. Line 2 specifies a "fast read-write buffer" labeled "SJ", allocating 2100 bytes of memory. Line 3 initializes the 5335A for a measurement; the buffer is cleared in line 4. In line 5, 100 measurements are transferred directly into buffer "SJ" from the counter; line 6 checks for a completed transfer of data, after which, the controller will beep.

The 9825A will, in lines 8 through 10, remove 21 bytes at a time from buffer "SJ" and store them temporarily in A$, display this information as well as the measurement number; this operation is performed N times.

9825A EXAMPLE

```
0: dim A$[21]
1: 100→N
2: buf "SJ",21*N,3
3: wrt 703,"in,gm2,cy2"
4: buf "SJ"
5: tfr 703,"SJ",N*21
6: if rds("SJ")=-1;jmp 0
7: beep
8: for X=1 to N
9: red "SJ",A$
10: fxd 0
11: dsp A$,X
12: wait 500
13: next X
14: beep
15: end
*5418
```

HP 85 EXAMPLE

```
10 IMAGE 3D,7X,19A
50 DIM A$[19],B$[2108]
70 OUTPUT 703 ;"in,gm2,cy2"
90 IOBUFFER B$
110 TRANSFER 703 TO B$ FHS
130 BEEP 175,150
150 FOR X=1 TO 100
160 ENTER B$ ; A$
170 CLEAR @ DISP USING "5/"
176 DISP USING 10 ; X;A$
178 WAIT 500
180 NEXT X
190 BEEP 175,150
250 END
```

EXAMPLE 11. SERVICE REQUEST and WAIT

The following program serves as an example of the SRQ (Service Request) feature in the 5335A. As the controller is executing each program line, it logs in the interrupt request and assigns it a priority; the 9825A will finish the current line and then branch to the service routine (End of Line branching—EOL). Once the service routine is completed (by executing its "iret" statement), the main program pointer will return to the following line from where the interrupt occurred. Line 1 sets up the 5335A into the WAIT mode and enables the sending of SRQ at the end of a measurement; line 2 specifies where to go when the 9825A receives a SRQ, and line 3 enables the use of SRQ. Line 4 simply loops, doing nothing. Lines 5 through 8 are executed whenever an SRQ from the counter is received, measurement data is then read and the counter is reset.

9825A EXAMPLE

```
0: dim A$[21]
1: wrt 703,"wa1,sr1"
2: oni 7,"SRQ"
3: eir 7
4: gto 3
5: "SRQ":
6: if bit(6,rds(703))
7: red 703,A$
8: dsp A$
9: wrt 703,"re"
10: iret
11: end
*2714
```

HP 85 EXAMPLE

```
10 DIM A$[21]
20 OUTPUT 703 ;"wa1,sr1"
30 ON INTR 7 GOTO 60
40 ENABLE INTR 7;8
50 WAIT 100
60 STATUS 7,1 ; T
70 IF T<>8 THEN 60
80 ENTER 703 ; A$
90 CLEAR @ DISP A$
100 OUTPUT 703 ;"re"
110 END
```

EXAMPLE 12. TRIGGER LEVEL

In this example, the controller will set up the counter for trigger Level function (fu14) in step 1; then the 5335A will read into two string variables A$ and B$ in step 2 (two complete 19-character sets are sent out in succession, one for each channel). Steps 3 and 4 will display the contents of the string variables; the whole process is repeated in step 5.

9825A EXAMPLE

```
0: dim A$[211,B$[21]
1: wrt 703,"fu14"
2: red 703,A$,B$
3: dsp "TRIGGER LEVEL A=",A$[11,19];wait 3000
4: dsp "TRIGGER LEVEL B=",B$[11,19];wait 3000
5: gto 1
6: end
*28390
```

HP 85 EXAMPLE

```
10 DIM A$[21],B$[21]
20 OUTPUT 703 ;"wa1,fu14"
30 ENTER 703 ; A$,B$
35 CLEAR @ DISP USING "3/"
40 DISP "TRIGGER LEVEL A=      ";A$[11,19]
41 DISP USING "3/"
50 DISP "TRIGGER LEVEL B=      ";B$[11,19]
60 END
```

3-230. Trigger Level Programming Example (Option 040)

3-231. The following HP-IB programming example is provided for information and illustration only. Sample programs are provided for both 9825A and HP 85A Controllers, and assume a 5335A address of decimal "28".

EXAMPLE 13. TRIGGER LEVEL PROGRAMMING

The following program sets up a time interval measurement for a triangular waveform with an amplitude of 2V p-p. The program loops through two measurements, with different trigger level settings, which results in different time measurements. The instrument is labeled "SJ", and a value of 0.2 is input into "V". The 5335A is initialized ("in"), set to TIME A→B ("fu2"), with COM A ("co1"), B SLOPE Negative ("bs1"), and Trigger Levels to Remote ("tr1"). Both channel trigger levels ("at" and "bt") are set to "V" (V=0.2V). The resultant Time Interval measurement is read into "A", and displayed as "T.I.= _____ Sec". The value of "V" is changed to 0.9 ("V+.7→V"). After a two second wait, the string command is sent again, with the new value for "V" programmed into both channel trigger levels. The second measurement is read into "A" and displayed. After a two second wait, the program loops to the beginning and starts again.

9825A EXAMPLE

```
0: dev "SJ",728;flt 2
1: .2→V
2: wrt "SJ","in,fu2,col,bsl,trl,at",V,"bt",V
3: red "SJ",A
4: dsp "T.I.=",A,"Sec"
5: V+.7→V
6: wait 2000
7: wrt "SJ","in,fu2,col,bsl,trl,at",V,"bt",V
8: red "SJ",A
9: dsp "T.I.=",A,"Sec"
10: wait 2000
11: gto 1
12: end
*24043
```

HP 85 EXAMPLE

```
10 IMAGE 3 X,"T.I.=   ",MD.2DE," Sec."
20 S=703
30 V=.2
40 OUTPUT S ;"in,fu2,co1,bs1,tr1,at",V,"bt",V
50 ENTER S ; A
60 CLEAR @ DISP USING 10 ; A
70 DISP
80 V=V+.7
90 WAIT 2000
100 OUTPUT S ;"in,fu2,co1,bs1,tr1,at",V,"bt",V
110 ENTER S ; A
120 DISP USING 10 ; A
130 DISP
140 WAIT 2000
150 GOTO 30
160 END
```

3-232. OPTIONS

3-233. The operating characteristics of the 5335A are affected by the addition of any of the options described in the following paragraphs.

3-234. Time Base Option 010

3-235. Option 010 provides an Oven-Controlled Crystal Oscillator Time Base, that results in higher accuracy and longer periods between calibration (refer to *Table 1-1*). The oven temperature is maintained when the 5335A LINE switch is in either the ON or the STBY position (provided the instrument is connected to the power mains).

NOTE

The Option 010 Oven-Controlled-Oscillator, HP Model 10811A, is a direct replacement for the previous HP Model 10544A. Service documentation for the *older* 10544A is provided in Section VIII under Assembly A12 Oven Oscillator. All service documentation for the newer HP 10811A is provided in the HP 10811A Operating and Service Manual included with Option 010.

3-236. Digital Voltmeter Option 020

3-237. Option 020 provides a fully floating, autoranging digital voltmeter. This module measures dc inputs up to 1000 volts through front panel connectors. Refer to Specifications, *Table 1-1*, for the specific operating characteristics.

3-238. C Channel Option 030

3-239. Option 030 provides a C Channel Input Module, which expands the frequency counting range of the counter to 1.3 GHz. A front panel control adjusts the input sensitivity. A front panel preamp power receptacle is provided. Refer to Specifications, *Table 1-1*, for the specific operating characteristics.

3-240. Programmable Input Option 040

3-241. The programmable input amplifiers, Option 040, have relay-controlled and fully programmable (through the HP-IB) INPUT controls, as well as programmable trigger level. Refer to *Table 1-1* for specifications. Operating instructions are given in this section.

3-242. OPERATOR'S MAINTENANCE

3-243. The only maintenance the operator should normally perform is replacement of the primary power fuse located within the Line Module Assembly. For instructions on how to change the fuse, refer to Section II, 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 fuseholders must be avoided.

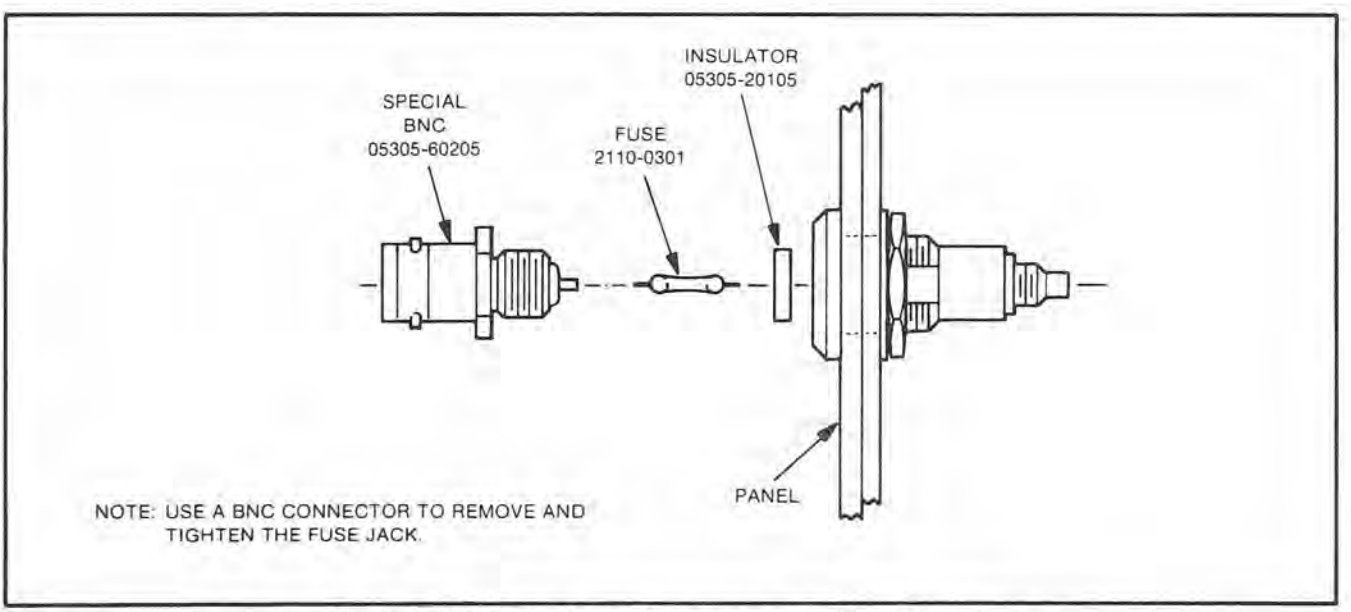


Figure 3-33. Details of Input Connector J1 and Fuse Mounting

3-244. When Option 030 C Channel is installed, the operator may be required to replace the input BNC fuse. This is a 1/8A fuse (HP Part No. 2110-0301) which is located within the INPUT C BNC connector (see *Figure 3-33* 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.

3-245. Power/Warm-Up

3-246. The HP Model 5335A requires a power source of 100, 120, 220, or 240V ac, +5%, -10%, 48 to 66 Hz single phase. The selection of line voltage and input power fuse is described in Section II, Preparation for Use.

3-247. The 5335A has a two-position POWER switch, STBY and ON. For 5335A Option 010 only, it is important that the instrument remain connected to the power source in the STBY mode when not in use. This supplies power to the crystal oven maintaining a constant oven temperature, thus eliminating the need for a warm-up period. When the STBY mode is not used and power is disconnected from the instrument, allow 30 minutes from the application of external power in the ON mode for the instrument (crystal oven) to warm-up.

WARNING

POWER IS ALWAYS PRESENT AT THE POWER 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.

3-248. OPERATOR'S CHECK

3-249. The following procedures will verify the basic operation of the HP 5335A Universal Counter. These tests are not intended to verify the overall accuracy or performance specifications of the instrument. They should, however, provide the operator a quick method of determining that the counter is operating properly. The tests are provided in two levels; a DISPLAY CHECK and a FRONT PANEL CHECK. The operator should perform both tests.

a. DISPLAY CHECK

To perform the HP 5335A DISPLAY CHECK, momentarily press the key labeled "CHECK". Verify that all display annunciators, except "STBY" and the A and B Channel Trigger lights, cycle ON and OFF. Pressing any Function key will return normal operation.

b. FRONT PANEL CHECK

To perform the HP 5335A FRONT PANEL CHECK, use a BNC cable to connect the rear panel TBO (Time Base Output) to the front panel INPUT A. Set the HP 5335A controls as follows:

Set Z=1M/50Ω ..... to 50Ω

3-250. Press and hold the "CHECK" button for about three seconds. Verify that all HP 5335A display annunciators turn ON for approximately ten seconds; during which the front end amplifiers are checked for the accuracy, cross-talk, attenuation and separate/common with the input signal. Successful completion of the test loop is indicated by a display of "FE PASS". Any failures are identified by a numbered fail message. For a description of the numbered FAIL messages, refer to paragraph 3-252.

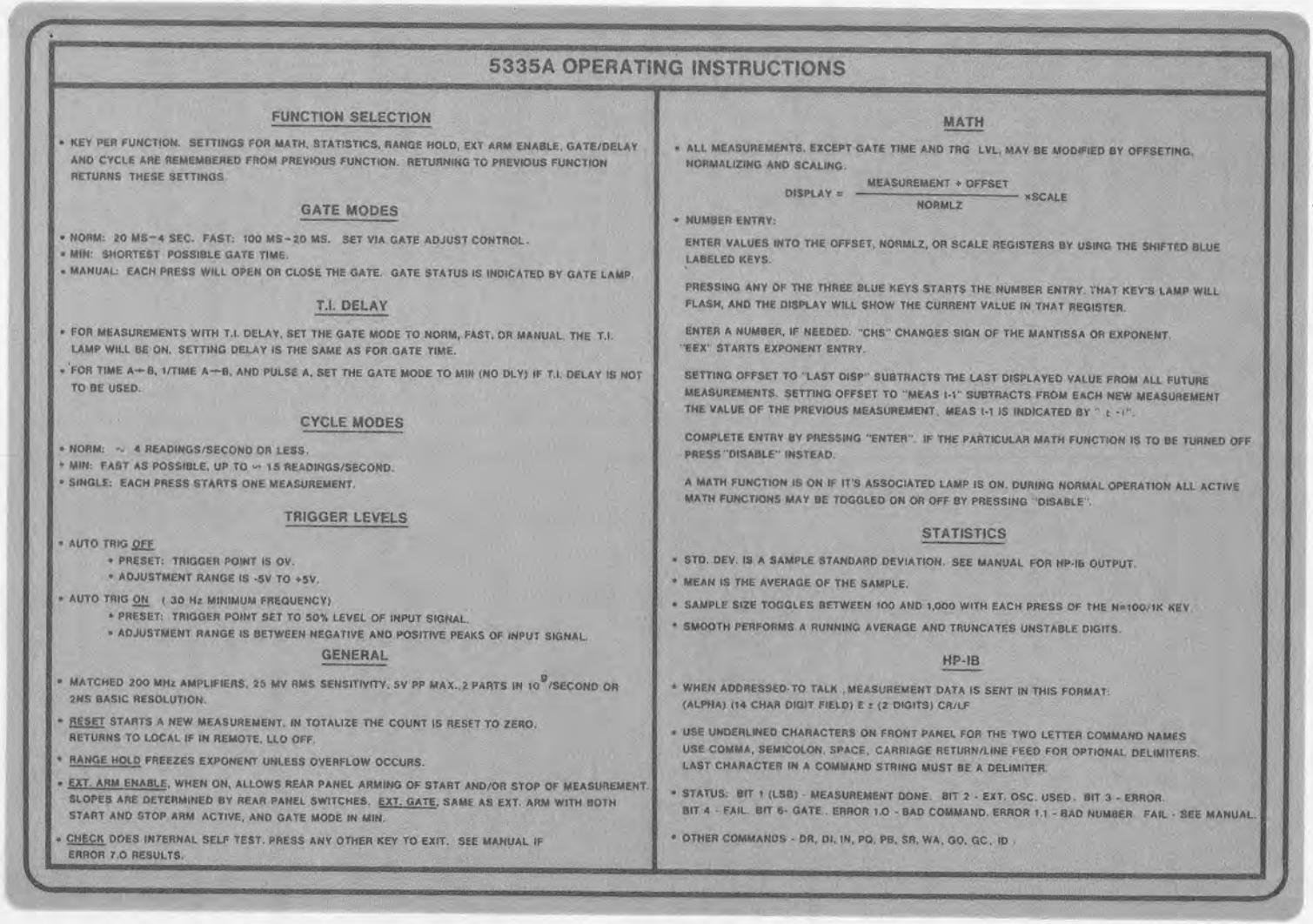
3-251. The FRONT PANEL CHECK is a built-in continuous loop, which will repeat until manually reset. To halt the test and return to normal operation, press any Function key.

3-252. ERROR/FAIL MESSAGES

3-253. Under certain conditions the 5335A will display either Error or Fail type messages. These messages typically occur during the power-up cycle. The fail messages are displayed in a continuous loop, and generally indicate a hardware related problem. Error messages indicate that the user has attempted an improper operation, either through the keyboard or the HP-IB. Refer to *Table 4-1*, Error Messages, and *Table 4-2*, Fail Messages. If a Fail message is displayed, refer to the troubleshooting information in Section VIII.

3-254. OPERATOR INSTRUCTION LABEL

3-255. *Figure 3-34* is a copy of the operator instruction label on the 5335A Top Cover.



5335A OPERATING INSTRUCTIONS

FUNCTION SELECTION

- KEY PER FUNCTION. SETTINGS FOR MATH, STATISTICS, RANGE HOLD, EXT ARM ENABLE, GATE/DELAY AND CYCLE ARE REMEMBERED FROM PREVIOUS FUNCTION. RETURNING TO PREVIOUS FUNCTION RETURNS THESE SETTINGS.

GATE MODES

- NORM: 20 MS-4 SEC. FAST: 100 MS-20 MS. SET VIA GATE ADJUST CONTROL.
- MIN: SHORTEST POSSIBLE GATE TIME.
- MANUAL: EACH PRESS WILL OPEN OR CLOSE THE GATE. GATE STATUS IS INDICATED BY GATE LAMP.

T.I. DELAY

- FOR MEASUREMENTS WITH T.I. DELAY, SET THE GATE MODE TO NORM, FAST, OR MANUAL. THE T.I. LAMP WILL BE ON. SETTING DELAY IS THE SAME AS FOR GATE TIME.
- FOR TIME A→B, 1/TIME A→B, AND PULSE A, SET THE GATE MODE TO MIN (NO DLY) IF T.I. DELAY IS NOT TO BE USED.

CYCLE MODES

- NORM: ~ 4 READINGS/SECOND OR LESS.
- MIN: FAST AS POSSIBLE, UP TO ~ 15 READINGS/SECOND.
- SINGLE: EACH PRESS STARTS ONE MEASUREMENT.

TRIGGER LEVELS

- AUTO TRIG OFF
  - PRESET: TRIGGER POINT IS 0V.
  - ADJUSTMENT RANGE IS -5V TO +5V.
- AUTO TRIG ON (30 Hz MINIMUM FREQUENCY)
  - PRESET: TRIGGER POINT SET TO 50% LEVEL OF INPUT SIGNAL.
  - ADJUSTMENT RANGE IS BETWEEN NEGATIVE AND POSITIVE PEAKS OF INPUT SIGNAL.

GENERAL

- MATCHED 200 MHz AMPLIFIERS, 25 MV RMS SENSITIVITY, 5V PP MAX., 2 PARTS IN 10^9/SECOND OR 2NS BASIC RESOLUTION.
- RESET STARTS A NEW MEASUREMENT. IN TOTALIZE THE COUNT IS RESET TO ZERO. RETURNS TO LOCAL IF IN REMOTE, LLO OFF.
- RANGE HOLD FREEZES EXPONENT UNLESS OVERFLOW OCCURS.
- EXT. ARM ENABLE, WHEN ON, ALLOWS REAR PANEL ARMING OF START AND/OR STOP OF MEASUREMENT. SLOPES ARE DETERMINED BY REAR PANEL SWITCHES. EXT. GATE, SAME AS EXT. ARM WITH BOTH START AND STOP ARM ACTIVE, AND GATE MODE IN MIN.
- CHECK DOES INTERNAL SELF TEST. PRESS ANY OTHER KEY TO EXIT. SEE MANUAL IF ERROR 7.0 RESULTS.

MATH

- ALL MEASUREMENTS, EXCEPT GATE TIME AND TRG LVL, MAY BE MODIFIED BY OFFSETING, NORMALIZING AND SCALING.

$$\text{DISPLAY} = \frac{\text{MEASUREMENT} + \text{OFFSET}}{\text{NORMLZ}} \times \text{SCALE}$$

- NUMBER ENTRY:

  ENTER VALUES INTO THE OFFSET, NORMLZ, OR SCALE REGISTERS BY USING THE SHIFTED BLUE LABELED KEYS.

  PRESSING ANY OF THE THREE BLUE KEYS STARTS THE NUMBER ENTRY. THAT KEY'S LAMP WILL FLASH, AND THE DISPLAY WILL SHOW THE CURRENT VALUE IN THAT REGISTER.

  ENTER A NUMBER, IF NEEDED. "CHS" CHANGES SIGN OF THE MANTISSA OR EXPONENT. "EEX" STARTS EXPONENT ENTRY.

  SETTING OFFSET TO "LAST DISP" SUBTRACTS THE LAST DISPLAYED VALUE FROM ALL FUTURE MEASUREMENTS. SETTING OFFSET TO "MEAS 1-1" SUBTRACTS FROM EACH NEW MEASUREMENT THE VALUE OF THE PREVIOUS MEASUREMENT. MEAS 1-1 IS INDICATED BY " Δ -1".

  COMPLETE ENTRY BY PRESSING "ENTER". IF THE PARTICULAR MATH FUNCTION IS TO BE TURNED OFF PRESS "DISABLE" INSTEAD.

  A MATH FUNCTION IS ON IF IT'S ASSOCIATED LAMP IS ON. DURING NORMAL OPERATION ALL ACTIVE MATH FUNCTIONS MAY BE TOGGLED ON OR OFF BY PRESSING "DISABLE".

STATISTICS

- STD. DEV. IS A SAMPLE STANDARD DEVIATION. SEE MANUAL FOR HP-IB OUTPUT.
- MEAN IS THE AVERAGE OF THE SAMPLE.
- SAMPLE SIZE TOGGLES BETWEEN 100 AND 1,000 WITH EACH PRESS OF THE N=100/1K KEY.
- SMOOTH PERFORMS A RUNNING AVERAGE AND TRUNCATES UNSTABLE DIGITS.

HP-IB

- WHEN ADDRESSED TO TALK, MEASUREMENT DATA IS SENT IN THIS FORMAT: (ALPHA) (14 CHAR DIGIT FIELD) E ± (2 DIGITS) CR/LF
- USE UNDERLINED CHARACTERS ON FRONT PANEL FOR THE TWO LETTER COMMAND NAMES. USE COMMA, SEMICOLON, SPACE, CARRIAGE RETURN/LINE FEED FOR OPTIONAL DELIMITERS. LAST CHARACTER IN A COMMAND STRING MUST BE A DELIMITER.
- STATUS: BIT 1 (LSB) - MEASUREMENT DONE. BIT 2 - EXT. OSC. USED. BIT 3 - ERROR. BIT 4 - FAIL. BIT 6- GATE. ERROR 1.0 - BAD COMMAND. ERROR 1.1 - BAD NUMBER. FAIL - SEE MANUAL.
- OTHER COMMANDS - DR, DI, IN, PQ, PB, SR, WA, GO, GC, ID.

Figure 3-34. 5335A Operating Instructions Label

SECTION IV
PERFORMANCE TESTING

4-1. INTRODUCTION

4-2. The procedures in this section provide three types of tests. First, a quick method of verifying the basic operation of the HP 5335A Universal Counter. They can be performed without access to the interior of the instrument. Second, a complete performance test for the 5335A. And third, an HP-IB verification test using either the HP 9825A or HP 85A controller.

4-3. EQUIPMENT REQUIRED

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

4-5. TEST RECORD

4-6. Results of the operation verification should be recorded on a copy of the Operation Verification Test Card, at the end of the operation verification test. Results of the complete performance test should be recorded on a copy of the Performance Test Card at the end of this section.

4-7. ERROR/FAIL MESSAGES

4-8. Under certain conditions the 5335A will display either Error or Fail messages. These messages typically occur during the power-up cycle. The fail messages are displayed in a continuous loop, and generally indicate a hardware related problem. Error messages indicate that the user has attempted an improper operation, either through the keyboard or the HP-IB. *Table 4-1* lists the Error Messages, and *Table 4-2* lists the Fail Messages. If a Fail message is displayed, refer to the troubleshooting information in Section VIII.

Table 4-1. Error Messages

1.0	HP-IB Error:	Incorrect Command
1.1	HP-IB Error:	Number out of range or incorrect number within command
7.0	Check Error:	Cable may not be connected between T.B.O. and INPUT A for extended CHECK, Diagnostic 01 or Diagnostic 14.

Table 4-2. Fail Messages

FAIL	1.0–1.4	ROM FAILURE (U22)
	1.5–1.8	ROM FAILURE (U23)
	1.9	ROM FAILURE (SPECIALS)
	2.0	RAM FAILURE (6802)
	2.1	RAM FAILURE (U26)
	2.2	RAM FAILURE (U25)
	3.1	OUT-BUS PROBLEM (BIT 5 OR 7)
	3.2–3.3	OUT-BUS PROBLEM (BITS 0-7, OR U8, U9, U13, U14, U6, OR U7)
	3.4	START ARM SWITCH PROBLEM
	3.5	STOP ARM SWITCH PROBLEM
	4.1	MRC STATUS REGISTER WON'T RESET (U6-U7)
	4.2	MRC E-REG WON'T RESET
	4.3	MRC T-REG WON'T RESET
	4.4	IMPROPER MID-MEAS REGISTER STATUS
	4.5	IMPROPER END-OF-MEAS REGISTER STATUS
	4.6	MRC COUNTING PROBLEM IN REG-E OR T
	4.7	MRC E-REG OVERFLOW PROBLEM
	4.8	MRC T-REG OVERFLOW PROBLEM
	4.9	MRC O/F COUNTING PROB IN REG-E OR T
	5.1	START INTERPOLATOR PROBLEM
	5.2	STOP INTERPOLATOR PROBLEM
	5.3	INTERPOLATOR COUNTING PROBLEM
	5.4	INTERPOLATOR RESET PROBLEM
	6.1	FAILURE TO MEASURE T/L REFERENCE GND
	6.2	FAILURE TO MEASURE T/L REFERENCE +5V
	6.3	FAILURE TO MEASURE T/L REFERENCE -5V
	7.1	CH-A FREQUENCY NOT CORRECT
	7.2	COM/SEP RELAY COUPLING SIGNAL TO CH-B
	7.3	CH-B UNABLE TO TRIG THRU COMMON-A
	7.4	CH-B FREQUENCY NOT CORRECT
	7.5	CH-A PRESCALER NOT FUNCTIONING PROPERLY

4-9. LOCAL OPERATION VERIFICATION

4-10. The abbreviated checks given in paragraphs 4-13 to 4-33 can give the operator a high degree of confidence that the 5335A is operating properly, without performing a complete performance test. The operation verification is useful for incoming QA, routine maintenance, and after instrument repair. The Options 020, and 030 Operation Verification are included in these paragraphs.

4-11. The tests in the following procedure were designed to be performed sequentially. The last step in each test will leave the 5335A prepared for the next test in the sequence.

CAUTION

Before switching on the instrument, ensure the following:

1) **The transformer primary is matched to the available line voltage.**
2) **The correct fuse is installed.**
3) **All safety precautions have been observed.**

4-12. For details see Power Requirements, Line Voltage Selection, Power Cables, and associated warnings and cautions in Section II of this manual.

4-13. PRELIMINARY PROCEDURES

4-14. The following preliminary procedure steps must be performed before proceeding with the operation verification.

a. Preset:

5335A Power Switch ..... to STBY (OUT)

NOTE

If the 5335A line voltage selector is set to 120V the line voltage is nominally 115V.

b. Connect:

5335A Power Cable .... to Line Voltage

c. Verify:

Red Standby Lamp ..... is ON

d. Preset:

5335A Rear HP-IB
ADDRESS Switches ..... to 0 (DOWN)

e. Preset 5335A Front Panel as follows:

CHANNEL A & B:
PRESET ..... ON (fully CCW)
1 MΩ/50Ω ..... 50Ω (IN)
AUTO TRIG ..... ON (IN)
CHANNEL A & B:
X10 ATTN ..... X1 (OUT)
AC/DC ..... DC (OUT)
SLOPES ..... POS (OUT)
GATE ADJ ..... fully CCW
COM A ..... ON (IN)

4-15. Power-Up/Self Check Test Procedure I

4-16. When the counter is turned on, an internal check is made of several major components in the counter's circuitry. After the power-up sequence, the counter will initialize itself. All Math and Statistics will be OFF, the function will be FREQ. A, and the Gate and Cycle Modes will be in NORM. All of the input controls will be set according to their switch positions. If Option 040 is installed, the input switches LED will be in the "OFF" condition!

4-17. Any failures during the power-up cycle will disable the counter and produce a display of numbered ERROR or FAIL messages. For a description refer to ERROR MESSAGES, paragraph 4-7. Perform the following steps to use the POWER-UP SELF CHECK test:

NOTE

Remove any signal from INPUT A at this time.

a. Set:

5335A Power Switch ..... to ON (IN)

b. Verify:

1. Red Standby Lamp is OFF.
2. All display and annunciator lamps turn on momentarily (excluding standby and trigger lamps).
3. Display shows "HP-IB Addr 00" for about 1 second.
4. Display shows "0"; Hz lamp is ON.
5. FREQ A lamp is ON.
6. All other lamps are off (except trigger which may be on).
7. Fan is ON.
8. NO FAIL or ERROR messages displayed.

4-18. Super Check Test Procedure II

4-19. The SUPER CHECK is a continuous diagnostic loop which will repeat until manually reset; during this cycle the Front End amplifiers are checked for accuracy, cross talk, attenuation and separate/common with the input signal. In addition the 5335A checks the operation of the following:

ROMS
RAMS
DATA BUS
FRONT PANEL DISPLAY
MRC
INTERPOLATORS

TRIGGER LEVEL REFERENCES (GND, +5V, -5V)
CHANNEL A & B TRIGGERING
SEP/COM RELAY
PRESCALER
POWER SUPPLY VOLTAGES (+5V, +3V, -5.2V)

4-20. Any failures are identified by a numbered ERROR or FAIL message. For a description refer to ERROR/FAIL MESSAGES, paragraph 4-7. If a FAIL message is displayed, refer to the troubleshooting information in Section VIII.

4-21. Perform the following steps to use the SUPER CHECK:

a. Connect a 4-foot BNC cable (HP P/N 10503A) from the 5335A rear panel TIME BASE OUT to the front panel INPUT A jack. Ensure both inputs are set to 50Ω.

b. Press 5335A keys

1. SCALE
2. SMOOTH (Display will show "SPECIAL +0")
3. 9
4. 9
5. ENTER (Display will show "dIAG 01")

c. Verify:

1. All display annunciator lamps turn ON for about 5 seconds.

2. Successful completion of the SUPER CHECK front end test loop displays the message "FE PASS" for about 15 seconds.

3. Display shows **nominal** values of three Supply Voltages:

5. 000 00 V
3. 000 00 V
-5. 200 00 V

NOTE

If TIME BASE OUT is not connected to INPUT A, ERROR 7.0 will be displayed.

4-22. Front End (Input Amplifier) Switch Test Procedure III

4-23. Perform the following steps to test the Input Amplifier switches:

a. Set 5335A front end (INPUT) switches as follows:

CHANNEL A & B:
SLOPES ..... NEGATIVE (IN)
PRESETS ..... OFF
ATTEN ..... X10 (IN)
COM A ..... ON (IN)
AUTO TRIG ..... ON (IN)

b. Press 5335A keys:

1. SCALE, SMOOTH, 9, 9, ENTER
2. SCALE, 5, ENTER

NOTE

This diagnostic is disabled with Option 040 installed. Use Diagnostic 17 to check Option 040.

NOTE

Step (1) is not necessary when done in sequence.

c. Observe 5335A display shows "8.8.8.8.8.8.8.8."

d. Verify and record on test card.

e. Set 5335A front end switches as follows:

CHANNEL A & B:
SLOPES ..... POSITIVE (OUT)
PRESETS ..... ON
ATTEN ..... X1 (OUT)
COM A ..... OFF (OUT)
AUTO TRIG ..... OFF (OUT)

f. Observe 5335A display is BLANK (no "8" showing).

g. Verify and record on test card.

h. Press the following 5335A keys:

CHANNEL A & B SLOPES
CHANNEL A & B PRESETS
CHANNEL A & B ATTN
COM A
AUTO TRIG

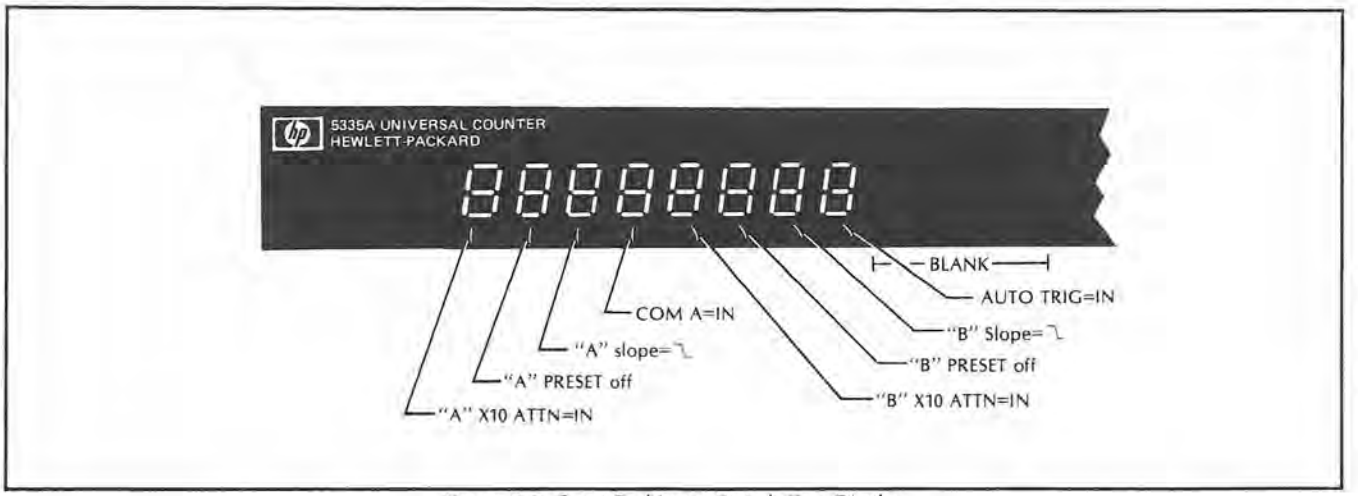


Figure 4-1. Front End Input Switch Test Display

i. Observe when the respective KEY is pressed IN the display shows a figure "8" at the corresponding digit and the display goes blank when the respective KEY is OUT, as shown in *Figure 4-1*.

j. Verify and record on test card.

4-24. Rear Panel External Arm Slope Switch Test Procedure IV

4-25. Perform the following steps to use the SLOPE switch test:

a. Set the HP 5335A power switch to STBY, then ON. Use an HP 3325A Synthesizer/Function Generator to input a 10 MHz 1 Vp-p sine wave to the TIME BASE IN (TBI) input at the rear of the HP 5335A.

b. Set 5335A rear panel EXTERNAL ARM START and STOP slope switches:

BOTH . . . . . to Positive (UP)

c. Press the following 5335A keys:

1. SCALE, SMOOTH, 9, 9, ENTER ("Error 7.0" may be displayed; IGNORE)

2. Wait for 5 sec; SCALE, 6, ENTER

d. Observe 5335A display shows "8.8.8." (only the 4th, 6th and 8th digit ON).

e. Verify and record on test card.

f. Set 5335A rear panel EXTERNAL ARM START and STOP slope switches:

BOTH . . . . . to Negative (DOWN)

g. Observe 5335A display shows "8.8.8." (only the 4th, 5th, and 7th digit ON).

h. Verify and record on test card.

i. Remove Signal from TIMEBASE IN.

j. Observe 5335A display, 4th digit goes blank.

k. Set 5335A rear panel EXTERNAL ARM START and STOP slope switches:

BOTH . . . . . to OFF (MIDDLE)

l. Observe 5335A display is BLANK.

m. Verify and record on test card.

NOTE

If any 5335A front panel MATH, STATISTICS, FUNCTION, GATE MODE, or CYCLE KEY is pressed while in dIAG 06, the segments and decimal point of the 3rd digit in the display will cycle.

Refer to *Figure 4-2* Rear Arm Switch Test Display.

NOTE

While in Diagnostic 06 the rear panel EXTERNAL ARM START and STOP Switch positions correspond to the Display Digits as shown in *Figure 4-2* and the 3rd and 4th display digits will respond as indicated.

NOTE

You must cycle POWER SWITCH to STBY and back to ON to exit Diagnostic 06.

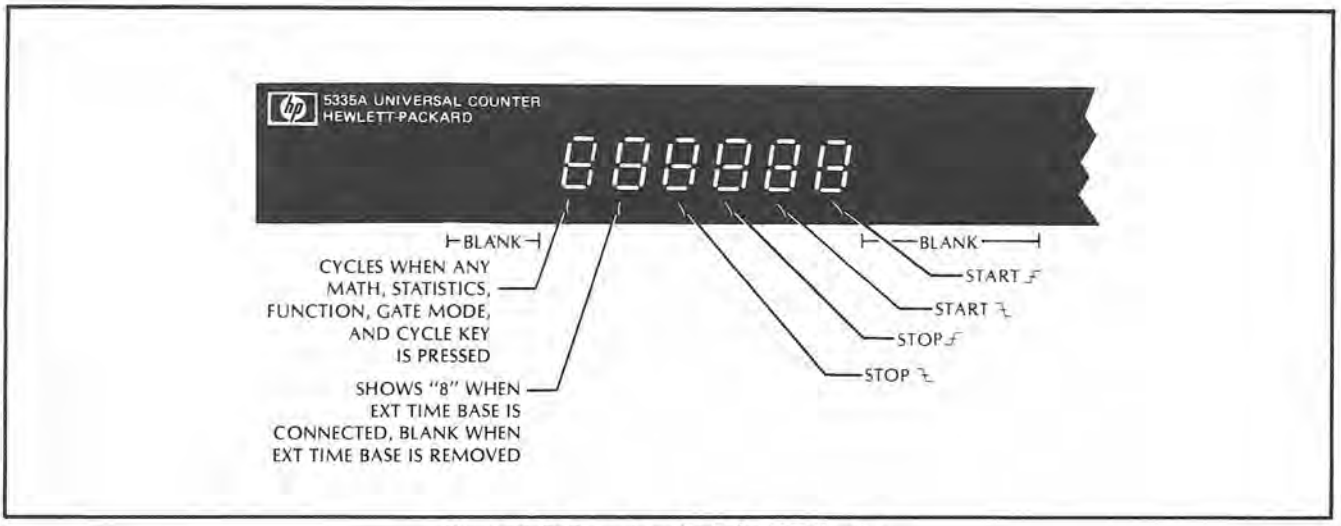


Figure 4-2. Rear Arm Switch Test Display

4-26. Keyboard Check Test Procedure V

4-27. Perform the following steps to use the keyboard test:

a. Press 5335A keys:

1. SCALE, SMOOTH, 9, 9, ENTER
2. SCALE, 1, 7, ENTER (Display shows "dIAG 17")

b. Press each key on the 5335A front panel. Begin with the upper left key (MATH DISABLE) and go down each column until the lower right key is pressed.

NOTE

INPUT section if for Option 040 **only**.

c. Observe as each key is pressed:

1. The "+0" EXPONENT will light and two digits on the display will match digits in *Figure 4-3*.
2. The key's lamp will turn ON (except for RESET, CHECK, and CYCLE NORM, which have no lamp).

d. Verify and record on test card.

NOTE

You must cycle Power Switch to STBY and back to ON to exit the KEYBOARD CHECK.

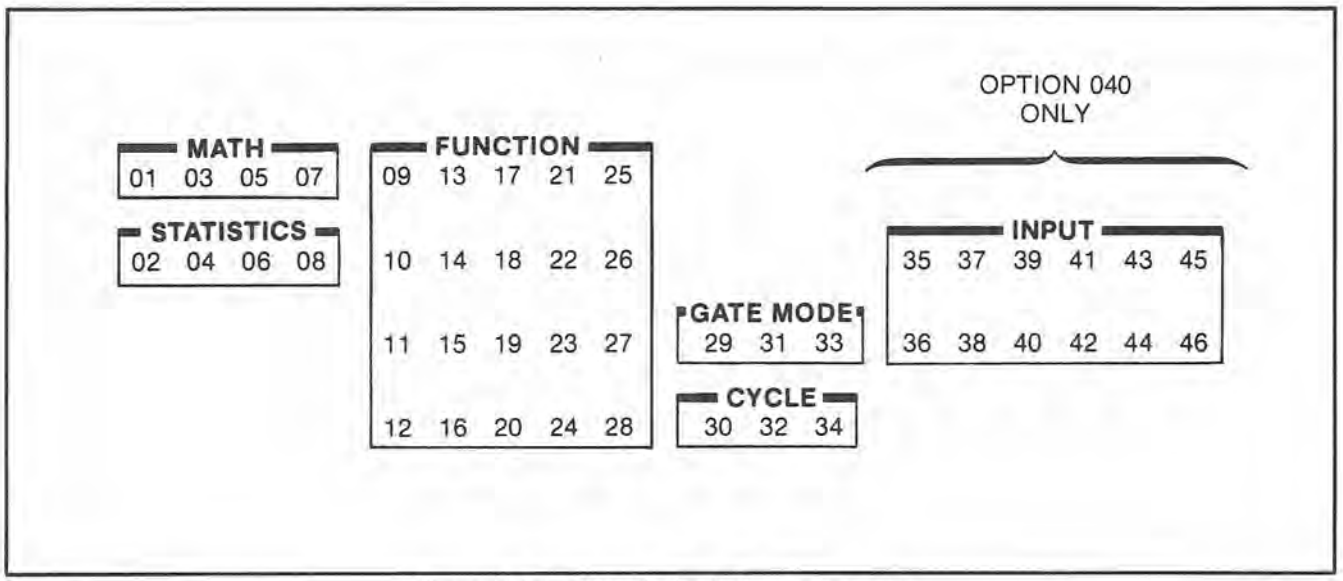


Figure 4-3. Keyboard Check Key Assignments

4-28. DVM Test (Option 020) Procedure VI

4-29. Perform the following steps to use the DVM test:

a. Connect a 4-foot BNC cable from the 5335A rear panel Trigger Level "A" or "B" to the DVM input jack. (Use a BNC-to-banana connector.)

b. Set:

CHANNEL A & B:
PRESET ..... OFF (in CCW position)
AUTO TRIG ..... OFF

c. Press:

5335A Key ..... VOLTS

d. Observe:

Display shows approx. ..... "–5.2XX" V

e. Invert the DVM input terminal connector.

f. Observe:

Display shows approx. ..... "+5.2XX" V

g. Verify and record on test card.

4-30. Channel "C" Test (Option 030) Procedure VII

4-31. Perform the following steps to use the Channel "C" test:

a. Connect the following:

1. The HP 86603A to the 5335A Channel C INPUT.
2. The HP 8660C Time Base Out to the 5335A Time Base IN.

b. Press:

5335A Key ..... FREQ C

c. Vary the frequency of the HP 8660C.

d. Observe the 5335A display shows the output frequencies of the HP 8660C within the C Channel published Specs.

e. Verify and record on test card.

4-32. Programmable Input Amplifier Test (Option 040) Procedure VIII

4-33. Perform the following steps to use the Option 040 INPUT test:

a. Connect the 5335A Trigger Levels OUT A&B (rear panel) to the 1740A oscilloscope as shown in *Figure 4-4*.

b. On the 5335A, press: SCALE, SMOOTH, 9, 9, ENTER. Then press: SCALE, 3, 4, ENTER.

c. Set the oscilloscope channel A&B to zero reference in the middle of the screen. Also set the vertical scale in both scope channels to 2 volts/div.

d. Observe the scope display sweeping vertically from –5.11 volts to +5.11 volts, for both Channels A and B.

e. Verify and record on test card.

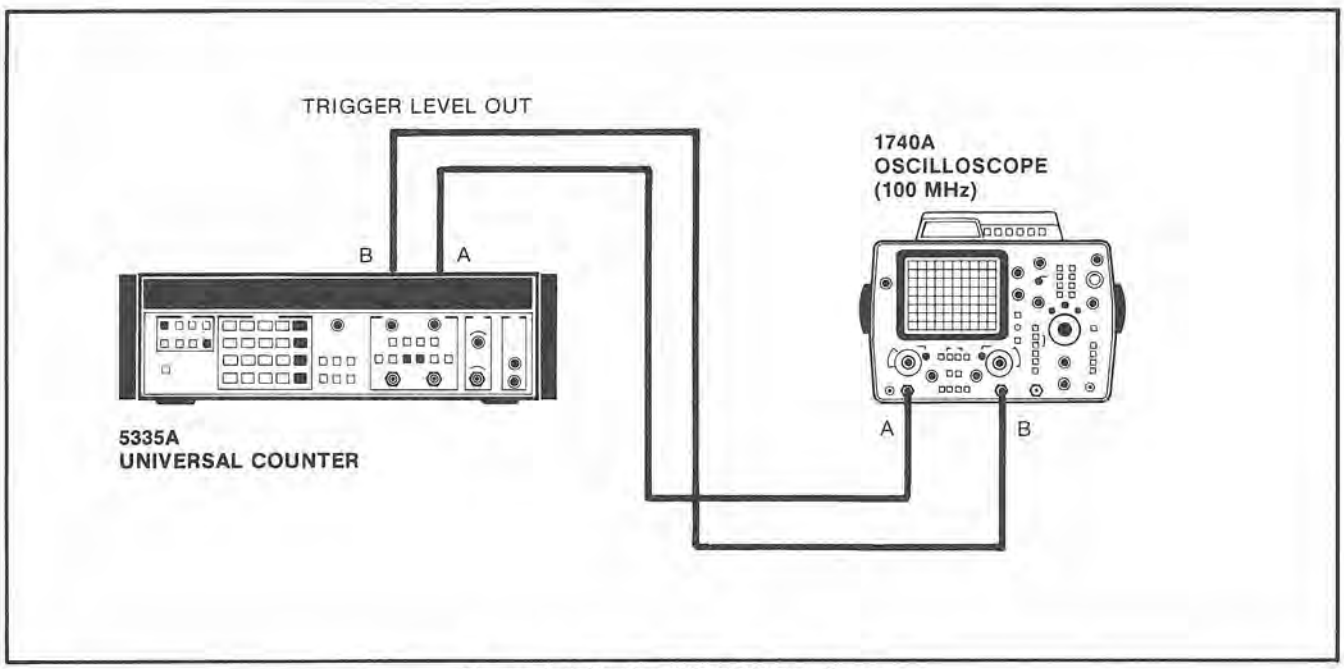


Figure 4-4. Option 040 DAC Test Setup

4-34. PERFORMANCE TEST FOR THE 5335A AND ALL OPTIONS

4-35. The following procedures can be used as Performance Test for the 5335A Universal Counter and all its options. Results of Performance Test may be tabulated on the 5335A Performance Test Card.

4-36. The procedures listed were designed to be performed **sequentially**; this is particularly true for tests II and III, and also, for tests X, XI. The tests included are as follows:

I	POWER-UP/SELF TEST
II	SUPERCHECK
III	KEYBOARD CHECK
IV	REAR PANEL/EXTERNAL ARM SWITCH TEST
V	GATE TIME
VI	CHANNEL A and B FREQUENCY RESPONSE and SENSITIVITY
VII	RATIO A/B
VIII	TIME INTERVAL AND INVERSE TIME INTERVAL
IX	PULSE WIDTH A AND PULSE WIDTH B
X	RISE AND FALL TIME A
XI	SLEW RATE A
XII	PHASE A rel B
XIII	DVM TEST (OPTION 020)
XIV	CHANNEL C TEST (OPTION 030)
XV	PROGRAMMABLE FRONT END (OPTION 040)

4-37. Power-Up/Self Check Test Procedure I

4-38. DESCRIPTION: The 5335A Universal Counter power is set to STBY, then ON; the counter will be cycled through its Power-up subroutine. This test is perfomed with **NO** External Time Base signal applied to the counter. A function test is made of all major functional blocks, after which, the 5335A will go to its default state.

4-39. Perform the following steps to use the Power-Up Self Check:

a. Set the 5335A front panel GATE ADJ to fully counterclockwise position.

b. Set the 5335A power switch to STBY, then to ON. Verify that:

1. Red LED "STBY" lamp is OFF.
2. All display and annunciator lamps turn ON momentarily (excluding "STBY" and trigger lamps).
3. Display shows the selected HP-IB address.
4. "FREQ A" and "Hz" lamps are ON; display shows: "0.".
5. All other lamps are OFF (except Trigger lamps which may be on).
6. Fan is ON.

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

4-40. Supercheck Test Procedure II

4-41. DESCRIPTION: SUPERCHECK is a continuous diagnostic loop which will repeat until manually reset. A signal is applied to INPUT A and the front end amplifiers are checked for accuracy, crosstalk and attenuation; the 5335A "kernel" and its major supporting blocks are also checked. The 5335A should display the expected results.

NOTE

This SUPERCHECK test and the following KEYBOARD CHECK test **MUST** be performed sequentially.

4-42. Perform the following steps to use the SUPERCHECK test:

a. Connect a 4-foot BNC cable (HP P/N 10503A) from the 5335A rear panel TIME BASE OUT 10 MHz (TBO) to the front panel INPUT A jack.

b. Set Channel A 1 MΩ/50Ω impedance switch to the 50Ω position (IN).

c. Press:
SCALE (verify SCALE lamp is flashing)
SMOOTH (display shows: "SPECIAL +0")
9
9
ENTER (display will show "dIAG 01")

d. Verify:

1. All display annunciator lamps turn ON for about 5 seconds.
2. After successful completion of the Front End Input test, the display shows: "FE PASS", for about 15 seconds.

3. Display shows **NOMINAL** values of 3 supply voltages:

+5. 000 00 V
+3. 000 00 V
–5. 200 00 V

4. Test then repeats itself.

NOTE
If TIME BASE OUT is not connected to INPUT A, ERROR 7.0 will be displayed.

5. Record results on test card (PASS/FAIL).

4-43. Keyboard Check Test Procedure III

4-44. DESCRIPTION: This subroutine is designed to verify the ability of the microprocessor to identify an individual software-read front panel momentary switch when it is pressed. When this subroutine is enabled, a number should be displayed on the 5335A when any switch is pressed, corresponding to *Figure 4-5*. The selected key LED will remain ON while the number is being displayed. A "+0" will be displayed in the exponent section of the display during the test.

4-45. Perform the following steps to use KEYBOARD test:

a. Press: SCALE 1, 7, ENTER (Display shows "dIAG 17").

b. Press each key on the 5335A front panel. Begin with the upper left key (MATH DISABLE) and go down each column until the lower right key is pressed.

NOTE
INPUT section is for Option 040 **only.**

c. As each key is pressed observe:

1. The "+0" EXPONENT will light and a 2-digit display will actively correspond to *Figure 4-5*.

2. The key's lamp will turn ON (except for RESET, CHECK, and CYCLE NORM, which have no lamps).

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

4-46. Rear Panel — External Arm Switch Test Procedure IV

4-47. DESCRIPTION: The 5335A Universal Counter is programmed to test its A6 Rear Panel Arming switches in their different modes of operations; also tested is the External Time Base Input circuitry. *Figure 4-6* shows display results of this test.

4-48. Perform the following steps to use the EXTERNAL ARM switch test:

a. Set the HP 5335A power switch to STBY, then ON. Use an HP 3325A Synthesizer/Function Generator to input a 10 MHz 1 Vp-p sine wave to the TIME BASE IN (TBI) input at the rear of the HP 5335A. Set the HP 5335A rear panel EXTERNAL ARM START and STOP slope switches to positive (up) position.

b. Press: SCALE, SMOOTH, 9, 9, ENTER ("ERROR 7.0" may be displayed; IGNORE).

c. Wait for 5 seconds, press: SCALE, 6, ENTER.

d. Observe that 5335A displays "eights" in the 4th, 6th, and 8th positions. Also, EXTERNAL TIME BASE lamp will be ON.

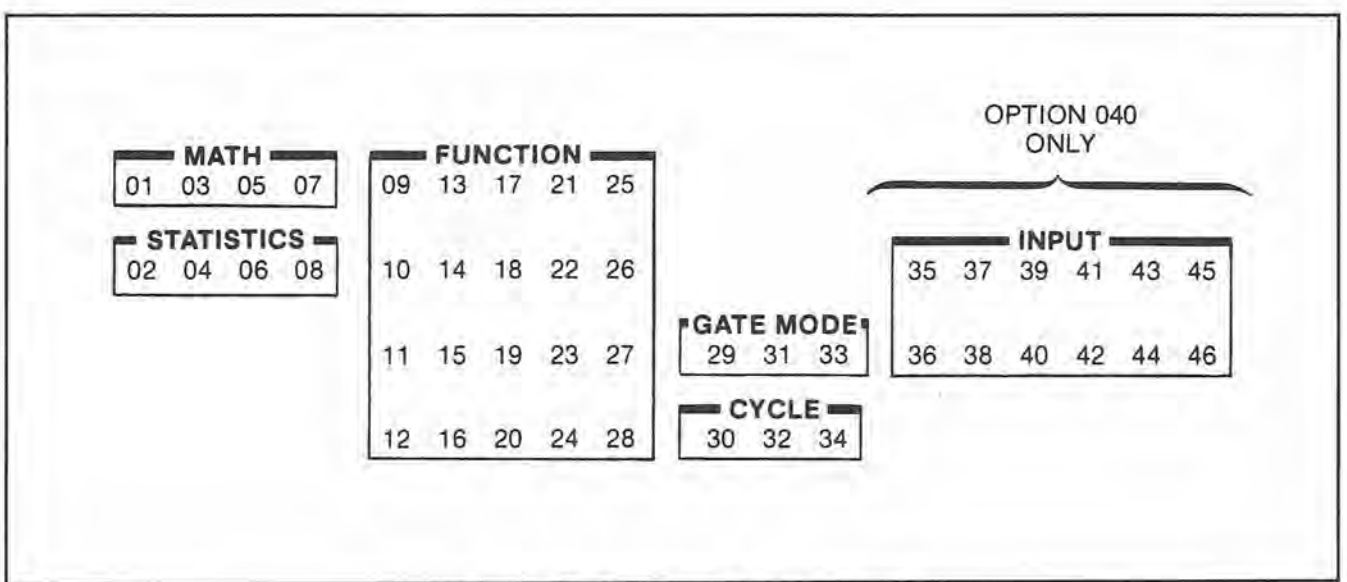


Figure 4-5. Keyboard Check Key Assignments

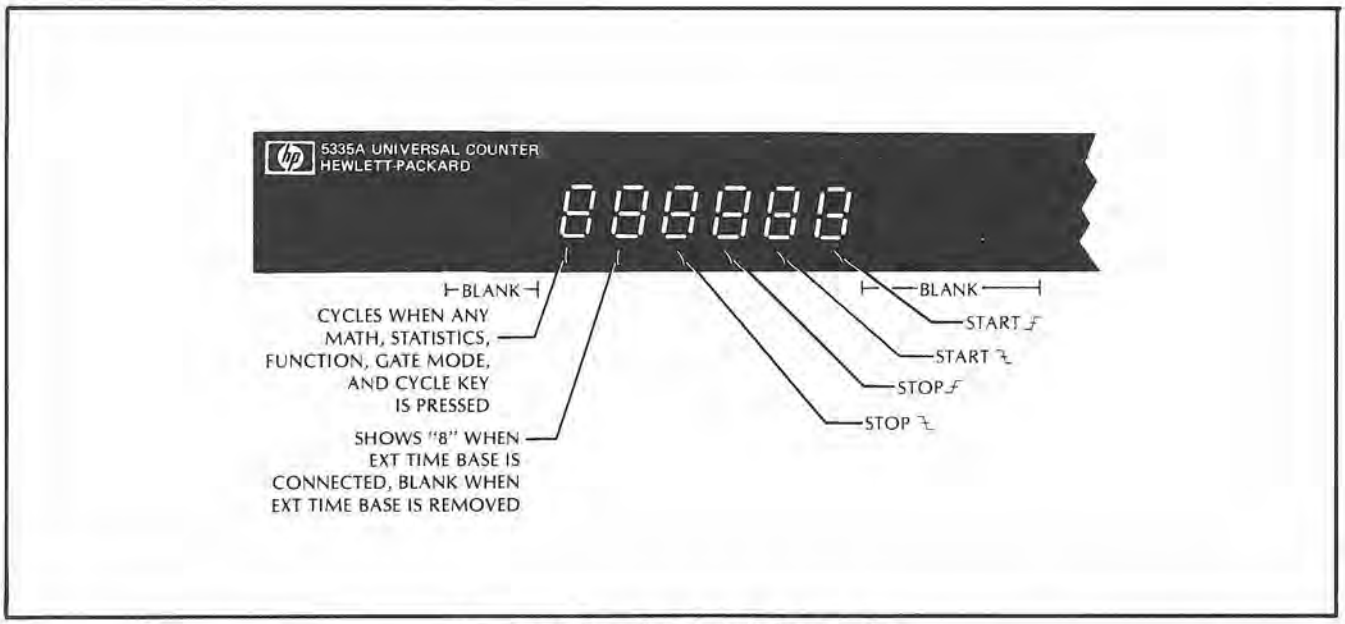


Figure 4-6. Rear Arm Switch Test Display

e. Set EXTERNAL ARM START and STOP slope switches to Negative (DOWN) position. Observe counter display showing "eights" in the 4th, 5th, and 7th positions.

f. Remove BNC cable from TBI; set EXTERNAL ARM START and STOP slope switches to OFF (MIDDLE) position.

g. Observe 5335A display is BLANK.

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

NOTE

If any 5335A front panel MATH, STATISTICS, FUNCTION, GATE MODE, or CYCLE key is pressed while in Diagnostic 06, the segments and decimal point of the 3rd digit in the display will cycle.

4-49. Gate Time Test Procedure V

4-50. SPECIFICATIONS: NORM: 20 milliseconds to 4 seconds, NOMINAL. FAST: 100 µs to 20 milliseconds, NOMINAL.

4-51. DESCRIPTION: The 5335A Universal Counter variable gate time function is exercised in both of its ranges. The counter is set to its GATE TIME function, and the gate time is varied throughout its range. The 5335A should display the correct count.

4-52. Perform the following steps to use the GATE TIME test:

a. Set the 5335A power switch to STBY, then ON.

b. Set the 5335A front panel controls as follows:

GATE MODE ..... NORM
CYCLE ..... NORM
FUNCTION ..... GATE TIME
GATE ADJ ..... fully ccw

c. Vary the GATE ADJ control from full ccw to full cw position; the 5335A should display from less than 20 ms to greater than 4 seconds.

d. Record result on test card (PASS/FAIL).

e. Set GATE MODE to "FAST" (lamp ON). Vary the GATE ADJ pot from full ccw to full cw position; observe the 5335A displaying fast gate time from less than 100 µs to greater than 20 ms.

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

4-53. Channel A and B Frequency Response and Sensitivity Test Procedure VI

4-54. Channel A Test

4-55. SPECIFICATIONS: 0 to 200 MHz (prescaled by 2); 25 mV rms sine wave.

a. DC coupled: 0 to 200 MHz.

b. AC coupled (1 MΩ): 30 Hz to 200 MHz.

c. AC coupled (50Ω): 200 kHz to 200 MHz.

4-56. DESCRIPTION: A signal generator with calibrated output is set to the specified 5335A channel A minimum signal sensitivity level. The frequency is slowly increased from dc up to 20 MHz at constant

level, and the 5335A reading is checked for the proper count. For the range of 20 MHz to 200 MHz, a different generator is used. Connect test equipment as shown in *Figure 4-7*.

4-57. Perform the following steps to use the Frequency Response test:

a. Set the 5335A front panel controls as follows:

FUNCTION ..... FREQ A
MATH ..... Off (LEDs off)
STATISTICS ..... Off (LEDs off)
GATE MODE ..... NORM
GATE ADJ ..... fully ccw
CYCLE ..... NORM
INPUT (Channel A and B):
1 MΩ/50Ω ..... 50Ω (ON)
Trigger Level ..... PRESET
X10/X1 ATTN ..... X1 (OUT/OFF)
AC/DC ..... DC (OUT/OFF))
FILTER (Option 040) ..... OFF
AUTO TRIG ..... OUT (OFF)
COM A ..... OUT (OFF)

DC to 20 MHz (dc coupled)

b. Connect the 3325A Synthesizer/Function Generator to the 5335A INPUT A as in *Figure 4-7*.

c. Set the 3325A to output a 0.01 Hz sine wave at 25 mV rms. Increase the frequency of the 3325A, and verify that the 5335A displays the proper frequency from 0.01 Hz up to 20 MHz.

d. Measure actual sensitivity by decreasing the 3325A level until the 5335A gives an unstable count at these frequencies: 0.01 Hz, 10 Hz, 100 kHz, 10 MHz, 20 MHz.

e. Record results on test card (VALUE).

30 Hz to 20 MHz (ac coupled; 1 MΩ)

f. Set Channel A 1 MΩ/50Ω switch to 1 MΩ; set the AC/DC switch to ac coupling. Set the 3325A through a 50Ω feedthrough to the 5335A INPUT A. Set the 3325A to output a 30 Hz sine wave at 25 mV rms. Increase the frequency of the 3325A, and verify that the 5335A displays the proper frequency from 30 Hz to 20 MHz.

g. Measure actual sensitivity by decreasing the 3325A level until the 5335A gives an unstable count at these frequencies: 30 Hz, 10 kHz, 1 MHz, 10 MHz, 20 MHz.

h. Record results on test card (VALUE).

200 kHz to 20 MHz (ac coupled; 50 ohms)

i. Remove the 50Ω feedthrough from INPUT A. Set Channel A 1 MΩ/50Ω switch to **50Ω**; set the 3325A to output a 200 kHz sine wave at 25 mV rms. Increase the frequency of the 3325A and verify that the 5335A displays the proper frequency from 200 kHz to 20 MHz.

j. Measure actual sensitivity by decreasing the 3325A level until the 5335A gives an unstable count at these frequencies: 200 kHz, 500 kHz, 1 MHz, 10 MHz, 20 MHz.

k. Record results on test card (VALUE).

20 MHz to 200 MHz (dc coupled)

l. Connect the HP 8654A Signal Generator to the 5335A INPUT A as shown in *Figure 4-8*.

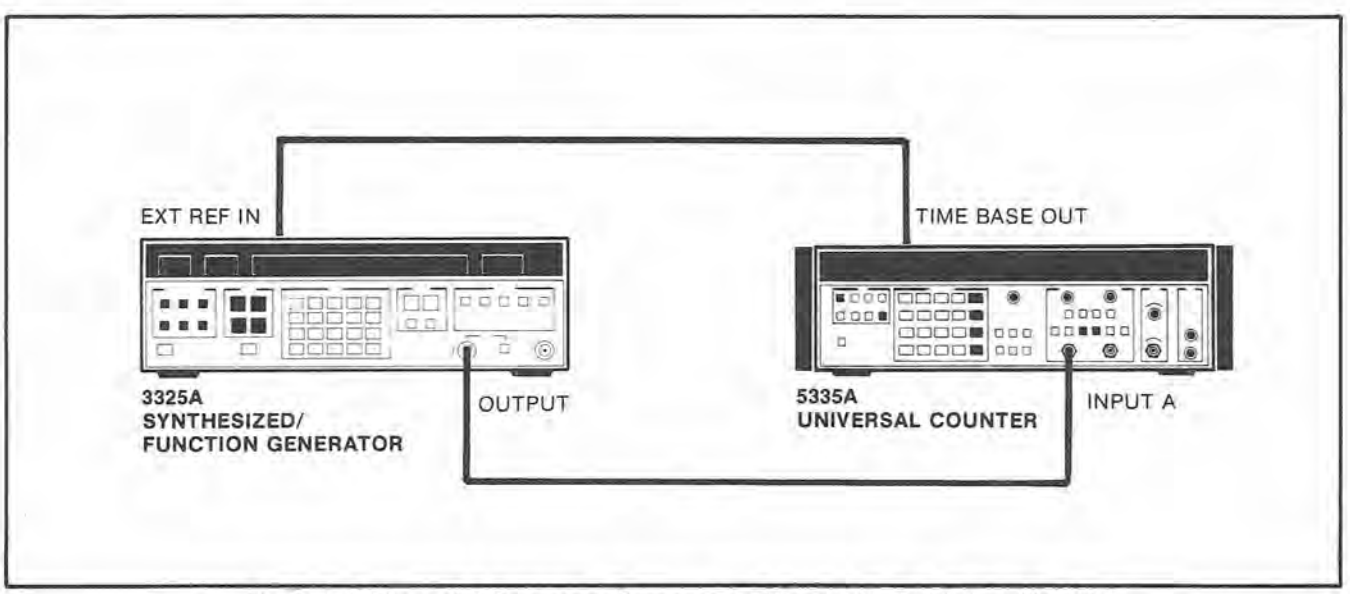


Figure 4-7. Channel A Frequency Response and Sensitivity Test Setup (20 MHz)

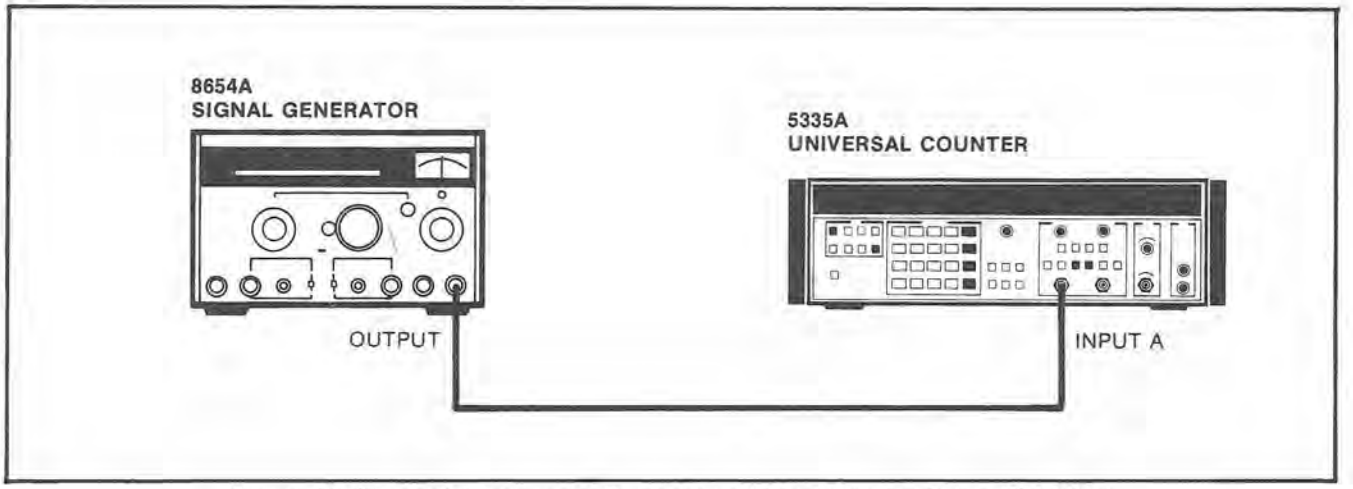


Figure 4-8. Channel A Frequency Response and Sensitivity Test Setup (200 MHz)

m. Set Channel A AC/DC switch to **dc** coupling. Set the 8654A to output a 20 MHz sine wave at 25 mV rms. Increase the frequency of the 8654A, and verify that the 5335A displays the proper frequency from 20 MHz to 200 MHz.

n. Measure actual sensitivity by decreasing the 8654A level until the 5335A gives an unstable count at these frequencies: 20 MHz, 50 MHz, 125 MHz, 200 MHz.

o. Record results on test card (VALUE).

20 MHz to 200 MHz (ac coupled)

p. Set Channel A AC/DC switch to **ac** coupling; set the 8654A to output a 20 MHz sine wave at 25 mV rms. Increase the frequency of the 8654A and verify that the 5335A displays the proper frequency from 20 MHz to 200 MHz.

q. Measure actual sensitivity by decreasing the 8654A level until the 5335A gives an unstable count at these frequencies: 20 MHz, 50 MHz, 125 MHz, 200 MHz.

r. Record results on test card (VALUE).

4-58. Channel B Test

4-59. SPECIFICATIONS: 0 to 100 MHz; 25 mV rms sine wave:

a. DC coupled: 0 to 100 MHz.

b. AC coupled (1 MΩ): 30 Hz to 100 MHz.

c. AC coupled (50Ω): 200 kHz to 100 MHz.

4-60. DESCRIPTION: A signal generator with calibrated output is set to the specified 5335A Channel B minimum signal sensitivity level. The frequency is slowly increased from dc up to 20 MHz at constant level, and the 5335A reading is checked for the proper count. For the range of 20 MHz to 100 MHz, a different generator is used.

4-61. Perform the following steps to use the B Frequency Response Test:

a. Press: SCALE, SMOOTH, 1, 7, ENTER. This will enable special function Frequency B.

DC to 20 MHz (dc coupled)

b. Connect the 3325A Synthesizer/Function Generator to the 5335A INPUT B as in shown *Figure 4-9*.

c. Set the 3325A to output a 0.01 Hz sine wave at 25 mV rms. Increase the frequency of the 3325A and verify that the 5335A displays the proper frequency from 0.01 Hz up to 20 MHz.

d. Measure actual sensitivity by decreasing the 3325A level until the 5335A gives an unstable count at these frequencies: 0.01 Hz, 10 Hz, 100 kHz, 10 MHz, 20 MHz.

e. Record results on test card (VALUE).

30 Hz to 20 MHz (ac coupled; 1 MΩ)

f. Set Channel B 1 MΩ/50Ω switch to **1 MΩ**; set the AC/DC switch to ac coupling. Connect the 3325A through a 50Ω feedthrough to the 5335A INPUT B. Set the 3325A to output a 30 Hz sine wave at 25 mV rms. Increase the frequency of the 3325A and verify that the 5335A displays the proper frequency from 30 Hz to 20 MHz.

g. Measure actual sensitivity by decreasing the 3325A level until the 5335A gives an unstable count at these frequencies: 30 Hz, 10 kHz, 1 MHz, 10 MHz, 20 MHz.

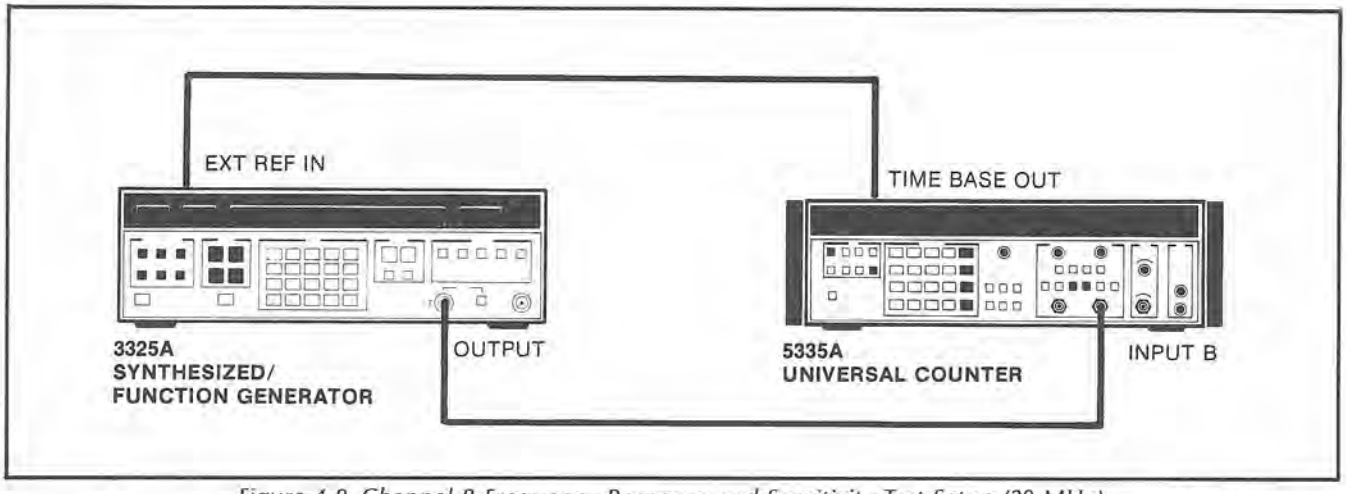


Figure 4-9. Channel B Frequency Response and Sensitivity Test Setup (20 MHz)

h. Record results on test card (VALUE).

200 kHz to 20 MHz (ac coupled; 50Ω)

i. Remove the 50Ω feedthrough from INPUT B. Connect the 3325A OUTPUT to the 5335A INPUT B. Set Channel B 1 MΩ/50Ω switch to **50Ω**; set the 3325A to output a 200 kHz sine wave at 25 mV rms. Increase the frequency of the 3325A and verify that the 5335A displays the proper frequency from 200 kHz to 20 MHz.

j. Measure actual sensitivity by decreasing the 3325A level until the 5335A gives an unstable count at these frequencies: 200 kHz, 500 kHz, 1 MHz, 10 MHz, 20 MHz.

k. Record results on test card (VALUE).

20 MHz to 100 MHz (dc coupled)

l. Connect the HP 8654A Signal Generator to the 5335A INPUT B as shown in *Figure 4-10*.

m. Set Channel B AC/DC switch to **dc** coupling. Set the 8654A to output a 20 MHz sine wave at 25 mV rms. Increase the frequency of the 8654A and verify that the 5335A displays the proper frequency from 20 MHz to 100 MHz.

n. Measure actual sensitivity by decreasing the 8654A level until the 5335A gives an unstable count at these frequencies: 20 MHz, 50 MHz, 100 MHz.

o. Record results on test card (VALUE).

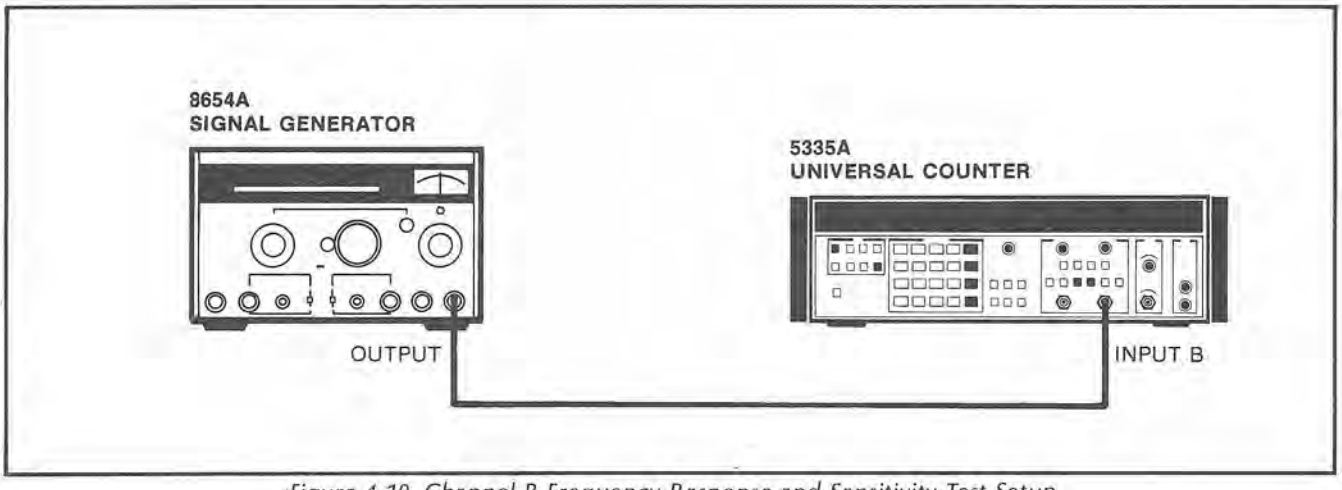


Figure 4-10. Channel B Frequency Response and Sensitivity Test Setup

20 MHz to 100 MHz (ac coupled)

p. Set Channel B AC/DC switch to **ac** coupling; set the 8654A to output a 20 MHz sine wave at 25 mV rms. Increase the frequency of the 8654A and verify that the 5335A displays the proper frequency from 20 MHz to 100 MHz.

q. Measure actual sensitivity by decreasing the 8654A level until the 5335A gives an unstable count at these frequencies: 20 MHz, 50 MHz, 100 MHz.

r. Record results on test card (VALUE).

4-62. Ratio A/B Function Test Procedure VII

4-63. SPECIFICATIONS: Channel A, 0 to 200 MHz (prescaled by 2). Channel B, 0 to 100 MHz

4-64. DESCRIPTION: A signal generator with calibrated output drives channels A and B of the 5335A under test. The counter is set to RATIO A/B and COM A input. The test is setup so that the counter will display a continuous ratio of "1", over the frequency range of 0 to 20 MHz. For the range of 20 MHz to 200 MHz, a different generator is used.

4-65. Perform the following steps to use the RATIO A/B test:

a. Set the 5335A front panel controls as follows:

FUNCTION ..... RATIO A/B
MATH ..... Off (LEDs off)
STATISTICS ..... Off (LEDs off)
GATE MODE ..... NORM
CYCLE ..... NORM
GATE ADJ ..... fully ccw
INPUT (Channel A and B):
1 MΩ/50Ω ..... 50Ω (ON)
Trigger Level ..... PRESET
X10/X1 ATTN ..... X1 (OUT/OFF)
AC/DC ..... DC (OUT/OFF)
FILTER (Option 040) ..... OFF
AUTO TRIG ..... OUT (OFF)
COM A ..... IN (ON)

0 to 20 MHz.

b. Connect the 3325A Synthesizer/Function Generator to the 5335A INPUT A as shown in *Figure 4-11*.

c. Set HP 3325A to 10 Hz, 10 kHz, 5 MHz, and 20 MHz at 25 mV rms sine wave. The 5335A should display a stable ratio as shown:

HP 3325A	HP 5335A display:
10 Hz	1.
10 KHz	1.00
5 MHz	1. 000 0
20 MHz	1. 000 00

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

20 MHz to 200 MHz.

e. Connect the HP 3325A Synthesizer/Function Generator and the HP 8660C Synthesized Signal Generator to the 5335A as shown in *Figure 4-12* (the 8660C, 3325A, and the 5335A time bases shall be locked together).

f. Set the HP 5335A front panel COM A to OFF (OUT) position. Set the HP 3325A to output a 20 MHz at 25 mV rms sine wave. Set the HP 8660C to output a 50 MHz, 100 MHz, 150 MHz, 200 MHz at 25 mV rms sine wave. Verify that the 5335A displays (±1 count): 2. 500 00, 5. 000 00, 7. 500 00, 10. 000 00, respectively.

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

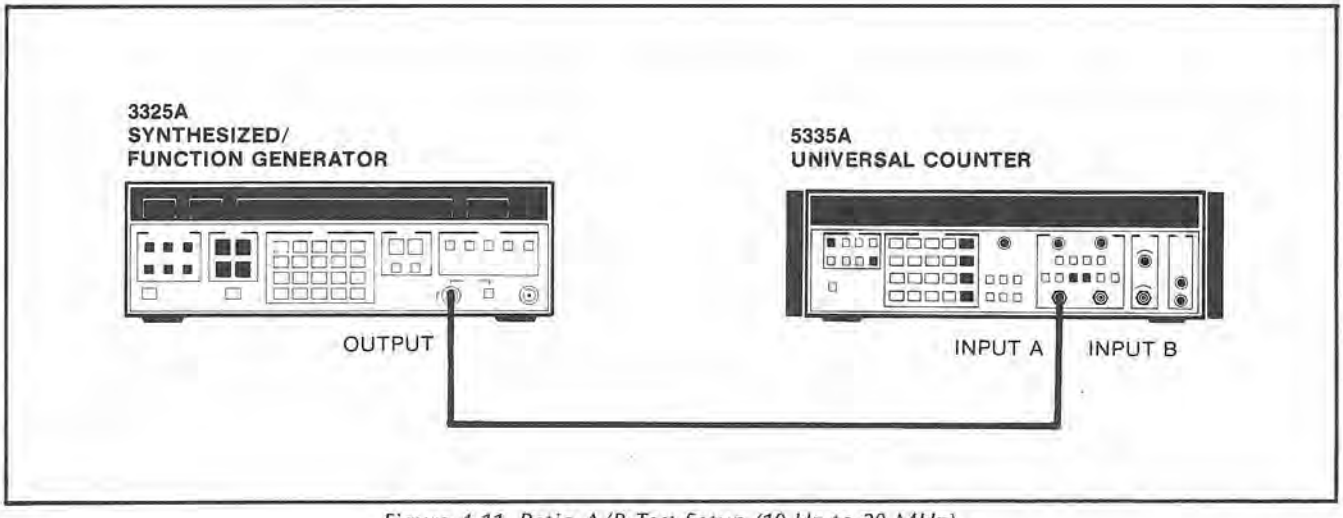


Figure 4-11. Ratio A/B Test Setup (10 Hz to 20 MHz)

4-66. Time Interval and Inverse Time Interval Test Procedure VIII

4-67. Specifications:

a. Time Interval: 0 ns to 10^{+7} seconds.

b. Inverse Time Interval: 10^{-7} to 10^{+9} seconds.

4-68. DESCRIPTION: A function generator with calibrated output drives channels A and B of the 5335A under test, with a square wave signal. The counter is set to TIME A→B and COM A input. The 5335A should display the proper count. The 5335A and the signal generator time bases shall be locked together.

4-69. Perform the following steps to use the Time Interval test:

a. Connect the 3325A Synthesizer/Function Generator to the 5335A INPUT A as shown in *Figure 4-13*.

b. Set the 5335A front panel controls as follows:

FUNCTION ..... TIME A→B
MATH ..... Off (LEDs off)
STATISTICS ..... Off (LEDs off)
GATE MODE ..... MIN (LED ON)
CYCLE ..... NORM
GATE ADJ ..... fully ccw
INPUT (Channel A and B):
1 MΩ/50Ω ..... 50Ω (ON)
Trigger Level ..... PRESET
X10/X1 ATTN ..... X1 (OUT/OFF)
AC/DC ..... DC (OUT/OFF)
Channel A Slope .... POS (OUT/OFF)
Channel B Slope ..... NEG (IN/ON)
FILTER (Option 040) ..... OFF
AUTO TRIG ..... OUT (OFF)
COM A ..... IN (ON)

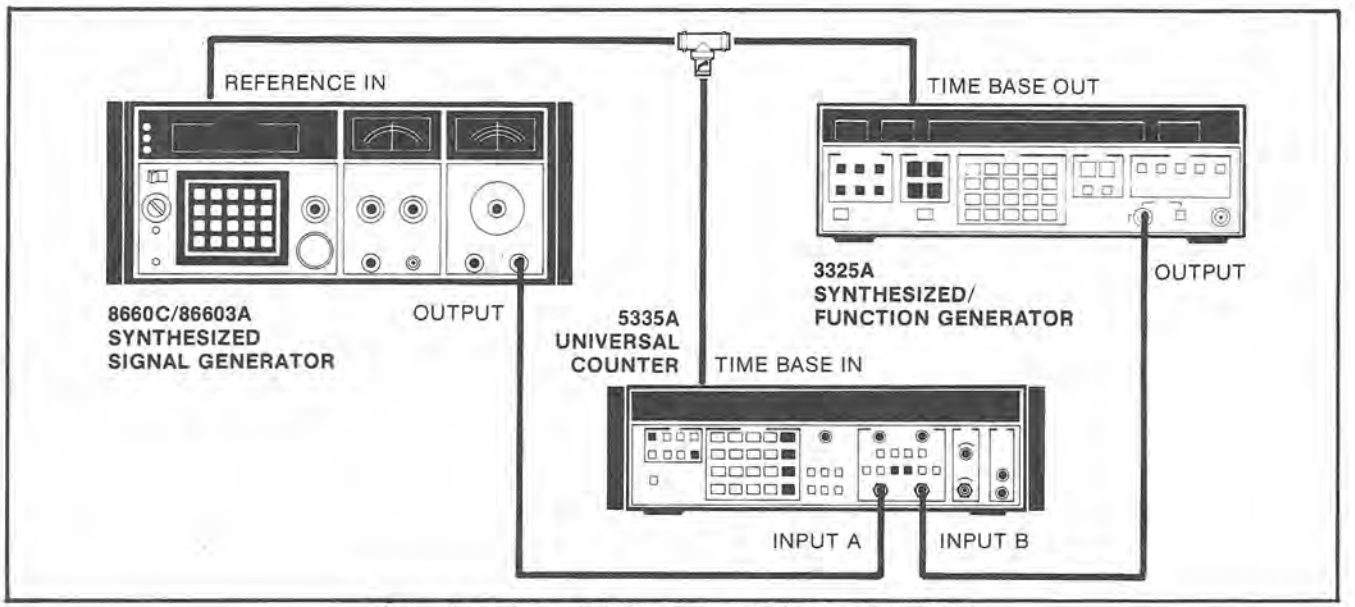


Figure 4-12. Ratio A/B Test Setup (20 MHz to 200 MHz)

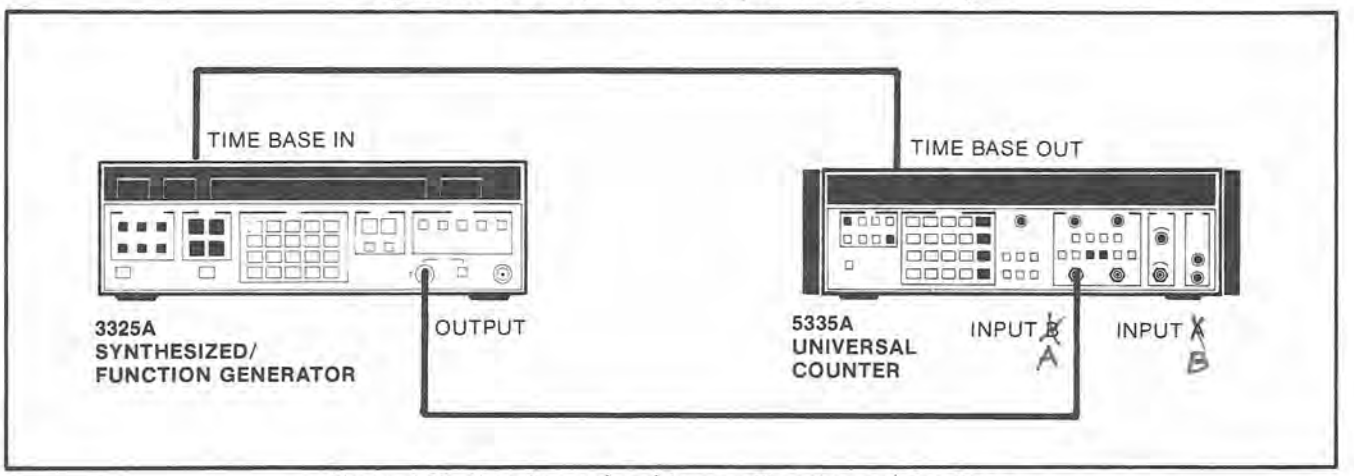


Figure 4-13. Time Interval and Inverse Time Interval Test Setup

c. Set HP 3325A to 5 MHz at 100 mV rms square wave. The 5335A should read 100 ns ±5 ns.

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

e. Set the HP 5335A for the INVERSE TIME INTERVAL (1/TIME A→B) function. Verify that the counter displays: 10.0 +6 ±0.5 +6.

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

4-70. Pulse Width A and Pulse Width B Procedure IX

4-71. SPECIFICATIONS: 5 ns to 10^{+7} seconds.

4-72. DESCRIPTION: A Pulse Generator provides a pulse waveform which is applied to the 5335A INPUT A (INPUT B). The counter is set to its PULSE WIDTH A and PULSE WIDTH B funtions. The 5335A should display the proper count.

4-73. Perform the following steps to use the PULSE WIDTH test:

a. Connect the HP 8082 Pulse Generator to the HP 5335A INPUT A as shown in *Figure 4-14*.

b. Set the 5335A front panel controls as follows:

FUNCTION ..... PULSE A
MATH ..... Off (LEDs off)
STATISTICS ..... Off (LEDs off)
GATE MODE ..... MIN (LED ON)
CYCLE ..... NORM
INPUT (Channel A and B):
1 MΩ/50Ω ..... 50Ω (ON)
X10/X1 ATTN ..... X1 (OUT/OFF)
AC/DC ..... DC (OUT/OFF)
Slope ..... POS (OUT/OFF)
Trigger Level ..... PRESET
FILTER (Option 040) ..... OFF
AUTO TRIG ..... IN (ON)
COM A ..... OUT (OFF)

c. Using the HP 1743A oscilloscope Delta Time function, set HP 8082A to output a 1V, 4-microsecond pulse, with a period of 10 μs, at the fastest transition times (approximately 1 ns). The 5335A should display 4.000 μs ±5 ns.

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

e. Set the 5335A channel A slope to NEG (IN/ON). Verify that the counter displays 6.000 μs ±5 ns.

f. Record result on test card (PASS/FAIL).

g. Press: SCALE, SMOOTH, 2, 0, ENTER. This will enable special function PULSE B. Reconnect the HP 8082A to the 5335A INPUT B.

h. Verify that the 5335A displays 6.000 μs ±5 ns.

i. Record result on test card (PASS/FAIL).

j. Set the 5335A channel A slope to POS (OUT/OFF). Verify that the counter displays 4.000 μs ±5 ns.

k. Record result on test card (PASS/FAIL).

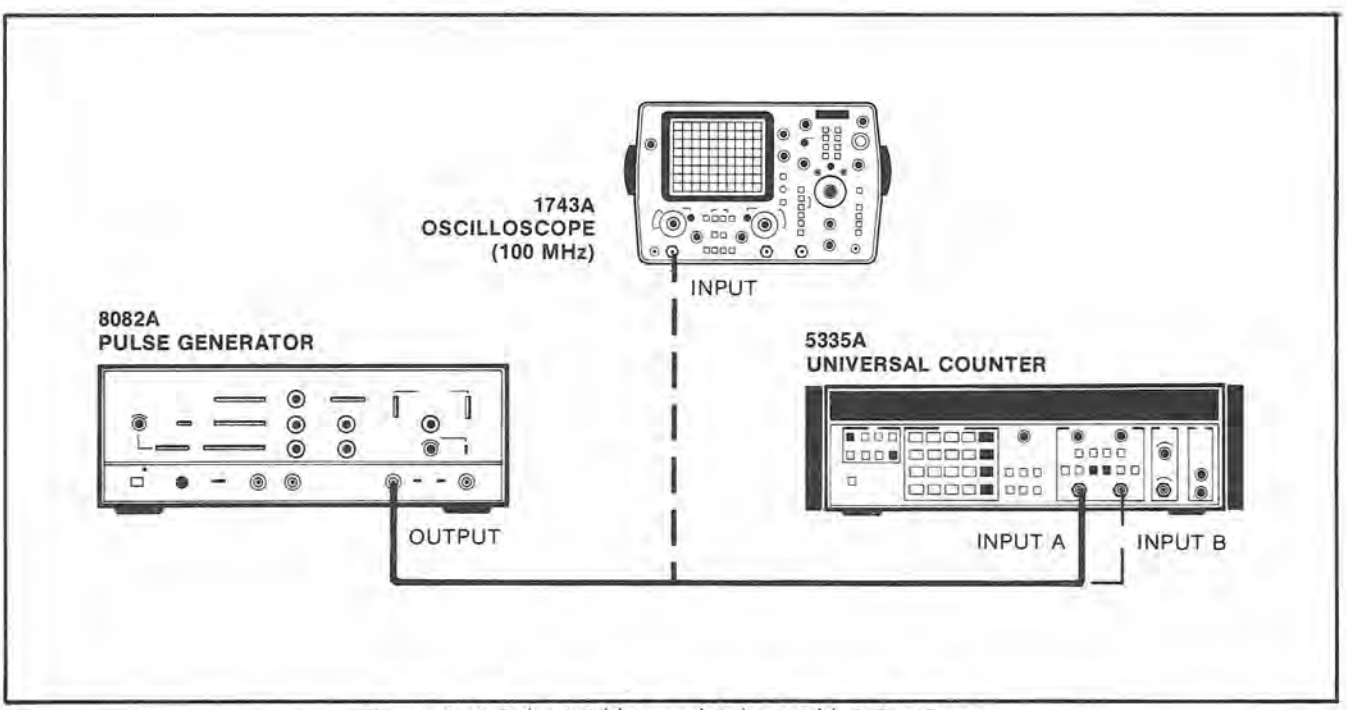


Figure 4-14. Pulse Width A and Pulse Width B Test Setup

4-74. Rise and Fall Time A Test Procedure X

4-75. Specifications:

a. Pulse transition range: 20 ns to 10 ms.
b. Minimum pulse height: 500 mV peak-peak.
c. Minimum pulse width at peak of signal: 20 ns.
d. Duty cycle range: 20% to 80%.
e. Range: 50 Hz to 25 MHz (50% duty cycle).

4-76. DESCRIPTION: A Pulse Generator provides a trapezoidal signal, which is applied to the 5335A INPUT A. The counter is set to measure the RISE and FALL TIME A of the signal. The 5335A should display the proper count.

NOTE

The waveform used in this test is also used in the SLEW RATE A test.

4-77. Perform the following steps to use the RISE and FALL A test:

a. Connect the 8082A Pulse Generator to the 5335A INPUT A as shown in *Figure 4-15*.

b. Set the 5335A front panel controls as follows:

FUNCTION ..... RISE/FALL A
MATH ..... Off (LEDs off)
STATISTICS ..... Off (LEDs off)
CYCLE ..... NORM
INPUT (Channel A and B):
1 MΩ/50Ω ..... 50Ω (ON)
X10/X1 ATTN ..... X1 (OUT/OFF)
AC/DC ..... DC (OUT/OFF)
Channel A Slope ..... POS (OUT/OFF)
FILTER (Option 040) ..... OFF

c. Using the HP 1743A oscilloscope Delta Time function, set HP 8082A to output a pulse as shown in *Figure 4-16*. Verify that the 5335A displays 400 ns ±82 ns.

d. Set the 5335A for the FALL TIME A function by setting channel A slope to NEG (IN/ON). Verify that the counter displays 400 ns ±82 ns.

e. Record results on test card (PASS/FAIL).

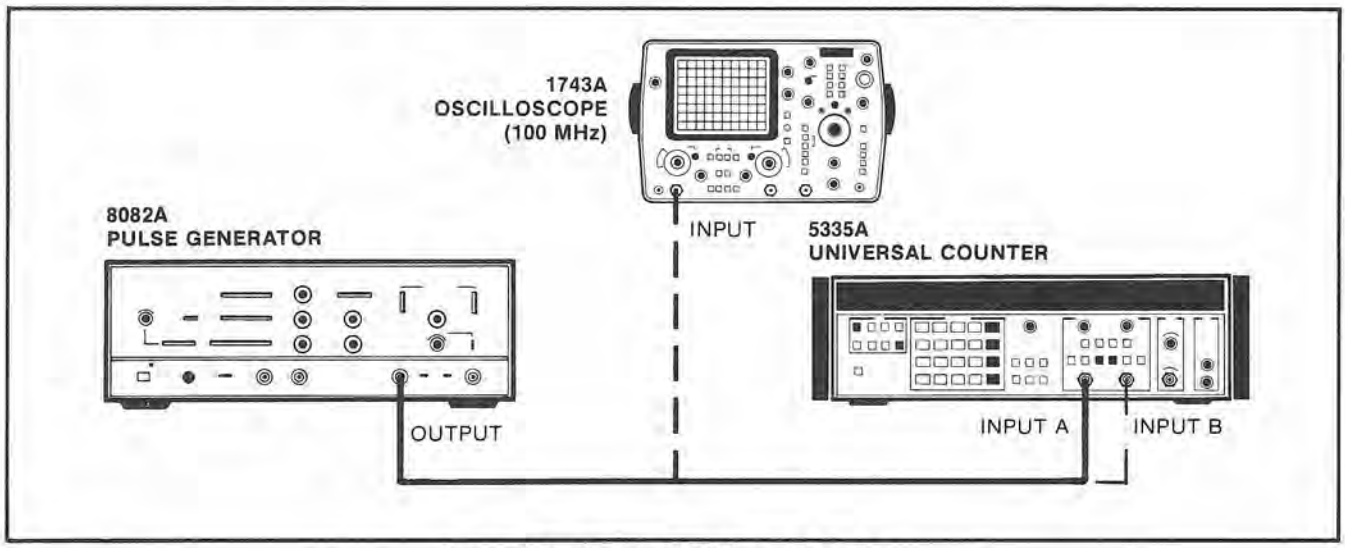


Figure 4-15. Rise and Fall Time A Test Setup

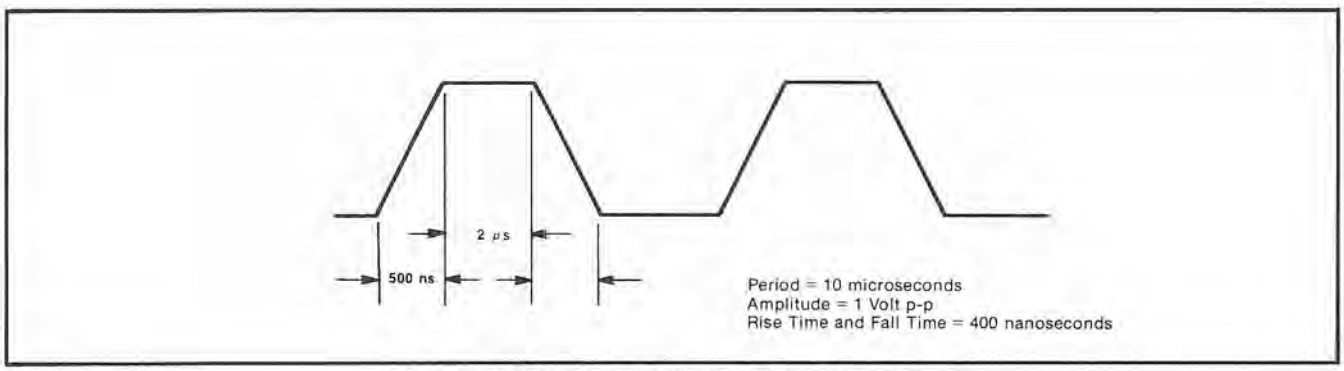


Figure 4-16. Rise and Fall Time A Test Waveform

4-78. Slew Rate A Test Procedure XI

4-79. Specifications:

a. 50 V/s to 10^{+8} V/s.

b. Range: 50 Hz to 25 MHz (50% duty cycle).

c. Minimum pulse height: 500 mV peak-to-peak.

d. Minimum pulse width at peak of signal: 20 ns.

e. Duty cycle range: 20% to 80%

4-80. DESCRIPTION: A Pulse Generator provides a trapezoidal waveform (same as for RISE/FALL TIME A), which is applied to the 5335A INPUT A. The counter is set to its SLEW RATE A function. The 5335A should display the proper count.

4-81. Perform the following steps to use the SLEW RATE test:

a. Repeat steps a and c from RISE/FALL TIME A test.

b. Set the 5335A front panel controls as follows:

FUNCTION ..... SLEW RATE A
MATH ..... Off (LEDs off)
STATISTICS ..... Off (LEDs off)
CYCLE ..... NORM
INPUT (Channel A and B):
1 MΩ/50Ω ..... 50Ω (ON)
X10/X1 ATTN ..... X1 (OUT/OFF)
AC/DC ..... DC (OUT/OFF)
Channel A Slope ... POS (OUT/OFF)
FILTER (Option 040) ..... OFF

c. Verify that the 5335A displays $2.00 \times 10^{+6}$ V/s $\pm 0.65 \times 10^{+6}$ V/s.

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

4-82. Phase A rel B Test Procedure XII

4-83. Specifications:

a. −180° to 360° (Range Hold OFF).

b. 0° to 360° (Range Hold ON).

c. Frequency Range: 30 Hz to 1 MHz.

4-84. DESCRIPTION: A Pulse Generator with complementary outputs drives both channels A and B of the 5335A under test. The counter is set to the "PHASE A rel B" function and the channels are set in SEP mode. The 5335A should display the phase relationship between the two signals.

4-85. Perform the following steps to use the PHASE A rel B test:

a. Set the 5335A front panel controls as follows:

FUNCTION ..... PHASE A rel B
MATH ..... Off (LEDs off)
STATISTICS ..... Off (LEDs off)
CYCLE ..... NORM
INPUT (Channel A and B):
1 MΩ/50Ω ..... 50Ω (ON)
X10/X1 ATTN ..... X1 (OUT/OFF)
AC/DC ..... DC (OUT/OFF)
Slope ..... POS (OUT/OFF)
FILTER (Option 040) ..... OFF
COM A ..... OUT (OFF)

b. Connect the 8082A Pulse Generator to the 5335A INPUT A and B as shown in *Figure 4-17*.

c. Set HP 8082A to output a 1 μs square wave at 1-volt peak-to-peak. Set the generator to output signals with the fastest transition time (approximately 1 ns). The 5335A should display 180° ±1.5°.

d. Record result on test card (PASS/FAIL).

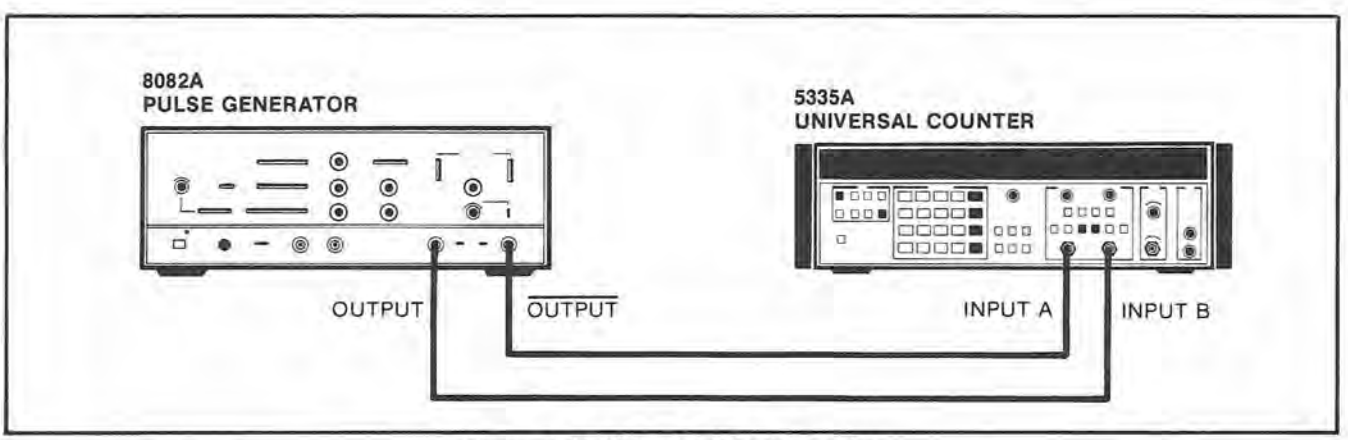


Figure 4-17. Phase A rel B Test Set-Up

4-86. DVM (Option 020) Test Procedure XIII

4-87. SPECIFICATION: The 5335A will measure input voltages in the ±1000V range. Option 020 is an autoranging, autopolarity, floating DVM, based on a voltage-to-frequency conversion design.

4-88. DESCRIPTION: A precision power supply is connected to the 5335A's DVM input. Several voltages are selected to cover the voltage range of the DVM. The 5335A should display the correct reading.

4-89. Perform the following steps to use the DVM test:

a. Set the 5335A front panel controls as follows:

FUNCTION ..... GATE TIME
MATH ..... Off (LEDs off)
STATISTICS ..... Off (LEDs off)
CYCLE ..... NORM
GATE MODE ..... NORM
GATE ADJ ..... (150 ±25) ms

b. Apply power to the 5335A, enable the volts function, then allow a 20-minute warm-up.

c. Place a jumper across the DVM's input connectors and verify that counter displays 0V ± 600 µV.

d. Record result on test card (PASS/FAIL).

e. Remove jumper from DVM input terminals.

f. Connect power supply to the 5335A DVM input terminals as shown in *Figure 4-18.*

g. Set DC Standard for 4.0000 volts. The counter should display 4.000V ±3.8 mV. Repeat for -4.0000 volts.

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

i. Set DC Standard for 40.000 volts. The counter should display 40.00V ±38 mV. Repeat for -40.000 volts.

j. Record results on test card (PASS/FAIL).

k. SET DC Standard for 400.00 volts. The 5335A should display 400.0V ±380 mV. Repeat for -400.00 volts.

l. Record results on test card (PASS/FAIL).

4-90. Channel C (Option 030) Test Procedure XIV

4-91. SPECIFICATIONS: 150 MHz to 1.3 GHz, prescaled by 20.

a. 10 mV rms sine wave (-27 dBm) to 1 GHz.

b. 100 mV rms sine wave (-7 dBm) to 1.3 GHz.

4-92. DESCRIPTION: A signal generator is connected through a power splitter to the 5335A Channel C input and to a Power Meter. The signal generator is varied over the frequency range, maintaining the specified signal level. The counter should display the correct frequencies.

4-93. Perform the following steps to use the Channel C test:

a. Set the 5335A front panel controls as follows:

FUNCTION ..... GATE TIME
MATH ..... Off (LEDs off)
STATISTICS ..... Off (LEDs off)
CYCLE ..... NORM
GATE MODE ..... NORM
GATE TIME ..... to 2 s ±0.1 s
INPUT C Sensitivity ..... MAX (CW)

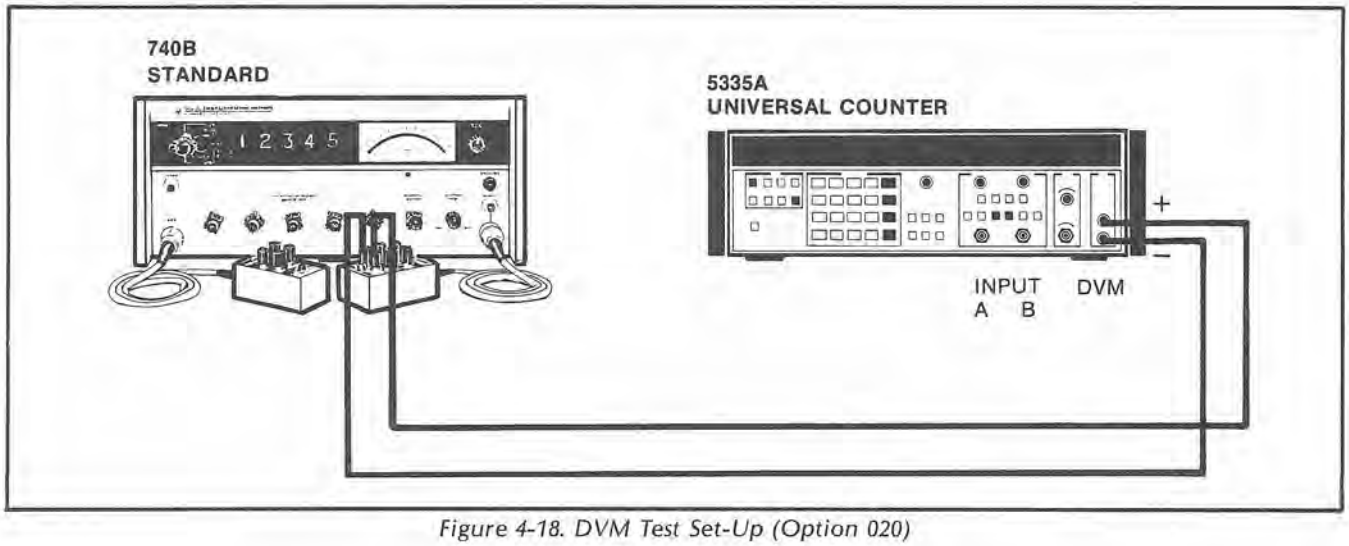


Figure 4-18. DVM Test Set-Up (Option 020)

b. Apply power to the 5335A, enable the FREQ C function, then allow a 5-minute warm-up.

150 MHz to 1 GHz

c. Connect the signal generator and the power meter to the 5335A INPUT C as shown in *Figure 4-19*.

d. Set the signal generator output such that the power meter reads –21 dBm at 150 MHz. Increase the frequency of the signal generator while maintaining a –21 dBm reading on the power meter, and verify that the 5335A displays the proper frequency from 150 MHz to 1 GHz.

e. Measure actual sensitivity by decreasing the 86603A level until the 5335A gives an unstable display at these frequencies: 150 MHz, 500 MHz, 800 MHz, 1000 MHz.

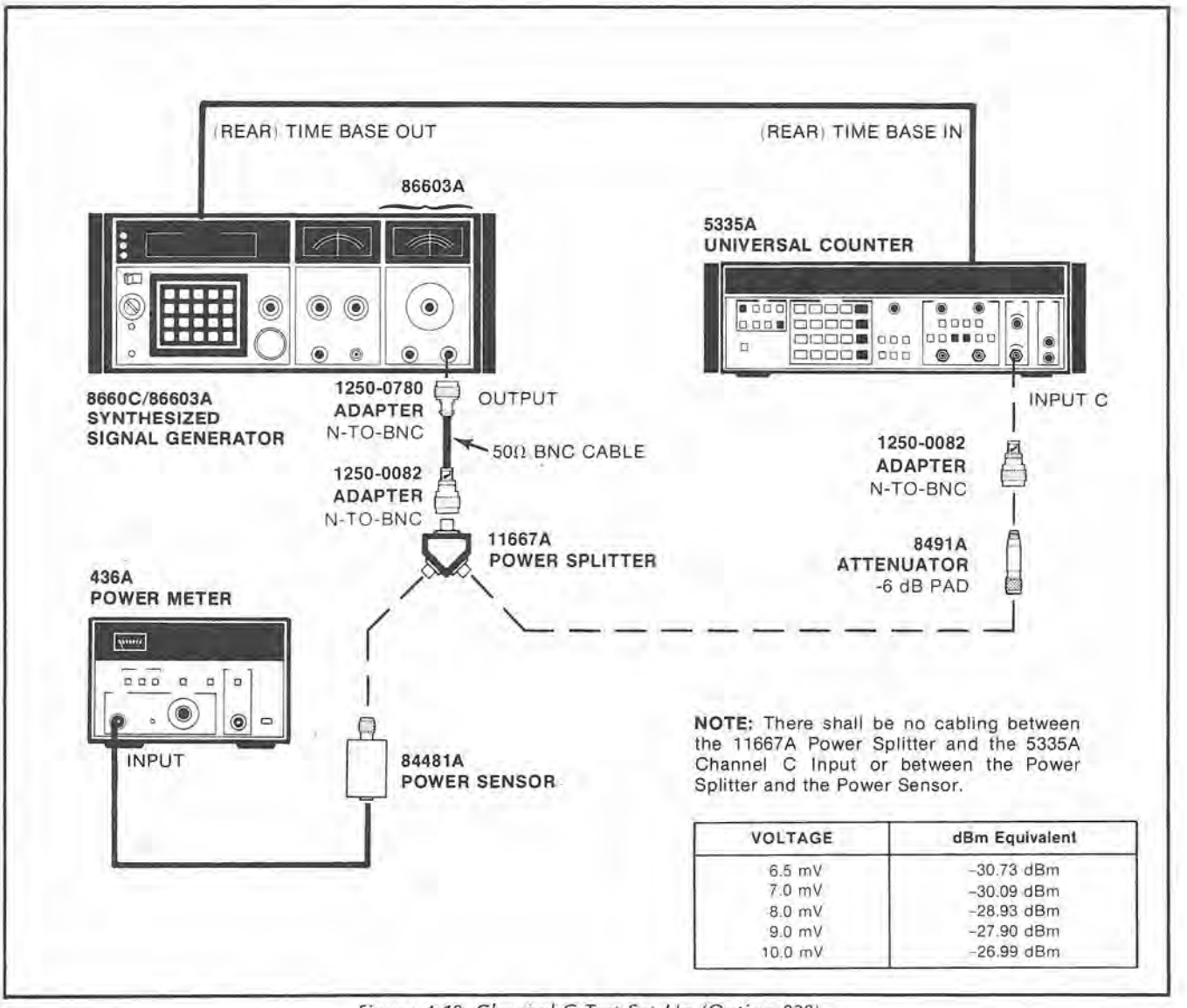
f. Record results on test card (VALUE).

1 GHz to 1.3 GHz

g. Set the 86603A for an output at 1 GHz at –1 dBm, as read on the power meter. Increase the frequency of the 8660C while maintaining a –1 dBm reading on the power meter, and verify that the 5335A displays the proper frequency from 1 GHz to 1.3 GHz.

h. Measure actual sensitivity by decreasing the 86603A level until the 5335A gives an unstable display at these frequencies: 1.1 GHz, 1.3 GHz.

i. Record results on test card (VALUE).



VOLTAGE	dBm Equivalent
6.5 mV	–30.73 dBm
7.0 mV	–30.09 dBm
8.0 mV	–28.93 dBm
9.0 mV	–27.90 dBm
10.0 mV	–26.99 dBm

Figure 4-19. Channel C Test Set-Up (Option 030)

4-94. HP-IB VERIFICATION PROGRAM USING THE 9825A CONTROLLER

4-95. The 9825A program listed in *Table 4-4* exercises the 5335A through various operating modes via the HP-IB interface. It is also designed to test Option 020 (DVM), Option 030 (Channel C), and Option 040 (Programmable Input). If the 5335A successfully completes all phases of the verification program, then there is a high probability that the HP-IB Interface (A7 and A14 assemblies), and the counter are working properly.

4-96. To perform the verification, set up the 5335A as shown in *Figure 4-20*, and set the 5335A rear panel address switches to address 28.

4-97. The program listed in *Table 4-4* may be keyed into the 9825A or loaded from an HP-IB Verification Cassette, HP Part Number 59300-10001 (revision L or later), which also contains HP-IB verification programs for the 59300 series of instruments. To run the program on the cassette, insert the cassette into the 9825A, load file Ø (type ldpØ), and press EXECUTE. Enter "5335" when the instrument model number is requested, and press CONTINUE. Enter select code "728" when the select code is requested, and press CONTINUE. The 9825A will then load the 5335A verification program into memory.

4-98. Set up the 5335A front panel switches as described in the printout, and press CONTINUE. Follow the directions described on the printout to proceed with the HP-IB verification.

4-99. The program goes through 15 check points for the standard instrument, and an additional 3 check points for Options 020, 030, and 040. The information in *Table 4-3* shows what occurs during each test and what should be observed by the operator if the test has been successfully completed. At the conclusion of each test, the program stops and displays the current check point. To advance to the next test, simply press CONTINUE. If it is desired to repeat a test, key in "**cont**" and the check point number, and press EXECUTE (e.g., to repeat test 3, key in . . . **cont "3"**). To go on to the next test after looping, press CONTINUE.

4-100. At the end of the HP-IB Verification Program, the controller will ask if you want to repeat one of the tests, Answer "1" for YES and "Ø" for NO, then push CONTINUE. If YES, the controller then asks which test is to be repeated. Enter the appropriate number for the test needed (as indicated on the printout), then press CONTINUE. The selected test will be repeated. At the end of that particular test the question whether or not to repeat a test is asked again. If you want to repeat the same test press CONTINUE three times. If not, press CONTINUE, enter Ø and press CONTINUE again.

NOTE

If the last test performed was TEST #14, Front Panel Switch Test, you will need to turn the 5335A power OFF then ON in order to return the counter to local control.

4-101. If it is desired to test a specific check point within the HP-IB Verification Program, load the tape or key in the program in the normal manner. Proceed until the controller prints the set-up information. Then key in . . . **cont "rpt"** . . . and press EXECUTE. The program will advance to the end and the controller

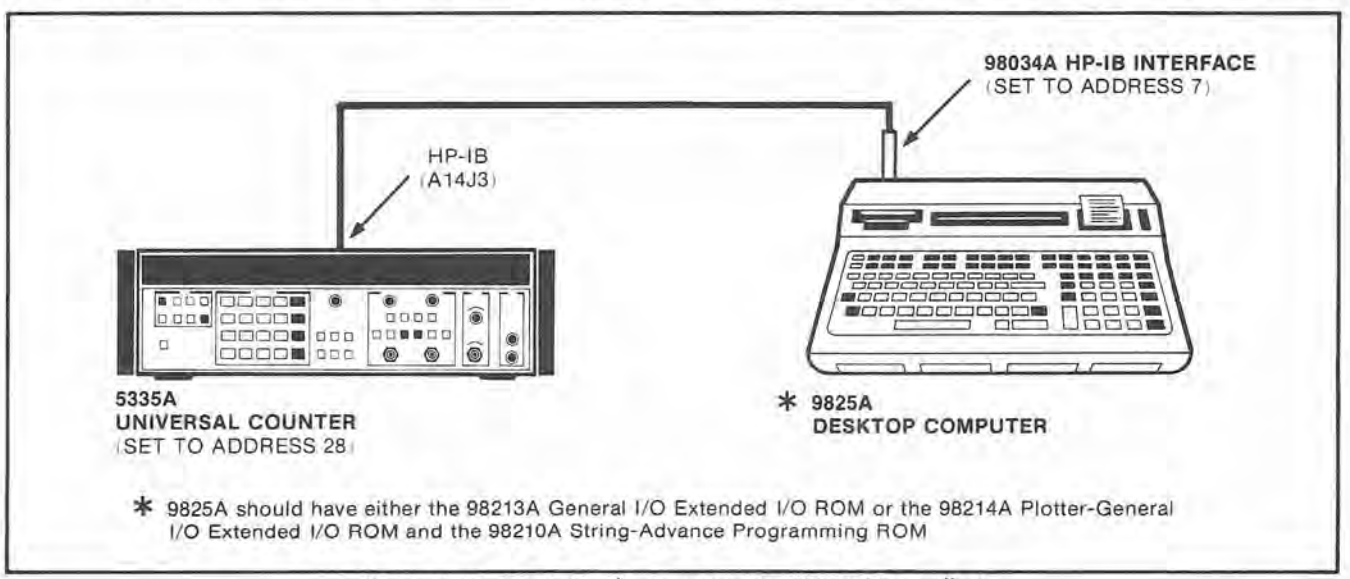


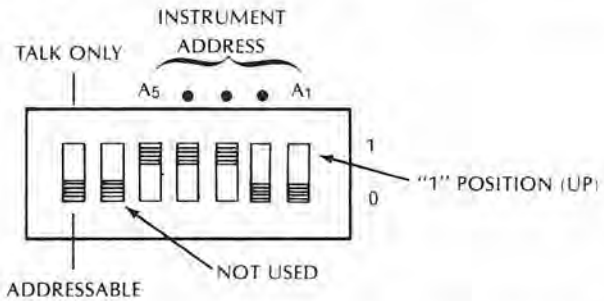
Figure 4-20. HP-IB Verification Set-Up (9825A Controller)

will ask if you want to repeat one of the tests. Then use the method described in paragraph 4-99.

4-102. To perform the HP-IB verification proceed as follows:

a. Set-up the 5335A and the 9825A as shown in *Figure 4-20.*

b. Set the 5335A rear panel ADDRESS switch (A14S1) as follows:



c. Key the program listed in *Table 4-4* into the 9825A, or insert cassette, HP P/N 59300-10001 (revision L or later).

d. Load and run file Ø. (key in . . . . . ldpØ); press EXECUTE.

e. Key in the model number of the instrument to be tested (i.e., 5335); press CONTINUE.

f. Key in select code **728**; press CONTINUE.

g. Set-up the 5335A as described in the printout and press CONTINUE.

h. Always press CONTINUE to advance the program.

Table 4-3. 9825A Verification Program Prinout

```
****************

5335A UNIVERSAL
COUNTER HP-IB
Verification
Program.

****************


CONNECT:
Time Base Out
from rear panel
to INPUT A.
```

Set-up instructions for the 5335A front panel.

Table 4-3. 9825A Verification Program Printout (Continued)

```
CHECK POINT  1
5335A POWER-UP
CHECK.

Turn 5335A power
OFF then ON.


VERIFY:
*RED LED 'STBY'
 lamp is OFF
*All display
 ennunciator
 lamps turn ON
 momentarily
 (excluding
 'STBY' and
 trigger lamps)
*Display shows
 the selected
 HP-IB address
 for about 1 sec
*Display then
 shows '0'
 momentarily;
 Funtion FREQ A
 and Hz annun.
 lamps are ON
*Then 5335A will
 display:
 10. 000 000 +6
 with 'Hz' LED
 ON; 'GATE', 'A'
 and 'B' Trigger
 lites flashing.
```

Checks the 5335A power-up conditions and performs basic Frequency A measurement.

```
CHECK POINT  2
Program sends
5335A 'listen'
address.

Verify:
Display is same
as above except
'LISTEN' and
'REMOTE'
ennunciators
are lit.
```

Set the 5335A in the "REMOTE" and "LISTEN" state.

Table 4-3. 9825A Verification Program Printout (Continued)

```
----------------
CHECK POINT  3


SETUP:
both chans
50 ohms;X1;DC;
all slopes=pos;
levels = preset;
sep/com A=com A;
Auto Trig. ON;
Gate Adj.=
full ccw.


Program sends
5335A talk
address. Verify:
Display is same
as CHECK POINT 1
except 'TALK'
and 'REMOTE'
annunciators
are lit.


OUTPUT test:
Verify:
Same reading on
calculator
display
as on 5335A
display.
(Available for
10 seconds.)


----------------
CHECK POINT  4
Press LOC/RESET
on 5335A.
Verify: 'REMOTE'
LED goes out.
```

Addresses the 5335A to make a FREQ A measurement and to output the data.

Operator verification of proper operation of the front panel LOC/REM function. (No remote codes sent.)

Table 4-3. 9825A Verification Program Printout (Continued)

```
----------------
CHECK POINT  5
Program sets
5335A in the
'local-lockout'
mode.
Press LOC/RESET
on the 5335A and
verify that
'REMOTE' LED
stays ON.
```

Programs the 5335A to go-to-remote and activates counters local-lockout (LLO).

```
----------------
CHECK POINT  6
Program sets
5335A in the
WAIT and
SERVICE REQUEST
mode.

Verify that the
following LEDs
are lit during
five (5)
measurements:
*   TALK
*   LISTEN
*   SRQ
*   REMOTE
```

The 5335A is programmed to wait until it is addressed to talk before making another measurement. At the end of the measurements the program will "beep".

Table 4-3. 9825A Verification Program Printout (Continued)

```
CHECK POINT  7
TEACH-LEARN Test

Verify that the
5335A displays
11. 224 49 +15
Hz.


5335A will teach
the 9825A the
front panel
setup.


Verify that the
5335A displays
100. 000 00 -9
with 'S' and
Function PER A
lites ON, and
'GATE' LED fla-
shing.


5335A will learn
from 9825A.
Verify that the
5335A displays
11. 224 49 +15
Hz.
```

The 5335A is first programmed for a particular setting, then the counter will teach the 9825A the front panel setup. When CONTINUE is pressed, the 5335 is set up for a Period A measurement.

When CONTINUE is pressed again, the 5335A will learn from the 9825A.

Table 4-3. 9825A Verification Program Printout (Continued)

```
CHECK POINT  8
FREQ B Test.

SETUP:
Connect TBO from
rear panel to
INPUT B.


VERIFY:
*5335A displays
 10. 000 000 +6
*'Hz' lamp ON
*'GATE' lamp
 flashing
*'TALK' and
 'REMOTE' lamps
 are lit
*All FUNCTION
 lamps OFF
*'B' trigger
 light flashing.
```

The 5335A is set up and programmed for a Frequency B measurement.

```
CHECK POINT  9
TRIG LEVEL Test.

Program sets
Trig Lvl funct.

VERIFY:
Trigger Level A=
+0.00V  (actual)

Trigger Level B=
+0.00V  (actual)
```

The 5335A is set up to measure and display Channel A and B trigger levels.

Table 4-3. 9825A Verification Program Printout (Continued)

```
CHECK POINT  10
GATE TIME Test.

GATE ADJ. Normal
Range test.
Vary 'GATE ADJ.'
pot and verify
change in Gate
Time displayed,
NOMINALLY,
between 20
milliseconds
and 4 seconds.


GATE ADJ. Fast
Range test.
Vary 'GATE ADJ.'
pot and verify
change in Gate
Time displayed,
NOMINALLY,
between 100
microseconds
and 20 milli-
seconds.
```

Both gate time ranges of the 5335A are programmed.

Table 4-3. 9825A Verification Program Printout (Continued)

```
CHECK POINT  11
RISE/FALL TIME
Test.

SETUP:
Connect TBO from
rear panel to
INPUT A.


RISE TIME test.
VERIFY:
*RISE/FALL A
 lamp is ON
*5335A displays
 approximately
 30 nanoseconds
*Gate Mode MIN
 lamp is ON
*'GATE' lamp
 flashing
*'A' and 'B'
 trigger lamps
 flashing
*'TALK'
 lamp ON
*'REMOTE'
 lamp ON.


FALL TIME test.
Verify:  5335A
display is about
the same as for
Rise Time test.
```

The 5335A is exercised in the Rise and Fall Time mode.

Table 4-3. 9825A Verification Program Printout (Continued)

```
------      -----
CHECK POINT  12
OVERFLOW Test.

Verify ONLY
lamps lit during
the 11 seconds
wait period:
*FREQ A
*GATE MODE
 Manual
*'Hz'
*'GATE'
*'LISTEN'
*'REMOTE'
*'A' trigger
 lamp (flashing)
5335A Display:
'0.'


Verify:
Same as above
except---
*5335A displays
+10.000000002 +6
 (actual)
*'LISTEN'
 lamp is OFF
*'GATE'
 lamp is OFF
*'TALK'
 lamp is ON.
```

CHECK POINT 12 exercises the "gate open" and "gate closed" functions.

Table 4-3. 9825A Verification Program Printout (Continued)

```
CHECK POINT  13
TIME INTERVAL
Test.

VERIFY:
*TIME A→B
 lamp is ON
*5335A displays
 approximately
 50 nanoseconds
*Gate Mode MIN
 lamp is ON
*'GATE' lamp
 flashing
*'A' and 'B'
 trigger lamps
 flashing
*'TALK'
 lamp ON
*'REMOTE'
 lamp ON.
```

The 5335A is programmed in the TIME A→B function.

```
INVERSE TIME
INTERVAL Test.
VERIFY:
*1/TIME A→B
 lamp is ON
*5335A displays
 approximately
 20.   +6
*Gate Mode MIN
 lamp is ON
*'GATE' lamp
 flashing
*'A' and 'B'
 trigger lamps
 flashing
*'TALK'
 lamp ON
*'REMOTE'
 lamp ON.
```

The INVERSE TIME A→B is exercised; the actual displayed value may differ.

Table 4-3. 9825A Verification Program Printout (Continued)

```
----------------
CHECK POINT  14
FRONT PANEL
Switch Test.

Press each
momentary type
key on the 5335A
front panel,
beginning with
upper left key
(MATH DISABLE)
and go down each
column.


Press CONTINUE
to perform test.


A number will be
displayed when
a key is pressed
corresponding to
FIGURE A.
```

Programs the 5335A for Diagnostic #17.

Figure A

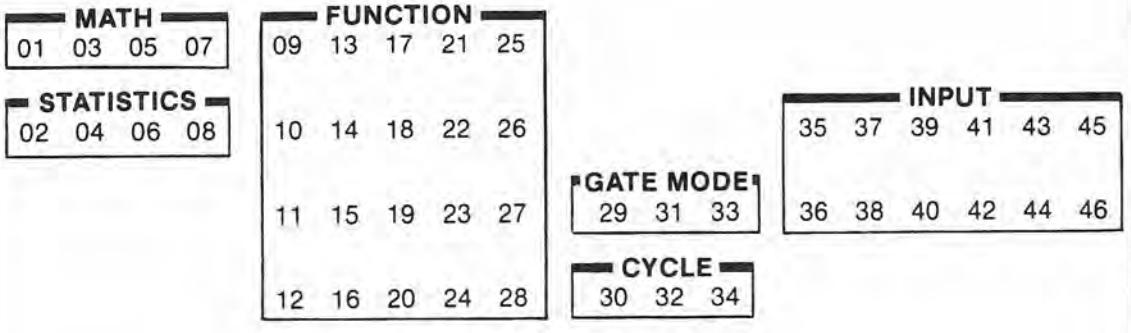


Table 4-3. 9825A Verification Program Printout (Continued)

```
CHECK POINT  15
FRONT END Test.

VERIFY:
*All display
 annunciator
 lamps turn ON
 for about 5
 seconds
*5335A displays
 'FE PASS'
 for about 15
 seconds
*Then 5335A will
 display:
 the voltages at
 A2U4(2,12,10);
 NOMINAL values
 are:
  5. 000 00 V
  3. 100 00 V
 -5. 200 00 V
```

The 5335A is programmed to fully test the front end by connecting the Time Base Out to INPUT A.

```
CHECK POINT  16
OPTION 020 Test.

SETUP:
Connect Trigger
Level 'A' from
rear panel to
DVM input jack;
set PRESET 'A'
off, but in CCW
position.

Verify that
5335A displays
approximately
-5.XXX Volts.


Rotate 'A' level
control CW
and check
that display is
about the same
as before with
opposite sign.
```

The 5335A is set up to verify the proper operation of the DVM, Option 020.

Table 4-3. 9825A Verification Program Printout (Continued)

```
----------------
CHECK POINT  17
OPTION 030 Test.

SETUP:
Connect an
86603A to 5335A
'C' Input and
8660C TBO to
5335A Time
Base In.


Verify that
5335A displays
the frequency of
the 8660C.
(150MHz→1.3GHz)
```

Programs and verifies the correct operation of the Channel C, Option 030.

```
----------------
CHECK POINT  18
OPTION 040 Test.

VERIFY:
All INPUT momen-
tary switches
are activated
& de-activated.
```

Exercises Option 040 Front End Input momentary switches.

```
DAC Test.


Pass DAC Test.
```

Performs a functional test on the 5335A Channel A and B DACS.

```
****************

  END OF 5335A
  HP-IB TEST.

****************
```

Table 4-4. 5335A HP-IB Verification Program Listing (9825A Controller)

```
0: "5335A HP-IB VERIFICATION PROGRAM  --  REV. B":
1:
2: dim A$[32],B$[20],C$[16],D$[16],E$[40],F$[20],A[30]
3: "CHECK POINT    --Press CONTINUE."→A$
4: "----------------"→D$;"****************"→C$
5: "Press CONTINUE  to perform test."→E$;0→X→Y
6: "code":ent "Select code ?",S
7: if S=721;dsp "Error: calculator address";wait 2000;gto "code"
8: if S>730;dsp "Out of address range → high";wait 2000;gto "code"
9: if S<700;dsp "Out of address range → low";wait 2000;gto "code"
10: dev "sj",S;prt C$;spc ;prt "5335A UNIVERSAL","COUNTER HP-IB"
11: prt "Verification","Program.";spc ;prt C$;spc 2
12: prt "CONNECT:","Time Base Out","from rear panel","to INPUT A.";spc 3
13: dsp A$[18];stp
14: "1":dsp A$[1,11]," 1"
15: prt D$;wrt 16,A$[1,13],"1"
16: prt "5335A POWER-UP","CHECK.";spc
17: prt "Turn 5335A power","OFF then ON.";spc 2;dsp A$[18];stp
18: prt "VERIFY:","*RED LED 'STBY'"
19: prt " lamp is OFF","*All display"," annunciator"," lamps turn ON"
20: prt " momentarily"," (excluding"," 'STBY' and"," trigger lamps)"
21: prt "*Display shows"," the selected"," HP-IB address"
22: prt " for about 1 sec","*Display then"," shows '0'"," momentarily;"
23: prt " Funtion FREQ A"," and Hz annun."
24: prt " lamps are ON","*Then 5335A will"," display:"
25: prt " 10. 000 000 +6"," with 'Hz' LED"," ON; 'GATE', 'A'"
26: prt " and 'B' Trigger"," lites flashing.";spc 2
27: dsp A$[1,11]," 1",A$[16];stp
28: if X=1;gto "rpt"
29: "2":dsp A$[1,11]," 2"
30: prt D$;wrt 16,A$[1,13],"2"
31: prt "Program sends","5335A 'listen'","address.";spc
32: prt "Verify:","Display is same","as above except","'LISTEN' and"
33: prt "'REMOTE'","annunciators","are lit.";spc 2
34: wrt "sj"
35: dsp A$[1,11]," 2",A$[16];stp
36: if X=1;gto "rpt"
37: "3":dsp A$[1,11]," 3";lcl "sj"
38: prt D$;wrt 16,A$[1,13],"3";spc 2
39: prt "SETUP:","both chans","50 ohms,X1,DC,","all slopes=pos,"
40: prt "levels = preset,","sep/com A=com A,","Auto Trig. ON,"
41: prt "Gate Adj.=","full ccw.";spc 2;dsp E$;stp
42: prt "Program sends","5335A talk","address. Verify:"
43: prt "Display is same","as CHECK POINT 1"
44: prt "except 'TALK'","and 'REMOTE'","annunciators","are lit.";spc 2
45: wrt "sj","in";red "sj",B$;dsp A$[1,11]," 3",A$[16];stp
46: prt "OUTPUT test:","Verify:","Same reading on","calculator","display"
47: prt "as on 5335A","display.","(Available for","10 seconds.)";spc 2
48: dsp E$;stp
49: for I=1 to 30;red "sj",B$;dsp B$;next I;beep
50: dsp A$[1,11]," 3",A$[16];stp
51: if X=1;gto "rpt"
52: "4":dsp A$[1,11]," 4"
53: prt D$;wrt 16,A$[1,13],"4"
```

Table 4-4. 5335A HP-IB Verification Program Listing (9825A Controller) (Continued)

```
54: prt "Press LOC/RESET","on 5335A.","Verify: 'REMOTE'","LED goes out."
55: spc 2
56: dsp A$[1,11]," 4",A$[16];stp
57: if X=1;gto "rpt"
58: "5":dsp A$[1,11]," 5"
59: prt D$;wrt 16,A$[1,13],"5"
60: prt "Program sets","5335A in the","'local-lockout'","mode."
61: prt "Press LOC/RESET","on the 5335A and","verify that","'REMOTE' LED"
62: prt "stays ON.";spc 2
63: wrt "sj";llo 7
64: dsp A$[1,11]," 5",A$[16];stp
65: if X=1;gto "rpt"
66: "6":dsp A$[1,11]," 6"
67: prt D$;wrt 16,A$[1,13],"6"
68: prt "Program sets","5335A in the","WAIT and","SERVICE REQUEST","mode."
69: spc ;prt "Verify that the","following LEDs","are lit during"
70: prt "five (5)","measurements:"
71: prt "*  TALK","*  LISTEN","*  SRQ","*  REMOTE";spc 2;stp ;dsp E$
72: lcl "sj";wrt "sj","walsrl";0→I
73: oni 7,"SRQ"
74: eir 7
75: gto -1;if I>5;gto 81
76: "SRQ":for I=1 to 5
77: if bit(6,rds("sj"));red "sj",B$;dsp B$
78: wrt "sj","re";wait 1000
79: next I
80: iret
81: dsp A$[1,11]," 6",A$[16];beep;stp
82: if X=1;gto "rpt"
83: "7":dsp A$[1,11]," 7"
84: prt D$;wrt 16,A$[1,13],"7"
85: prt "TEACH-LEARN Test";spc
86: prt "Verify that the","5335A displays","11. 224 49 +15  Hz.";spc 2
87: dsp F$;stp
88: rem "sj";wrt "sj","fulmsl122448800"
89: prt "5335A will teach","the 9825A the","front panel","setup.";spc 2
90: wrt "sj","pg"
91: for I=1 to 30
92: rdb("sj")→A[I];next I
93: gto -1;if A[24]=17 and A[25]=34;gto +1
94: gto -2;if A[26]=68 and A[27]=136 and A[28]=0 and A[29]=0;gto +1
95: dsp "5335A → 9825A   ",A$[18];0→I;stp
96: prt "Verify that the","5335A displays","100. 000 00 -9"
97: prt "with 'S' and","Function PER A","lites ON, and"
98: prt "'GATE' LED fla-","shing."
99: wrt "sj","fu9";lcl "sj"
100: spc 2;dsp A$[1,11],"7",A$[16];stp
101: prt "5335A will learn","from 9825A.","Verify that the"
102: prt "5335A displays","11. 224 49 +15  Hz.";spc 2
103: wtb "sj","pb";for I=1 to 30;wtb "sj",A[I];next I;lcl "sj"
104: dsp "9825A → 5335A   ",A$[18];stp
105: if X=1;gto "rpt"
106: "8":dsp A$[1,11]," 8"
107: prt D$;wrt 16,A$[1,13],"8"
108: prt "FREQ B Test.";spc ;prt "SETUP:","Connect TBO from","rear panel to"
109: prt "INPUT B.";spc 2;dsp A$[1,11]," 8",A$[16];stp
110: prt "VERIFY:","*5335A displays"," 10. 000 000 +6","*'Hz' lamp ON"
```

Table 4-4. 5335A HP-IB Verification Program Listing (9825A Controller) (Continued)

```
111: prt "*´GATE´ lamp"," flashing","*´TALK´ and"
112: prt " ´REMOTE´ lamps"," are lit","*All FUNCTION"," lamps OFF"
113: prt "*´B´ trigger"," light flashing.";spc 2
114: wrt "sj","co0ful7";red "sj",B$
115: dsp A$[1,11]," 8",A$[16];stp
116: if X=1;gto "rpt"
117: "9":dsp A$[1,11]," 9"
118: prt D$;wrt 16,A$[1,13],"9"
119: prt "TRIG LEVEL Test.";spc
120: wrt "sj","ful4";red "sj",B$,F$
121: prt "Program sets","Trig Lvl funct.";spc ;prt "VERIFY:"
122: wrt 16,"Trigger Level A="
123: wrt 16,B$[11,15],"V  (actual)";spc
124: prt "Trigger Level B="
125: wrt 16,F$[11,15],"V  (actual)";spc 2
126: dsp A$[1,11]," 9",A$[16];stp
127: if X=1;gto "rpt"
128: "10":dsp A$[1,11],"10";prt D$;wrt 16,A$[1,13],"10"
129: prt "GATE TIME Test.";spc
130: prt "GATE ADJ. Normal","Range test.","Vary ´GATE ADJ.´"
131: prt "pot and verify","change in Gate","Time displayed,","NOMINALLY,"
132: prt "between 20","milliseconds","and 4 seconds.";spc 2
133: wrt "sj","ful3gm0rh0";dsp A$[1,11],"10",A$[16];red "sj",B$;stp
134: prt "GATE ADJ. Fast","Range test.","Vary ´GATE ADJ.´"
135: prt "pot and verify","change in Gate","Time displayed,","NOMINALLY,"
136: prt "between 100","microseconds","and 20 milli-","seconds.";spc 2
137: wrt "sj","ful3gm1rh0";red "sj",B$
138: dsp A$[1,11],"10",A$[16];stp
139: if X=1;gto "rpt"
140: "11":prt D$;wrt 16,A$[1,13],"11";dsp A$[1,11],"11"
141: prt "RISE/FALL TIME","Test.";spc
142: prt "SETUP:","Connect TBO from","rear panel to","INPUT A.";spc 2
143: dsp E$;stp
144: dsp A$[1,11],"11";prt "RISE TIME test."
145: prt "VERIFY:","*RISE/FALL A"," lamp is ON"
146: prt "*5335A displays"," approximately"," 30 nanoseconds"
147: prt "*Gate Mode MIN"," lamp is ON","*´GATE´ lamp"," flashing"
148: prt "*´A´ and ´B´"," trigger lamps"," flashing","*´TALK´"
149: prt " lamp ON","*´REMOTE´"," lamp ON.";spc 2
150: wrt "sj","inful0";wait 3000
151: dsp A$[1,11],"11",A$[16];red "sj",B$;stp
152: dsp A$[1,11],"11";prt "FALL TIME test."
153: prt "Verify:  5335A","display is about","the same as for"
154: prt "Rise Time test.";spc 2
155: wrt "sj","as1";wait 3000
156: dsp A$[1,11],"11",A$[16];red "sj",B$;stp
157: if X=1;gto "rpt"
158: "12":dsp A$[1,11],"12";prt D$;wrt 16,A$[1,13],"12"
159: prt "OVERFLOW Test.";spc
160: prt "Verify ONLY","lamps lit during","the 11 seconds","wait period:"
161: prt "*FREQ A","*GATE MODE"," Manual","*´Hz´","*´GATE´","*´LISTEN´"
162: prt "*´REMOTE´","*´A´ trigger"," lamp (flashing)"
163: prt "5335A Display:","´0.´";spc 2
164: dsp E$;stp
165: wrt "sj","ingm3go";dsp A$[1,11],"12";wait 11000;wrt "sj","gc"
166: red "sj",B$;beep
167: prt "Verify:","Same as above","except---","*5335A displays"
```

Table 4-4. 5335A HP-IB Verification Program Listing (9825A Controller) (Continued)

```
168: wrt 16,B$[3,15]," +",B$[19];prt " (actual)"
169: prt "*´LISTEN´"," lamp is OFF","*´GATE´"," lamp is OFF"
170: prt "*´TALK´"," lamp is ON.";spc 2
171: dsp A$[1,11],"12",A$[16];stp
172: if X=1;gto "rpt"
173: "13":dsp A$[1,11],"13";prt D$;wrt 16,A$[1,13],"13"
174: prt "TIME INTERVAL","Test.";spc
175: prt "VERIFY:","*TIME A→B"," lamp is ON"
176: prt "*5335A displays"," approximately"," 50 nanoseconds"
177: prt "*Gate Mode MIN"," lamp is ON","*´GATE´ lamp"," flashing"
178: prt "*´A´ and ´B´"," trigger lamps"," flashing","*´TALK´"
179: prt " lamp ON","*´REMOTE´"," lamp ON.";spc 2
180: wrt "sj","infu2bs1col";dsp A$[1,11],"13",A$[16];red "sj",B$;stp
181: dsp A$[1,11],"13";prt "INVERSE TIME","INTERVAL Test."
182: prt "VERIFY:","*1/TIME A→B"," lamp is ON"
183: prt "*5335A displays"," approximately"," 20.  +6"
184: prt "*Gate Mode MIN"," lamp is ON","*´GATE´ lamp"," flashing"
185: prt "*´A´ and ´B´"," trigger lamps"," flashing","*´TALK´"
186: prt " lamp ON","*´REMOTE´"," lamp ON.";spc 2
187: wrt "sj","fu6";dsp A$[1,11],"13",A$[16];red "sj",B$;stp
188: if X=1;gto "rpt"
189: "14":dsp A$[1,11],"14";prt D$;wrt 16,A$[1,13],"14"
190: prt "FRONT PANEL","Switch Test.";spc
191: prt "Press each","momentary type"
192: prt "key on the 5335A","front panel,","beginning with"
193: prt "upper left key","(MATH DISABLE)"
194: prt "and go down each","column.";spc 2
195: prt E$;dsp "    See FIGURE A !!!!!";spc 2;stp
196: wrt "sj","fu99ms17";wait 100;lcl "sj"
197: prt "A number will be","displayed when"
198: prt "a key is pressed","corresponding to"
199: prt "FIGURE A.";spc 2;dsp A$[1,11],"14",A$[16];stp
200: if X=1;gto "rpt"
201: "15":dsp A$[1,11],"15";prt D$;wrt 16,A$[1,13],"15"
202: prt "FRONT END Test.";spc
203: prt "VERIFY:","*All display"," annunciator"," lamps turn ON"
204: prt " for about 5"," seconds","*5335A displays"," ´FE PASS´"
205: prt " for about 15"," seconds","*Then 5335A will"," display:"
206: prt " the voltages at A2U4(2,12,10);  NOMINAL values  are:"
207: prt "  5. 000 00 V","  3. 100 00 V"," -5. 200 00 V";spc 2
208: wrt "sj","fu99ms0"
209: dsp A$[1,11],"15",A$[16];stp
210: if X=1;gto "rpt"
211: "16":ent "OPTION 020 (1=Y,0=N) ?",A
212: if A#0 and A#1;gto -1
213: if A=0;gto "17"
214: prt D$;wrt 16,A$[1,13],"16";dsp A$[1,11],"16"
215: prt "OPTION 020 Test.";spc ;prt "SETUP:","Connect Trigger"
216: prt "Level ´A´ from","rear panel to","DVM input jack;"
217: prt "set PRESET ´A´  off, but in CCW position.";spc
218: prt "Verify that","5335A displays","approximately","-5.XXX Volts."
219: spc 2;dsp E$;red "sj",B$;stp
220: wrt "sj","fu15"
221: prt "Rotate ´A´ level","control CW ","and check"
222: prt "that display is","about the same","as before with"
223: prt "opposite sign.";spc 2
224: dsp A$[1,11],"16",A$[16];red "sj",B$;stp
```

Table 4-4. 5335A HP-IB Verification Program Listing (9825A Controller) (Continued)

```
225: if X=1;gto "rpt"
226: "17":ent "OPTION 030 (1=Y,0=N) ?",B
227: if B#0 and B#1;gto -1
228: if B=0;gto "18"
229: prt D$;wrt 16,A$[1,13],"17";dsp A$[1,11],"17"
230: prt "OPTION 030 Test.";spc ;prt "SETUP:","Connect an"
231: prt "86603A to 5335A","'C' Input and","8660C TBO to"
232: prt "5335A Time","Base In.";spc 2
233: dsp E$;stp
234: wrt "sj","fu5";red "sj",B$;dsp A$[1,11],"17"
235: prt "Verify that","5335A displays","the frequency of","the 8660C."
236: prt "(150MHz→1.3GHz)";spc 2
237: dsp A$[1,11],"17",A$[16];stp
238: if X=1;gto "rpt"
239: "18":ent "OPTION 040  (1=Y, 0=N) ?",C;1000→D;.02→G
240: if C#0 and C#1;gto -1
241: if C=0;gto "rpt"
242: prt D$;wrt 16,A$[1,13],"18";dsp A$[1,11],"18"
243: prt "OPTION 040 Test.";spc ;prt "VERIFY:","All INPUT momen-"
244: prt "tary switches","are activated","& de-activated.";spc 2;dsp E$;stp
245: wrt "sj","inaflasl";wait D;wrt "sj","azlaal";wait D
246: wrt "sj","axl";wait D;wrt "sj","bxl";wait D
247: wrt "sj","bzlbal";wait D;wrt "sj","bflbsl";wait D
248: wrt "sj","colaul";wait D;wrt "sj","co0au0";wait D
249: wrt "sj","bf0bs0";wait D;wrt "sj","bz0ba0";wait D;wrt "sj","bx0";wait D
250: wrt "sj","ax0";wait D;wrt "sj","az0aa0";wait D;wrt "sj","intrlat0bt0"
251: prt "DAC Test.";spc 2;dsp E$;stp
252: for E=0 to 9;-5.12+2^E*.01→F;wrt "sj","ful4at",F,"bt",F
253: "DACS":red "sj",B$,F$;dsp A$[1,11],"18"
254: if abs(val(B$[11])-F)>G or abs(val(F$[11])-F)>G;gto "ERROR"
255: wait 1000;next E
256: for E=0 to 9;5.12-2^E*.01→F;wrt "sj","at",F,"bt",F
257: "DACS":red "sj",B$,F$;dsp A$[1,11],"18"
258: if abs(val(B$[11])-F)>G or abs(val(F$[11])-F)>G;gto "ERROR"
259: wait 1000;next E;prt "Pass DAC Test.";spc 2;gto 262
260: "ERROR":dsp "DACs are out of tolerance";beep;wait 500;beep;stp
261: gto "rpt"
262: dsp A$[1,11],"18",A$[16];stp
263: "rpt":ent "Repeat a Check Point (1=Y,0=N) ?",X
264: if X#1 and X#0;gto -1
265: if X=0;gto "end"
266: if X=1;ent "Check Point number (1 thru 18) ?",N
267: if N>18 or N<1;gto -1
268: jmp N
269: gto "1"
270: gto "2"
271: gto "3"
272: gto "4"
273: gto "5"
274: gto "6"
275: gto "7"
276: gto "8"
277: gto "9"
278: gto "10"
279: gto "11"
280: gto "12"
281: gto "13"
```

Table 4-4. 5335A HP-IB Verification Program Listing (9825A Controller (Continued)

```
282: gto "14"
283: gto "15"
284: gto "16"
285: gto "17"
286: gto "18"
287: "end":prt C$;spc ;prt "  END OF 5335A","  HP-IB TEST."
288: beep;wait 500;beep;spc ;prt C$;spc 6
289: wrt "sj","in";lcl "sj";dsp "END OF 5335A HP-IB TEST."
290: end
*24989
```

4-103. 5335A HP-IB VERIFICATION PROGRAM USING THE HP 85A CONTROLLER

4-104. The HP 85A program listed in *Table 4-5* exercises the 5335A through various operating modes via the HP-IB interface; it is also designed to test Option 020 (DVM), Option 030 (Channel C), and Option 040 (Programmable Input). If the 5335A successfully completes all phases of the verification program, then there is a very high probability that the interface and the counter are working properly.

4-105. To perform the verification, set up the 5335A as shown in *Figure 4-21*.

4-106. Perform the following steps:

a. Key-in the program listed in *Table 4-5* or insert cassette, HP Part Number 59300-10002 into the HP 85A.

b. Load and run file "Autost" (type: 'CHAIN "Autost"'; press 'END LINE').

c. Press the special function key corresponding to the model number to be tested. Follow instructions on HP 85A screen.

d. Set up counter as described in the display.

e. Set the ADDRESS switches to any value between 00 and 30 inclusive, except the controller address (decimal 21).

f. Always press "CONTINUE" to advance program.

4-107. At the end of the HP-IB Verification Program, the controller will ask if you want to repeat one of the tests. Enter the appropriate number for the test needed (as indicated on the controller display), then press: "END LINE"; the selected test will then be repeated. Enter Ø if you wish to terminate the test program. At the end of the particular test, the question of whether you wish to repeat a test is asked again. If you want the same test, enter the test number, and press "END LINE".

4-108. Use the following procedure if it is desired to test a specific check-point with the HP-IB Verification Program.

a. Load the tape in the normal manner and proceed until the controller displays the set-up information.

b. Type "CONT 6210"; then press "END LINE". The program will advance to the end and ask if any of the tests need to be repeated. Then use the method described in the preceding paragraph.

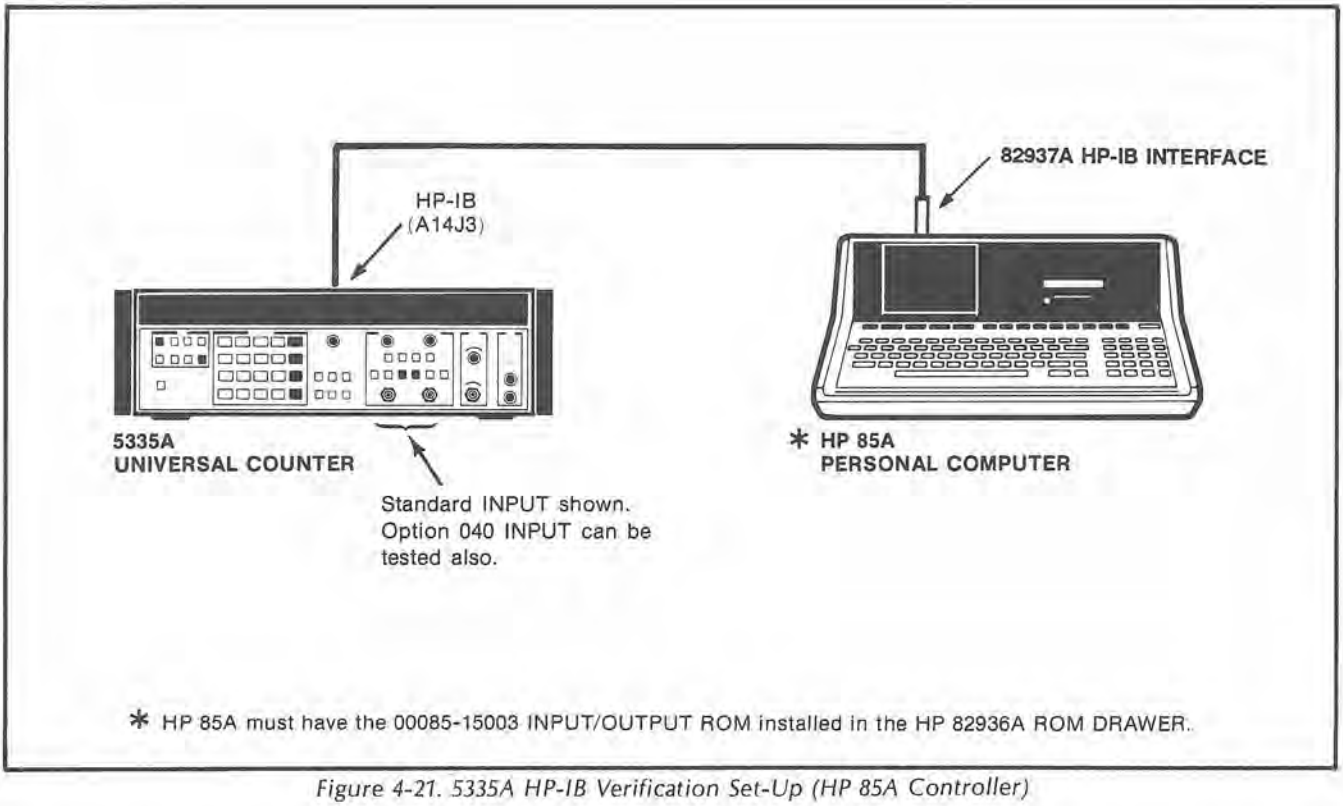


Figure 4-21. 5335A HP-IB Verification Set-Up (HP 85A Controller)

Table 4-5. 5335A HP-IB Verification Program Listing (HP 85A Controller)

```
10 REM     5335A HP-IB VERIFICATION PROGRAM - REV C    ***** "5335A" *****
20 REM     Revision Date:     3 de Diciembre de 1982              VGM
50 DIM A$[50],B$[21],C$[32],D$[45],E$[40],F$[21],A(30)
70 A$="CHECKPOINT     --Press 'CONT' when done."
90 C$="********************************"
95 D$="  Please wait while DAC Test is   performed!"
110 E$="Press 'CONT' to perform test."
130 Y,X=0 @ G=.02 @ D=1000
150 BEEP 75,250 @ CLEAR @ DISP USING "4/"
155 DISP "After entering a 3 digit select" @ DISP
157 DISP "code (7XX), press 'END LINE'." @ DISP @ INPUT S
170 IF NOT (S=721) THEN 210 ELSE DISP "Error: Calculator Address  !!!"
190 WAIT 2000 @ GOTO 150
210 IF NOT (S>730) THEN 250 ELSE DISP "Out of Address Range: too High !"
230 WAIT 2000 @ GOTO 150
250 IF NOT (S<700) THEN 290 ELSE DISP "Out of Address Range: too Low !!"
270 WAIT 2000 @ GOTO 150
290 CRT IS 1 @ PRINTER IS 2 @ NORMAL @ RESET 7 @ LOCAL S @ CLEAR @ DISP C$
310 DISP "    5335A UNIVERSAL COUNTER";"  HP-IB Verification Program."
330 DISP C$ @ DISP USING "2/"
350 DISP "CONNECT:  'TIME BASE OUT'";"from rear panel to INPUT A." @ DISP
355 DISP "Set 'GATE ADJ' to CCW and       Channel A & B INPUT to:"
357 DISP "PRESET, 50 Ohms, X1, DC, and    positive slope."
370 DISP @ DISP USING "#,K,/" ; A$[16] @ PAUSE
390 CLEAR @ DISP C$ @ GOSUB 6410
410 DISP A$[1,13];"1:";"  *** 5335A POWER-UP CHECK ***" @ DISP
430 DISP "Turn 5335A power OFF then ON;";"VERIFY:"
470 DISP "* RED LED 'STBY' lamp is OFF;"
490 DISP "* All lamps turn ON momentarily;"
510 DISP "* Selected HP-IB add. displayed;"
530 DISP "* 'FREQ A' & 'Hz' lamps are ON;"
550 DISP "* Display shows:  10. 000 000 +6"
570 DISP "  with 'Hz' LED ON; 'GATE' & 'A'"
590 DISP "  Trigger light flashing." @ DISP @ DISP USING "#,K,/" ; A$[16]
595 PAUSE
610 IF X<>0 THEN 6210
630 CLEAR @ DISP C$ @ GOSUB 6410 @ DISP @ RESET 7 @ OUTPUT S ;"in"
650 DISP A$[1,11];"2:";" LOCAL/RESET TEST" @ DISP USING "2/"
670 DISP "Press LOCAL/RESET on 5335A front" @ DISP
690 DISP "panel and verify that 'REMOTE'" @ DISP @ DISP "LED goes out."
710 DISP USING "3/" @ DISP A$[16] @ PAUSE
730 IF X<>0 THEN 6210
750 CLEAR @ DISP C$ @ GOSUB 6410 @ DISP
770 DISP A$[1,11];"3:";"   *** LOCAL-LOCKOUT TEST ***" @ DISP
790 DISP "Press LOCAL/RESET and verify" @ DISP
810 DISP "that 'REMOTE' LED stays ON."
830 DISP USING "2/" @ OUTPUT S @ LOCAL LOCKOUT 7 @ DISP @ DISP A$[16] @ PAUSE
850 IF X<>0 THEN 6210
870 CLEAR @ DISP C$ @ GOSUB 6410 @ DISP
890 DISP A$[1,11];"4:";"'WAIT' & 'SRQ' mode TEST" @ DISP
910 DISP "Verify the following LEDs are"
930 DISP "lit for five (5) measurements:" @ DISP
950 DISP "     *  TALK"
970 DISP "     *  LISTEN"
990 DISP "     *  SRQ"
1010 DISP "     *  REMOTE" @ DISP
1030 DISP E$ @ LOCAL S @ PAUSE
1050 CLEAR @ DISP C$ @ DISP
1070 DISP A$[1,11];"4:";"'WAIT' & 'SRQ' mode TEST" @ BEEP @ I=0 @ DISP
1090 OUTPUT S ;"inga.02" @ ON INTR 7 GOSUB 1150
1110 ENABLE INTR 7;8 @ OUTPUT S ;"walsrl" @ WAIT 100
```

Table 4-5. 5335A HP-IB Verification Program Listing (HP 85A Controller) (Continued)

```
1130 IF NOT (I>5) THEN 1110 ELSE 1190
1150 FOR I=1 TO 5 @ STATUS 7,1 ; T@ ENTER S ; B$@ DISP "      ";B$
1170 OUTPUT S ;"re" @ WAIT 1000 @ NEXT I @ RETURN
1190 DISP USING "3/" @ DISP A$[16] @ BEEP @ PAUSE
1210 IF X<>0 THEN 6210
1230 CLEAR @ DISP C$ @ GOSUB 6410 @ DISP
1250 DISP A$[1,12];"5:";" *** TEACH - LEARN mode TEST ***" @ DISP
1270 DISP "Verify that the 5335A displays:";" '11. 224 49 +15  Hz'."
1290 DISP USING "4/" @ DISP E$
1310 PAUSE @ REMOTE S
1330 OUTPUT S ;"fulms1122448800" @ DISP A$[16] @ BEEP @ PAUSE
1350 CLEAR @ DISP C$ @ DISP
1370 DISP A$[1,12];"5:";" *** TEACH - LEARN mode TEST ***" @ DISP
1390 DISP "5335A Counter will teach the";"HP-85A controller the front"
1410 DISP "panel setup." @ DISP @ OUTPUT S ;"pq"
1430 FOR I=1 TO 30 @ ENTER S USING "#,B" ; A(I)@ NEXT I
1450 IF NOT (A(24)=17 AND A(25)=34 AND A(26)=68) THEN 1430
1470 IF NOT (A(28)=0 AND A(29)=0) THEN 1430
1490 DISP A$[16] @ I=0 @ BEEP @ PAUSE
1510 CLEAR @ DISP C$ @ DISP
1530 DISP A$[1,12];"5:";" *** TEACH - LEARN mode TEST ***" @ DISP
1550 DISP "Verify that the 5335A displays";"100. 000 00 -9 with 'S' and"
1570 DISP "Function PER A  LED's ON,";"and 'GATE' LED  flashing."
1590 OUTPUT S ;"fu9" @ LOCAL S @ DISP USING "3/" @ DISP A$[16] @ BEEP @ PAUSE
1610 CLEAR @ DISP C$ @ DISP
1630 DISP A$[1,12];"5:";" *** TEACH - LEARN mode TEST ***" @ DISP
1650 DISP "5335A Counter will learn";"from HP-85A controller." @ DISP
1670 DISP "Verify that the 5335A displays:";"'11. 224 49 +15 Hz.'"
1690 DISP USING "2/" @ OUTPUT S USING "#,K" ; "pb"
1710 FOR I=1 TO 30 @ OUTPUT S USING "#,B" ; A(I) @ NEXT I @ LOCAL S
1730 DISP A$[16] @ BEEP @ PAUSE
1750 IF X<>0 THEN 6210
1770 CLEAR @ DISP C$ @ GOSUB 6410 @ DISP
1790 DISP A$[1,12];"6:";"*** FREQUENCY 'B' mode TEST ***" @ DISP
1810 DISP "SETUP:";"Connect Time Base Out (TBO)"
1830 DISP "from rear panel to INPUT B." @ DISP USING "2/"
1850 DISP E$ @ PAUSE
1870 OUTPUT S ;"co0ful7" @ ENTER S ; B$
1890 CLEAR @ DISP A$[1,12];"6:";"*** FREQUENCY 'B' mode TEST ***" @ DISP
1910 DISP "VERIFY:" @ DISP @ DISP "* 5335A displays:" @ DISP "    ";B$
1970 DISP "* 'GATE' lamp flashing;" @ DISP "* 'TALK' & 'REMOTE' lamps are ON"
2010 DISP "* All FUNCTION lamps are OFF;"
2030 DISP "* 'B' trigger light flashing." @ DISP
2050 DISP @ DISP A$[16] @ PAUSE
2070 IF X<>0 THEN 6210
2090 CLEAR @ DISP C$ @ GOSUB 6410 @ DISP
2110 DISP A$[1,12];"7:";"*** TRIGGER LEVEL mode TEST ***" @ DISP USING "2/"
2150 OUTPUT S ;"walful4" @ ENTER S ; B$,F$@ DISP "VERIFY:" @ DISP
2190 DISP "Trig. Lvl A = ";B$[11,19];"  Volts" @ DISP
2210 DISP "Trig. Lvl B = ";F$[11,19];"  Volts"
2230 DISP USING "2/" @ DISP A$[16] @ BEEP @ PAUSE
2250 IF X<>0 THEN 6210
2270 CLEAR @ DISP C$ @ GOSUB 6410 @ DISP
2290 DISP A$[1,12];"8:";"*** GATE TIME mode TEST ***" @ DISP
2310 DISP " GATE ADJ. Normal Range test:" @ DISP
2350 DISP "Vary 'GATE ADJ.' pot and verify";"change in Gate Time displayed,"
2370 DISP "NOMINALLY, between 20 millisec.";"and 4 seconds."
2390 DISP USING "2/" @ OUTPUT S ;"wa0ful3gm0rh0"
2410 DISP A$[16] @ ENTER S ; B$@ BEEP @ PAUSE
2430 CLEAR @ DISP @ DISP A$[1,12];"8:";"*** GATE TIME mode TEST ***" @ DISP
2450 DISP " GATE ADJ. Fast Range test:" @ DISP
```

Table 4-5. 5335A HP-IB Verification Program Listing (HP 85A Controller) (Continued)

```
2470 DISP "Vary 'GATE ADJ.' pot and verify";"change in Gate Time displayed,"
2490 DISP "NOMINALLY, between 100 microsec.";"and 20 milliseconds."
2510 DISP USING "2/" @ OUTPUT S ;"ful3gmlrh0"
2530 ENTER S ; B$@ DISP @ DISP A$[16] @ BEEP @ PAUSE
2550 IF X<>0 THEN 6210
2570 CLEAR @ DISP C$ @ GOSUB 6410 @ DISP
2590 DISP A$[1,12];"9:";"* RISE and FALL TIME mode TEST *" @ DISP
2610 DISP "SETUP:";"Connect Time Base Out (TBO)"
2630 DISP "from rear panel to INPUT A." @ DISP USING "3/" @ DISP E$ @ PAUSE
2670 CLEAR @ DISP A$[1,13];"9:";"* RISE and FALL TIME mode TEST *" @ DISP
2675 OUTPUT S ;"inful0" @ WAIT 3000 @ ENTER S ; B$
2690 DISP "   ***   RISE TIME test   ***" @ DISP @ DISP "VERIFY:"
2730 DISP "* 5335A Displays:" @ DISP "   ";B$
2750 DISP "* RISE/FALL A  LED is ON;"
2770 DISP "* Gate Mode MIN  LED is ON;"
2790 DISP "* 'GATE' LED is flashing;"
2810 DISP "* 'A' & 'B' trig. lamps blinking"
2830 DISP "* 'TALK' and 'REMOTE'  LED's ON." @ DISP
2852 DISP USING "#,K,/" ; A$[16] @ ENTER S ; B$@ BEEP @ PAUSE
2870 CLEAR @ DISP A$[1,12];"9:";"* RISE and FALL TIME mode TEST *" @ DISP
2875 OUTPUT S ;"asl" @ WAIT 3000 @ ENTER S ; B$
2890 DISP "   ***   FALL TIME test   ***" @ DISP
2915 DISP "Verify that 5335A displays:" @ DISP "   ";B$ @ DISP USING "4/"
2975 DISP @ DISP A$[16] @ BEEP @ PAUSE
2990 IF X<>0 THEN 6210
3010 CLEAR @ DISP C$ @ GOSUB 6410
3030 DISP A$[1,12];"10:";"  *** OVERFLOW mode TEST ***" @ DISP
3050 DISP "Verify that the ONLY lamps lit";"during the 11 second wait"
3070 DISP "period are :"
3090 DISP "* 'Hz' , 'GATE' , 'LISTEN',"
3110 DISP "* 'REMOTE', FREQ A ,";"* Manual GATE MODE and"
3130 DISP "* 'A' trigger lamp (flashing);"
3150 DISP "* 5335A Displays:  '0.'" @ DISP USING "2/" @ DISP USING "#,K,/" ; E$
3155 PAUSE
3170 OUTPUT S ;"inwalgm3" @ DISP A$[1,10];"  10:";A$[16] @ WAIT 11000
3190 OUTPUT S ;"gc" @ ENTER S ; B$@ BEEP @ CLEAR @ DISP
3210 DISP A$[1,12];"10:";"  *** OVERFLOW mode TEST ***" @ DISP
3230 DISP "VERIFY:  " @ DISP
3250 DISP "* 5335A displays:" @ DISP "   ";B$
3270 DISP "* 'LISTEN' and 'GATE' lamps OFF"
3290 DISP "* 'TALK' lamp ON."
3310 DISP USING "3/" @ DISP A$[16] @ PAUSE
3330 IF X<>0 THEN 6210
3350 CLEAR @ DISP C$ @ GOSUB 6410 @ DISP
3355 OUTPUT S ;"in"
3370 DISP A$[1,12];"11:";"*** TIME INTERVAL mode TEST ***" @ DISP
3395 OUTPUT S ;"fu2bslcolwa0" @ OUTPUT S ;"re" @ ENTER S ; B$@ DISP "VERIFY:"
3410 DISP "* 5335A displays:" @ DISP "   ";B$
3430 DISP "* 'GATE' lamp flashing;"
3450 DISP "* 'TALK' and 'REMOTE' lamps ON;"
3470 DISP "* TIME A->B lamp is ON;"
3490 DISP "* 'MIN' GATE MODE lamp is ON;"
3510 DISP "* 'A' & 'B' trig. lamps flashing" @ DISP
3530 DISP USING "#,K,/" ; A$[16] @ BEEP @ PAUSE
3550 CLEAR @ DISP A$[1,13];"11:";"*INVERSE TIME INTERVAL mode TEST" @ DISP
3570 DISP "VERIFY:" @ DISP @ OUTPUT S ;"fu6" @ ENTER S ; B$
3590 DISP "* 5335A displays approximately:" @ DISP "   ";B$
3610 DISP "* 'GATE' lamp flashing;"
3630 DISP "* 'TALK' and 'REMOTE'  LED's ON;"
3650 DISP "* 1/TIME A->B lamp is ON;"
3670 DISP "* 'MIN' GATE MODE lamp is ON;   * 'A' & 'B' trig. lamps flashing"
```

Table 4-5. 5335A HP-IB Verification Program Listing (HP 85A Controller) (Continued)

```
3690 BEEP @ DISP @ DISP A$[16] @ PAUSE
3710 IF X<>0 THEN 6210
3730 CLEAR @ DISP C$ @ GOSUB 6410 @ DISP
3750 DISP A$[1,12];"12:";"*** FRONT PANEL SWITCH TEST ***" @ DISP
3770 DISP "Press each momentary type key on";"the 5335A front panel."
3790 DISP
3810 DISP "A number will be displayed when";"a key is pressed corresponding"
3830 DISP "to the following figure (INPUT"
3850 DISP "section is for Option 040 ONLY):" @ DISP @ DISP E$ @ PAUSE
3890 PRINT "    MATH            FUNCTION" @ PRINT
3910 PRINT " 01 03 05 07     09 13 17 21 25" @ PRINT
3930 PRINT " 02 04 06 08     10 14 18 22 26" @ PRINT
3950 PRINT "                 11 15 19 23 27" @ PRINT
3970 PRINT "                 12 16 20 24 28" @ PRINT USING "3/"
3990 PRINT "  GATE MODE          INPUT" @ PRINT
4010 PRINT "  29 31 33     35 37 39 41 43 45" @ PRINT
4030 PRINT "  30 32 34     36 38 40 42 44 46" @ PRINT USING "6/"
4070 OUTPUT S ;"fu99msl7" @ WAIT 100 @ LOCAL S
4090 DISP A$[1,10];"  12   ";A$[16] @ PAUSE
4130 IF X<>0 THEN 6210
4150 CLEAR @ DISP C$ @ GOSUB 6410
4170 DISP A$[1,12];"13:";"  *** FRONT END INPUT TEST ***" @ DISP
4190 DISP "VERIFY:"
4210 DISP "* All LEDs are ON (about 5 secs)";"* 5335A displays 'FE PASS';"
4230 DISP "* Then 5335A will display";"  the voltages at A2U4(2,12,10);"
4250 DISP "  NOMINAL values  are:";"     5. 000 00 V   ";"     3. 100 00 V"
4270 DISP "    -5. 200 00 V"
4290 OUTPUT S ;"fu99ms0" @ DISP @ DISP USING "#,K,/" ; A$[16] @ PAUSE
4295 OUTPUT S ;"in"
4310 IF X<>0 THEN 6210
4330 CLEAR @ DISP C$ @ GOSUB 6410 @ DISP @ A=0
4350 DISP "If DVM Option is installed,","enter 1; if not, enter 0, then"
4355 DISP "press 'END LINE'." @ DISP @ INPUT A
4370 IF A<>0 AND A<>1 THEN 4330
4390 IF A=0 THEN 4790
4420 CLEAR @ DISP C$ @ GOSUB 6410 @ DISP @ OUTPUT S ;"in" @ LOCAL S
4430 DISP A$[1,12];"14:";"** OPTION 020  * DVM *  TEST **" @ DISP
4450 DISP "SETUP:";"a) Connect Trig. Level 'A' from"
4470 DISP "   rear panel to DVM input jack;" @ DISP
4490 DISP "b) Set PRESET 'A' off,";"   but in CCW position."
4520 DISP USING "2/" @ DISP E$ @ PAUSE
4530 OUTPUT S ;"ful5" @ ENTER S ; B$@ CLEAR @ DISP C$ @ DISP
4550 DISP A$[1,12];"14:";"** OPTION 020  * DVM *  TEST **" @ DISP
4570 DISP "Verify that 5335A displays:    " @ DISP
4590 DISP "   ";B$[10,19];"  'Volts'" @ DISP USING "2/"
4610 DISP A$[16] @ BEEP @ PAUSE
4620 CLEAR @ DISP C$ @ DISP
4622 DISP A$[1,12];"14:";"** OPTION 020  * DVM *  TEST **" @ DISP USING "2/"
4630 DISP "Rotate Channel 'A' level control";"to the CW position."
4650 DISP USING "2/" @ DISP A$[16] @ PAUSE
4670 CLEAR @ DISP C$ @ DISP
4690 DISP A$[1,12];"14:";"** OPTION 020  * DVM *  TEST **" @ DISP
4710 ENTER S ; B$@ DISP "Verify that 5335A displays:    " @ DISP
4730 DISP "   ";B$[10,19];"  'Volts'" @ DISP USING "3/" @ DISP A$[16]
4750 BEEP @ PAUSE
4770 IF X<>0 THEN 6210
4790 CLEAR @ DISP C$ @ GOSUB 6410 @ DISP @ B=0
4810 DISP "If Channel C Opt. is installed,","enter 1; if not, enter 0, then"
4815 DISP "press: 'END LINE'." @ DISP @ INPUT B
4830 IF B<>0 AND B<>1 THEN 4790
4850 IF B=0 THEN 5090
```

Table 4-5. 5335A HP-IB Verification Program Listing (HP 85A Controller) (Continued)

```
4855 CLEAR @ DISP C$ @ GOSUB 6410 @ DISP
4870 DISP A$[1,12];"15:";"OPTION 030 - CHANNEL 'C' TEST" @ DISP
4890 DISP "SETUP:";"a) Connect an 86603A to the";"   5335A INPUT 'C';"
4910 DISP "b) Connect the 8660C TBO to the";"   5335A Time Base In."
4930 DISP USING "3/" @ DISP E$ @ PAUSE
4950 OUTPUT S ;"fu5" @ ENTER S ; B$
4970 CLEAR @ DISP C$ @ DISP
4990 DISP A$[1,12];"15:";"OPTION 030 - CHANNEL 'C' TEST" @ DISP
5010 DISP "Verify that 5335A displays the";"frequency of the 8660C"
5030 DISP "(150MHz -> 1.3GHz)." @ DISP USING "2/" @ DISP "   ";B$
5050 DISP USING "2/" @ DISP A$[16] @ BEEP @ PAUSE
5070 IF X<>0 THEN 6210
5090 CLEAR @ DISP C$ @ GOSUB 6410 @ DISP @ C=0
5095 DISP "If Option 040 is installed,","enter 1; if not, enter 0, then"
5097 DISP "press: 'END LINE'." @ DISP @ INPUT C
5130 IF C<>0 AND C<>1 THEN 5090
5150 IF C=0 THEN 6210
5170 CLEAR @ DISP C$ @ GOSUB 6410 @ DISP
5190 DISP A$[1,12];"16:";"OPT 040  PROGRAMMABLE INPUT TEST" @ DISP
5210 DISP "Verify that all INPUT momentary";"switches are activated and"
5230 DISP "de-activated; the switches LED";"should turn ON then OFF."
5250 DISP USING "4/" @ DISP E$ @ PAUSE
5270 OUTPUT S ;"inaflas1" @ WAIT D
5290 OUTPUT S ;"azlaal" @ WAIT D
5310 OUTPUT S ;"ax1" @ WAIT D
5330 OUTPUT S ;"bx1" @ WAIT D
5350 OUTPUT S ;"bz1ba1" @ WAIT D
5370 OUTPUT S ;"bf1bs1" @ WAIT D
5390 OUTPUT S ;"co1au1" @ WAIT D
5410 OUTPUT S ;"co0au0" @ WAIT D
5430 OUTPUT S ;"bf0bs0" @ WAIT D
5450 OUTPUT S ;"bz0ba0" @ WAIT D
5470 OUTPUT S ;"bx0" @ WAIT D
5490 OUTPUT S ;"ax0" @ WAIT D
5510 OUTPUT S ;"az0aa0" @ WAIT D
5530 OUTPUT S ;"intrlat0bt0"
5550 CLEAR @ DISP C$ @ DISP
5570 DISP A$[1,12];"16:";"OPT 040  PROGRAMMABLE INPUT TEST" @ DISP
5590 DISP USING "2/" @ DISP A$[16] @ BEEP @ PAUSE
5610 CLEAR @ DISP C$ @ DISP
5630 DISP A$[1,12];"16:";"OPT 040  PROGRAMMABLE INPUT TEST" @ DISP
5650 DISP @ DISP "*******     DAC Test     *******"
5670 DISP USING "3/" @ DISP D$[1,32] @ DISP @ DISP "        ";D$[33] @ BEEP
5690 FOR E=0 TO 9 @ F=-5.12+2^E*.01 @ GOSUB 5750
5710 FOR E=0 TO 9 @ F=5.12-2^E*.01 @ GOSUB 5750
5730 GOTO 5850
5750 OUTPUT S ;"ful4walat";F;"bt";F @ WAIT D @ ENTER S ; B$,F$
5770 IF ABS(VAL(B$[11])-F)>G THEN 5930
5790 IF ABS(VAL(F$[11])-F)>G THEN 6070
5810 NEXT E @ WAIT 2000 @ RETURN
5850 OUTPUT S ;"wa0" @ CLEAR @ DISP C$ @ DISP
5870 DISP A$[1,12];"16:";"OPT 040  PROGRAMMABLE INPUT TEST"
5890 DISP USING "3/" @ DISP " ****   Passed DAC Test.   ****" @ GOTO 6190
5930 CLEAR @ DISP C$ @ DISP
5950 DISP A$[1,12];"16:";"OPT 040  PROGRAMMABLE INPUT TEST" @ DISP
5970 GOSUB 6410
5990 DISP @ DISP "*******     DAC Test     *******" @ DISP USING "2/"
6010 DISP "DAC is out of tolerance:" @ DISP
6030 DISP "ChA Prog. Lvl=    ";F;"ChA Actual Lvl=   ";B$[11]
6050 DISP "Tolerance=        ";G @ END
6070 CLEAR @ DISP C$ @ DISP
```

Table 4-5. 5335A HP-IB Verification Program Listing (HP 85A Controller) (Continued)

```
6090 DISP A$[1,12];"16:";"OPT 040  PROGRAMMABLE INPUT TEST" @ DISP
6110 GOSUB 6410
6130 DISP "DAC is out of tolerance:" @ DISP
6150 DISP "ChB Prog. Lvl=    ";F;"ChB Actual Lvl=   ";F$[11]
6170 DISP "Tolerance=         ";G @ END
6190 DISP USING "4/" @ DISP A$[16] @ BEEP @ PAUSE
6210 BEEP 75,250 @ CLEAR @ DISP USING "4/"
6212 DISP "This is the end of the program." @ DISP USING "2/"
6215 DISP "If you need to repeat a Check   Point, enter the Check Point"
6217 DISP "number (1 thru 16), if not,"
6220 DISP "enter 0, then press 'END LINE'." @ DISP @ INPUT X
6230 IF X<0 OR X>16 THEN 6210 ELSE OUTPUT S ;"wa0"
6250 IF X=0 THEN 6330
6295 IF X>12 THEN 6315
6310 ON X GOTO 390,630,750,870,1230,1770,2090,2270,2570,3010,3350,3730
6315 ON X-12 GOTO 4150,4330,4790,5090
6330 CLEAR @ DISP USING "4/" @ DISP C$ @ DISP
6350 DISP " END OF 5335A UNIVERSAL COUNTER";" HP-IB Verification Test."
6370 DISP @ DISP C$ @ GOSUB 6410 @ OUTPUT S ;"in" @ LOCAL S @ REWIND @ END
6410 BEEP @ WAIT 250 @ BEEP @ RETURN
```

OPERATION VERIFICATION RECORD (TEST CARD)

HEWLETT-PACKARD MODEL 5335A
UNIVERSAL COUNTER

Date _____

Test Performed by: _____

Serial No. _____

STEP NO.	DESCRIPTION	RESULTS	
		PASS	FAIL
I	POWER-UP/SELF TEST	_____	_____
II	SUPERCHECK	_____	_____
III	KEYBOARD CHECK	_____	_____
IV	REAR PANEL/EXTERNAL ARM SWITCH TEST	_____	_____
V	KEYBOARD CHECK	_____	_____
VI	DVM TEST (Option 020)	_____	_____
VII	CHANNEL C TEST (Option 030)	_____	_____
VIII	PROGRAMMABLE INPUT TEST (Option 040)	_____	_____

PERFORMANCE TEST CARD

HEWLETT-PACKARD MODEL 5335A
UNIVERSAL COUNTER

Serial Number: _____

Test Performed by: _____

Date: _____

TEST	DESCRIPTION	PASS	FAIL	ACTUAL VALUE
I	POWER-UP/SELF TEST	_____	_____	
II	SUPERCHECK	_____	_____	
III	KEYBOARD CHECK	_____	_____	
IV	REAR PANEL/EXTERNAL ARM SWITCH TEST	_____	_____	
V	GATE TIME			
	20 ms to 4 s	_____	_____	
	100 μs to 20 ms	_____	_____	
VI	FREQUENCY RESPONSE and SENSITIVITY			
	Channel A (<25 mV rms):			
	A) DC to 20 MHz (dc coupled)			
	0.01 Hz			_____
	10 Hz			_____
	100 kHz			_____
	10 MHz			_____
	20 MHz			_____
	B) 30 Hz — 20 MHz (ac coupled)			
	30 Hz			_____
	10 kHz			_____
	1 MHz			_____
	10 MHz			_____
	20 MHz			_____
	C) 200 kHz — 20 MHz (50Ω)			
	200 kHz			_____
	500 kHz			_____
	1 MHz			_____
	10 MHz			_____
	20 MHz			_____
	D) 20 MHz — 200 MHz (dc coupled)			
	20 MHz			_____
	50 MHz			_____
	125 MHz			_____
	200 MHz			_____
	E) 20 MHz — 200 MHz (ac coupled)			
	20 MHz			_____
	50 MHz			_____
	125 MHz			_____
	200 MHz			_____

PERFORMANCE TEST CARD (Continued)

TEST	DESCRIPTION	PASS	FAIL	ACTUAL VALUE
VI	FREQUENCY RESPONSE and SENSITIVITY			
	Channel B (<25 mV rms):			
	A) DC to 20 MHz (dc coupled)			
	0.01 Hz			_____
	10 Hz			_____
	100 kHz			_____
	10 MHz			_____
	20 MHz			_____
	B) 30 Hz — 20 MHz (AC coupled)			
	30 Hz			_____
	10 kHz			_____
	1 MHz			_____
	10 MHz			_____
	20 MHz			_____
	C) 200 kHz — 20 MHz (50Ω)			
	200 kHz			_____
	500 kHz			_____
	1 MHz			_____
	10 MHz			_____
	20 MHz			_____
	D) 20 MHz — 100 MHz (dc coupled)			
	20 MHz			_____
	50 MHz			_____
	100 MHz			_____
	E) 20 MHz — 100 MHz (ac coupled)			
	20 MHz			_____
	50 MHz			_____
	100 MHz			_____
VII	RATIO A/B			
	Display (±1 count):			
	10 Hz 1.	_____	_____	
	10 kHz 1.00	_____	_____	
	5 MHz 1. 000 0	_____	_____	
	20 MHz 1. 000 00	_____	_____	
	50 MHz 2. 500 00	_____	_____	
	100 MHz 5. 000 00	_____	_____	
	150 MHz 7. 500 00	_____	_____	
	200 MHz 10. 000 00	_____	_____	
VIII	TIME INTERVAL AND INVERSE TIME INTERVAL			
	Time Interval (100 ±5) ns	_____	_____	
	Inverse Time Interval (10.0 ±0.5)10^{+6} units/s	_____	_____	
IX	PULSE WIDTH A AND PULSE WIDTH B			
	Pulse Width A			
	Positive Pulse:			
	(4.000 μs ±5 ns)	_____	_____	
	Negative Pulse:			
	(6.000 μs ±5 ns)	_____	_____	
	Pulse Width B			
	Negative Pulse:			
	(6.000 μ ±5 ns)	_____	_____	
	Positive Pulse:			
	(4.000 μ ±5 ns)	_____	_____	

PERFORMANCE TEST CARD (Continued)

TEST	DESCRIPTION	PASS	FAIL	ACTUAL VALUE
X	RISE and FALL TIME A			
	Rise Time A (400 +82) ns	_____	_____	
	Fall Time A (400 +82) ns	_____	_____	
XI	SLEW RATE A			
	(2.00 ±0.65) V/s	_____	_____	
XII	PHASE A rel B			
	(180 ±1.5) degrees	_____	_____	
XIII	DVM TEST (Option 020)			
	Shorted input:			
	0V ± 600 mV	_____	_____	
	±4.000V ±3.8 mV	_____	_____	
	±40.00V ±38 mV	_____	_____	
	±400.0V ±380 mV	_____	_____	
XIV	CHANNEL C TEST (Option 030)			
	A) 150 MHz to 1 GHz (≤ –27 dBm)			
	150 MHz			_____
	500 MHz			_____
	800 MHz			_____
	1.0 GHz			_____
	B) 1 GHz to 1.3 GHz (≤ –7 dBm)			
	1.1 GHz			_____
	1.3 GHz			_____

SECTION V
ADJUSTMENTS

5-1. INTRODUCTION

5-2. This section describes the adjustments required to maintain the HP 5335A operating characteristics within specifications. Adjustments should be made when required, such as after a performance test failure or when components are replaced that may affect an adjustment.

5-3. *Table 5-1* lists the adjustment procedures, in the recommended order of performance, and indicates the adjustable components involved. *Table 5-2* lists the additional adjustment procedures for a 5335A equipped with Option 040.

5-4. EQUIPMENT REQUIRED

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

5-6. ADJUSTMENT LOCATIONS

5-7. Adjustment locations are identified in the procedure for each adjustment.

5-8. SAFETY CONSIDERATIONS

5-9. This section contains warnings that must be followed for your protection and to avoid damage to the instrument.

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 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. ADJUSTMENT PROCEDURES

5-11. A1 Power Supply Adjustment Procedure

5-12. The voltage supplies in the 5335A that require adjustment are +3 volts, and +15 volts. To perform these adjustments, proceed as follows:

a. Connect the positive terminal of the DVM to A1U4(1) and the negative terminal to chassis ground.

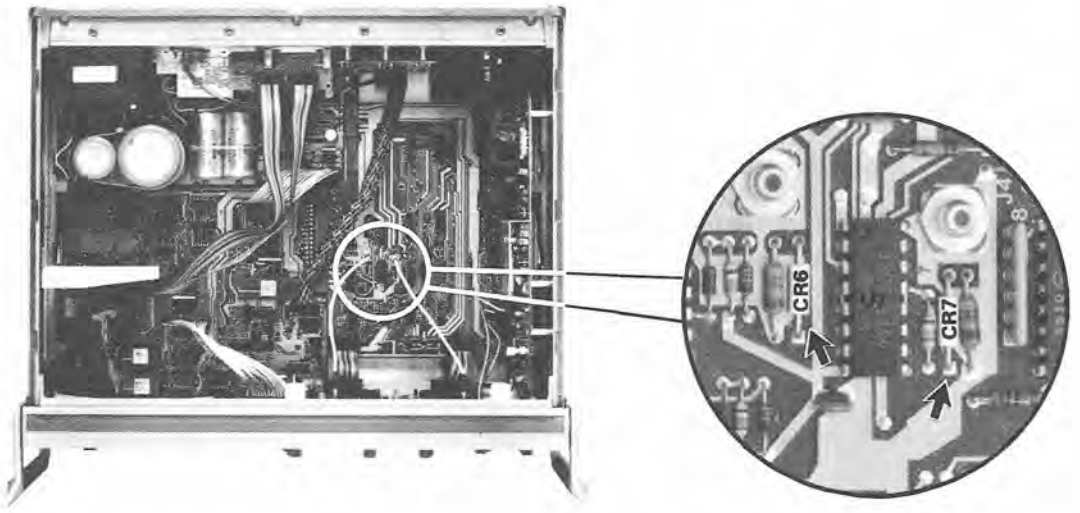
b. Adjust A1R1 for a DVM reading of 3.000 Vdc (±20 mV).

c. Call up Diagnostic routine #32, as follows:

Press:
SCALE
SMOOTH
9, 9
ENTER (wait for 5 seconds)
SCALE
3, 2
ENTER

Table 5-1. Adjustments

ASSEMBLY		ADJUSTMENTS	COMMENTS
NAME	NUMBER		
Power Supply	A1	A1R1, R15	Uses Diagnostic Loop #32.
Input Amplifier	A3	A3R37, R47, R88, R96	Uses Special Function Loop #17.
D.V.M.	A8	Zero Adj, Ref Sym, Low, Med, High	Allow 20 min warmup. Perform adjustments in indicated order.
C CHANNEL	A9	A9R22, R23, R24	Allow 5 minutes for warmup.
Oscillator	A4/A15	A4C6/FREQ ADJUST	Check against known House Standard.
Level Shifter	A2	A2R65, R66	Uses Special Function Loop #17.
Rear Panel	A6	A6R22	Uses external signal generator.



REMOVE 5335A TOP COVER
CONNECT PROBE TO ANODE OF:
CHANNEL A .... A2CR7 OR
CHANNEL B A2CR6

TOP VIEW

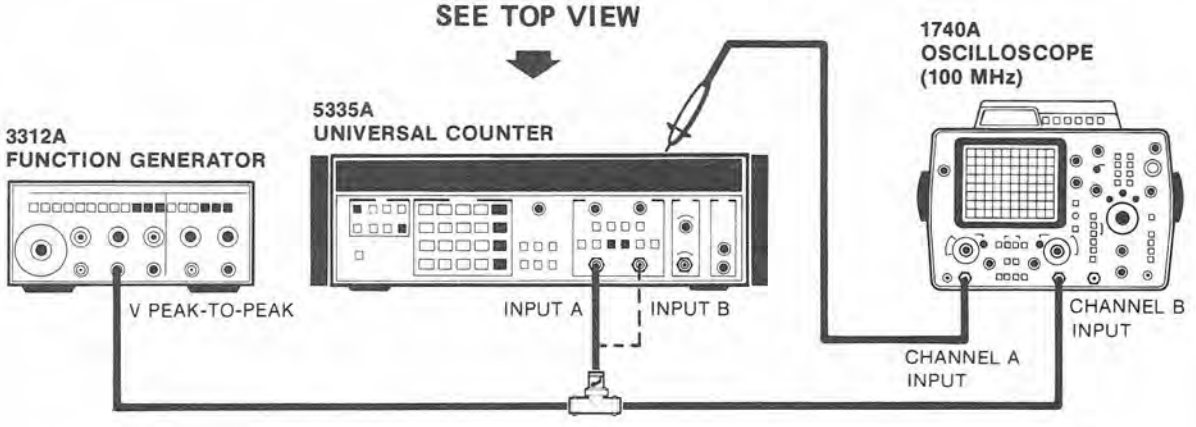


Figure 5-1. Input Amplifier Adjustment Setup.

d. The 5335A should display 2.985 Vdc (±50 mV).

CAUTION

After making the power supply adjustments, and in order to provide the proper voltage to the MRC external arm input, REMOVE A6C1.

e. Connect the positive terminal of the DVM to A1U6(3) or the cathode of A1CR2, and the negative terminal to chassis ground.

f. Adjust A1R15 for a DVM reading of ~~15.70~~ 15.0 Vdc ~~(±20 mV dc).~~ +/- 100 mV

g. Turn off the 5335A, and disconnect the test equipment.

5-13. A3 Input Amplifier Adjustment Procedure

5-14. To perform the Offset and Hysteresis adjustments required for A3, proceed as follows:

a. Remove the 5335A top cover, and locate variable resistors R37, R47, R88, and R96 on the A3 Input Amplifier Assembly (~~05335-60003~~ 05335-60033). Refer to Assembly Adjustment Locator in *Figure* ~~5-1,~~ ~~and component locators in Section VIII.~~ 8-109

b. Set the 5335A front panel controls as follows:

GATE TIME ..... Adjust to about 150 ms
FUNCTION ..... FREQ A
GATE MODE ..... NORM
CYCLE ..... NORM
INPUT (Channels A and B)
1 MΩ/50Ω ..... 50Ω (IN)*
Trigger Level ..... PRESET
ATTN ..... X1 (OUT)*
AC/DC ..... DC (OUT)*
COM A ..... OUT
AUTO TRIG ..... OUT
POWER STBY/ON ..... ON

*In the parenthetical notes such as (IN), the "in" refers to the position of the designated front panel switch.

c. Set the 3312A Function Generator to output a 1.0 kHz sine wave at ~100 mV p-p.

d. Connect the test equipment as shown in *Figure* 5-1; for the Channel A adjustment, connect the oscilloscope A channel probe to the junction of A2U11(7) and A2R39.

WARNING

DO NOT SHORT THE PROBE TO ANY OTHER TRACES OR COMPONENTS, OR DAMAGE WILL OCCUR TO THE CIRCUITRY, PARTICULARLY TO THE AMPLIFIER SCHMITT IC'S.

e. Set the oscilloscope for the X-Y mode, and calibrate by centering the dot at center screen.

f. Position both A3R96 (offset) and A3R88 (hysteresis) to approximately midrange.

g. Adjust A3R96 (offset) to position the waveform at the center of the screen. Adjust A3R88 (hysteresis) for 20 mV p-p on the X-axis. Refer to the waveform in *Figure* 5-2.

h. Disconnect the oscilloscope A channel probe from A2R39 and connect the probe to the junction of A2U7(12) and A2R32. Disconnect the signal generator output from the 5335A Channel A INPUT and connect it to the Channel B INPUT.

i. Set the 5335A for Special Function #17; (press: SCALE, SMOOTH, 1, 7, ENTER).

j. Position both A3R47 (offset) and A3R37 (hysteresis) to approximately midrange.

k. Adjust A3R47 (offset) to position the waveform at the center of the screen. Adjust A3R37 (hysteresis) for 20 mV p-p on the X-axis. Refer to the waveform in *Figure* 5-2. This completes the adjustment of Channel A and B; turn the 5335A off and disconnect all test equipment.

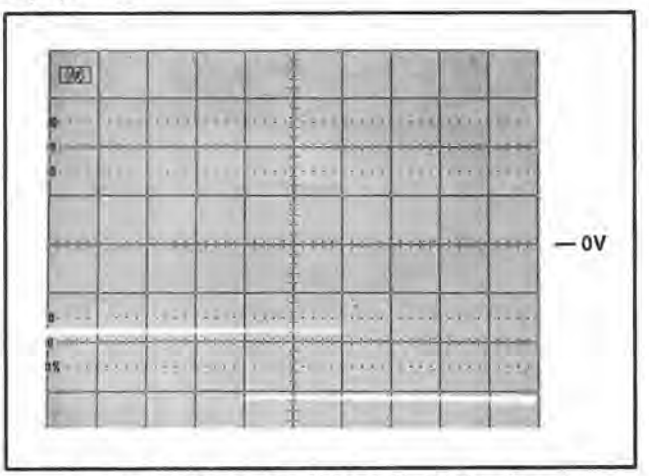


*Figure 5-2. Input Amplifier Adjust Waveform**

* A-Channel: 0.05 mV/cm ..... Y-axis (with a 10:1 probe)

* B-Channel: 0.01 mV/cm ..... X-axis

5-15. A8 Digital Voltmeter (Option 020) Adjustment Procedure

5-16. To perform the adjustments required for the DVM, proceed as follows:

a. Turn on 5335A and allow instrument (and voltmeter) to warm-up for 20 minutes.

NOTE

The following adjustments are sequential and should be performed in the order indicated.

b. Set the 5335A to the VOLTS function, and adjust the GATE TIME for ~150 ms.

c. Short the DCV-COM VOLTS module inputs together, to force the DVM into the 10 μV resolution range.

d. Press DISABLE, N=1000 to get an additional two digits of display. Connect the HP 3455A negative (Low) lead to the "floating" ground (COM) on A8. Connect the positive (Hi) lead to A8TP1; the reading on the multimeter should be 0V (±5 μV). If not, adjust A8 "Zero Offset" for 0V (±5 μV).

e. Remove the short between the DCV-COM inputs of the VOLTS module. Set the DC Standard to 4.0000 volts, and connect it to the VOLTS module input. Observe and record the 5335A display. Reverse the polarity of the input voltage, and observe and record the negative display. Take the sum of the absolute values of the two readings, and divide-by-two. Adjust "REF SYM" for a display of that calculated value.

f. Adjust "Low V" until the 5335A displays 4.0000V (±100 μV).

g. Set the DC Standard to 40.000 volts. Adjust "Med V" for a display of 40.000V (±1 mV).

WARNING

THE FOLLOWING STEP REQUIRES HIGH VOLTAGE. EXTREME CARE SHOULD BE EXERCISED.

h. Set the DC Standard to 400.000 volts. Adjust "High V" for a display of 400.00V (±10 mV).

i. Return the DC Standard to 4.000 volts, then turn the DC Standard and the 5335A off; disconnect all test equipment.

5-17. A9 Channel C (Option 030) Adjustment Procedure

5-18. To perform the adjustments required for the CHANNEL C, proceed as follows:

a. Turn on 5335A and allow instrument (and CHANNEL C) to warm-up for 5 minutes.

b. Remove the instrument top cover and locate variable resistors R22 (L), R23 (H), and R24 (K) on the A9 Channel C Assembly (05335-60009). Refer to the A9 component locator in Section VIII.

c. Set the 5335A front panel controls as follows:

GATE MODE ..... NORM
GATE CYCLE ..... NORM
GATE TIME ..... to about 1.2 s
FUNCTION ..... FREQ C
INPUT C Sensitivity ..... MAX
(no input signal)

(SELF OSCILLATING ADJUSTMENT)

d. Set A9R22 (L) to full clockwise position, and adjust A9R23 (H) until the 5335A displays 1010 MHz (±10 MHz).

e. Adjust A9R24 (K) for maximum display of frequency. Readjust A9R23 (H) for a display of 1010 MHz (±10 MHz). Steps d and e may have to be repeated.

(SENSITIVITY ADJUSTMENT)

f. Connect the instrument as shown in *Figure 5-3.*

g. Adjust the Channel C front panel SENSITIVITY control to MAX (fully clockwise).

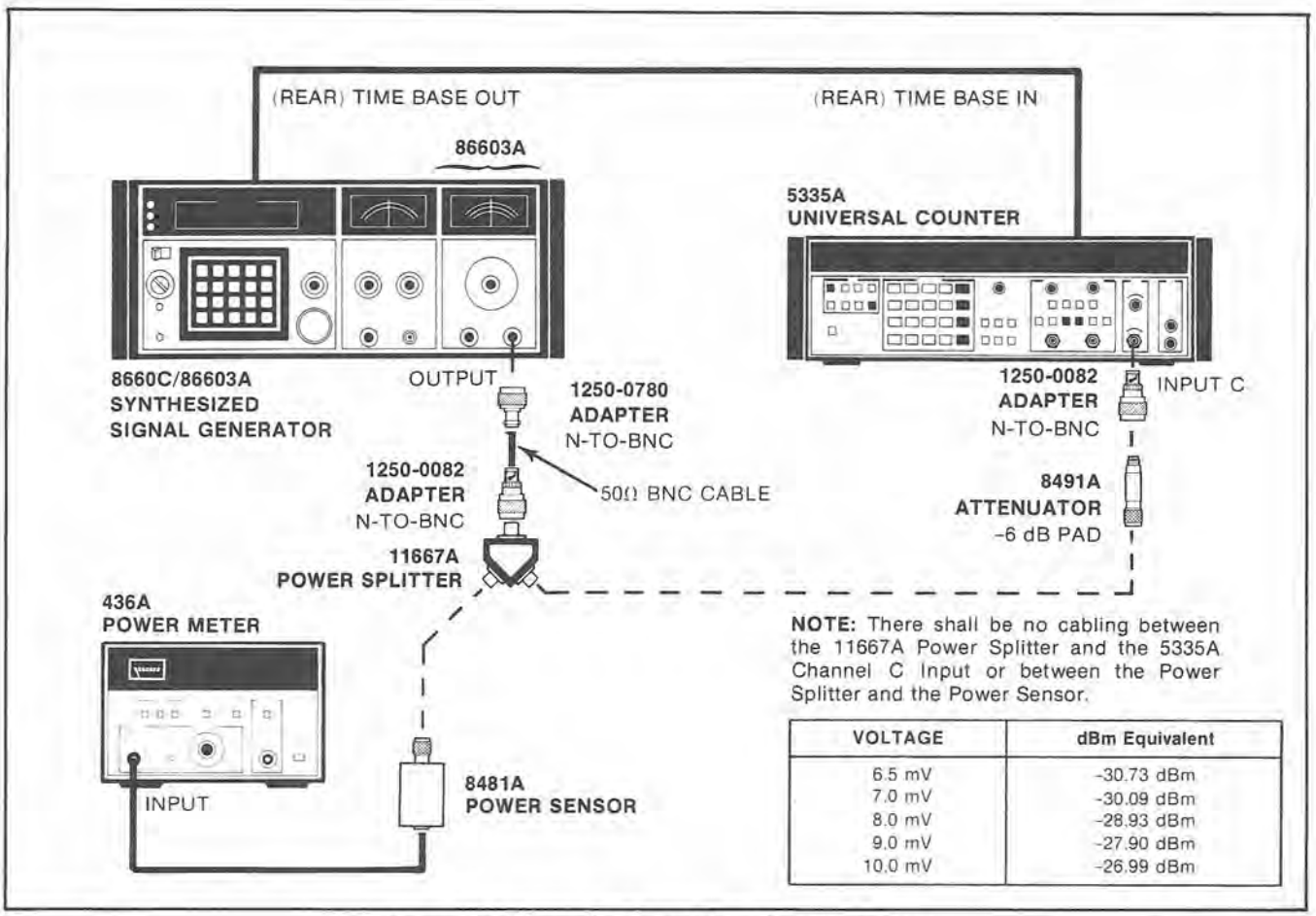
h. Set A9R22 (L pot) fully counterclockwise.

i. Set the 8660C to output a 1 GHz sinewave, varying the 86603A vernier until the HP 436A Power Meter reads -24 dBm, ±0.3 dBm. Adjust A9R22 ("L" pot) clockwise slowly until the 5335A displays 1 GHz (±1 Hz).

j. Set the 5335A GATE TIME to about 1.5 seconds.

k. Set the 8660C to output 1.3 GHz sinewave, varying the 86603A vernier until the HP 436A power meter reads -13 dBm (-19 dBm, 25 mV rms at the 5335A input). Verify that the counter displays 1.300 000 000 +9 (±1 Hz).

l. Turn the 5335A and 8660C off, and disconnect all test equipment.



VOLTAGE	dBm Equivalent
6.5 mV	-30.73 dBm
7.0 mV	-30.09 dBm
8.0 mV	-28.93 dBm
9.0 mV	-27.90 dBm
10.0 mV	-26.99 dBm

Figure 5-3. Channel C Sensitivity Adjustment Setup

5-19. Oscillator Adjustment Procedure (Local and Option 010)

5-20. Every few months, the oscillator should be checked to a house standard. When adjustment is required, use the oscilloscope method shown below. When checking the optional oven oscillator, Option 010, allow a 24-hour warmup period before adjustment. To perform the oscillator adjustment, proceed as follows:

a. As shown in *Figure 5-4*, connect a reference frequency standard to the external sync input of the oscilloscope.

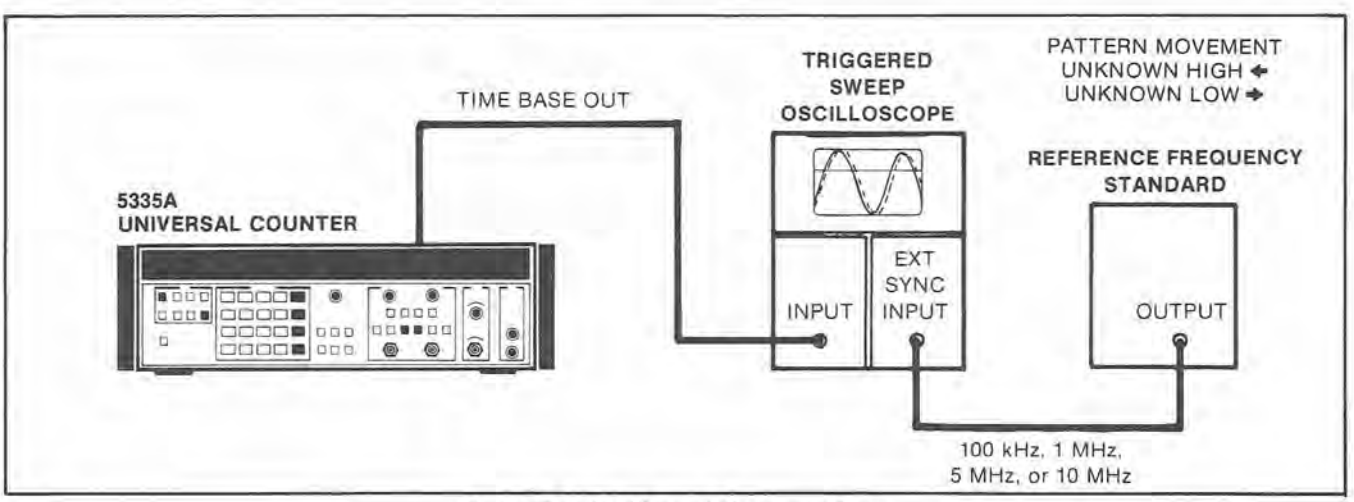


Figure 5-4. Oscillator Adjustment Setup

b. Connect rear panel TIME BASE OUT of the 5335A to Channel A of the scope.

c. Adjust the oscillator frequency for the minimum sideways movement of the 10 MHz displayed signal. For the local oscillator, adjust A4C6; for Option 010, HP 10544A/10811A Oven Oscillator, adjust the screwdriver adjustment labeled FREQ ADJ.

d. By timing the sideways movement (in centimetres persecond), the approximate frequency offset can be determined based on the oscilloscope sweep speed as shown in *Table 5-2*.

5-21. A2 Channel A and B Level Shifter Adjustment Procedure

5-22. To perform the adjustments required for the A2 Level Shifter proceed as follows:

a. Remove the 5335A top cover and locate variable resistors R65 and R66 on the A2 Amplifier Support Assembly (05335-60002).

b. Connect the 8640B Signal Generator, RF OUTPUT to 5335A INPUT A, and the 8640B TIME BASE OUT to 5335A TIME BASE IN as shown in *Figure 5-5*.

c. Set the 5335A front panel controls as follows:

FUNCTION ..... PER A
GATE MODE ..... NORM
CYCLE ..... NORM
INPUT (Channels A and B)
  SLOPE ..... (negative)
  1 MΩ/50Ω ..... 50Ω (IN)
  TRIGGER LEVEL ..... PRESET (OUT)
  X1/X10 ATTN ..... X1 (OUT)
  AC/DC ..... DC
COM A ..... OUT
AUTO TRIG ..... OUT

d. Set the 8640B to output a 110 MHz signal at 15 mV rms.

NOTE

8640B amplitude may be increased up to 20 mV rms if necessary, to obtain stable count within ±2 Hz.

Table 5-2. Frequency Offset Estimation

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 SECOND HAND OF WATCH OR CLOCK

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

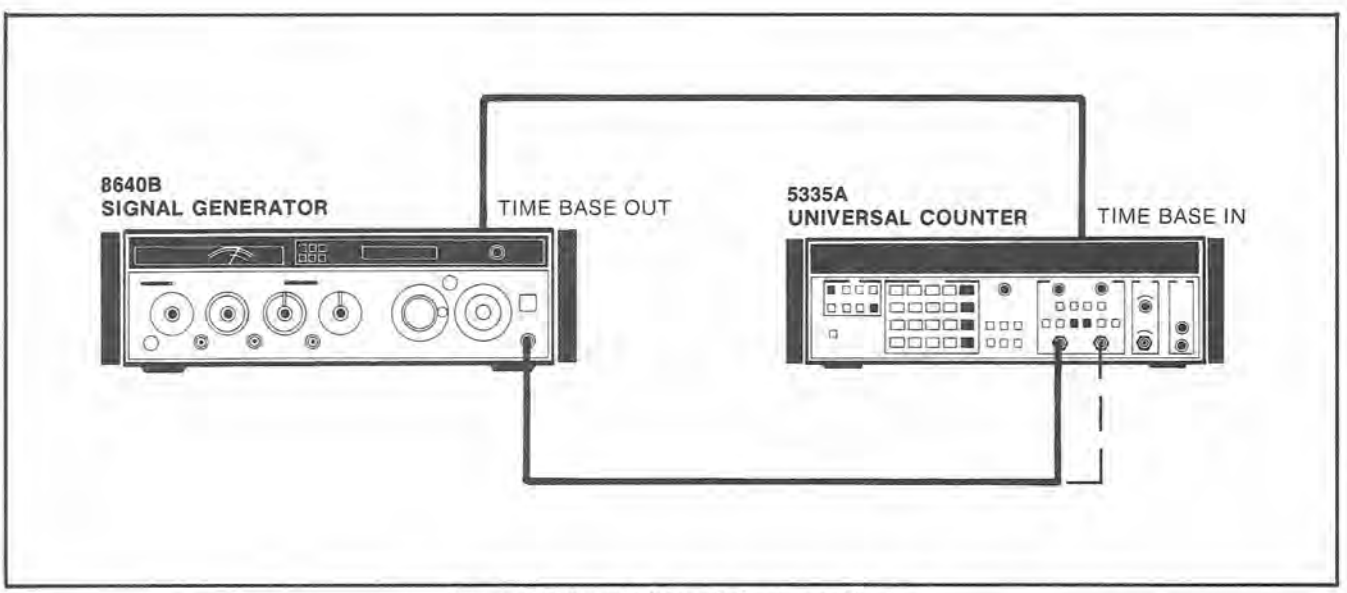


Figure 5-5. Level Shifter Adjustment Set-Up

e. Press the 5335A GATE TIME key and adjust the GATE ADJ knob to where the 5335A display shows 300 milliseconds. (±50 ms). Press the 5335A RESET key to return the function to PER A. Verify the PER A key lamp is ON.

f. Adjust A2R66 for Channel A to where the 5335A display remains stable at 9.0909091 ns within ±2 counts.

NOTE

It may be necessary to vary the GATE ADJ knob to obtain the required resolution (i.e., 9.090909X).

g. Set Channel A slope to (⨍) positive and adjust A2R66 to where the count is stable within ±2 counts. Display should be stable to within ±2 counts on both slopes (⨍ and ⨍).

h. Connect the 8640B Signal Generator to 5335A INPUT B. Ensure the 8640B is set to output a 110 MHz signal at 15 mV rms.

i. Set the 5335A to Special Function 17, by pressing: SCALE, SMOOTH, 1, 7, ENTER.

j. For Channel B adjust A2R65 for a 5335A stable display of 110 MHz ±1 Hz on both negative slope (⨍) and positive slope (⨍). This completes the Channel A and B level shifter adjustment.

k. Disconnect all test equipment.

5-23. Channel A and B Peak Detector Adjustment Procedure

5-24. To perform the Peak Detector adjustments required for the A3 assembly proceed as follows:

a. Remove the 5335A top cover, and locate variable resistors R99, R100, R101, and R102 on the A3 Amplifier Buffer Assembly (05335-60003).

b. Set the 5335A front panel controls as follows:

FUNCTION ..... FREQ A
INPUT (CHANNELS A AND B)
1 MΩ/50Ω ..... 50Ω (IN)
ATTN ..... X1 (OUT)
AC/DC ..... DC (OUT)
AUTO TRIG ..... ON (IN)
COM A ..... ON (IN)
TRIGGER LEVEL POTS ..... CCW
(but not in PRESET)

Channel A Peak Detector Adjustment

c. Connect a Function Generator (HP 3312A) to Input A; set the function generator to output a ~~200 Hz square wave at 500 mV p-p~~. 30 HZ SINEWAVE AT 5 V P-P

d. Connect the DVM (HP 3455A) positive input to either side of A3R54 (422 ohms) and the DVM negative input to the ground test pin on A3.

e. Adjust A3R100 ("-PK") so that the DVM displays ~~-240 mV ±5 mV~~. (-) 2.44 V +/- 10 mV

f. Rotate Channel A Trigger Level Pot to the CW position; adjust A3R99 ("+PK") so that the DVM displays ~~+240 mV ±5 mV~~. (+) 2.44 V +/- 10 mV

Channel B Peak Detector Adjustment

g. ~~Connect a Function Generator (HP 3312A) to Input B, set the function generator to output a 200 Hz square wave at 500 mV p-p.~~ 30HZ SINEWAVE AT 5 V P-P

h. Connect the DVM (HP 3455A) positive input to either side of A3R38 (422 ohms) and the DVM negative input to the ground test pin on A3.

i. Adjust A3R102 ("-PK") so that the DVM displays ~~-240 mV ±5 mV~~. (-) 2.44 V +/- 10 mV

j. Rotate Channel B Trigger Level Pot to the CW position; adjust A3R101 ("+PK") so that the DVM displays ~~+240 mV ±5 mV~~. (+) 2.44 V +/- 10 mV

NOTE

If one Peak Detector can be adjusted to ±240 mV, the other Peak should be adjusted to that same magnitude with opposite polarity, in order to maintain symmetry. If the Peak Detectors cannot be adjusted into the permissable range, a 3.16 MΩ resistor (P/N 0699-0070) may be installed in place of the 4.64 MΩ resistor. Use the following table to determine which resistor to change:

Magnitude of Peak	Channel A		Channel B	
	+Peak	-Peak	+Peak	-Peak
Too High	R89	R92	R1	R10
Too Low	R90	R91	R2	R11

5-25. A6 Rear Panel Assembly Adjustment Procedure

NOTE

The following procedure can ONLY be used to adjust Part Number 05335-61006, A6 board.

5-26. Use the following procedure to adjust the External Arm circuitry in A6 rear panel assembly, part number 05335-61006. This is the only adjustment in the A6 assembly.

a. Set the 5335A front and rear panel controls as follows:

FUNCTION ..... GATE TIME
EXTERNAL ARM (Rear panel)
START switch ..... Positive edge (UP)
STOP switch ..... Positive edge (UP)

b. Enable the EXT ARM ENABLE Function and the CYCLE MIN on the 5335A front panel. With no signal applied to the EXTERNAL ARM IN, observe that the GATE TIME, EXT ARM ENABLE, GATE MODE MIN, and CYCLE MIN LED's are ON; also the GATE LED is not flashing.

c. Connect the 5335A rear panel $\overline{\text{GATE OUT}}$ connector to the 1740A oscilloscope INPUT A and the 3325A Synthesizer/Function Generator to the 5335A EXTERNAL ARM IN connector (through a 50Ω feed-through) as shown in *Figure 5-6*.

d. Set the HP 3325A to output a 3-volt peak-to-peak square wave with an offset of +1.5 volt, at a frequency of 100 Hz.

e. Set the 5335A EXTERNAL ARM ADJ (through the rear panel) to full clockwise position. This will set the External Arming circuitry for TTL level signals.

f. Observe that the 5335A displays about 10 ms. Also, the 1740A display shows a 10 ms negative TTL pulse, indicating that the gate is being armed by the 100 Hz signal into the EXTERNAL ARM IN.

g. Turn off and disconnect all test equipment.

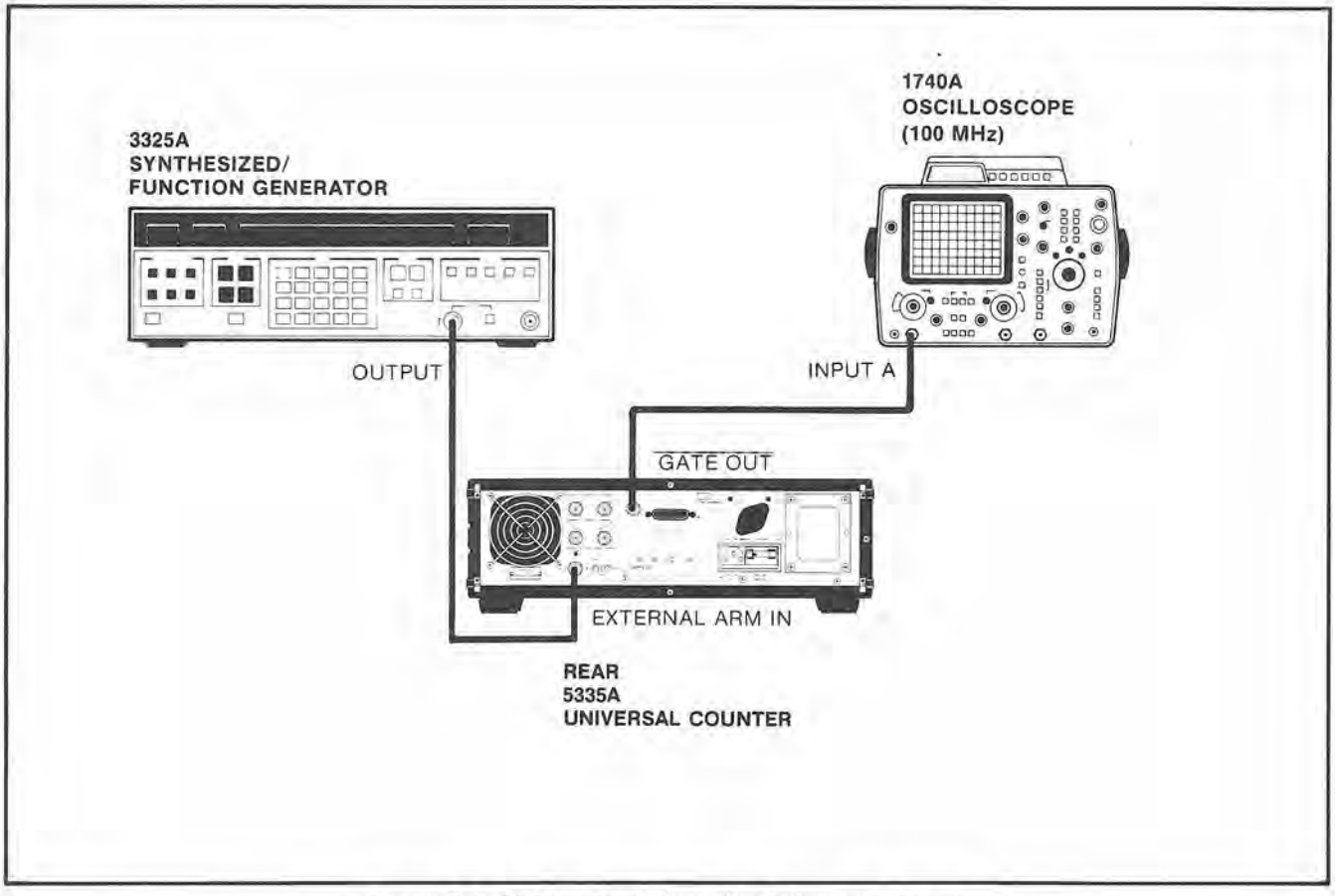


Figure 5-6. A6 Rear Panel Assembly Adjustment Setup

5-27. OPTION 040 ADJUSTMENT PROCEDURES

5-28. The following procedures can be used for adjusting the HP 5335A Universal Counter with Option 040. They cover the adjustments for the Input Amplifiers and Peak Detectors on the A12 board, and the Digital-to-Analog Converters (DAC's) and the attenuators on the A11 board. These are the only adjustments that differ from the standard 5335A adjustment.

5-29. A12 Programmable Input Amplifier (Option 040) Adjustment Procedure

5-30. To perform the Offset and Hysteresis adjustments required for A12, proceed as follows:

a. Remove the 5335A top cover, and locate variable resistors R43, R53, R110, and R105 on the A12 Programmable Input Amplifier Assembly (05335-60012). Refer to Assembly Adjustment Locator in *Figure 5-7*, and corresponding component locators.

b. Set the 5335A front panel controls as follows:

GATE TIME . Adjust to about 150 ms
FUNCTION ..... FREQ A
GATE MODE ..... NORM
CYCLE ..... NORM
INPUT (Channels A and B)
1 MΩ/50Ω ..... 50Ω (~~1MΩ~~) (LITE ON)
TRIGGER LEVEL ... PRESET (~~OUT~~)
ATTN ..... X1 (~~OUT~~) (LITE OFF)
AC/DC ..... DC (LITE OFF)
COM A ..... ~~OUT~~ OFF (LITE OFF)
AUTO TRIG ..... ~~OUT~~ OFF (LITE OFF)
~~POWER STBY/ON ..... ON~~

c. Set the 3312A Function Generator to output a 1.0 kHz sine wave at ~100 mV p-p.

d. Connect the test equipment as shown in *Figure 5-7*; for the Channel A adjustment, connect the oscilloscope Channel A probe to the junction of A11R47 and R54.

WARNING

DO NOT SHORT THE PROBE TO ANY OTHER TRACES OR COMPONENTS, OR DAMAGE WILL OCCUR TO THE CIRCUITRY, PARTICULARLY TO THE AMP SCHMITT IC'S.

e. Set the oscilloscope for the X-Y mode, and calibrate by centering the dot at center screen.

f. Position both A12R105 (offset) and A12R110 (hysteresis) to approximately midrange.

g. Adjust A12R105 (offset) to position the waveform at the center of the screen. Adjust A12R110 (hysteresis) 20 mV p-p on the X-axis. Refer to the waveform in *Figure 5-8*.

h. Disconnect the oscilloscope Channel A probe from junctions of A11R54 and R47 and connect the probe to the junction of A11R37 and R38. Disconnect the signal generator output from the 5335A Channel A INPUT and connect it to the Channel B INPUT.

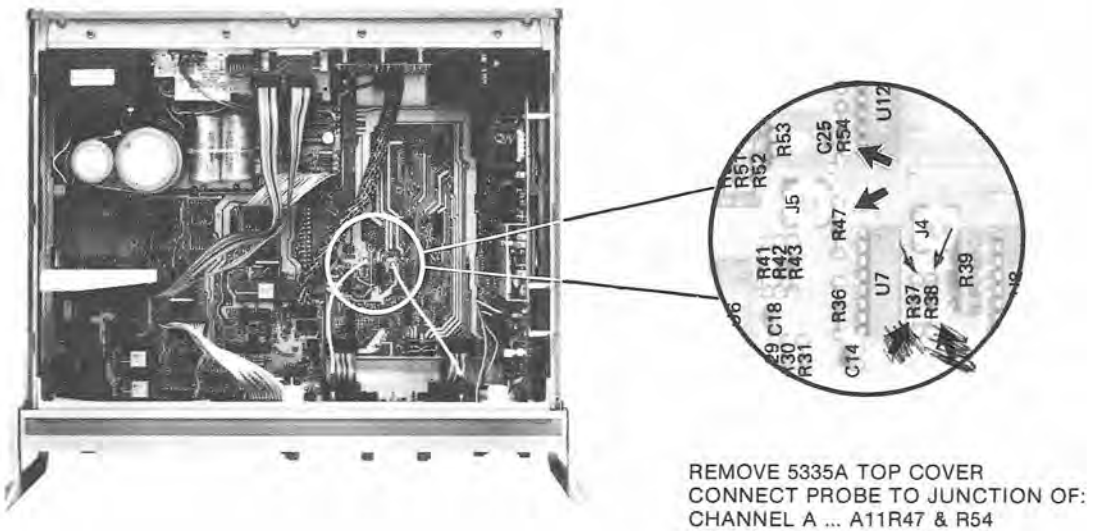
i. Set the 5335A for Special Function #17; (press: SCALE, SMOOTH, 1, 7, ENTER).

j. Position both A12R53 (offset) and A12R43 (hysteresis) to approximately midrange.

k. Adjust A12R53 (offset) to position the waveform at the center of the screen. Adjust A12R43 (hysteresis) for 20 mV p-p on the X-axis. Refer to the waveform in *Figure 5-8*. This completes the adjustment of Channels A and B; turn the 5335A off and disconnect all test equipment.

Table 5-3. Option 040 Adjustments

Procedure	Assemblies	Adjustments	Comments
Input Amplifier	A12	A12R43, R53, R110, R105	Uses Special Function #17
Peak Detectors	A12	A12R107, R111, R2, R21	Perform adjustments in indicated order
Digital-to-Analog Converters	A11	A11R74, R75, R70, R69, R48, R53	Uses Special Function #18 and #19
Attenuators	A12	A12C46, C30	Perform adjustments in indicated order



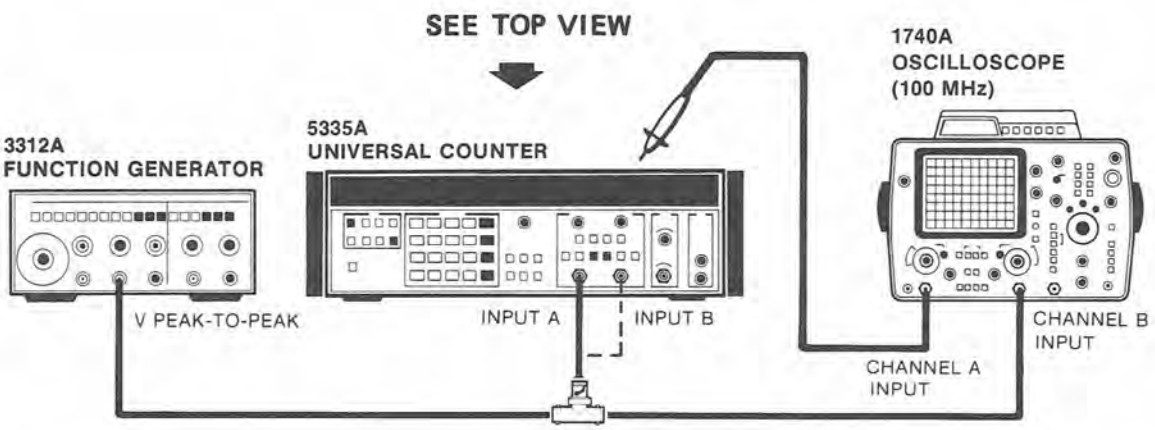


Figure 5-7. Programmable Input Amplifier Adjustment Setup

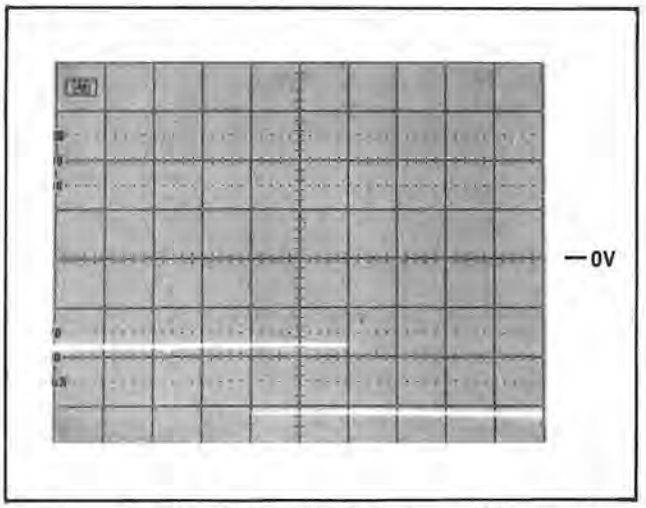


*Figure 5-8. Input Amplifier Adjustment Waveform**

*Channel A: 0.05 V/cm ..... Y-axis
(with a 10:1 probe)

*Channel B: 0.01 V/cm ..... X-axis

5-31. A12 Peak Detectors Adjustment Procedure

5-32. To perform the Peak Detector adjustments required for the A12 assembly proceed as follows:

a. Remove the 5335A top cover, and locate variable resistors R107, R111, R2, and R21 on the ~~A21~~ A12 Programmable Input Amplifier Assembly (05335-60012).

b. Connect the test equipment as per *Figure ~~5-8~~* 5-11.

c. Set the 5335A front panel controls as follows:

FUNCTION ..... FREQ A
INPUT (Channels A and B)
1 MΩ/50Ω ..... 50Ω (~~IN~~) (LITE ON)
ATTN ..... X1 (~~OUT~~) (LITE OFF)
AC/DC ..... DC (~~OUT~~) (LITE OFF)
AUTO TRIG ..... ON (~~IN~~) (LITE ON)
COM A ..... ON (~~IN~~) (LITE ON)
TRIGGER LEVEL POTS ..... CCW
(but not in PRESET)

d. Set the HP 3312A Function Generator to output ~~a 200 Hz square wave at 500 mV p-p~~. 30 Hz SINEWAVE AT 5V p-p

CHANNEL A:

e. Connect the HP 3455A DVM positive input to A11 (ATL) test point and the DVM negative input to the "GAA" test point.

f. Adjust A12R~~111~~ R111 ~~R107~~ ("-PK") so that DVM displays ~~-240 mV ±5 mV~~. (-) 2.44V +/- 10mV

g. Rotate Channel A Trigger Level Pot to the CW position; adjust A12R~~107~~ ("+PK") so that DVM displays ~~+240 mV ±5 mV~~. + 2.44V +/- 10mV

R ~~111~~ 107

CHANNEL B:

h. Connect the HP 3455A DVM positive input to A11 "BTL" test point and the DVM negative input to the "GAB" test point.

i. Adjust A12R21 ("-PK") so that DVM displays ~~-240 mV ±5 mV~~. +(-) 2.44V +/- 10mV

j. Rotate Channel B Trigger Level Pot to the CW position; adjust A12R2 ("+PK") so that DVM displays ~~+240 mV ±5 mV.~~ +(-) 2.44V +/- 10mV

NOTE

SEE CHANGE 4/25/85

If one Peak Detector ~~can~~ CANNOT be adjusted to ±240 mV, the other Peak Detector should be adjusted to that same magnitude with opposite polarity, in order to maintain symmetry. If the Peak Detectors cannot be adjusted into the permissable range, a 3.16 MΩ resistor (P/N 0699-0070) may be installed in place of the 4.64 MΩ resistor. Use the following table to determine which resistor to change:

+/- 10mV +(-) 2.44V

MAGNITUDE OF PEAK	CHANNEL A		CHANNEL B	
	+PEAK	-PEAK	+PEAK	-PEAK
TOO HIGH	R100	R101	R7	R16
TOO LOW	R106	R108	R8	R17

k. Turn off 5335A and all test equipment; also, disconnect all test equipment.

~~5-33.~~ A12C46 Adjustment Procedure

a. Connect power cable to the 5335A; switch the line power from STBY to ON.

b. Connect the HP 8654A Signal Generator to the 5335A INPUT A as shown:

SEE CHANGE 4/25/85

SERIAL PREFIX OR SERIES NUMBER	CHANGES

Page 5-11. Adjustments:

5-33. **A12C46 Adjustment Procedure:**

a. Connect power cable to the 5335A; switch the line power from STBY to ON.

b. Connect the HP3312A Function Generator to the 5335A INPUT A.

c. Set the 5335A front panel controls as follows:

FUNCTION ..... RISE/FALL A
GATE ADJ ..... fully CCW
INPUT (Chan A)
1 Meg/50 ohm ..... 50 ohm (ON)
TRIGGER LEVEL ..... PRESET
X10/X1 ATTN ..... X1 (OFF)
AC/DC ..... DC (OFF)
FILTER ..... (OFF)

d. Set the 3312A Function Generator to output a 50 Hz squarewave at 5 volts p-p. Make a note of the measurement value displayed by the 5335A.

e. Set the 5335A Channel A ATTENUATOR TO X10.

f. Locate variable capacitor A12 C46.

g. Adjust A12 C46 so that the 5335A display is the same as the value noted in step "d", (+0/-3 nanoseconds).

5-34. **A12C30 Adjustment Procedure**

a. Switch the 5335A line power from ON to OFF, then back to ON.

b. Connect the HP8654A Signal Generator to the 5335 INPUT A, as shown in Figure 5-9.

SERIAL PREFIX OR SERIES NUMBER | CHANGES

Page 5-11. Adjustments:

c. Set the 5335A front panel controls as follows:

FUNCTION ..... FREQ A
MATH ~~MATCH~~ ..... OFF (LEDS OFF)
STATISTICS ..... OFF (LEDS OFF)
GATE MODE ..... NORM
CYCLE ..... NORM
GATE ADJ ..... fully CCW
INPUT (Chan A)
1 Meg/50 ohm ..... 50 ohm (ON)
TRIGGER LEVEL ..... PRESET
X10/X1 ATTN ..... X1 (OFF)
AC/DC ..... AC (ON)
FILTER ..... (OFF)
COM ..... (OFF)

e. Set the 8654A Signal Generator to output a 100 MHz sinewave at a minimum output level on the 30 mV range. Increase the output level until the 5335A displays a stable count of "100 MHz". Record this signal level as "CHAN A, X1 = xx mV", and save for step "g".

f. Set the 5335A Channel A ATTENUATOR to X10 (on). Change the 8654A output range to the 300mV scale (10 times output level of step "e"). Increase the output level until the 5335A displays a stable count of "100 MHz". Record this signal level as "CHAN A,X10 = xxx mV", and save for step "g".

g. Divide the value of recorded level from step "f" by recorded level from step "e", to determine the actual attenuation factor of CHAN A. Result should be approximately "10". Record this value as "CHAN A ATTN FACTOR= xx", and save for step "1".

h. Press: SCALE, SMOOTH, 1,7, ENTER. This will enable special function FREQ B.

i. Set the 5335A front panel controls as follows:

INPUT (Chan B)
1 Meg/50 ohm ..... 50 ohm (ON)
TRIGGER LEVEL ..... PRESET
X10/X1 ATTN ..... X1 (OFF)
AC/DC ..... AC (ON)
FILTER ..... (OFF)
COM ..... (OFF)

j. Connect the 8654A Signal Generator to the 5335A INPUT B, as shown in Figure 5-10.

SERIAL PREFIX OR SERIES NUMBER	CHANGES

Page 5-11. Adjustments:

k. Set the 8654A Signal Generator to output a 100 MHz sinewave at the minimum output level on the 30 mV range. Increase the output level until the 5335A displays a stable count of "100 MHz". Record the signal level as "CHAN B, X1 = xx mV", and save for step "1".

l. Multiply the value of recorded level from step "k" by the factor determined in step "g".

m. Set the 5335A Channel B ATTENUATOR to X10 (on). Change the 8654A output range to the 300mV scale (10 times output level of step "e"), and adjust the level as close as possible to the value determined in step "l".

n. Locate variable capacitor A12 C30.

o. Adjust A12 C30 so that the 5335A display just gives a stable count of 100 MHz.

2336 Paragraph 5-32, step a:
>Change Part Number of A12 Programmable Input Amplifier Assembly from 05335-60012 to 05335-60032.

Page 5-13. Adjustments:

All Serials Paragraph 5-36, step a:
>Add "R48 (A) and R53 (B)." to the list of variable resistors in step a.

Paragraph 5-36, step b:
>Delete the first sentence "Repeat step 5-32(e)" and replace with "Connect the HP3455A DVM positive input to A11 (ATL) test point and negative input to A11 (GAA) test point."

Paragraph 5-36, step f:
>Change step "f." to "g."
>Add step f:
"All Level Shift resistors R48 and R53 are adjusted exactly as A2 Level Shift resistors A2R65 and R66. To adjust the A11 Level Shift resistors, follow the procedure listed in paragraph 5-21, substituting R53 for R66 and R48 and R65 in the instructions."

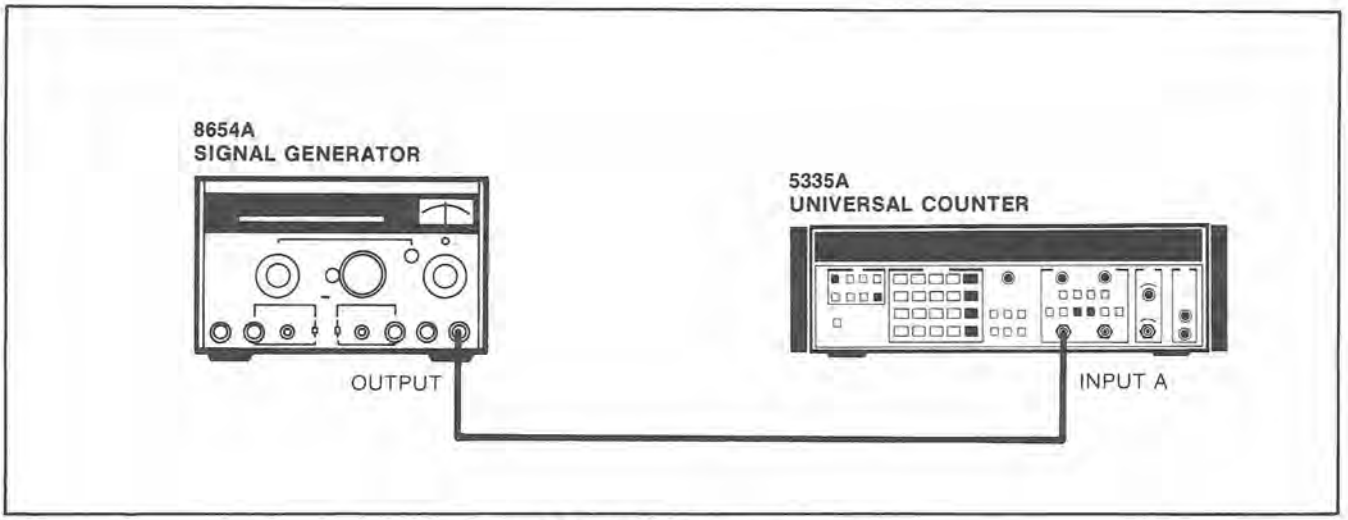


Figure 5-9. A12C46 Adjustment Setup

c. Set the 5335A front panel controls as follows:

GATE ADJ ..... fully CCW
INPUT (Channel A)
1 MΩ/50Ω ..... 50Ω (ON)
TRIGGER LEVEL ..... PRESET
X10/X1 ATTN ..... X1 (OFF)
AC/DC ..... AC (ON)
FILTER ..... (OFF)
COM A ..... (OFF)

d. Set the 8654A to output a 100 MHz sine wave at a minimum output level on the 30 mV range. Increase the output level of the 8654A until the 5335A displays a stable count of 100 MHz. Record this level.

e. Set the 5335A Channel A Attenuator to **X10 (ON)**, and COM A momentary switch to **ON**. Set the 8654A output range to the 300 mV scale.

f. Set the 8654A to output a level 10 times the previously recorded level in step d.

g. Locate variable capacitors A12C46 and C30 on the 05335-60012 Assembly.

h. Adjust A12C46 so that the 5335A display just gives a stable count of 100 MHz.

NOTE

This adjustment must be preformed very carefully in order to obtain the desired results.

5-34. A12C30 Adjustment Procedure

a. Switch the 5335A line power from ON to OFF, then back to ON.

b. Press: SCALE, SMOOTH, 1, 7, ENTER. This will enable special function Frequency B.

c. Connect the HP 8654A Signal Generator to the 5335A INPUT B as shown:

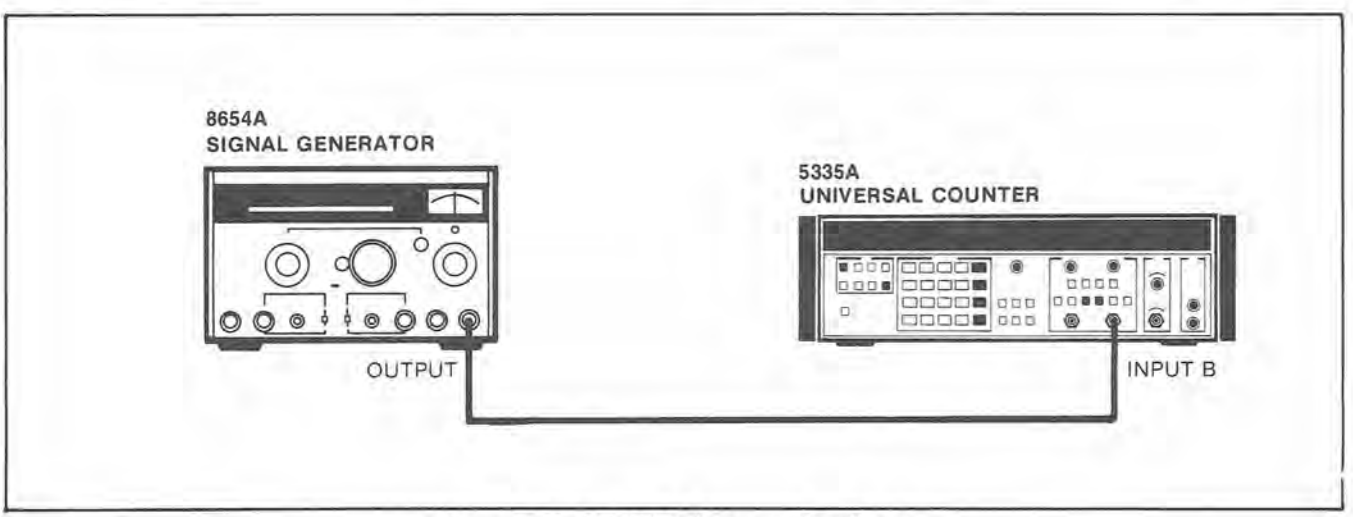


Figure 5-10. A12C30 Adjustment Test Setup

d. Set the 5335A front panel controls as follows:

MATH	Off (LEDs off)
STATISTICS	Off (LEDs off)
GATE MODE	NORM
CYCLE	NORM
GATE ADJ	fully CCW
INPUT (Channel B)	
1 MΩ/50Ω	50Ω (ON)
TRIGGER LEVEL	PRESET
X10/X1 ATTEN	X1 (OFF)
AC/DC	AC (ON)
FILTER	(OFF)
COM A	(OFF)

e. Set the 8654A to output a 100 MHz sine wave at a minimum output level on the 30 mV range. Increase the output level of the 8654A until the 5335A displays a stable count of 100 MHz. Record this level.

f. Set the 5335A Channel B Attenuator to **X10 (ON)**. Set the 8654A output range to the 300 mV scale.

g. Set the 8654A to output a level 10 times the previously recorded level in step e.

h. Adjust A12C30 so that the 5335A display just gives a stable count of 100 MHz.

i. Replace top cover on the 5335A.

5-35. A11 DAC Adjustment Procedure

5-36. To perform the DAC adjustments required on the A11 asssembly, proceed as follows:

a. Remove the 5335A top cover, and locate variable resistors R74 (AØ), R75 (-5.12 "A"), R70 (BØ), and R69 (-5.12 "B"). R48(A), R53(B)
CONN. DVM + TO A11 (ATL) AND DVM − TO A11 (GAA)

b. ~~Repeat step 5-32(e).~~ Press: SCALE, SMOOTH, 9, 9, ENTER; wait 5 seconds then press: SCALE, 1, 8, ENTER. Adjust R74 (AØ) so that DVM displays 0V ±1 mV.

c. Disconnect DVM positive probe from "ATL" test point and connect the probe to "BTL" test point; also connect DVM negative terminal to "GAB". Vary R70 (BØ) for a DVM reading of 0V ±1 mV.

d. Press: SCALE, 1, 9, ENTER. Vary R69 (-5.12 "B") so that DVM displays -5.12 ±1 mV.

e. Disconnect DVM positive terminal from "BTL" test point and connect the terminal to "ATL" test point; also connect DVM negative terminal to "GAA". Vary R75 (-5.12 "A") for a DVM reading of -5.12V ±1 mV.

g. Turn the 3455A and the 5335A off; disconnect all test equipment.

f. ALL LEVEL SHIFT RESISTORS R48 AND R53 ARE ADJUSTED EXACTLY AS A2 LEVEL SHIFT RESISTORS A2R65 AND R66. TO ADJUST THE A11 LEVEL SHIFT RESISTORS, FOLLOW THE PROCEDURE LISTED IN PARA. 5-21, SUBSTITUTING R53 FOR R66, AND R48 FOR R65 IN THE INSTRUCTIONS

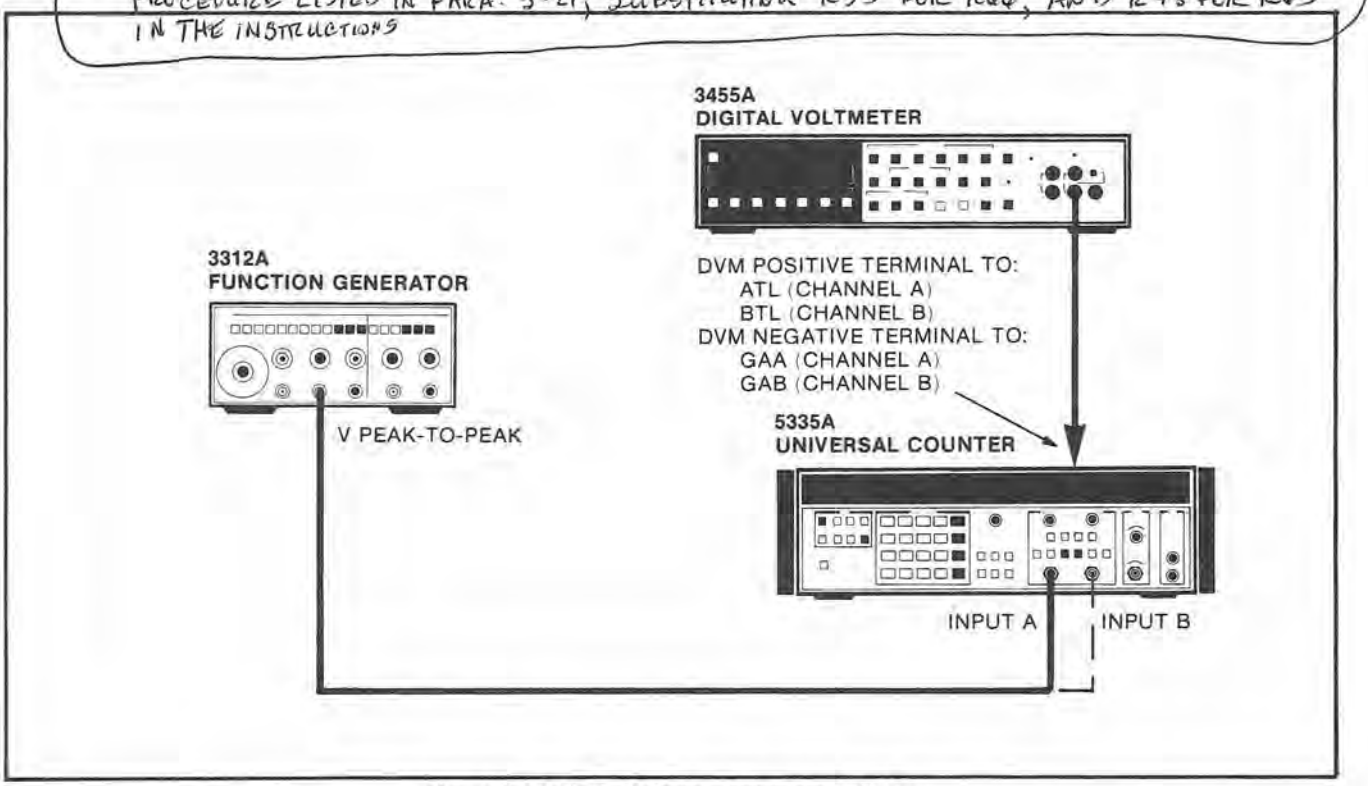


Figure 5-11. Peak Detector Adjustment Setup

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION

6-2. This section contains information for ordering parts. *Table 6-1* lists abbreviations used in the parts list and throughout the manual. *Tables 6-2* and *6-3* lists all replaceable parts for the standard 5335A and Option 010 in reference designation order. *Tables 6-4, 6-5,* and *6-6* list replaceable parts for Options 020, 030, and 040, respectively. *Table 6-7* contains the names and addresses that correspond with the manufacturer's code numbers.

6-3. ABBREVIATIONS

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

6-5. REPLACEABLE PARTS

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

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

b. Miscellaneous chassis-mounted electrical parts in alphanumerical order by reference designation.

c. Miscellaneous chassis and mechanical 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 manufacturer's number for the part.

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

6-9. ORDERING INFORMATION

6-10. To order a part listed in 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 instrument 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.

6-12. DIRECT MAIL ORDER SYSTEM

6-13. Within the USA, Hewlett-Packard can supply parts through a direct mail order system. Advantages of using the 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 orders require billing and invoicing).

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

d. No invoices — 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 6-1. Abbreviations and Reference Designations

REFERENCE DESIGNATIONS

A	= assembly
AT	= attenuator; isolator; termination
B	= fan; motor
BT	= battery
C	= capacitor
CP	= coupler
CR	= diode; diode thyristor; varactor
DC	= directional coupler
DL	= delay line
DS	= annunciator; signaling device (audible or visual); lamp; LED
E	= miscellaneous electrical part
F	= fuse
FL	= filter
H	= hardware
HY	= circulator
J	= electrical connector (stationary portion); jack
K	= relay
L	= coil; inductor
M	= 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 ratio
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}

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1	05335-60001	7	*1	BOARD ASSEMBLY-POWER SUPPLY(SERIES 2044)	28480	05335-60001
A1C1	0180-1746	5	3	CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A1C2	0180-2865	1	1	CAPACITOR-FXD 100UF+100-10% 15VDC AL	28480	0180-2865
A1C3	0180-1701	2	1	CAPACITOR-FXD 6.8UF+-20% 6VDC TA	56289	150D685X0006A2
A1C4	0180-0230	0	3	CAPACITOR-FXD 1UF+-20% 50VDC TA	56289	150D105X0050A2
A1C5	0160-2208	4	2	CAPACITOR-FXD 330PF +-5% 300VDC MICA	28480	0160-2208
A1C6	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A1C7	0180-0230	0		CAPACITOR-FXD 1UF+-20% 50VDC TA	56289	150D105X0050A2
A1C8	0160-3879	7	1	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A1C9	0160-2208	4		CAPACITOR-FXD 330PF +-5% 300VDC MICA	28480	0160-2208
A1C10	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A1C11	0180-0230	0		CAPACITOR-FXD 1UF+-20% 50VDC TA	56289	150D105X0050A2
A1C12	0180-2351	0	2	CAPACITOR-FXD 2000UF+75-10% 50VDC AL	28480	0180-2351
A1C13	0180-2351	0		CAPACITOR-FXD 2000UF+75-10% 50VDC AL	28480	0180-2351
A1C14	0180-2799	0	1	CAPACITOR-FXD .017F+75-10% 20VDC AL	28480	0180-2799
A1C15	0160-4557	0	1	CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A1C16	0180-0567	6	1	CAPACITOR-FXD 8000UF+75-10% 30VDC AL	00853	500802U030AB2B
A1CR1	1902-0522	6	2	DIODE-ZNR 1N5340B 6V 5% PD=5W IR=1UA	04713	1N5340B
A1CR2	1902-0632	9	1	DIODE-ZNR 1N5354B 17V 5% PD=5W TC=+75%	04713	1N5354B
A1CR3	1902-0522	6		DIODE-ZNR 1N5340B 6V 5% PD=5W IR=1UA	04713	1N5340B
A1CR4	1901-0662	3	1	DIODE-PWR RECT 100V 6A	04713	MR751
A1CR5				NOT ASSIGNED		
A1CR6	1901-0731	7	1	DIODE-PWR RECT 400V 1A	28480	1901-0731
A1CR7	1901-0050	3	2	DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A1CR8	1906-0096	7	1	DIODE-FW BRDG 200V 2A	04713	MDA202
A1CR9	1901-0673	6	2	DIODE-PWR RECT 100V 5A SUS	03508	A15A
A1CR10	1901-0673	6		DIODE-PWR RECT 100V 5A SUS	03508	A15A
A1CR11	1906-0213	0	1	DIODE-CT-RECT 200V 12A	01295	TIR101B
A1CR12	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A1F1	2110-0010	9	1	FUSE 5A 250V NTD 1.25X.25 UL	75915	312005
A1F2	2110-0043	8	2	FUSE 1.5A 250V NTD 1.25X.25 UL	28480	2110-0043
A1F3	2110-0083	6	1	FUSE 2.5A 250V NTD 1.25X.25 UL	28480	2110-0083
A1F4	2110-0043	8		FUSE 1.5A 250V NTD 1.25X.25 UL	28480	2110-0043
A1J1	1251-6608	0	1	CONNECTOR 16-PIN M POST TYPE	28480	1251-6608
A1J2				NOT ASSIGNED		
A1J3	1251-0600	0	9	CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A1J4	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A1J5	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A1J6	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A1J7	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A1J8	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A1J9	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A1J10	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A1J11	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A1K1	0490-1172	8	1	RELAY 6A 24VDC-COIL 5A 115VAC	28480	0490-1172
A1Q1	1853-0454	8	1	TRANSISTOR PNP SI DARL TO-220AB PD=2W	01295	TIP106
A1Q2	1853-0036	2	1	TRANSISTOR PNP SI PD=310MW FT=250MHZ	28480	1853-0036
A1Q3	1854-0215	1	1	TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A1R1	2100-3212	8	1	RESISTOR-TRMR 200 10% C TOP-ADJ 1-TRN	28480	2100-3212
A1R2	0812-0019	4	1	RESISTOR .33 5% 3W PW TC=0+-90	28480	0812-0019
A1R3	0757-0401	0	1	RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A1R4	0698-0063	4	1	RESISTOR 5.23K 1% .125W F TC=0+-100	91637	CMF-1/8-T1-5231-F
A1R5	0757-0442	9	1	RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A1R6	0757-0280	3	4	RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A1R7	0812-0045	6	1	RESISTOR .15 5% 3W PW TC=0+-90	28480	0812-0045
A1R8	0757-0438	3	1	RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A1R9	0698-4002	9	1	RESISTOR 5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5001-F
A1R10	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A1R11	0698-0084	9	2	RESISTOR 2.15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2151-F
A1R12	0698-0084	9		RESISTOR 2.15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2151-F
A1R13	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A1R14	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A1R15	2100-3383	4	1	RESISTOR-TRMR 50 10% C TOP-ADJ 1-TRN	28480	2100-3383
A1R16	0757-0421	4	1	RESISTOR 825 1% .125W F TC=0+-100	24546	C4-1/8-T0-825R-F
A1TP1	1251-4707	6	2	CONNECTOR-SGL CONT PIN .031-IN-BSC-SZ	28480	1251-4707
A1TP2	1251-4707	6		CONNECTOR-SGL CONT PIN .031-IN-BSC-SZ	28480	1251-4707
A1U1	1826-0316	4	1	V REF TO-5	27014	LH0070-1H
A1U2	1820-0477	6	2	IC OP AMP GP 8-DIP-P PKG	S0545	UPC301AC
A1U3	1820-0477	6		IC OP AMP GP 8-DIP-P PKG	S0545	UPC301AC
A1U4	1826-0393	7	1	IC V RGLTR TO-220	27014	LM317T
A1U6	1826-0607	6	1	IC-REGULATOR 7815A 15V	28480	1826-0607

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
A1U7	1826-0214	1	1	IC V RGLTR TO-220	04713	MC7915CT
A1XA2P2	1251-2160	1	1	CONNECTOR-PC EDGE 6-CONT/ROW 2-ROWS	28480	1251-2160
A1XF1	2110-0269	0	8	FUSEHOLDER-CLIP TYPE.25D-FUSE	28480	2110-0269
A1XF2	2110-0269	0		FUSEHOLDER-CLIP TYPE.25D-FUSE	28480	2110-0269
A1XF3	2110-0269	0		FUSEHOLDER-CLIP TYPE.25D-FUSE	28480	2110-0269
A1XF4	2110-0269	0		FUSEHOLDER-CLIP TYPE.25D-FUSE	28480	2110-0269
A1XK1	0490-0468	3	1	SOCKET-RLY 16-CONT CRADLE DIP-SLDR	28480	0490-0468
				A1 MISCELLANEOUS PARTS		
A1MP1	05335-00005	5	1	HEAT SINK FOR A1CR11	28480	05335-00005

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

Table 6-2. Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A2	05335-60002	8	1	BOARD ASSEMBLY-AMP SUPP(SERIES 2224)	28480	05335-60002
A2C1	0160-4557	0	4	CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A2C2	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A2C3	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A2C4	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A2C5	0160-3879	7	6	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C6	0160-4554	7	6	CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A2C7	0160-0127	2	2	CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
A2C8	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A2C9	0160-0127	2		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
A2C10	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C11	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C12	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C13	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C14	0160-2219	7	1	CAPACITOR-FXD 1100PF +-5% 300VDC MICA	28480	0160-2219
A2C15	0140-0210	2	1	CAPACITOR-FXD 270PF +-5% 300VDC MICA	72136	DM15F271J0300WV1CR
A2C16	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A2C17	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A2C18	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C19	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A2C20	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A2CR1	1901-0376	6	2	DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A2CR2	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A2CR3	1901-0050	3	3	DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A2CR4	1902-3097	6	1	DIODE-ZNR 5.23V 2% DO-35 PD=.4W	28480	1902-3097
A2CR5	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A2CR6				NOT ASSIGNED		
A2CR7				NOT ASSIGNED		
A2CR8	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A2J1	1200-0614	9	2	SOCKET-RLY 18-CONT DIP-SLDR	28480	1200-0614
A2J2	1200-0614	9		SOCKET-RLY 18-CONT DIP-SLDR	28480	1200-0614
A2J3	1250-0835	1	2	CONNECTOR-RF SMC M PC 50-OHM	28480	1250-0835
A2J4	1250-0835	1		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-0835
A2L1	9100-1788	6	4	CHOKE-WIDE BAND ZMAX=680 OHM@ 180 MHZ	02114	VK200 20/4B
A2L2	9100-1788	6		CHOKE-WIDE BAND ZMAX=680 OHM@ 180 MHZ	02114	VK200 20/4B
A2L3	9100-1788	6		CHOKE-WIDE BAND ZMAX=680 OHM@ 180 MHZ	02114	VK200 20/4B
A2L4	9100-1788	6		CHOKE-WIDE BAND ZMAX=680 OHM@ 180 MHZ	02114	VK200 20/4B
A2Q1	1854-0246	8	1	TRANSISTOR NPN SI PD=350MW FT=250MHZ	04713	SPS 233
A2R1	0757-0280	3	7	RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A2R2	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A2R3	0757-0443	0	4	RESISTOR 11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1102-F
A2R4	0698-6943	1	4	RESISTOR 20K .1% .125W F TC=0+-50	28480	0698-6943
A2R5	0698-6943	1		RESISTOR 20K .1% .125W F TC=0+-50	28480	0698-6943
A2R6	0757-0447	4	4	RESISTOR 16.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1622-F
A2R7	0698-6943	1		RESISTOR 20K .1% .125W F TC=0+-50	28480	0698-6943
A2R8	0757-0443	0		RESISTOR 11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1102-F
A2R9	0757-0443	0		RESISTOR 11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1102-F
A2R10	0757-0442	9	4	RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A2R11	0757-0447	4		RESISTOR 16.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1622-F
A2R12	0698-4008	5	8	RESISTOR 40K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4002-F
A2R13	0698-4008	5		RESISTOR 40K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4002-F
A2R14	0757-0447	4		RESISTOR 16.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1622-F
A2R15	0757-0416	7	1	RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A2R16	0698-6943	1		RESISTOR 20K .1% .125W F TC=0+-50	28480	0698-6943
A2R17	0698-4008	5		RESISTOR 40K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4002-F
A2R18	0698-4008	5		RESISTOR 40K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4002-F
A2R19	0698-4008	5		RESISTOR 40K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4002-F
A2R20	0698-4008	5		RESISTOR 40K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4002-F
A2R21	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A2R22	0757-0447	4		RESISTOR 16.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1622-F
A2R23	0698-6369	5	2	RESISTOR 1M .1% .25W F TC=0+-25	28480	0698-6369
A2R24	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A2R25	0698-7203	8	2	RESISTOR 42.2 1% .05W F TC=0+-100	24546	C3-1/8-T0-42R2-F
A2R26	0698-7212	9	2	RESISTOR 100 1% .05W F TC=0+-100	24546	C3-1/8-T0-100R-F
A2R27	0698-7222	1	4	RESISTOR 261 1% .05W F TC=0+-100	24546	C3-1/8-T0-261R-F
A2R28	0698-7226	5	2	RESISTOR 383 1% .05W F TC=0+-100	24546	C3-1/8-T0-383R-F
A2R29	0757-0443	0		RESISTOR 11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1102-F
A2R30	0698-4008	5		RESISTOR 40K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4002-F
A2R31	0698-4008	5		RESISTOR 40K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4002-F
A2R32	0698-7215	2	2	RESISTOR 133 1% .05W F TC=0+-100	24546	C3-1/8-T0-133R-F
A2R33	0757-0399	5	3	RESISTOR 82.5 1% .125W F TC=0+-100	24546	C4-1/8-T0-82R5-F
A2R34	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A2R35	0698-7203	8		RESISTOR 42.2 1% .05W F TC=0+-100	24546	C3-1/8-T0-42R2-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
A2R36	0698-7212	9		RESISTOR 100 1% .05W F TC=0+-100	24546	C3-1/8-T0-100R-F
A2R37	0698-7222	1		RESISTOR 261 1% .05W F TC=0+-100	24546	C3-1/8-T0-261R-F
A2R38	0698-7226	5		RESISTOR 383 1% .05W F TC=0+-100	24546	C3-1/8-T0-383R-F
A2R39	0757-0399	5		RESISTOR 82.5 1% .125W F TC=0+-100	24546	C4-1/8-T0-82R5-F
A2R40	1810-0364	9	1	NETWORK-RES 6-SIP470.0 OHM X 5	01121	206A471
A2R41	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A2R42	0698-3437	2	2	RESISTOR 133 1% .125W F TC=0+-100	24546	C4-1/8-T0-133R-F
A2R43	0757-0399	5		RESISTOR 82.5 1% .125W F TC=0+-100	24546	C4-1/8-T0-82R5-F
A2R44	0757-0465	6	2	RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A2R45	0698-8094	7	1	RESISTOR 1.82M 1% .5W F TC=0+-100	28480	0698-8094
A2R46	0698-6369	5		RESISTOR 1M .1% .25W F TC=0+-25	28480	0698-6369
A2R47	0757-0398	4	2	RESISTOR 75 1% .125W F TC=0+-100	24546	C4-1/8-T0-75R0-F
A2R48	0757-1108	6	2	RESISTOR 300 1% .125W F TC=0+-100	24546	C4-1/8-T0-301-F
A2R49	0757-1108	6		RESISTOR 300 1% .125W F TC=0+-100	24546	C4-1/8-T0-301-F
A2R50	0757-0398	4		RESISTOR 75 1% .125W F TC=0+-100	24546	C4-1/8-T0-75R0-F
A2R51	0698-7215	2	1	RESISTOR 133 1% .05W F TC=0+-100	24546	C3-1/8-TO-133R-F
A2R52	0698-6612	1	1	RESISTOR 2K .1% .125W F TC=0+-50	28480	0698-6612
A2R53	0698-3491	8	1	RESISTOR 1K .1% .125W F TC=0+-50	28480	0698-3491
A2R54	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A2R55	0698-7222	1		RESISTOR 261 1% .05W F TC=0+-100	24546	C3-1/8-T0-261R-F
A2R56	0698-7222	1		RESISTOR 261 1% .05W F TC=0+-100	24546	C3-1/8-T0-261R-F
A2R57	0757-0428	1	1	RESISTOR 1.62K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1621-F
A2R58	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A2R59	0698-3437	2		RESISTOR 133 1% .125W F TC=0+-100	24546	C4-1/8-T0-133R-F
A2R60	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A2R61	1810-0280	8	1	NETWORK-RES 10-SIP10.0K OHM X 9	01121	210A103
A2R62	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A2R63	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A2R64	0757-0317	7	1	RESISTOR 1.33K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1331-F
A2R65	2100-3383	4	2	RESISTOR-TRMR 50 10% C TOP-ADJ 1-TRN	28480	2100-3383
A2R66	2100-3383	4		RESISTOR-TRMR 50 10% C TOP-ADJ 1-TRN	28480	2100-3383
A2U1	1826-0315	3	3	IC OP AMP GP QUAD 14-DIP-P PKG	27014	LM348N
A2U2	1826-0609	8	3	IC MULTIPLXR ANLG 16-DIP-C PKG	06665	MUX08FQ
A2U3	1826-0315	3		IC OP AMP GP QUAD 14-DIP-P PKG	27014	LM348N
A2U4	1826-0609	8		IC MULTIPLXR ANLG 16-DIP-C PKG	06665	MUX08FQ
A2U5	1826-0610	1	1	IC MULTIPLXR 4-CHAN-ANLG DUAL 16-DIP-C	06665	MUX24FQ
A2U6	1858-0040	8	1	TRANSISTOR ARRAY 16-PIN PLSTC DIP	3L585	CA3127E
A2U7	1820-1359	5	1	IC MUXR/DATA-SEL ECL 4-TO-1-LINE DUAL	04713	MC10174P
A2U8	1820-1173	1	1	IC XLTR ECL TTL-TO-ECL QUAD 2-INP	04713	MC10124L
A2U9	1826-0575	7	1	IC CONV V/FREQ 14-DIP-P PKG	15818	9400CJ
A2U10	1826-0609	8		IC MULTIPLXR ANLG 16-DIP-C PKG	06665	MUX08FQ
A2U11	1820-0794	0	1	IC FF ECL D-M/S	04713	MC1670L
A2U12	1820-1196	8	2	IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS174N
A2U13	1826-0315	3		IC OP AMP GP QUAD 14-DIP-P PKG	27014	LM348N
A2U14	1820-1240	3	1	IC DCDR TTL S 3-TO-8-LINE 3-INP	01295	SN74S138N
A2U15	1820-1196	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS174N
A2U16	1820-1917	1	1	IC BFR TTL LS LINE DRVR OCTL	01295	SN74LS240N
A2W1	8159-0005	0	2	JUMPER-INSULATED 22 AWG LEAD	28480	8159-0005
A2W2	8159-0005	0		JUMPER-INSULATED 22 AWG LEAD	28480	8159-0005
A2XA8	1251-0472	4	2	CONNECTOR-PC EDGE 6-CONT/ROW 2-ROWS	28480	1251-0472
A2XA9	1251-0472	4		CONNECTOR-PC EDGE 6-CONT/ROW 2-ROWS	28480	1251-0472

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
A3	05335-60003	9	1	BOARD ASSEMBLY-AMP BUFFER(SERIES 2224)	28480	05335-60003
A3C1	0160-3877	5	4	CAPACITOR-FXD 100PF +-20% 200VDC CER	28480	0160-3877
A3C2	0180-2814	0	4	CAPACITOR-FXD 22UF+-20% 10VDC TA	28480	0180-2814
A3C3	0180-2821	9	4	CAPACITOR-FXD 22UF+-20% 35VDC TA	28480	0180-2821
A3C4	0160-4233	9	4	CAPACITOR-FXD .47UF +-5% 50VDC MET-POLYC	28480	0160-4233
A3C5	0160-4325	0	4	CAPACITOR-FXD .33UF +-5% 50VDC MET-POLYC	28480	0160-4325
A3C6	0180-2814	0		CAPACITOR-FXD 22UF+-20% 10VDC TA	28480	0180-2814
A3C7	0160-4325	0		CAPACITOR-FXD .33UF +-5% 50VDC MET-POLYC	28480	0160-4325
A3C8	0160-4233	9		CAPACITOR-FXD .47UF +-5% 50VDC MET-POLYC	28480	0160-4233
A3C9	0160-3879	7	28	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C10	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C11	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C12	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C13	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C14	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C15	0160-3877	5		CAPACITOR-FXD 100PF +-20% 200VDC CER	28480	0160-3877
A3C16	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C17	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C18	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C19	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C20	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C21	0160-4424	0	2	CAPACITOR-FXD .047UF +-20% 500VDC CER	51642	400-500-X7R-473M
A3C22	0160-4705	0	2	CAPACITOR-FXD 2.2PF +-5% 500VDC CER	28480	0160-4705
A3C23*	0160-3875	3		CAPACITOR-FXD 22PF +-5% 200VDC CER 0+-30	28480	0160-3875
A3C24	0160-4703	8	2	CAPACITOR-FXD 68PF +-5% 500VDC CER 0+-30	28480	0160-4703
A3C25	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C26	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C27*	0160-4040	6	2	CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A3C28	0180-2821	9		CAPACITOR-FXD 22UF+-20% 35VDC TA	28480	0180-2821
A3C29	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C30	0180-2821	9		CAPACITOR-FXD 22UF+-20% 35VDC TA	28480	0180-2821
A3C31	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C32	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C33	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C34	0160-4703	8		CAPACITOR-FXD 68PF +-5% 500VDC CER 0+-30	28480	0160-4703
A3C35	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A3C36	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C37*	0160-3875	3	2	CAPACITOR-FXD 22PF +-5% 200VDC CER 0+-30	28480	0160-3875
A3C38	0160-4705	0		CAPACITOR-FXD 2.2PF +-5% 500VDC CER	28480	0160-4705
A3C39	0160-4424	0		CAPACITOR-FXD .047UF +-20% 500VDC CER	51642	400-500-X7R-473M
A3C40	0180-2814	0		CAPACITOR-FXD 22UF+-20% 10VDC TA	28480	0180-2814
A3C41	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C42	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C43	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C44	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C45	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C46	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C47	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C48	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C49	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C50	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C51	0160-4325	0		CAPACITOR-FXD .33UF +-5% 50VDC MET-POLYC	28480	0160-4325
A3C52	0160-4233	9		CAPACITOR-FXD .47UF +-5% 50VDC MET-POLYC	28480	0160-4233
A3C53	0160-4233	9		CAPACITOR-FXD .47UF +-5% 50VDC MET-POLYC	28480	0160-4233
A3C54	0180-2821	9		CAPACITOR-FXD 22UF+-20% 35VDC TA	28480	0180-2821
A3C55	0160-3877	5		CAPACITOR-FXD 100PF +-20% 200VDC CER	28480	0160-3877
A3C56	0180-2814	0		CAPACITOR-FXD 22UF+-20% 10VDC TA	28480	0180-2814
A3C57	0160-4325	0		CAPACITOR-FXD .33UF +-5% 50VDC MET-POLYC	28480	0160-4325
A3C58	0160-3877	5		CAPACITOR-FXD 100PF +-20% 200VDC CER	28480	0160-3877
A3C59				NOT ASSIGNED		
A3C60*	0160-3874	2	1	CAPACITOR-FXD 10PF +-.5PF 200VDC CER	28480	0160-3874
A3CR1,CR4,CR5†	05335-80003	1	6	DIODES-MATCHED SET OF FOUR	28480	05335-80003
A3CR2,CR6,CR7†	05335-80003	1		DIODES-MATCHED SET OF FOUR	28480	05335-80003
A3CR3	1901-1080	1	2	DIODE SCHOTTKY	28480	1901-1080
A3CR8-CR11†	05335-80003	1		DIODES-MATCHED SET OF FOUR	28480	05335-80003

†MATCHED DIODES AVAILABLE ONLY IN SETS OF FOUR.

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
A3CR11	05335-80003	1		DIODES-MATCHED SET	28480	05335-80003
A3CR12	1902-0041	4	2	DIODE-ZNR 5.11V 5% DO-35 PD=.4W	28480	1902-0041
A3CR13	1902-0057	2	2	DIODE-ZNR 6.49V 5% DO-35 PD=.4W	28480	1902-0057
A3CR14	1901-0050	3	1	DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR15	1902-3136	4	2	DIODE-ZNR 8.06V 5% DO-35 PD=.4W	28480	1902-3136
A3CR16	1902-3136	4		DIODE-ZNR 8.06V 5% DO-35 PD=.4W	28480	1902-3136
A3CR17	1901-1080	1		DIODE-SCHOTTKY 1N5817 20V 1A	28480	1901-1080
A3CR18	1902-0057	2		DIODE-ZNR 6.49V 5% DO-35 PD=.4W	28480	1902-0057
A3CR19	1902-0041	4		DIODE-ZNR 5.11V 5% DO-35 PD=.4W	28480	1902-0041
A3CR20-CR23†	05335-80003	1		DIODES-MATCHED SET OF FOUR	28480	05335-80003
A3CR24,CR25,CR28†	05335-80003	1		DIODES-MATCHED SET OF FOUR	28480	05335-80003
A3CR26,CR27,CR29†	05335-80003	1		DIODES-MATCHED SET OF FOUR	28480	05335-80003
A3DS1	1990-0487	7	2	LED-LAMP LUM-INT=1MCD IF=20MA-MAX YEL	28480	5082-4584
A3DS2	1990-0487	7		LED-LAMP LUM-INT=1MCD IF=20MA-MAX YEL	28480	5082-4584
A3J1	1250-0835	1	2	CONNECTOR-RF SMC M PC 50-OHM	28480	1250-0835
A3J2	1200-0614	9	2	SOCKET-RLY 18-CONT DIP-SLDR	28480	1200-0614
A3J3	1250-1671	5	2	CONNECTOR-RF BNC FEM SGL-HOLE-RR 50-OHM	28480	1250-1671
A3J4	1250-1671	5		CONNECTOR-RF BNC FEM SGL-HOLE-RR 50-OHM	28480	1250-1671
A3J5	1200-0614	9		SOCKET-RLY 18-CONT DIP-SLDR	28480	1200-0614
A3J6	1250-0835	1		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-0835
A3K1	0490-0508	2	1	RELAY 2C 12VDC-COIL .5A 28VDC DPDT	28480	0490-0508
A3L1	05335-80001	9	2	INDUCTOR	28480	05335-80001
A3L2	05335-80001	9		INDUCTOR	28480	05335-80001
A3Q1	1854-0686	0	4	TRANSISTOR NPN SI TO-72 PD=200MW FT=4GHZ	28480	1854-0686
A3Q2	1854-0636	0	4	TRANSISTOR NPN SI TO-92 PD=350MW	28480	1854-0636
A3Q3	1854-0636	0		TRANSISTOR NPN SI TO-92 PD=350MW	28480	1854-0636
A3Q4	1855-0300	7	2	TRANSISTOR J-FET N-CHAN D-MODE TO-106	28480	1855-0300
A3Q4 ALTERNATE	1855-0212	0	2	TRANSISTOR J-FET N-CHAN SI (ALTERNATE PART)	28480	1855-0212
A3Q5	1855-0300	7		TRANSISTOR J-FET N-CHAN D-MODE TO-106	28480	1855-0300
A3Q5 ALTERNATE	1855-0212	0		TRANSISTOR J-FET N-CHAN SI (ALTERNATE PART)	28480	1855-0212
A3Q6	1854-0636	0		TRANSISTOR NPN SI TO-92 PD=350MW	28480	1854-0636
A3Q7	1854-0636	0		TRANSISTOR NPN SI TO-92 PD=350MW	28480	1854-0636
A3Q8	1854-0686	0		TRANSISTOR NPN SI TO-72 PD=200MW FT=4GHZ	28480	1854-0686
A3Q9	1854-0686	0		TRANSISTOR NPN SI TO-72 PD=200MW FT=4GHZ	28480	1854-0686
A3Q10	1854-0686	0		TRANSISTOR NPN SI TO-72 PD=200MW FT=4GHZ	28480	1854-0686
A3R1	0699-0071	6	8	RESISTOR 4.64M 1% .125W F TC=0+-100	28480	0699-0071
A3R2	0699-0071	6		RESISTOR 4.64M 1% .125W F TC=0+-100	28480	0699-0071
A3R3	0698-7267	4	8	RESISTOR 19.6K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1962-F
A3R4	0698-7267	4		RESISTOR 19.6K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1962-F
A3R5	0698-7227	6	6	RESISTOR 422 1% .05W F TC=0+-100	24546	C3-1/8-T0-422R-F
A3R6	0698-7212	9	6	RESISTOR 100 1% .05W F TC=0+-100	24546	C3-1/8-T0-100R-F
A3R7				NOT ASSIGNED		
A3R8				NOT ASSIGNED		
A3R9	0698-7212	9		RESISTOR 100 1% .05W F TC=0+-100	24546	C3-1/8-T0-100R-F
A3R10	0699-0071	6		RESISTOR 4.64M 1% .125W F TC=0+-100	28480	0699-0071
A3R11	0699-0071	6		RESISTOR 4.64M 1% .125W F TC=0+-100	28480	0699-0071
A3R12	0698-7267	4		RESISTOR 19.6K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1962-F
A3R13	0698-7267	4		RESISTOR 19.6K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1962-F
A3R14	0698-7218	5	2	RESISTOR 178 1% .05W F TC=0+-100	24546	C3-1/8-T0-178R-F
A3R15	0698-7249	2	4	RESISTOR 3.48K 1% .05W F TC=0+-100	24546	C3-1/8-T0-3481-F
A3R16	0698-0087	2	2	RESISTOR 316 1% .25W F TC=0+-100	24546	C5-1/4-T0-316R-F
A3R17	0698-7205	0	8	RESISTOR 51.1 1% .05W F TC=0+-100	24546	C3-1/8-T0-51R1-F
A3R18	0698-7249	2		RESISTOR 3.48K 1% .05W F TC=0+-100	24546	C3-1/8-T0-3481-F
A3R19	0698-6433	4	4	RESISTOR 100 1% .25W F TC=0+-100	28480	0698-6433
A3R20	0698-6433	4		RESISTOR 100 1% .25W F TC=0+-100	28480	0698-6433
A3R21	0698-7212	9		RESISTOR 100 1% .05W F TC=0+-100	24546	C3-1/8-T0-100R-F
A3R22	2100-3802	2	2	RESISTOR-VAR W/SW 10K 20% LIN SPST-NO	28480	2100-3802
A3R23	0698-7188	8	2	RESISTOR 10 1% .05W F TC=0+-100	24546	C3-1/8-T0-10R-F
A3R24	0698-7198	0	6	RESISTOR 26.1 1% .05W F TC=0+-100	24546	C3-1/8-T0-26R1-F
A3R25	0698-7198	0		RESISTOR 26.1 1% .05W F TC=0+-100	24546	C3-1/8-T0-26R1-F
A3R26	0698-7222	1	2	RESISTOR 261 1% .05W F TC=0+-100	24546	C3-1/8-T0-261R-F
A3R27	0699-0073	8	2	RESISTOR 10M 1% .125W F TC=0+-150	28480	0699-0073
A3R28	0698-7205	0		RESISTOR 51.1 1% .05W F TC=0+-100	24546	C3-1/8-T0-51R1-F
A3R29*	0698-7247	0	2	RESISTOR 2.87K 1% .05W F TC=0+-100	24546	C3-1/8-T0-2871-F
A3R30	0698-3922	0	4	RESISTOR 487K .1% .125W F TC=0+-50	28480	0698-3922

†MATCHED DIODES AVAILABLE ONLY IN SETS OF FOUR.

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
A3R31	0698-7227	6		RESISTOR 422 1% .05W F TC=0+-100	24546	C3-1/8-TO-422R-F
A3R32	0698-6400	5	2	RESISTOR 900K 1% .25W F TC=0+-100	19701	MF52C1/4-T0-9003-F
A3R33	0757-0416	7	2	RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A3R34	0698-7205	0		RESISTOR 51.1 1% .05W F TC=0+-100	24546	C3-1/8-T0-51R1-F
A3R35	0698-7216	3	2	RESISTOR 147 1% .05W F TC=0+-100	24546	C3-1/8-T0-147R-F
A3R36	0698-7252	7	2	RESISTOR 4.64K 1% .05W F TC=0+-100	24546	C3-1/8-T0-4641-F
A3R37	2100-1738	9	2	RESISTOR-TRMR 10K 10% C TOP-ADJ 1-TRN	73138	82PR10K
A3R38	0698-7227	6		RESISTOR 422 1% .05W F TC=0+-100	24546	C3-1/8-T0-422R-F
A3R39	0698-7245	8	2	RESISTOR 2.37K 1% .05W F TC=0+-100	24546	C3-1/8-T0-2371-F
A3R40	0698-7238	9	4	RESISTOR 1.21K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1211-F
A3R41	0698-7198	0		RESISTOR 26.1 1% .05W F TC=0+-100	24546	C3-1/8-T0-26R1-F
A3R42	0698-6430	1	2	RESISTOR 111K .5% .125W F TC=0+-100	28480	0698-6430
A3R43	0698-3905	9	4	RESISTOR 513K .1% .125W F TC=0+-50	28480	0698-3905
A3R44	0698-7241	4	2	RESISTOR 1.62K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1621-F
A3R45	0698-3905	9		RESISTOR 513K .1% .125W F TC=0+-50	28480	0698-3905
A3R46	0698-3922	0		RESISTOR 487K .1% .125W F TC=0+-50	28480	0698-3922
A3R47	2100-2497	9	2	RESISTOR-TRMR 2K 10% C TOP-ADJ 1-TRN	73138	82PR2K
A3R48	0698-7238	9		RESISTOR 1.21K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1211-F
A3R49	0698-7245	8		RESISTOR 2.37K 1% .05W F TC=0+-100	24546	C3-1/8-T0-2371-F
A3R50	0698-3905	9		RESISTOR 513K .1% .125W F TC=0+-50	28480	0698-3905
A3R51	0698-6430	1		RESISTOR 111K .5% .125W F TC=0+-100	28480	0698-6430
A3R52	0698-7238	9		RESISTOR 1.21K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1211-F
A3R53	0698-7198	0		RESISTOR 26.1 1% .05W F TC=0+-100	24546	C3-1/8-T0-26R1-F
A3R54	0698-7227	6		RESISTOR 422 1% .05W F TC=0+-100	24546	C3-1/8-T0-422R-F
A3R55	0698-7216	3		RESISTOR 147 1% .05W F TC=0+-100	24546	C3-1/8-T0-147R-F
A3R56	0698-3905	9		RESISTOR 513K .1% .125W F TC=0+-50	28480	0698-3905
A3R57	0698-7238	9		RESISTOR 1.21K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1211-F
A3R58	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A3R59	0698-7222	1		RESISTOR 261 1% .05W F TC=0+-100	24546	C3-1/8-T0-261R-F
A3R60	0699-0073	8		RESISTOR 10M 1% .125W F TC=0+-150	28480	0699-0073
A3R61	0698-6400	5		RESISTOR 900K 1% .25W F TC=0+-100	19701	MF52C1/4-T0-9003-F
A3R62	0698-3922	0		RESISTOR 487K .1% .125W F TC=0+-50	28480	0698-3922
A3R63	0698-3922	0		RESISTOR 487K .1% .125W F TC=0+-50	28480	0698-3922
A3R64	0698-7227	6		RESISTOR 422 1% .05W F TC=0+-100	24546	C3-1/8-T0-422R-F
A3R65	0698-7212	9		RESISTOR 100 1% .05W F TC=0+-100	24546	C3-1/8-T0-100R-F
A3R66	2100-3802	2		RESISTOR-VAR W/SW 10K 20% LIN SPST-NO	28480	2100-3802
A3R67	0698-7188	8		RESISTOR 10 1% .05W F TC=0+-100	24546	C3-1/8-T0-10R-F
A3R68	0698-7218	5		RESISTOR 178 1% .05W F TC=0+-100	24546	C3-1/8-T0-178R-F
A3R69	0698-6433	4		RESISTOR 100 1% .25W F TC=0+-100	28480	0698-6433
A3R70	0698-6433	4		RESISTOR 100 1% .25W F TC=0+-100	28480	0698-6433
A3R71	0698-7205	0		RESISTOR 51.1 1% .05W F TC=0+-100	24546	C3-1/8-T0-51R1-F
A3R72	0698-7227	6		RESISTOR 422 1% .05W F TC=0+-100	24546	C3-1/8-T0-422R-F
A3R73	0698-7249	2		RESISTOR 3.48K 1% .05W F TC=0+-100	24546	C3-1/8-T0-3481-F
A3R74	0698-0087	2		RESISTOR 316 1% .25W F TC=0+-100	24546	C5-1/4-T0-3160-F
A3R75	0698-7205	0		RESISTOR 51.1 1% .05W F TC=0+-100	24546	C3-1/8-T0-51R1-F
A3R76	0698-7249	2		RESISTOR 3.48K 1% .05W F TC=0+-100	24546	C3-1/8-T0-3481-F
A3R77	0698-7198	0		RESISTOR 26.1 1% .05W F TC=0+-100	24546	C3-1/8-T0-26R1-F
A3R78	0698-7198	0		RESISTOR 26.1 1% .05W F TC=0+-100	24546	C3-1/8-T0-26R1-F
A3R79	0698-7212	9		RESISTOR 100 1% .05W F TC=0+-100	24546	C3-1/8-T0-100R-F
A3R80				NOT ASSIGNED		
A3R81				NOT ASSIGNED		
A3R82	0698-7212	9		RESISTOR 100 1% .05W F TC=0+-100	24546	C3-1/8-T0-100R-F
A3R83*	0698-7247	0		RESISTOR 2.87K 1% .05W F TC=0+-100	24546	C3-1/8-T0-2871-F
A3R84	0698-7267	4		RESISTOR 19.6K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1962-F
A3R85	0698-7267	4		RESISTOR 19.6K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1962-F
A3R86	0698-7205	0		RESISTOR 51.1 1% .05W F TC=0+-100	24546	C3-1/8-T0-51R1-F
A3R87	0698-7252	7		RESISTOR 4.64K 1% .05W F TC=0+-100	24546	C3-1/8-T0-4641-F
A3R88	2100-1738	9		RESISTOR-TRMR 10K 10% C TOP-ADJ 1-TRN	73138	82PR10K
A3R89	0699-0071	6		RESISTOR 4.64M 1% .125W F TC=0+-100	28480	0699-0071
A3R90	0699-0071	6		RESISTOR 4.64M 1% .125W F TC=0+-100	28480	0699-0071
A3R91	0699-0071	6		RESISTOR 4.64M 1% .125W F TC=0+-100	28480	0699-0071
A3R92	0699-0071	6		RESISTOR 4.64M 1% .125W F TC=0+-100	28480	0699-0071
A3R93	0698-7241	4		RESISTOR 1.62K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1621-F
A3R94	0698-7267	4		RESISTOR 19.6K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1962-F
A3R95	0698-7267	4		RESISTOR 19.6K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1962-F
A3R96	2100-2497	9		RESISTOR-TRMR 2K 10% C TOP-ADJ 1-TRN	73138	82PR2K
A3R97	0698-7284	5	2	RESISTOR 100K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1003-F
A3R98	0698-7284	5		RESISTOR 100K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1003-F
A3R99	2100-0644	4	4	RESISTOR-TRMR 2M 20% C TOP-ADJ 1-TRN	28480	2100-0644
A3R100	2100-0644	4		RESISTOR-TRMR 2M 20% C TOP-ADJ 1-TRN	28480	2100-0644
A3R101	2100-0644	4		RESISTOR-TRMR 2M 20% C TOP-ADJ 1-TRN	28480	2100-0644
A3R102	2100-0644	4		RESISTOR-TRMR 2M 20% C TOP-ADJ 1-TRN	28480	2100-0644
A3R103	0698-7209	4	2	RESISTOR 75 1% .05W F TC=0+-100	24546	C3-1/8-T0-75R0-F
A3R104	0698-7205	0		RESISTOR 51.1 1% .05W F TC=0+-100	24546	C3-1/8-T0-51R1-F
A3R105	0698-7209	4		RESISTOR 75 1% .05W F TC=0+-100	24546	C3-1/8-TO-74R0-F
A3R106	0698-7205	0		RESISTOR 51.1 1% .05W F TC=0+-100	24546	C3-1/8-TO-51R1-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
A3S1				NSR, PART OF R22		
A3S2	3101-2498	3	10	SWITCH-PB DPDT ALTNG .25A 115VAC	28480	3101-2498
A3S3	3101-2498	3		SWITCH-PB DPDT ALTNG .25A 115VAC	28480	3101-2498
A3S4	3101-2498	3		SWITCH-PB DPDT ALTNG .25A 115VAC	28480	3101-2498
A3S5	3101-2498	3		SWITCH-PB DPDT ALTNG .25A 115VAC	28480	3101-2498
A3S6	3101-2498	3		SWITCH-PB DPDT ALTNG .25A 115VAC	28480	3101-2498
A3S7	3101-2498	3		SWITCH-PB DPDT ALTNG .25A 115VAC	28480	3101-2498
A3S8	3101-2498	3		SWITCH-PB DPDT ALTNG .25A 115VAC	28480	3101-2498
A3S9	3101-2498	3		SWITCH-PB DPDT ALTNG .25A 115VAC	28480	3101-2498
A3S10	3101-2498	3		SWITCH-PB DPDT ALTNG .25A 115VAC	28480	3101-2498
A3S11				NSR, PART OF R66		
A3S12	3101-2498	3		SWITCH-PB DPDT ALTNG .25A 115VAC	28480	3101-2498
A3U1	1826-0600	9	2	IC OP AMP LOW-BIAS-H-IMPD QUAD 14-DIP-P	01295	TL074ACN
A3U2	1826-0570	2	2	IC	28480	1826-0570
A3U3	1826-0035	4	2	IC OP AMP LOW-DRIFT TO-99 PKG	27014	LM308AH
A3U4	1826-0035	4		IC OP AMP LOW-DRIFT TO-99 PKG	27014	LM308AH
A3U5	1826-0570	2		IC	28480	1826-0570
A3U6	1826-0600	9		IC OP AMP LOW-BIAS-H-IMPD QUAD 14-DIP-P	01295	TL074ACN
			1	A3 MISCELLANEOUS PARTS		
	0340-0092	2	4	TERMINAL SOLDER SPCL-FDTHRU PRESS-MTG	28480	0340-0092
	0360-1682	0	1	TERMINAL-TEST SGL-TUR PRESS-MTG	28480	0360-1682
	1205-0061	0	2	HEAT SINK TO-5/TO-39-CS	28480	1205-0061
	4040-1616	6	2	STANDOFF-LED	28480	4040-1616
	5041-0234	5	8	CAP-PUSHBUTTON LIGHT GRAY	28480	5041-0234
	5041-0300	6	2	CAP-PUSHBUTTON DARK GRAY	28480	5041-0300
	2950-0035	8	2	NUT-HEX-DBL-CHAM 0.4688-32 × 9/16 (BNC MTG)	00000	ORDER BY DESCRIPTION

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

Table 6-2. Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A4	05335-60004	0	1	BOARD ASSEMBLY-MAIN LOGIC(SERIES 2224)	28480	05335-60004
A4C1	0160-4554	7	17	CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A4C2	0140-0234	0	2	CAPACITOR-FXD 500PF +-1% 300VDC MICA	72136	DM15F501F0300WV1C
A4C3	0140-0234	0		CAPACITOR-FXD 500PF +-1% 300VDC MICA	72136	DM15F501F0300WV1C
A4C4	0160-0576	5	9	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A4C5	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A4C6	0121-0061	1	1	CAPACITOR-V TRMR-CER 5.5-18PF 350V	52763	304322 5.5/18PF NPO
A4C7	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A4C8	0160-3879	7	9	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A4C9	0160-0368	3	1	CAPACITOR-FXD 16PF +-5% 500VDC MICA	28480	0160-0368
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	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A4C13	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
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	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A4C17	0160-2222	2	2	CAPACITOR-FXD 1500PF +-5% 300VDC MICA	28480	0160-2222
A4C18	0160-2230	2	1	CAPACITOR-FXD 3300PF +-5% 300VDC MICA	28480	0160-2230
A4C19	0180-0155	8	2	CAPACITOR-FXD 2.2UF+-20% 20VDC TA	56289	150D225X0020A2
A4C20	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A4C21	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A4C22	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A4C23	0160-2222	2		CAPACITOR-FXD 1500PF +-5% 300VDC MICA	28480	0160-2222
A4C24	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A4C25	0160-2224	4	1	CAPACITOR-FXD 1800PF +-5% 300VDC MICA	28480	0160-2224
A4C26	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A4C27	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A4C28	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A4C29	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A4C30	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A4C31	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A4C32	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A4C33	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A4C34	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A4C35	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A4C36	0180-2662	6	1	CAPACITOR-FXD 10UF+-10% 10VDC TA	25088	D4R7GS1A10K
A4C37	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A4C38	0160-0575	4	1	CAPACITOR-FXD .047UF +-20% 50VDC CER	28480	0160-0575
A4C39	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A4C40	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A4C41	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A4C42	0180-2929	8	1	CAPACITOR-FXD 68UF+-10% 10VDC TA	28480	0180-2929
A4C43	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A4C44	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A4C45	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A4C46	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A4C47	0180-0230	0	1	CAPACITOR-FXD 1UF+-20% 50VDC TA	56289	150D105X0050A2
A4C48	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A4C49	0180-0155	8		CAPACITOR-FXD 2.2UF+-20% 20VDC TA	56289	150D225X0020A2
A4C50	0160-3875	3	2	CAPACITOR-FXD 22PF +-5% 200VDC CER 0+-30	28480	0160-3875
A4C51	0160-3875	3		CAPACITOR-FXD 22PF +-5% 200VDC CER 0+-30	28480	0160-3875
A4C52	0180-0374	3	1	CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A4CR1	1901-0050	3	8	DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4CR2	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4CR3	1901-0535	9	3	DIODE-SM SIG SCHOTTKY	28480	1901-0535
A4CR4	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4CR5	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4CR6	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4CR7	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4CR8	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4CR9	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4CR10	1901-0535	9		DIODE-SM SIG SCHOTTKY	28480	1901-0535
A4CR11	1901-0535	9		DIODE-SM SIG SCHOTTKY	28480	1901-0535
A4DS1	1990-0627	7	1	LED-LAMP LUM-INT=1MCD IF=20MA-MAX RED	28480	1990-0627
A4J1	1200-0482	9	1	SOCKET-IC 16-CONT DIP-SLDR	28480	1200-0482
A4J2	1251-6608	0	2	CONNECTOR 16-PIN M POST TYPE	28480	1251-6608
A4J3	1251-6608	0		CONNECTOR 16-PIN M POST TYPE	28480	1251-6608
A4L1	9100-0348	2	1	INDUCTOR RF-CH-MLD 1UH 1% .166DX.385LG	28480	9100-0348

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
A4Q1	1854-0215	1	7	TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A4Q2	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A4Q3	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A4Q4				NOT ASSIGNED		
A4Q5				NOT ASSIGNED		
A4Q6	1853-0015	7	4	TRANSISTOR PNP SI PD=200MW FT=500MHZ	28480	1853-0015
A4Q7	1853-0015	7		TRANSISTOR PNP SI PD=200MW FT=500MHZ	28480	1853-0015
A4Q8	1853-0015	7		TRANSISTOR PNP SI PD=200MW FT=500MHZ	28480	1853-0015
A4Q9	1853-0015	7		TRANSISTOR PNP SI PD=200MW FT=500MHZ	28480	1853-0015
A4Q10	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A4Q11	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A4Q12	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A4Q13	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A4R1	0757-0394	0	3	RESISTOR 51.1 1% .125W F TC=0+-100	24546	C4-1/8-T0-51R1-F
A4R2	1810-0364	9	1	NETWORK-RES 6-SIP470.0 OHM X 5	01121	206A471
A4R3	0757-0419	0	4	RESISTOR 681 1% .125W F TC=0+-100	24546	C4-1/8-T0-681R-F
A4R4	0757-0419	0		RESISTOR 681 1% .125W F TC=0+-100	24546	C4-1/8-T0-681R-F
A4R5	0698-3438	3	1	RESISTOR 147 1% .125W F TC=0+-100	24546	C4-1/8-T0-147R-F
A4R6	0698-0082	7	1	RESISTOR 464 1% .125W F TC=0+-100	24546	C4-1/8-T0-4640-F
A4R7	1810-0203	5	1	NETWORK-RES 8-SIP470.0 OHM X 7	01121	208A471
A4R8	0757-0420	3	2	RESISTOR 750 1% .125W F TC=0+-100	24546	C4-1/8-T0-751-F
A4R9	0757-0280	3	14	RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A4R10				NOT ASSIGNED		
A4R11	0757-0420	3		RESISTOR 750 1% .125W F TC=0+-100	24546	C4-1/8-T0-751-F
A4R12	0698-7211	8	2	RESISTOR 90.9 1% .05W F TC=0+-100	24546	C3-1/8-T0-90R9-F
A4R13	1810-0205	7	1	NETWORK-RES 8-SIP4.7K OHM X 7	01121	208A472
A4R14	1810-0318	3	1	NETWORK-RES 6-SIP1.0K OHM X 5	01121	206A102
A4R15	0757-0419	0		RESISTOR 681 1% .125W F TC=0+-100	24546	C4-1/8-T0-681R-F
A4R16	0757-0419	0		RESISTOR 681 1% .125W F TC=0+-100	24546	C4-1/8-T0-681R-F
A4R17	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A4R18	0698-3444	1	1	RESISTOR 316 1% .125W F TC=0+-100	24546	C4-1/8-T0-316R-F
A4R19	0698-7238	9	1	RESISTOR 1.21K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1211-F
A4R20	0757-0394	0		RESISTOR 51.1 1% .125W F TC=0+-100	24546	C4-1/8-T0-51R1-F
A4R21	0698-7211	8		RESISTOR 90.9 1% .05W F TC=0+-100	24546	C3-1/8-T0-90R9-F
A4R22	0757-0401	0	2	RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A4R23	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A4R24	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A4R25	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A4R26	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A4R27	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A4R28	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A4R29	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A4R30	0757-0465	6	2	RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A4R31	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A4R32	0757-0394	0		RESISTOR 51.1 1% .125W F TC=0+-100	24546	C4-1/8-T0-51R1-F
A4R33	0698-3440	7	1	RESISTOR 196 1% .125W F TC=0+-100	24546	C4-1/8-T0-196R-F
A4R34	0698-3431	6	3	RESISTOR 23.7 1% .125W F TC=0+-100	03888	PME55-1/8-T0-23R7-F
A4R35	0698-0084	9	1	RESISTOR 2.15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2151-F
A4R36	0698-3431	6		RESISTOR 23.7 1% .125W F TC=0+-100	03888	PME55-1/8-T0-23R7-F
A4R37	0698-3431	6		RESISTOR 23.7 1% .125W F TC=0+-100	03888	PME55-1/8-T0-23R7-F
A4R38*	0757-0441	8	2	RESISTOR 8.25K 1% .125W F TC=0+-100	24546	C4-1/8-T0-8251-F
A4R39*	0757-0441	8		RESISTOR 8.25K 1% .125W F TC=0+-100	24546	C4-1/8-T0-8251-F
A4R40	1810-0374	1	1	NETWORK-RES 8-SIP1.0K OHM X 4	01121	208B102
A4R41	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A4R42	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A4R43	0757-0442	9	4	RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A4R44	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A4R45	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A4R46	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A4R47	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A4R48	1810-0206	8	1	NETWORK-RES 8-SIP10.0K OHM X 7	01121	208A103
A4R49	1810-0365	0	1	NETWORK-RES 6-SIP2.2K OHM X 5	01121	206A222
A4R50	0757-0438	3	2	RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A4R51	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A4R52	0757-1094	9	1	RESISTOR 1.47K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1471-F
A4R53	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A4R54	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A4R55	0698-7250	5	1	RESISTOR 3.83K 1% .05W F TC=0+-100	24546	C3-1/8-T0-3831-F
A4S1	3101-0680	1	1	SWITCH-PB DPDT ALTNG 4A 250VAC	28480	3101-0680
A4U1	1820-0802	1	1	IC GATE ECL NOR QUAD 2-INP	04713	MC10102P
A4U2	1820-0810	1	1	IC RCVR ECL LINE RCVR TPL 2-INP	04713	MC10116P
A4U3	1820-1052	5	1	IC XLTR ECL ECL-TO-TTL QUAD 2-INP	04713	MC10125L
A4U4	1826-0210	7	2	IC COMPARATOR HS 14-DIP-P PKG	27014	LM361N
A4U5	1826-0210	7		IC COMPARATOR HS 14-DIP-P PKG	27014	LM361N
				NOTE — A4U5 IS NOT INCLUDED ON REPLACEMENT A4 BOARDS AND MUST BE ORDERED SEPARATELY.		

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
A4U6	1820-2312	2	1	IC-MULTIPLE REGISTER COUNTER	28480	1820-2312
A4U7	1820-2075	4	1	IC MISC TTL LS	01295	SN74LS245N
A4U8	1820-1989	7	2	IC CNTR TTL LS BIN DUAL 4-BIT	07263	74LS393PC
A4U9	1820-1438	1	2	IC MUXR/DATA-SEL TTL LS 2-TO-1-LINE QUAD	01295	SN74LS257AN
A4U10	1820-1281	2	1	IC DCDR TTL LS 2-TO-4-LINE DUAL 2-INP	01295	SN74LS139N
A4U11	1820-1144	6	1	IC GATE TTL LS NOR QUAD 2-INP	01295	SN74LS02N
A4U12	1820-1416	5	1	IC SCHMITT-TRIG TTL LS INV HEX 1-INP	01295	SN74LS14N
A4U13	1820-1989	7		IC CNTR TTL LS BIN DUAL 4-BIT	07263	74LS393PC
A4U14	1820-1438	1		IC MUXR/DATA-SEL TTL LS 2-TO-1-LINE QUAD	01295	SN74LS257AN
A4U15	1820-2024	3	2	IC DRVR TTL LS LINE DRVR OCTL	01295	SN74LS244N
				SOCKET-IC 20-CONT DIP DIP-SLDR		
A4U16	1820-2866	1	2	IC-CMOS BI-DIRECTIONAL BUS TRANSCEIVER	28480	1820-2866
A4U17	1820-1112	8	2	IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
A4U18	1820-1112	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
A4U19	1820-1240	3	1	IC DCDR TTL S 3-TO-8-LINE 3-INP	01295	SN74S138N
A4U20	1820-1202	7	1	IC GATE TTL LS NAND TPL 3-INP	01295	SN74LS10N
A4U21	1820-1197	9	1	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A4U22	1818-1249	7	1	IC NMOS 65536 (64K) ROM 450-NS 3-S	55576	SYP2364 MASKED
A4U23	1818-1250	8	1	IC NMOS 65536 (64K) ROM 450-NS 3-S	55576	SYP2364 MASKED
				SOCKET-IC 20-CONT DIP DIP-SLDR		
A4U24	1820-2866	1		IC-CMOS BI-DIRECTIONAL BUS TRANSCEIVER	28480	1820-2866
A4U25	1818-0381	6	2	IC NMOS 1024 (1K) STAT RAM 250-NS	55576	SYP2111A-2
A4U26	1818-0381	6		IC NMOS 1024 (1K) STAT RAM 250-NS	55576	SYP2111A-2
				SOCKET-IC 20-CONT DIP DIP-SLDR		
A4U27	1820-2024	3		IC DRVR TTL LS LINE DRVR OCTL	01295	SN74LS244N
A4U28	1820-2099	2	1	IC MICPROC NMOS 8-BIT	04713	MC6802P
A4U29	1826-0275	4	1	IC 78L12A V RGLTR TO-92	04713	MC78L12ACP
A4U30	1858-0040	8	1	TRANSISTOR ARRAY 16-PIN PLSTC DIP	3L585	CA3127E
A4U31	1858-0063	5	1	TRANSISTOR ARRAY 14-PIN PLSTC DIP	3L585	CA3102E
A4W1	8159-0005	0	1	WIRE JUMPER 22 AWG	28480	8159-0005
A4XA7	1251-2026	8	1	CONNECTOR-PC EDGE 18-CONT/ROW 2-ROWS	28480	1251-2026
A4XA15	1251-2035	9	1	CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-2035
A4XA2P1	1251-3076	0	1	CONNECTOR-PC EDGE 18-CONT/ROW 2-ROWS	28480	1251-3076
A4XU6	1200-0682	1	3	SOCKET-IC 40-CONT DIP DIP-SLDR	28480	1200-0682
A4XU7,XU16,XU24,XU27	1200-0825	4		SOCKET-IC 20-CONT DIP DIP-SLDR	28480	1200-0825
A4XU22	1200-0912	0	3	SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0912
A4XU23	1200-0912	0		SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0912
A4XU28	1200-0682	1		SOCKET-IC 40-CONT DIP DIP-SLDR	28480	1200-0682
A4XY1	1200-0475	0	3	CONNECTOR-SGL CONT SKT .017-IN-BSC-SZ	28480	1200-0475
A4Y1	0410-0423	2	1	CRYSTAL-QUARTZ 10.000 MHZ	28480	0410-0423
A4Y2	0410-0465	2	1	CRYSTAL-QUARTZ 4.00000 MHZ HC-6/U-HLDR	28480	0410-0465
				A4 MISCELLANEOUS PARTS		
A4H31	1400-0531	3	2	CABLE CLAMP-PLASTIC SELF ADHESIVE	28480	1400-0531
	0360-1682	0	2	TERMINAL-STUD SGL-TUR PRESS-MTG	28480	0360-1682
	1251-4707	6	10	CONNECTOR-SGL CONT PIN .031-IN-BSC-SZ	28480	1251-4707
	5040-0201	4	1	CAP-PUSHBUTTON CHALK WHITE	28480	5040-0201

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

Table 6-2. Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A5	05335-60005	1	1	BOARD ASSEMBLY-DISPLAY (SERIES 2224)	28480	05335-60005
A5C1				NOT ASSIGNED		
A5C2	0160-3879	7	4	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A5C3	0180-0137	6	1	CAPACITOR-FXD 100UF+-20% 10VDC TA	56289	150D107X0010R2
A5C4	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A5C5	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A5C6	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A5DS1	1990-0574	3	13	DISPLAY-NUM-SEG 1-CHAR .43-H RED	28480	5082-7651
A5DS2	1990-0574	3		DISPLAY-NUM-SEG 1-CHAR .43-H RED	28480	5082-7651
A5DS3	1990-0574	3		DISPLAY-NUM-SEG 1-CHAR .43-H RED	28480	5082-7651
A5DS4	1990-0574	3		DISPLAY-NUM-SEG 1-CHAR .43-H RED	28480	5082-7651
A5DS5	1990-0574	3		DISPLAY-NUM-SEG 1-CHAR .43-H RED	28480	5082-7651
A5DS6	1990-0574	3		DISPLAY-NUM-SEG 1-CHAR .43-H RED	28480	5082-7651
A5DS7	1990-0574	3		DISPLAY-NUM-SEG 1-CHAR .43-H RED	28480	5082-7651
A5DS8	1990-0574	3		DISPLAY-NUM-SEG 1-CHAR .43-H RED	28480	5082-7651
A5DS9	1990-0574	3		DISPLAY-NUM-SEG 1-CHAR .43-H RED	28480	5082-7651
A5DS10	1990-0574	3		DISPLAY-NUM-SEG 1-CHAR .43-H RED	28480	5082-7651
A5DS11	1990-0574	3		DISPLAY-NUM-SEG 1-CHAR .43-H RED	28480	5082-7651
A5DS12	1990-0574	3		DISPLAY-NUM-SEG 1-CHAR .43-H RED	28480	5082-7651
A5DS13	1990-0681	3	1	DISPLAY-AN-SEG 1-CHAR .408-H RED	28480	5082-7656
A5DS14	1990-0574	3		DISPLAY-NUM-SEG 1-CHAR .43-H RED	28480	5082-7651
A5DS15-A5DS48	1990-0851	9	34	LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0851
A5DS49	1990-0486	6	10	LED-LAMP LUM-INT 1MCD IF=20MA-MAX RED	28480	5082-4684
A5DS50	1990-0486	6		LED-LAMP LUM-INT 1MCD IF=20MA-MAX RED	28480	5082-4684
A5DS51	1990-0486	6		LED-LAMP LUM-INT 1MCD IF=20MA-MAX RED	28480	5082-4684
A5DS52	1990-0486	6		LED-LAMP LUM-INT 1MCD IF=20MA-MAX RED	28480	5082-4684
A5DS53	1990-0486	6		LED-LAMP LUM-INT 1MCD IF=20MA-MAX RED	28480	5082-4684
A5DS54	1990-0486	6		LED-LAMP LUM-INT 1MCD IF=20MA-MAX RED	28480	5082-4684
A5DS55	1990-0486	6		LED-LAMP LUM-INT 1MCD IF=20MA-MAX RED	28480	5082-4684
A5DS56	1990-0486	6		LED-LAMP LUM-INT 1MCD IF=20MA-MAX RED	28480	5082-4684
A5DS57	1990-0486	6		LED-LAMP LUM-INT 1MCD IF=20MA-MAX RED	28480	5082-4684
A5DS58	1990-0486	6		LED-LAMP LUM-INT 1MCD IF=20MA-MAX RED	28480	5082-4684
A5J1	1251-6608	0	1	CONNECTOR-16 PIN MALE POST TYPE	28480	1251-6608
A5J2	1251-6023	3	1	CONNECTOR-RT ANGLE 16-PIN MALE	28480	1251-6023
A5R1	0699-0069	2	1	RESISTOR 2.15M 1% .125W F TC=0+-100	28480	0699-0069
A5R2	0698-0084	9	1	RESISTOR 2.15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2151-F
A5R3	2100-3792	9	1	RESISTOR-VAR CONTROL CC 1M 10% 10CW	01121	WP4C032S105AA
A5R4	1810-0205	7	1	NETWORK-RES 8-SIP4.7K OHM X 7	01121	208A472
A5R5	0757-0439	4	1	RESISTOR 6.81K 1% .125W F TC=0+-100	24546	C4-1/8-T0-6811-F
A5S1-A5S34	5060-9436	7	34	PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A5U1	1820-2132	4	3	IC DRVR CMOS LED DRVR	32293	ICM7218A
A5U2	1820-2132	4		IC DRVR CMOS LED DRVR	32293	ICM7218A
A5U3	1820-1207	2	1	IC GATE TTL LS NAND 8-INP	01295	SN74LS30N
A5U4	1820-1195	7	1	IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N
A5U5	1820-1858	9	1	IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A5U6	1820-1641	8	1	IC DRVR TTL LS BUS DRVR HEX 1-INP	01295	SN74LS365AN
A5U7	1820-2132	4		IC DRVR CMOS LED DRVR	32293	ICM7218A
A5W1	8159-0005	0	1	WIRE JUMPER 22AWG W PVC INS.	28480	8159-0005
A5XDS1-A5XDS14	1200-0483	0	14	SOCKET-IC 14-CONT DIP-SLDR	28480	1200-0483
				A5 MISCELLANEOUS PARTS		
	4040-1614	4	9	STANDOFF-LED	28480	4040-1614
	4040-1615	5	1	STANDOFF-LED (GATE TIME DELAY)	28480	4040-1615
	5041-0252	7	8	SWITCH CAP 5/16 X 5/16 LITE GREY/L PIPE	28480	5041-0252
	5041-0253	8	16	SWITCH CAP 5/16 X 1/2 LITE GREY/L PIPE	28480	5041-0253
	5041-0276	5	1	SWITCH CAP 5/16 X 5/16 LITE GREY/LESS L	28480	5041-0276
	5041-0450	7	3	SWITCH CAP 5/16 X 5/16 BLU/L PIPE	28480	5041-0450
	5041-0318	6	2	SWITCH CAP 5/16 X 5/16 DK GRY/L PIPE	28480	5041-0318
	5041-1732	0	1	SWITCH CAP 5/16 X 1/2 (RESET)	28480	5041-1732
	5041-0319	7	2	SWITCH CAP 5/16 X 1/2 DK GRY/L PIPE	28480	5041-0319
	5041-1733	1	1	SWITCH CAP 5/16 X 1/2 (CHECK)	28480	5041-1733

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
A6	05335-61006	4	1	REAR BOARD ASSEMBLY (SERIES 2224)	28480	05335-61006
A6C1+	0160-4557	0	5	CAPACITOR-FXD .1UF +-20% 50VDC CER +A6C1NOT IN ALL INST.-ADDED AT FACTORY WHEN NECESSARY.	16299	CAC04X7R104M050A
A6C2	0180-0210	6	3	CAPACITOR-FXD 3.3UF+-20% 15VDC TA	56289	150D335X0015A2
A6C3	0160-4554	7	4	CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A6C4	0180-0210	6		CAPACITOR-FXD 3.3UF+-20% 15VDC TA	56289	150D335X0015A2
A6C5	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A6C6	0180-0210	6		CAPACITOR-FXD 3.3UF+-20% 15VDC TA	56289	150D335X0015A2
A6C7	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A6C8	0160-3046	0	4	CAPACITOR-FXD 250PF +-1% 100VDC MICA	28480	0160-3046
A6C10	0160-3874	2	2	CAPACITOR-FXD 10PF +-.5PF 200VDC CER	28480	0160-3874
A6C11	0160-3874	2		CAPACITOR-FXD 10PF +-.5PF 200VDC CER	28480	0160-3874
A6C12	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A6C13	0160-3046	0		CAPACITOR-FXD 250PF +-1% 100VDC MICA	28480	0160-3046
A6C14	0160-3046	0		CAPACITOR-FXD 250PF +-1% 100VDC MICA	28480	0160-3046
A6C15	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A6C16	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A6C17	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A6C18	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A6C19	0160-3046	0		CAPACITOR-FXD 250PF +-1% 100VDC MICA	28480	0160-3046
A6C20	0160-0682	4	1	CAPACITOR-FXD 3.3PF +-.5PF 200VDC CER	28480	0160-0682
A6CR1	1901-0050	3	5	DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A6CR2	1901-0535	9	1	DIODE-SM SIG SCHOTTKY	28480	1901-0535
A6CR3	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A6CR4	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A6CR5	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A6CR6	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A6J1	1250-1453	1	6	CONNECTOR-RF BNC FEM SGL-HOLE-RR 50 OHM	28480	1250-1453
A6J2	1250-1453	1		CONNECTOR-RF BNC FEM SGL-HOLE-RR 50 OHM	28480	1250-1453
A6J3	1250-1453	1		CONNECTOR-RF BNC FEM SGL-HOLE-RR 50 OHM	28480	1250-1453
A6J4	1250-1453	1		CONNECTOR-RF BNC FEM SGL-HOLE-RR 50 OHM	28480	1250-1453
A6J5	1250-1453	1		CONNECTOR-RF BNC FEM SGL-HOLE-RR 50 OHM	28480	1250-1453
A6J6	1250-1453	1		CONNECTOR-RF BNC FEM SGL-HOLE-RR 50 OHM	28480	1250-1453
A6J7	1200-0482	9	1	SOCKET-IC 16-CONT DIP-SLDR	28480	1200-0482
A6L1	9100-0348	2	3	INDUCTOR RF-CH-MLD 1UH 1% .166DX.385LG	28480	9100-0348
A6L2	9100-0348	2		INDUCTOR RF-CH-MLD 1UH 1% .166DX.385LG	28480	9100-0348
A6L3	9100-0348	2		INDUCTOR RF-CH-MLD 1UH 1% .166DX.385LG	28480	9100-0348
A6Q1	1854-0215	1	6	TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A6Q2	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A6Q3	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A6Q4	1853-0036	2	1	TRANSISTOR PNP SI PD=310MW FT=250MHZ	28480	1853-0036
A6Q5	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A6Q6	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A6Q7	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A6R1	0757-0401	0	1	RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A6R2	0698-3162	0	1	RESISTOR 46.4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4642-F
A6R3	0757-0418	9	1	RESISTOR 619 1% .125W F TC=0+-100	24546	C4-1/8-TO-619R
†A6R5	1810-0367	2	1	NETWORK-RES 6-SIP 4.7K OHM X5	01121	205A472
†A6R7	0698-3439	4	1	RESISTOR 178 1% .125W F TC=0+-100	24546	C4-1/8-TO-178R-F
A6R8	0757-0280	3	4	RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A6R9	0698-3444	1	1	RESISTOR 316 1% .125W F TC=0+-100	24546	C4-1/8-T0-316R-F
A6R10	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A6R11	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1001-F
†A6R13	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1001-F
†A6R15	0757-0442	9	2	RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1002-F
A6R16	0757-0178	8	1	RESISTOR 100 1% .25W F TC=0+-100	24546	C5-1/4-T0-101-F
A6R17	0757-1093	8	2	RESISTOR 3K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3001-F
A6R18	0757-0439	4	1	RESISTOR 6.81K 1% .125W F TC=0+-100	24546	C4-1/8-T0-6811-F
A6R19	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A6R20	0757-1093	8		RESISTOR 3K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3001-F
A6R21	0698-3152	8	1	RESISTOR 3.48K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3481-F
A6R22	2100-2497	9	1	RESISTOR-TRMR 2K 10% C TOP-ADJ 1-TRN	73138	82PR2K
A6R23	0698-3155	1	1	RESISTOR 4.64K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4641-F
A6R24	0698-3450	9	1	RESISTOR 42.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4222-F
A6S1	3101-1782	6	2	SWITCH-TOGGLE SUB-MIN SPDT 250VAC	28480	3101-1782
A6S2	3101-1782	6		SWITCH-TOGGLE SUB-MIN SPDT 250VAC	28480	3101-1782

†A6R4,R6,R12,R14 — NOT ASSEMBLY

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	05335-60007	3	1	BOARD ASSEMBLY-HP-IB(SERIES 2224)	28480	05335-60007
A7C1	0160-3879	7	5	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A7C2	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A7C3	0180-0374	3	1	CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A7C4	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A7C5	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A7C6	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A7J1	1200-0482	9	4	SOCKET-IC 16-CONT DIP-SLDR	28480	1200-0482
A7J2	1200-0482	9		SOCKET-IC 16-CONT DIP-SLDR	28480	1200-0482
A7R1	1810-0205	7	1	NETWORK-RES 8-SIP4.7K OHM X 7	01121	208A472
A7U1	1820-2219	8	1	IC MICPROC-ACCESS NMOS 8-BIT	04713	MC68488P
A7U2	1820-1281	2	1	IC DCDR TTL LS 2-TO-4-LINE DUAL 2-INP	01295	SN74LS139N
A7U3	1820-2058	3	4	IC MISC TTL S QUAD	07263	MC3448AL
A7U4	1820-2058	3		IC MISC TTL S QUAD	07263	MC3448AL
A7U5	1820-1199	1	1	IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A7U6	1820-2058	3		IC MISC TTL S QUAD	07263	MC3448AL
A7U7	1820-2058	3		IC MISC TTL S QUAD	07263	MC3448AL
A7U8	1820-2024	3	1	IC DRVR TTL LS LINE DRVR OCTL	01295	SN74LS244N
A7XU1	1200-0682	1	1	SOCKET-IC 40-CONT DIP DIP-SLDR	28480	1200-0682
A8	05335-60008			OPT. 020,DVM, REFER TO TABLE 6-4.		
A9	05335-60009			OPT. 030, CHAN C, REFER TO TABLE 6-5.		
A10	05335-60010			OPT. 040, REFER TO TABLE 6-6.		
A11	05335-60011			OPT. 040, REFER TO TABLE 6-6.		
A12	05335-60012			OPT. 040, REFER TO TABLE 6-6.		
A13	0960-0443	1	1	LINE MODULE- FILTERED	28480	0960-0443
A14	05370-60005	4	1	BOARD ASSY,HP-IB CONNECTOR(SERIES 1748)	28480	05370-60005
A14H13	0380-0643	3	2	STANDOFF-HEX .255-IN-LG 6-32THD	00000	ORDER BY DESCRIPTION
A14H14	2190-0034	5	2	WASHER-LK HLCL NO. 10 .194-IN-ID	28480	2190-0034
A14H28	1530-1098	4	2	CLEVIS 0.070-IN W SLT: 0.454-IN PIN CTR	00000	ORDER BY DESCRIPTION
A14J1	1200-0482	9		SOCKET-IC 16-CONT DIP-SLDR	28480	1200-0482
A14J2	1200-0482	9		SOCKET-IC 16-CONT DIP-SLDR	28480	1200-0482
A14J3	1251-3283	1	1	CONNECTOR 24-PIN F MICRORIBBON	28480	1251-3283
A14S1	3101-1973	7	1	SWITCH-SL 7-1A DIP-SLIDE-ASSY .1A 50VDC	28480	3101-1973
A14XS1	1200-0485	2	1	SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0485
				A14 MISCELLANEOUS PARTS		
A15	10544	8		(OPTION 010)	28480	10544
A15	10544-60011	3	1	10 MHZ OVEN OSCILLATOR(OPT. 010)	28480	10544-60011
A15	10811-60111	8	1	10MHZ OVEN OSC.(ALT. 10811-60111)	28480	10811-60111
	10811-90002	9	1	OPERATING AND SERVICE MANUAL FOR 10811-60111	28480	10811-90002
				NOTE The 10544-60011 and 10811-60111 oscillators are directly interchangeable. Instruments with Serial Numbers 2202A02626 or above may have either oscillator assembly. The 10811-60111 oscillator is field serviceable. Repairs may be accomplished by referring to the 10811A/B Operating and Service Manual (10811-90002). This manual is included with every instrument with the 10811-60111 oscillator assembly for A15.		
A16				NOT ASSIGNED		
A17	05335-20203	7	1	BOARD-SHIELD (P/O OPT. 040)	28480	05335-20203

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

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
				MISCELLANEOUS CHASSIS ELECTRICAL PARTS		
B1	3160-0209	4	1	FAN-TBAX 32-CFM 105-125V 50/60-HZ	23936	8500D
F1	2110-0007	4	1	FUSE 1A 250V TD 1.25X.25 UL (FOR 100/120V OPERATION)	75915	313001
F1	2110-0202	1	1	FUSE .5A 250V TD 1.25X.25 UL (FOR 220/240V OPERATION)	75915	313.500
Q1	1854-0611	1	1	TRANSISTOR NPN 2N6055 SI DARL TO-3	04713	2N6055
T1	9100-4113	7	1	TRANSFORMER-AC POWER	28480	9100-4113
W1	8120-1378	1	1	CABLE ASSY-18AWG 3-COND(AC INPUT)	28480	8120-1378
W2	05335-60101	8	1	CABLE ASSEMBLY-DC POWER (A1 TO A4)	28480	05335-60101
W3	8120-2884	6	1	CABLE ASSY-BRAIDED (A4 TO A6)	28480	8120-2884
W4	05335-60102	9	1	CABLE ASSEMBLY-DISPLAY 15-PIN	28480	05335-60102
W5	8120-2867	5	2	CABLE ASSY-2.5"LG 18-PIN MALE PLUGS	28480	8120-2867
W6	8120-2867	5		CABLE ASSY-2.5"LG 18-PIN MALE PLUGS	28480	8120-2867
W7	05335-60112	1	1	CABLE ASSY-COAX 50-OHM (SERIAL PREFIX 2134A AND ABOVE)	28480	05335-60112
W8	05335-60112	1	3	CABLE ASSY-COAX 50-OHM (SERIAL PREFIX 2134A AND ABOVE)	28480	05335-60112
W9	8120-2959	6	2	CABLE ASSY-RIBBON 9"LG 16-PIN MALE PLUGS	28480	8120-2959
W10	8120-2959	6		CABLE ASSY-RIBBON 9"LG 16-PIN MALE PLUGS	28480	8120-2959
W11	05335-60104	1	1	CABLE ASSY-3-WIRE W/SOCKET(FOR Q1)	28480	05335-60104
				MISCELLANEOUS CHASSIS HARDWARE PARTS		
H1	2360-0113	2	9	SCREW-MACH 6-32 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
H2	2336-0190	4	10	SCREW-MACH 6-32 X 3/16 IN LG FLAT HD 100	28480	2336-0190
H3	2360-0115	4	13	SCREW-MACH 6-32 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
H4	2510-0192	6	16	SCREW-MACH 8-32 .25-IN-LG 100 DEG	00000	ORDER BY DESCRIPTION
H5	3050-0066	8	3	WASHER-FL MTLC NO. 6 .147-IN-ID	28480	3050-0066
H6	2680-0128	7	4	SCREW-MACH 10-32 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
H7	2360-0111	0	1	SCREW-MACH 6-32 .188-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
H8	2360-0121	2	4	SCREW-MACH 6-32 .5-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
H9	2420-0001	5	9	NUT-HEX-W/LKWR 6-32-THD .109-IN-THK	00000	ORDER BY DESCRIPTION
H10	2950-0035	8	8	NUT-HEX-DBL-CHAM 15/32-32-THD	00000	ORDER BY DESCRIPTION
H11	2190-0102	8	6	WASHER-LK INTL T 15/32 IN .472-IN-ID	28480	2190-0102
H12	2950-0052	9	2	NUT-HEX-DBL-CHAM 1/4-40-THD .062-IN-THK	00000	ORDER BY DESCRIPTION
H13	0380-0644	4	2	STANDOFF-HEX 9/32 6-32 MALE TO METRIC FE	00000	ORDER BY DESCRIPTION
H14	2190-0034	5	2	WASHER-LK HLCL NO. 10 .194-IN-ID	28480	2190-0034
H15	0626-0002	0	2	SCREW-TPG 6-20 .5-IN-LG PAN-HD-SLT	00000	ORDER BY DESCRIPTION
H16	1200-0043	8	1	INSULATOR-XSTR ALUMINUM	28480	1200-0043
H17	2510-0135	7	4	SCREW-MACH 8-32 2.25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
H18	2580-0003	5	4	NUT-HEX-W/LKWR 8-32-THD .125-IN-THK	00000	ORDER BY DESCRIPTION
H19	3050-0001	1	4	WASHER-FL MTLC NO. 8 .172-IN-ID	28480	3050-0001
H20	2190-0143	7	4	WASHER-FL NM NO. 8 .17-IN-ID .438-IN-OD	28480	2190-0143
H21	2200-0103	2	17	SCREW-MACH 4-40 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
H22	3050-0105	6	3	WASHER-FL MTLC NO. 4 .125-IN-ID	28480	3050-0105
H23	3050-0003	3	5	WASHER-FL NM NO. 6 .141-IN-ID .375-IN-OD	28480	3050-0003
H24	3050-0124	9	5	WASHER-FL MTLC NO. 5 .13-IN-ID	28480	3050-0124
H25	0340-0468	6	5	INSULATOR-XSTR NYLON	28480	0340-0468
H26	0340-0525	6	5	INSULATOR-XSTR HARD-ANODIZED-AL	28480	0340-0525
H27	0510-1148	2	15	CLIP-SPRING RETAINING(FOR A5 CKT BD)	28480	0510-1148
H28	1530-1098	4	5	CLEVIS 0.070-IN W SLT: 0.454-IN PIN CTR	00000	ORDER BY DESCRIPTION
H29	1400-0482	3	1	CABLE TIE .062-3-DIA .14-WD NYL	28480	1400-0482
H30	1400-0507	3	2	TIE-WRAP PLASTIC 8" LG	28480	1400-0507
H31	1400-0531	3	2	CLAMP-CABLE PRESS-ON SELF ADHESIVE	28480	1400-0531
H32	2950-0072	3	3	NUT-HEX-DBL-CHAM 1/4-32-THD .062-IN-THK	00000	ORDER BY DESCRIPTION
H33	1200-0523	9	2	LOCK-DUAL INLINE PKG INLINE PKG	52072	CA-16-200-DL
H34	0340-0486	8	1	COVER-XSTR INSULATING BLK NYLON	28480	0340-0486
H35	0370-1005	2	3	KNOB-BASE-PTR 3/8 JGK .125-IN-ID	28480	0370-1005
H36	2190-0068	5	2	WASHER-LK INTL T 1/2 IN .505-IN-ID	28480	2190-0068
H37	0590-0038	5	2	NUT-HEX-DBL-CHAM 1/2-32-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
H38	7120-3731	3	1	LABEL-WARNING HIGH VOLTAGE (APPLIED ON T1)	28480	7120-3731
H39	7120-1254	1	1	LOGO-HP FRONT WINDOW(CEMENT-ON)	28480	7120-1254

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

Table 6-3. Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
				MISCELLANEOUS CHASSIS PARTS FOR STD. INSTRUMENT AND OPTIONS 020, 030, 040		
MP1	05335-00001	1	1	PANEL-FRONT MAIN (STD.)	28480	05335-00001
MP2	05335-00002	2	2	PANEL-FRONT BLANK FILLER LESS OPTIONS	28480	05335-00002
MP3	05335-00003	3	1	PANEL-FRONT SUB	28480	05335-00003
MP4	05335-00004	4	1	PANEL-REAR (SERIAL PREFIX 2104A & BELOW)	28480	05335-00004
MP4	05335-00014	6	1	PANEL-REAR (SERIAL PREFIX 2120A & ABOVE)	28480	05335-00014
MP5	05335-20201	5	1	WINDOW-FRONT PLASTIC RED	28480	05335-20201
MP6	5040-6937	5	3	RETAINER-SLIDE WINDOW BLACK PLASTIC	28480	5040-6937
MP7	5060-9899	6	2	HANDLE-FRONT SYSTEM II	28480	5060-9899
MP8	5020-8896	7	2	HANDLE-FRONT TRIM	28480	5020-8896
MP9	2510-0195	9	6	SCREW-MACH 8-32 .375-IN-LG 100 DEG	28480	2510-0195
MP10	5040-6928	4	1	STRIP-DIVIDER FRONT PANEL PLASTIC	28480	5040-6928
MP11	5060-9833	8	1	COVER-TOP 12-INCH DP	28480	5060-9833
MP12	5060-9845	2	1	COVER-BOTTOM	28480	5060-9845
MP13	5060-9110	4	1	COVER-SIDE VENTILATED (LEFT)	28480	5060-9110
MP14	5060-9878	1	1	COVER-SIDE FOR STRAP HANDLE (RIGHT)	28480	5060-9878
MP15	5060-9802	1	1	HANDLE-SIDE STRAP	28480	5060-9802
MP16	5060-7219	0	1	CAP-FRONT HANDLE STRAP	28480	5060-7219
MP17	5040-7220	1	1	CAP-REAR HANDLE STRAP	28480	5040-7220
MP18	2680-0172	1	2	SCREW-MACH 10-32 .375-IN-LG 100 DEG	28480	2680-0172
MP19	5040-7201	8	2	FOOT-CABINET FRONT	28480	5040-7201
MP20	1460-1345	5	2	STAND-TILT SS STL	28480	1460-1345
MP21	5040-7222	3	2	FOOT-CABINET REAR NON-SKID	28480	5040-7222
MP22	3160-0309	5	1	GRILL-FAN	4NB33	12601-43 UL VERSION
MP23	5040-7202	9	1	TRIM-CABINET TOP-FRONT INSERT PLASTIC	28480	5040-7202
MP24	05335-00015	7	2	BRKT-SUPPORT FLAT/THD INSERT (TOP FRONT)	28480	05335-00015
MP25	05335-00009	9	1	SHIELD-INSULATOR SAFETY COVER	28480	05335-00009
MP26	05335-40001	5	2	CROSS BRACE CHASSIS-CKT-BD-MTG MOLDED	28480	05335-40001
MP27	05335-00010	2	1	BRACKET-SUPPORT HP-IB ASSY A7	28480	05335-00010
MP28	0460-0832	2	2	PAD-VINYL SELF ADHESIVE 7.25 IN LG	76381	SJ-5510
MP29	5020-8803	6	1	FRAME-CHASSIS FRONT	28480	5020-8803
MP30	5020-8804	7	1	FRAME-CHASSIS REAR	28480	5020-8804
MP31	5020-8835	4	4	FRAME-CORNER STRUT	28480	5020-8835
MP32	7120-8385	3	1	LABEL-OPERATION TOP COVER	28480	7120-8385
MP33	05335-00013	5	1	PANEL-FRONT OPT. 040	28480	05335-00013
MP34	05335-00007	7	1	PANEL-FRONT INSERT OPT. 020 (DVM)	28480	05335-00007
MP35	05335-00008	8	1	PANEL-FRONT INSERT OPT. 030 ("C" CHANNEL)	28480	05335-00008

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

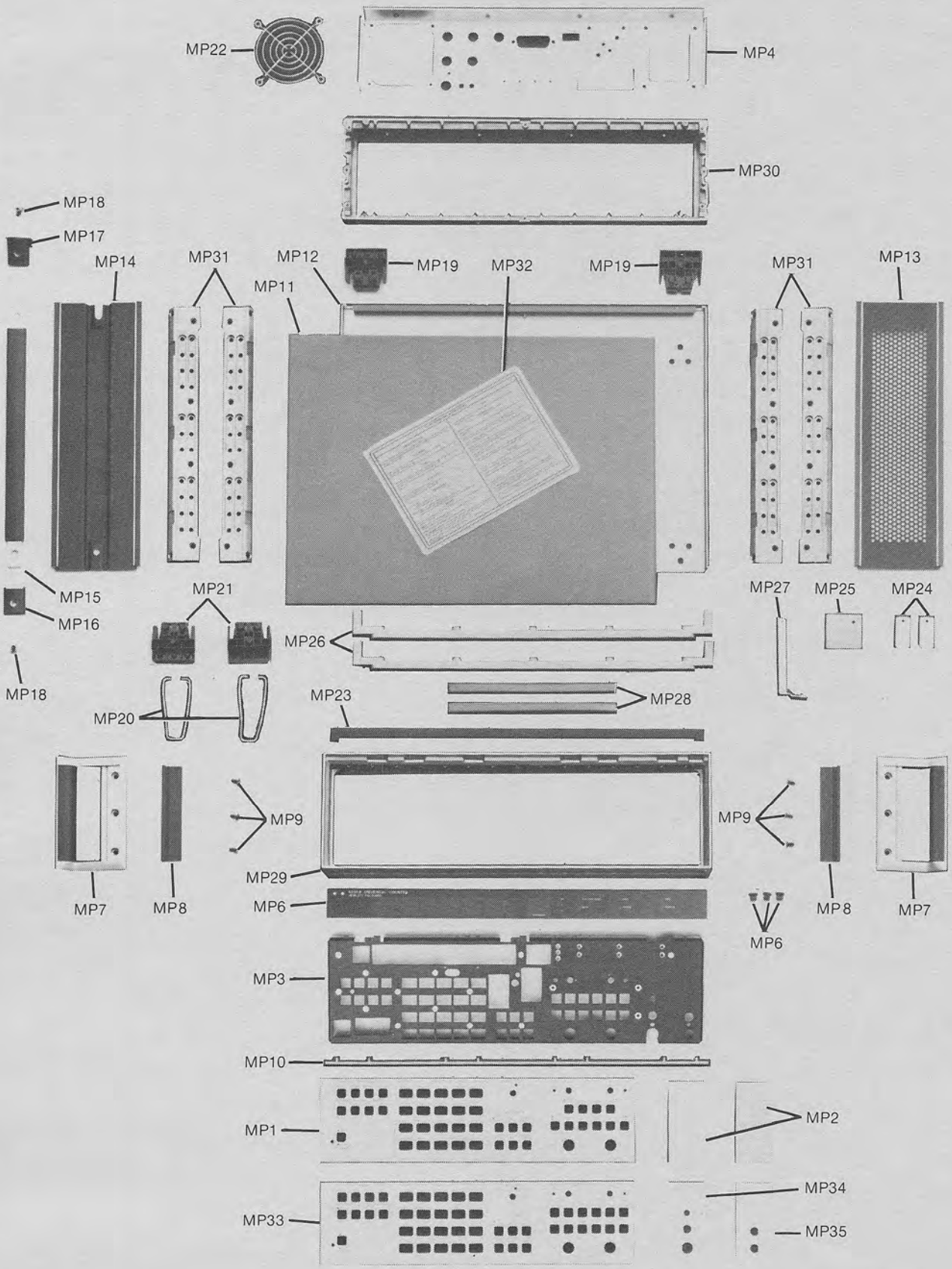
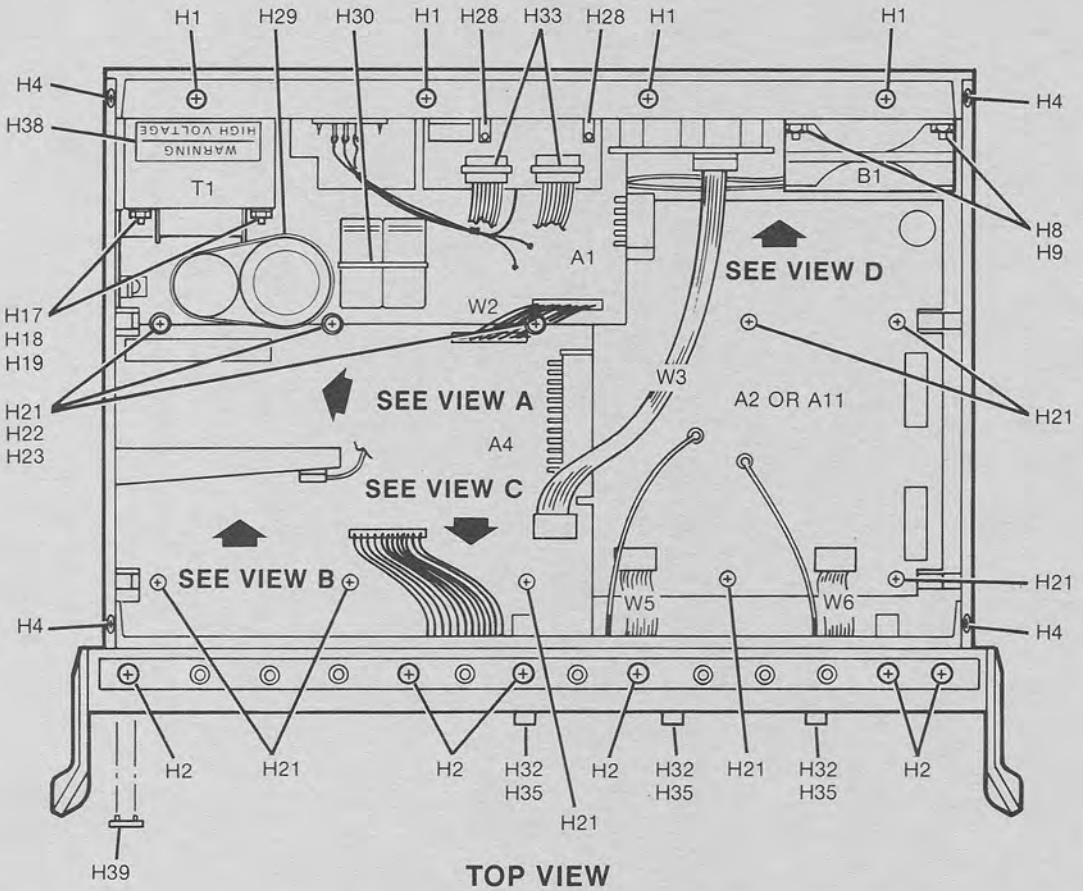
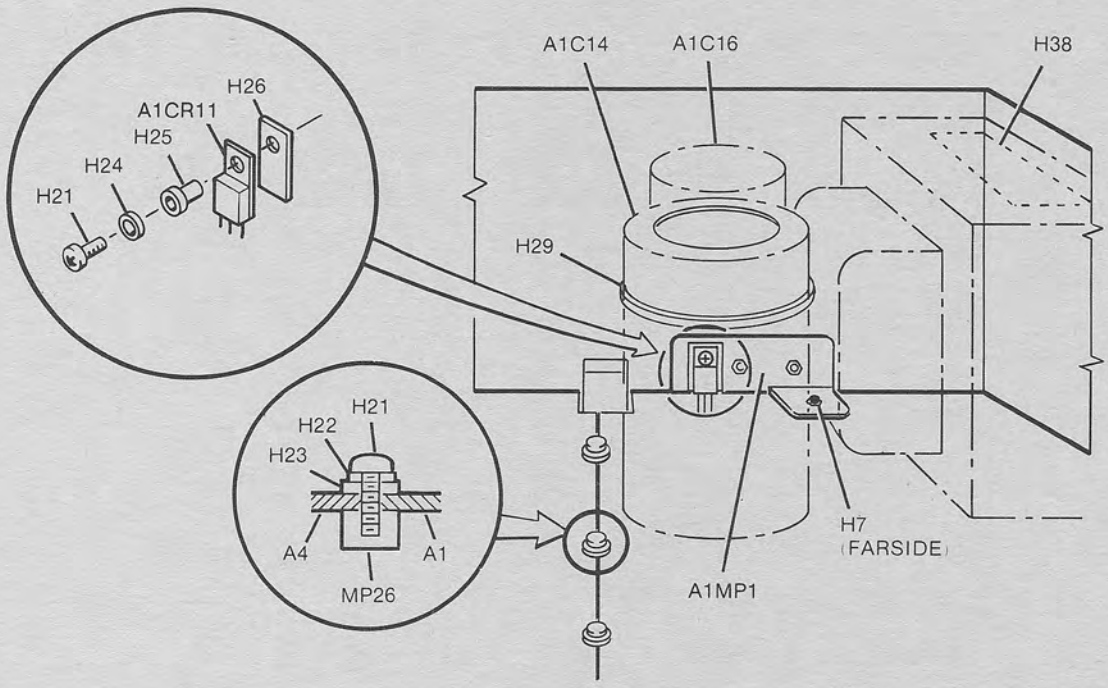


Figure 6-1. Cabinet Parts



REFERENCE DESIGNATION	HP PART NUMBER	C D	DESCRIPTION
H1	2360-0113	2	SCREW-MACH 6-32 × .250-IN-LG PAN-HD POZI/LOCK
H2	2360-0190	4	SCREW-MACH 6-32 × 3/16-IN-LG FLAT HD 100-DEG POZI
H4	2510-0192	6	SCREW-MACH 8-32 × .250-IN-LG FLAT-HD 100-DEG POZI
H8	2360-0121	2	SCREW-MACH 6-32× .50-IN-LG PAN-HD POZI/LOCK
H9	2420-0001	5	NUT-HEX 6-32 × 5/16-IN WITH LOCK
H17	2510-0135	7	SCREW-MACH 8-32 × 2.25-IN-LOG PAN-HD POZI
H18	2580-0003	5	NUT-HEX 8-32 × 11/32 WITH LOCK
H19	3050-0001	1	WASHER-FLAT NO. 8 METALIC .172-IN-ID
H21	2200-0103	2	SCREW-MACH 4-40 × .250-IN PAD-HD POZI/LOCK
H22	3050-0105	6	WASHER-FLAT NO. 4 METALIC .125-IN-ID
H23	3050-0003	3	WASHER-FLAT NO. 6 FIBER .375-IN-OD
H28	1530-1098	4	CLEVIS-MOUNTING CIRCUIT BOARD
H29	1400-0482	3	TIE-WRAP PLASTIC 11-IN-LG
H30	1400-0507	3	TIE-WRAP PLASTIC 8-IN-LG
H32	2950-0072	3	NUT-HEX 1/4-32 × 5/16-IN
H33	1200-0523	9	LOCK-PLUG DUAL-INLINE 16-PIN
H35	0370-1005	2	KNOB-BASE-PTR 3/8JGK .125-IN-ID
H38	7120-3731	3	LABEL-WARNING HIGH VOLTAGE (APPLIED ON T1)
H39	7120-1254	1	LOGO-HP FRONT WINDOW (CEMENT-ON)

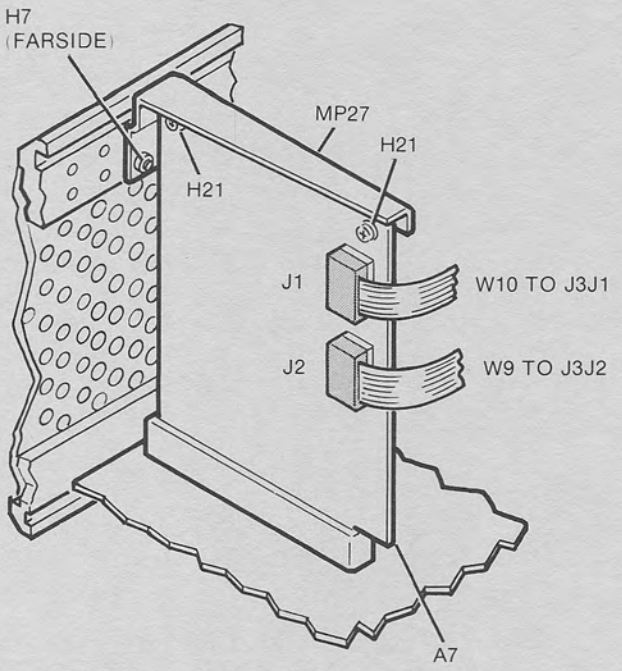
Figue 6-2. Top View Parts



VIEW A OF TOP VIEW

REFERENCE DESIGNATION	HP PART NUMBER	C D	DESCRIPTION
H7	2360-0111	0	SCREW-MACH 6-32 × 3/16-IN-LG PAN-HD POZI/LOCK
H21	2200-0103	2	SCREW-MACH 4-40 × .250-IN PAN-HD POZI/LOCK
H22	3050-0105	6	WASHER-FLAT NO. 4 METALIC .125-IN-ID
H23	3050-0003	3	WASHER-FLAT NO. 6 FIBER .375-IN-OD
H24	3050-0124	9	WASHER-FLAT NO. 4 METALIC
H25	0340-0468	6	WASHER-EXTRUDED XSTR-INSULATOR NYLON
H26	0340-0525	6	INSULATOR-XSTR HARD-ANODIZED-AL
H29	1400-0482	3	TIE-WRAP PLASTIC 11-IN-LG
H38	7120-3731	3	LABEL-WARNING HIGH VOLTAGE (APPLIED ON T1)

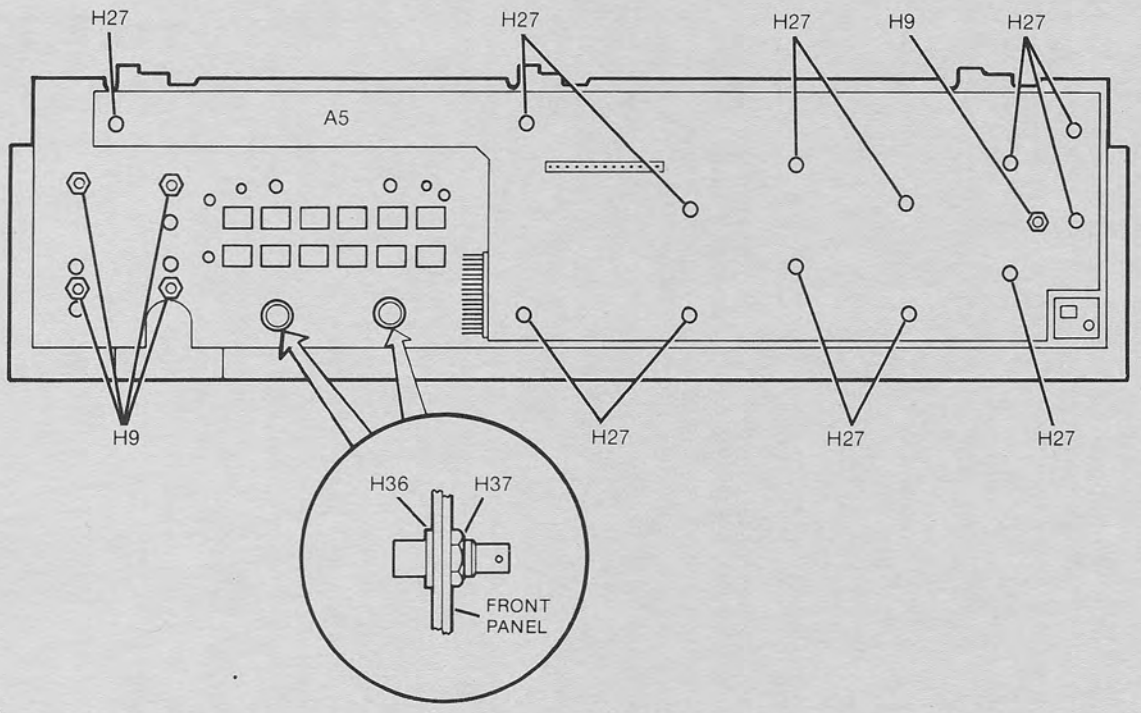
Figure 6-3. View A Parts



VIEW B OF TOP VIEW

REFERENCE DESIGNATION	HP PART NUMBER	C D	DESCRIPTION
H7	2360-0111	0	SCREW-MACH 6-32 × 3/16-IN-LG PAN-HD POZI/LOCK
H21	2200-0103	2	SCREW-MACH 4-40 × .250-IN PAN-HD POZI/LK

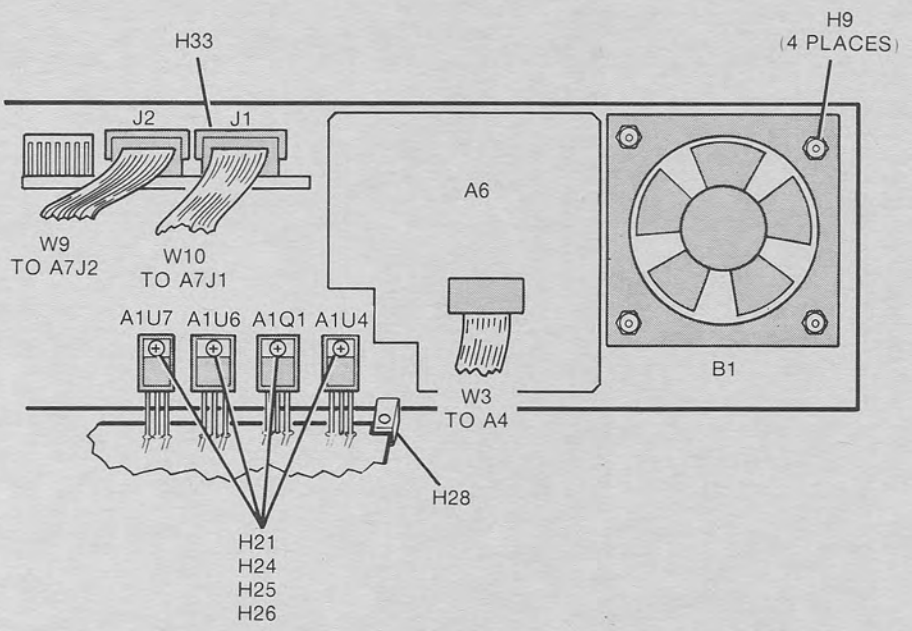
Figure 6-4. View B Parts



VIEW C OF TOP VIEW

REFERENCE DESIGNATION	HP PART NUMBER	C D	DESCRIPTION
H9	2420-0001	5	NUT-HEX 6-32 × 5/16-IN WITH LOCK
H27	0510-1148	2	CLIP-SPRING RETAINING (FOR A5 CLT BD)
H36	2190-0068	9	WASHER-LOCK .50-IN-ID (BEHIND FRONT PANEL BNC)
H37	0590-0382	5	NUT-HEX 1/2-32 × 9/16-IN (FRONT-PANEL BNC)

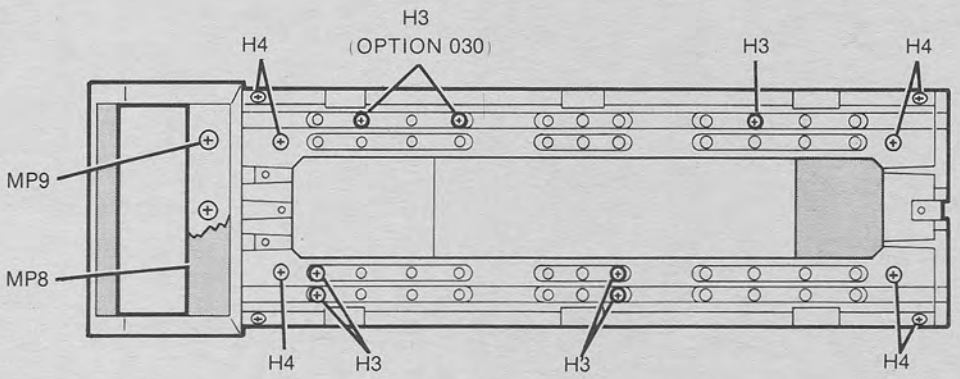
Figure 6-5. View C Parts



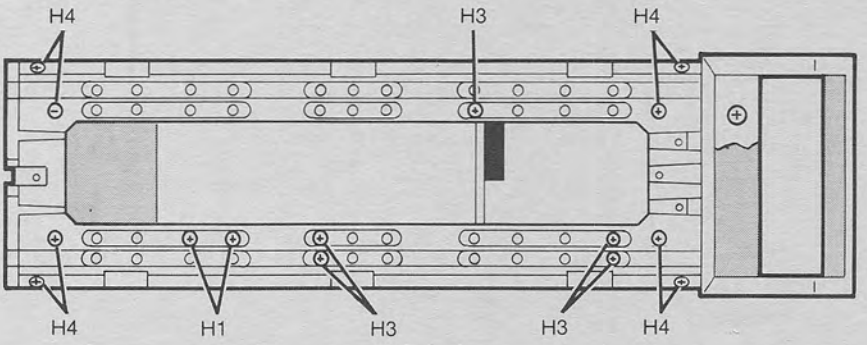
VIEW D OF TOP VIEW

REFERENCE DESIGNATION	HP PART NUMBER	C D	DESCRIPTION
H9	2420-0001	5	NUT-HEX 6-32 × 5/16-IN WITH LOCK
H21	2200-0103	2	SCREW-MACH 4-40 × .250-IN PAD-HD POZI/LOCK
H24	3050-0124	9	WASHER-FLAT NO. 4 METALIC
H25	0340-0468	6	WASHER-EXTRUDED XSTR-INSTULATOR NYLON
H26	0340-0525	6	INSULATOR-XSTR HARD-ANODIZED-AL
H28	1530-1098	4	CLEVIS-MOUNTING CIRCUIT BOARD
H33	1200-0523	9	LOCK-PLUG DUAL-INLINE 16-PIN

Figure 6-6. View D Parts



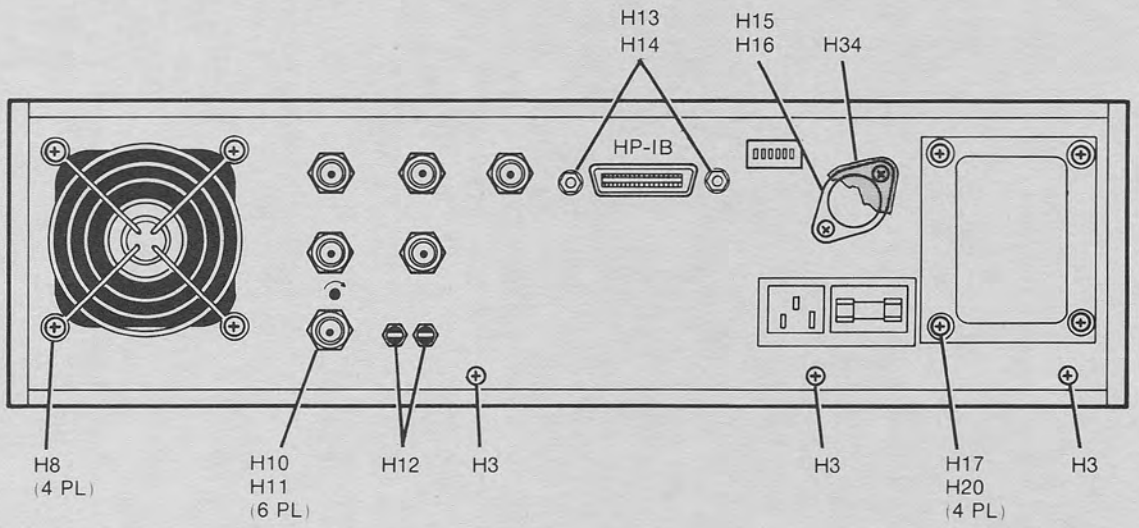
RIGHT SIDE WITH STRAP HANDLE & SIDE COVER REMOVED



LEFT SIDE WITH VENTILATED COVER REMOVED

REFERENCE DESIGNATION	HP PART NUMBER	C D	DESCRIPTION
H1	2360-0113	2	SCREW-MACH 6-32 × .250-IN-LG PAN-HD POZI/LOCK
H3	2360-0115	4	SCREW-MACH 6-32 × 5/16-IN-LG PAN-HD POZI-LOCK
H4	2510-0192	6	SCREW-MACH 8-32 × .250-IN-LG FLAT-HD 100-DEG POZI

Figure 6-7. Side View Parts



REAR PANEL

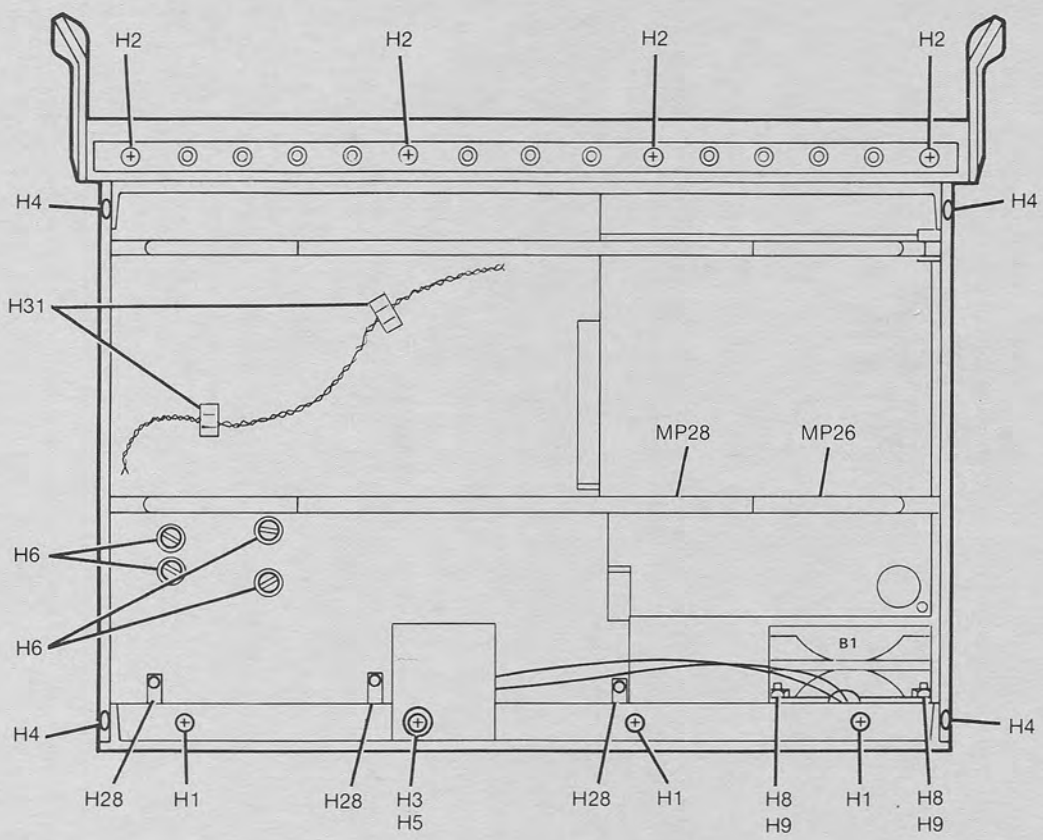
REFERENCE DESIGNATION	HP PART NUMBER	C D	DESCRIPTION
H3	2360-0115	4	SCREW-MACH 6-32 × 5/16-IN-LG PAN-HD POZI/LOCK
H8	2360-0121	2	SCREW-MACH 6-32× .50-IN-LG PAN-HD POZI/LOCK
H10	2950-0035	8	NUT-HEX 15/32-32 × 9/16-IN
H11	2190-0102	8	WASHER-LOCK INTERNAL TOOTH 15/32-IN-ID
H12	2950-0052	9	NUT-HEX 1/4-40 × 5/16-IN
H13	0380-0644	4	STANDOFF-HEX 9/32 × 6-32 MALE-TO-METRIC FEMALE
H14	2190-0034	5	WASHER-SPLIT LOCK NO. 10 .194-IN-ID
H15	0626-0002	0	SCREW-SELF TAPPING 6-20 × .50-IN-LG
H16	1200-0043	8	INSTULATOR-XSTR HARD-ANODIZED-AL (FOR Q1)
H17	2510-0135	7	SCREW-MACH 8-32 × 2.25-IN-LOG PAN-HD POZI
H20	2190-0143	7	WASHER-FLAT NO. 8 FIBER .172-IN-ID
H34	0340-0486	8	COVER-XSTR INSULATING BLOCK-NYLON

Figure 6-8. Rear Panel Parts

Table 6-4. Option 020 DVM Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
				(OPTION 020)		
A8	05335-60008	4	1	BOARD ASSEMBLY-DVM (SERIES 1928)	28480	05335-60008
A8C1	0180-2730	9	2	CAPACITOR-FXD 1700UF+75-10% 30VDC AL	28480	0180-2730
A8C2	0180-2730	9		CAPACITOR-FXD 1700UF+75-10% 30VDC AL	28480	0180-2730
A8C3	0160-0576	5	4	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A8C4	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A8C5	0160-4557	0	1	CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A8C6	0180-2821	9	2	CAPACITOR-FXD 22UF+-20% 35VDC TA	28480	0180-2821
A8C7	0180-2821	9		CAPACITOR-FXD 22UF+-20% 35VDC TA	28480	0180-2821
A8C8	0160-0300	3	1	CAPACITOR-FXD 2700PF +-10% 200VDC POLYE	28480	0160-0300
A8C10	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A8C11	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A8C12	0160-4554	7	5	CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A8C13	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A8C14	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A8C15	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A8C16	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A8C17	0160-4801	7	1	CAPACITOR-FXD 100PF +-5% 100VDC CER	28480	0160-4801
A8C18	0160-0314	9	1	CAPACITOR-FXD .01UF +-5% 400VDC POLYE	84411	663UW10354W2
A8CR1	1906-0069	4	1	DIODE-FW BRDG 400V 1A	28480	1906-0069
A8CR2	1901-0033	2	1	DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
A8CR3	1901-0050	3	2	DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A8CR4	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A8H30	1400-0507	3	1	TIE WRAP 8" LG PLASTIC	28480	1400-0507
A8Q1				NOT ASSIGNED		
A8Q2	1854-0215	1	1	TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A8Q3	1853-0036	2	2	TRANSISTOR PNP SI PD=310MW FT=250MHZ	28480	1853-0036
A8Q4	1855-0368	7	3	TRANSISTOR J-FET N-CHAN D-MODE TO-72 SI	28480	1855-0368
A8Q5	1855-0368	7		TRANSISTOR J-FET N-CHAN D-MODE TO-72 SI	28480	1855-0368
A8Q6	1855-0368	7		TRANSISTOR J-FET N-CHAN D-MODE TO-72 SI	28480	1855-0368
A8Q7	1853-0036	2		TRANSISTOR PNP SI PD=310MW FT=250MHZ	28480	1853-0036
A8R1	0757-0428	1	1	RESISTOR 1.62K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1621-F
A8R2	2100-3094	4	3	RESISTOR-TRMR 100K 10% C SIDE-ADJ 17-TRN	02111	43P104
A8R3	0757-0286	9	1	RESISTOR 100 1% .125W F TC=0+-25	19701	MF4C1/8-T9-101-F
A8R4	0698-6964	6	3	RESISTOR 49.5K .1% .125W F TC=0+-25	28480	0698-6964
A8R5				NOT ASSIGNED		
A8R6	0698-0082	7	1	RESISTOR 464 1% .125W F TC=0+-100	24546	C4-1/8-T0-4640-F
A8R7	0698-3155	1	1	RESISTOR 4.64K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4641-F
A8R8	0698-4008	5	1	RESISTOR 40K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4002-F
A8R9	0698-3162	0	5	RESISTOR 46.4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4642-F
A8R10	2100-3154	7	1	RESISTOR-TRMR 1K 10% C SIDE-ADJ 17-TRN	02111	43P102
A8R11	0698-6964	6		RESISTOR 49.5K .1% .125W F TC=0+-25	28480	0698-6964
A8R12	0698-3162	0		RESISTOR 46.4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4642-F
A8R13	0698-6606	3	1	RESISTOR 495K 1% .125W F TC=0+-25	28480	0698-6606
A8R14	0698-3162	0		RESISTOR 46.4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4642-F
A8R15	2100-3103	6	1	RESISTOR-TRMR 10K 10% C SIDE-ADJ 17-TRN	02111	43P103
A8R16	0757-0442	9	6	RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A8R17	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A8R18	0757-0465	6	1	RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A8R19	2100-3094	4		RESISTOR-TRMR 100K 10% C SIDE-ADJ 17-TRN	02111	43P104
A8R20	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A8R21	0698-7959	1	1	RESISTOR 4.95M 1% 1W F TC=0+-25	28480	0698-7959
A8R22	0698-3162	0		RESISTOR 46.4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4642-F
A8R23	1810-0374	1	1	NETWORK-RES 8-SIP1.0K OHM X 4	01121	208B102
A8R24	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A8R25	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A8R26	0698-6367	3	1	RESISTOR 22.22 .1% .125W F TC=0+-25	28480	0698-6367
A8R27	0698-6964	6		RESISTOR 49.5K .1% .125W F TC=0+-25	28480	0698-6964
A8R28	0698-3931	1	1	RESISTOR 2M .1% .125W F TC=0+-25	28480	0698-3931
A8R29	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A8R30	2100-3094	4		RESISTOR-TRMR 100K 10% C SIDE-ADJ 17-TRN	02111	43P104
A8R31	0698-3162	0		RESISTOR 46.4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4642-F
A8R32	0698-3964	0	1	RESISTOR 8M .5% .25W F TC=0+-25	03888	PME64T98M.5%
A8T1	9100-0439	2	1	TRANSFORMER-ISOLATION 35.4V +-13.7%	28480	9100-0439
A8TP1-A8TP4	0360-1682	0	4	TERMINAL-STUD SGL-TUR PRESS-MTG	28480	0360-1682
A8U1	1826-0625	8	1	IC-V RGLTR	28480	1826-0625
A8U2	1990-0429	7	1	OPTO-ISOLATOR LED-IC GATE IF=10MA-MAX	28480	1990-0429
A8U3	1820-1195	7	1	IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N
A8U4	1826-0650	9	1	IC-V RGLTR-V-REF-ADJ 2.5/10V	28480	1826-0650
A8U5	1826-0635	0	2	IC OP AMP LOW-OFS 8-DIP-P PKG	06665	OP-07CP

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



BOTTOM VIEW

REFERENCE DESIGNATION	HP PART NUMBER	C D	DESCRIPTION
H1	2360-0113	2	SCREW-MACH 6-32 × .250-IN-LG PAN-HD POZI/LOCK
H2	2360-0190	4	SCREW-MACH 6-32 × 3/16-IN-LG FLAT HD 100-DEG POZI
H3	2360-0115	4	SCREW-MACH 6-32 × 5/16-IN-LG PAN-HD POZI/LOCK
H4	2510-0192	6	SCREW-MACH 8-32 × .250-IN-LG FLAT-HD 100-DEG POZI
H5	3050-0066	8	WASHER-FLAT NO. 6 METALIC .375-IN-OD
H6	2680-0128	7	SCREW-MACH 10-32 × .250-IN-LOG PAN-HD POZI/LOCK
H8	2360-0121	2	SCREW-MACH 6-32 × .50-IN-LG PAN-HD POZI/LOCK
H9	2420-0001	5	NUT-HEX 6-32 × 5/16-IN WITH LOCK
H28	1530-1098	4	CLEVIS-MOUNTING CIRCUIT BOARD
H31	1400-0531	3	CLAMP-CABLE PRESS-ON SELF ADHESIVE

Figure 6-9. Bottom View Parts

Table 6-4. Option 020 DVM Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A8U6	1826-0624	7	1	IC CONV V/FREQ 14-DIP-P PKG	8E175	VFC32KP
A8U7	1826-0610	1	1	IC MULTIPLXR 4-CHAN-ANLG DUAL 16-DIP-C	06665	MUX24FQ
A8U8	1826-0635	0		IC OP AMP LOW-OFS 8-DIP-P PKG	06665	OP-07CP
A8U9	1990-0543	6	4	OPTO-ISOLATOR LED-PXSTR IF=150MA-MAX	01295	TIL116
A8U10	1990-0543	6		OPTO-ISOLATOR LED-PXSTR IF=150MA-MAX	01295	TIL116
A8U11	1826-0627	0	1	IC OP AMP PRCN TO-99 PKG	24355	AD542L
A8U12	1990-0543	6		OPTO-ISOLATOR LED-PXSTR IF=150MA-MAX	01295	TIL116
A8U13	1990-0543	6		OPTO-ISOLATOR LED-PXSTR IF=150MA-MAX	01295	TIL116
				A8 MISCELLANEOUS PARTS		
	0340-0060	4	2	TERMINAL-STUD SPCL-FDTHRU PRESS-MTG	98291	011-6809 000 209
	0360-0124	3	2	CONNECTOR-SGL CONT PIN .04-IN-BSC-SZ RND	28480	0360-0124
	0380-0310	1	2	STANDOFF-RVT-ON .75-IN-LG 6-32THD	28480	0380-0310
	0380-0311	2	1	STANDOFF-RVT-ON .5-IN-LG 6-32THD	28480	0380-0311
	05335-00011	3	1	SHIELD-DVM	28480	05335-00011
				OPT. 020 REQUIRES THE FOLLOWING PARTS THAT ARE NOT PART OF CKT BD. A8.		
A8W1	05335-60111	9	1	CABLE ASSEMBLY-DVM POS/BP	28480	05335-60111
A8W2	05335-60110	0	1	CABLE ASSEMBLY-DVM NEG/BP	28480	05335-60110
A8H1	2950-0144	0	2	NUT-HEX 3/8-32 × 13MM PLASTIC	28480	2950-0144
A8MP35	05335-00007	7	1	PANEL-FRONT DVM	28480	05335-00007

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

Table 6-5. Option 030 "C" Channel Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A9	05335-60009	5	1	BOARD ASSEMBLY-CHANNEL C (SERIES 2121)	28480	05335-60009
A9C1	0160-0576	5	17	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A9C2	0180-2617	1	5	CAPACITOR-FXD 6.8UF+-10% 35VDC TA	25088	D6R8GS1B35K
A9C3	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A9C4	0180-2617	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	25088	D6R8GS1B35K
A9C5	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A9C6	0160-3878	6	3	CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A9C7	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A9C8	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A9C9	05335-80004	2	1	COIL-CAPACITOR ASSEMBLY	28480	05335-80004
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	0180-2617	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	25088	D6R8GS1B35K
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	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
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	0160-3874	2	1	CAPACITOR-FXD 10PF +-.5PF 200VDC CER	28480	0160-3874
A9C20	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A9C21	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A9C22	0180-2617	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	25088	D6R8GS1B35K
A9C23	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A9C24	0180-2617	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	25088	D6R8GS1B35K
A9C25	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A9C26	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A9C27	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A9C28	0160-3879	7	1	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A9CR1	1901-0639	4	4	DIODE-PIN	28480	5082-3080
A9CR2	1901-0639	4		DIODE-PIN	28480	5082-3080
A9CR3	1901-0639	4		DIODE-PIN	28480	5082-3080
A9CR4	1901-0639	4		DIODE-PIN	28480	5082-3080
A9CR5	05335-80005	3	1	DIODE-MATCHED SET OF 2(CR5 & CR14)	28480	05335-80005
A9CR6	1901-0050	3	2	DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A9CR7	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A9CR8	1901-1068	5	4	DIODE-SM SIG SCHOTTKY	28480	1901-1068
A9CR9	1901-1068	5		DIODE-SM SIG SCHOTTKY	28480	1901-1068
A9CR10	1902-0551	1	2	DIODE-ZNR 6.2V 5% PD=1W IR=10UA	28480	1902-0551
A9CR11	1901-1068	5		DIODE-SM SIG SCHOTTKY	28480	1901-1068
A9CR12	1901-1068	5		DIODE-SM SIG SCHOTTKY	28480	1901-1068
A9CR13	1902-0551	1		DIODE-ZNR 6.2V 5% PD=1W IR=10UA	28480	1902-0551
A9CR14	05335-80005	3		DIODE-MATCHED SET OF 2(CR5 & CR14)	28480	05335-80005
A9J1	1251-4275	3	1	CONNECTOR 3-PIN M POST TYPE	28480	1251-4275
A9J3	1250-0835	1	1	CONNECTOR-RF SMC M PC 50-OHM	28480	1250-0835
A9L1	9100-2272	5	1	INDUCTOR RF-CH-MLD 47UH 10% .105DX.26LG	28480	9100-2272
A9L2	9100-2256	5	2	INDUCTOR RF-CH-MLD 560NH 10% .105DX.26LG	28480	9100-2256
A9L3	9100-2255	4	1	INDUCTOR RF-CH-MLD 470NH 10% .105DX.26LG	28480	9100-2255
A9L4	9100-2256	5		INDUCTOR RF-CH-MLD 560NH 10% .105DX.26LG	28480	9100-2256
A9L5	9100-1788	6	1	CHOKE-WIDE BAND ZMAX=680 OHM@ 180 MHZ	02114	VK200 20/4B
A9Q1	1854-0345	8	1	TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW	04713	2N5179
A9R1	0698-7211	8	3	RESISTOR 90.9 1% .05W F TC=0+-100	24546	C3-1/8-TO-90R9-F
A9R2	0698-7211	8		RESISTOR 90.9 1% .05W F TC=0+-100	24546	C3-1/8-TO-90R9-F
A9R3	0698-7228	7	2	RESISTOR 464 1% .05W F TC=0+-100	24546	C3-1/8-TO-464R-F
A9R4	0698-7222	1	3	RESISTOR 261 1% .05W F TC=0+-100	24546	C3-1/8-TO-261R-F
A9R5	0698-7228	7		RESISTOR 464 1% .05W F TC=0+-100	24546	C3-1/8-TO-464R-F
A9R6	0698-7236	7	4	RESISTOR 1K 1% .05W F TC=0+-100	24546	C3-1/8-TO-1001-F
A9R7	0698-7198	0	3	RESISTOR 26.1 1% .05W F TC=0+-100	24546	C3-1/8-TO-26R1-F
A9R8	0698-7216	3	1	RESISTOR 147 1% .05W F TC=0+-100	24546	C3-1/8-TO-147R-F
A9R9	0698-7211	8		RESISTOR 90.9 1% .05W F TC=0+-100	24546	C3-1/8-TO-90R9-F
A9R10	0698-7198	0		RESISTOR 26.1 1% .05W F TC=0+-100	24546	C3-1/8-TO-26R1-F
A9R11	0698-7259	4	2	RESISTOR 9.09K 1% .05W F TC=0+-100	24546	C3-1/8-TO-9091-F
A9R12	0698-7205	0	1	RESISTOR 51.1 1% .05W F TC=0+-100	24546	C3-1/8-TO-51R1-F
A9R13	0698-7259	4		RESISTOR 9.09K 1% .05W F TC=0+-100	24546	C3-1/8-TO-9091-F
A9R14	0698-7241	4	1	RESISTOR 1.62K 1% .05W F TC=0+-100	24546	C3-1/8-TO-1621-F
A9R15	0698-7242	5	1	RESISTOR 1.78K 1% .05W F TC=0+-100	24546	C3-1/8-TO-1781-F
A9R16	0757-0178	8	1	RESISTOR 100 1% .25W F TC=0+-100	24546	C5-1/4-TO-101-F
A9R17	0698-7252	7	1	RESISTOR 4.64K 1% .05W F TC=0+-100	24546	C3-1/8-TO-4641-F
A9R18	0698-7188	8	2	RESISTOR 10 1% .05W F TC=0+-100	24546	C3-1/8-TO-10R-F
A9R19	0698-7188	8		RESISTOR 10 1% .05W F TC=0+-100	24546	C3-1/8-TO-10R-F
A9R20	0698-7222	1		RESISTOR 261 1% .05W F TC=0+-100	24546	C3-1/8-TO-261R-F

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

Table 6-5. Option 030 "C" Channel Replaceable Parts (Continued)

Reference Designation	HP Part Number	CD	Qty	Description	Mfr Code	Mfr Part Number
A9R21	0698-7222	1		RESISTOR 261 1% .05W F TC=0+-100	24546	C3-1/8-T0-261R-F
A9R22	2100-1788	9	1	RESISTOR-TRMR 500 10% C TOP-ADJ 1-TRN	73138	82PR500
A9R23	2100-1985	8	2	RESISTOR-TRMR 20 20% C TOP-ADJ 1-TRN	32997	3329H-1-200
A9R24	2100-1985	8		RESISTOR-TRMR 20 20% C TOP-ADJ 1-TRN	32997	3329H-1-200
A9R25	0698-7236	7		RESISTOR 1K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1001-F
A9R26	0698-7236	7		RESISTOR 1K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1001-F
A9R27	0698-7198	0		RESISTOR 26.1 1% .05W F TC=0+-100	24546	C3-1/8-T0-26R1-F
A9R28	0698-7288	9	1	RESISTOR 147K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1473-F
A9R29	0698-7236	7		RESISTOR 1K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1001-F
A9U1	5088-7036	7	1	1.6 GHZ AMPLIFIER ASSEMBLY	28480	5088-7036
A9U2	1820-2382	6	1	IC DIVR ECL DECD	28480	1DC2A
A9U3	1820-1225	4	1	IC FF ECL D-M/S DUAL	04713	MC10231P
A9U4	1826-0412	1	1	IC COMPARATOR PRCN DUAL 8-DIP-P PKG	27014	LM393N
A9U5	1820-1112	8	1	IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
				A9 MISCELLANEOUS PARTS		
	0360-0451	9	6	TERMINAL-STUD SGL-PIN SWGFRM-MTG	28480	0360-0451
	0520-0128	7	4	SCREW-MACH 2-56 .25-IN-LG PAN-HD-POZI	28480	0520-0128
	0610-0003	8	4	NUT-HEX-DBL-CHAM 2-56-THD .062-IN-THK	28480	0610-0003
	2190-0014	1	4	WASHER-LK INTL T NO. 2 .089-IN-ID	28480	2190-0014
	05305-00010	6	3	CLAMP-HEAT SINK (FOR U1)	28480	05305-00010
	05335-00012	4	3	CLAMP-HEAT SINK (FOR U2)	28480	05335-00012
	1251-1556	7	16	CONNECTOR-SGL CONT SKT .018-IN-BSC-SZ	28480	1251-1556
				OPT. 030 REQUIRES THE FOLLOWING PARTS WHICH ARE NOT PART OF CIRCUIT BD A9.		
A9H35	0370-1005	2	1	KNOB-BASE-PTR 3/8JGK.125" ID	28480	0370-1005
A9W1	05335-60105	2	1	CABLE ASSEMBLY-50-OHM INPUT	28480	05335-60105
A9W2	05335-60106	3	1	CABLE ASSEMBLY-SENSITIVITY/A9W2R1	28480	05335-60106
A9W2R1	2100-2635	7	1	RESISTOR-VAR CONTROL CCP 50K 20% LIN	28480	2100-2635
	2950-0060	9	2	WASHER-LOCK INT-T 1/4-IN	28480	2950-0060
A9W3	05335-60109	6	1	CABLE ASSEMBLY-EXT PREAMPL POWER	28480	05335-60109
A9W3J2	5060-0467	6	1	CONNECTOR-MALE PROBE-PWR	28480	5060-0467
A9W2H32	2950-0072	3	2	NUT-HEX-DBL-CHAM 1/4-32-THD .062-IN-THK	00000	ORDER BY DESCRIPTION
	0590-0038	5	1	NUT-HEX-DBL-CHAM 1/2-32 X 9/16	00000	ORDER BY DESCRIPTION
	2110-0301	1	1	FUSE-125MA 125V	28480	2110-0301
	2190-0068	5	1	WASHER-LK INTL-T 1/2"DIA	28480	2190-0068
	2190-0124	4	1	WASHER-LK INTL T NO. 16 .195-IN-ID	28480	2190-0124
	05305-20104	1	1	HOLDER-FUSE SHELL	28480	05305-20104
	05305-20105	2	1	INSULATOR-FUSE	28480	05305-20105
	05305-60205	7	1	CONNECTOR ASSEMBLY-BNC (REMOVABLE)	28480	05305-60205
	05305-60206	8	1	CONNECTOR ASSEMBLY-SMC	28480	05305-60206
	05335-00002	2		PANEL-FRONT (OPTION)	28480	05335-00002
	05335-00008	8	1	PANEL-FREQ "C"	28480	05335-00008

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

Table 6-6. Option 040 Programmable Input Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A10	05335-60010	8	1	BOARD ASSY-SWITCH PANEL (SERIES 2202)	28480	05335-60010
A10DS1	1990-0851	9	12	LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0851
A10DS2	1990-0851	9		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0851
A10DS3	1990-0851	9		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0851
A10DS4	1990-0851	9		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0851
A10DS5	1990-0851	9		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0851
A10DS6	1990-0851	9		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0851
A10DS7	1990-0851	9		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0851
A10DS8	1990-0851	9		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0851
A10DS9	1990-0851	9		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0851
A10DS10	1990-0851	9		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0851
A10DS11	1990-0851	9		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0851
A10DS12	1990-0851	9		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0851
A10J1	1251-6203	1	1	CONNECTOR,16-PIN FEMALE	28480	1251-6203
A10S1	5060-9436	7	12	PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A10S2	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A10S3	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A10S4	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A10S5	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A10S6	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A10S7	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A10S8	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A10S9	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A10S10	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A10S11	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A10S12	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
				A10 MISCELLANEOUS PARTS		
	5041-0318	6	2	SWITCH CAP/LITE PIPE DARK GREY	28480	5041-0318
	5041-0252	7	10	SWITCH CAP/LITE PIPE LIGHT GREY	28480	5041-0252

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

Table 6-6. Option 040 Programmable Input Replaceable Parts (Con't)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A11	05335-60011	9	1	BOARD ASSEMBLY-AMPLIFIER (SERIES 2224)	28480	05335-60011
A11C1	0160-4557	0	8	CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A11C2	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A11C3	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A11C4	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A11C5	0160-4554	7	15	CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A11C6	0160-0127	2	2	CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
A11C7	0160-0127	2		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
A11C8	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A11C9	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A11C10	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A11C11	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A11C12	0160-3879	7	8	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A11C13	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A11C14	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A11C15	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A11C16	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A11C17	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A11C18	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A11C19	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A11C20	0160-4040	6	1	CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A11C21	0160-4481	9	1	CAPACITOR-FXD 270PF +-5% 100VDC CER	51642	150-100-NP0-271J
A11C22	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A11C23	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A11C24	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A11C25	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A11C26	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A11C27	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A11C28	0160-3874	2	2	CAPACITOR-FXD 10PF +-.5PF 200VDC CER	28480	0160-3874
A11C29	0160-3874	2		CAPACITOR-FXD 10PF +-.5PF 200VDC CER	28480	0160-3874
A11C30	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A11C31	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A11C32	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A11C33	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A11C34	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A11C35	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A11C36	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A11C37	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A11CR1	1901-0376	6	2	DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A11CR2	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A11CR3	1901-0050	3	3	DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A11CR4	1902-3097	6	1	DIODE-ZNR 5.23V 2% DO-35 PD=.4W	28480	1902-3097
A11CR5	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A11CR6	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A11J1	1200-0614	9	2	SOCKET-RLY 18-CONT DIP-SLDR	28480	1200-0614
A11J2	1200-0614	9		SOCKET-RLY 18-CONT DIP-SLDR	28480	1200-0614
A11J3	1251-0472	4	2	CONNECTOR-PC EDGE 6-CONT/ROW 2-ROWS	28480	1251-0472
A11J4	1250-0835	1	2	CONNECTOR-RF SMC M PC 50-OHM	28480	1250-0835
A11J5	1250-0835	1		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-0835
A11J6	1251-0472	4		CONNECTOR-PC EDGE 6-CONT/ROW 2-ROWS	28480	1251-0472
A11L1	9100-1788	6	4	CHOKE-WIDE BAND ZMAX=680 OHM@ 180 MHZ	02114	VK200 20/48
A11L2	9100-1788	6		CHOKE-WIDE BAND ZMAX=680 OHM@ 180 MHZ	02114	VK200 20/48
A11L3	9100-1788	6		CHOKE-WIDE BAND ZMAX=680 OHM@ 180 MHZ	02114	VK200 20/48
A11L4	9100-1788	6		CHOKE-WIDE BAND ZMAX=680 OHM@ 180 MHZ	02114	VK200 20/48
A11Q1	1854-0246	8	9	TRANSISTOR NPN SI PD=350MW FT=250MHZ	04713	SPS 233
A11Q2	1854-0246	8		TRANSISTOR NPN SI PD=350MW FT=250MHZ	04713	SPS 233
A11Q3	1854-0246	8		TRANSISTOR NPN SI PD=350MW FT=250MHZ	04713	SPS 233
A11Q4	1854-0246	8		TRANSISTOR NPN SI PD=350MW FT=250MHZ	04713	SPS 233
A11Q5	1854-0246	8		TRANSISTOR NPN SI PD=350MW FT=250MHZ	04713	SPS 233
A11Q6	1854-0246	8		TRANSISTOR NPN SI PD=350MW FT=250MHZ	04713	SPS 233
A11Q7	1854-0246	8		TRANSISTOR NPN SI PD=350MW FT=250MHZ	04713	SPS 233
A11Q8	1854-0246	8		TRANSISTOR NPN SI PD=350MW FT=250MHZ	04713	SPS 233
A11Q9	1854-0246	8		TRANSISTOR NPN SI PD=350MW FT=250MHZ	04713	SPS 233
A11Q10	1853-0036	2	9	TRANSISTOR PNP SI PD=310MW FT=250MHZ	28480	1853-0036
A11Q11	1853-0036	2		TRANSISTOR PNP SI PD=310MW FT=250MHZ	28480	1853-0036
A11Q12	1853-0036	2		TRANSISTOR PNP SI PD=310MW FT=250MHZ	28480	1853-0036
A11Q13	1853-0036	2		TRANSISTOR PNP SI PD=310MW FT=250MHZ	28480	1853-0036
A11Q14	1853-0036	2		TRANSISTOR PNP SI PD=310MW FT=250MHZ	28480	1853-0036
A11Q15	1853-0036	2		TRANSISTOR PNP SI PD=310MW FT=250MHZ	28480	1853-0036

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

Table 6-6. Option 040 Programmable Input Replaceable Parts (Con't)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A11Q16	1853-0036	2		TRANSISTOR PNP SI PD=310MW FT=250MHZ	28480	1853-0036
A11Q17	1853-0036	2		TRANSISTOR PNP SI PD=310MW FT=250MHZ	28480	1853-0036
A11Q18	1853-0036	2		TRANSISTOR PNP SI PD=310MW FT=250MHZ	28480	1853-0036
A11R1	0757-0280	3	6	RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A11R2	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A11R3	0757-0443	0	4	RESISTOR 11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1102-F
A11R4	0698-6943	1	4	RESISTOR 20K .1% .125W F TC=0+-50	28480	0698-6943
A11R5	0757-0447	4	4	RESISTOR 16.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1622-F
A11R6	0757-0443	0		RESISTOR 11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1102-F
A11R7	0757-0443	0		RESISTOR 11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1102-F
A11R8	0698-6943	1		RESISTOR 20K .1% .125W F TC=0+-50	28480	0698-6943
A11R9	0698-6943	1		RESISTOR 20K .1% .125W F TC=0+-50	28480	0698-6943
A11R10	0698-4008	5	8	RESISTOR 40K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4002-F
A11R11	0757-0447	4		RESISTOR 16.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1622-F
A11R12	0698-4008	5		RESISTOR 40K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4002-F
A11R13	0757-0442	9	6	RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A11R14	0698-6369	5	2	RESISTOR 1M .1% .25W F TC=0+-25	28480	0698-6369
A11R15	0757-0447	4		RESISTOR 16.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1622-F
A11R16	0698-4008	5		RESISTOR 40K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4002-F
A11R17	0698-6369	5		RESISTOR 1M .1% .25W F TC=0+-25	28480	0698-6369
A11R18	0698-4008	5		RESISTOR 40K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4002-F
A11R19	0698-3437	2	1	RESISTOR 133 1% .125W F TC=0+-100	24546	C4-1/8-T0-133R-F
A11R20	0698-6943	1		RESISTOR 20K .1% .125W F TC=0+-50	28480	0698-6943
A11R21	0757-0416	7	1	RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A11R22	0698-4008	5		RESISTOR 40K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4002-F
A11R23	0698-4008	5		RESISTOR 40K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4002-F
A11R24	0757-0447	4		RESISTOR 16.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1622-F
A11R25	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A11R26	0757-0399	5	1	RESISTOR 82.5 1% .125W F TC=0+-100	24546	C4-1/8-T0-82R5-F
A11R27	0698-8094	7	1	RESISTOR 1.82M 1% .5W F TC=0+-100	28480	0698-8094
A11R28	0698-7203	8	2	RESISTOR 42.2 1% .05W F TC=0+-100	24546	C3-1/8-T0-42R2-F
A11R29	0698-7212	9	2	RESISTOR 100 1% .05W F TC=0+-100	24546	C3-1/8-T0-100R-F
A11R30	0698-7222	1	4	RESISTOR 261 1% .05W F TC=0+-100	24546	C3-1/8-T0-261R-F
A11R31	0698-7226	5	2	RESISTOR 383 1% .05W F TC=0+-100	24546	C3-1/8-T0-383R-F
A11R32	0757-0465	6	2	RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A11R33	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A11R34	0757-0443	0		RESISTOR 11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1102-F
A11R35	0698-4008	5		RESISTOR 40K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4002-F
A11R36	0698-7222	1		RESISTOR 261 1% .05W F TC=0+-100	24546	C3-1/8-T0-261R-F
A11R37	0698-7215	2	2	RESISTOR 133 1% .05W F TC=0+-100	24546	C3-1/8-T0-133R-F
A11R38	0698-7210	7	2	RESISTOR 82.5 1% .05W F TC=0+-100	24546	C3-1/8-T0-82R5-F
A11R39	1810-0364	9	1	NETWORK-RES 6-SIP470.0 OHM X 5	01121	206A471
A11R40	0698-7203	8		RESISTOR 42.2 1% .05W F TC=0+-100	24546	C3-1/8-T0-42R2-F
A11R41	0698-7212	9		RESISTOR 100 1% .05W F TC=0+-100	24546	C3-1/8-T0-100R-F
A11R42	0698-7222	1		RESISTOR 261 1% .05W F TC=0+-100	24546	C3-1/8-T0-261R-F
A11R43	0698-7226	5		RESISTOR 383 1% .05W F TC=0+-100	24546	C3-1/8-T0-383R-F
A11R44	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A11R45	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A11R46	0698-4008	5		RESISTOR 40K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4002-F
A11R47	0698-7210	7		RESISTOR 82.5 1% .05W F TC=0+-100	24546	C3-1/8-T0-82R5-F
A11R48	2100-3383	4	4	RESISTOR-TRMR 50 10% C TOP-ADJ 1-TRN	28480	2100-3383
A11R49	0757-0398	4	2	RESISTOR 75 1% .125W F TC=0+-100	24546	C4-1/8-T0-75R0-F
A11R50	0757-1108	6	2	RESISTOR 300 1% .125W F TC=0+-100	24546	C4-1/8-T0-301-F
A11R51	0757-1108	6		RESISTOR 300 1% .125W F TC=0+-100	24546	C4-1/8-T0-301-F
A11R52	0757-0398	4		RESISTOR 75 1% .125W F TC=0+-100	24546	C4-1/8-T0-75R0-F
A11R53	2100-3383	4		RESISTOR-TRMR 50 10% C TOP-ADJ 1-TRN	28480	2100-3383
A11R54	0698-7215	2		RESISTOR 133 1% .05W F TC=0+-100	24546	C3-1/8-T0-133R-F
A11R55	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A11R56	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A11R57	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A11R58	0698-6612	1	1	RESISTOR 2K .1% .125W F TC=0+-50	28480	0698-6612
A11R59	0698-3491	8	1	RESISTOR 1K .1% .125W F TC=0+-50	28480	0698-3491
A11R60	1810-0382	1	1	NETWORK-RES 10-SIP100.0 OHM X 9	01121	210A101
A11R61	0698-7222	1		RESISTOR 261 1% .05W F TC=0+-100	24546	C3-1/8-T0-261R-F
A11R62	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A11R63	1810-0280	8	1	NETWORK-RES 10-SIP10.0K OHM X 9	01121	210A103
A11R64	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A11R65	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A11R66	0757-0317	7	1	RESISTOR 1.33K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1331-F
A11R67	1810-0277	3	1	NETWORK-RES 10-SIP2.2K OHM X 9	01121	210A222
A11R68	1810-0275	1	1	NETWORK-RES 10-SIP1.0K OHM X 9	01121	210A102
A11R69	2100-0568	1	2	RESISTOR-TRMR 100 10% C TOP-ADJ 1-TRN	28480	2100-0568
A11R70	2100-3383	4		RESISTOR-TRMR 50 10% C TOP-ADJ 1-TRN	28480	2100-3383
A11R71	0757-0403	2	2	RESISTOR 121 1% .125W F TC=0+-100	24546	C4-1/8-T0-121R-F
A11R72	0757-0428	1	2	RESISTOR 1.62K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1621-F
A11R73	0757-0403	2		RESISTOR 121 1% .125W F TC=0+-100	24546	C4-1/8-T0-121R-F
A11R74	2100-3383	4		RESISTOR-TRMR 50 10% C TOP-ADJ 1-TRN	28480	2100-3383
A11R75	2100-0568	1		RESISTOR-TRMR 100 10% C TOP-ADJ 1-TRN	28480	2100-0568

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

Table 6-6. Option 040 Programmable Input Replaceable Parts (Con't)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A11R76	0757-0428	1		RESISTOR 1.62K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1621-F
A11U1	1826-0315	3	3	IC OP AMP GP QUAD 14-DIP-P PKG	27014	LM348N
A11U2	1826-0609	8	3	IC MULTIPLXR ANLG 16-DIP-C PKG	06665	MUX08FQ
A11U3	1826-0315	3		IC OP AMP GP QUAD 14-DIP-P PKG	27014	LM348N
A11U4	1826-0609	8		IC MULTIPLXR ANLG 16-DIP-C PKG	06665	MUX08FQ
A11U5	1826-0610	1	1	IC MULTIPLXR 4-CHAN-ANLG DUAL 16-DIP-C	06665	MUX24FQ
A11U6	1858-0040	8	1	TRANSISTOR ARRAY 16-PIN PLSTC DIP	3L585	CA3127E
A11U7	1820-1359	5	1	IC MUXR/DATA-SEL ECL 4-TO-1-LINE DUAL	04713	MC10174P
A11U8	1820-1173	1	1	IC XLTR ECL TTL-TO-ECL QUAD 2-INP	04713	MC10124L
A11U9	1826-0315	3		IC OP AMP GP QUAD 14-DIP-P PKG	27014	LM348N
A11U10	1826-0575	7	1	IC CONV V/FREQ 14-DIP-P PKG	15818	9400CJ
A11U11	1826-0609	8		IC MULTIPLXR ANLG 16-DIP-C PKG	06665	MUX08FQ
A11U12	1820-0794	0	1	IC FF ECL D-M/S	04713	MC1670L
A11U13	1820-1917	1	1	IC BFR TTL LS LINE DRVR OCTL	01295	SN74LS240N
A11U14	1820-1196	8	2	IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS174N
A11U15	1820-1196	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS174N
A11U16	1820-1858	9	3	IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A11U17	1820-1858	9		IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A11U18	1820-1858	9		IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A11U19	1820-1240	3	2	IC DCDR TTL S 3-TO-8-LINE 3-INP	01295	SN74S138N
A11U20	1820-1240	3		IC DCDR TTL S 3-TO-8-LINE 3-INP	01295	SN74S138N
A11U21	1820-1984	2	2	IC CONV 10-B-D/A 16-DIP-C PKG	24355	AD561KD
A11U22	1826-0135	5	1	IC OP AMP GP DUAL 14-DIP-C PKG	07263	UA747DM
A11U23	1820-1984	2		IC CONV 10-B-D/A 16-DIP-C PKG	24355	AD561KD
A11U24	1820-1445	0	1	IC LCH TTL LS 4-BIT	01295	SN74LS375N
A11U25	1820-1197	9	1	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A11XU7	1200-0482	9	4	SOCKET-IC 16-CONT DIP-SLDR	28480	1200-0482
A11XU21	1200-0482	9		SOCKET-IC 16-CONT DIP-SLDR	28480	1200-0482
A11XU23	1200-0482	9		SOCKET-IC 16-CONT DIP-SLDR	28480	1200-0482
A11XU23	1200-0482	9		SOCKET-IC 16-CONT DIP-SLDR	28480	1200-0482
	0360-1682	0	7	TERMINAL-STUD SGL-TUR PRESS-MTG (TP1,2,COM,ATL,BTL,GAS,GAB)	28480	0360-1682

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

Table 6-6. Option 040 Programmable Input Replaceable Parts (Con't)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A12	05335-60012	0	1	BOARD ASSEMBLY-AMPLIFIER (SERIES 2232)	28480	05335-60012
A12C2	0160-3877	5	4	CAPACITOR-FXD 100PF +-20% 200VDC CER	28480	0160-3877
A12C3	0180-2814	0	4	CAPACITOR-FXD 22UF+-20% 10VDC TA	28480	0180-2814
A12C4	0160-4233	9	4	CAPACITOR-FXD .47UF +-5% 50VDC MET-POLYC	28480	0160-4233
A12C5	0180-2814	0		CAPACITOR-FXD 22UF+-20% 10VDC TA	28480	0180-2814
A12C6	0180-2821	9	4	CAPACITOR-FXD 22UF+-20% 35VDC TA	28480	0180-2821
A12C7	0180-2821	9		CAPACITOR-FXD 22UF+-20% 35VDC TA	28480	0180-2821
A12C8	0160-4325	0	4	CAPACITOR-FXD .33UF +-5% 50VDC MET-POLYC	28480	0160-4325
A12C9	0160-3879	7	26	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C10	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C11	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C12	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C13	0160-4233	9		CAPACITOR-FXD .47UF +-5% 50VDC MET-POLYC	28480	0160-4233
A12C14	0160-4325	0		CAPACITOR-FXD .33UF +-5% 50VDC MET-POLYC	28480	0160-4325
A12C15	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C16	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C17	0160-3877	5		CAPACITOR-FXD 100PF +-20% 200VDC CER	28480	0160-3877
A12C18	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C19	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C20	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C21	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C22	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C24	0160-4424	0	2	CAPACITOR-FXD .047UF +-20% 500VDC CER	51642	400-500-X7R-473M
A12C25	0160-4703	8	2	CAPACITOR-FXD 68PF +-5% 500VDC CER 0+-30	28480	0160-4703*
A12C26	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C27	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C28	0160-5245	5	2	CAPACITOR-FXD 3.3PF +-5% 500VDC CER	28480	0160-5245
A12C29	0160-4040	6	2	CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A12C30	0121-0473	9	2	CAPACITOR-V TRMR-CER 5-25PF 100V PC-MTG	28480	0121-0473
A12C31	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C32	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C33	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A12C35	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C36	0160-4703	8		CAPACITOR-FXD 68PF +-5% 500VDC CER 0+-30	28480	0160-4703
A12C37	0160-4424	0		CAPACITOR-FXD .047UF +-20% 500VDC CER	51642	400-500-X7R-473M
A12C38	0180-2814	0		CAPACITOR-FXD 22UF+-20% 10VDC TA	28480	0180-2814
A12C39	0160-5245	5		CAPACITOR-FXD 3.3PF +-5% 500VDC CER	28480	0160-5245
A12C40	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C41	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C42	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C43	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C44	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C45	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C46	0121-0473	9		CAPACITOR-V TRMR-CER 5-25PF 100V PC-MTG	28480	0121-0473
A12C47	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C48	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C49	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C50	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C51	0180-2821	9		CAPACITOR-FXD 22UF+-20% 35VDC TA	28480	0180-2821
A12C52	0160-3877	5		CAPACITOR-FXD 100PF +-20% 200VDC CER	28480	0160-3877
A12C53	0160-3877	5		CAPACITOR-FXD 100PF +-20% 200VDC CER	28480	0160-3877
A12C54	0180-2814	0		CAPACITOR-FXD 22UF+-20% 10VDC TA	28480	0180-2814
A12C55	0160-4325	0		CAPACITOR-FXD .33UF +-5% 50VDC MET-POLYC	28480	0160-4325
A12C56	0160-4325	0		CAPACITOR-FXD .33UF +-5% 50VDC MET-POLYC	28480	0160-4325
A12C57	0160-4233	9		CAPACITOR-FXD .47UF +-5% 50VDC MET-POLYC	28480	0160-4233
A12C58	0180-2821	9		CAPACITOR-FXD 22UF+-20% 35VDC TA	28480	0180-2821
A12C59	0160-4233	9		CAPACITOR-FXD .47UF +-5% 50VDC MET-POLYC	28480	0160-4233
A12C60	0160-5244	4	2	CAPACITOR-FXD 12PF +-5% 500VDC CER 0+-30	28480	0160-5244
A12C61	0160-5244	4		CAPACITOR-FXD 12PF +-5% 500VDC CER 0+-30	28480	0160-5244
A12CR1	1901-1080	1	2	DIODE-SCHOTTKY 1N5817 20V 1A	28480	1901-1080
A12CR2,CR6,CR7	05335-80003	1	6	DIODE MATCHED SET OF FOUR	28480	05335-80003
A12CR3,CR8,CR9	05335-80003	1		DIODE MATCHED SET OF FOUR	28480	05335-80003
A12CR4,5,10,&11	05335-80003	1		DIODE MATCHED SET OF FOUR	28480	05335-80003
				MATCHED DIODES AVAILABLE ONLY IN SETS OF FOUR		

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

Table 6-6. Option 040 Programmable Input Replaceable Parts (Con't)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A12CR11+	05335-80003	1		DIODE-MATCHED SET	28480	05335-80003
A12CR12	1902-0057	2	2	DIODE-ZNR 6.49V 5% DO-35 PD=.4W	28480	1902-0057
A12CR13	1902-0041	4	2	DIODE-ZNR 5.11V 5% DO-35 PD=.4W	28480	1902-0041
A12CR14	1901-0050	3	9	DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A12CR15	1902-3136	4	2	DIODE-ZNR 8.06V 5% DO-35 PD=.4W	28480	1902-3136
A12CR16	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A12CR17	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A12CR18	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A12CR19	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A12CR20	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A12CR21	1902-3136	4		DIODE-ZNR 8.06V 5% DO-35 PD=.4W	28480	1902-3136
A12CR22	1901-1080	1		DIODE-SCHOTTKY 1N5817 20V 1A	28480	1901-1080
A12CR23	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A12CR24	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A12CR25,26,29,&30	05335-80003	1		DIODE-MATCHED SET OF FOUR	28480	05335-80003
A12CR27	1902-0041	4		DIODE-ZNR 5.11V 5% DO-35 PD=.4W	28480	1902-0041
A12CR28	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A12CR31,CR32,CR36	05335-80003	1		DIODE-MATCHED SET OF FOUR	28480	05335-80003
A12CR33,CR34,CR37	05335-80003	1		DIODE-MATCHED SET OF FOUR	28480	05335-80003
A12CR35	1902-0057	2		DIODE-ZNR 6.49V 5% DO-35 PD=.4W	28480	1902-0057
A12CR36+	05335-80003	1		DIODE-MATCHED SET	28480	05335-80003
A12CR37+	05335-80003	1		DIODE-MATCHED SET	28480	05335-80003
A12DS1	1990-0487	7	2	LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	5082-4584
A12DS2	1990-0487	7		LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	5082-4584
A12H10	2950-0035	8	1	NUT-HEX-DBL-CHAM 15/32-32-THD	00000	ORDER BY DESCRIPTION
A12J2	1200-0614	9	2	SOCKET-RLY 18-CONT DIP-SLDR	28480	1200-0614
A12J3	1250-1671	5	2	CONNECTOR-RF BNC FEM SGL-HOLE-RR 50-OHM	28480	1250-1671
A12J4	1250-0835	1	2	CONNECTOR-RF SMC M PC 50-OHM	28480	1250-0835
A12J6	1250-1671	5		CONNECTOR-RF BNC FEM SGL-HOLE-RR 50-OHM	28480	1250-1671
A12J7	1200-0614	9		SOCKET-RLY 18-CONT DIP-SLDR	28480	1200-0614
A12J8	1250-0835	1		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-0835
A12K1	0490-0508	2	9	RELAY 2C 12VDC-COIL .5A 28VDC	28480	0490-0508
A12K2	0490-0508	2		RELAY 2C 12VDC-COIL .5A 28VDC	28480	0490-0508
A12K3	0490-0508	2		RELAY 2C 12VDC-COIL .5A 28VDC	28480	0490-0508
A12K4	0490-0508	2		RELAY 2C 12VDC-COIL .5A 28VDC	28480	0490-0508
A12K5	0490-0508	2		RELAY 2C 12VDC-COIL .5A 28VDC	28480	0490-0508
A12K6	0490-0508	2		RELAY 2C 12VDC-COIL .5A 28VDC	28480	0490-0508
A12K7	0490-0508	2		RELAY 2C 12VDC-COIL .5A 28VDC	28480	0490-0508
A12K8	0490-0508	2		RELAY 2C 12VDC-COIL .5A 28VDC	28480	0490-0508
A12K9	0490-0508	2		RELAY 2C 12VDC-COIL .5A 28VDC	28480	0490-0508
A12L1	05335-80001	9	2	INDUCTOR	28480	05335-80001
A12L2	05335-80001	9		INDUCTOR	28480	05335-80001
A12Q2	1854-0636	0	4	TRANSISTOR NPN SI TO-92 PD=350MW	28480	1854-0636
A12Q3	1854-0686	0	4	TRANSISTOR NPN SI TO-72 PD=200MW FT=4GHZ	28480	1854-0686
A12Q4	1854-0686	0		TRANSISTOR NPN SI TO-72 PD=200MW FT=4GHZ	28480	1854-0686
A12Q5	1854-0636	0		TRANSISTOR NPN SI TO-92 PD=350MW	28480	1854-0636
A12Q6†	1855-0212	0	2	TRANSISTOR J-FET N-CHAN SI	28480	1855-0212
A12Q6†	1855-0300	7	2	TRANSISTOR J-FET N-CHAN D-MODE TO-106	28480	1855-0300
A12Q8†	1855-0212	0		TRANSISTOR J-FET N-CHAN SI	28480	1855-0212
A12Q8†	1855-0300	7		TRANSISTOR J-FET N-CHAN D-MODE TO-106	28480	1855-0300
A12Q9	1854-0636	0		TRANSISTOR NPN SI TO-92 PD=350MW	28480	1854-0636
A12Q10	1854-0686	0		TRANSISTOR NPN SI TO-72 PD=200MW FT=4GHZ	28480	1854-0686
A12Q11	1854-0636	0		TRANSISTOR NPN SI TO-92 PD=350MW	28480	1854-0636
A12Q12	1854-0686	0		TRANSISTOR NPN SI TO-72 PD=200MW FT=4GHZ	28480	1854-0686
A12R2	2100-3359	4	4	RESISTOR-TRMR 2M 20% C SIDE-ADJ 1-TRN	28480	2100-3359
A12R3				NOT ASSIGNED		
A12R4	0698-7267	4	8	RESISTOR 19.6K 1% .05W F TC=0+-100	24546	C3-1/8-TO-1962-F
A12R5	0698-7267	4		RESISTOR 19.6K 1% .05W F TC=0+-100	24546	C3-1/8-TO-1962-F
A12R7*	0699-0071	6	8	RESISTOR 4.64M 1% .125W F TC=0+-100	28480	0699-0071
A12R8*	0699-0071	6		RESISTOR 4.64M 1% .125W F TC=0+-100	28480	0699-0071
A12R9	0698-7227	6	4	RESISTOR 422 1% .05W F TC=0+-100	24546	C3-1/8-TO-422R-F
A12R10	0698-7212	9	2	RESISTOR 100 1% .05W F TC=0+-100	24546	C3-1/8-TO-100R-F
A12R12	0698-7209	4	2	RESISTOR 75 1% .05W F TC=0+-100	24546	C3-1/8-TO-75R0-F
A12R13	0698-7224	3	4	RESISTOR 316 1% .05W F TC=0+-100	24546	C3-1/8-TO-316R-F
A12R14	0698-7224	3		RESISTOR 316 1% .05W F TC=0+-100	24546	C3-1/8-TO-316R-F
A12R15	0698-7218	5	2	RESISTOR 178 1% .05W F TC=0+-100	24546	C3-1/8-TO-178R-F
A12R16*	0699-0071	6		RESISTOR 4.64M 1% .125W F TC=0+-100	28480	0699-0071
A12R17*	0699-0071	6		RESISTOR 4.64M 1% .125W F TC=0+-100	28480	0699-0071
A12R18	0698-7267	4		RESISTOR 19.6K 1% .05W F TC=0+-100	24546	C3-1/8-TO-1962-F

†1855-0300 and 1855-0212 TRANSISTORS ARE DIRECTLY INTERCHANGEABLE.

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

Table 6-6. Option 040 Programmable Input Replaceable Parts (Con't)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A12R19	0698-7267	4		RESISTOR 19.6K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1962-F
A12R20	0698-7249	2	4	RESISTOR 3.48K 1% .05W F TC=0+-100	24546	C3-1/8-T0-3481-F
A12R21	2100-3359	4		RESISTOR-TRMR 2M 20% C SIDE-ADJ 1-TRN	28480	2100-3359
A12R22	0698-7205	0	8	RESISTOR 51.1 1% .05W F TC=0+-100	24546	C3-1/8-T0-51R1-F
A12R23	0698-7249	2		RESISTOR 3.48K 1% .05W F TC=0+-100	24546	C3-1/8-T0-3481-F
A12R24	0698-7205	0		RESISTOR 51.1 1% .05W F TC=0+-100	24546	C3-1/8-T0-51R1-F
A12R25	0698-7198	0	9	RESISTOR 26.1 1% .05W F TC=0+-100	24546	C3-1/8-T0-26R1-F
A12R26	0698-7198	0		RESISTOR 26.1 1% .05W F TC=0+-100	24546	C3-1/8-T0-26R1-F
A12R27	0698-7205	0		RESISTOR 51.1 1% .05W F TC=0+-100	24546	C3-1/8-T0-51R1-F
A12R28	2100-3802	2	2	RESISTOR-VAR W/SW 10K 20% LIN SPST-NO	28480	2100-3802
A12R29	0698-3922	0	4	RESISTOR 487K .1% .125W F TC=0+-50	28480	0698-3922
A12R30	0698-0087	2	2	RESISTOR 316 1% .25W F TC=0+-100	24546	C5-1/4-T0-3160-F
A12R31	0698-7227	6		RESISTOR 422 1% .05W F TC=0+-100	24546	C3-1/8-T0-422R-F
A12R32	0698-7247	0	2	RESISTOR 2.87K 1% .05W F TC=0+-100	24546	C3-1/8-T0-2871-F
A12R33	0698-7238	9	4	RESISTOR 1.21K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1211-F
A12R34	0698-7284	5	2	RESISTOR 100K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1003-F
A12R35	0698-7198	0		RESISTOR 26.1 1% .05W F TC=0+-100	24546	C3-1/8-T0-26R1-F
A12R36	0699-0073	8	2	RESISTOR 10M 1% .125W F TC=0+-150	28480	0699-0073
A12R37	0698-7205	0		RESISTOR 51.1 1% .05W F TC=0+-100	24546	C3-1/8-T0-51R1-F
A12R38	0699-0676	7	2	RESISTOR-511K OHM .1% .125W F TC=0+-50	28480	0699-0676
A12R39	0698-6433	4	4	RESISTOR 100 1% .25W F TC=0+-100	28480	0698-6433
A12R40	0698-7252	7	2	RESISTOR 4.64K 1% .05W F TC=0+-100	24546	C3-1/8-T0-4641-F
A12R41	0698-6433	4		RESISTOR 100 1% .25W F TC=0+-100	28480	0698-6433
A12R42	0757-0416	7	2	RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A12R43	2100-3274	2	2	RESISTOR-TRMR 10K 10% C SIDE-ADJ 1-TRN	28480	2100-3274
A12R44	0698-6400	5	2	RESISTOR 900K 1% .25W F TC=0+-100	19701	MF52C1/4-T0-9003-F
A12R45	0698-7245	8	2	RESISTOR 2.37K 1% .05W F TC=0+-100	24546	C3-1/8-T0-2371-F
A12R46	0698-7238	9		RESISTOR 1.21K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1211-F
A12R47	0698-7236	7	2	RESISTOR 1K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1001-F
A12R48	0698-7216	3	2	RESISTOR 147 1% .05W F TC=0+-100	24546	C3-1/8-T0-147R-F
A12R49				NOT ASSIGNED		
A12R50	0698-7198	0		RESISTOR 26.1 1% .05W F TC=0+-100	24546	C3-1/8-T0-26R1-F
A12R51	0698-7241	4	2	RESISTOR 1.62K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1621-F
A12R52	0698-6430	1	2	RESISTOR 111K .5% .125W F TC=0+-100	28480	0698-6430
A12R53	2100-3273	1	2	RESISTOR-TRMR 2K 10% C SIDE-ADJ 1-TRN	28480	2100-3273
A12R54	0698-3922	0		RESISTOR 487K .1% .125W F TC=0+-50	28480	0698-3922
A12R55	0698-3905	9	2	RESISTOR 513K .1% .125W F TC=0+-50	28480	0698-3905
A12R56	0698-7245	8		RESISTOR 2.37K 1% .05W F TC=0+-100	24546	C3-1/8-T0-2371-F
A12R57	0698-7238	9		RESISTOR 1.21K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1211-F
A12R58	0698-3905	9		RESISTOR 513K .1% .125W F TC=0+-50	28480	0698-3905
A12R59	0698-7198	0		RESISTOR 26.1 1% .05W F TC=0+-100	24546	C3-1/8-T0-26R1-F
A12R60	0698-7216	3		RESISTOR 147 1% .05W F TC=0+-100	24546	C3-1/8-T0-147R-F
A12R61	0698-6433	4		RESISTOR 100 1% .25W F TC=0+-100	28480	0698-6433
A12R62				NOT ASSIGNED		
A12R63				NOT ASSIGNED		
A12R64	0698-7236	7		RESISTOR 1K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1001-F
A12R65	0698-6433	4		RESISTOR 100 1% .25W F TC=0+-100	28480	0698-6433
A12R66	0698-3922	0		RESISTOR 487K .1% .125W F TC=0+-50	28480	0698-3922
A12R67				NOT ASSIGNED		
A12R68	0698-6400	5		RESISTOR 900K 1% .25W F TC=0+-100	19701	MF52C1/4-T0-9003-F
A12R69	0698-7238	9		RESISTOR 1.21K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1211-F
A12R70	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A12R71	0699-0073	8		RESISTOR 10M 1% .125W F TC=0+-150	28480	0699-0073
A12R72	0698-7198	0		RESISTOR 26.1 1% .05W F TC=0+-100	24546	C3-1/8-T0-26R1-F
A12R75	0698-7227	6		RESISTOR 422 1% .05W F TC=0+-100	24546	C3-1/8-T0-422R-F
A12R76	0699-0676	7		RESISTOR-511K OHM .1% .125W F TC=0+-50	28480	0699-0676
A12R77	0698-7198	0		RESISTOR 26.1 1% .05W F TC=0+-100	24546	C3-1/8-T0-26R1-F
A12R78	0698-3922	0		RESISTOR 487K .1% .125W F TC=0+-50	28480	0698-3922
A12R79	0698-7227	6		RESISTOR 422 1% .05W F TC=0+-100	24546	C3-1/8-T0-422R-F
A12R80	2100-3802	2		RESISTOR-VAR W/SW 10K 20% LIN SPST-NO	28480	2100-3802
A12R81	0698-7212	9		RESISTOR 100 1% .05W F TC=0+-100	24546	C3-1/8-T0-100R-F
A12R82	0698-7218	5		RESISTOR 178 1% .05W F TC=0+-100	24546	C3-1/8-T0-178R-F
A12R83	0698-7205	0		RESISTOR 51.1 1% .05W F TC=0+-100	24546	C3-1/8-T0-51R1-F
A12R84	0698-6430	1		RESISTOR 111K .5% .125W F TC=0+-100	28480	0698-6430
A12R85	0698-7249	2		RESISTOR 3.48K 1% .05W F TC=0+-100	24546	C3-1/8-T0-3481-F
A12R86	0698-7205	0		RESISTOR 51.1 1% .05W F TC=0+-100	24546	C3-1/8-T0-51R1-F
A12R87	0698-7209	4		RESISTOR 75 1% .05W F TC=0+-100	24546	C3-1/8-T0-75R0-F
A12R88	0698-7205	0		RESISTOR 51.1 1% .05W F TC=0+-100	24546	C3-1/8-T0-51R1-F
A12R89	0698-7249	2		RESISTOR 3.48K 1% .05W F TC=0+-100	24546	C3-1/8-T0-3481-F
A12R90	0698-0087	2		RESISTOR 316 1% .25W F TC=0+-100	24546	C5-1/4-T0-3160-F
A12R91	0698-7267	4		RESISTOR 19.6K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1962-F
A12R92	0698-7267	4		RESISTOR 19.6K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1962-F
A12R93	0698-7198	0		RESISTOR 26.1 1% .05W F TC=0+-100	24546	C3-1/8-T0-26R1-F
A12R94	0698-7198	0		RESISTOR 26.1 1% .05W F TC=0+-100	24546	C3-1/8-T0-26R1-F
A12R95	0698-7224	3		RESISTOR 316 1% .05W F TC=0+-100	24546	C3-1/8-T0-316R-F

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

Table 6-6. Option 040 Programmable Input Replaceable Parts (Con't)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A12R96	0698-7224	3		RESISTOR 316 1% .05W F TC=0+-100	24546	C3-1/8-TO-316R-F
A12R97	0698-7247	0		RESISTOR 2.87K 1% .05W F TC=0+-100	24546	C3-1/8-TO-2871-F
A12R98	0698-7284	5		RESISTOR 100K 1% .05W F TC=0+-100	24546	C3-1/8-TO-1003-F
A12R99	0698-7205	0		RESISTOR 51.1 1% .05W F TC=0+-100	24546	C3-1/8-TO-51R1-F
A12R100*	0699-0071	6		RESISTOR 4.64M 1% .125W F TC=0+-100	28480	0699-0071
A12R101*	0699-0071	6		RESISTOR 4.64M 1% .125W F TC=0+-100	28480	0699-0071
A12R102	0698-7252	7		RESISTOR 4.64K 1% .05W F TC=0+-100	24546	C3-1/8-TO-4641-F
A12R103	0698-7267	4		RESISTOR 19.6K 1% .05W F TC=0+-100	24546	C3-1/8-TO-1962-F
A12R104	0698-7267	4		RESISTOR 19.6K 1% .05W F TC=0+-100	24546	C3-1/8-TO-1962-F
A12R105	2100-3273	1		RESISTOR-TRMR 2K 10% C SIDE-ADJ 1-TRN	28480	2100-3273
A12R106*	0699-0071	6		RESISTOR 4.64M 1% .125W F TC=0+-100	28480	0699-0071
A12R107	2100-3359	4		RESISTOR-TRMR 2M 20% C SIDE-ADJ 1-TRN	28480	2100-3359
A12R108*	0699-0071	6		RESISTOR 4.64M 1% .125W F TC=0+-100	28480	0699-0071
A12R109	0698-7241	4		RESISTOR 1.62K 1% .05W F TC=0+-100	24546	C3-1/8-TO-1621-F
A12R110	2100-3274	2		RESISTOR-TRMR 10K 10% C SIDE-ADJ 1-TRN	28480	2100-3274
A12R111	2100-3359	4		RESISTOR-TRMR 2M 20% C SIDE-ADJ 1-TRN	28480	2100-3359
A12R112	0698-7277	6	2	RESISTOR 51.1K 1% .05W F TC=0+-100	24546	C3-1/8-TO-5112-F
A12R113	0698-7277	6		RESISTOR 51.1K 1% .05W F TC=0+-100	24546	C3-1/8-TO-5112-F
A12S1				NSR P/O R80 & R28 TRIG CONTROL		
A12S2				NSR P/O R80 & R28 TRIG CONTROL		
A12U1	1826-0600	9	2	IC OP AMP LOW-BIAS-H-IMPD QUAD 14-DIP-P	01295	TL074ACN
A12U2	1826-0570	2	2	IC	28480	1826-0570
A12U3	1826-0035	4	2	IC OP AMP LOW-DRIFT TO-99 PKG	27014	LM308AH
A12U4	1826-0035	4		IC OP AMP LOW-DRIFT TO-99 PKG	27014	LM308AH
A12U5	1826-0570	2		IC	28480	1826-0570
A12U6	1826-0600	9		IC OP AMP LOW-BIAS-H-IMPD QUAD 14-DIP-P	01295	TL074ACN
				A12 MISCELLANEOUS PARTS		
	0340-0092	2	4	TERMINAL-SOLDER SPCL-FDTHRU PRESS-MTG	28480	0340-0092
	1205-0061	0	2	HEAT SINK TO-5/TO-39-CS	28480	1205-0061
H10	1250-0035	8	2	NUT-HEX-DBL-CHAM 15/32-32-THD	28480	2950-0035
	4040-1616	6	2	STANDOFF-LED	28480	4040-1616

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

Table 6-7. Manufacturers Code List

MFR. NO.	MANUFACTURER NAME	ADDRESS	ZIP CODE
S0545	Nippon Electric Company	Tokyo, Japan	
00000	Any Satisfactory Supplier		
00853	Sangamo Elec. Co. So. Carolina Div.	Pickens, SC	29671
01121	Allen-Bradley Co.	Milwaukee, WI	53204
01295	Texas Instr. Inc. Semicond. Cmpnt. Div.	Dallas, TX	75222
02111	Spectrol Electronics Corp.	City of Ind., CA	91745
02114	Ferroxcube Corp.	Saugerties, NY	12477
03508	GE Co. Semiconductor Prod. Dept.	Auburn, NY	13201
03888	KDI Pyrofilm Corp.	Whippany, NJ	07981
04713	Motorola Semiconductor Products	Phoenix, AZ	85008
06665	Precision Monolithics Inc.	Santa Clara, CA	95050
07263	Fairchild Semiconductor Div.	Mountain View, CA	94042
15818	Teledyne Semiconductor	Mountain View, CA	94043
16299	Corning Gl. Wk. Elec. Cmpnt. Div.	Raleigh, NC	27604
19701	Mepco/Electra Corp.	Mineral Wells, TX	76067
23936	Pamotor Div. William J. Purdy	Burlingame, CA	94010
24355	Analog Devices Inc.	Norwood, MA	02062
24546	Corning Glass Works (Bradford)	Bradford, PA	16701
25088	Siemens Corp.	Iselin, NJ	08830
27014	National Semiconductor Corp.	Santa Clara, CA	95051
28480	Hewlett-Packard Co. Corporate Hq.	Palo Alto, CA	94304
3L585	RCA Corp., Sold State Division	Sommerville, NJ	08876
32293	Intersil Inc.	Cupertino, CA	95014
32997	Bourns Inc. Trimpot Prod. Div.	Riverside, CA	92507
4N833	ETRI, Inc.	Monroe, NC	60521
51642	Centre Engineering Inc.	State College, PA	16801
52072	Circuit Assembly Corp.	Costa Mesa, CA	92626
52763	Stettner Electronics Inc.	Chattanooga, TN	13035
55576	Synertek	Santa Clara, CA	95051
56289	Sprague Electric Co.	North Adams, MA	01247
72136	Electro Motive Corp.	Florence, SC	06226
73138	Beckman Instruments Inc. Helipot Div.	Fullerton, CA	92634
75915	Littelfuse Inc.	Des Plaines, IL	60016
76381	3M Company	St. Paul, MN	55101
8E175	Burr Brown Co.	Tucson, AZ	35801
84411	TRW Capacitor Div.	Ogallala, NE	69153
91637	Dale Electronics Inc.	Columbus, NE	68601
98291	Sealectro Corp.	Mamaroneck, NY	10544

SECTION VII
MANUAL CHANGES

7-1. INTRODUCTION

7-2. This section contains information necessary to adapt this manual to older instruments by making manual changes to "backdate" the manual for a particular instrument configuration as determined by the Serial Prefix Number or complete Serial Number on the rear of the instrument.

7-3. MANUAL CHANGES

7-4. This manual applies directly to model 5335A Universal Frequency Counters with Serial Prefix No. 2232A and includes any Option 040 circuit boards with Series Number 2232.

7-5. As engineering changes are made, newer instruments may have Serial Prefix numbers higher than 2232A or circuit boards for options with series numbers higher than 2232. Manuals for these instruments will be supplied with MANUAL CHANGES, printed on yellow paper, containing the required information. Replace affected pages or change existing information as directed in the MANUAL CHANGES. Contact the nearest Hewlett-Packard Sales and Service Office if the change information is missing.

7-6. OLDER INSTRUMENTS

7-7. If your instrument has a Serial Prefix Number or an option circuit board series number lower than 2232A, refer to *Table 7-1* and perform the manual backdating change(s) that applies to your instrument. Older instruments are at the bottom of the table. The terms "or above" and "or below" used in *Table 7-1*, or the changes, refer to instrument serial prefix or series numbers. Newer instruments manufactured after any prefix/series number are identified by the term "or above". Older instruments made before any prefix/series number are referred to by "or below".

Table 7-1. Manual Backdating

If Instrument Has Serial Prefix or Option Series	Change Number	Circuit Board or Circuits Involved
2232A	NONE	NO BACKDATING CHANGES
2224A	1	A12
2220A	1,2	A2, A3, A5-A7, A11, and A12
2216A	1,2,3	A4, A11
2208A	1,2,3,4	A4
2202A02446 OR ABOVE	1,2,3,4,5	A4
2202A02445 OR BELOW	1 through 6	A5, A10
2152A	1 through 7	A15
2140A	1 through 8	A3
2134A	1 through 9	A3
A9 SERIES 2121	1 through 10	A9
2120A	1 through 11	A2, A3, W7, W8
2104A	1 through 12	A3, A4, A6, and A12
2044A	1 through 13	A13
A9 SERIES 2036	1 through 14	A9
2032A	1 through 15	A9
2028A	1 through 16	A10, A11, and A12
2024A	1 through 17	A1, A5, A10, A11, and A12
2012A	1 through 18	A1
2008A	1 through 19	A3 and A9
1928A	1 through 20	A1, A2, and A13

CHANGE 1 (Serial Prefix No. 2224A)

Section VI, Table 6-6, A12 Replaceable Parts (Opt. 040):
Change ckt bd A12 (05335-60012) to SERIES 2224.
Change A12R112 & R113 Reference Designations to A12R47 & R67, respectively.

Section VIII, A12 Schematic Diagram:
Change A12 (05335-60012) diagram to SERIES 2224.
Delete resistor R112 between K2 pins 6 and 8.
Add 51.1K resistor R47 between K2 pins 6 and 7.
Delete resistor R113 between K7 pin 2 and the junction of resistors R68 and R72.
Add 51.1K resistor R67 between K7 pin 3 and junction of R68 and R72.

CHANGE 2 (Serial Prefix No. 2220A)
Section VI, Table 6-2, Assy A2, A3, and A5-A7 Replaceable Parts:
Change ckt bd A2 (05335-60002) to SERIES 2134.
Change A2J1 & J2 to Part No. 1200-0617;CD=2.
Socket 1200-0614 is recommended for replacement.
Add 1200-0617; CD=2; QTY=2; LOCK INLINE 18-PIN.

Change ckt bd A3 (05335-60003) to SERIES 2152.
Change A3J2 & J5 to Part No. 1200-0617; CD=2.
Socket 1200-0614 is recommended for replacement.
Add 1200-0617; CD=2; QTY=2; LOCK INLINE 18-PIN.

Change ckt bd A5 (05335-60005) to SERIES 2202.
Change A5XDS1-DS14 to 1200-0679; CD=6; QTY=14; SOCKET-IC 14-CONT DIP-SLDR.
Socket 1200-0679 is recommended to replace XDS1-14.

Change ckt bd A6 (05335-61006) to SERIES 2120.
Change A6J7 to Part No. 1200-0519; CD=3.
Socket 1200-0482 is recommended to replace A6J7.
Add 1200-0523; CD=9; LOCK DUAL INLINE 16-PIN.

Change ckt bd A7 (05335-60007) to SERIES 1928.
Change A7J1 & J2 to Part No. 1200-0519; CD=3.
Add 1200-0523; CD=9; QTY=2; LOCK INLINE 16-PIN.
Socket 1200-0482 is recommended to replace J1-J2.
Change A7XU1 to Part No. 1200-0552; CD=4.
Socket 1200-0682 is recommended to replace A7XU1.

Section VI, Table 6-6, A11 and A12 Replaceable Parts:
Change ckt bd A11 (05335-60011) to SERIES 2220.
Change A11J1 & J2 to Part No. 1200-0617; CD=2.
Socket 1200-0614 is recommended to replace A11J1-J2.
Add 1200-0617; CD=2; QTY=2; LOCK INLINE 18-PIN.

Change ckt bd A12 (05335-60012) to SERIES 2120.
Change A12J2 & J7 to Part No. 1200-0617; CD=2.
Socket 1200-0614 is recommended to replace A12J2-J7.
Add 1200-0617; CD=2; QTY=2; LOCK INLINE 18-PIN.

Section VIII, A2, A3, A5-A7, A11, & A12 Schematic:
Change A2 (05335-60002) diagram to SERIES 2134.
Change A3 (05335-60003) diagram to SERIES 2152.
Change A5 (05335-60005) diagram to SERIES 2202.
Change A6 (05335-61006) diagram to SERIES 2120.
Change A7 (05335-60007) diagram to SERIES 1928.
Change A11 (05335-60011) diagram to SERIES 2220.
Change A12 (05335-60012) diagram to SERIES 2120.

CHANGE 3. (Serial Prefix No. 2216A)
Section VI, Table 6-2, A4 Replaceable Parts:
Change ckt bd A4 (05335-60004) to SERIES 2216.
Change A4J1 to Part No. 1200-0519; CD=3.
Use Socket 1200-0482 to replace A4J1.
Add 1200-0523; CD=9; LOCK DUAL INLINE 16-PIN.

Section VI, Table 6-6, A11 Replaceable Parts (Opt. 040):
Change ckt bd A11 (05335-60011) to SERIES 2028.
Change A11XU21 & XU23 to Part No. 1200-0423; CD=8.
Use Socket 1200-0482 to replace A11XU21-XU23.
Add 1200-0523; CD=9; LOCK DUAL INLINE 16-PIN.

Section VIII, A4 and A11 Schematic Diagrams:
Change A4 (05335-60004) diagram to SERIES 2216.
Change A11 (05335-60011) diagram to SERIES 2028.

CHANGE 4. (Serial Prefix No. 2208A)
Table 6-2, A4 Replaceable Parts:
Change ckt bd A4 (05335-60004) to SERIES 2208.
Change A4XU22 & XU23 to Part No. 1200-0522; CD=8.
Delete 1200-0825 20-pin sockets for A4XU7 & XU27.

Section VIII, A4 Schematic Diagram:
Change A4 (05335-60004) diagram to SERIES 2208.

CHANGE 5. (Serial Prefix No. 2202A02446 or above)
Section VI, Table 6-2, A4 Replaceable Parts:
Change ckt bd A4 (05335-60004) to SERIES 2120.
Change A4U16 & U24 to Part No. 1820-2075; CD=4; QTY=2; TTL 74LS245 XCR.
The 1820-2866 74SC245 CMOS is recommended for replacement of A4U16 & U24 in all instruments.
Delete 1200-0825 20-pin sockets A4XU16 & XU24.

Section VIII, A4 Schematic Diagram:
Change A4 (05335-60004) diagram to SERIES 2120.

CHANGE 6. (Serial No. 2202A02445 and below)
Section VI, Table 6-2, A5 Replaceable Parts:
Change ckt bd A5 (05335-60005) to SERIES 2044.
Change A5DS15-DS48 to Part No. 1990-0670; CD=0; QTY=34; LED-VISIBLE YELLOW MINI.

Section VIII, A5 Schematic Diagram:
Change A5 (05335-60005) diagram to SERIES 2044.

Section VI, Table 6-6, A10 Replaceable Parts:
Change ckt bd A10 (05335-60010) to SERIES 2028.
Change A10DS1-DS12 to Part No. 1990-0670; CD=0; QTY=12; LED-VISIBLE YELLOW MINI.

Section VIII, A10 Schematic Diagram:
Change A10 (05335-60010) diagram to SERIES 2028.

CHANGE 7. (Serial Prefix No. 2152A)
Section VI, A15 Replaceable Parts (Option 010)
Delete 10811-60111 10 MHz Oven Oscillator.
Delete 10811-90002 Operating and Service Manual.
The 10544-60011 and 10811-60111 oscillators are directly interchangeable. The Part No. 10811-60111 oscillator can be used to add or replace A15 in any instrument with a Serial Number Prefix below 2202A.

CHANGE 8. (Serial Prefix No. 2140A)
Section VI, Table 6-2, A3 Replaceable Parts:
Change ckt bd A3 (05335-60003) to SERIES 2140
Change A3R99-R101 to Part No. 2100-3359; CD=4.
Change A3S2-S10 & S12 to Part No. 3101-2124.
The 3101-2498 switches have gold contacts and are recommended for repacement in all instruments.

Section VIII, A3 Schematic Diagram:
Change A3 (05335-60003) diagram to SERIES 2140.

CHANGE 9. (Serial Prefix No. 2134A)
Section VI, Table 6-2, A3 Replaceable Parts:
Change ckt bd A3 (05335-60003) to SERIES 2134.
Change A3C27 & C35 to Part No. 0160-3878.
The 0160-4040 capacitor is recommended replacement for improved reliability.

Section VIII, A3 Schematic Diagram:
Change A3 (05335-60003) diagram to SERIES 2134.

CHANGE 10. (A9 option bd SERIES 2036)

Section VI, Table 6-5, A9 Replaceable Parts
Change ckt bd A9 (05335-60009) to SERIES 2036.
The instrument Serial Prefix Number does not change with this change in circuit board A9.
Change A9R14 to 0698-7233; CD=4; RESISTOR 750 1% .05W F TC=0±100.
Change A9R15 to 0698-7234; CD=5; RESISTOR 825 1% .05W F TC=0±100.
The higher resistor values, shown in Table 6-5 are are recommended for replacement.

Section VIII, A9 Schematic Diagram:
Change A9 (05335-60009) diagram to SERIES 2036.
Change R14 value from 1.62K to 750 ohms.
Change R15 value from 1.78K to 825 ohms.

CHANGE 11. (Serial Prefix No. 2120A)

Section VI, Table 6-2, A2 Replaceable Parts:
Change ckt bd A2 (05335-60002) to SERIES 2008.
Change A2R32 & R51 to 0698-7242; CD=5; RESISTOR 1.78K 1% .05W F TC=0±100.
Add A2CR6 & CR7; 1901-0050; CD=3; DIODE-SWITCHING 80V 200MA 2NS.
Delete A2W1 & A2W2 wire jumpers (8159-0005).

Section VI, Table 6-2, A3 Replaceable Parts:
Change ckt bd A3 (05335-60003) to SERIES 2120.
Change A3C4, 5, 7, 8, 51, 52, 53, & C57 to 0160-4931; CD=4; CAP.-FXD .47UF MATCHED SETS OF TWO; C4-C7, C5-C8, C51-C52, & C53-C57.
Add A3R7*, R8*, R80*, & R81*; 0698-7288; CD=9; RESISTOR 147K 1% .05W F TC=0±100.
Delete A3Q9 & A3Q10 transistors (1854-0686).
Delete resistors A3R99 through A3R106.
NOTE — Resistors A3R7*, R8*, R80*, and R81* require selected components in the peak detector circuit. A procedure for selecting the resistors is given in paragraphs 7-8 through 7-14.

Section VI, Table 6-3, Replaceable Electrical Parts:
Change W7 and W8 to 05335-60103; CD=0; QTY=2; CABLE ASSY-COAX 75 OHM (SERIAL PREFIX 2120A OR BELOW). If instrument has Option 040, W7 and W8 must be 50 ohm (Part No. 05335-60112) cables.

Section VIII, A2 Schematic Diagram.
Change 05335-60002 (A2) to SERIES 2008.
Change A2R32 & R51 to 1780 ohms.
Replace wire jumpers A2W1 & A2W2 with diodes A2CR6 & A2CR7, respectively.
Add A2CR6 in series with channel B input.
Connect anode to junction of J4 and R33; cathode to junction of R32 and U7(12,13).
Add A2CR7 in series with channel B input.
Connect anode to junction of J3 and R39; cathode to junction of R32, U11(7), & U7(3).

Section VIII A3 Schematic Diagram:
Change A3 (05335-60003) diagram to SERIES 2120.
Change A3C4,C5,C7,C8,C51,C52,C53, & C57 to .47U
Add 147K resistors R7*, R8*, R80*, & R81*.
Connect R7* in parallel with diode CR1, R8* in parallel with CR2, R80* in parallel with CR28, and R81* in parallel with CR29.
Delete 2M controls R99 through R102 and replace each with a wire jumper.
Delete R105, R106, & Q10 in output "BO" line to J1 and connect U2(19) directly to J1.
Add "75 OHM" to W8 cable connected to J1.
Delete R103, R104, & Q9 in output "AO" line to J6 and connect U5(19) directly to J6.
Add "75 OHM" to W7 cable connected to J6.

NOTE

The A2 Series 2008 and A3 Series 2120 circuit boards in instruments with Serial Prefix 2120A, or below, cannot be directly interchanged with Series 2134, or above, circuit boards. Interconnect cables W7 and W8, between A2 and A3, must be 75-ohms in instruments with a Serial Prefix of 2120A or below.

CHANGE 12. (Serial Prefix No. 2104A)

Section VI, Table 6-2, Assemblies A3,A4,A6,&A12 Replaceable Parts:
Change ckt bd A3 (05335-60003) to SERIES 1928.
Change A3R16 & R74 to 0698-3444; CD=1; RESISTOR 316 ohms 1% .125W TC=0±100.

Change ckt bd A4 (05335-60004) to SERIES 1928.
Add A4R10; 0757-0280; CD=3); RESISTOR 1.00K 1% .125W F. TC=0±100.
Change A4R17 to 0698-7260; CD=7; RESISTOR 10.0K 1% .05W F TC=0-100.
Change A4R36 & R37 to 0698-3431; CD=8; RESISTOR 28.7 ohms 1.% .125W F TC=0±100.
Delete CR11 diode 1901-0535.
Delete R55 resistor 0698-7250.

Change A6 ckt bd to Part No. 05335-60006.
Replace the portion of Table 6-2 listing replaceable parts for A4 Part No. 05335-61006 with the parts for A6 Part No. 05335-60006 in Table 7-2.
Delete MP4 Part No. 05335-00014 rear panel from Table 6-3 "Miscellaneous Chassis Parts". The 05335-60006 assembly has slide switches for A6S1 and A6S2 which required a rear panel with slots for the switch handles.

Change ckt bd A12 (05335-60012) to SERIES 2028.
Change A12R30 & R90 to 0698-3444; CD=1; RESISTOR 316 ohms 1% .125W TC=0±100.

Section VIII A3, A4, A6, and A12 Schematic Diagrams:
Change A3 (05335-60003) diagram to SERIES 1928.
Replace schematic diagram and component locator for A6 (HP Part No. 05335-61006) with schematic diagram and component locator in Figures 7-1 and 7-2 for A6 Part No. 05335-60006 (SERIES 1928).

Change A4 (05335-60004) diagram to SERIES 1928.
Delete diode CR11 and resistor R55.
Replace CR11 with a wire jumper.
Change the value of R17 to 10K ohms.
Add R10 1000 ohm resistor betweeen U2A(8,11,12) and the junction of C13, R17, and CR3.

Change A12 (05335-60012) diagram to SERIES 2028.
Change A12R30 & R90 to 316 ohms.

CHANGE 13. (Serial Prefix No. 2044A)
Section VI,Table 6-2, A13 Replaceable Parts:
Change A13 LINE MODULE-FILTERED part number from 0960-0443 to number 0969-0448 as shown by the diagram in Figure 7-3. The instrument Serial Prefix Number becomes 2044A .

Section VIII, A1/A13 Schematic Diagram:
Change part number for A13 to 0969-0448 and mark A13 diagram to show differences shown in Figure 7-2.

CHANGE 14. (A9 SERIES 2036)
Section VI, Table 6-5, A9 Replaceable Parts:
Change ckt bd A9 (05335-60009) to SERIES 2012.
Delete A9C28 .01UF capacitor (Part No. 0160-3879).

Section VIII, A9 Schematic Diagram:
Change A9 (05335-60009) diagram to SERIES 2012.
Delete .01UF capacitor C28.

CHANGE 15. (Serial Prefix No. 2032A)
All instruments with Option 030 and a Serial Prefix Number of 2032A have SERIES 2036 circuit boards for A9. The following instruments with Option 030 also have SERIES 2036 circuit boards.

2012A00191, 00192, 00206, and 00211.
2028A00241, 00247, and 00248.
2024A00217, 00219, 00221-00225, 00227, 00230, 00233, and 00235.
2028A00251, 00253, 00256-00259, 00265, 00266, 00268-00270, 00277, 00279, 00282, 00284, 00287, 00294, and 00300.

All other instruments with with Option 030 and serial numbers below the above instruments have a SERIES 2012 board for A9.

CHANGE 16. (Serial Prefix No. 2028A)
Option 040 for Programmable Input Amplifiers first introduced in instruments with Serial Prefix Number 2028A. Circuit board A10 (HP Part No. 05335-60010) is added. Circuit board A2 is replaced by A11 (HP Part No. 05335-60011), and A3 is replaced by circuit board A12 (HP Part No. 05335-60012). These circuit boards require 50-ohm (HP Part No. 05335-60112) cable assemblies for W7 and W8.

Circuit board A10 has two more keys (A/B FILTER) which necessitates a new HP Part No. 05335-00013 (MP33) front panel.

CHANGE 17. (Serial Prefix No. 2024A)
Section VI, Table 6-2, A1 and A5 Replaceable Parts:
Change ckt bd A1 (05335-60001) to SERIES 2024.
Change A1CR1 to 1902-0940; CD=2; DIODE-ZNR 1N5339B 5.6V 5% PD=5W.
Use the 1902-0522 (6V) diode to replace A1CR1.

Change ckt bd A5 (05335-60005) to SERIES 1928.
Delete 6.81K resistor A5R5 (0757-0439).

Section VI, Table 6-3, Misc. Chassis Parts:
Delete MP33 part number 05335-00013 front panel.

Section VI, Table 6-6, Option 040 Replaceable Parts:
Delete the entire contents of Table 6-6.

Section VIII, A1 and A5 Schematic Diagram:
Change A1 (05335-60001) diagram to SERIES 2024. No other schematic change is required.
Change A5 (05335-60005) diagram to SERIES 1928.
Delete 6810 ohm resistor A5R5.

CHANGE 18. (Serial Prefix 2012A)
Section V. Power Supply Adjustment Procedure:
Delete Paragraphs 5-12.e. and 5-12.f. Instruments with Serial Prefix No. 2012A or below do not have an adjustment for the 15.7V supply.

Section VI, Table 6-2, A1 Replaceable Parts:
Change ckt bd A1 (05335-60001) to SERIES 1928.
Add A1CR5; 1901-0050; CD=3; DIODE-SWITCHING 80V 200MA 20NS DO-35.
Delete A1CR12 switching diode (1901-0050).
Delete 50-ohm trimmer resistor A1R15 (2100-3383).
Delete 825-ohm fixed resitor A1R16 (0757-0421).
Delete A1MP1 Heatsink Part No. 05335-00005.

Section VI, Table 6-3,, Misc. Chassis Parts:
Add 05335-00005; CD=5; HEATSINK.
Add HP Part No. 5001-0439; CD=2; SIDE TRIM.

Section VIII, A1 Schematic Diagram:
Change 05335-60001 to SERIES 1928.
Replace A1CR12 with a wire jumper.
Delete 825 ohm resistor A1R16.
Replace 50-ohm trimmer resistor A1R15 with added diode A1CR5. Connect CR5 anode to U6(2) and cathode to circuit board common with CR2 anode.

CHANGE 19. (Serial Prefix No. 2008A)
Section VI, Table 6-2, A3 Replaceable Parts:
Change ckt bd A3 (05335-60003) to SERIES 2008.
Change A3C3* and A3C7* to 0160-4493; CD=3; CAPACITOR-FXD 27PF 5% 200VDCW CERAMIC TC=0±30. The 0160-3875 capacitor (22 pF) is a preferred replacement.

Section VI, Table 6-5, A9 Replaceable Parts:
Change ckt bd A9 (05335-60009) to SERIES 1928.
Change A9L2 & L4 to 9100-2272; CD=5; INDUCTOR RFC-MLD 47UH 10%.

Section VIII, A3 and A9 Schematic Diagrams:
Change A3 (05335-60003) schematic to SERIES 2008.
Change A3C23* & A3C7* (near X10 ATTN) to 27 pF.
Change A9 (05335-60009) Schematic to SERIES 1928
Change values of A9L2 & L4 to 0.47UH.

CHANGE 20. (Serial Prefix No. 1928A)
Section VI, A2 and A13 Table of Replaceable Parts:
Change ckt bd A2 (05335-60002) to SERIES 1928.
Delete 50 ohm trimmer resistors A2R65 and R66 (Part No.2100-3383).
Change A2R47 & R50 to 0757-0401; CD=0; RESISTOR-FXD 100 1% .125W F TC=0±100.
Change A13 LINE MODULE-FILTERED to Part No. 0960-0433. The schematic diagram for this module is shown with the schematic diagram for A1 in Section VIII of this manual.

Section VIII, A2 Schematic Diagram:
Change A2 (05335-60002) diagram to SERIES 1928.
Delete A2R65 & R66 trimmer resistors.
Change the value of A2R47 & R50 to 100 ohms.
Connect the bottom end of A2R47 & R50 to circuit board common.

Table 7-2. A6 (05335-60006) Series 1928 Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A6	05335-60006	2	1	BOARD ASSEMBLY-REAR	28480	05335-60006
A6C1*	0160-4557	0	5	CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A6C2	0180-0210	6	3	CAPACITOR-FXD 3.3UF+-20% 15VDC TA	56289	150D335X0015A2
A6C3	0160-4554	7	5	CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A6C4	0180-0210	6		CAPACITOR-FXD 3.3UF+-20% 15VDC TA	56289	150D335X0015A2
A6C5	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A6C6	0180-0210	6		CAPACITOR-FXD 3.3UF+-20% 15VDC TA	56289	150D335X0015A2
A6C7	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A6C8	0160-3046	0	4	CAPACITOR-FXD 250PF +-1% 100VDC MICA	28480	0160-3046
A6C9	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A6C10	0160-3874	2	3	CAPACITOR-FXD 10PF +-.5PF 200VDC CER	28480	0160-3874
A6C11	0160-3874	2		CAPACITOR-FXD 10PF +-.5PF 200VDC CER	28480	0160-3874
A6C11	0160-3874	2		CAPACITOR-FXD 10PF +-.5PF 200VDC CER	28480	0160-3874
A6C12	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A6C13	0160-3046	0		CAPACITOR-FXD 250PF +-1% 100VDC MICA	28480	0160-3046
A6C14	0160-3046	0		CAPACITOR-FXD 250PF +-1% 100VDC MICA	28480	0160-3046
A6C15	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A6C16	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A6C17	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A6C18	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A6C19	0160-3046	0		CAPACITOR-FXD 250PF +-1% 100VDC MICA	28480	0160-3046
A6C20	0160-0682	4	1	CAPACITOR-FXD 3.3PF +-.5PF 200VDC CER	28480	0160-0682
A6CR1	1901-0050	3	5	DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A6CR2	1901-0535	9	1	DIODE-SM SIG SCHOTTKY	28480	1901-0535
A6CR3	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A6CR4	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A6CR5	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A6CR6	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A6J1	1250-1453	1	6	CONNECTOR-RF BNC FEM SGL-HOLE-RR 50-OHM	28480	1250-1453
A6J2	1250-1453	1		CONNECTOR-RF BNC FEM SGL-HOLE-RR 50-OHM	28480	1250-1453
A6J3	1250-1453	1		CONNECTOR-RF BNC FEM SGL-HOLE-RR 50-OHM	28480	1250-1453
A6J4	1250-1453	1		CONNECTOR-RF BNC FEM SGL-HOLE-RR 50-OHM	28480	1250-1453
A6J5	1250-1453	1		CONNECTOR-RF BNC FEM SGL-HOLE-RR 50-OHM	28480	1250-1453
A6J6	1250-1453	1		CONNECTOR-RF BNC FEM SGL-HOLE-RR 50-OHM	28480	1250-1453
A6J7	1200-0519	3	1	SOCKET-IC 16-CONT DIP-SLDR	28480	1200-0519
A6L1	9100-0348	2	3	INDUCTOR RF-CH-MLD 1UH 1% .166DX.385LG	28480	9100-0348
A6L2	9100-0348	2		INDUCTOR RF-CH-MLD 1UH 1% .166DX.385LG	28480	9100-0348
A6L3	9100-0348	2		INDUCTOR RF-CH-MLD 1UH 1% .166DX.385LG	28480	9100-0348
A6Q1	1854-0215	1	6	TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A6Q2	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A6Q3	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A6Q4	1853-0036	2	1	TRANSISTOR PNP SI PD=310MW FT=250MHZ	28480	1853-0036
A6Q5	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A6Q6	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A6Q7	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A6R1	0757-0401	0	1	RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A6R2	0698-3162	0	1	RESISTOR 46.4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4642-F
A6R3	0757-0405	4	1	RESISTOR 162 1% .125W F TC=0+-100	24546	C4-1/8-T0-162R-F
A6R4	0757-0280	3	4	RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A6R5	0698-3155	1	1	RESISTOR 4.64K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4641-F
A6R6	1810-0367	2	1	NETWORK-RES 6-SIP4.7K OHM X 5	01121	206A472
A6R7	0698-0084	9	1	RESISTOR 2.15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2151-F
A6R8				NOT ASSIGNED		
A6R9	0698-3444	1	1	RESISTOR 316 1% .125W F TC=0+-100	24546	C4-1/8-T0-316R-F
A6R10	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A6R11	0757-1093	8	2	RESISTOR 3K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3001-F
A6R12	0757-1094	9	1	RESISTOR 1.47K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1471-F
A6R13	0757-0442	9	2	RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A6R14	0757-0178	8	1	RESISTOR 100 1% .25W F TC=0+-100	24546	C5-1/4-T0-101-F
A6R15	0757-1093	8		RESISTOR 3K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3001-F
A6R16	0757-0439	4	1	RESISTOR 6.81K 1% .125W F TC=0+-100	24546	C4-1/8-T0-6811-F
A6R17	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A6R18	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A6R19	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A6S1	3101-2383	5	2	SWITCH-SL DP3T MINTR .5A 125VAC PC	28480	3101-2383
A6S2	3101-2383	5		SWITCH-SL DP3T MINTR .5A 125VAC PC	28480	3101-2383

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

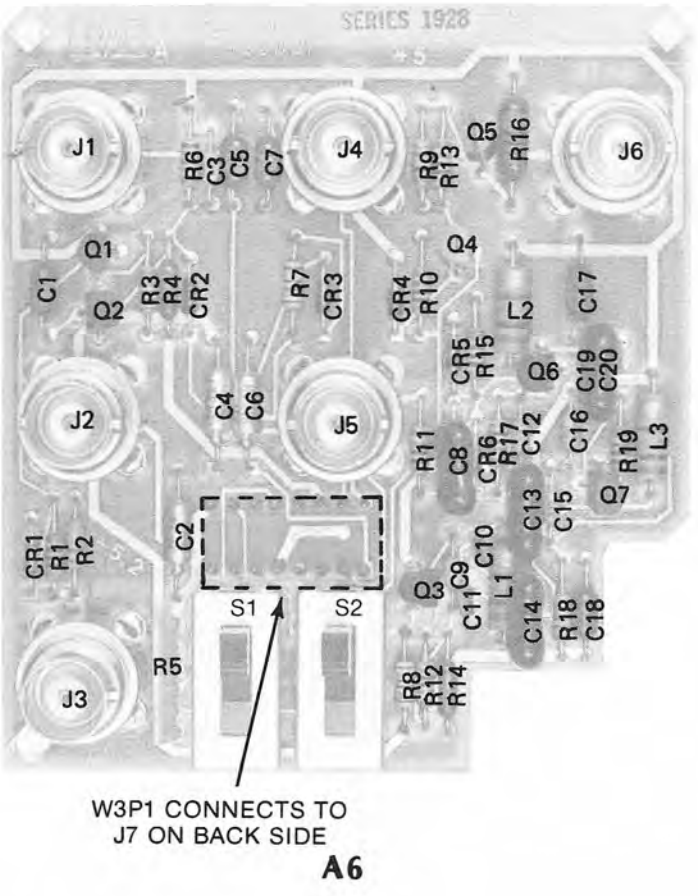
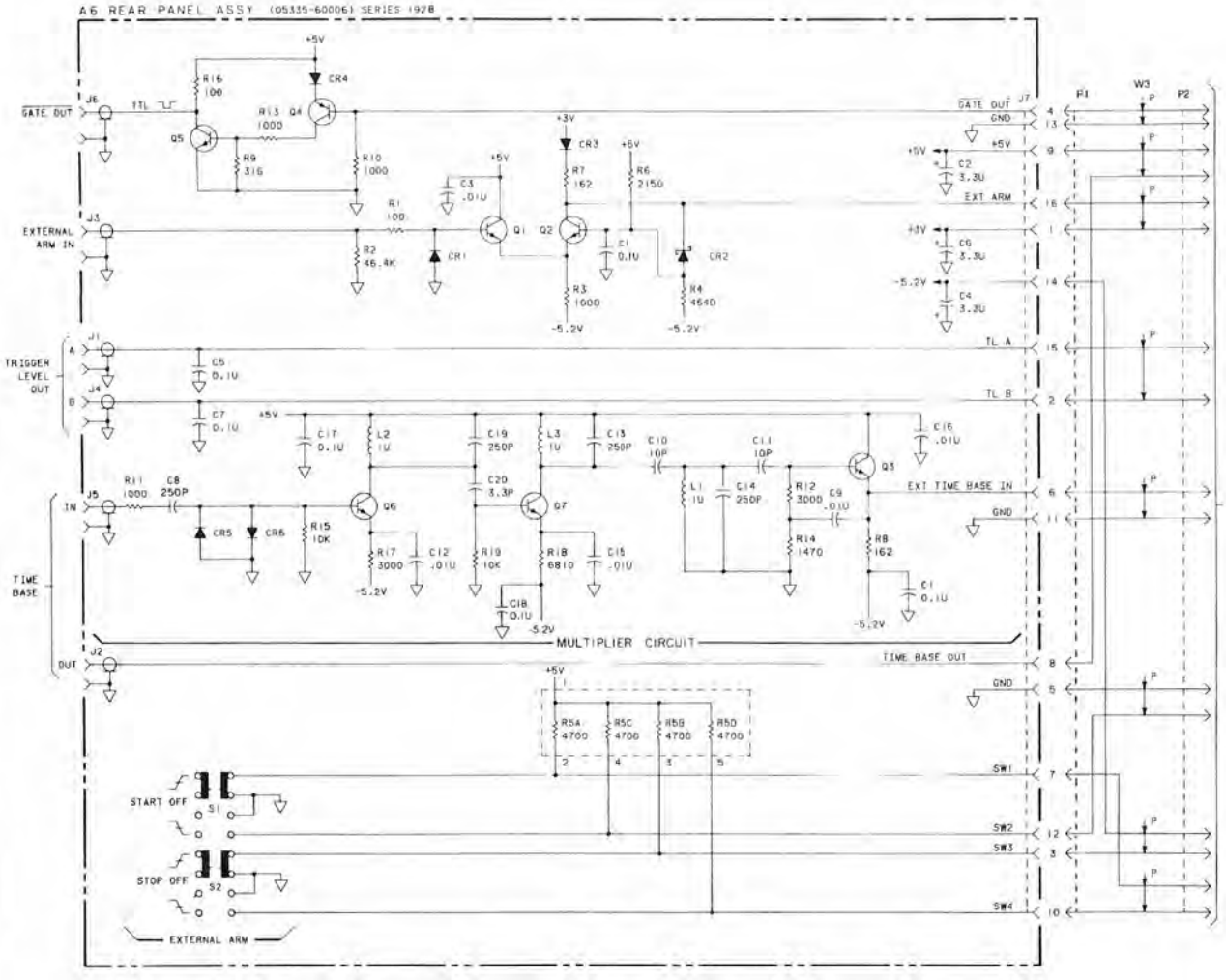


Figure 7-1. A6 (05335-60006) Series 1928 Component Locator



NOTE

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR A COMPLETE REFERENCE DESIGNATION.
2. UNLESS OTHERWISE INDICATED:
   RESISTANCE IN OHMS
   CAPACITANCE IN FARADS
   INDUCTANCE IN HENRIES
3. ASTERISK (*) INDICATES FACTORY SELECTED COMPONENT VALUE. AVERAGE VALUE SHOWN. PART MAY NOT BE IN ALL INSTRUMENTS.

REFERENCE DESIGNATOR
A6
C1-C20 CR1-CR6 J1-J7 L1-L3 R1-R19 S1, S2 Q1-Q7

TABLE OF ACTIVE COMPONENTS

A6	
REFERENCE DESIGNATION	HP PART NUMBER
CR1, 3, 5, 6, 7	1901-0050
CR2	1901-0535
Q1-3, 5-7	1854-0215
Q4	1853-0036

Figure 7-2. A6 (05335-60006) Series 1928 Schematic Diagram

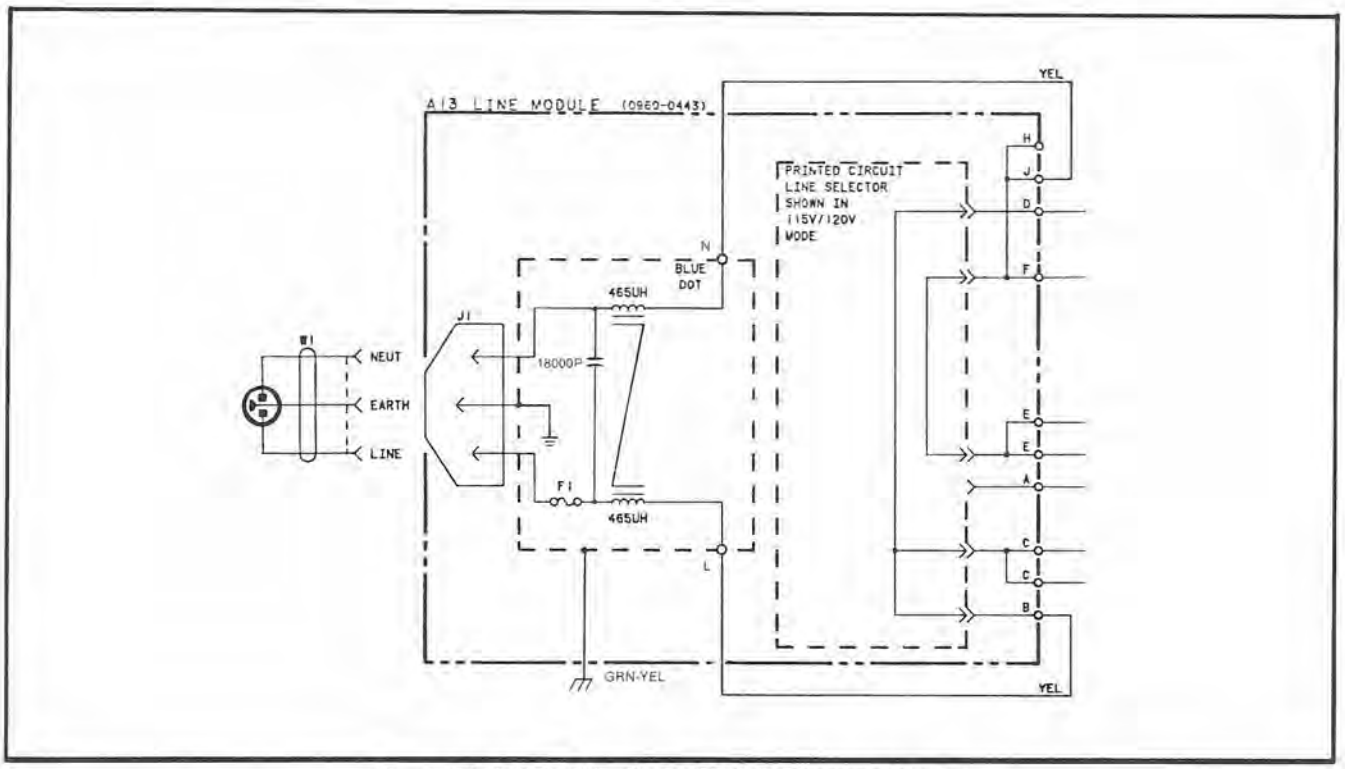


Figure 7-3. A13 Part Number 0960-0448 Schematic Diagram

7-8. SELECTED COMPONENTS (A3 SERIES 2120 OR BELOW)

7-9. Some parts in A3 (05335-60003) SERIES 2120 or below are selected during final checkout at the factory. Components are selected to provide optimum performance with other parts in the peak detector circuits as shown in *Table 7-3*.

7-10. Procedure For Selecting R7, R8, R80, or R81 in A3 Assembly

7-11. This procedure should be performed after changing any active component in the peak detector circuits or if a peak detector circuit malfunction is suspected. The resistors are located in the Channel A and Channel B peak-detector circuits; R7 and R8 in Channel B, R80 and R81 in Channel A.

7-12. To select any one or all four resistors connect a Function Generator with a 200 Hz square wave 500 mV p-p output to the 5335A Channel A input connector. Connect a 4½ digit voltmeter or digital multimeter, such as HP Model 3465A, to either end of the resistor shown in Table 7-4. To determine the correct input channel for the resistor to be selected, refer to the same table. Set 5335A front-panel controls as follows:

INPUT (CHANNELS A and B)
1 Meg/50 ohm ..... 50 ohm
AC/DC ..... DC (OUT)
ATTN ..... X1 (OUT)
FUNCTION ..... FREQ A
AUTO TRIG ..... ON (IN)
COM A ..... ON (IN)

Table 7-3. A3 Series 2120 or below Selected Components

Resistor	Peak Detector	Diodes	Capacitors
R7	B Channel, Positive	CR1, CR4, CR5	C4, C7
R8	B Channel, Negative	CR2, CR6, CR7	C5, C8
R80	A Channel, Positive	CR24, CR25, CR28	C51, C52
R81	A Channel, Negative	CR26, CR27, CR19	C53, C57

Table 7-4. Selecting A3R7, R8, R80 or R81

RESISTOR	VOLTAGE (mV)	VOLTMETER		INPUT A OR B TRIGGER LEVEL
		A3 (+)	A3 (-)	
R7	+220 to +270	R38	COM	Fully cw
R8	-220 to -270	R38	COM	Fully ccw out of PRESET
R80	+220 to +270	R54	COM	Fully cw
R81	-220 to -270	R54	COM	Fully ccw out of PRESET

7-13. The digital voltmeter should display an indication of -220 mV to -270 mV. If the voltage is less than -220 mV (i.e., -210 mV), increase the resistor value as described in paragraphs 7-14.a. and 7-14.b. If the voltage is greater than -27 mV (i.e., -280 mV), decrease the resistor value as described in paragraphs 7-14.a. and 7-14.b.

7-14. After connecting the test equipment as described in paragraph 7-12, proceed as follows:

a. When selecting the optimum value for A3R7, A3R8, A3R80, or A3R81 use a 1%, .05W resistor (NOMINAL VALUE is 147K). The following are the values and HP part numbers for resistors which may be used.

Value	HP Part No.
75K	0698-8615
100K	0698-7284
147K*	0698-7288
OPEN	——

*NOMINAL VALUE

b. Select the nominal value, 147K. Measure the voltage at the test point described in Table 7-4 for each selected resistor. If the voltage is less than specified, increase the resistance by removing the resistor (A3R7, A3R8, A3R80, or A3R81), and leaving the circuit open (∞Ω). If the voltage is greater than specified, decrease the resistance first to 100K, and if necessary to 75K.

NOTE

If one of the four values listed does NOT bring the voltage within the specified range, DO NOT SELECT ANY OTHER VALUE. Proceed as described in steps c through e.

c. The circuit that contains each factory selected resistor has a set of matched diodes, and a set of matched capacitors. The matched sets for each circuit are shown in *Table 7-3*.

d. Measure the forward voltage drop across each diode of the matched set in the circuit for the resistor you are selecting. The voltage drop across each diode should match within less than 5 mV of each other.

If the voltages do not match within 5 mV, replace all three diodes in the set (order Part Number 05335-80003 for set of four matched diodes). If the voltage match, or if replacing the diodes does not correct the problem, then proceed to the next step.

e. Check the matched capacitors in the circuit containing the resistor to be selected. Verify that both capacitors in the set are .47 μF at 1% tolerance. If they are not within the value specified, replace both capacitors. (Order Part Number 0160-4931 for matched set of two capacitors.)

SECTION VIII
SERVICE

8-1. INTRODUCTION

8-2. This section provides service information and symbol descriptions, theory of operation, troubleshooting procedures, and schematic diagrams. The arrangement of the content of this section is described in detail below. Refer to the Table of Contents for specific page and paragraph numbers.

a. SCHEMATIC DIAGRAM SYMBOLS AND REFERENCE DESIGNATIONS. Describes the symbols used on schematic diagrams and reference designators used for parts, subassemblies and assemblies.

b. IDENTIFICATION MARKINGS. Describes the method used by Hewlett-Packard for identifying printed-circuit boards and assemblies.

c. SAFETY CONSIDERATIONS. Describes the safety considerations applicable during maintenance, adjustments, and repair.

d. SAFETY SYMBOLS. Lists and describes the safety symbols used on equipment and in manuals.

e. RECOMMENDED TEST EQUIPMENT. Refers to test equipment specified in *Table 1-4*.

f. SERVICE AIDS. Information provided to assist service personnel.

g. FACTORY SELECTED COMPONENTS. Lists procedures for replacement of parts whose values are selected at time of manufacture for optimum performance.

h. LOGIC SYMBOLS. Description of logic symbols used on schematics.

i. THEORY OF OPERATION. Presents the theory of operation for the 5335A in two levels.

1. First, the Overall Counter Operation is described using the simplified block diagram. This discussion introduces the major functional circuits and briefly explains their purpose and operation during normal measurements.
2. Second, the Block Diagram Description gives an in-depth explanation of each assembly; its function and operation with respect to measurement cycles. These paragraphs reference the detailed block diagram. Included in this discussion are descriptions of the multiple-register-counter (MRC), the microprocessor system, principles of the Interpolating technique, and the use of "peak-detectors" for triggering modes.

j. TROUBLESHOOTING. Provides the troubleshooting information for the HP 5335A in the following forms:

1. DIAGNOSTICS, which are built-in to the instrument, are used in a sequence illustrated in Block Diagrams. They serve to verify, by self-check, various functional subsections of the counter's circuitry. They can be selectively activated, in isolated loops, to allow on-line testing.
2. SIGNATURE ANALYSIS, which when integrated with the specified diagnostic routines, allows on-circuit troubleshooting to component level. All instructions, signatures, and physical Test-Points are provided.
3. SCHEMATIC DIAGRAMS, for all assemblies are provided at the end of this section. They are arranged in numerical order according to the assembly number.

8-3. SCHEMATIC DIAGRAM SYMBOLS AND REFERENCE DESIGNATORS

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

8-5. Reference Designations

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

8-7. IDENTIFICATION MARKINGS ON PRINTED-CIRCUIT BOARDS

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

8-9. The assembly part number has 10 digits (such as 05335-60001) and is the primary identification. All assemblies with the same part number are inter-

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

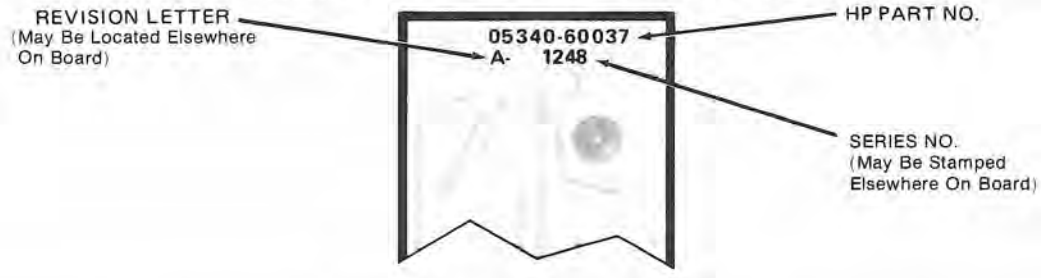
INSTRUCTION MANUAL REFERENCE

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

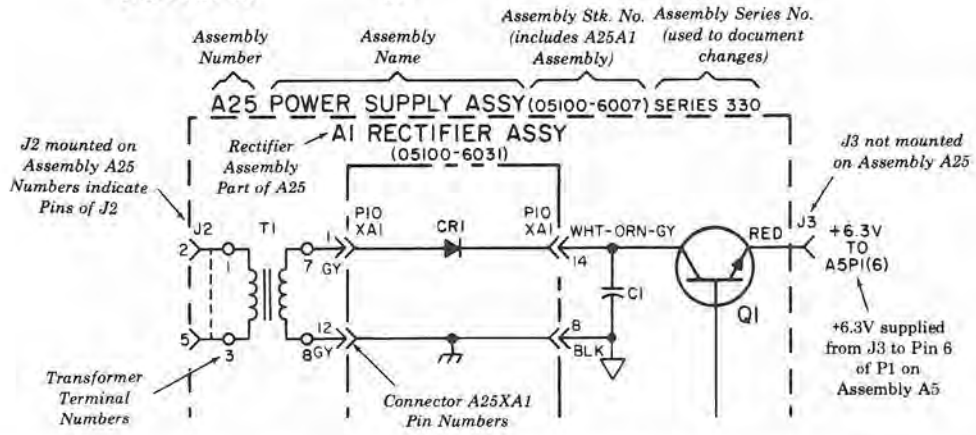


Figure 8-1. Schematic Diagram Notes

changeable. When a production change is made on an assembly that makes it incompatible with previous assemblies, a change in part number is required. The series number (such as 1936A) is used to document minor electrical changes. As changes are made, the series number is incremented. When replacement boards are ordered, you may receive a replacement with a different series number. If there is a difference between the series number marked on the board and the schematic in this manual, a minor electrical difference exists. If the number on the printed-circuit board is lower than that on the schematic, refer to Section VII for backdating information. If it is higher, refer to the looseleaf manual change sheets for this manual. If the manual change sheets are missing, contact your local Hewlett-Packard Sales and Support Office. See the listing on the back cover of this manual.

8-10. Revision letters (A, B, etc.) denote changes in printed-circuit layout. For example, if a capacitor type is changed (electrical value may remain the same) and requires different spacing for its leads, the printed-circuit board layout is changed and the revision letter is incremented to the next letter. When a revision letter changes the series number is also usually changed. The production code is the four-digit seven-segment number used for production purposes.

8-11. Assembly Identification

8-12. The assembly number, name, and Hewlett-Packard part number of 5335A assemblies are listed in *Table 8-1*.

Table 8-1. Assemblies and Major Parts Usage

REF. DES.	PART NAME	HP PART NUMBER	OPTION 010	OPTION 020	OPTION 030	OPTION 040	STAND INST.
A1	POWER SUPPLY	05335-60001	YES	YES	YES	YES	YES
A2	AMPL. SUPPORT	05335-60002	YES	YES	YES	NO	YES
A3	AMPL. BUFFER	05335-60003	YES	YES	YES	NO	YES
A4	MAIN LOGIC	05335-60004	YES	YES	YES	YES	YES
A5	DISPLAY	05335-60005	YES	YES	YES	YES	YES
A6	REAR PANEL BD	05335-61006	YES	YES	YES	YES	YES
A7	HP-IB CKT BD	05335-60007	YES	YES	YES	YES	YES
A8	DVM CKT BD	05335-60008	NOTE	YES	NOTE	NOTE	NO
A9	CHAN. "C"	05335-60009	NOTE	NOTE	YES	NOTE	NO
A10	SW PANEL	05335-60010	NOTE	NOTE	NOTE	YES	NO
A11	AMPL SUPPORT BD	05335-60011	YES	YES	YES	YES	NO
A12	PROG.AMP/BUFFER	05335-60012	YES	YES	YES	YES	NO
A13	POWER MODULE	0960-0443	YES	YES	YES	YES	YES
A14	HP-IB CONN.	05335-60014	YES	YES	YES	YES	YES
A15	10 MHz OSC.	10544-60511 OR 10811-60111	YES	NOTE	NOTE	NOTE	NO
A16	SERVICE AID BD	05335-60013	NO	NO	NO	NO	AVAIL ACCES
A17	SHIELD BD	05335-20203	NOTE	NOTE	NOTE	YES	NO
MP1	MAIN-PANEL STD.	05335-00001	YES	YES	YES	NO	YES
MP33	MAIN-PANEL 040.	05335-00013	NOTE	NOTE	NOTE	YES	NO
MP2	FILLER PANELS	05335-00002	2	1	1	2	2
MP34	PANEL-FRONT 030	05335-00007	NOTE	NOTE	YES	NOTE	NO
MP35	PANEL-FRONT 020	05335-00008	NOTE	YES	NOTE	NOTE	NO

"NOTE" INDICATES COMPATIBLE ASSEMBLIES IN OPTION CIRCUIT BOARDS.
ALL OR ANY ONE OPTION CAN BE INSTALLED IN THE 5335A.

8-13. SAFETY CONSIDERATIONS

8-14. Although this instrument has been designed in accordance with international safety standards, this manual contains information, cautions, and warnings which must be followed to ensure safe operation and to retain the instrument in safe condition. Service and adjustments should be performed only by service-trained personnel.

WARNING

ALL PROTECTIVE EARTH TERMINALS, EXTENSION CORDS, AUTOTRANSFORMERS AND DEVICES CONNECTED TO THE INSTRUMENT 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.

ONLY THE 250V FUSES WITH THE REQUIRED RATED CURRENT AND SPECIFIED TYPE SHOULD BE USED. DO NOT USE REPAIRED FUSES OR SHORT CIRCUITED FUSEHOLDERS. TO DO SO COULD CAUSE A SHOCK OR FIRE HAZARD.

8-15. Any adjustment, maintenance, and repair of the opened instrument under voltage should be avoided as much as possible and, when inevitable, should be carried out only by a skilled person who is aware of the hazard involved.

8-16. Capacitors inside the instrument may still be charged even if the instrument has been disconnected from its source of power.

WARNING

POWER IS ALWAYS PRESENT AT THE POWER 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.

8-17. Make sure that only fuses with the required rated current and of the specified type (normal blow, time delay, etc.) are used for replacement. The use of repaired fuses and the short-circuiting of fuseholders must be avoided. Whenever it is likely that this protection has been impaired, the 5335A must be made inoperative and be secured against any unintended operation.

WARNING

THE SERVICE INFORMATION IS OFTEN USED WITH POWER SUPPLIED AND PROTECTIVE COVERS REMOVED FROM THE 5335A. ENERGY AVAILABLE AT MANY POINTS MAY, IF CONTACTED, RESULT IN PERSONAL INJURY.

CAUTION

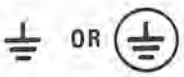
Series pass transistor cases on rear panel have voltage on them and require insulators between them and the heatsink. Power supply damage is inevitable if transistor cases are shorted to the chassis.

8-18. Safety Symbols

8-19. The following safety symbols are used on equipment and in manuals:

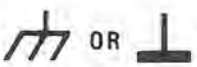
Instruction manual symbol. The product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect against damage to the instrument.

Indicates dangerous voltage (terminals fed 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.

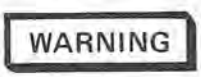


Frame and chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.

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 is not correctly performed or adhered to, could result in damage to or destruction of part all of the product.

8-20. RECOMMENDED TEST EQUIPMENT

8-21. Test equipment and test equipment accessories required to maintain the 5335A are listed in *Table 1-4*. Equipment other than that listed may be used if it meets the listed critical specifications.

8-22. SERVICE AIDS

8-23. Pozidriv Screwdrivers

8-24. Many screws in the 5355A appear to be Phillips, but are not. To avoid damage to the screw slots, Pozidriv screwdrivers should be used.

8-25. Service Aids on Printed Circuit Boards

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

8-27. How to Use the A16 Service Aid Board (05335-60013)

8-28. A 5335A Service Aid board is available that can facilitate the testing of the A4U28 Microprocessor address lines and the A4U22 and U23 ROMs data lines using the signature analysis technique. The part number for the Service Aid board is 05335-60013.

8-29. For convenience, when testing the A4U28 Microprocessor address lines, the Signature Analyzer can be connected to the A16 assembly directly (connections for CLOCK, START, STOP, and GROUND exist on the board). However, for testing the ROMs data lines the Signature Analyzer CLOCK Pod lead should be connected to the test pin marked "CK2" (located next to A4U23) when testing A4U23, and to "CK3" (located next to A4U22) when testing A4U22.

8-30. Complete instructions for use of the service aid board are given in the troubleshooting part of this section.

8-31. FACTORY SELECTED COMPONENTS

8-32. Some component values are selected at the time of final checkout at the factory. These values are selected to provide optimum compatibility with associated components and are identified on schematics and parts lists by an asterisk (*). The recommended procedure for replacing a factory-selected part is as follows:

a. Refer to paragraphs 8-33 through 8-35 for test procedures required for selection of critical value parts.

b. For factory selected components that are not listed in paragraphs 8-33 through 8-35, use the original value.

c. After replacing parts, perform the test specified for the circuit in the performance and adjustment sections of this manual to verify correct operation.

8-33. Procedure to Select A3R83 on the Amplifier Buffer Assembly

SELECTED VALUES	from 1.21K to 15K
NOMINAL VALUE	2.7K

a. Connect the SIGNAL OUT from the function generator (HP 3325A) to the 5335A Channel A INPUT, and to the B INPUT on the oscilloscope (HP 1725A).

b. Connect the A PROBE from the oscilloscope to resistor R39 on the A2 assembly (A2R39), between R39 and the anode of CR7.

c. Set the 3325A (function generator):

FREQUENCY ..... 1 kHz sine wave
AMPLITUDE ..... 100 mV p-p
DC OFFSET 0

d. Set the 1725A (oscilloscope):

DISPLAY ..... X-Y FUNCTION
CHANNEL A VOLTS/DIV ..... to .05
CHANNEL A INPUT ..... 1M ohm, DC
CHANNEL B VOLTS/DIV ..... to .01
CHANNEL B INPUT ..... 50 ohm, DC

e. Set the 5335A:

FUNCTION ..... TIME A→B
COM A ..... OFF (OUT)
AUTO TRIG ..... OFF (OUT)
EXT ARM ENABLE ..... OFF
INPUT (CHANNELS A and B):
1M/50 ohm ..... 1M (OUT)
AC/DC ..... DC (OUT)
X10 ATTN ..... OFF (OUT)
TRIGGER LEVELS . PRESET (fully CCW)

f. Set the oscilloscope for the X-Y mode, and calibrate by centering the dot at center screen.

g. Adjust A3R96 (offset) to position the waveform at the center of the scope screen. Adjust A3R88 (hysteresis) for 18 to 20 mV p-p on the X-axis.

h. If the waveform is less than 18 mV p-p, then decrease the value of A3R83. If the waveform is greater than 20 mV p-p, increase the value of A3R83.

8-34. Procedure to Select A3R29 on the Amplifier Buffer Assembly

a. Connect the Signal OUT from the function generator (HP 3325A) to the 5335A Channel B INPUT, and to the B INPUT on the oscilloscope (HP 1725A).

b. Connect the A PROBE from the oscilloscope to resistor R33 on the A2 assembly (A2R33), between R33 and the anode of CR6.

c. Set the test equipment as described in the procedure to select A3R83, (paragraph 8-33 steps c through e).

d. Set the oscilloscope for the X-Y mode, and calibrate by centering the dot at center screen.

e. Adjust A3R47 (offset) to position the waveform at the center of the scope screen. Adjust A3R37 (hysteresis) for 18 to 20 mV p-p on the X-axis.

f. If the waveform is less than 18 mV p-p, then decrease the value of A3R29. If the waveform is greater than 20 mV p-p, increase the value of A3R29.

8-35. Procedure to Select the X10 Compensating Capacitors A3C37 And A3C23

a. Connect the 8640B Signal Generator RF output to 5335A input A as shown in *Figure 8-2*.

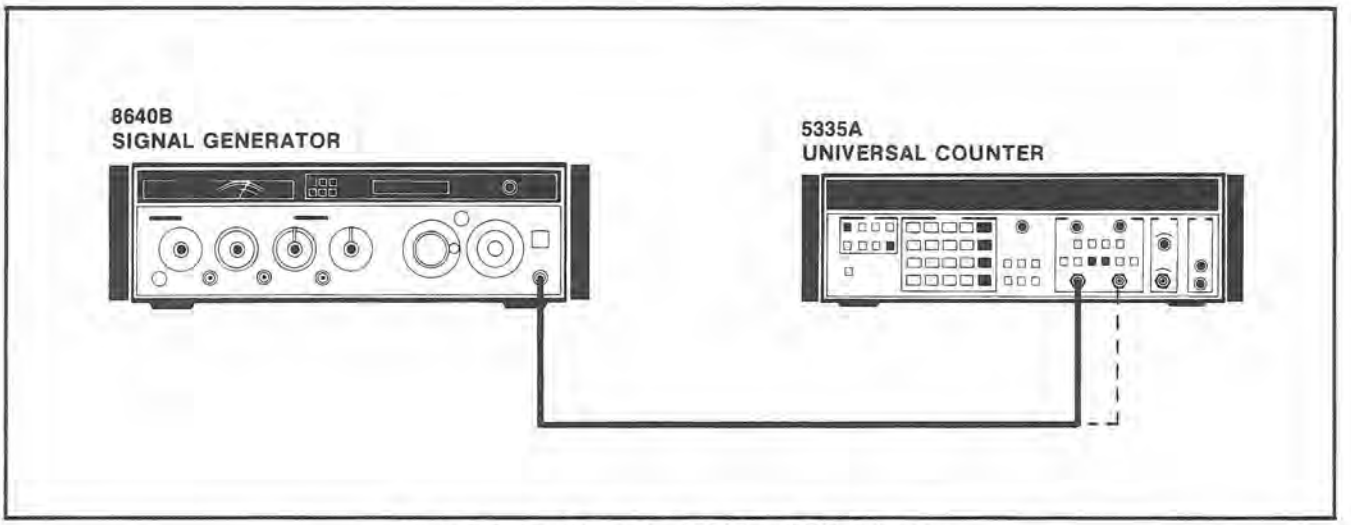


Figure 8-2. Test Setup for A3C37 and C23 Selection

b. Set 5335A front panel controls as follows:

FUNCTION ..... FREQ A
GATE MODE ..... NORM
CYCLE ..... NORM
INPUT (CHANNELS A and B):
1 M/50 ohm ..... 50 ohm
TRIGGER LEVEL ..... PRESET
X10/X1 ATTEN X1
AC/DC ..... DC
COM A ..... OUT
AUTO TRIG ..... OUT

c. Set the 8640B to output a 10 MHz signal at 25 mV rms. Verify that the 5335A counter displays the frequency output of the signal generator.

d. Reduce the signal level slowly until the 5335A stops giving the correct reading; record this level (minimum sensitivity).

e. Set the generator to output a 100 MHz at 25 mV rms and repeat step d. Do the same at 200 MHz. Record all readings.

f. Set Channel A attenuator to X10 and repeat steps c through e above, adjusting the signal generator output.

g. Take the ratio of the readings of minimum sensitivity of X10 to X1 at 10 MHz, 100 MHz and 200 MHz. If the ratio is greater than 14, use the 18 pF capacitor (P/N 0160-4492); if the ratio is less than 6, use the 27 pF capacitor (P/N 0160-4493). This is summarized in the following table:

Ratio	Capacitor Value, pF	HP P/N
>14	18	0160-4492
<6	27	0160-4493

Nominal value for A3C37 and C23: 22 pF, P/N 0160-3875.

h. Repeat steps c through g to verify that the ratio is between 7 and 13. If it is outside this range, then a problem exists elsewhere.

i. Connect the signal generator to the 5335A Input B; set the 8640B to output a 10 MHz signal at 25 mV rms. Set 5335A to frequency B by pressing SCALE, SMOOTH, 1, 7, ENTER; verify the 5335A displays the frequency of the generator.

j. Repeat steps d through h, checking the ratio at 10 MHz, 50 MHz and at 100 MHz.

8-36. LOGIC SYMBOLS

8-37. The electronic symbology used in this book is explained starting in paragraphs 8-38.

8-38. EXPLANATION OF NEW LOGIC SYMBOLS (by F.A. Mann)*

8-39. Introduction

8-40. The International Electrotechnical Commission (IEC) has been developing a very powerful symbolic

*From "1981 Supplement to the TTL Data Book for Design Engineers", copyright © 1981 Texas Instruments Incorporated. Reproduced by permission.

language that can show the relationship of each input of a digital logic circuit to each output without showing explicitly the internal logic. At the heart of the system is dependency notation, which will be explained in a later paragraph.

8-41. The system was introduced in the USA in a rudimentary form in IEEE/ANSI Standard Y32.14-1973. Lacking at that time a complete development of dependency notation, it offered little more than a substitution of rectangular shapes for the familiar distinctive shapes for representing the basic functions of AND, OR, negation, etc. This is no longer the case.

8-42. Internationally, Working Group 2 of IEC Technical Committee TC-3 is preparing a new document (Publication 617-12) that will consolidate the original work started in the mid 1960's and published in 1972 (Publication 117-15) and the amendments and supplements that have followed. Similarly for the USA, IEEE Committee SCC 11.9 is revising the publication IEEE Standard 91/ANSI Y32.14. Texas Instruments (and Hewlett-Packard) is participating in the work of both organizations and (a) Supplement to the (Texas Instruments) TTL Data Book introduces new logic symbols in anticipation of the new standards. When changes are made as the standards develop, future editions of the TTL Data Book will take those changes into account.

8-43. The following explanation of the new symbolic language is necessarily brief and greatly condensed from what the standards publications will finally contain. This (description) is not intended to be sufficient for those people who will be developing symbols for new devices. It is primarily intended to make possible the understanding of the symbols used in this book; comparing the symbols with functional block diagrams and/or function tables will further help that understanding.

8-44. Symbol Composition

8-45. A symbol comprises an outline or a combination of outlines together with one or more qualifying symbols (characters). The shape of the symbols (outline) is not significant. As shown in *Figure 8-3*, general qualifying symbols are used to tell exactly what logical operation is performed by the elements. *Table 8-2* shows the general qualifying symbols used in the T.I. TTL data book. Input lines are placed on the left and output lines are placed on the right. When an exception is made to that convention, the direction of signal flow is indicated by an arrow as shown in *Table 8-3*.

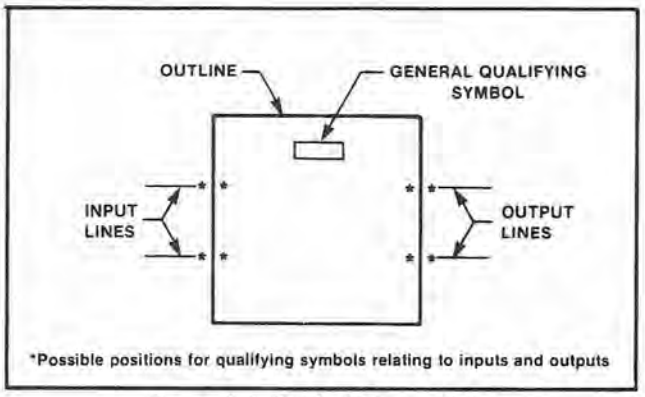


Figure 8-3. Symbol Composition

8-46. All outputs of a single, unsubdivided element always have identical internal logic states determined by the function of the element except when otherwise indicated by an associated qualifying symbol or label inside the element.

8-47. The outlines of elements may be abutted (adjoining) or embedded (enclosed) in which case the following conventions apply. There is no logic connection between the elements when the line common to their outlines is in the direction of signal flow. There is at least one logic connection between the elements when the line common to their outlines is perpendicular to the direction of signal flow. The number of logic connections between elements will be clarified by the use of qualifying symbols and this is discussed further under that topic. If no indications are shown on either side of the common line, it is assumed there is only one connection.

8-48. When a circuit has one or more inputs that are common to more than one element of the circuit, the common-control block may be used. This is the only distinctively shaped outline used in the IEC system.

8-49. *Figure 8-4* shows that unless otherwise qualified by dependency notation, an input to the common-control block is an input to each of the elements below the common-control block.

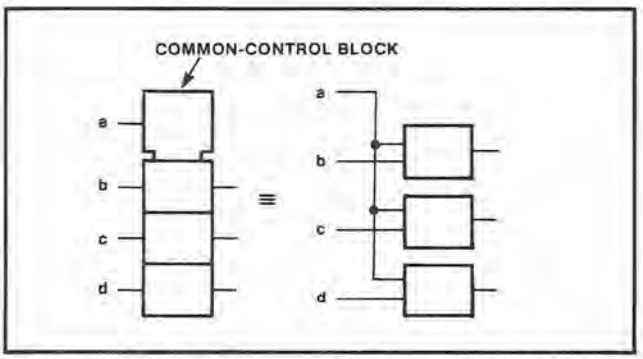


Figure 8-4. Illustration of Common-Control Block

8-50. A common output depending on all elements of the array can be shown as the output of a common-output element. Its distinctive visual feature is the double line at its top. In addition the common-output element may have other inputs as shown in *Figure 8-5*. The function of the common-output element must be shown by use of a general qualifying symbol.

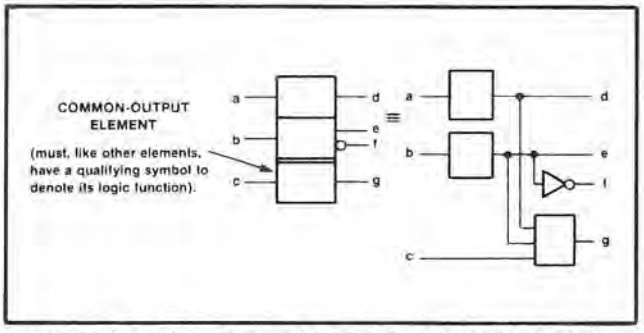


Figure 8-5. Illustration of Common-Output Element

8-51. Qualifying Symbols

8-52. GENERAL QUALIFYING SYMBOLS. *Table 8-2* shows the general symbols used in this data book. These characters are placed near the top center or the geometric center of a symbol or symbol element to define the basic function of the device represented by the symbol or of the element.

8-53. QUALIFYING SYMBOLS FOR INPUTS AND OUTPUTS. Qualifying symbols for inputs and outputs are shown in *Table 8-3* and will be familiar to most users with the possible exception of the logic polarity and analog signal indicators. The older logic negation indicator means that the external 0 (zero) state produces the internal 1 state. The internal 1 state means the active state. Logic negation may be used in pure logic diagrams; in order to tie the external 1 and 0 logic states to the level H (high) and L (low), a

Table 8-2. General Qualifying Symbols

SYMBOL	DESCRIPTION	EXAMPLE
&	AND gate or function.	SN7400
≥1	OR gate or function. The symbol was chosen to indicate that at least one active input is needed to activate the output.	SN7402
=1	Exclusive OR. One and only one input must be active to activate the output.	SN7486
=	Logic identity. All inputs must stand at same state.	SN74180
2k	An even number of inputs must be active.	SN74180
2k+1	An odd number of inputs must be active.	*
1	The one input must be active.	SN7404
▷ or ◁	A buffer or element with more than usual output capability (symbol is oriented in the direction of signal flow).	SN74S436
⊓	Schmitt trigger; element with hysteresis.	SN74LS18
X/Y	Coder, code Converter (DEC/BCD, BIN/OCT, BIN/7-SEG, etc.).	SN74LS347
MUX	Multiplexer/data selector.	SN74150
DMUX or DX	Demultiplexer.	SN74138
Σ	Adder.	SN74LS385
P—Q	Subtracter.	SN74LS385
CPG	Look-ahead carry generator.	SN74182
π	Multiplier.	SN74LS384
COMP	Magnitude Comparator.	SN74LS682
ALU	Arithmetic logic unit.	SN74LS381
⊓	Retriggerable monostable.	SN74LS422
1⊓	Nonretriggerable monostable (one-shot)	SN74121
G	Astable element. (Showing waveform is optional.)	SN74LS320

*Not all of the general qualifying symbols have been used in this book, but they are included here for the sake of completeness.

Table 8-2. General Qualifying Symbols (Continued)

SYMBOL	DESCRIPTION	EXAMPLE
!G	Synchronously starting astable.	SN74LS624
G!	Astable element that stops with a completed pulse.	SN74LS624
SRGm	Shift register. m = number of bits.	SN74LS595
CTRm	Counter. m = number of bits; cycle length = 2m.	SN54LS590
CTR DIVm	Counter with cycle length = m.	SN74LS668
ROM	Read-only memory.	*
RAM	Random-access read/write memory.	SN74170
FIFO	First-in, first-out memory.	SN74LS222

statement of whether positive logic (1=H, 0=L) or negative logic (1=L, 0=H) is being used is required or must be assumed. Logic polarity indicators eliminate the need for calling out the logic convention and are used in this (T.I.) data book in the symbology for actual devices. The presence of the triangular polarity indicator indicates that the Low logic level will produce the internal 1 state (the active state) or that, in the case of an output, the internal 1 state will produce the external Low level. Note how the active direction of transition for a dynamic input is indicated in positive logic, negative logic, and with polarity indication.

8-54. The internal connections between logic elements abutted together in a symbol may be indicated by the symbols shown. Each logic connection may be shown by the presence of qualifying symbols at one or both sides of the common line and if confusion can arise about the numbers of connections, use can be made of one of the internal connection symbols.

8-55. The internal (virtual) input is an input originating somewhere else in the circuit and is not connected directly to a terminal. The internal (virtual) output is likewise not connected directly to a terminal.

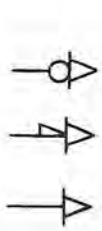
8-56. The application of internal inputs and outputs requires an understanding of dependency notation, which is explained in paragraph 8-65.

8-57. In an array of elements, if the same general qualifying symbol and the same qualifying symbols associated with inputs and outputs would appear inside each of the elements of the array, these qualifying symbols are usually shown only in the first element. This is done to reduce clutter and to save time in recognition. Similarly, large identical elements that are subdivided into smaller elements may each be represented by an unsubdivided outline. The SN54LS440 symbol illustrates this principle.

8-58. SYMBOLS INSIDE THE OUTLINE. *Table 8-4* shows some symbols used inside the outline. Note particularly that open-collector, open-emitter, and three-state outputs have distinctive symbols. Also note that an EN input affects all the outputs of the circuit and has no effect on inputs. When an enable input affects only certain outputs and/or affects one or more inputs, a form of dependency notation will indicate this (see paragraph 8-100). The effects of the EN input on the various types of outputs are shown.

8-59. It is particularly important to note that a D input is always the data input of a storage element. At its internal 1 state, the D input sets the storage element to its 1 state, and at its internal 0 state it resets the storage element to its 0 state.

Table 8-3. Qualifying Symbols for Inputs and Outputs

	Logic negation at input. External 0 produces internal 1.
	Logic negation at output. Internal 1 produces external 0.
	Active-low input. Equivalent to in positive logic.
	Active-low output. Equivalent to in positive logic.
	Active-low input in the case of right-to-left signal flow.
	Active-low output in the case of right-to-left signal flow.
	Signal flow from right-to-left. If not otherwise indicated, signal flow is from left-to-right.
	Bidirectional signal flow.
	Dynamic inputs active on indicated transition. POSITIVE LOGIC: 1→0; NOT USED; 0→1. NEGATIVE LOGIC: 0→1; NOT USED; 1→0. POLARITY INDICATION: NOT USED; H→L; L→H.
	Nonlogic connection.A label inside the symbol will usually define the nature of this pin.
	Input for analog signals.
	Internal connection. 1 state on left procudes 1 state on right.
	Negated internal connection. 1 state on left produces 0 state on right.
	Dynamic internal connection. Transition from 0 to 1 on left produces transitory 1 state on right.
	Internal input (virtual input). It always stands at its internal 1 state unless affected by an overriding dependency relationship.
	Internal output (virtual output). Its effect on an internal input to which it is connected is indicated by dependency notation.

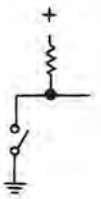
8-60. The binary grouping symbol will be explained more fully in paragraph 8-136. Binary-weighted inputs are arranged in order and the binary weights of the least-significant and the most-significant lines are indicated by numbers. In this data book weights of input and outupt lines will be represented by powers of two usually only when the binary grouping symbol is used, otherwise, decimal numbers will be used. The grouped inputs generate an internal number on which a mathematical function can be performed or that can be an identifying number for dependency notation. See *Figure 8-31*. A frequent use is in addresses for memories.

8-61. Reversed in direction, the binary grouping symbol can be used with outputs. The concept is analogous to that for the inputs and the weighted outputs will indicate the internal number assumed to be developed within the circuit.

8-62. Other symbols are used inside the outlines in this data book in accordance with the IEC/IEEE standards but are not shown here. Generally these are associated with arithmetic operations and are self-explanatory.

8-63. When nonstandardized information is shown inside an outline, it is usually enclosed in square brackets [like these].

Table 8-4. Symbols Inside the Outline

⌐⊢	Postponed output (of a pulse-triggered flip-flop). The output changes when input initiating change (e.g., a C input) returns to its initial external state or level.
⊣⊓	Bi-threshold input (input with hysteresis).
◇⊢	NPN open-collector or similar output that can supply a relatively low-impedance L level when not turned off. Requires external pull-up. Capable of positive-logic wired-AND connection. 
◈⊢	Passive-pull-up output is similar to NPN open-collector output but is supplemented with a built-in passive pull-up.
◇⊢	NPN open-emitter or similar output that can supply a relatively low-impedance H level when not turned off. Requires external pull-down. Capable of positive-logic wired-OR connection. 
◈⊢	Passive-pull-down output is similar to NPN open-emitter output but is supplemented with a built-in passive pull-down.
▽⊢	Three-state output.
⊣ EN	Enable input When at its internal 1-state, all outputs are enabled. When at its internal 0-state, open-collector and open-emitter outputs are off, three-state outputs are at normally defined internal logic states and at external high-impedance state, all all other outputs (e.g., totem-poles) are at the internal 0-state.
J, K, R, S, T	Usual meanings associated with flip-flop (e.g., R = reset, T = toggle).
⊣ D	Data input to a storage element equivalent to: 
⊣ -m ⊣ +m	Shift right (left) inputs, m = 1, 2, 3, etc. If m = 1, it is usually not shown.
⊣ +m ⊣ -m	Counting up (down) inputs, m = 1, 2, 3, etc. If m = 1, it is usually not shown.
o m	Binary grouping. m is highest power of 2.
⊣ CT = 15	The contents-setting input, when active, causes the content of a register to take on the indicated value.
CT = 9 ⊢	The content output is active if the content of the register is as indicated.
⊓	Input line grouping .... indicates two or more terminals used to implement a single logic input. e.g., The paired expander inputs of SN7450. 
"1" ⊢	Fixed-state output always stands at its internal 1 state. For example, see SN74185.

8-64. Dependency Notation

8-65. GENERAL EXPLANATION. Dependency notation is the powerful tool that sets the IEC symbols apart from previous systems and makes compact, meaningful, symbols possible. It provides the means of denoting the relationship between inputs, outputs, or inputs and outputs without actually showing all the elements and interconnections involved. The information provided by dependency notation supplements that provided by the qualifying symbols for an element's function.

8-66. In the convention for the dependency notation, use will be made of the terms "affecting" and "affected". In cases where it is not evident which inputs must be considered as being the affecting or the affected ones (e.g., if they stand in an AND relationship), the choice may be made in any convenient way.

8-67. So far, 11 types of dependency have been defined and 10 of these are used in the Texas Instruments data book. They are listed below in the order in which they are presented and are summarized in *Table 8-5*.

Paragraph	Dependency Type or Other Subject
8-68	G, AND
8-72	General rules for dependency notation
8-79	V, OR
8-81	N, Negate, (Exclusive OR)
8-83	Z, Interconnection
8-86	X, Transmission
8-90	C, Control
8-93	S, Set and R, Reset
8-100	EN, Enable
8-103	M, Mode
8-116	A, Address

Table 8-5. Summary of Dependency Notation

TYPE OF DEPENDENCY	LETTER SYMBOL*	AFFECTING INPUT AT ITS 1-STATE	AFFECTING INPUT AT ITS 0-STATE
Address	A	Permits action (address selected)	Prevents action (address not selected)
Control	C	Permits action	Prevents action
Enable	EN	Permits action.	Prevents action of inputs. ◇ outputs off. ▽ outputs at external high impedance, no change in internal logic state. Other outputs at internal 0 state.
AND	G	Permits action	Imposes 0 state
Mode	M	Permits action (mode selected)	Prevents action (mode not selected)
Negate (X-OR)	N	Complements state	No effect.
RESET	R	Affected output reacts as it would to S = 0, R = 1	No effect
SET	S	Affected output reacts as it would to S = 1, R = 0	No effect
OR	V	Imposes 1 state	Permits action
Transmission	X	Bidirectionally connected input to output	Input to output bidirectionally not connected
Interconnection	Z	Imposes 1 state	Imposes 0 state

*These letter symbols appear at the AFFECTING input (or output) and are followed by a number. Each input (or output) AFFECTED by that input is labeled with that same number. When the labels EN, R, and S appear at inputs without the following numbers, the descriptions above do not apply. The action of these inputs is described under "Symbols Inside the Outline".

8-68. G (AND) DEPENDENCY. A common relationship between two signals is to have them ANDed together. This has traditionally been shown by explicitly drawing an AND gate with the signals connected to the inputs of the gate. The 1972 IEC publication and the 1973 IEEE/ANSI standard showed several ways to show this AND relationship using dependency notation. While nine other forms of dependency have since been defined, the ways to invoke AND dependency are now reduced to one.

8-69. In *Figure 8-6* input **b** is ANDed with input **a** and the complement of **b** is ANDed with **c**. The letter G has been chosen to indicate AND relationships and is placed at input **b**, inside the symbol. A number considered appropriate by the symbol designer (1 has been used here) is placed after the letter G and also at each affected input. Note the bar over the 1 at input **c**.

8-70. In *Figure 8-7*, output **b** affects input **a** with an AND relationship. The lower example shows that it is the internal logic state of **b**, unaffected by the negation sign, that is ANDed. *Figure 8-8* shows input **a** to be ANDed with a dynamic input **b**.

8-71. The rules for G dependency can be summarized thus:

> When a G*m* input or output (*m* is a number) stand at its internal 1 state, all inputs and outputs affected by G*m* stand at their normally defined internal logic states. When the G*m* input or output stands at its 0 state, all inputs and outputs affected by G*m* stand at their internal 0 states.

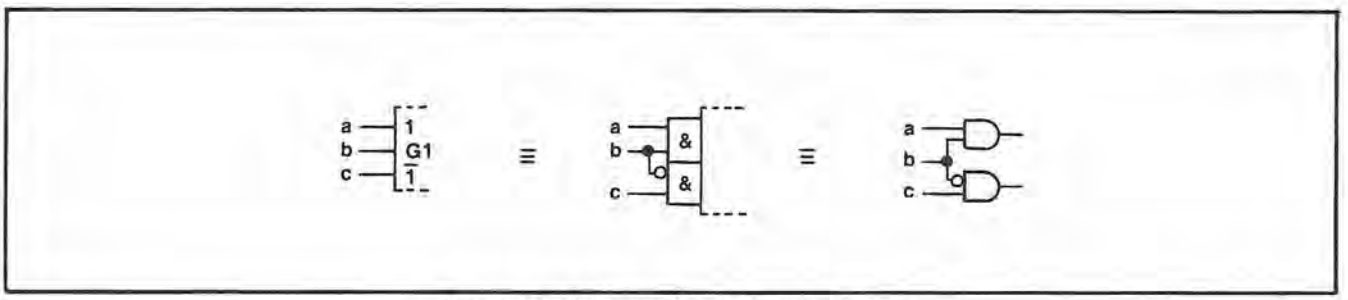


Figure 8-6. G Dependency Between Inputs

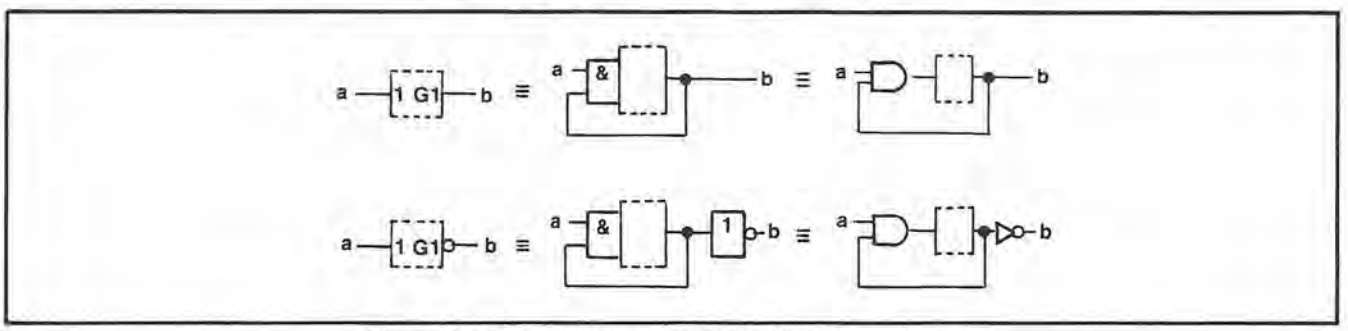


Figure 8-7. G Dependency Between Outputs and Inputs

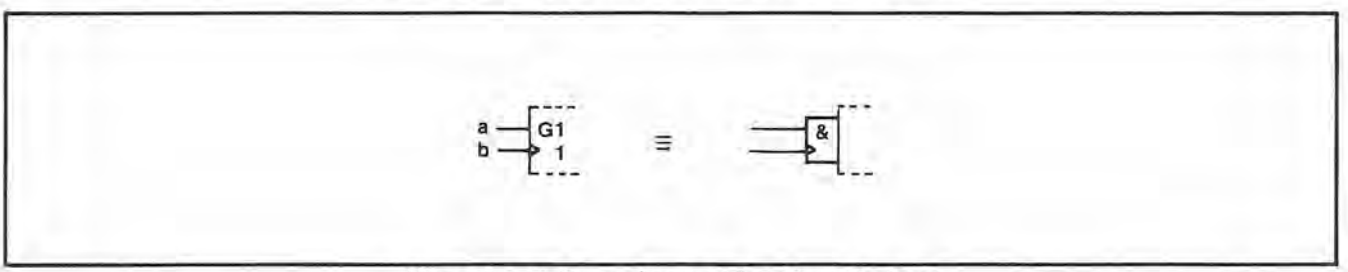


Figure 8-8. G Dependency with A Dynamic Input

8-72. CONVENTIONS FOR THE APPLICATION OF DEPENDENCY NOTATION IN GENERAL. The rules for applying dependency relationships in general follow the same pattern as was illustrated for G dependency.

8-73. Application of dependency notation is accomplished by:

a. Labeling the input (or output) affecting other inputs or outputs with the letter symbol indicating the relationship involved (e.g., G for AND) followed by an identifying number, appropriately chosen, and;

b. Labeling each input or output affected by that affecting input (or output) with the same number.

8-74. If it is the complement of the internal logic state of the affecting input or output that does the affecting, then a bar is placed over the identifying numbers at the affected inputs or outputs. See *Figure 8-6.*

8-75. If two affecting inputs or outputs have the same letter and same identifying number, they stand in an OR relationship to each other. See *Figure 8-9.*

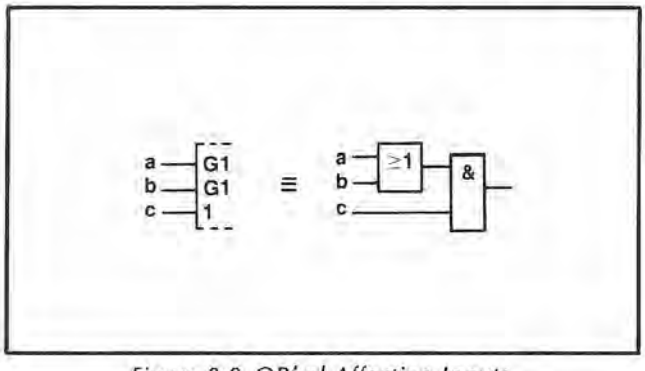


Figure 8-9. OR'ed Affecting Inputs

8-76. If the affected input or output requires a label to denote its function (e.g., "D"), this label will be prefixed by the identifying number of the affecting input. See *Figure 8-15.*

8-77. If an input or output is affected by more than one affecting input, the identifying numbers of each of the affecting inputs will appear in the label of the affected one, separated by commas. The normal reading order of these numbers is the same as the sequence of the affecting relationships. See *Figure 8-15.*

8-78. If the labels denoting the functions of affected inputs or outputs must be numbers (e.g., outputs of a coder), the identifying numbers to be associated with both affecting inputs and affected inputs or outputs will be replaced by another character selected to avoid ambiguity, e.g., Greek letters. See *Figure 8-10.*

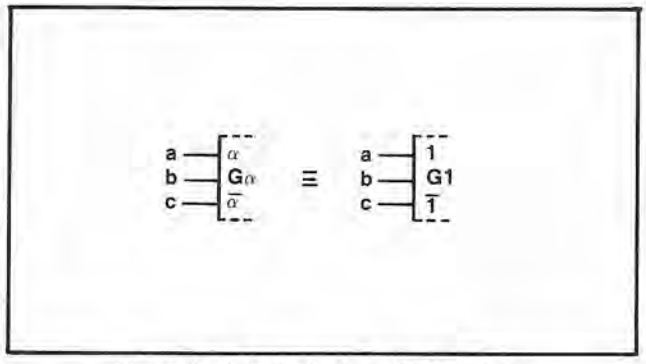


Figure 8-10. Substitution for Numbers

8-79. V (OR) DEPENDENCY. The symbol denoting OR dependency is the letter V. See *Figure 8-11.*

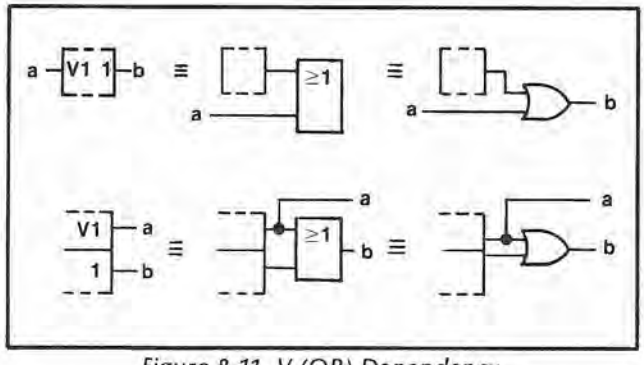


Figure 8-11. V (OR) Dependency

8-80. When a V*m* input or output stands at its internal 1 state, all inputs and outputs affected by V*m* stand at their internal 1 states. When the V*m* input or output stands at its internal 0 state, all inputs and outputs affected by V*m* stand at their normally defined internal logic states.

8-81. N (NEGATE, X-OR) DEPENDENCY. The symbol denoting negate dependency is the letter N. See *Figure 8-12.* Each input or output affected by an N*m* input or output stands in an exclusive-OR relationship with the N*m* input or output.

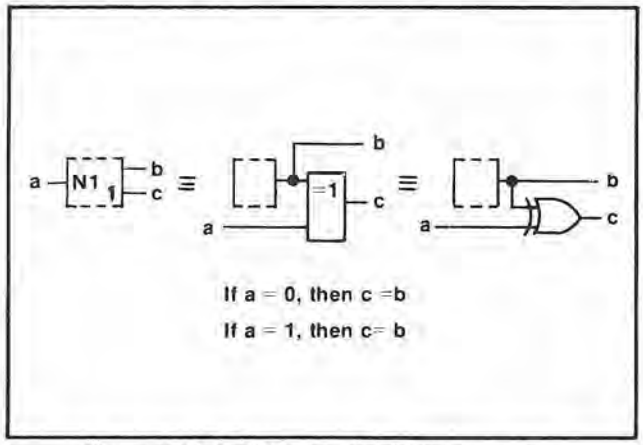


Figure 8-12. N (Negate, X-OR) Dependency

8-82. When an N*m* input or output stands at its internal 1 state, the internal logic state of each input and each output affected by N*m* is the complement of what it would otherwise be. When an N*m* input or output stands at its internal 0 state, all inputs and outputs affected by N*m* stand at their normally defined internal logic states.

8-83. Z (INTERCONNECTION) DEPENDENCY. The symbol denoting interconnection dependency is the letter Z.

8-84. Interconnecting dependency is used to indicate the existence of internal logic connections between inputs, outputs, internal inputs, and/or internal outputs.

8-85. The internal logic state of an input or output affected by a Z*m* input or output will be same as the internal logic state of the Z*m* input or output, unless modified by additional dependency notation. See *Figure 8-13*.

NOTE

Paragraphs 8-86 to 8-89 and *Figure 8-14* are not taken from Texas Instruments publications.

8-86. X (TRANSMISSION) DEPENDENCY. The symbol X denotes transmission dependency.

8-87. When an X*m* input or an X*m* output stands at its internal 1 state, all input-output lines affected by this X*m* input or X*m* output are bidirectionally connected together and stand at the same internal logic state or analog signal level.

8-88. When a X*m* input or X*m* output stands at its internal 0 state, the connection associated with this set of dependency notation is broken.

8-89. If **a** stands at its 1 state, there is a bidirectional connection between **b** and **c**. If **a** stands at its 0 state, there is a bidirectional connection between **c** and **d**. See *Figure 8-14*.

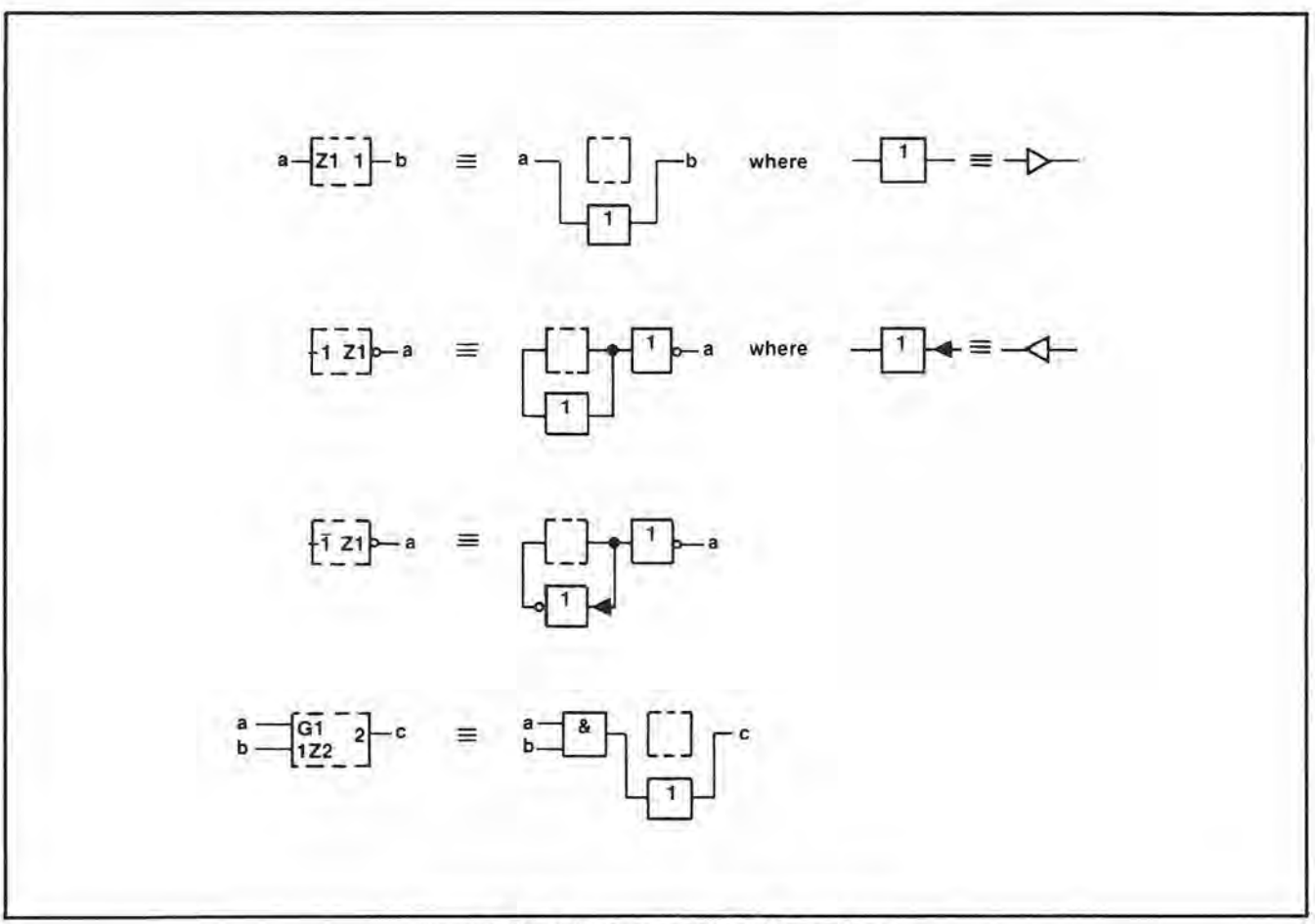


Figure 8-13. Z (Interconnection) Dependency

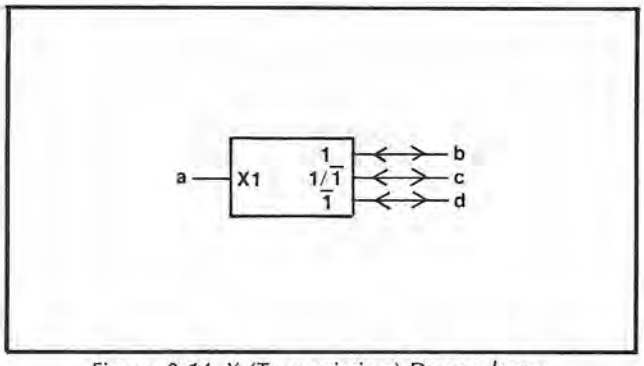


Figure 8-14. X (Transmission) Dependency

8-90. C (CONTROL) DEPENDENCY. The symbol denoting control dependency is the letter C.

8-91. Control inputs are usually used to enable or disable the data (D, J, K, R, or S) inputs of storage elements. They may take on their internal 1 states (be active) either statically or dynamically. In the latter case the dynamic input symbol is used as shown in the third example of *Figure 8-15*.

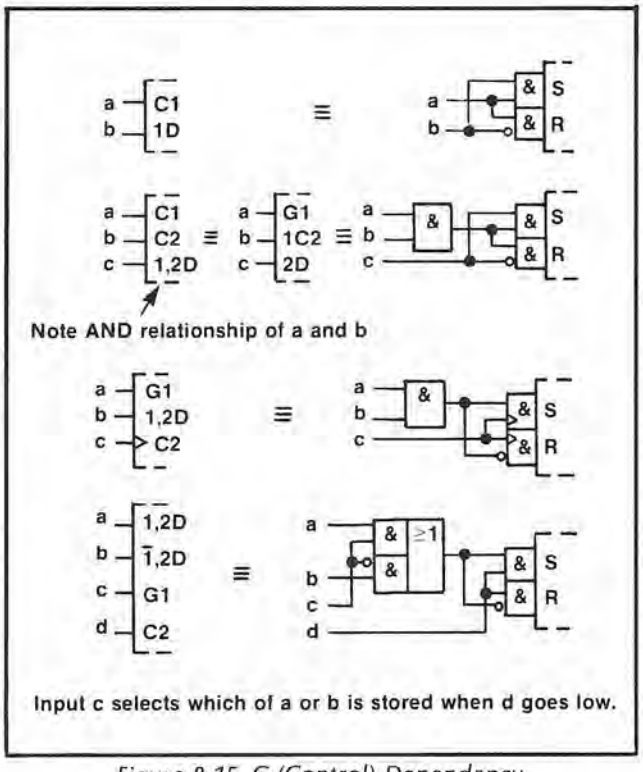


Figure 8-15. C (Control) Dependency

8-92. When a C*m* input or output stands at its internal 1 state, the inputs affected by C*m* have their normally defined affect on the function of the element, i.e., these inputs are enabled. When a C*m* input or output stands at its internal 0 state, the inputs affected by C*m* are disabled and have no effect on the function of the element.

8-93. S (SET) and R (RESET) DEPENDENCIES. The symbol denoting set dependency is the letter S. The symbol denoting reset dependency is the letter R.

8-94. Set and reset dependencies are used if it is necessary to specify the effect of the combination R=S=1 on a bistable element. Case 1 in *Figure 8-16* does not use S or R dependency.

8-95. When an S*m* input is at its internal 1 state, outputs affected by the S*m* input will react, regardless of the state of an R input, as they normally would react to the combination S=1, R=0. See cases 2, 4, and 5 in *Figure 8-16*.

8-96. When an R*m* input is at its internal 1 state, outputs affected by the R*m* input will react, regardless of the state of an S input, as they normally would react to the combination S=0, R=1. See cases 3, 4, and 5 in *Figure 8-16*.

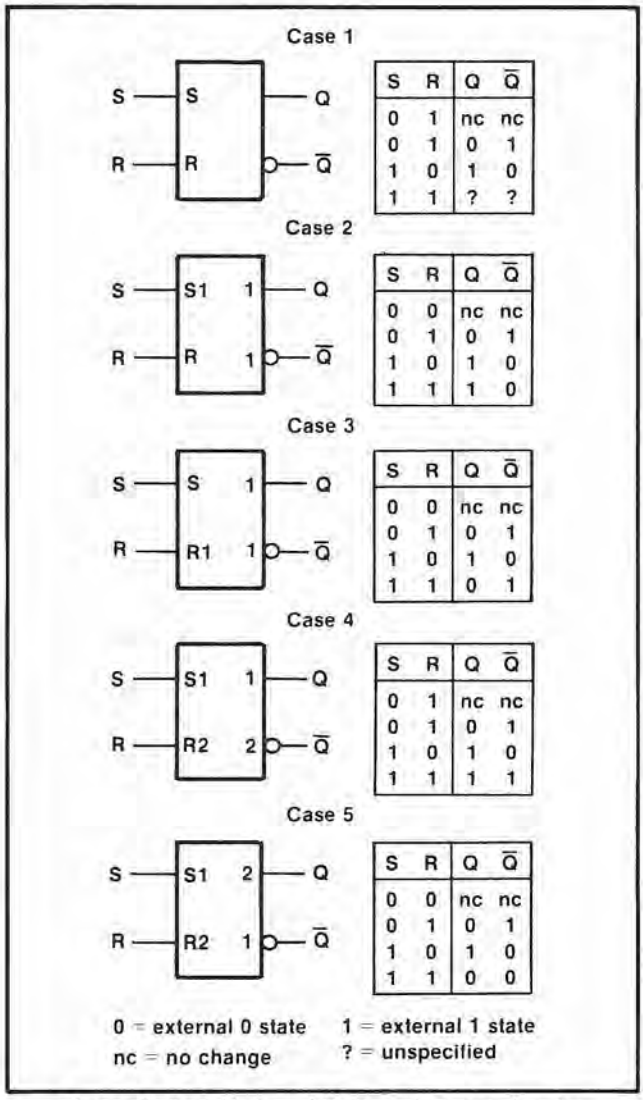


Figure 8-16. S (Set) and R (Reset) Dependencies

8-97. When an S*m* or R*m* input is at its internal 0 state, it has no effect.

8-98. Note that the noncomplementary output patterns in cases 4 and 5 are only pseudostable. The simultaneous return of the inputs to S=R=0 produces an unforeseeable stable and complementary output pattern.

8-99. EN (ENABLE) DEPENDENCY. The symbol denoting enable dependency is the combination of letters EN.

8-100. An EN*m* input has the same effect on outputs as an EN input, see paragraph 8-52, but it effects only those outputs labeled with the identifying number *m*. It also affects those inputs labeled with the identifying number *m*. By contrast an EN input affects all outputs and no inputs. The effect of an EN*m* input on an affected input is identical to that of a C*m* input. See *Figure 8-17*.

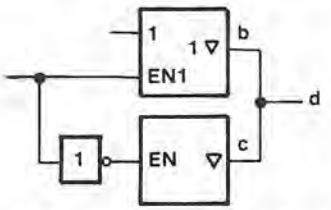


Figure 8-17. EN (Enable) Dependency

8-101. When an EN*m* input stands at its internal 1 state, the inputs affected by EN*m* have their normally defined effect on the function of the element and the outputs affected by this input stand at their normally defined internal logic states, i.e., these inputs and outputs are enabled.

8-102. When an EN*m* input stands at its internal 0 state, the inputs affected by EN*m* are disabled and have no effect on the function of the element, and the outputs affected by EN*m* are also disabled. Open-collector outputs are turned off, three-state outputs stand at their normally defined internal logic states but externally exhibit high impedance, and all other outputs (e.g., totem-pole outputs) stand at their internal 0 states.

8-103. M (MODE) DEPENDENCY. The symbol denoting mode dependency is the letter M.

8-104. Mode dependency is used to indicate that the effects of particular inputs and outputs of an element depend on the mode in which the element is operating.

8-105. If an input or output has the same effect in different modes of operation, the identifying numbers of the relevant affecting M*m* inputs will appear in the label of that affected input or output between parentheses and separated by solidi. See *Figure 8-22*.

8-106. M DEPENDENCY AFFECTING INPUTS. M dependency affects inputs the same as C dependency. When an M*m* input or M*m* output stands at its internal 1 state, the inputs affected by this M*m* input or M*m* output have their normally defined effect on the function of the element, i.e., the inputs are enabled.

8-107. When an M*m* input or M*m* output stands at its internal 0 state, the inputs affected by this M*m* input or M*m* output have no effect on the function of the element. When an affected input has several sets of labels separated by solidi (e.g., C4/2−/3+), any set in which the identifying number of the M*m* input or M*m* output appears has no effect and is to be ignored. This represents disabling of some of the functions of a multifunction input.

8-108. The circuit in *Figure 8-18* has two inputs, **b** and **c**, that control which one of four modes (0, 1, 2, or 3) will exist at any time. Inputs **d**, **e**, and **f** are D inputs subject to dynamic control (clocking) by the **a** input. The numbers 1 and 2 are in the series chosen to indicate the modes so inputs **e** and **f** are only enabled in mode 1 (for parallel loading) and input **d** is only enabled in mode 2 (for serial loading). Note that input **a** has three functions. It is the clock for entering data. In mode 2, it causes right shifting of data, which means a shift away from the control block. In mode 3, it causes the contents of the register to be incremented by one count.

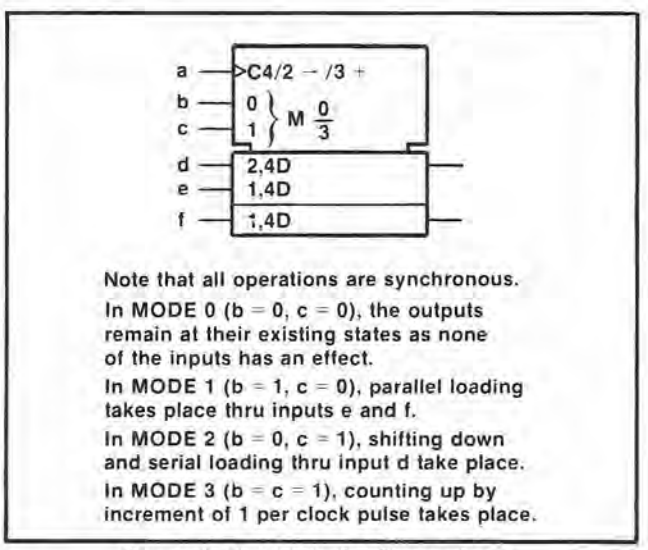


Figure 8-18. M (Mode) Dependency

8-109. M DEPENDENCY AFFECTING OUTPUTS. When an *Mm* input or *Mm* output stands at its internal 1 state, the affected outputs stand at their normally defined internal logic states, i.e., the outputs are enabled.

8-110. When an *Mm* input or *Mm* output stands at its internal 0 state, at each affected output any set of labels containing the identifying number of that *Mm* input or *Mm* output has no effect and is to be ignored. When an output has several different sets of labels separated by solidi (e.g., 2, 4/3, 5), only those sets in which the identifying number of this *Mm* input or *Mm* output appears are to be ignored.

8-111. In *Figure 8-19*, mode 1 exits when the **a** input stands at its internal 1 state. The delayed output symbol is effective only in mode 1 (when input **a** = 1) in which case the device functions as a pulse-triggered flip-flop. See paragraphs 8-124 through 8-128. When input **a** = 0, the device is not in mode 1 so the delayed output symbol has no effect and the device functions as a transparent latch.

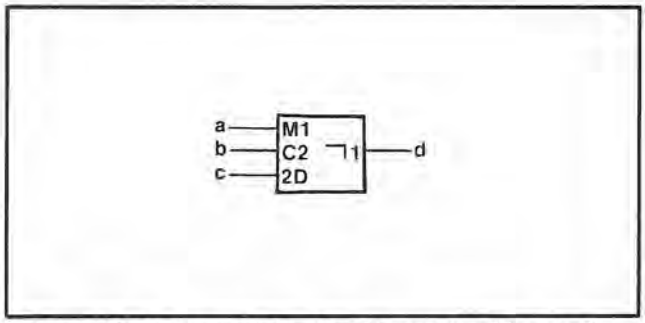


Figure 8-19. Type of Flip-Flop Determined by Mode

8-112. In *Figure 8-20*, if input **a** stands at its internal 1 state establishing mode 1, outupt **b** will stand at its internal 1 state only when the content of the register equal 9. Since output **b** is located in the common-control block with no defined function outside of mode 1, this output will stand at its internal 0 state when input **a** stands at its internal 0 state, regardless of the register content.

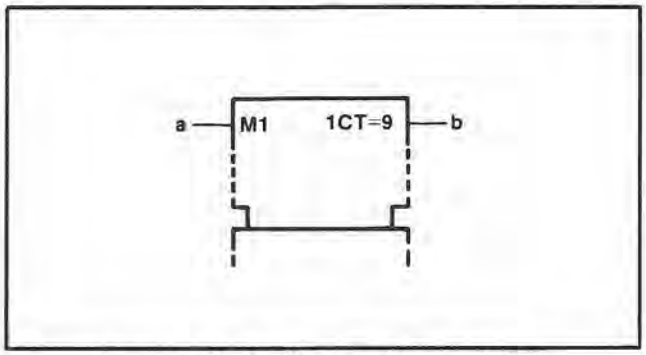


Figure 8-20. Disabling an Output of the Common Control Block

8-113. In *Figure 8-21*, if input **a** stands at its internal 1 state establishing mode 1, output **b** will stand at its internal 1 state only when the content of the register equals 15. If input **a** stands at its internal 0 state, output **b** will stand at its internal 1 state only when the content of the register equals 0.

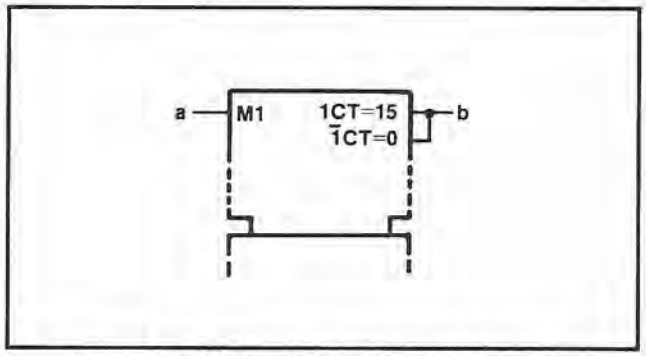


Figure 8-21. Determining an Output Function

8-114. In *Figure 8-22* inputs **a** and **b** are binary weighted to generate the numbers 0, 1, 2, or 3. This determines which one of the four modes exists.

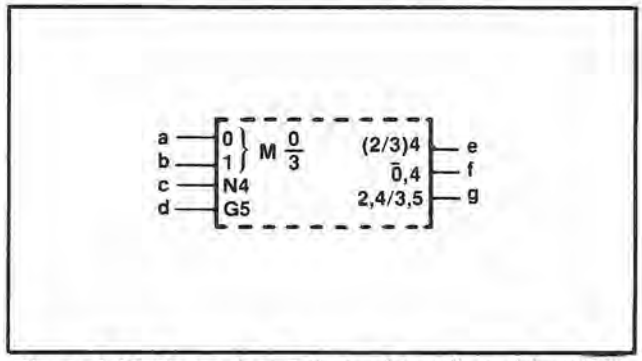


Figure 8-22. Dependent Relationship Affected by Mode

8-115. At output **e** the label set causing negation (if **c** = 1) is effective only in modes 2 and 3. In modes 0 and 1 this output stands at its normally defined state as if it had no labels. At output **f** the label set has effect when the mode is not 0 so output **e** is negated (if **c** = 1) in modes 1, 2, and 3. In mode 0 the label set has no effect so the output stands at its normally defined state. In this example 0, 4 is equivalent to (1/2/3)4. At output **g** there are two label sets. the first set, causing negation (if **c** = 1), is effective only in mode 2. The second set, subjecting **g** to AND dependency on **d**, has effect only in mode 3.

8-116. A (ADDRESS) DEPENDENCY. The symbol denoting address dependency is the letter A.

8-117. Address dependency provides a clear representation of those elements, particularly memories, that use address control inputs to select specified

sections of a multidimensional array. Such a section of a memory array is usually called a word. The purpose of address dependency is to allow a symbolic presentation of the entire array. An input of the array shown at a particular element of this general section is common to the corresponding elements of all selected sections of the array. An output of the array shown at a particular element of this general section is the result of the OR function of the outputs of the corresponding elements of selected sections. If the label of an output of the array shown at a particular element of this general section indicates that this output is an open-circuit output or a three-state output, then this indication refers to the output of the array and not to those of the sections of the array.

8-118. Inputs that are not affected by any affecting address input have their normally defined effect on all sections of the array, whereas inputs affected by an address input have their normally defined effect only on the section selected by that address input.

8-119. An affecting address input is labeled with the letter A followed by an identifying number that corresponds with the address of the particular section of the array selected by this input. Within the general section presented by the symbol, inputs and outputs affected by an A*m* input are labeled with the letter A, which stands for the identifying numbers, i.e., the addresses, of the particular sections.

8-120. *Figure 8-23* shows a 3-word by 2-bit memory having a separate address line for each word and uses EN dependency to explain the operation. To select word 1, input **a** is taken to its 1 state, which establishes mode 1. Data can now be clocked into the inputs marked "1, 4D". Unless words 2 and 3 are also selected, data cannot be clocked in at the inputs marked "2, 4D" and "3, 4D". The outputs will be the OR functions of the selected outputs, i.e., only those enabled by the active EN functions.

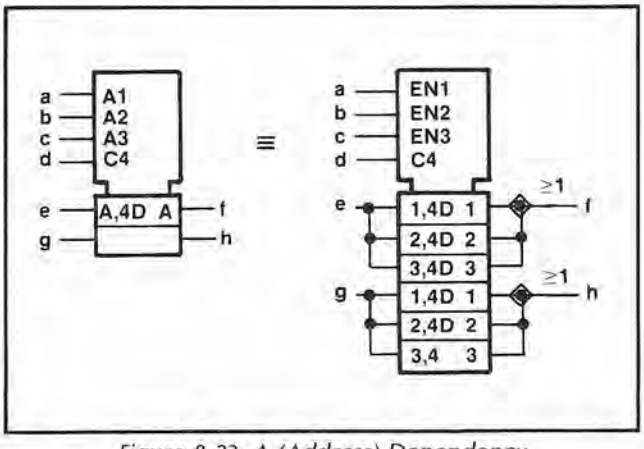


Figure 8-23. A (Address) Dependency

8-121. The identifying numbers of affecting address inputs correspond with the addresses of the sections selected by these inputs. They need not necessarily differ from those of other affecting dependency-inputs (e.g., G, V, N, ...), because in the general section presented by the symbol they are replaced by the letter A.

8-122. If there are several sets of affecting A*m* inputs for the purpose of independent and possibly simultaneous access to sections of the array, then the letter A is modified to 1A, 2A, ..., because they have access to the same sections of the array, these sets of A inputs may have the same identifying numbers.

8-123. *Figure 8-24* is another illustration of the A (Address) dependency.

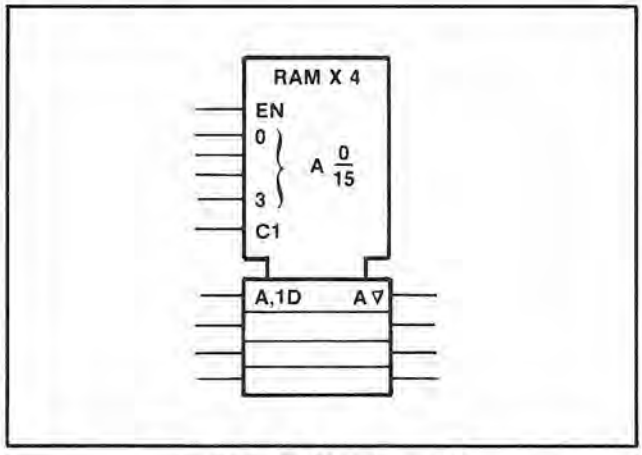


*Figure 8-24. RAM Example**

*Arrary of 16 sections of four transparent latches with three-state outputs comprising a 16-word by four-bit random access memory.

8-124. Bistable Elements

8-125. The dynamic input symbol, the postponed output symbol, and dependency notation provide the tools to defferentiate four main types of bistable elements and make synchronous and asynchronous inputs easily recognizable. See *Figure 8-25*. The first column shows the essential distinguishing features; the other columns show examples.

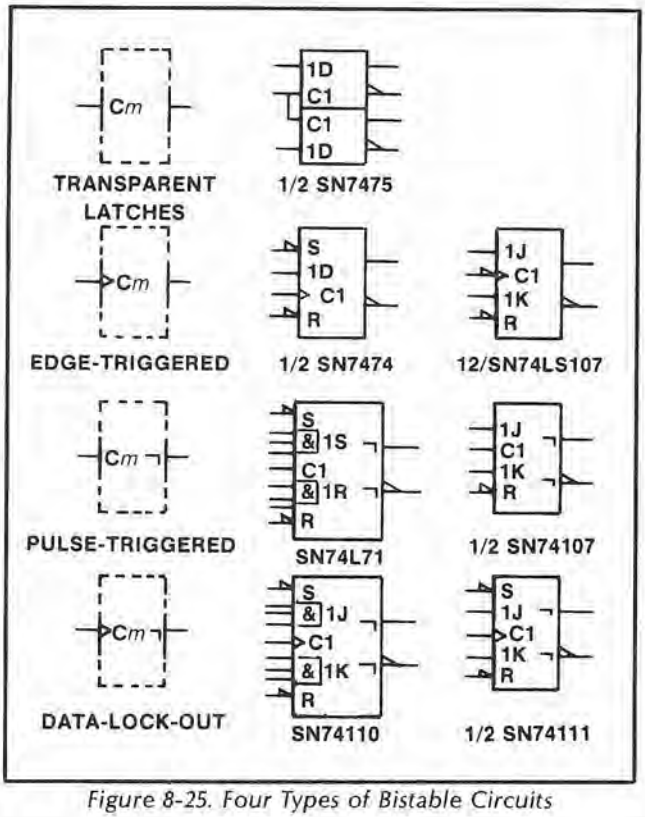


Figure 8-25. Four Types of Bistable Circuits

8-126. Transparent latches have a level-operated control input. The D input is active as long as the C input is at its internal 1 state. The outputs respond immediately. Edge-triggered elements accept data from D, J, K, R, or S inputs on the active transition of C. Pulse-triggered elements require the setup of data before the start of the control pulse; the C input is considered static since the data must be maintained as long as C is at its 1 state. The output is postponed until C returns to its 0 state. The data-lock-out element is similar to the pulse-triggered version except that the C input is considered dynamic in that shortly after C goes through its active transition, the data inputs are disabled and data does not have to be held. However, the output is still postponed until the C input returns to its initial external level.

8-127. Notice that synchronous inputs can be readily recognized by their dependency (1D, 1J,, 1K, 1S, 1R) compared to the asynchronous inputs (S,R), which are not dependent on the C inputs.

8-128. Coders

8-129. The general symbol for a coder or code converter is shown in *Figure 8-26*. X and Y may be replaced by appropriate indications of the code used to represent the information at the inputs and at the outputs, respectively.

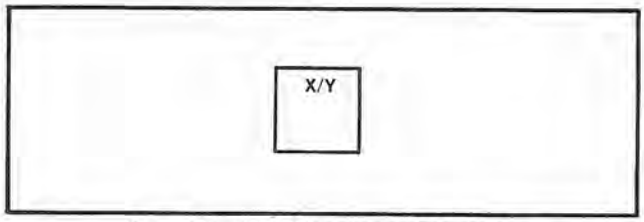


Figure 8-26. Coder General Symbol

8-130. Indication of code conversion is based on the following rule:

Depending on the input code, the internal logic states of the inputs determine an internal value. This value is reproduced by the internal logic states of the outputs, depending on the output code.

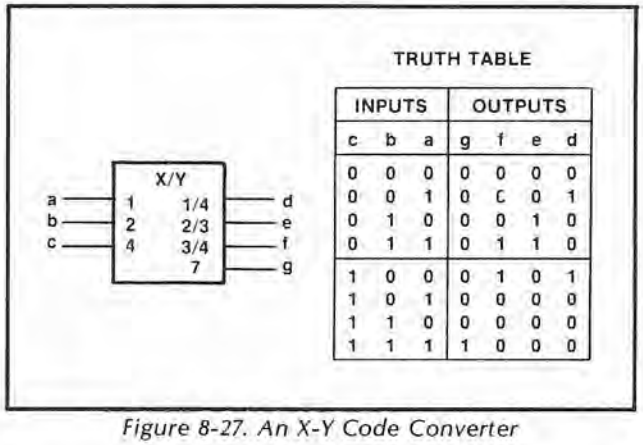
8-131. The indication of the relationships between the internal logic states of the inputs and the internal value is accomplished by:

a. Labeling the inputs with numbers. In this case the internal value equals the sum of the weights associated with those inputs that stand at their internal 1 state, or by;

b. Replacing X by an appropriate indication of the input code and labeling the inputs with characters that refer to this code.

8-132. The relationships between the internal value and the internal logic states of the outputs are indicated by:

a. Labeling each output with a list of numbers representing those internal values that lead to the internal 1 state of that output. These numbers shall be separated by solidi (slant:/) as in *Figure 8-27*. This labeling may also be applied when Y is replaced by a letter denoting a type of dependency (see paragraphs 8-134 and 8-135). If a continuous range of internal values produces the internal 1 state of an output, this can be indicated by two numbers that are inclusively the beginning and the end of the range, with these two numbers separated by three dots, e.g., 4...9 = 4/5/6/7/8/9, or by;

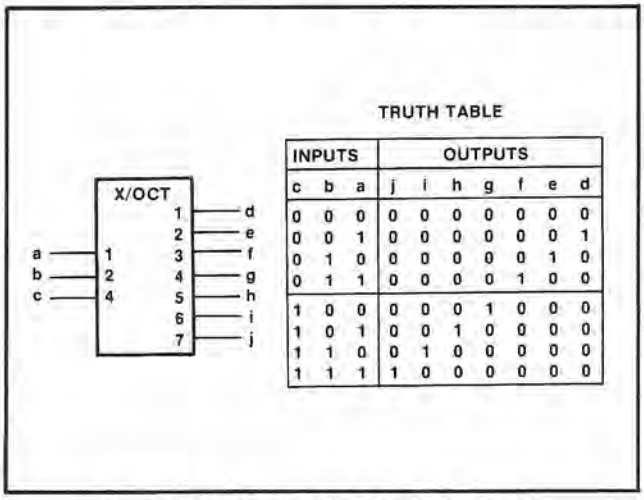


TRUTH TABLE

INPUTS			OUTPUTS			
c	b	a	g	f	e	d
0	0	0	0	0	0	0
0	0	1	0	0	0	1
0	1	0	0	0	1	0
0	1	1	0	1	1	0
1	0	0	0	1	0	1
1	0	1	0	0	0	0
1	1	0	0	0	0	0
1	1	1	1	0	0	0

Figure 8-27. An X-Y Code Converter

b. Replacing Y by an appropriate indication of the output code and labeling the outputs with characters that refer to this code as in *Figure 8-28.*



TRUTH TABLE

INPUTS			OUTPUTS						
c	b	a	j	i	h	g	f	e	d
0	0	0	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0	1
0	1	0	0	0	0	0	0	1	0
0	1	1	0	0	0	0	1	0	0
1	0	0	0	0	0	1	0	0	0
1	0	1	0	0	1	0	0	0	0
1	1	0	0	1	0	0	0	0	0
1	1	1	1	0	0	0	0	0	0

Figure 8-28. An X-Octal Code Converter

8-133. Alternatively, the general symbol may be used together with an appropriate reference to a table in which the relationship between the inputs and outputs is indicated. This is a recommended way to symbolize a PROM after it has been programmed.

8-134. USE OF A CODER TO PRODUCE AFFECTING INPUTS. If often occurs that a set of affecting inputs for dependency notation is produced by decoding the signals on certain inputs to an element. In such a case use can be made of the symbol for a coder as an embedded symbol. See *Figure 8-29.*

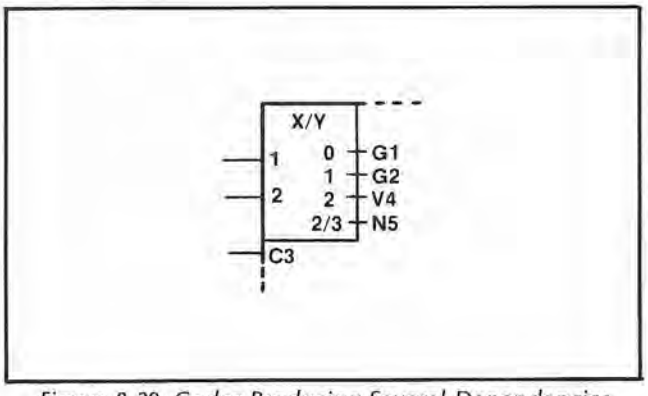


Figure 8-29. Coder Producing Several Dependencies

8-135. If all affecting inputs produced by a coder are of the same type and their identifying numbers correspond with the numbers shown at the outputs of the coder, Y (in the qualifying symbol X/Y) may be replaced by the letter denoting the type of dependency. The indications of the affecting inputs should then be omitted. See *Figure 8-30.*

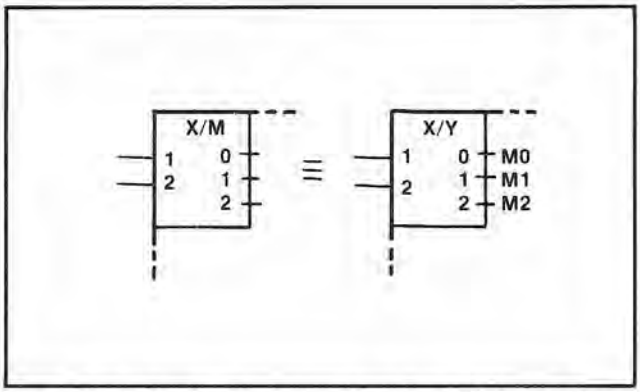


Figure 8-30. Coder Producing One Type of Dependency

8-136. Use of Binary Grouping to Produce Affecting Inputs

8-137. If all affecting inputs produced by a coder are of the same type and have consecutive identifying numbers not necessarily corresponding with the numbers that would have been shown at the outputs of the coder, use can be made of the binary grouping symbol (see paragraph 8-60). *k* external lines effectively generate 2*k* internal inputs. The bracket is followed by the letter denoting the type of dependency followed by m1/m2. The m1 is to be replaced by the smallest identifying number and the m2 by the largest one, as shown in *Figure 8-31.*

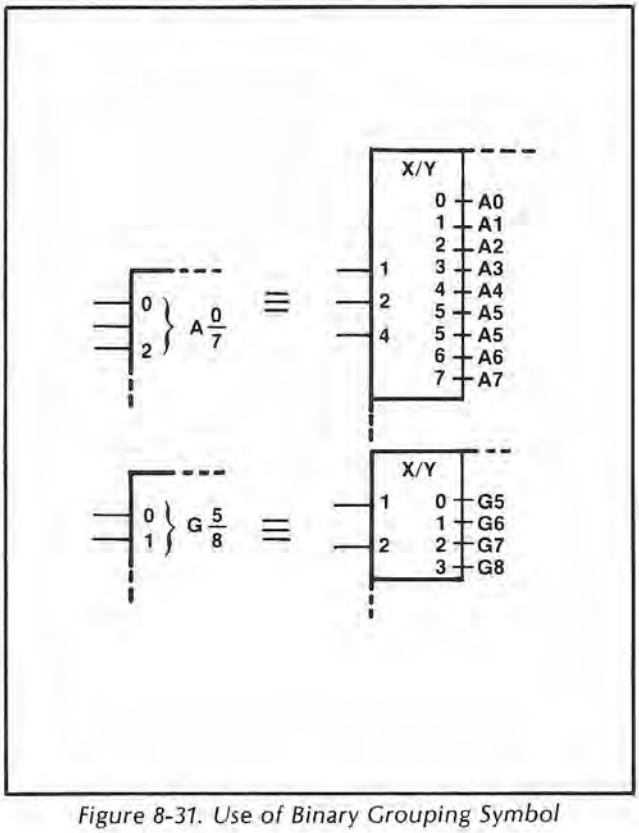


Figure 8-31. Use of Binary Grouping Symbol

8-138. Sequence of Input Labels

8-139. If an input having a single functional effect is affected by other inputs, the qualifying symbol (if there is any) for that functional effect is preceded by the labels corresponding to the affecting inputs. The left-to-right order of these preceding labels is the order in which the effects or modifications must be applied. The affected input has no functional effect on the element if the logic state of any one of the affecting inputs, considered separately, would cause the affected input to have no effect, regardless of the logic states of other affecting inputs.

8-140. If an input has several different functional effects or has several different sets of affecting inputs, depending on the mode of action, the input may be shown as often as required. However, there are cases in which this method of presentation is not advantageous. In those cases the input may be shown once with the different sets of labels separated by solidi. See *Figure 8-32*. No meaning is attached to the order of these sets of labels. If one of the functional effects of an input is that of an unlabled input of the element, a solidus will precede the first set of labels shown.

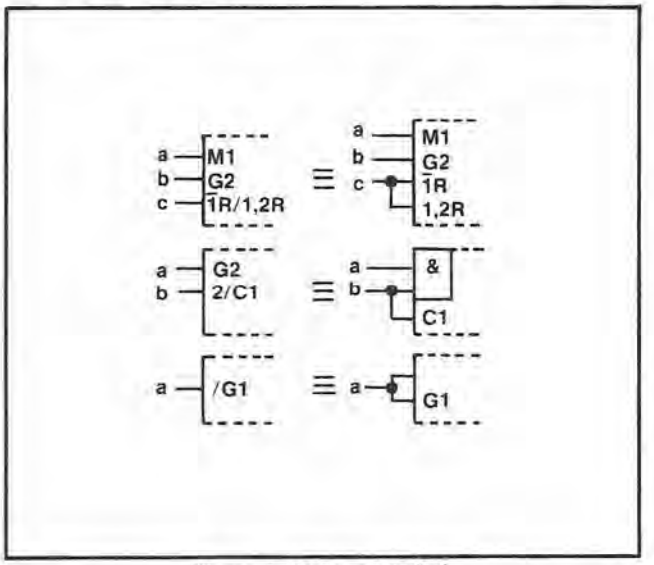


Figure 8-32. Input Labels

8-141. If all inputs of a combinational element are disabled (caused to have no effect on the function of the element), the internal logic states of the outputs of the element are not specified by the symbol. If all inputs of a sequential element are disabled, the content of this element is not changed and the outputs remain at their existing internal logic states.

8-142. Input labels may be factored using algebraic techniques. See *Figure 8-33*.

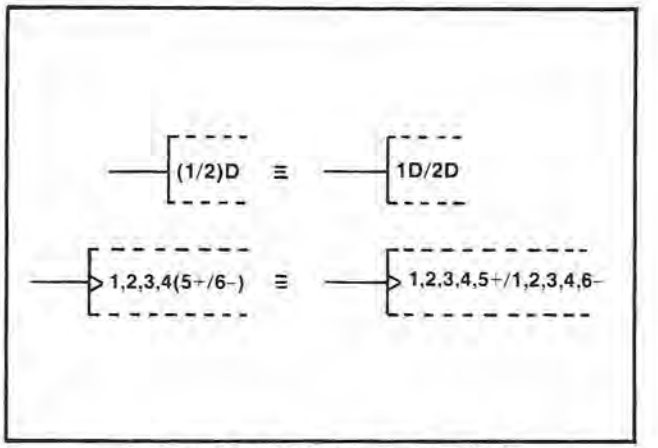


Figure 8-33. Factoring Input Labels

8-143. Sequence of Output Labels

8-144. If an output has a number of different labels, regardless of whether they are identifying numbers of affecting inputs or outputs or not, these labels are shown in the following order:

a. If the postponed output symbol has to be shown, this comes first, if necessary preceded by the indications of the inputs to which it must be applied;

b. Followed by the labels indicating modifications of the internal logic state of the output, such that the left-to-right order of these labels corresponds with the order in which their effects must be applied;

c. Followed by the label indicating the effect of the output on inputs and other outputs of the element.

8-145. Symbols for open-circuit or three-state outputs, where applicable, are placed just inside the outside boundary of the symbol adjacent to the output line. See *Figure 8-34*.

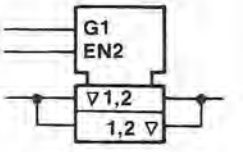


Figure 8-34. Placement of Three-State Symbols

8-146. If an output needs several different sets of labels that represent alternative functions (e.g., depending on the mode of action), these sets may be shown on different output lines that must be connected outside the outline. However, there are cases in which this method of presentation is not advantageous. In those cases the output may be shown once with the different sets of labels separated by solidi. See *Figure 8-35.*

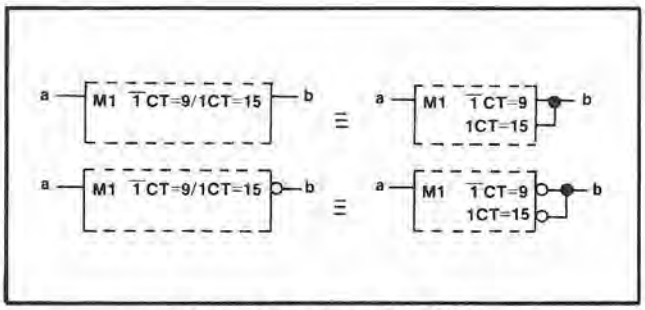


Figure 8-35. Output Labels

8-147. Two adjacent identifying numbers of affecting inputs in a set of labels that are not already separated by a nonnumeric character should be separated by a comma.

8-148. If a set of labels of an output not containing a solidus contains the identifying number of an affecting M*m* input standing at its internal 0 state, this set of labels has no effect on that output.

8-149. Labels may be factored using algebraic techniques. See *Figure 8-36* for output label factoring.

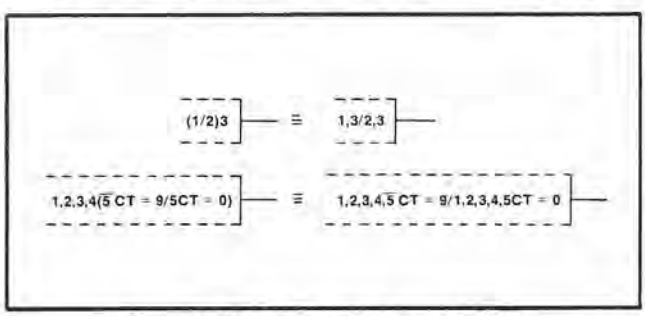


Figure 8-36. Factoring Output Labels

8-150. THEORY OF OPERATION

8-151. Overall Counter Operation

8-152. The HP Model 5335A is a Universal Counter, with measurement capabilities that include frequency, period, time, ratio, totalize, and volts. The following description introduces the major functional circuit blocks, and refers to the Simplified Block Diagram in *Figure 8-37.*

8-153. The overall operation of the counter centers on the continuous interaction of the multiple-register-counter (MRC) and the controlling microprocessor system. The MRC, referred to as a "counter-on-a-chip" is an LSI circuit, which contains the counting registers used to accumulate the raw input measurement data. The microprocessor system contains the processor, counter operating program (in ROM), and memory space (in RAM).

8-154. Inputs to channel A (and/or Channel B) are routed through signal conditioning circuits which perform the operator selections of coupling, impedance, and attenuation. The signal is directed through a parallel input buffer stage, (which provides separate buffers for high and low frequency signals), through a protective limiter, to the input Schmitt amplifier where it is buffered, shaped, level-shifted and input to the respective channel signal multiplexer. The A and B channel signal multiplexers accept the various input signals and direct the required signal to the MRC inputs. The trigger mode circuit configures the type of input channel triggering selected; either manual or automatic, preset or adjustable. Both input channels have peak detector circuits which during automatic modes, are used to derive DC levels representing the positive and negative peaks of the input. From these, the 50%, 10% and 90% points of the input signals can be used.

8-155. The outputs of the channel A and channel B signal multiplexers are directed to the MRC, where they are accumulated in registers, counted, and stored as raw measurement data. The data is then retrieved by the microprocessor system, manipulated to achieve the desired measurement mode, modified by special functions (if required) and routed to the display. The local reference oscillator is directed to the MRC through the oscillator select circuit. An interpolating configuration divides up the time between time base pulses, and allows the MRC to count with much finer resolution. For a typical measurement, the microprocessor reads the MRC registers, reads the interpolator counters, performs the necessary calculations and displays the result. In between measurements, the MRC registers and the interpolator counters are reset. The microprocessor system operates on a program, permanently stored in ROM, which allows it to continually cycle, making measurements, while routinely monitoring the MRC, the front panel keyboard, and the HP-IB for inputs and interrupts. Additionally, the program in ROM provides for operator interactive diagnostics, used during troubleshooting.

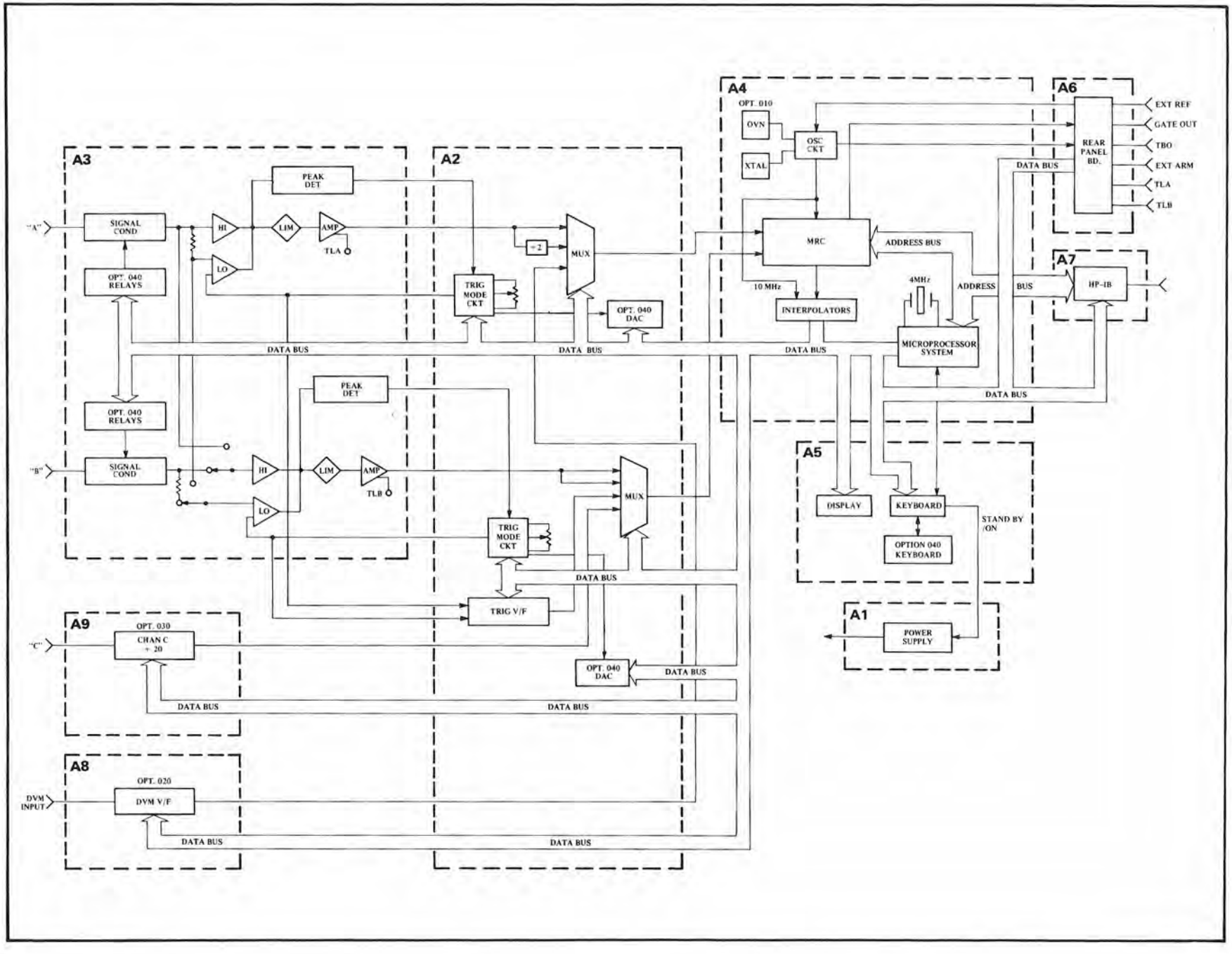


Figure 8-37. Simplified Block Diagram

8-156. FUNCTIONAL DESCRIPTIONS OF ASSEMBLIES

8-157 A complete functional description of all individual assemblies and interaction among assemblies is given in the following paragraphs. Use the individual schematic diagrams for each assembly for reference while reading the descriptions.

8-158. A1 POWER SUPPLY ASSEMBLY

8-159. This assembly processes and provides all electrical power for the 5335A. The power transformer, T1, has multiple primary windings for several possible power line voltages from 100 volts to 240 volts at 50 to 60 Hz. The secondary of T1 has two center-tapped windings, 19 volts and 9.5 volts. AC power is provided from the 19-volt winding for the digital voltmeter, Option 020. Both secondaries have bridge rectifiers with large capacitor filters and bleeder resitors. Outputs of the bridge rectifiers are switched by the power relay K1 which is controlled by the front panel POWER switch (A4S1). The two bridge rectifier filter supplies are connected separately to the voltage regulators. Five separate regulated voltages are produced: Negative 15 volts, negative 5.2 volts, positive 15.7 volts, positive 5 volts, and positive 3 volts. A separate positive 10-volt reference voltage is produced for the internal voltmeter in A2. The ventilating fan receives power through a contact on the power relay. All of the regulators receive power through the relay which is controlled by the front panel POWER switch, S1. AC power is supplied to the Option 020 Digital Voltmeter from transformer T1 through relay K1. The five voltage regulators are linear. The positive +15.7 volt, positive 3 volt and negative 15 volt regulators are three-terminal units. The positive 5 volt and negative 5.2 volt regulators are Darlington pass transistors driven by operational amplifiers. Refer to the foldout schematic and block diagrams at the rear of this manual.

8-160. There are three levels of overcurrent protection for the power supply. First, a fuse in series with the power line protects the power transformer and all following circuits. Then a glass fuse after each of the four filter capacitors protects each power source individually from defects from the power relay and on to all the circuits of the 5335A. The third level of overcurrent protection is fast electrical sensing of the overcurrent by the regulator circuits and automatic regulation of the current output. Overvoltage crowbar protection is provided for the outputs of the positive 5 and 15 volt and negative 5.2 volt supplies.

8-161. A13 LINE MODULE

8-162. The A13 line power module schematic diagram is on the same page as the A1 power supply schematic because functionally A1 and A13 are closely related and electrically connected. External AC power is connnected to the 5335A through a power cable (cord) and throught the A13 line power module. The A13 module has the power line fuse, a radio frequency interference filter, and the line voltage selector printed circuit board.

8-163. A2 AMPLIFIER SUPPORT BOARD

8-164. The A2 Amplifier support board has the trigger mode and level selection circuits, trigger level voltmeter, channel selection circuits, and control data latch circuits. Refer to the foldout schematic and block diagrams at the rear of this manual.

8-165. The triggering for each input channel is determined by the trigger level selector, U2, from the four major modes of triggering available; Manual, Preset, Auto-Preset, and Auto-Adjustable. Other unique modes set trigger points to 10% and 90%, for rise and fall time measurments. Many of the triggering modes involve the channel peak detectors (on A3) which detect the voltage extremes of the incoming signal. The microprocessor (on A4) responding to operator instruction and the selected function mode sets the proper trigger level, and directs it through the trigger mode selector to the input buffer A3U4 or A3U3).

8-166. Auto-Triggering and Peak-Detectors

8-167. There are four major trigger modes used in the 5335A. The comparative signal level relationships between these modes is illustrated in *Figure 8-38.*

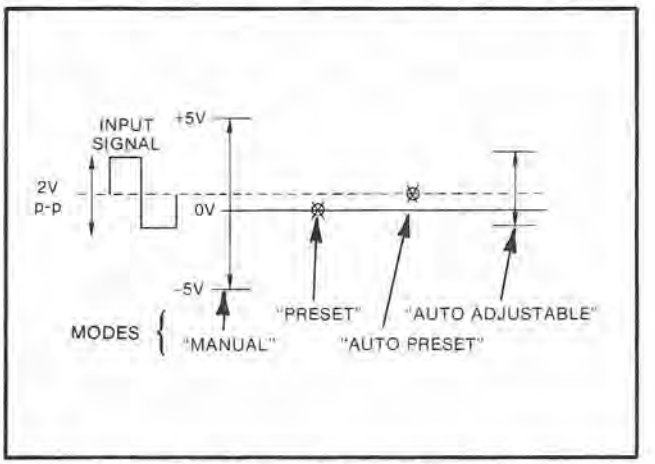


Figure 8-38. Trigger Modes Relationships

8-168. The MANUAL and PRESET modes derive the trigger level in a conventional fashion by setting the trigger level adjustment to some point between the fixed limits of negative 5 volts dc and positive 5 volts dc. The AUTO triggering modes, however, derive their trigger levels, based on the amplitude of the input signal. The AUTO PRESET mode sets the trigger level at the 50% point of the input signal, and the AUTO ADJUSTABLE mode allows selection of any level between the positive and negative peak levels of the input signal.

8-169. An essential part of the AUTO TRIGGERING modes is the operation of the peak detectors, which are used to produce dc levels, representative of the positive and negative peaks of the input signal. Using these levels, the 50%, 10%, and 90% points of the input signal can be determined. These points, totally relative to the input, are made available as trigger levels for AUTO modes. Most measurements use the 50% point. Rise and Fall measurements use the 10% and 90% points. *Figure 8-39* is a simplified peak detector schematic.

8-170. A basic peak-detector consists of a diode and a capacitor. This circuit, however, presents several inherent problems; primarily the 0.6 volt drop across the diode and the nonlinear response related to the duty cycle of the input. The peak detector circuit in the 5335A compensates for these factors by providing two parallel peak detectors in a balanced configuration. One peak detector is used to compensate the other for any errors. For example, if the positive peak of an input sine wave is at 2V, the lower detector will charge the capacitor to about 2V–Vd. The upper detector will charge the capacitor to about 2V–2Vd and pass through a unity gain buffer, to offset the lower detector buffered output. The output will be +2V, and all factors due to the diodes cancel out. There are four peak-detectors in the counter input, one for each peak of both channels. The diodes are reversed in the negative detectors.

8-171. To turn off the peak-detectors, the diodes must be back-biased. The operator switches the detectors off by pressing the AUTO TRIG key on the front panel so the key is out. This switch position is sensed by the microprocessor, which controls the auto circuitry that back biases the detectors.

8-172. The outputs of the A and B channel peak detectors are connected to either end of the trigger level adjustment pot. When AUTO TRIG is off, the ends of the pot are at +5.2 and –5.2 volts which is the Manual range of adjustment. When the AUTO mode is turned on, the ends of the trigger level adjustment control (R66) are the positive and negative peak levels of the input signal, provided by the respective peak detector. The entire range of trigger level adjustability is repositioned within the peak-to-peak amplitude of the input signal; which for most situations increases the resolution of the setting.

8-173. The Trigger Level multiplexers, controlled by the microprocessor, configure the selected trigger level mode. In the MANUAL ADJUSTABLE mode, the

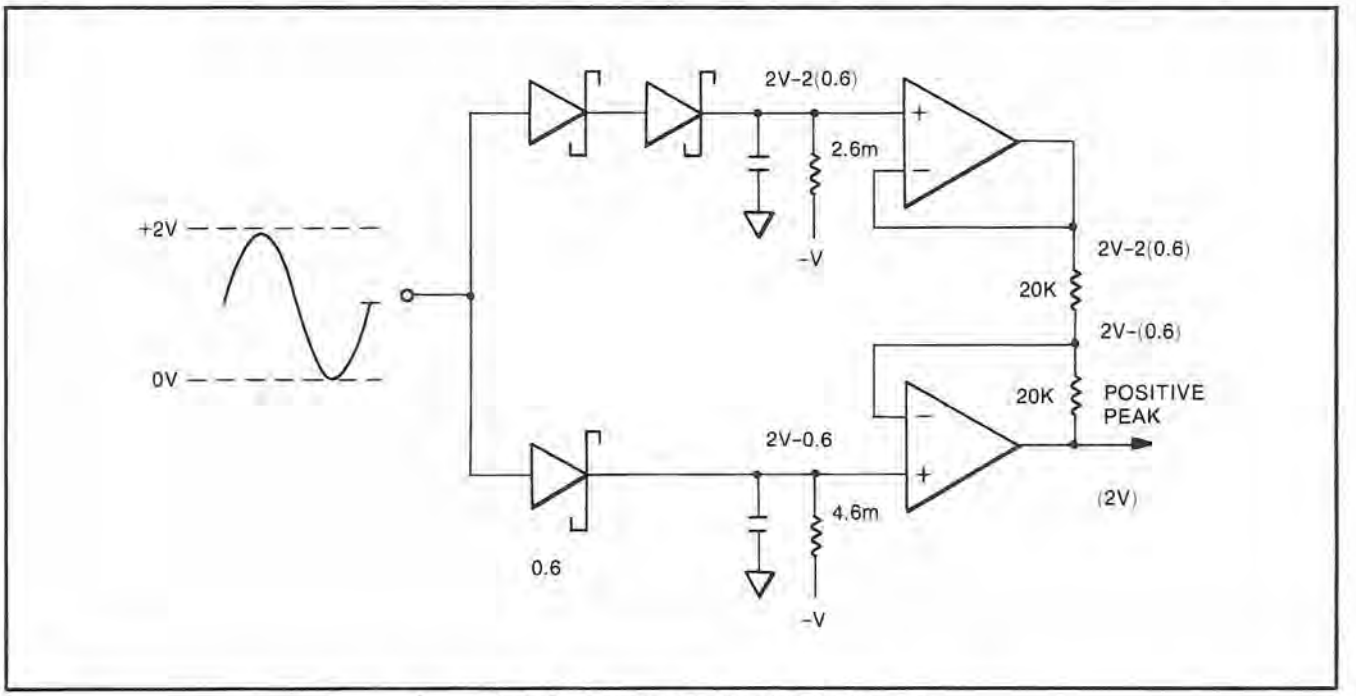


Figure 8-39. Peak Detector Simplified Schematic

trigger level goes through the Trigger Level multiplexer, then through the Auto/Man multiplexer (A2U5A) to the input level shifting buffer. The +5.2V and -5.2V levels used in the MANUAL mode are derived from circuitry that sets the peak detectors to +5.2V and -5.2V. In the AUTO ADJUSTABLE mode, the trigger level (derived from the input peak detectors) go through the trigger level multiplexer (A2U2) and then through an error integrator (A2U3), which tries to adjust the trigger level to about zero. The difference error is then routed through an analog switch to the input level shifting buffer (A3U3), which correspondingly shifts the "input signal dc level" to the error value. It is important to realize that in the 5335A, the input amplifier trigger level is always set to zero, and that it is the level of the input signal that is varied by the trigger level adjustment. In other words, instead of bringing the trigger point up to the desired trigger setting, the input signal level is brought down to the trigger point, which is always zero volts.

8-174. The other two trigger modes, PRESET and AUTO PRESET, are special cases of Manual and Auto Adjustable. For PRESET, the trigger level multiplexer selects the analog ground input. The error integrators are not used. For AUTO PRESET (the 50% point) the midpoint of the resistor divider is selected. Since the resistor divider network is tied to the peak detectors, the Error Integrators are used. The resistor divider also provides the 10% and 90% points, selectable by the trigger level multiplexer for RISE and FALL modes.

8-175. Reading Trigger Levels

8-176. The 5335A has the ability to measure its trigger levels, using an internal dedicated dc voltmeter (A2U4/U9). A single voltage-to-frequency DVM is used to measure all of the combinations of trigger levels, for both channels.

8-177. Using this arrangement, the microprocessor (A4U28) selects any one of the DC inputs to feed the voltage-to-frequency converter. The output frequency is measured by the MRC and the microprocessor calculates the proportional voltage. The calculations use three known calibration points, -5V, 0V, and +5V, derived from a precision voltage reference on the power supply assembly (+10.00V). Pressing the TRIG LVL key on the front panel directs the microprocessor to measure and display the current channel A and channel B trigger levels. The voltmeter alternately measures channel A and channel B; the display of both levels, however, appears constant.

8-178. Address Bus and Data Bus Signals

8-179. Signals on the address bus and data bus to and from the microprocessor (A4U28) and the MRC (A4U6) are use in A2 to address and control functions in A2.

8-180. A3 INPUT AMPLIFIER BUFFER

8-181. The A3 board has the A and B input signal channel amplifiers and the A and B peak detector circuits. Refer to the A3 schematic and block diagams while reading the following paragraphs.

NOTE

The A and B input channels are basically identical circuits, but the description will only reference components in the A channel.

8-182. Inputs to the counter are received through Channel A (A3), Channel B (A3), Channel C (A9), and the DVM (A8).

8-183. The input amplifiers (Channel A and B) are a pair of high performance 200 MHz matched circuits. They have a sensitivity of 25 mV rms, and can trigger at any point between + and - 5 volts. The input signal passes through the ac/dc select circuit, (switch S10) through the 50Ω/1 MΩ select switch (S9) through the X1/X10 attenuator switch (S9) to the offset converter buffer. The selection of the COM A (Separate/Common) function is accomplished by a relay, controlled by the microprocessor(A4U28). This allows the selection of COM A either by front panel control or via the HP-IB.

8-184. The input buffer circuit is a parallel amplifier configuration. The signal is split and buffered in two parts. One part is ac coupled to a FET voltage follower (Q5), which buffers all the high frequencies (above 10 kHz). The other part is dc coupled to an Operational Amplifier (U4), which buffers the lower frequencies. The Trigger Level from the Trigger Level multiplexer is also input at this point to offset the signal. This signal is inverted, then reunited with the high frequency path. The combined signal is then passed through an emitter-follower transistor (Q8), through a protective bridge limiter (CR20-CR22) to the Schmitt-Amplifier (A3U5). The Schmitt-Amplifier is a high performance, 500 MHz band width device with settable hysteresis and a built-in three-state trigger light circuit. The square wave output of the input amplifier is then level-shifted to ECL, and sent to the A2 board.

8-185. The peak detector circuits on the A3 board are described in paragraph 8-166.

8-186. A4 MAIN LOGIC BOARD

8-187. The A4 board has the microprocessor system, the multiple register counter (MRC), time base oscillator, and the interpolator circuits. Refer to the A4 schematic diagram.

8-188. The 5335A is based on microprocessor architecture. It uses a Motorola MC6802 microprocessor (U28), which has a built-in clock circuit and 128 bytes (8 bits by 128 words) of read/write memory (RAM). Supporting the microprocessor are two 65K-bit ROMs (U22, U23) that form approximately 16K bytes of program storage area. There is an additional 256 bytes of program RAM provided by two 1K-bit static memories (U25, U26) used to provide buffering and address decoding. The microprocessor, directed by the permanently stored program routines (in ROM), actively controls the overall operation of the counter. It monitors for interrupts and for operator instructions, either through the front panel keyboard or the HP-IB, and directs the appropriate circuit configurations. It retrieves data, performs all the necessary mathematical computations, and displays the results.

8-189. The RESET circuit for the microprocessor is designed to give a several millisecond pulse whenever the +5 volt power is switched off. Reset occurs even for extremely quick power ON-OFF-ON sequences. The reset pulse is active low. The timing circuit which determines the length of the reset pulse is C42 and R43. Transistors Q10 and Q11 are a Schmitt trigger that supplies the fast RESET pulse to the microprocessor, to U28 and to the A7 HP-IB interface.

8-190. The desired output(s) of the channel A and B signal multiplexers are selected by the microprocessor, level-shifted (to MRC specific logic levels) and input to the MRC as channel A and channel B, respectively.

8-191. Operation of the counter centers on the interaction between the microprocessor system and the MRC. The MRC is a large-scale-integration, bipolar, integrated circuit utilizing both emitter-function logic and integrated-injection logic. It is a programmable, universal, counter-on-a-chip, containing four sets of registers: Events, Time, Status, and Control. The E (Events) and T (Time) registers collect the raw input measurement data. The S (Status) register includes E and T register overflow flags and information on the state of the measurement. The C (Control) register, directed by the microprocessor sets up the various measurement modes of the MRC, and resets the counters, synchronizers, and overflow flags. The MRC has inputs for Channels A, B, C, a time base, and an external arm signal. Outputs include two gate status lines, two interpolator lines, and a register reset line. When a measurement is completed, the MRC signals the microprocessor by pulling the IRQ (Interupt Request) line. Using the accumulated Events and Time data, the microprocessor can then calculate the selected function mode measurement. For example, dividing the contents of the Events register by the contents of the Time register produces the frequency of the measurement. Likewise, dividing T by E yields Period, and Time Interval uses the contents of T directly.

8-192. The measurement gate time is dictated either by the microprocessor or by a one-shot under front panel control. The time constant for the specified measurement time has two ranges; NORM, nominally 20 milliseconds to 4 seconds, and FAST, 100 microseconds to 20 milliseconds. Gate Times are continuously adjustable (as opposed to decade steps) through these ranges and the microprocessor automatically includes gate time in its calculations. A buffered TTL level output is provided to the rear panel representing the gate signal. The Gate open and Gate closed signals from the MRC are combined in an EXCLUSIVE OR gate (A4U30) to produce a $\overline{\text{GATE OUT}}$ signal. This signal is high when the gate is closed and low when the gate is open.

8-193. The MRC is fully synchronous with both the input and the time base. A "triple" synchronization circuit is used, which means that, with the use of interpolators, the exact gate time of a measurement is used for computations.

8-194. Interpolator Technique

8-195. A major feature of the 5335A is the pulse count interpolators. By using interpolators the inherent one count error is effectively reduced by a factor of 200. The basic principle is to detect the slight error factor, and then proportionally expand it (200X) to a time length which can be measured by the counter. Then, by using known calibration pulses, the actual error factor can be interpolated. The error is then effectively cancelled by compensating the MRC's adjustable gate time. The use of interpolators allows measurements to be resolved to near one nanosecond. Refer to *Figure 8-40.*

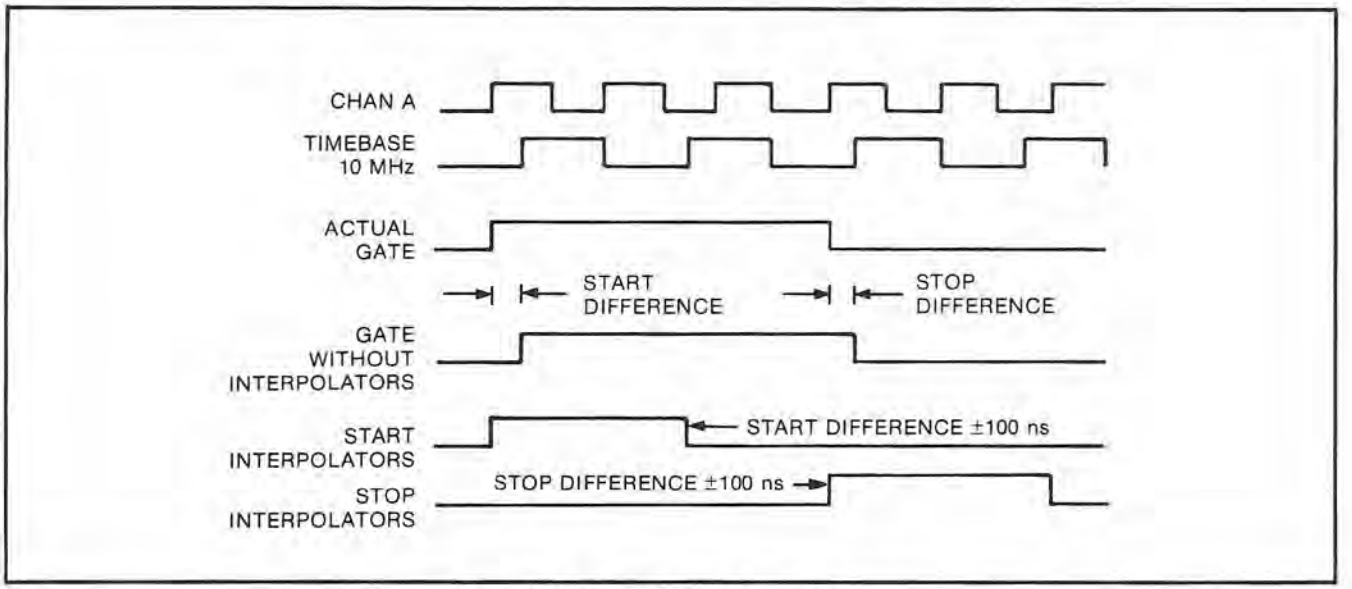


Figure 8-40. Interpolator Timing Diagram

8-196. Without interpolators, the gate signal during a measurement would normally be synchronous with the main clock (time base). The slight time difference between the actual events of Channel A triggering, and the opening and closing of the gate, would represent an unrecoverable error factor, limiting the accuracy of the measurement. The start and stop interpolators within the 5335A provide a method of determining the amount of time error (for both start and stop events) and adjusting the microprocessor gate time factor to compensate.

8-197. The MRC provides start and stop interpolator pulses, representing the time difference (error factor) between channel A trigger events and the time base. To measure these pulses, a dual slope integration scheme is used. Basically, the short interpolation pulse, from the MRC, is used to rapidly charge a capacitor, via a constant current source. When the pulse ends, the capacitor begins a scaled discharge at about 1/200th the charge rate. This proportionally expands the interpolator error pulse by a factor of 200X. This integrated waveshape is then squared and used to gate a time base signal into the interpolator counter. The count in the counter will proportionally reflect the length of the interpolator pulse. Refer to *Figure 8-41.*

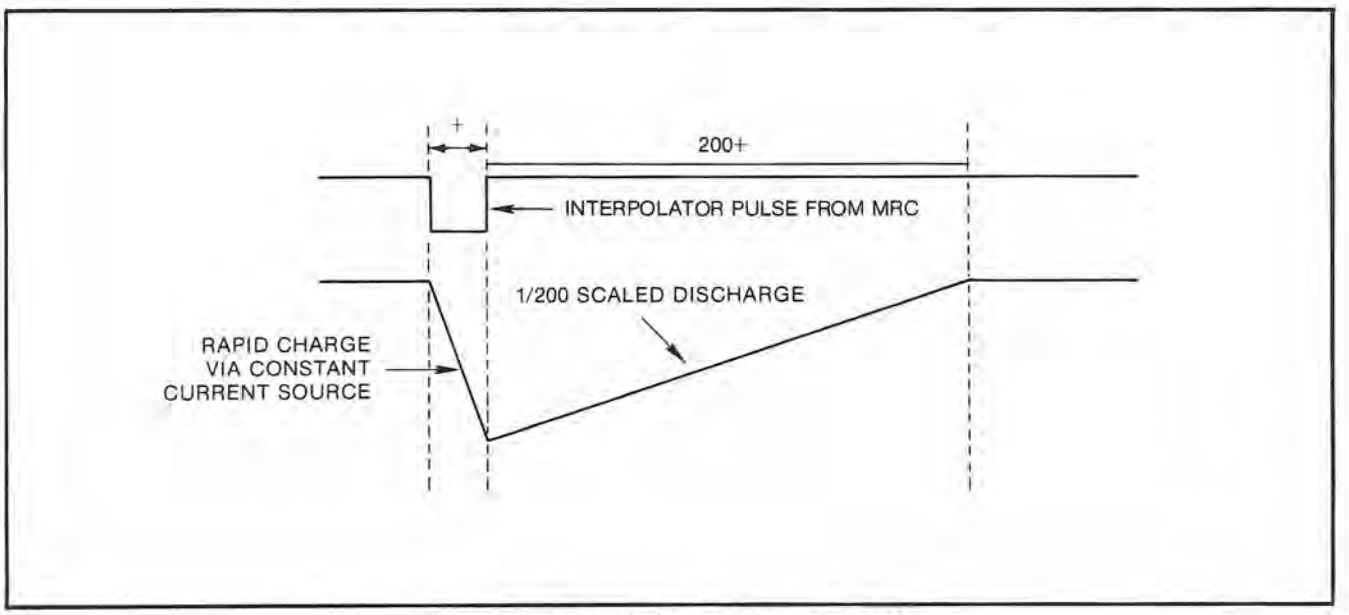


Figure 8-41. Expanded Interpolator Error Pulse

8-198. To convert the count in the interpolator counter to real nanoseconds, the MRC provides two calibration pulses; a short calibration pulse of 100 ns and a long calibration pulse of 200 ns. By inputting each of these known length pulses into the same integrator and noting the number of counts produced, a mathematical proportion is established, with which the true time for any pulse length can be interpolated. For example, if the short (100 ns) calibration pulse produced 200 counts, and the long (200 ns) calibration pulse produced 400 counts, a pulse of 150 ns would produce 300 counts. Inversely, if 300 was the number of counts accumulated during the interpolator pulse integrator cycle, then the error factor would be 150 ns. Refer to *Figure 8-42*.

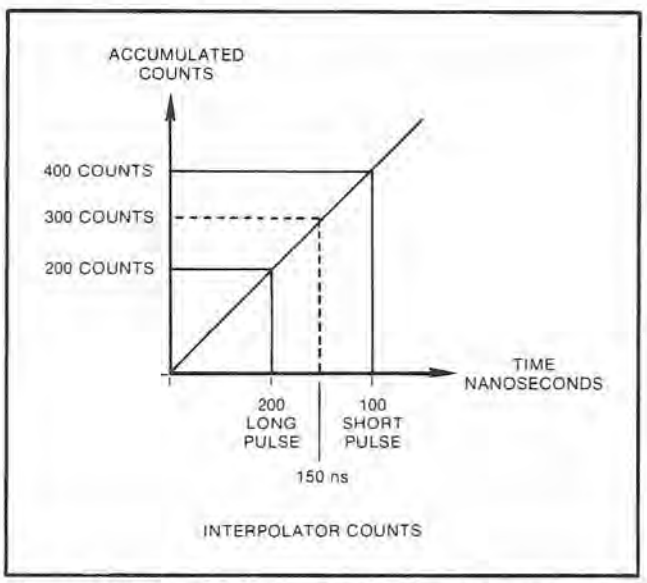


Figure 8-42. Short and Long Calibration Pulses Example

8-199. The final equation for determining the actual gate time is:

$$\text{GATE TIME} = (\text{Counts in T-register}) \times 100\text{ ns} + \frac{\text{Count X} - \text{Count S}}{\text{Count L} - \text{Count S}} \times 100\text{ ns} \quad \text{(for the Start Interpolator)}$$

$$- \frac{\text{Count X} - \text{Count S}}{\text{Count L} - \text{Count S}} \times 100\text{ ns} \quad \text{(for the Stop Interpolator)}$$

where:
Count X = effective counts from interpolation pulse
Count S = effective counts from short calibration pulse
Count L = effective counts from long calibraion pulse

For example, given the following values:

Count in MRC T register	= 10
Count from Start Interpolator	= 100 (+256)*
Count from Stop Interpolator	= 230
Count from short calibration pulse	= 200
Count from long calibration pulse	= 150 (+256)*

$$\text{GATE TIME} = (10 \times 100\text{ ns}) + \frac{356 - 200}{406 - 200} \times 100\text{ ns} - \frac{230 - 200}{406 - 200} \times 100\text{ ns} = 1000 + 75.7 - 14.6 = 1061.1\text{ ns}$$

***NOTE**

Any count less than 200 is increased by 256 to compensate for overflow of the eight-bit counter at 255.

8-200. If this were a time interval measurement, the microprocessor would be able to tell you the exact answer to about one nanosecond accuracy. In actual measurements the interpolators will yield different counts, other than the 200 and 400 counts indicated here.

8-201. The general measurement program routine is to make a measurement, read the MRC registers, read the interpolator counters, perform the calculations, and display the results. In between measurements, the MRC registers and the interpolator counters are reset.

8-202. The standard time base for the MRC is a 10 MHz crystal oscillator (A4U2B). Additionally, provisions are made to allow for an optional high-stability ovenized oscillator (e.g., HP 10811A). The microprocessor has its own associated oscillator, which generates an approximate 4 MHz clock. This signal is divided to 1 MHz within the microprocessor, and output to the counter as the main enable clock. All timing parameters within the counter are referenced to this clock.

8-203. Either 5 or 10 MHz signals may be used as an external reference. An external reference buffer circuit (U2A & U1) accepts any submultiple of 10 MHz, and outputs a 10 MHz frequency. The buffer automatically determines whether or not the input has enough amplitude to be used.

8-204. The switching between the internal and external time base signals is automatic. Whenever an external reference is connected to the rear panel TIME BASE IN connector, an external reference detector (U2A) circuit senses the signal and configures the time base multiplexer to pass the external signal instead of the local oscillator. The output of the external reference detector also goes to the microprocessor, which prompts the microprocessor to turn on the front panel EXT TIME BASE annunciator and send the status to any devices on the HP-IB. The selected time base is also buffered and provided to the rear panel for an auxiliary TIME BASE OUT connector.

8-205. A5 KEYBOARD AND DISPLAY

8-206. The A5 board has the visual output display and the operator control pushbutton keys. Refer to the A5 schematic diagram.

8-207. The DISPLAY assembly receives already decoded segment data from the microprocessor, latches it and inputs it to three LSI display IC's (U1, U2 and U7). These IC's then output the data, scanning the display with self-contained strobe circuitry. All information from the keyboard is transferred to the microprocessor through an interrupt scheme. The front panel keys are arranged into a matrix. In the quiescent state, no regular scanning of the matrix is performed. However, when a key is pressed, an interrupt line to the microprocessor is activated. The microprocessor scans its I/O bus and identifies the keyboard. It then performs a subroutine that scans the keyboard matrix, and responds to whatever key was pressed. If no key, or more than one key is found pressed, the program ignores the interrupt.

8-208. A6 REAR PANEL BOARD

8-209. THE A6 board has five separate functions associated with six connectors: J6 is $\overline{\text{GATE OUT}}$, J1 and J4 are TRIGGER LEVEL OUT A and B, J5 and J2 are TIME BASE IN and OUT, J3 is EXTERNAL ARM IN, and two switches EXTERNAL ARM START and STOP. (Refer to section III for details of uses of these functions.)

8-210. An amplifier (Q4–Q5) level shifts and buffers the $\overline{\text{GATE OUT}}$ signal from the MRC on A4. The TTL $\overline{\text{GATE OUT}}$ signal is available for external use.

8-211. A signal from other equipment may be applied to the EXTERNAL ARM IN connector to enable circuits in the 5335A. Amplifier Q1–Q2 isolates this signal. The EXTERNAL ARM input, in conjunction with a pair of three-position switches (S1 and S2), allows external arming of the start and/or stop of a measurement. The TTL EXT ARM input is buffered and converted to MRC-compatible logic levels, and directed to the MRC. The MRC internally compensates for external arming. Although externally armed, the measurement does not start or stop until an input signal is received.

8-212. The TRIGGER LEVEL OUT signals from the A and B input channels are available for external use at J1 (channel A) and J4 (channel B).

8-213. The TIME BASE IN (J5) connector allows an external signal to be used to control the timing of the 5335A counter, and the TIME BASE OUT connector (J2) provides the internal time base signal for use to external equipment. If the optional oven (temperature-controlled) oscillator is in the 5335A, the signal at the TIME BASE OUT connector would be derived from the Option 010 high quality oscillator.

8-214. A7 HEWLETT-PACKARD INTERFACE BUS BOARD

8-215. The A7 HP-IB Board serves to interconnect the 5335A and an external controller, via the Hewlett-Packard Interface Bus. The circuitry includes bus buffers, decoding ROMS and an LSI HP-IB interface IC. These circuits perform the handshake and interpret commands, data, interrupts.

8-216. The HP-IB interfaces with the A4 microprocessor system through A7U1 with an eight-bit bidirectional bus, a chip-select line, a Read/Write line, a Reset line, three register select lines, interrupt request line, two DMA control lines, and an address switch enable line. The microprocessor system on A4 controls HP-IB interface with commands to A7U1.

8-217. The HP-IB signals interface with the 5335A through the A14 assembly directly to A7, the HP-IB Logic board. The 16 HP-IB signals pass through individual transceivers. Four quad-bidirectional IC's U3, U4, U6, and U7 accommodate all 16 lines. Direction of data flow is controlled by three-state disabling of the undesired direction element. With power off the 5335A does not load the HP-IB. "HP-IB" is the implementation by Hewlett-Packard of the IEEE 488-1978 *"Digital Interface for Programmable Instrumentation"*. Hewlett-Packard and many other sources have literature about IEEE 488-1978.

8-218. A14 HP-IB CONNECTOR BOARD

8-219. The A14 HP-IB Connector Board schematic is on the same page with A7 board because two assemblies are directly related and physically connected. The A14 board connects the HP-IB functions to external equipment on the HP-IB, and allows the HP-IB address of the 5335A to be set as desired.

8-220. A8 DIGITAL VOLTMETER BOARD

8-221. The A8 board has the optional (020) Digital Voltmeter circuit for the 5335A.

8-222. The Digital Voltmeter input passes through U11, a buffer amplifier, then a programmable gain select (Q4–Q6), controlled by the microprocessor, through a multiplexer (U7) to a voltage-to-frequency converter (U6). The dc level is compared to a voltage

reference (U4–U5), and converted to a pulse train with frequency proportional to the input voltage. The output of U2 is then buffered and routed to the Channel A Signal multiplexer in A2 or A11, and eventually to the MRC (A4U6), where it can be counted, interpreted and sent to be displayed as a voltage. Data signals from the microprocessor are clocked through U3 and the optic-isolators U9, U10, U12 and U13 to control the gain (attenuation) select transistor, Q4–Q6. The Input Logic Switching Control circuitry consists of A8U3 register, that latch four bits from the microprocessor controlled data bus, U9, U10, U12, U13 optic-isolators, and A8Q2, Q3, and Q7, which decodes and provides range selection information, as well as control bits for U7, the reference multiplexer. A8U4 and A8U5 provide the +5V, Ground, and –5V references to the input of A8U7 multiplexer. The microprocessor utilizes these three voltage references to compute the unknown input voltage. The U7 control bits originate in U9 and U10 optic-isolators. The Voltage-to-Frequency converter circuit is composed of A8U6 V-to-F, U8 unity gain buffer, C12 the integrating capacitor, C8 the one-shot capacitor, and U2 optic-isolator converts the floating frequency output to a chassis-referenced output). Transformer T1 (1:1 ratio), full wave rectifier CR1, and U1 dual-tracking regulator, form the floating power supply of A8.

8-223. A9 CHANNEL C INPUT AMPLIFIER BOARD (OPTION 030)

8-224. The A9 board has the optional third input amplifier with a 1.3 gigahertz upper frequency range limit.

8-225. The channel C input signal passes through a fused input BNC connector, through a protective limiter (CR8, CR9, CR11, and CR12) to the pin diode attenuator (CR1-CR4). This attenuator provides a nominal amount of control of input SENSITIVITY, with the front panel control. The output of the attenuator feeds the broadband amplifier, U1. The output of the amplifier is divided by 20, by a decade divider (U2) and a binary divider, U3. This prescaled signal is then routed to the channel B signal multiplexer. A peak detector and Schmitt trigger (U4) are used to effectively disable the channel C output (by U3) whenever the peak detector level is below the threshold level. The microprocessor enables the channel C through a flip-flop (U5) which clocks the U3, allowing the prescaled signal to pass.

8-226. A10 SWITCH PANEL (OPTION 040)

8-227. The A10 switch panel has the 12 front panel INPUT control switches and corresponding lights to indicate active functions. Refer to the A10 schematic diagram while reading the following paragraph.

8-228. The A10 board switches connect to the A5 keyboard display which passes A10 switch activation conditions through to the 5335A data and address buses. The 12 pushbutton switches are momentary contact single-circuit components. The microprocessor system on A4 indirectly responds to the closure of a pushbutton switch and commands a corresponding relay on the A12 Programmable Input Amplifier.

8-229. A11 AMPLIFIER SUPPORT BOARD (OPTION 040)

8-230. The A11 amplifier support board has circuits for trigger mode selection, trigger level selection, channel selection, trigger level voltmeter, control data latching, and digital-to-analog conversion.

8-231. Trigger level source is selected by the trigger level selector (U2), from the four major modes of triggering available; Manual, Preset, Auto-Preset, and Auto-Adjustable. Other unique modes set trigger points to 10% and 90%, for rise and fall time measurements. Many of these triggering modes involve the A12 peak-detectors, which detect the voltage extremes of the incoming signal. The microprocessor, responding to operator instruction and function mode, selects the proper trigger level, and directs it through the trigger level selector (U2) to the A12 input buffer. The trigger levels for both channels are also directed through a dedicated trigger level DVM (U4, U10), and input to the channel B signal multiplexer (U7).

8-232. The two digital-to-analog trigger level converters (U23 and U21) are used to produce the trigger levels for channels A and B under two conditions. First: when the 5335A is under HP-IB control, the trigger level is programmed through the A4 microprocessor to the trigger level data latches (U16, U17, U24). Digital trigger level data from U16, U17, and U24 is applied to U21 and U23 which convert the data to analog voltages, passed through U22A or U22C to U5, the trigger level selector. Second: when the 5335A is under internal ROM diagnostic control, the trigger level is programmed by the microprocessor to the data latches (U16, U17, U24). And digital trigger level data is applied to U21 and U23, converted and passed to U5.

8-233. Relays K1 through K9 on the A12 board are actuated by the relay driver transistor pairs A11Q1–Q18. The relay drivers receive command data through transfer latch U18. Command data for the relay drivers originates in the microprocessor on A4.

8-234. A12 PROGRAMMABLE INPUT AMPLIFIER (OPTION 040)

8-235. The A12 Input Amplifier is an optional replacement for the A3 Input Amplifier. The A12 unit has all the capabilities of the A3 unit and added capability to have every function be remotely programmed. The A12 board has the A and B input signal channel amplifiers and the peak-detector circuits.

NOTE

The A and B input channels are basically identical circuits, but this description will only reference components in the A channel.

8-236. The A and B input channels are a pair of high-performance 200 MHz amplifiers. They have 25 mV rms sensitivity, and can be triggered at any point between ±5 volts. The input signal passes through the relay-controlled (K9) ac-dc coupling selection circuit, then through the relay-controlled (K6) 1 MΩ/50Ω input impedance selection circuit, then through the relay-controllecd (K8) X1/X10 attenuator, then through the relay-controlled (K7) input low-pass filter. The relay-controlled (K4) separate/common circuit is between the attenuator and filter circuits.

8-237. The relays (K1-K9) that switch nine functions on A12 are controlled by the A4 microprocessor system through the data and address buses. In turn the microprocessor system receives pushbutton commands to control the relays from A10 (the Option 040 switch panel) through A5 the, keyboard display.

8-238. The input buffer circuit is a parallel amplifier configuration. The signal is split and buffered in two parts. One part is ac coupled to a FET voltage follower (Q8), which buffers all the high frequencies (above 10 kHz). The other part is dc coupled to an Operational Amplifier (U4), which buffers the lower frequencies. The Trigger Level from the Trigger Mode multiplexer is also input at this point to offset the signal. This signal is inverted, then reunited with the high frequency path. The combined signal is then passed through an emitter follower (Q9), through a protective bridge limiter (CR25-CR30) to the Schmitt-Amplifier. The Schmitt-Amplifier is a high performance, 500 MHz band width device with settable hysteresis and a built-in three-state trigger light circuit. The square wave output of the input amplifier is then level-shifted to ECL, and sent to the A11 board.

8-239. A15 TEMPERATURE-CONTROLLED 10 MHz TIME BASE OSCILLATOR (OPTION 010)

8-240. The optional A15 temperature-controlled oscillator is described in a separate publication supplied with 5335A counters that include this option.

8-241. TROUBLESHOOTING (FAILURE ANALYSIS)

8-242. Troubleshooting or failure analysis of the 5335A as given in this manual includes built-in-diagnostics, conventional specific tests, and signature analysis.

8-243. The built-in diagnostics are stored in read-only-memory (ROM) integrated circuits. Complete instructions for using the diagnostics are given in this section. *Table 8-6* is a list of the built-in diagnostics.

8-244. Conventional specific tests for troubleshooting the assemblies in the 5335A are given in this section. The phrase "Signature Analysis" refers to an efficient system of digital electronic equipment troubleshooting available for the 5335A. More information about signature analysis is available from your Hewlett-Packard sales and service office. "Signatures" for many points in the 5335A circuits are given in this service manual.

Table 8-6. Diagnostics

DIAGNOSTIC #	DESCRIPTION	COMMENTS
0	SUPERCHECK	
1	(SCALE = 0 AUTOSETS TO 1)	
2	STIM MODE OF SIGNATURE ANALYSIS	
3	SETS FRONT END CONTROL TO 0'S	programmable input version
4	SETS FRONT END CONTROL TO 1'S	
5	DISPLAYS FRONT END SWITCH DATA	
6	DISPLAYS REAR SWITCH GROUP DATA	
7	DISPLAYS HP-IB ADDR SWITCHES	
8	PROD TEST OF ALL SWITCHES	
9	DOES SHORT CHECK OF MRC	
10	DOES EXTENDED CHECK OF MRC	checks overflow bit
11	INTERPOLATE LONG, NO DISPLAY (FAST)	
12	INTERPOLATE SHORT, W/DISPLAY	
13	INTERPOLATE LONG, W/DISPLAY	
14	CHECKS FRONT END USING TIME BASE OUT	
15	TURNS ON ALL DISPLAY ANNUNCIATORS	
16	DISPLAYS THE HP-IB ADDRESS	
17	DISPLAYS KEY # (OPER-CODE)	
18	TWEEK DACS TO ZERO	
19	TWEEK DACS TO -5.12V	
20	DVM MUX = -5V REF	DVM V→F
21	DVM MUX = GND REF	
22	DVM MUX = +5V REF	
23	DVM MUX = INPUT, RANGE = LOW	
24	DVM MUX = INPUT, RANGE = MED	
25	DVM MUX = INPUT, RANGE = HIGH	
26	TRIG DVM = -5V REF	
27	TRIG DVM = GND REF	
28	TRIG DVM = +5V REF	
29	TRIG DVM = TRIG A INPUT	AUTO TRIG must be OUT
30	TRIG DVM = TRIG B INPUT	
31	TRIG DVM = +5 VOLT SUPPLY	
32	TRIG DVM = +3 VOLT SUPPLY	
33	TRIG DVM = -5.2 VOLT SUPPLY	
34	INCREMENTAL TESTING OF DACS	

NOTE: All dIAG volts read in (volts) with "RANGEHOLD" off and read in V/F frequency out (Hz-volts) with "RANGEHOLD" on.

8-245. BUILT-IN DIAGNOSTICS

8-246. Introduction

8-247. The 5335A Universal Counter is a microprocessor-based system with 34 built-in diagnostic subroutines. These diagnostics can be used for automatic testing, and as an aid in troubleshooting the 5335A. Most of the diagnostic subroutines are used in a SUPER-CHECK routine. They can also be accessed directly for testing and troubleshooting of a specific section of the counter. A combination of diagnostic subroutines can be used to isolate a faulty section or group of components within the 5335A. Once the 5335A has been set in the diagnostic mode, switching from one diagnostic to another may be as simple as keying in the desired diagnostic number, with the exception of three diagnostics. (i.e., to exit Diagnostic #2, Diagnostic #6, and Diagnostic #17, you must cycle the 5335A power switch to STBY and back ON again.)

8-247. Accessing the Built-In Diagnostics

8-248. To access the built-in diagnostics from the front panel, there are certain conditions that must be met:

First, it is necessary to verify the proper operation of the **KERNEL**. The **KERNEL** is the heart of the system, the minimum hardware that must be functioning properly to operate the system. The **KERNEL** of the 5335A Universal Counter is the microprocessor (A4U28), the ROMS (A4U22 and A4U23), the RAMS (A4U25 and A4U26), the bidirectional buffers (A4U16 and A4U24), and the buffer (A4U27). (To verify the proper operation of the **KERNEL**, start with the POWER-UP SELF-CHECK, refer to paragraph 8-322.)

Second, the Address and the Data bus lines must not be shorted.

Third, the front panel display and keyboard must function properly.

Fourth, the power supplies and the microprocessor oscillators must be within specifications.

8-250. After successful completion of the POWER-UP SELF-CHECK, the 5335A must be set in the diagnostic mode. This is done by calling up Special Function 99. To call up Special Function 99 press the 5335A keys: SCALE, SMOOTH, 99, ENTER. To address a specific diagnostic, press: SCALE, the diagnostic number, and ENTER. Make sure the SCALE key lamp flashes after it is pressed. The noncyclic diagnostic subroutines can be reenabled by simply pressing RESET.

8-251. Any failures during the power-up cycle will disable the counter and produce one of the following:

a. A blank display.

b. A hieroglyphic is displayed.

c. Display shows a missing segment or digit.

d. Numbered ERROR or FAIL message is displayed.

NOTE

The fail messages are displayed in a continuous loop, and generally indicate a hardware related problem. Error messages indicate that the user has attempted an improper operation, either through the keyboard or the HP-IB. *Table 4-1* lists the Error Messages, and *Table 4-2* lists the Fail Messages.

8-252. Shaded Block Diagrams

8-253. Simplified block diagrams with some gray areas are interspersed with the numbered diagnostic tests. The white (not-shaded-gray) areas on these diagrams indicates which sections of the 5335A are tested by the associated numbered diagnostic. Conversely, the gray-shaded sections on the block diagram indicates which parts of the 5335A are NOT tested by the associated numbered diagnostic test.

8-254. DIAGNOSTIC #1 "SUPER CHECK"

NOTE

The 5335A rear panel TIME BASE OUT BNC connector must be connected by cable to the front panel INPUT A connector.

8-255. This diagnostic exercises a large portion of the 5335A Universal Counter. First, the microprocessor must be functioning properly. If it is not, the display may be blanked, a hieroglyphic may be displayed, or the 5335A will not respond to the front panel keys. If this is the case, the microprocessor can be tested using the Signature Analysis troubleshooting technique, with the microprocessor set in the FREERUN MODE. Refer to paragraph 8-408, Signature Analysis of the Microprocessor, for the FREERUN procedure. (See *Figure 8-60*, Troubleshooting Flowchart, for further information concerning display types and possible failure messages.)

NOTE

For Signature Analysis troubleshooting, ensure that the 5335A is NOT connected to the HP-IB bus.

8-256. Second, the ROMS (A4U22 and A4U23) are tested by the microprocessor, using a CHECKSUM. Each 8K ROM is divided into four 2K blocks. The 16-bit CHECKSUM is stored in the first two bytes of each 2K block. The CHECKSUM represents the correct arithmetic sum of the rest of the bits in each 2K block. The microprocessor adds all the words stored in the remaining bits of each 2K block and compares this with the CHECKSUM. If the resulting sum does not

match the CHECKSUM, FAILURES 1.0 → 1.9 will be displayed, or the 5335A display will be blanked. Refer to paragraph 8-406 for the Signature Analysis of the ROMS.

8-257. If no failure is indicated at this point, there is a high probability that A4U28 (microprocessor), A4U22 and A4U23 (ROMS), A4U24 and A4U27 (buffers), and A4U21 and A4U10 are functioning properly.

8-258. The next test performed is on the RAMS. They are tested for their ability to be written to and read from. The 5335A contains two RAMS, the microprocessor on-board RAM (internal to the 6802 microprocessor) and the U25/U26 RAM. When the same bit pattern that was written is not read back, FAILURES 2.0→2.2 will be displayed, the display will be blank, or a hieroglyphic could be displayed. If any of these failures are displayed by the 5335A, refer to paragraph 8-410 for the Signature Analysis of the Output Ports. The procedure given in paragraph 8-410, uses the RAMS to write the stimulus pattern for "key signature" troubleshooting in the A4 Main Logic Assembly, A5 Keyboard and Display Assembly, A7 HP-IB Logic Assembly and in the A8 DVM Assembly.

8-259. The microprocessor then proceeds to test the front panel display board which includes the annunciators, the momentary switches, the switch LED's, and the front panel display LED's. All display and annunciator lamps turn on for about one second. Visual failures such as a defective seven-segment-display, key lamp, or display annunciator will be detected during this portion of the test.

8-260. Next, the Data Bus is checked in two ways. First a ground signal is forced through Data line six (D6). The microprocessor sets up the conditions for A4U20(12) to enable A4U16 and A4U10. In turn A4U10 enables A4U19. Then A4U19(15) enables A4U15, which sets up the ground signal, and forces the signal onto D6. Data line six sends the signal through A4U16 and A4U24 and back to the microprocessor. The second part of the check is done by reading the Data Bus at the output of the Interpolator Counters which were reset by the MRC [A4U6(29)]. Errors 3.1 through 3.3 will be displayed if the microprocessor does not receive the given expected conditions. The procedure in paragraph 8-410 should isolate any problem developed while performing this test.

8-261. The proper internal operation of the MRC is verified next. The Status, Events and Time registers are thoroughly tested, (i.e., reset condition, end-of-measurement status, and their overflow conditions). Bidirectional buffer A4U7 is also tested in conjunction with the MRC. Any 4.X failure displayed indicates a faulty MRC or a defective A4U7.

8-262. The next block of circuitry tested is the START and STOP interpolators. The MRC generates a set of calibrating pulses and a Reset pulse. The calibrating pulses are used for testing the Charge and Discharge current sources and A4U4 and A4U5. The Reset pulse resets the interpolator counters at the end of each measurement test. A4U6, A4U4, A4U5, A4U8, A4U9, A4U13, A4U14, and the interpolator circuits are tested in this section. If a failure occurs at this point in the test, checkout the START and STOP interpolators by refering to paragraph 8-415.

8-263. The internal Trigger Level Voltmeter in the Amplifier Support Assembly (A2) is tested next. The +5V, 0V and -5V references are read through A2U4 (selected by A2U15), and converted to a frequency in A4U9, then level shifted by A2U8. The signal is then selected by A4U7 the multiplexer, and again level shifted by A2U6 into the MRC. Failures 6.1 through 6.3 will be displayed if these circuits do not function properly.

8-264. The next major test is performed on the 5335A Front End. The Time Base Out (TBO) must be connected to INPUT A. The presence of the signal in Channel A is sensed (if no signal is present at INPUT A, ERROR 7.0 is displayed), then the accuracy of the applied signal is checked, the COM A/SEP relay is checked in SEP and then in COM A (the presence and accuracy of the signal in Channel B is verified), then the Channel A prescaler is tested (A2U11 and A2U7). Failures 7.1 through 7.5 will be displayed if any malfunction is detected at this time. An "FE PASS" message will be displayed if all the above tests are successfully completed.

8-265. Three supplies are checked next in the A2 Amplifier Support Assembly. The +5V by A2U4(2,6), the +3V by A2U4(12) and the -5.2V by A2U2(3). These voltages are converted into their equivalent frequencies by A2U9 then routed through A2U8, A2U7, and A2U6 the MRC. Refer to paragraph 8-338 for the power supplies nominal voltages and their tolerances.

8-266. The whole procedure is then repeated, looping back to check the ROMS again. Refer to *Figure 8-43*, Diagnostic #01 Shaded Block Diagram.

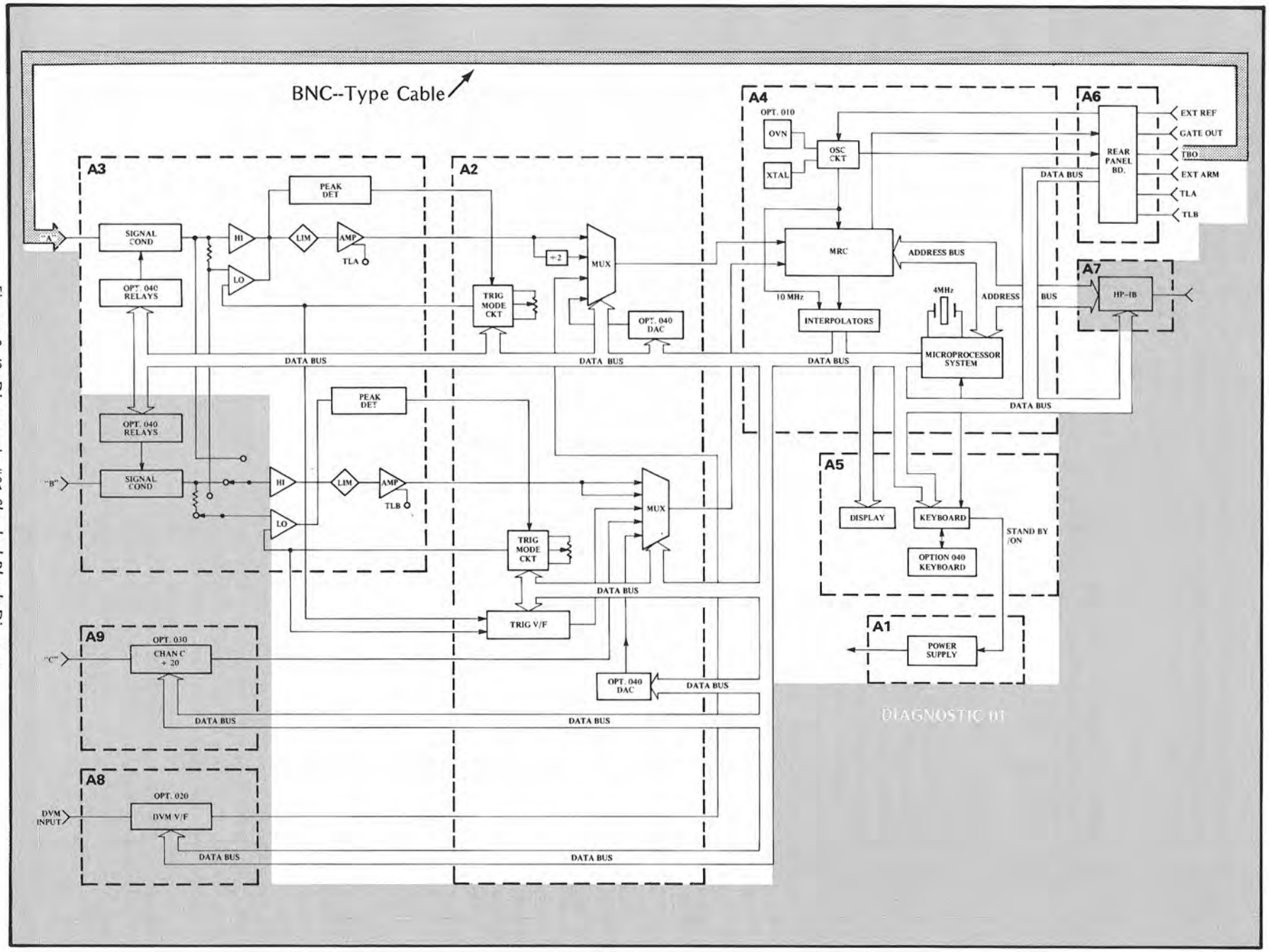


Figure 8-43. Diagnostic #01 Shaded Block Diagram

8-267. DIAGNOSTIC #2: SIGNATURE ANALYSIS STIMULUS MODE

8-268. This diagnostic procedure is designed to test all the output ports of the microprocessor system. They are:

Gate Range – Output Control Flip/Flops, A4U11 and U18

Keyboard – Display Control latch, A5U4

Keyboard – Display Data latch, A5U5

HP-IB Data Output port, A7U1, U4, U7 and A14J3

DVM option Control latch, (A8U3)

8-269. The Signature Analysis Stimulus Mode can be evoked through software (via the front panel keys) or by hard-wire (using a jumper wire on A14). Paragraph 8-410 describes the procedures for activating the Signature Analysis Stimulus Mode, and provides the expected output port signatures. Refer to *Figure 8-44*, Diagnostic #02 Shaded Block Diagram.

NOTE

To exit this diagnostic the 5335A POWER switch must be cycled to STBY and back to ON.

8-270. DIAGNOSTIC #3 AND #4: FRONT END LATCH CONTROL TEST

8-271. These diagnostic subroutines are designed to aid in the troubleshooting of the Front End Latch Control IC's A2U15 and U12 and related circuitry, including A3K1 in the standard front end.

8-272. They are also used to troubleshoot the latches of the programmable front end input (Option 040), A11U16, U17, U18, and U24 and the related circuitry, including A12K1 through K9.

8-273. Diagnostic #3 sets the outputs of the latches to a TTL "LOW" and Diagnostic #4 sets them to a TTL "HIGH". Use a logic probe, oscilloscope, or voltmeter to verify the logic levels of the latch outputs, and that the levels change when going from Diagnostic #3 to #4.

8-274. DIAGNOSTIC #5: FRONT END SWITCH TEST

8-275. This subroutine tests each of the following 5335A front end data switches:

Channel A and B X10
Channel A and B Slope
Channel A and B Preset
COM A
AUTO TRIG

Refer to *Figure 8-45*, Diagnostic #05 Shaded Block Diagram.

NOTE

The Channel A and B 1 MΩ/50Ω and AC/DC switches are not tested.

8-276. In this diagnostic, the leftmost eight digits of the display are used to give an active response for each of the tested front end data switches. Begin by pressing all of the tested switches (listed above) to the "IN" position. Key-up Diagnostic #5 and observe the display in *Figure 8-46*.

8-277. When a switch is active ("IN" position), the indicated LED should light. When released ("OUT" position) the indicated LED should blank out.

NOTE

This diagnostic is not operational with Option 040.

8-278. DIAGNOSTIC #6: REAR PANEL ARM-SLOPE SWITCH TEST

8-279. This is a subroutine that tests the A6 rear panel arming switches in their different modes of operation; also tested is the External Time Base Input. In this diagnostic, the third through eighth (from the left) digits are used to give an active response for various switches and inputs. Key up Diagnostic #6 and observe the display in *Figure 8-47*.

8-280. Placing the EXTERNAL ARM switches to the ⨍ or ⨏ positions should light up the indicated LED. The OFF position should blank out both digits. During this test, if any of the software-read front panel switches are pressed, the segments and decimal point of the third digit from the left will cycle once (e.g.,

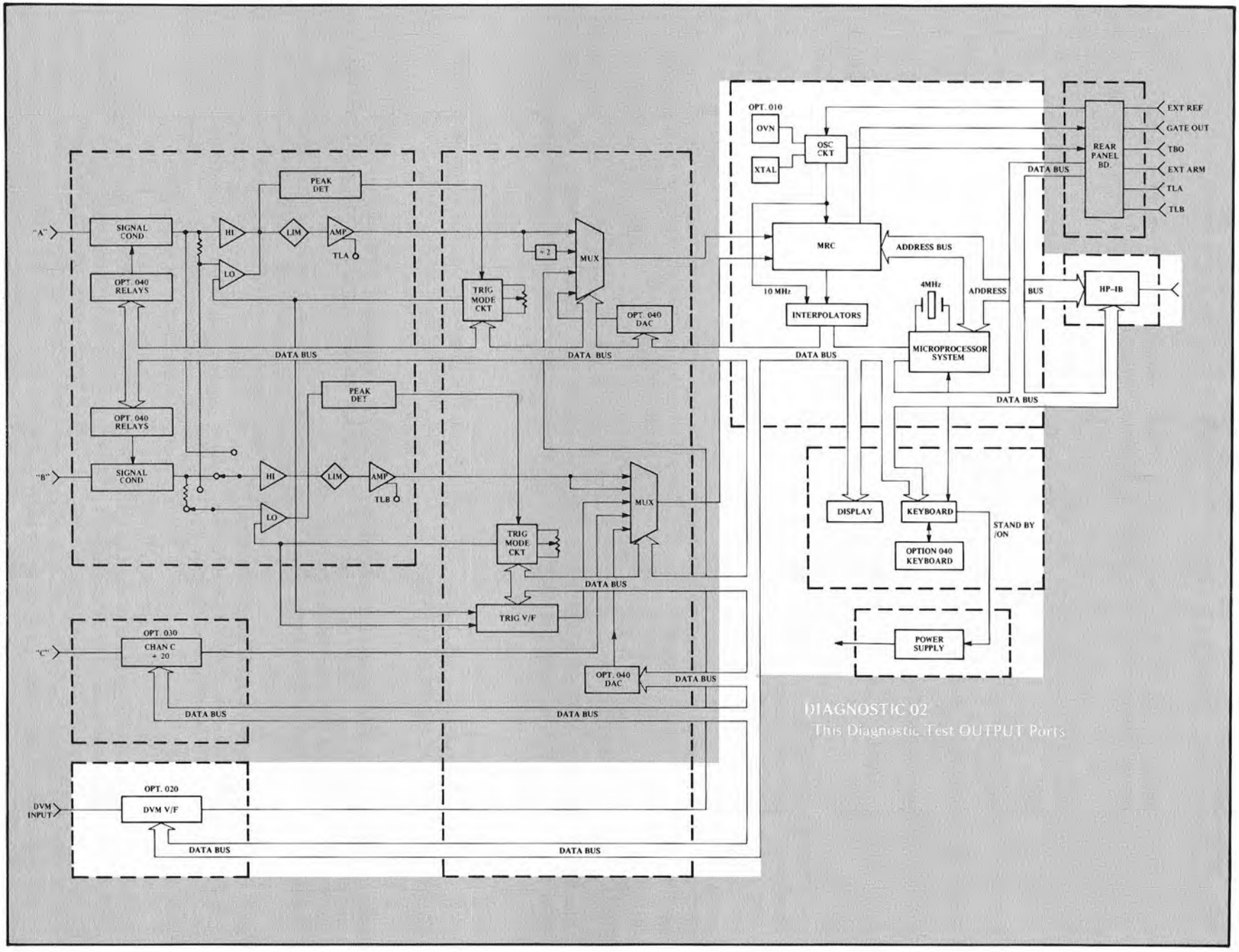


Figure 8-44. Diagnostic #02 Shaded Block Diagram

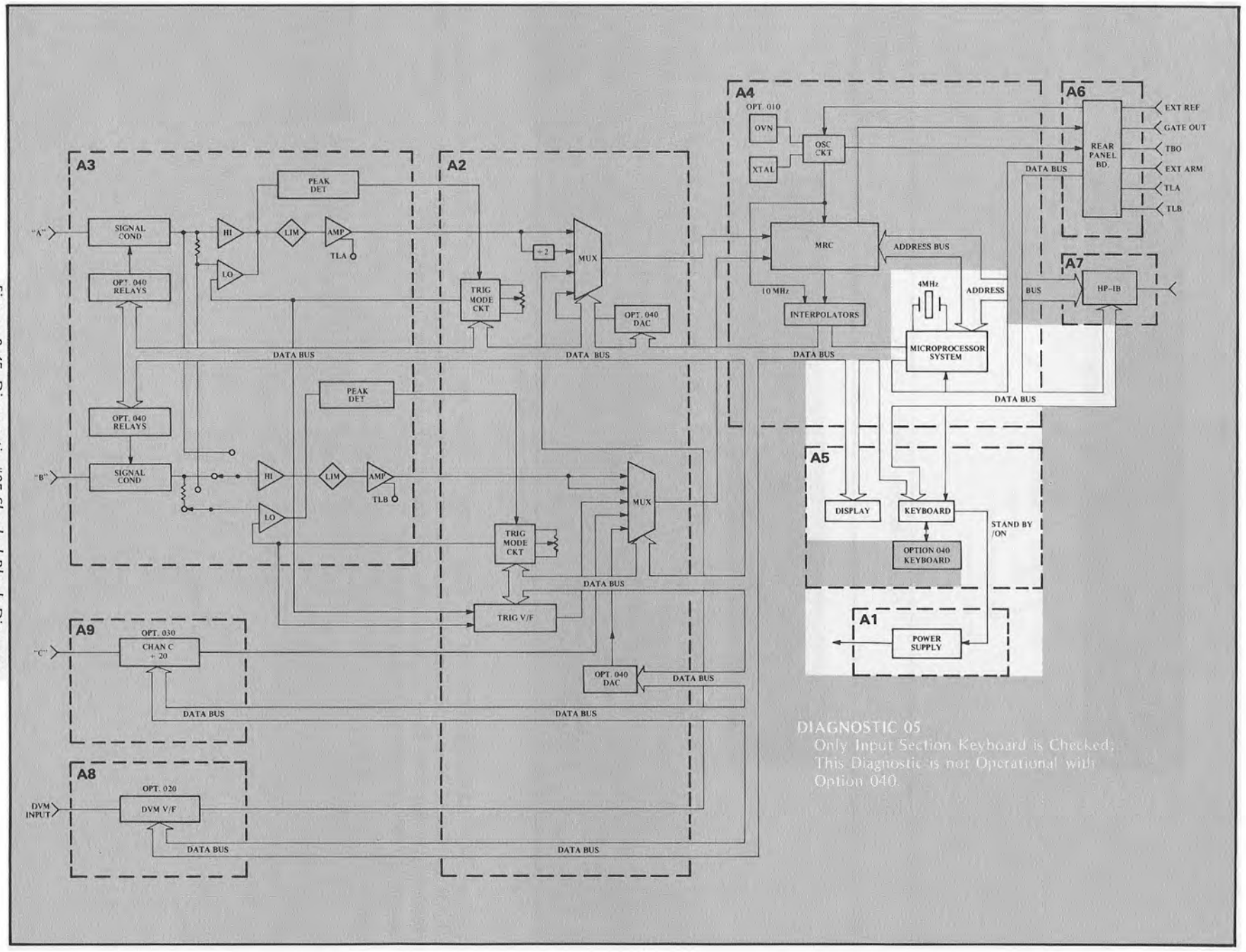


Figure 8-45. Diagnostic #05 Shaded Block Diagram

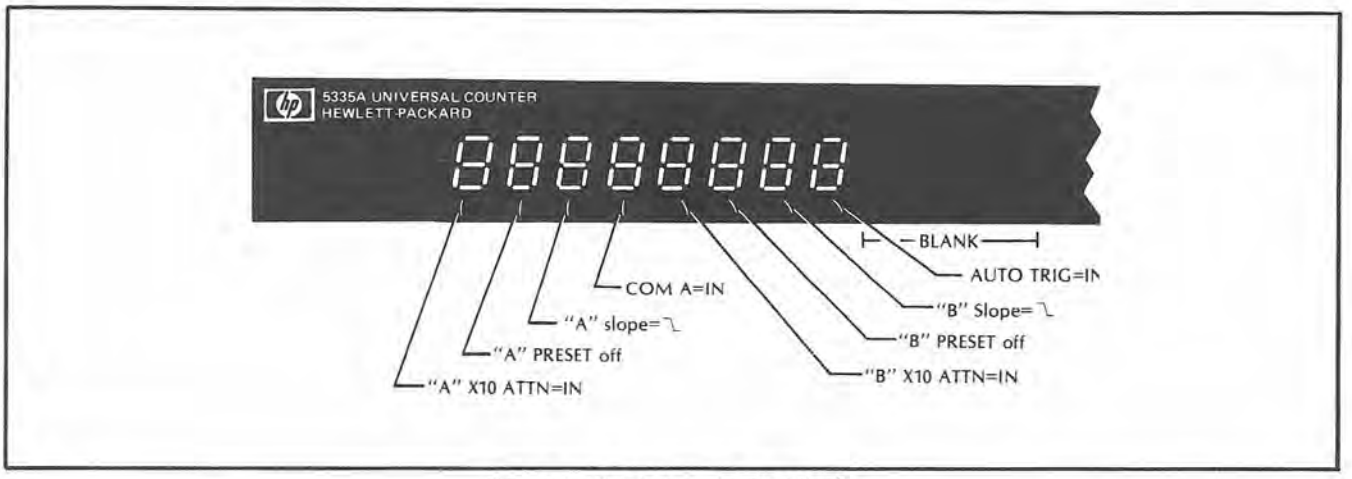


Figure 8-46. Diagnostic #05 Display

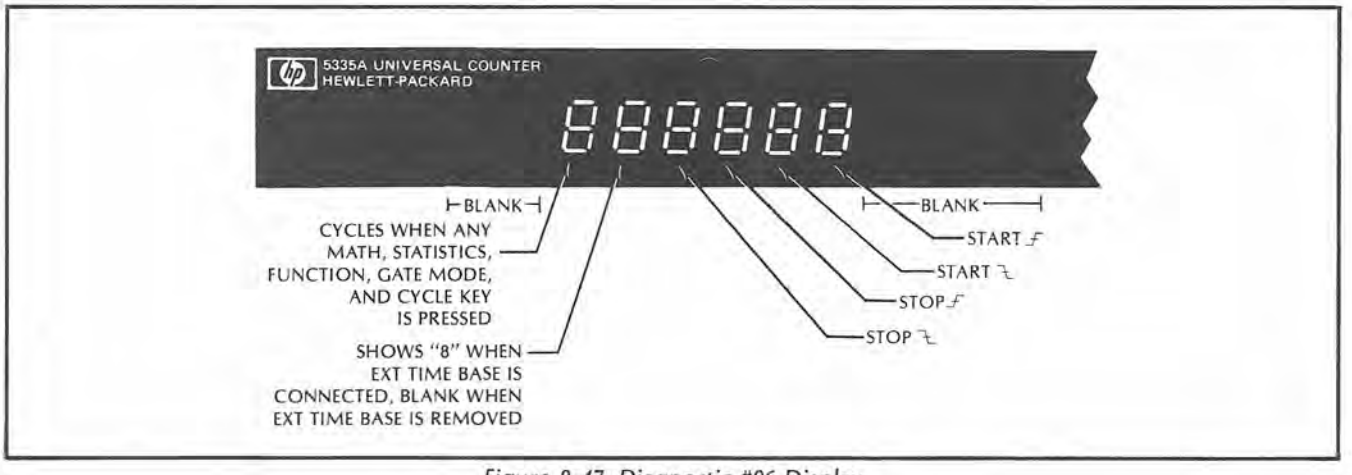


Figure 8-47. Diagnostic #06 Display

keys from the MATH, STATISTICS, FUNCTION, GATE MODE or CYCLE blocks). If the Time Base Out is connected to the Time Base In while in this test, the fourth digit from the left will display an eight "8". To exit this subroutine, the 5335A power should be turned off. Refer to *Figure 8-48*, Diagnostic #06 Shaded Block Diagram.

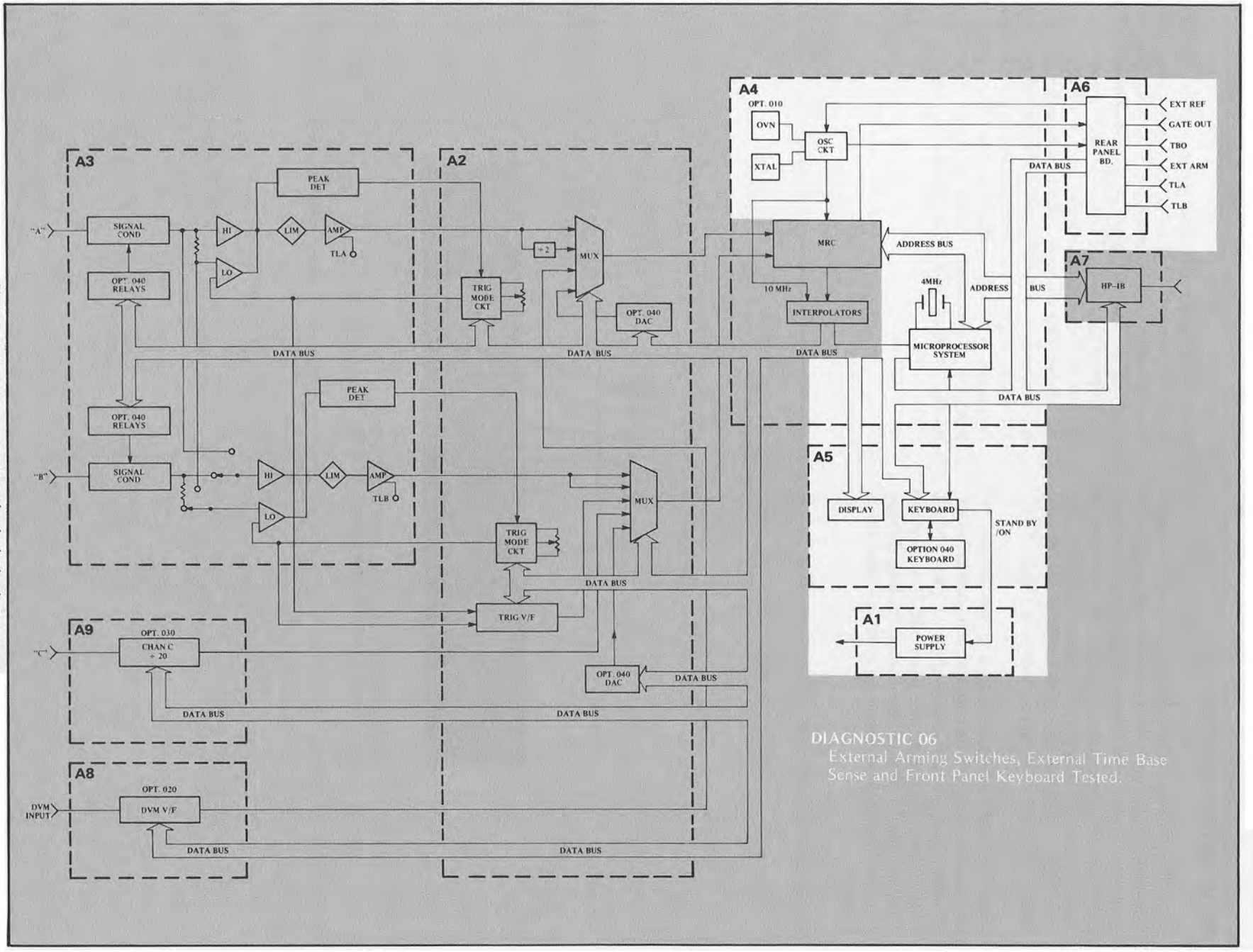


Figure 8-48. Diagnostic #06 Shaded Block Diagram

8-281. DIAGNOSTIC #7: HP-IB SWITCH STATUS

8-282. This subroutine is designed to test the *Status* of the HP-IB address switches. In this diagnostic, the second through eighth (from the left) digits are used to give an active response for each of the seven HP-IB switches. Key up Diagnostic #7 and observe the display. The individual LEDs will indicate the current status of the HP-IB switch as shown in *Figure 8-49*.

8-283. If the individual switch is set in the "1" position, the digit will be blanked; if it is set in the "0" position, the digit will be turned on, i.e., an "8" will be displayed. Changing the positions of any of the switches should change the corresponding display. Refer to *Figure 8-50*, Diagnostic #07 Shaded Block Diagram.

8-284. DIAGNOSTIC #9: MRC SHORT TEST

8-285. This diagnostic does a check of the Multiple Register Counter (MRC) and the Time Base, without testing the overflow network. The MRC status is checked at various points of a measurement. The contents of the MRC "E" and "T" registers are tested to see if they match under check measurement tolerances. The absolute value of the time base count is also checked. The 5335A will display messages "FAIL 4.1 → 4.6" if any of the tests fail. See *Table 4-2* for Fail Messages. A "PASS" message will be displayed if all tests are within limits. Refer to *Figure 8-51*, Diagnostics #09 and #10 Shaded Block Diagram.

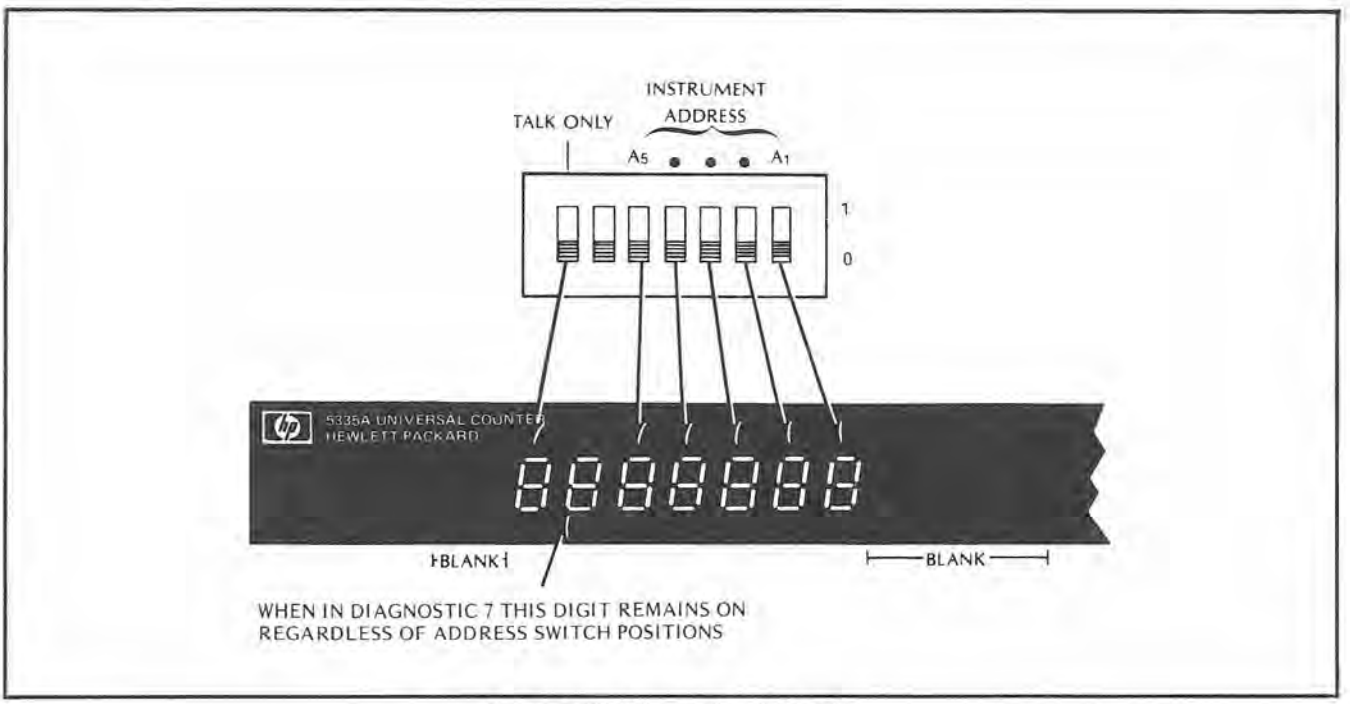


Figure 8-49. Diagnostic #07 Display

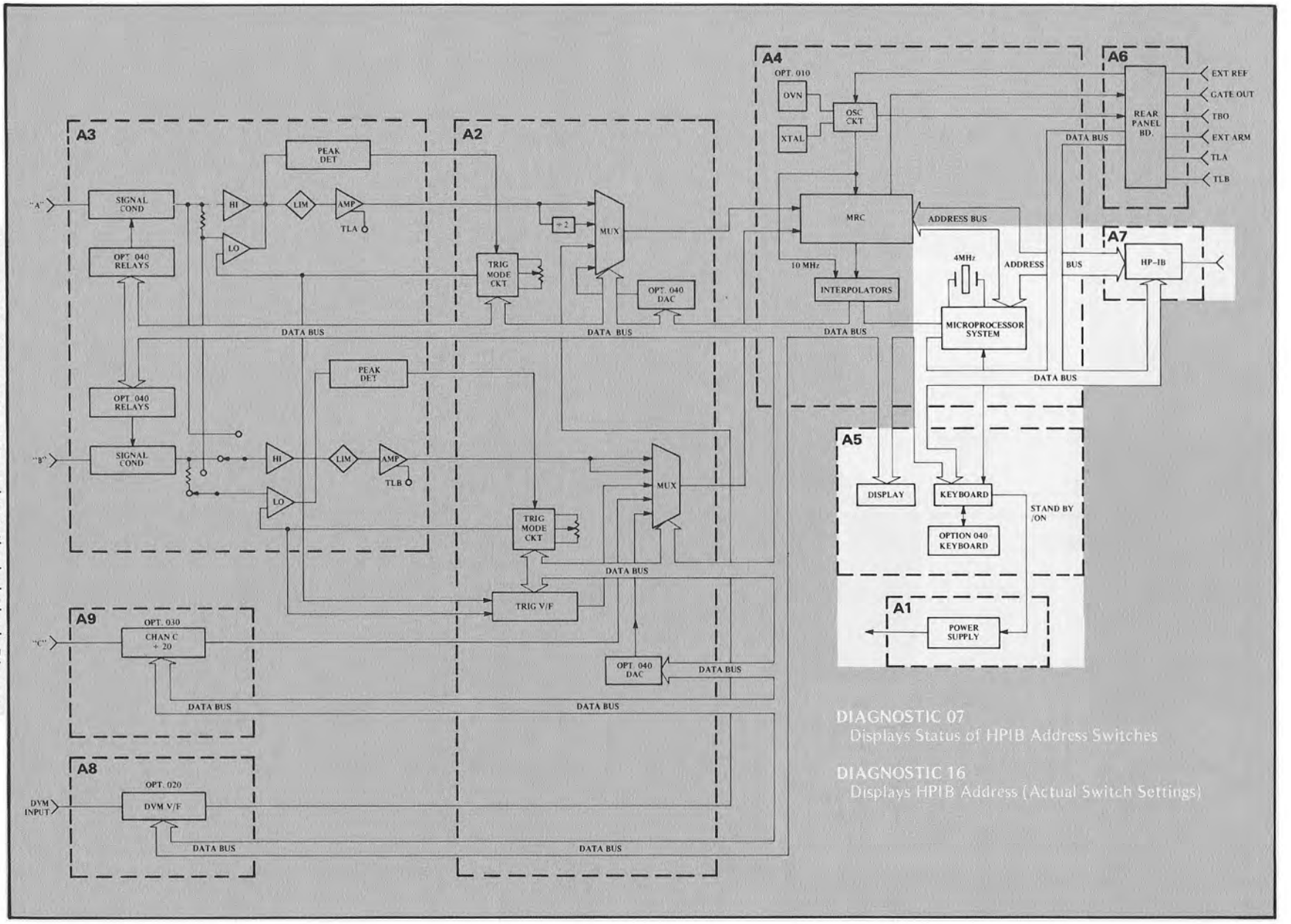


Figure 8-50. Diagnostics #07 and #16 Shaded Block Diagram

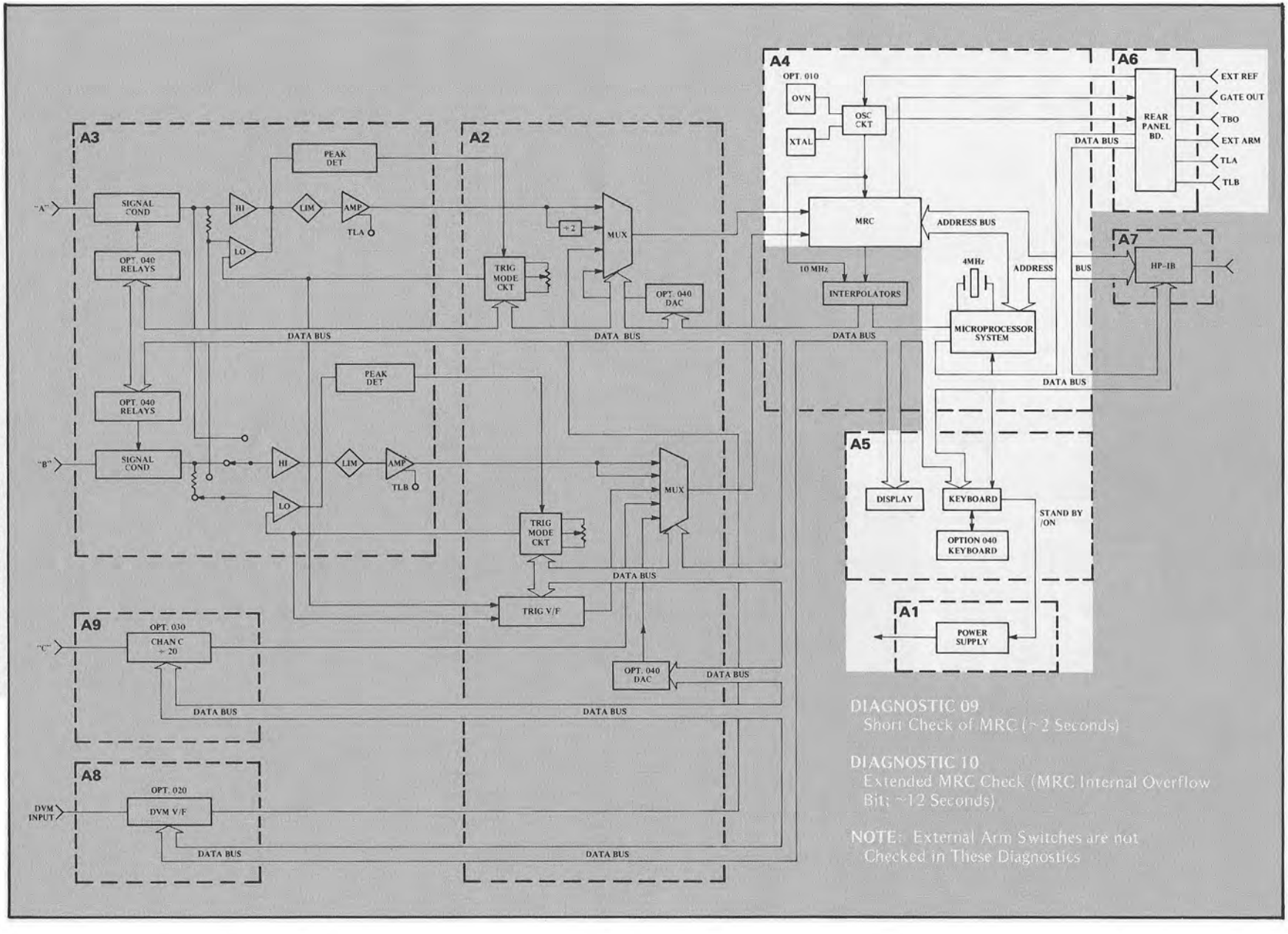


Figure 8-51. Diagnostics #09 and #10 Shaded Block Diagram

8-286. DIAGNOSTIC #10: MRC EXTENDED TEST

8-287. This diagnostic does a basic check of time base and the MRC as in Diagnostic #9. Additionally, an extended test of the MRC is done by checking the slower decades and the overflow network. Failure message 4.7 — 4.9 may be displayed during this subroutine. This diagnostic routine takes about 10 seconds. If the MRC tests are within limits, a "PASS" message will be displayed.

8-288. DIAGNOSTICS #11, #12 AND #13: INTERPOLATOR COUNTERS TEST

8-289. These diagnostic subroutines are designed to aid in the troubleshooting of the START and STOP interpolators: A4U5, U8, U4, U13, U14, U9, the Current Sources (U31A and B) plus related circuitry. Short and long calibrating pulses are used to set up the interpolators for troubleshooting. Diagnostic #11 is set up with a long calibrating pulse and it is cycled as fast as possible for better oscilloscope viewing. While in this subroutine, the 5335A will display: "dIAG 11".

8-290. Diagnostic #12 is set up with a short calibrating pulse. The contents of the interpolator counter will be displayed; two 3-digit numbers will be representing the START count (left number) and the STOP count (right number). Both numbers should be similar (±10 counts).

8-291. Diagnostic #13 is similar to Diagnostic #11, but when in this subroutine the contents of the interpolator counters are displayed. The numbers displayed should be approximately 26 to 86 counts less than the numbers displayed in Diagnostic #12.

8-292. See paragraph 8-415 for typical waveforms; and refer to *Figure 8-52*, Diagnostics #11, #12, and #13 Shaded Block Diagram.

8-293. DIAGNOSTIC #14: FRONT END CHECK

8-294. This diagnostic subroutine is designed to check out the 5335A front end circuitry with a 10 MHz signal applied to INPUT A. Connect the rear panel TBO, (or an external 10 MHz sine wave at ≈1V rms) to INPUT A. When Diagnostic #14 is keyed up, the following sequence of tests will be performed automatically:

a. Presence of the signal in Channel A (if no signal, ERROR 7.0 is displayed)

b. Accuracy of the signal in Channel A (FAIL 7.1 if wrong frequency)

c. Check Channel B for Cross Talk (FAIL 7.2 if 10 MHz is detected in Channel B; SEP/COM A in SEP)

d. Presence of signal in Channel B (FAIL 7.3 if no trigger through COM A)

e. Accuracy of signal in Channel B (FAIL 7.4 if wrong frequency)

f. Check Channel A prescaler (A2U11 and U7) (FAIL 7.5 if malfunctioning)

g. A "FE PASS" message will be displayed if all of the above tests are successfully completed. Refer to *Figure 8-53*, Diagnostic #14 Shaded Block Diagram.

8-295. DIAGNOSTIC #15: FRONT PANEL DISPLAY TEST

8-296. This diagnostic subroutine turns on all of the 5335A front panel display LED's, including the annunciators and the momentary switches. The Channel A and B trigger lights and the standby (STBY) LED are not tested. When Diagnostic #15 is keyed up, verify that all the indicated LEDs light up. Refer to *Figure 8-54*, Diagnostics #15 and #17 Shaded Block Diagram.

NOTE

The display may flicker a bit. This is because the circuitry is being continuously written to by the microprocessor.

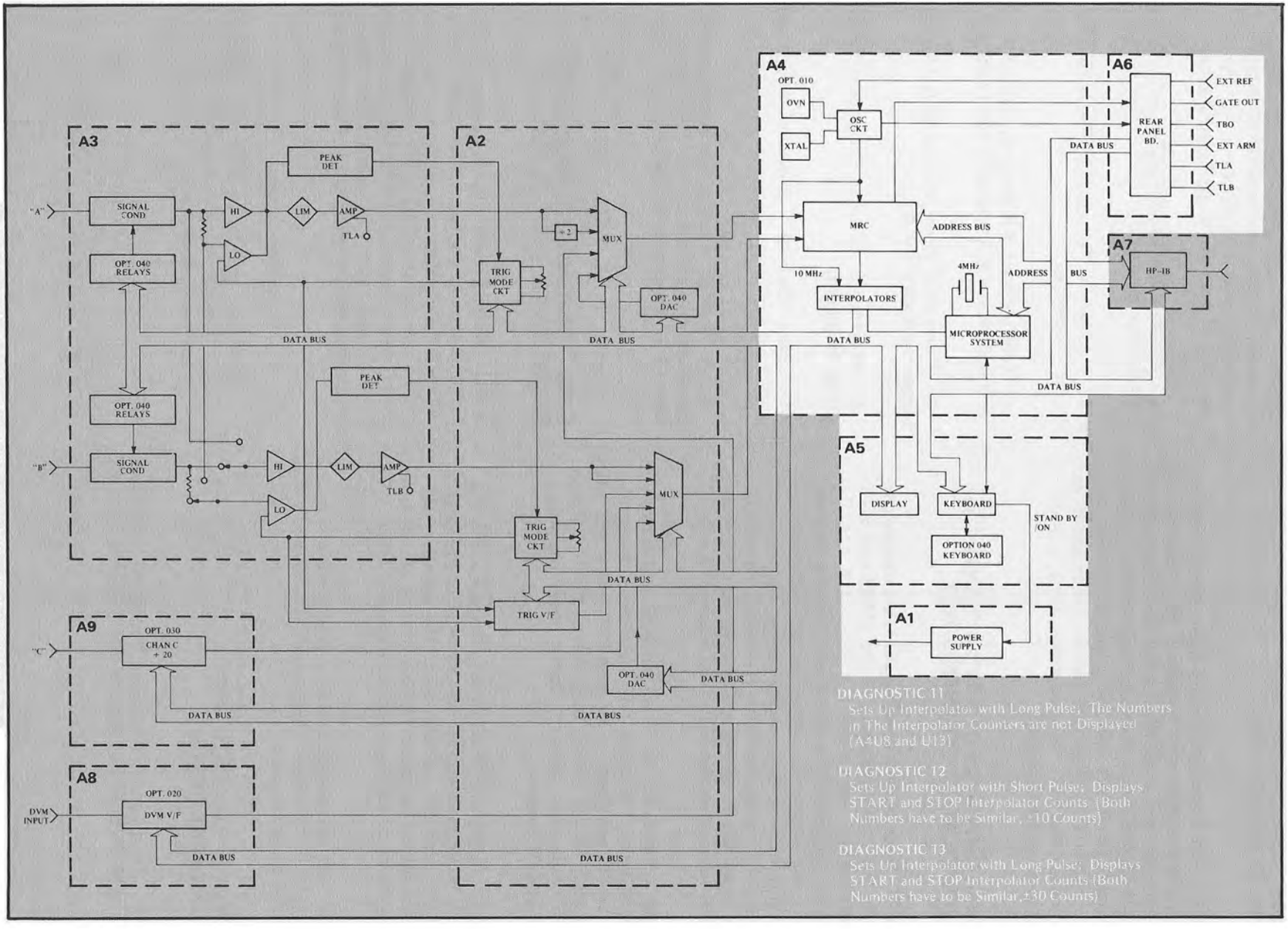


Figure 8-52. Diagnostics #11, #12, and #13 Shaded Block Diagram

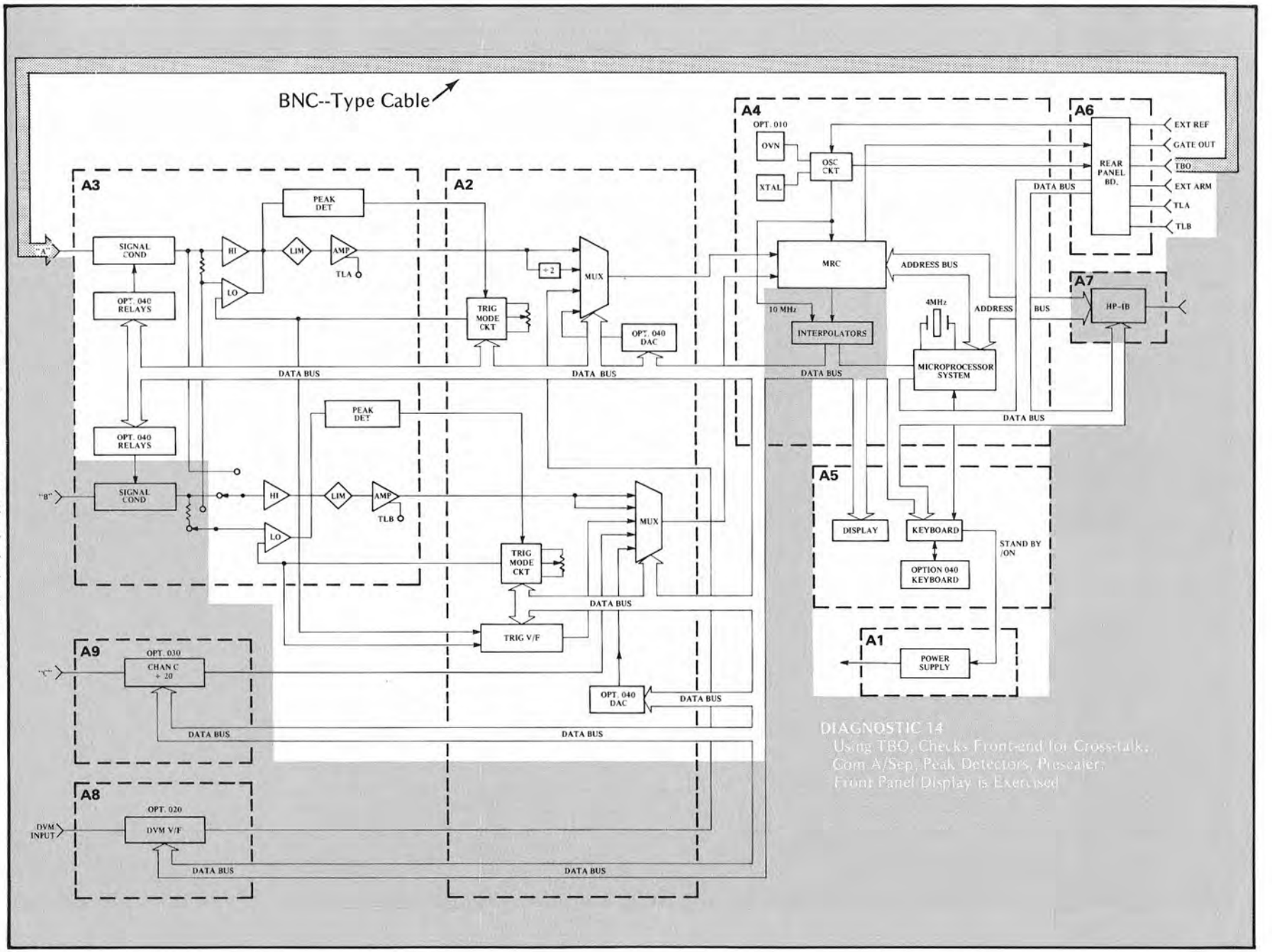


Figure 8-53. Diagnostic #14 Shaded Block Diagram

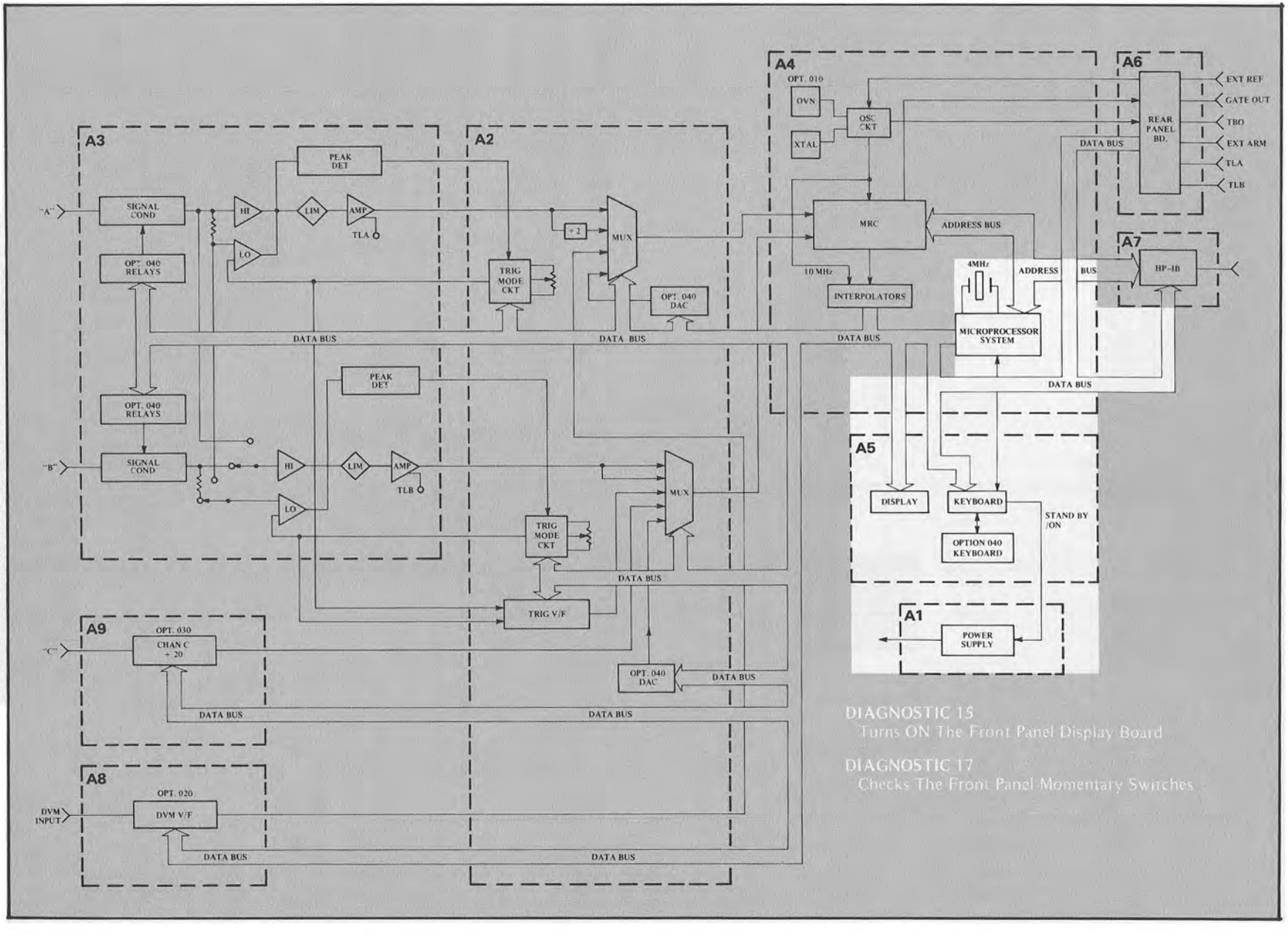


Figure 8-54. Diagnostics #15 and #17 Shaded Block Diagram

8-297. DIAGNOSTIC #16: HP-IB ADDRESS SWITCH

8-298. This diagnostic will check the status of the HP-IB address switches, similar to Diagnostic #7. This routine, however, decodes this information and displays a decimal HP-IB Bus address (i.e., HP-IB Addr 28). While in this subroutine, any change in the setting of the switches will be immediately decoded and the corresponding HP-IB Bus address will be displayed. Refer to *Figure 8-55* for example display.

8-299. DIAGNOSTIC #17: KEYBOARD CHECK

8-300. This diagnostic subroutine is designed to verify the ability of the microprocessor to identify an individual software-read front panel momentary switch when it is pressed. When Diagnostic #17 is keyed up, a number should be displayed when any switch is pressed corresponding to *Figure 8-56*. The selected key's LED will remain ON while the number is being displayed. A "+ 0" will be displayed in the exponent section of the display during the test.

NOTE

To exit this diagnostic, the 5335A Power Switch must be cycled to STBY and back ON.

8-301. DIAGNOSTIC #18 AND #19: DAC ADJUSTMENT (OPTION 040)

8-302. These diagnostic subroutines (#18 and #19) are designed to set up the trigger level DAC's (A11U23 and A11U21), for adjustment. These DAC's are on A11 Assembly of the 5335A Option 040 programmable front end. These two diagnostics are also used to troubleshoot A11 (Option 040). Refer to *Figure 8-57*, Diagnostics #18 and #19 Shaded Block Diagram.

8-303. When Diagnostic #18 is keyed up, this subroutine programs the Channel A and B trigger level DAC's to "0" volts.

8-304. When Diagnostic #19 is keyed up, this subroutine programs the Channel A and B trigger level DAC's for "–5.12" volts.

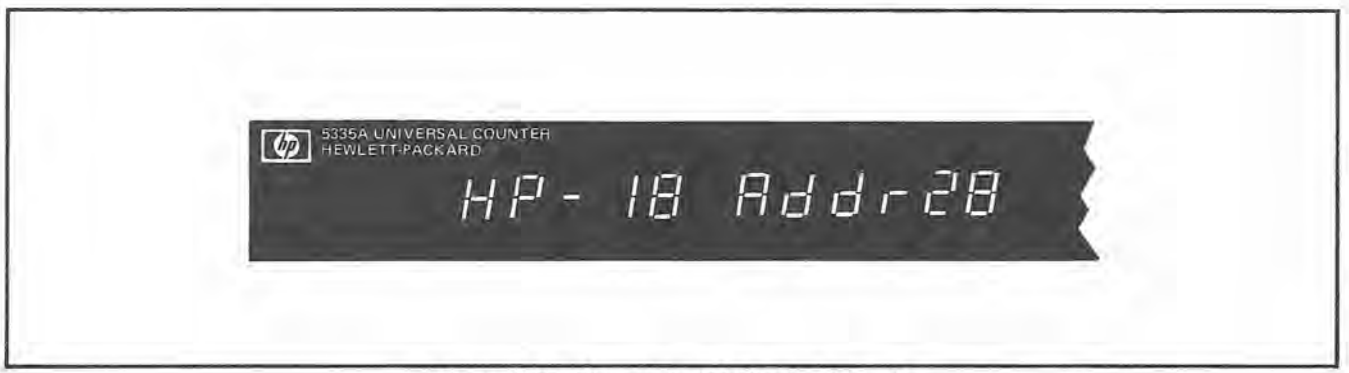


Figure 8-55. Diagnostic #16 Display Example

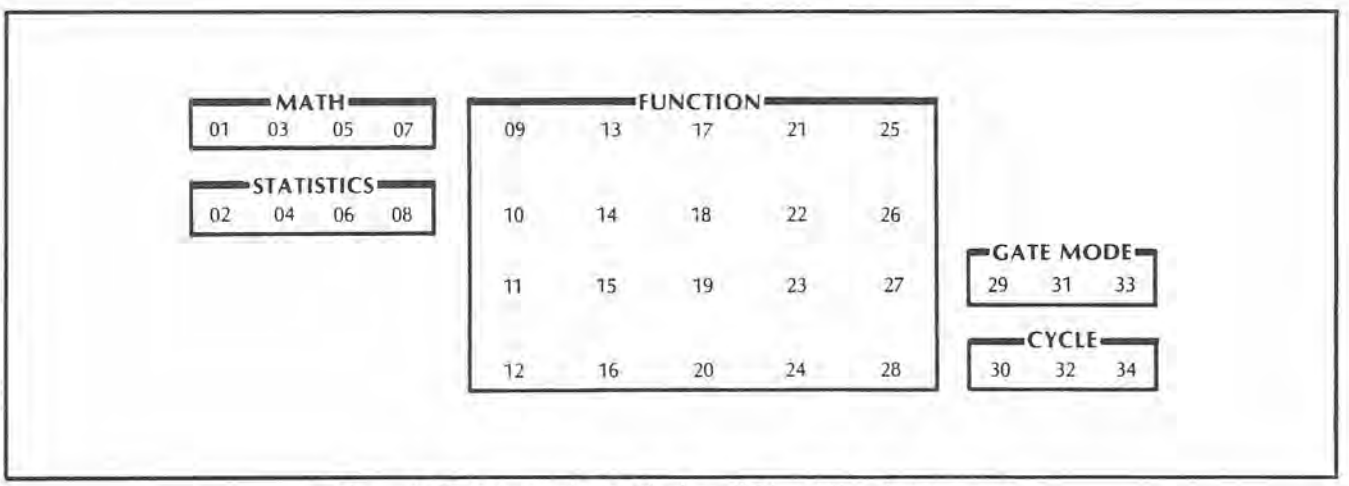


Figure 8-56. Diagnostic #17 Keyboard Check Key Assignments

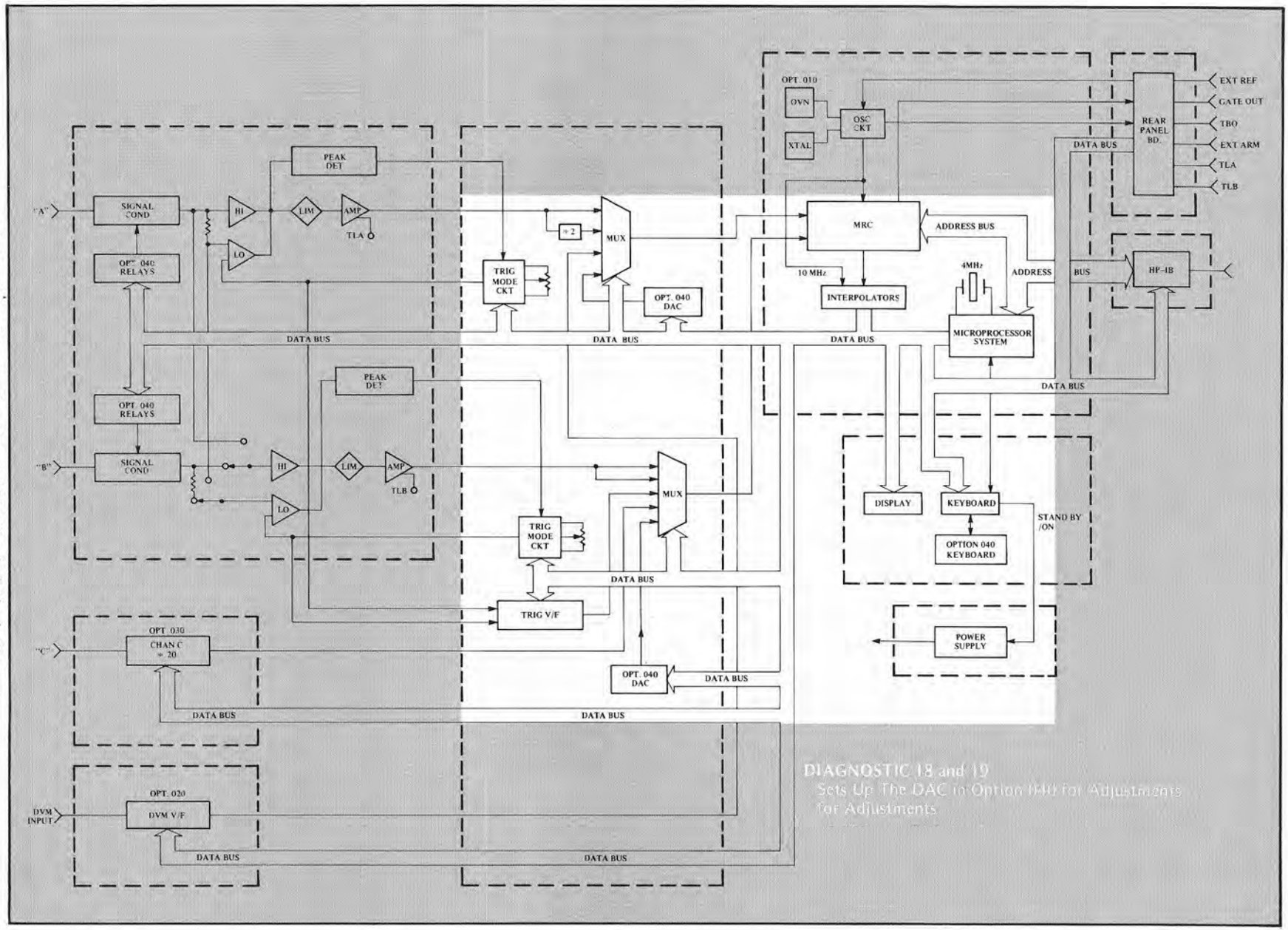


Figure 8-57. Diagnostics #18 and #19 Shaded Block Diagram

8-305. DIAGNOSTIC #20, #21 AND #22: DVM REFERENCE TEST (OPTION 020)

8-306. These diagnostic subroutines are designed to set up the DVM option to measure and display the voltage and frequency of the -5V, GND and +5V references. These subroutines verify all the A8 DVM circuitry, with the exception of A8U11. Refer to *Figure 8-58*, Diagnostics #20 through #25.

8-307. When Diagnostic #20 is keyed up, with the "RANGE HOLD" OFF, the 5335A will display the voltage of the -5V reference. With "RANGE HOLD" ON, the corresponding -5V reference frequency will be displayed. (This is true for all diagnostics that read in volts.) In the same manner, Diagnostics #21 and #22 measure and display the voltage and frequency of the GND (0.00V) and +5V references. Refer to the following table for expected results:

	DIAGNOSTIC		
	20	21	22
RANGE HOLD **OFF**	-5.00000V	0.00000V	+5.00000V
RANGE HOLD **ON**	900 Hz-V	6.1 kHz-V	11.3 kHz-V

8-308. DIAGNOSTIC #23, #24 AND #25: DVM RANGE TEST (OPTION 020)

8-309. These diagnostic subroutines force the DVM option into its LOW, MED, and HIGH range, respectively. By inputting a known dc voltage to the DVM input, the input amplifier A8U11, the FET's and transistor, which select the different ranges, can be tested. The autorange feature of the DVM is disabled in these tests.

8-310. DIAGNOSTIC #26, #27 AND #28: TRIGGER LEVEL DVM REFERENCE TEST

8-311. Refer to *Figure 8-59*, Diagnostics #26 through #33 Shaded Block Diagram. These diagnostic subroutines set up the trigger level DVM in the A2 amplifier support assembly so that the -5 volt, GND, (0.0 volt) and +5 volt reference voltages and frequencies can be measured and displayed. These subroutines operate the same as Diagnostics #20, #21 and #22. Diagnostic #26 programs the A2U4 multiplexer to read the -5V reference; Diagnostics #27 and #28 program the multiplexer to read the ground and +5 references respectively. A2U14, U15, U12, U4, U8, U9, and U7 are exercised with these subroutines. The following table lists the results:

	DIAGNOSTIC		
	26	27	28
RANGE HOLD **OFF**	-5.00000V	GND REF	+5.00000V
RANGE HOLD **ON**	190 Hz-V	1.9 kHz-V	3.7 kHz-V

8-312. DIAGNOSTIC #29 AND #30: TRIGGER LEVELS A AND B TEST

8-313. These diagnostic subroutines are similar to Diagnostics #26 through #28, except that the actual trigger level voltage for both Channels A and B can be varied over the entire range during this exercise. Again, the corresponding frequency for a given voltage can be displayed by activating "RANGE HOLD".

8-314. DIAGNOSTIC #31, #32, #33: A4 DVM POWER SUPPLIES TEST

8-315. These three diagnostics are similar to Diagnostics #26 through #28, except that the voltage and frequency of the three power supplies are measured and displayed. Diagnostic #31 measures the +5 volt supply, #32 measures the +3 volt supply, and #32 measures the -5.2 volt supply. Pressing "RANGE HOLD" will display the corresponding frequencies. The following table lists the results:

	DIAGNOSTICS		
	31	32	33
RANGE HOLD **OFF**	+5.00000V	+3.00000V	-5.20000V
RANGE HOLD **ON**	3.75 kHz-V	3.05 kHz-V	100 Hz-V

8-316. DIAGNOSTIC #34: INCREMENTAL TESTING OF THE DAC'S (OPTION 040)

8-317. This diagnostic subroutine programs the DAC's in the Option 040 to step through their voltage range (from -5.11V to +5.11V) in increments of 10 mV. This subroutine performs a "functional" test on the DAC, verifying its proper operation. A visual check on the functioning of the DAC can be obtained by connecting Trigger Level A (or B) from the 5335A rear panel to an oscilloscope. The level will vary from -5.11 volts to +5.11 volts continuously. This subroutine exercises the data latches A11U16, 17 and 24, the DAC's A11U21 and U23, and the multiplexer A11U5, plus associated circuitry. When this diagnostic is accessed the 5335A will display: "dIAG 34".

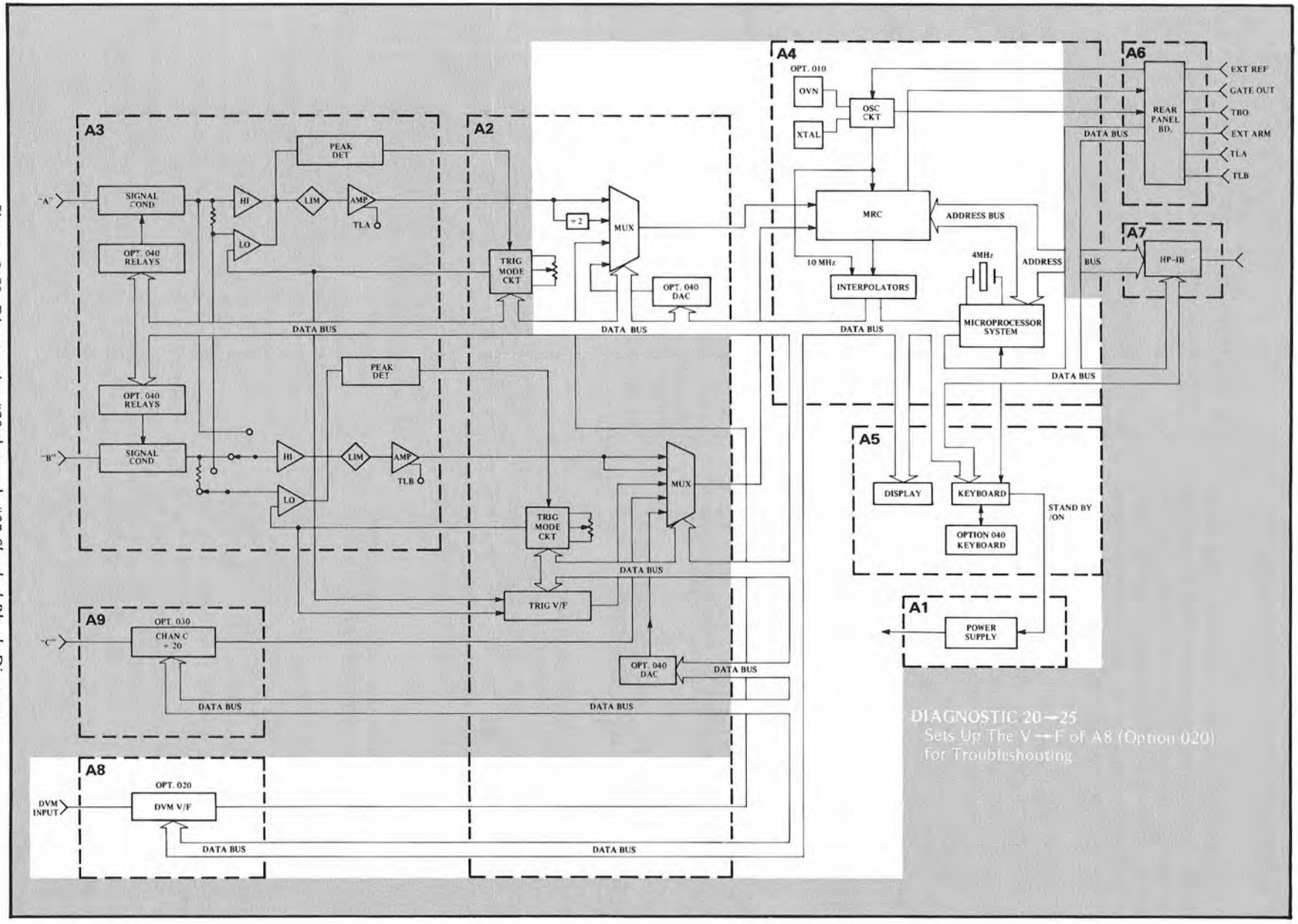


Figure 8-58. Diagnostics #20 through #25 Shaded Block Diagram

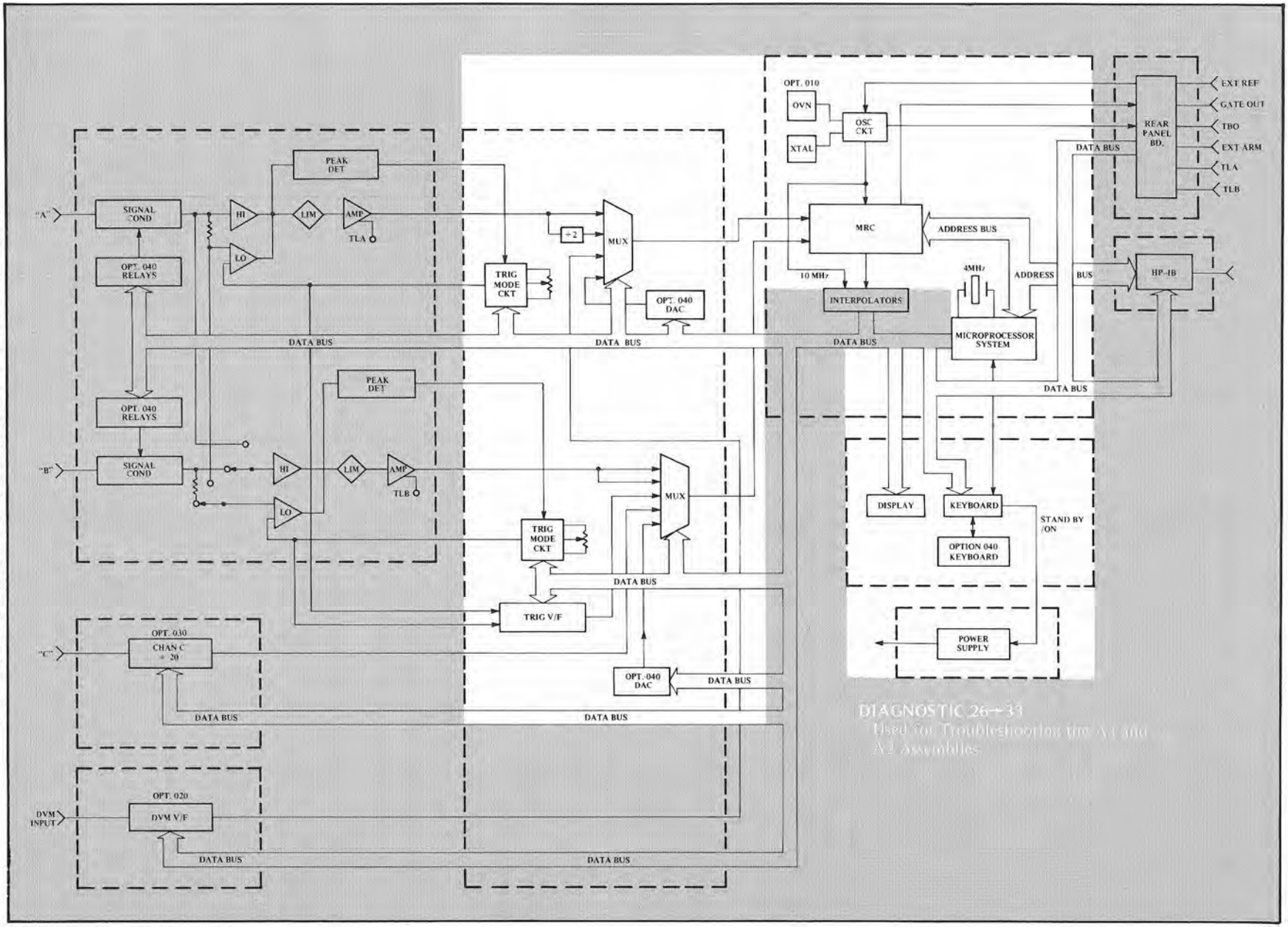


Figure 8-59. Diagnostics #26 through #33 Shaded Block Diagram

8-318. OVERALL TROUBLESHOOTING

8-319. The troubleshooting of the 5335A is keyed with the power-up self-test. The service technician should follow the flowchart procedure to isolate faulty assembly area. Once the problem source is identified, the technician can proceed to the appropriate assembly troubleshooting paragraphs and assembly schematic diagram. However, a complete list of all failure modes is impossible, and this text and schematic information can be expanded by the technician or user.

8-320. For any observed failure mode, it is recommended that the power supplies be checked first. The 5335A power supply contains seven dc supplies: +25 volts, +15.7 volts, −15 volts, +15 volts, +10 volts, +5 volts, +3 volts, and −5.2 volts. These supplies are generated in the A1 assembly; verify that they are within tolerance per *Table 8-7*. Next the 4 MHz microprocessor oscillator should be checked, as well as the 10 MHz timebase oscillator, per paragraph 8-423.

8-321. Once the 5335A power supplies and the microprocessor oscillator are verified to be working OK, the very next step is to verify the proper operation of the 5335A **KERNEL**.

CAUTION

Before switching on the instrument, ensure the following:

1. **The transformer primary is matched to the available line voltage.**
2. **The correct fuse is installed.**
3. **All safety precautions have been observed.**

For details see Power Requirements, Line Voltage Selection, Power Cables, and associated warnings and cautions in Section II of this manual.

8-322. POWER-UP/SELF-CHECK

8-323. First it is necessary to verify the proper operation of the **KERNEL**. The **KERNEL** is the heart of the system, the minimum hardware that must be functioning properly to operate the system. The **KERNEL** of the 5335A Universal Counter is the microprocessor (A4U28), the ROMS (A4U22 & A4U23), the RAMS (A4U25 & A4U26), the bidirectional buffers (A4U16 & A4U24), and the buffer (A4U27).

8-324. When the counter is turned on an automatic internal check is made of the **KERNEL**, the MRC (A4U6), the Start and Stop Interpolators, the A2 Voltage-to-Frequency converter, the input circuitry, the front panel keyboard and display, and the interconnecting data buses. After the power-up sequence, the counter will initialize itself. All Math and Statistics will be OFF, the function will be FREQ A, and the Gate and Cycle Modes will be in NORM. All of the input controls will be set according to their switch positions.

8-325. Any failures during the power-up cycle will disable the counter and produce one of the following:

a. A blank display.

b. A hieroglyphic is displayed.

c. Display shows a missing segment or digit.

d. Numbered ERROR or FAIL message is displayed.

8-326. Refer to *Figure 8-60*, Troubleshooting Flowchart, for further information concerning display types and possible failure messages.

8-327. Proceed with the POWER-UP/SELF-CHECK as follows:

a. PRESET: 5335A Power Switch to STBY (OUT).

b. VERIFY: Red Standby Lamp is ON.

c. SET: 5335A Power Switch to ON (IN).

d. VERIFY:

1. Red Standby Lamp is OFF.
2. All display and annunciator lamps turn on for about one second (excluding standby and trigger lamps).
3. Then the display shows the HP-IB Address for about one second.

e. Successful completion of the POWER-UP SELF-CHECK is denoted by the following:

1. NO FAIL or ERROR messages Displayed.
2. Display shows "0.".
3. Hz lamp is ON.
4. FREQ A lamp is ON.
5. All other lamps are off (except trigger).
6. Fan is ON.

NOTE

If the 5335A passes the POWER-UP SELF-CHECK, proceed to SECTION IV of this manual and perform the Operation Verification in paragraph 4-9.

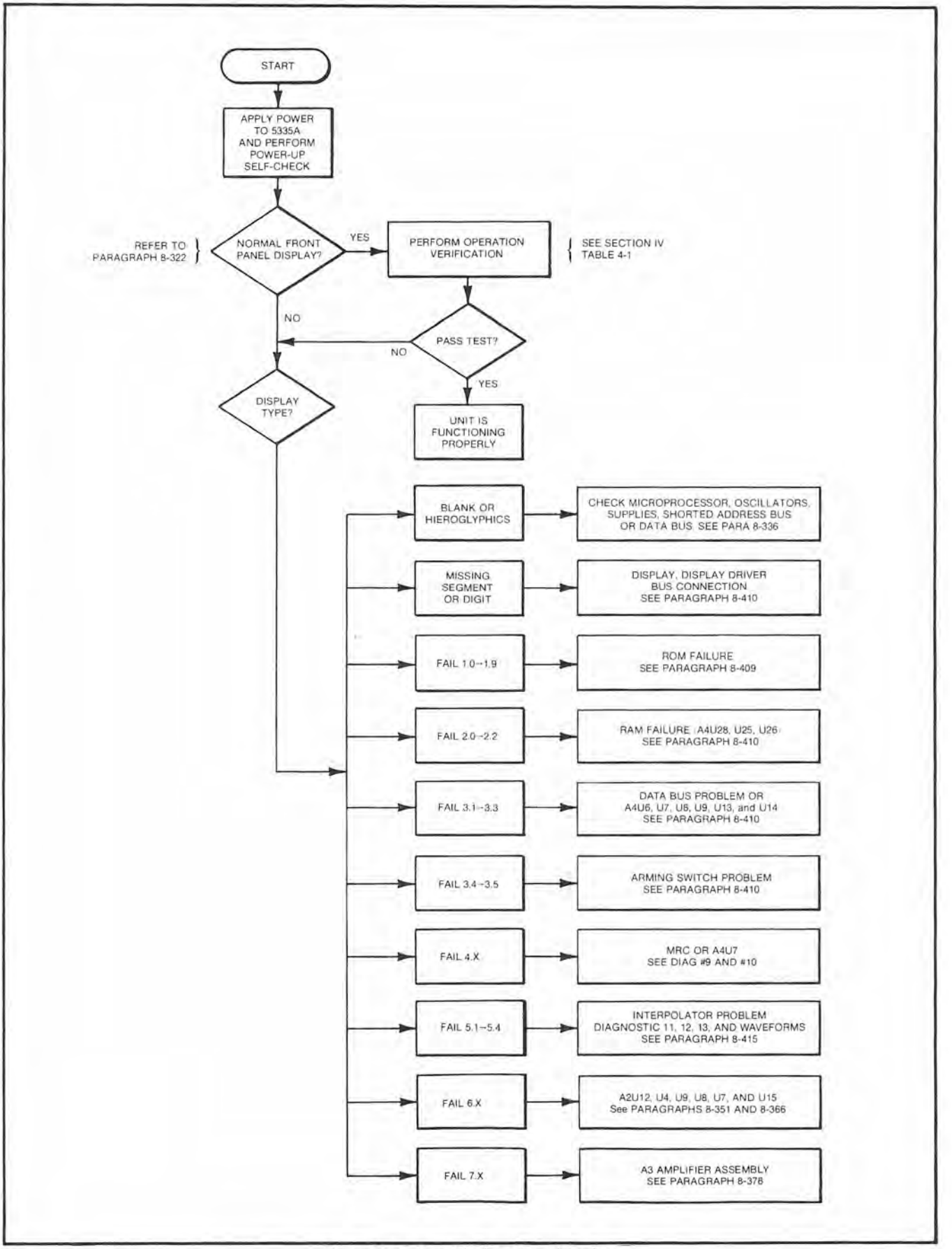


Figure 8-60. Troubleshooting Flowchart

8-328. If a failure occurs at POWER-UP, one of the diagnostics from *Table 8-6* may be used to isolate the failure. (Refer to *Figure 8-60*, Troubleshooting Flowchart, for further information concerning display types and possible failure messages.)

8-329. First establish that the 5335A responds to the keyboard commands by pressing any one of the FUNCTION, MATH, STATISTICS, GATE MODE, or CYCLE keys. If the keyboard responds correctly the key lamp will light, with the exception of the blue MATH keys. If one of the blue MATH keys is pressed the key lamp should flash.

8-330. If the 5335A responds to the keyboard commands proceed to the SUPER CHECK. If the keyboard does not respond as indicated, proceed to paragraph 8-406 for the Signature Analysis of the microprocessor.

8-331. SUPER CHECK (Diagnostic #01)

8-332. The SUPER CHECK is a continuous diagnostic loop which will repeat until manually reset; during this cycle the front end amplifiers are checked for accuracy, cross talk, attenuation and separate/common with the input signal. In addition the 5335A checks the operation of the following:

ROMS
RAMS
DATA BUS
FRONT PANEL DISPLAY
MRC
INTERPOLATORS
TRIGGER LEVEL REFERENCES (GND, +5V, -5V)
CHANNEL A & B TRIGGERING
SEP/COM RELAY
PRESCALER
POWER SUPPLY VOLTAGES (+5V, +3V, -5.2V)

NOTE

For a complete description of the SUPER CHECK refer to paragraph 8-254, and to the Troubleshooting Fowchart, *Figure 8-60*.

8-333. To perform the SUPER CHECK proceed as follows:

a. Connect a 4-foot BNC cable (HP P/N 10503A) from the 5335A rear panel TIME BASE OUT to the front panel INPUT A jack. Set the 5335A 1 MΩ/50Ω input controls to 50Ω.

b. Call up Special Function 99 by pressing the following 5335A keys:

1. SCALE verify the SCALE key lamp is flashing.
2. SMOOTH (Display will show "SPECIAL +0".)
3. 9
4. 9
5. ENTER (Display will show "dIAG 01" for about 5 seconds.)

c. VERIFY:

1. All display annunciator lamps turn ON for about 5 seconds.
2. Successful completion of the front end test loop displays the message "FE PASS" for about 15 seconds.
3. Display shows nominal values of 3 Supply Voltages:

   5. 000 00 V
   3. 000 00 V
   -5. 200 00 V

4. The test then repeats itself.

NOTE

If TIME BASE OUT is not connected to INPUT A, ERROR 7.0 will be displayed.

8-334. After successful entry into Special Function 99, any diagnostic can then be called up from the table of diagnostics (Refer to *Table 8-6*). Just press SCALE, (Verify the SCALE key lamp is flashing), the diagnostic number, and ENTER. The 5335A will access the given diagnostic.

8-335. Any failures are identified by a numbered ERROR or FAIL message. (For a description refer to ERROR/FAIL MESSAGES, paragraph 4-7.) If a failure occurs, one of the diagnostics from *Table 8-6* may be used to isolate the failure. (Refer to *Figure 8-60*, Troubleshooting Flowchart, for further information concerning display types and possible failure messages.)

8-336. Procedure for Inaccessible Diagnostics

8-337. If the diagnostics cannot be accessed, proceed as follows: (For example, the front panel display is blank and the 5335A does not respond to the keyboard commands.)

a. Check the Power Supplies. Refer to paragraph 8-338.

b. Check the microprocessor oscillators. Refer to paragraph 8-423. (If the supply voltages are correct, and the oscillators are operating properly, go to step c.)

c. Check the **KERNEL** of the 5335A. Refer to paragraph 8-408. This procedure is done with the microprocessor set in the FREERUN MODE and is not dependent on the front panel display. (If the signatures in *Tables 8-14* and *8-15* are correct, then the Address Bus is functioning properly. Proceed to step d.)

d. Check the ROMS and the Data lines. Refer to paragraph 8-406. If the signatures are correct, the Data Bus is functioning properly. Go to step e.)

e. Check the Keyboard and Display Assembly (A5) for open traces or open circuits, and the cable (W4) that connects the Keyboard and Display Assembly to the Main Logic Assembly (A4) for opens.

8-338. A1 POWER SUPPLY TROUBLESHOOTING

8-339. To verify proper operation of the 5335A, A1 Power Supply Assembly (05335-60001), check the seven dc voltages labeled on the A1 Power Supply board and the ac voltage on A1J1 (4, $\overline{4}$). If you have Option 020 (DVM Assembly 05335-60008), check the ac voltage on A1J1($\overline{4}$) going to the DVM via the A2 Assembly (05335-60002), and on the DVM board (05335-60008).

8-340. There are two adjustable supplies on the A1 Power Supply board, the +3.0V supply and the +15.7V supply. Make sure that all supply voltages are within tolerance. See *Table 8-7*.

Table 8-7. A1 Power Supply Voltage Tests

VOLTAGE (Vdc)	TOLERANCE (Vdc)	ADJUSTMENT
+15.70	±0.20	A1R15
−15.00	±0.75	NONE
+10.00	±0.01	NONE
+ 5.00	±0.12	NONE
− 5.20	±0.15	NONE
+ 3.00	±0.05	A1R1
+24.50	±2.50	NONE

8-341. If any of the voltages are not present at the supplies, check voltages at the fuse holders and at A1CR8 (pins marked + and − on the PC board and the schematic). Refer to the A1 power supply schematic and the block diagram (*Figure 8-61*) for additional information. If the voltages are present at the fuse holders, but not at the supplies, suspect the A1K1 relay.

8-342. If any of the power supply voltages are low, isolate the A1 Power Supply assembly by disconnecting the following:

a. The A2 Amplifier Support assembly (05355-60002) from the A1 Power Supply assembly.

b. The A4 Main Logic assembly (05335-60004) from the A1 Power Supply via W2.

NOTE

Connect A1J1(16)→A1J1(1) with a jumper.

c. The A5 Keyboard and Display assembly (05335-60005) from the A4 Main Logic Assembly via W4.

8-343. If the Power Supply voltages come back up to the specified values, reconnect a, b, and c above one at a time, checking the supply voltages on A1 after each assembly is reconnected. This will enable you to determine which assembly is loading down the supply voltages.

8-344. If the power supply voltages do not come back up to the specified values, troubleshoot the supply voltages on A1 as follows:

a. Check the +15 volt supply at A1U6(3); it should be at +15.7 volts ±0.2 volts. If it is not correct, check U1U6, CR2, C6, C7, and K1.

b. Check the +10 volts reference supply at A1U1(2) level should be at +10.00V ±0.01V. This supply is used as a reference for the +5 voltage (A1U3), −5.2 volts (A1U2) and also, as a reference voltage for the trigger level voltmeter, in the A2/A11 assemblies. If voltage is lower or higher than specified, check A1U1, U2, and U3.

c. Check the +5 volt supply at A1TP1 for a voltage of +5V ±0.12V. If voltage is not at the specified level, check the Q1 on the back panel (TO-3 package), A1Q3, CR3, CR4, U3, U4, C2, C4, and C8.

d. Verify the operation of the +3 volt supply at A1U4(2); voltage should be 3.0V ±0.05V. If the voltage is not correct, check U4 and U3.

e. Check the −5.2V supply at A1J1(3), for a value of −5.2V ±0.12V. If voltage not present at specified level, check A1Q1, Q2, U2, CR1, C1.

f. Check the −15V supply at A1U7(3), for a voltage level of −15V ±0.75V. If it is not correct, check U7, C10, and CR6.

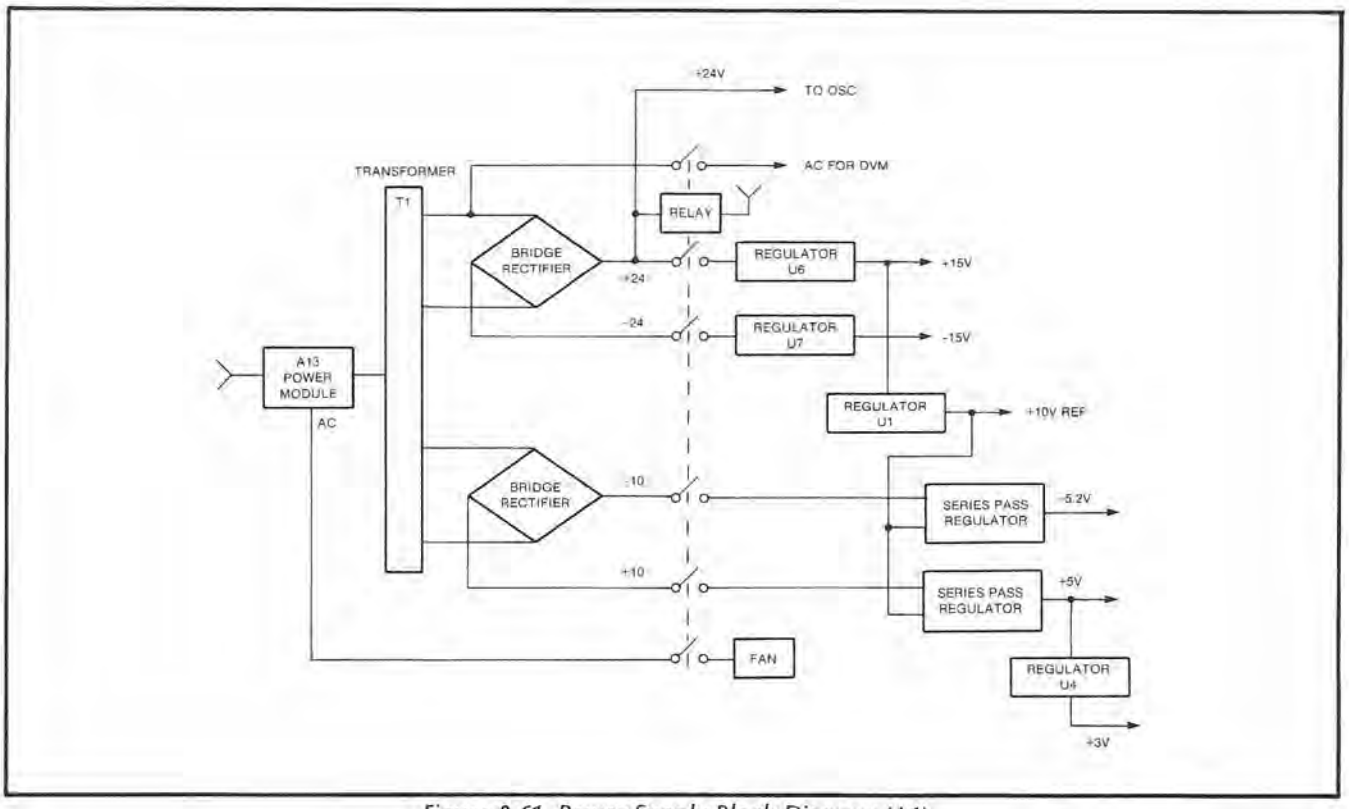


Figure 8-61. Power Supply Block Diagram (A1)

8-345. A2 AMPLIFIER SUPPORT TROUBLESHOOTING

8-346. The A2 Amplifier Support Assembly contains the Channel A and B Trigger Level selector, the Trigger Level Voltmeter, the Signal Selector Multiplexer, and the Front End latch control cicuitry. The Trigger Level Selector and the Front End latch control circuits complements the peak detector operation in the A3 Input Buffer assembly.

8-347. Trigger Level Selector Troubleshooting

8-348. Channel A Trigger Level Selector Multiplexer (A2U2) selects among the different input signals (Channel A trigger level pot, the 10%, 50%, and 90% of peak of signal, Ground, and –5.2V), a trigger level that is fed back to the A3 assembly. This multiplexer is controlled by the microprocessor, by way of A2U15 and U12.

8-349. To troubleshoot the Channel A trigger level selector circuitry, first check the logic levels at A2U2 pins 1, 15, and 16 as follows (from A2U12 and A2U15):

NOTE

"RANGE HOLD" must be **ON** during this test.

Table 8-8. A2U2 Analog Multiplexer Control Bits

C1 U2(15)	C12 U2(16)	C11 U2(1)	FUNCTION
0	0	0	Freq A, Manual Trigger Adj
0	0	1	DAC
0	1	0	Freq A, Manual Trig Preset
0	1	1	Diagnostic #33 (–5.2V)
1	0	0	Freq A, Auto Adjust
1	0	1	SLEW Rate A, ⨍
1	1	0	Freq A, Auto Preset
1	1	1	SLEW Rate A, ⨍

CAUTION

The assemblies and components involved in the following steps are all static sensitive, and should be handled at a static free work area, and in accordance with approved procedures.

8-350. If these bits are not set properly, check the Front End latch controls A2U15 and U12, by enabling Diagnostics #3 and #4.

8-351. Front End Latch Control Troubleshooting

8-352. Diagnostics #3 and #4 are designed to aid in the troubleshooting of A2U15 and U12, and related circuitry, including A3K1 in the standard front end (A3).

8-353. They are also used to troubleshoot the latches of the Option 040 programmable front end input, A11U16, U17, U18 and U24, and the related circuitry, including A12K1 through K9.

8-354. To enable Diagnostic #3, press: SCALE, SMOOTH, 9, 9, ENTER; wait 5 seconds, then press: SCALE, 3, ENTER. The 5335A will display: 'dIAG 03".

8-355. Diagnostic #3 sets the A2U15 and A1U12 latches output to a TTL 'LOW". With a logic probe oscilloscope, or a voltmeter, verify the state of the latches output per *Table 8-9*.

Table 8-9. A2 Troubleshooting A2U12 and A2U15

REF. DESIG.	PIN #	NOMENCLATURE	DIAG. #3	DIAG. #4
A2U15	1	+5V		
	2	C1	Low	High
	3	D0	1.45V	1.45V
	4	D1	1.45V	1.45V
	5	C2	Low	High
	6	D2	1.45V	1.45V
	7	C3	Low	High
	8	GND		
	9	*U697	4.5V	4.5V
	10	C4	Low	High
	11	D3	1.45V	1.45V
	12	C5	Low	High
	13	D6	1.45V	1.45V
	14	D7	5.0V	5.0V
	15	C6	Low	High
	16	+5V		
A2U12	1	+5V		
	2	C7	Low	High
	3	D0	1.45V	1.45V
	4	D1	1.45V	1.45V
	5	C8	Low	High
	6	D2	1.45V	1.45V
	7	C9	Low	High
	8	GND		
	9	*HA50	4.5V	4.5V
	10	C10	Low	High
	11	D3	1.45V	1.45V
	12	C11	Low	High
	13	D4	1.45V	1.45V
	14	D5	1.45V	1.45V
	15	C12	Low	High
	16	+5V		

* = FREERUN Signature [START, STOP, CLOCK ⊣ (CK1)]

8-356. To enable Diagnostic #4, press: SCALE, 4, ENTER. This diagnostic set the latches output to a TTL "HIGH"; verify their state per the previous table.

8-357. To check out the relay driver A2Q1, exit diagnostic mode by pressing FREQ A. Verify the voltages in both common (COM A) and separate as shown in *Figure 8-62*.

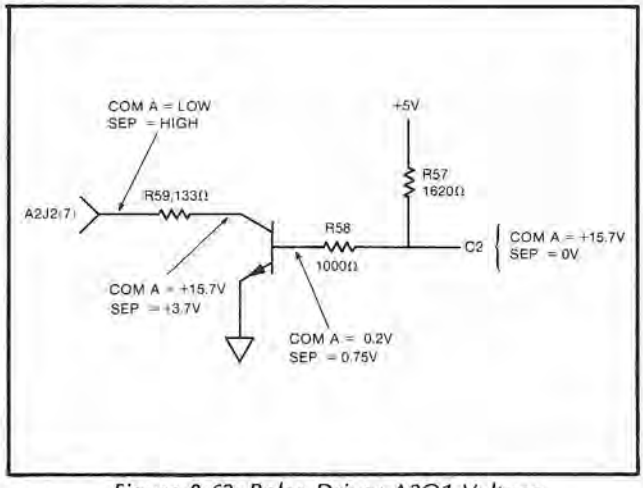


Figure 8-62. Relay Driver A2Q1 Voltage

8-358. A2U16 is an octal buffer that is used to send the status of certain front panel switches to the processor. To verify its operation, enable Diagnostic #5 by pressing:

SCALE, SMOOTH, 9,9, ENTER (then wait about 5 seconds)
press: SCALE, 5, ENTER

8-359. This diagnostic tests each of the 5335A front end data switches:

Channel AX10 & BX10
Channel A & B slopes
Channel A & B preset
COM A
AUTO TRIG

NOTE

Channel A & B 1M ohms/50 ohms and AC/DC switches are not tested.

8-360. With *Table 8-10* verify A2U16 inputs change state when appropriate switch is enabled:

Table 8-10. Troubleshooting A2U16 Signatures

PIN	A2U16	FUNCTION
*1	7HA6	Clock Enable
2	OFF=HIGH ON=LOW	Auto Enable
3		D6
4	⅂ HIGH (5V), ⅃ LOW (0V)	BSP ("B" slope)
5		D3
6	PRESET=5V, Not PRESET=0V	BPR ("B" PRESET)
7		D4
8	X1=5V, X10=0V	AAT ("A" Attenuator)
9		D5
10		Ground
11	⅂ 5V, ⅃ 0V	ASP ("A" slope)
12		D7
13	Separate=5V, COM A=0V	ACM (COM A)
14		D2
15	X1=5V, X10=0V	BAT ("B" Attenuator)
16		D1
17	PRESET=5V, Not PRESET=0V	APR ("A" PRESET)
18		D0
*19	7HA6	Clock Enable
20		V_{CC} = 5V

* FREERUN signature [START, STOP, CLOCK ⅂ (CK1)]

8-361. Also verify that by pressing all of the tested switches (listed in *Table 8-10)* to the "IN" position, the 5335A display will respond as shown in *Figure 8-63.*

8-362. When a switch is active ("IN" position), the indicated display digit should light. When released ("OUT" position) the indicated display digit should blank out.

NOTE

This diagnostic is not operational with Option 040.

8-363. A2U14 is a three-to-eight decoder that clocks A2U15 and U12 Front End latch controls and A2U16 the front end switch buffer.

8-364. To verify that U14 is working properly, set the 5335A to its FREERUN mode. Follow the procedure in paragraph 8-408. Verify the signatures in *Figure 8-64.*

8-365. If A2U14 input signatures are not correct, trace back to the microprocessor system signature in A4; see paragraph 8-404. If input signatures are good, but output signatures are bad, suspect U15, U12, U16, and last, U14.

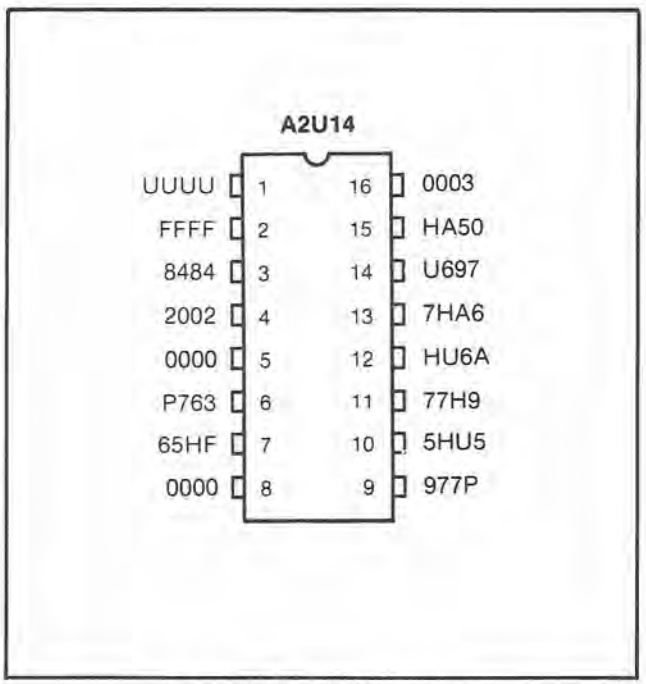


Figure 8-64. A2U14 Signatures

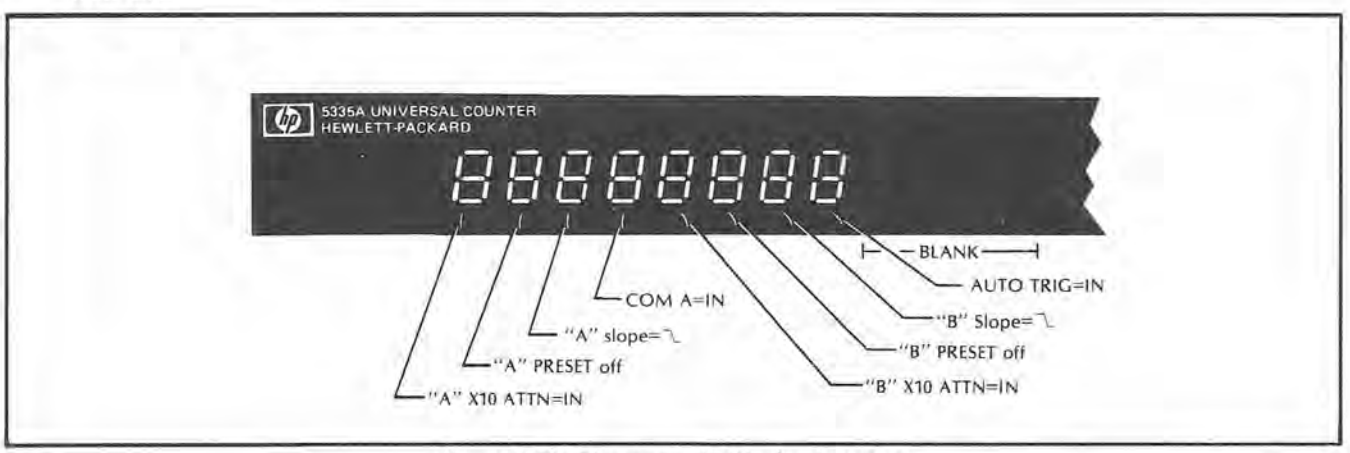


Figure 8-63. Diagnostic #5 Display Response

8-366. Trigger Level Voltmeter Troubleshooting

8-367. This section of A2 is composed of A2U4 multiplexer, U9 voltage-to-frequency converter; it is referenced to a very precise +10 volts supply from A1 power supply assembly. U13B uses the precise +10 volt reference to generate a -5 volt reference used in both U9 and U4. Refer to the Trigger Level Voltmeter Block Diagram, *Figure 8-65.*

NOTE

The +10V reference from A1 assembly should be verified to be within **±0.01V** before troubleshooting the Trigger Level DVM. Since if this reference is not correct, the trigger level DVM will not operate correctly.

8-368. To troubleshoot the Trigger Level DVM, first check U4 control bit pattern; Diagnostics #26 through #33 are used to set up these bit patterns. To enable these diagnostic, press:

a. SCALE, SMOOTH, 9, 9, ENTER; wait 5 seconds.

b. press: SCALE, (26 through 33), ENTER

8-369. After entering SUPER CHECK, select any one of the diagnostic desired. Verify the bit patterns of A2U4 per *Table 8-11.*

NOTE

"RANGE HOLD" must be set "**ON**" during these tests.

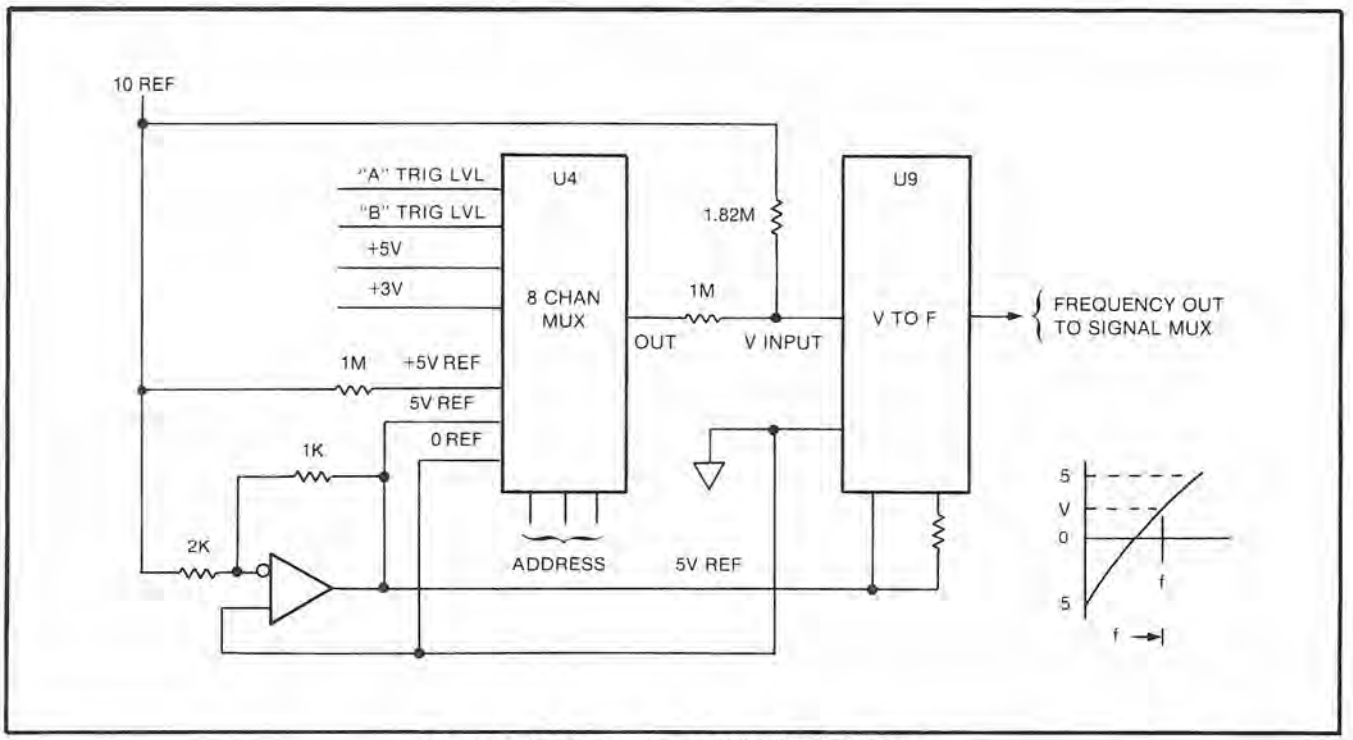


Figure 8-65. Trigger Level DVM Block Diagram

Table 8-11. A2U4 Analog Multiplexer Control Bits

U4(15)	U4(16)	U4(1)	FUNCTION	DIAG	APPROXIMATE FREQUENCY
0	0	0	Trig Lvl A	29	-5.2V 100 Hz 0V 1.87 kHz +5.2V 3.62 kHz
0	0	1	Trig Lvl B	30	Same as DIAG #29
0	1	0	+5V Supply	31	3.57 kHz
0	1	1	+5V Ref.	28	3.56 kHz
1	0	0	+3V Supply	32	2.83 kHz
1	0	1	Gnd. Ref.	27	1.86 kHz
1	1	0	-5V Ref.	26	170 Hz
0	0	0	-5.2V Supply	33	90 Hz

8-370. While in these diagnostics, with the RANGE HOLD function enabled, the 5335A will display the actual frequency that is counted in the MRC, out of A2U9(10). The approximate frequency given in the previous table will vary from unit to unit.

8-371. In Diagnostic #33 the microprocessor selects U4(4) which is TRIGGER LEVEL A, and A2U2(7), which is the -5.2 volt supply.

Table 8-12. U4 Input Voltage with Output Frequency at U8(1)

Input Voltage (V)	Output Frequency (Hz)
-5	162
-4	515
-3	874
-2	1.18K
-1	1.52K
0	1.86K
+1	2.21K
+2	2.54K
+3	2.88K
+4	3.22K
+5	3.56K

NOTE

The output frequency will vary slightly from instrument to instrument. The above table is for information **ONLY**, and gives only an approximation of the voltage-to-frequency relationship.

8-372. If A2U4 bit patterns are verified and U4 input and output correlates, but no corresponding frequency per *Table 8-12* out of U9(10), suspect U9, or level translator U8. If everything checks out through the Trigger Level DVM, then check out A2U7, the signal selector multiplexer and associated circuitry.

8-373. Signal Selector Multiplexer Troubleshooting

8-374. A2U7 is a dual 4-to-1 Multiplexer, and it selects which signal is counted into the MRC by way of the microprocessor; the control bits originates in the A2U12, and they are translated to ECL levels by U8. A12U11 is a divide-by-two flip-flop, controlled by bit C6, used to extend Channel A frequency range for Frequency A, Ratio A/B, and Ratio C/A functions. Refer to *Figure 8-66*.

8-375. The outputs of A2U7(2 & 15) as a function of control bits C9 and C10 per selected 5335A front panel function, are as listed in *Table 8-13*.

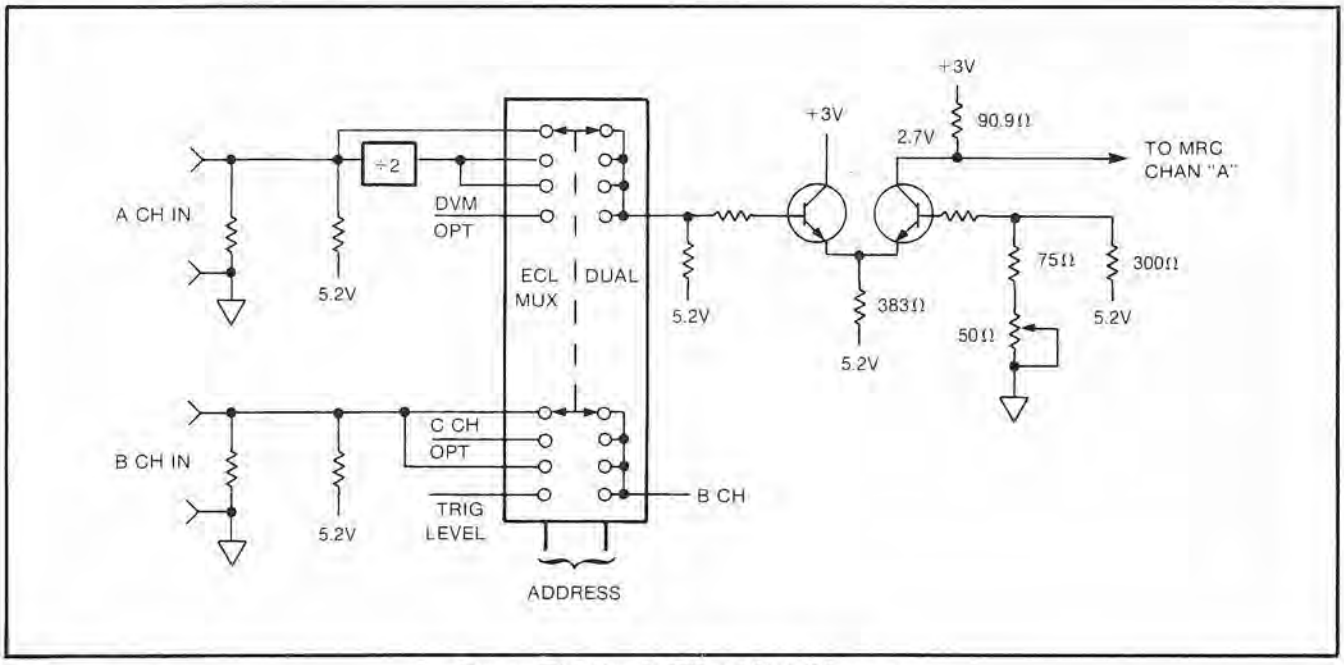


Figure 8-66. Signal Select Block Diagram

Table 8-13. A2U7 Outputs Related to Control Bits C6, C9 and C10

FUNCTION	U15(15) C6	U12(7) C9	U12(10) C10	U7(2) X	U7(15) Y
FREQ A	0	0	1	A/2	B
TIME A→B	1	0	0	A	B
TOT A	1	0	0	A	B
RATIO A/B	0	0	1	A/2	B
FREQ C	0	1	0		C/20
1/TIME A→B	1	0	0	A	B
PULSE A	1	0	0	A	B
RATIO C/A	0	1	0	A/2	C/20
PER A	1	0	0	A	B
RISE A (⎍)	1	0	0	A	A
FALL A (⎏)	1	0	0	A	A
SLEW A (⎍)	1/0	0/1	0/1	A/DVM	B/Trig Lvl
SLEW A (⎏)	1/0	0/1	0/1	A/DVM	B/Trig Lvl
DUTY CYCLE A	1	0	0	A	B
GATE TIME	SAME AS PRECEDING FUNCTION				
TRIG LVL	0	1	1	DVM	Trig Lvl
VOLTS	0	1	1	DVM	Trig Lvl
PHASE A rel B	0/1	0	1/0	A/DVM	B/Trig Lvl
FREQ B (17)	0	0	1	A/2	B
TIME B→A (18)	1	0	0	A	B
TOT A-B (19)	1	0	0	A	B
PULSE B (20)	1	0	0	A	B

8-376. Prescaler Troubleshooting

8-377. A2U11 prescales input signal to Channel A by a factor of two. It is enabled by control bit C6, from U15(15). Refer to *Figure 8-67*.

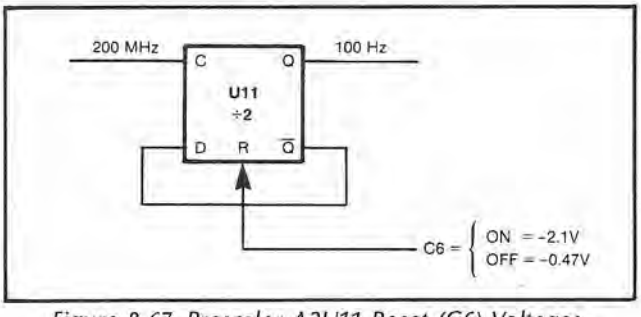


Figure 8-67. Prescaler A2U11 Reset (C6) Voltages

8-378. A3 INPUT AMPLIFIER BUFFER TROUBLESHOOTING

8-379. The A3 Amplifier Buffer Assembly consists of Input Offset buffer, the Bridge Limiter, the Peak Detectors, and the Amplifier Schmitt, for both channels A and B.

8-380. Input Offset Buffer Troubleshooting

8-381. The Input Offset Buffer is a split band amplifier, one path buffering the high frequency signals, and the other buffers the low frequency signals (below 10 kilohertz). To troubleshoot the Input Offset Buffer, check the **dc values** at key points, such as:

CHANNEL A

A3U4 pins 2, 3 and 6 (inputs and output),
A2U4 pins 1 and 8 (both sides of C35)
A3Q6, Q7, and Q8 (base emitter and collector)

8-382. This check MUST be done with NO INPUT SIGNAL and AUTO TRIG disabled; typical values are shown in *Figure 8-68*.

8-383. These dc values are **very** critical for maintaining the Q points of A3U4 (Channel A) and A3U3 (Channel B). If the values are not present, suspect A3U4, Q5, Q6, Q7, and Q8 (for Channel A). The Input Offset Buffer circuitry for Channel B is identical to Channel A, and it can be used for comparison basis.

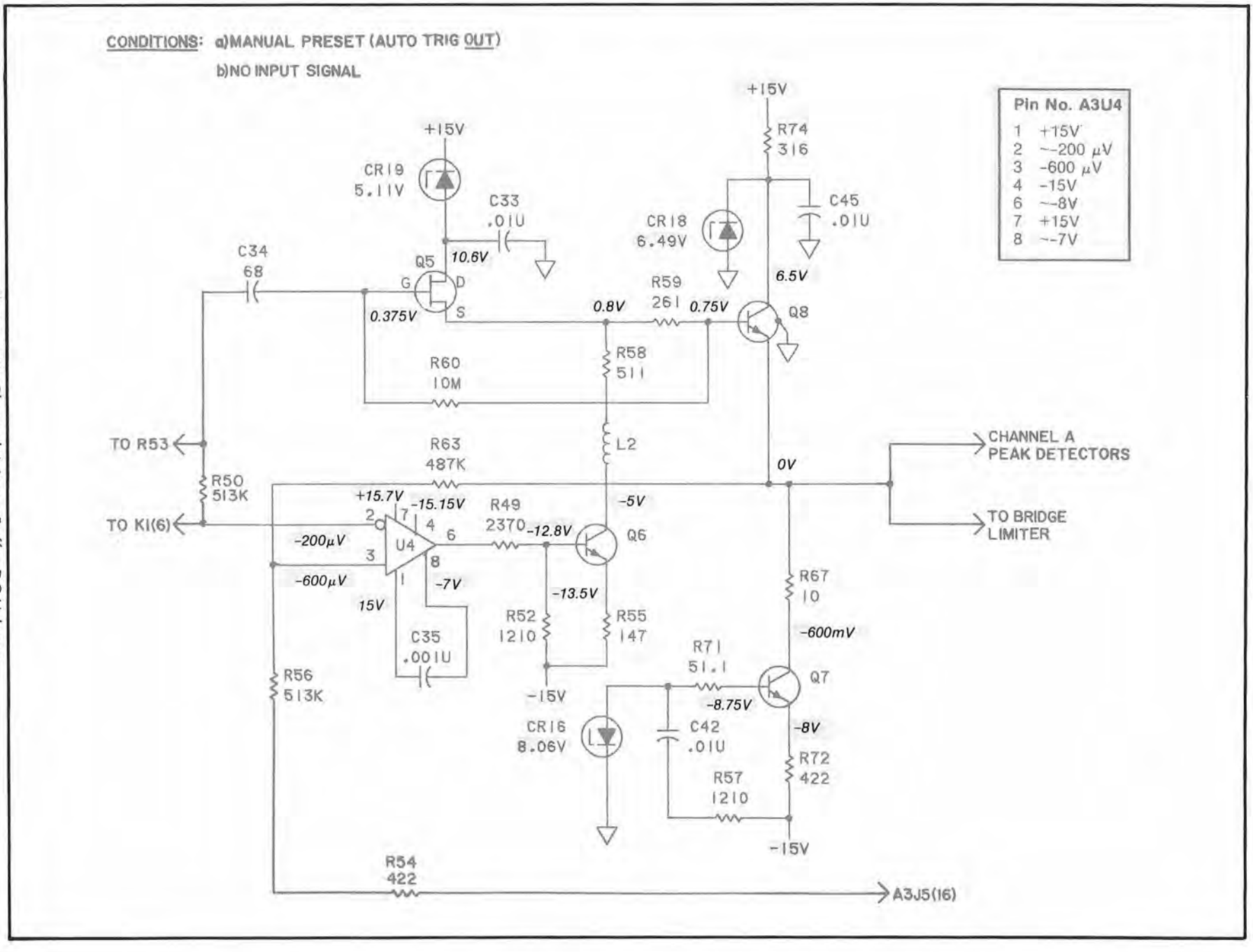


Figure 8-68. Channel A Input Buffer DC Voltages

8-384. Peak Detectors Troubleshooting

8-385. The Peak Detector circuitry is designed to be used during the AUTO TRIG mode only; they are used to detect the maximum amplitude of the input signal, and the microprocessor will figure out the 10%, 50% and 90% points of input signal, through A2U2 and A2U10. There are two peak detectors per channel: a positive and a negative peak detector. During manual mode of operation, the positive and negative peak detectors are tied to ±5.2 volts, respectively. The diodes used in the peak detectors are a closely matched set. A set of four matched peak detector diodes are available from Hewlett-Packard (see Section VI).

8-386. The peak detectors in the A3 assembly complements the channels A and B Trigger Level selector multiplexers, and the peak detector enabling circuitry, which are located in the A2 Amplifier Support assembly. See *Figure 8-69.*

8-387. The peak detector circuitry is contained in two assemblies: in A3 Amplifier Buffer assembly and in A2 Amplifier Support assembly. The peak detectors themselves are located in the A3 assembly. The signals that enable and disable the peak detectors originate on the A2 assembly, U15 through U1A, B, C, and D.

Table 8-14 lists the signals that control the peak detectors.

Table 8-14. Peak Detector Control Signals

PEAK DETECTOR CONDITION A2U1 (PIN)	ANE (8)	APE (14)	BNE (1)	BPE (7)
ENABLED	−12.5V	+15.0V	−12.5V	+15.0V
DISABLED	+5.2V	−5.2V	+5.2V	−5.2V

ANE = "A" NEGATIVE ENABLE (Enables Channel A Positive Peak Detector)
APE = "A" POSITIVE ENABLE (Enables Channel A Negative Peak Detector)
BNE = "B" NEGATIVE ENABLE (Enables Channel B Positive Peak Detector)
BPE = "B" POSITIVE ENABLE (Enables Channel B Negative Peak Detector)

8-388. A3 Troubleshooting Accessories

8-389. To facilitate the troubleshooting of the A3 assembly (outside the counter) procure the following accessories:

a. Two multiribbon cable assembly, P/N 8120-2463.

b. Two 50-ohm cable assembly, P/N 05335-60112.

c. Two SMC male-to-male adapter, P/N 1250-0827.

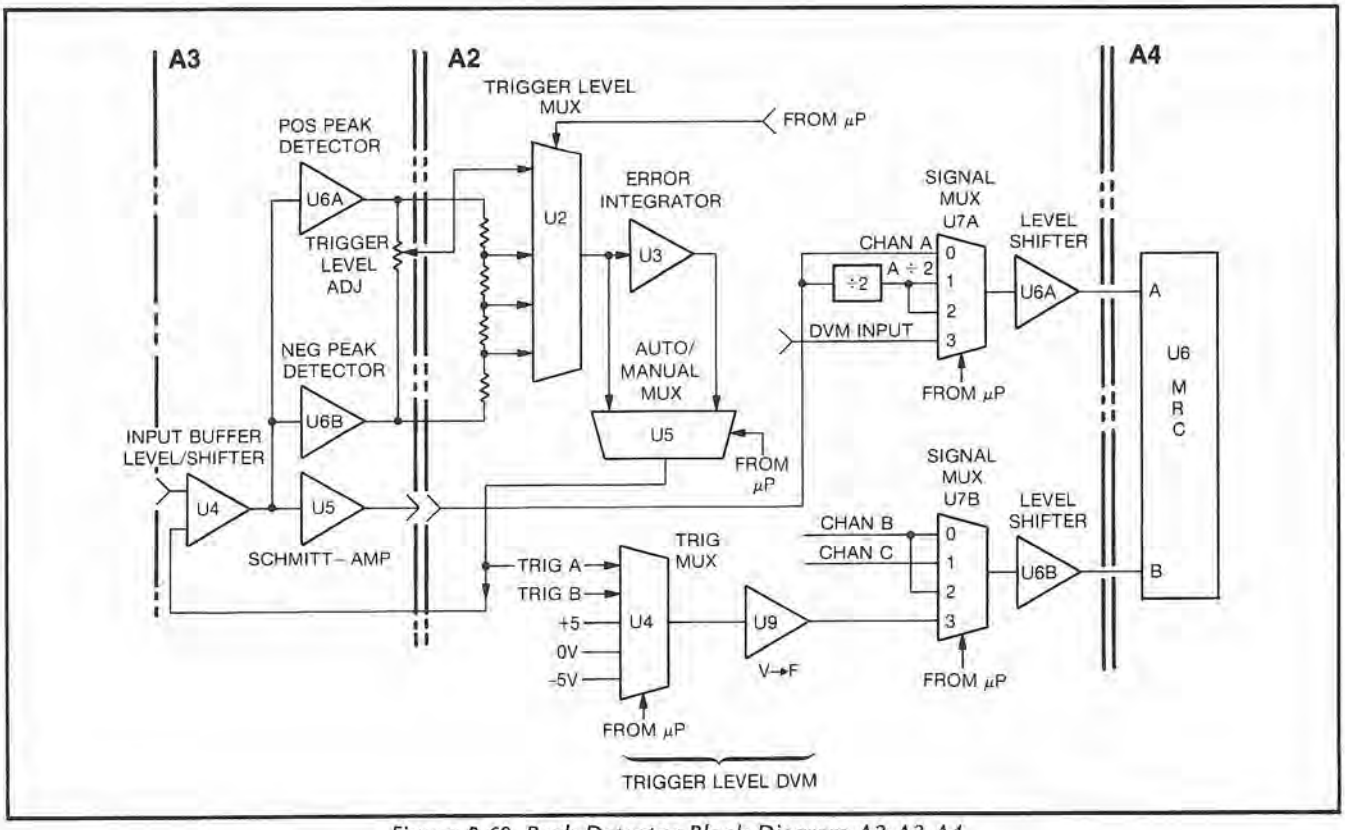


Figure 8-69. Peak Detector Block Diagram A2-A3-A4

8-390. A3 Troubleshooting Out-of-Cabinet Setup

a. Remove the A3 assembly from mainframe.

b. Replace both multiribbon cable assembly 8120-2867 with longer version, P/N 8120-2463.

c. Connect two 50-ohm cable assemblies end-to-end, P/N 05335-60112, with a SMC male-to-male adapter, P/N 1250-0827, for both channels A and B. These new connections will facilitate access to key points in the A3 assembly.

8-391. Peak Detectors in Manual Mode Troubleshooting

8-392. To troubleshoot the Peak Detectors, first check their operation in MANUAL mode. To do this, set the 5335A Auto Trigger mode to the OFF condition. Enable TRIG LVL function, and vary the front panel trigger level controls for both channels from ccw to cw positions. The displayed voltage for both channels should be between ±5.2 volts; the key point is that both peak detectors should display the same readings, ±10 millivolts.

8-393. In the manual mode, the peak detector outputs are tied to ±5.2 volts; Verify this voltage at A3J1(16) or at A2U5(8), the ATL line, by varying the channel A trigger level pot on the 5335A front panel. If voltage is not present, back trace through A2U5A, A2U2 (channel A trigger level selector), to the APL line.

8-394. Also, verify that peak detectors are truly disabled; check A2U1(8), (14), (1), (7).

8-395. When checking the forward voltage drop of the peak detector diodes, verify that all diodes within each peak detector are matched to within less than 5 mV; If they are not, replace all three diodes.

8-396. Peak Detectors in Auto Mode Troubleshooting

8-397. To troubleshoot peak detectors in AUTO mode, apply a 1 kHz square wave of 500 mV p-p to the 5335A INPUT A. See *Figure 8-70*. Set the 5335A to AUTO TRIG, and COM A, 50 ohms, X1, dc coupling.

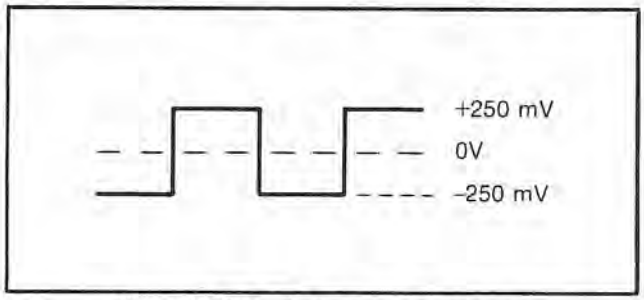


Figure 8-70. Peak Detector Test Signal

a. Enable TRIG LVL function; rotate the trigger level controls for channel A and B to the ccw position (not in PRESET). Observe the 5335A displaying the peak of signal, -0.24V ±0.01V. Rotate the trigger level pots to the full cw position and verify a display of (+0.24 ±0.01) volt.

b. Ground the ATL line (connect a jumper from either side of A3R54 to ground). This will force a feedback trigger level of zero volts to A3U4(3), and remove the effect of the peak detectors back into A3U4.

c. Rotate both trigger level pots to the ccw position.

d. Verify the APD line (channel A positive peak detector output) and AND line (channel A negative peak detector output), reflect the true peaks of signal, i.e., about +230 mV ±10 mV, and -230 mV ±10 mV, respectively. If this voltage is not present, check the voltages of A3U6 per *Figure 8-71* (in volts).

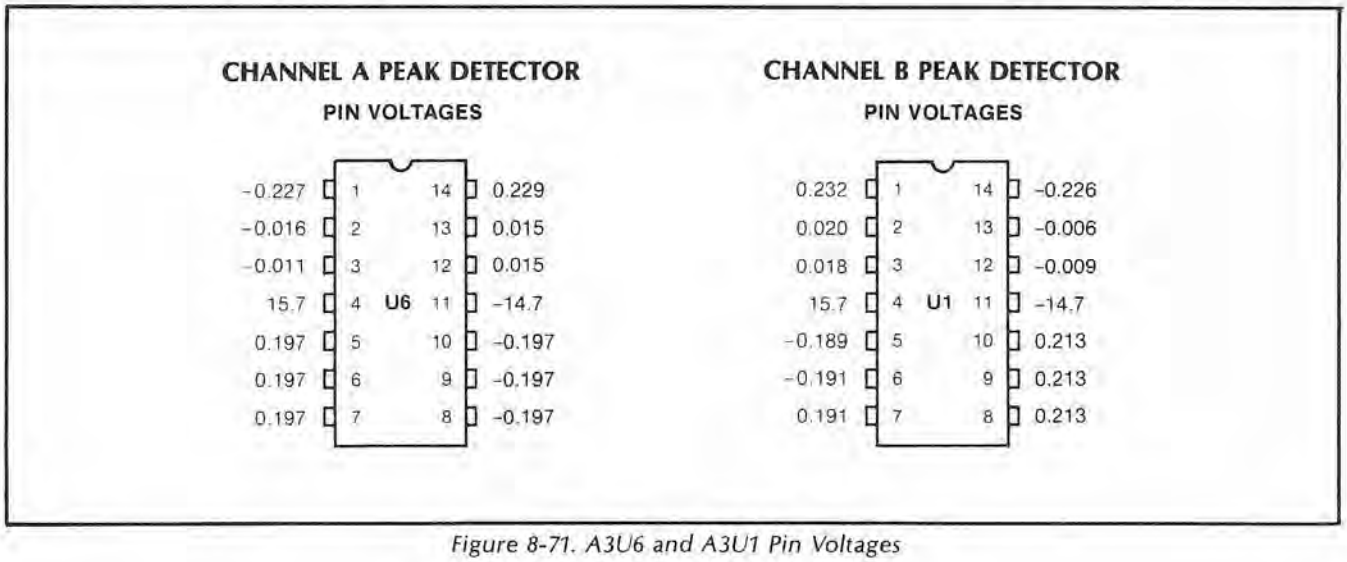


Figure 8-71. A3U6 and A3U1 Pin Voltages

e. To obtain the readings of A3U1 as listed above, ground the BTL line (connect a jumper from either side of A3R38 to ground).

f. If these voltages are not attained, verify that the peak detectors are fully enabled by A2U1. If they are not fully enabled, suspect A2U1. If they are enabled by proper voltage, try adjusting peak detectors; refer to adjustment procedure in Section V.

g. If they cannot be adjusted, suspect A3U6; also replace matched set of diodes A3CR24, CR25 and CR28 ("A" positive peak detector), A3CR26, CR27, CR29 ("A" negative peak detector), C51, C52, C58, C57, C53, C55.

8-398. Schmitt Amplifier Troubleshooting

8-399. The best way to verify the proper operation of the Schmitt amplifier is by checking its hysteresis. Refer to Input Amplifier adjustment procedure. The amplifier must be adjustable to between 18 and 20 mV peak-to-peak; Refer to paragraphs 8-33 and 8-34 if amplifier cannot be adjusted to these limits; also suspect A3U5 (Channel A) or A3U2 (Channel B).

8-400. Bridge Limiter Troubleshooting

8-401. The bridge limiter is composed of A3CR20-CR23 and it serves to protect the A3U5 Schmitt amplifier (Channel A) from overvoltage without distorting the signal on the receiving end.

8-402. Check that the forward voltage drop across each diode are matched within less than 5 mV of each other.

8-403. The four diodes are a closely matched set, and if one or more diode has to be replaced, all four MUST be replaced; P/N 05335-80003 is a set of four matched diodes set-up for replacement.

8-404. A4 MAIN LOGIC TROUBLESHOOTING

8-405. The A4 Main Logic Assembly contains the microprocessor system, Multiple Register Counter (MRC), the Start and Stop Interpolators, the Time Base circuits, and the GATE OUT circuits. Refer to *Figure 8-72.*

8-406. Microprocessor System Troubleshooting

8-407. The system is composed of U28 microprocessor, U22 and U23 ROM's, U25 and U26 RAM's, bidirectional data line buffers U16, U24, and U27 address buffer.

8-408. To troubleshoot the microprocessor system, we use signature analysis with microprocessor set up in the FREERUN mode. Use the following procedure to take microprocessor signatures:

a. Connect the Signature Analyzer START, STOP, and CLOCK leads to the appropriate test pins next to the A4U28 Microprocessor. Set the START, STOP, and CLOCK keys on the Signature Analyzer to the negative edge (⏜). Ensure that the Signature Analyzer CLOCK Pod lead is connected to the test pin marked "CK1".

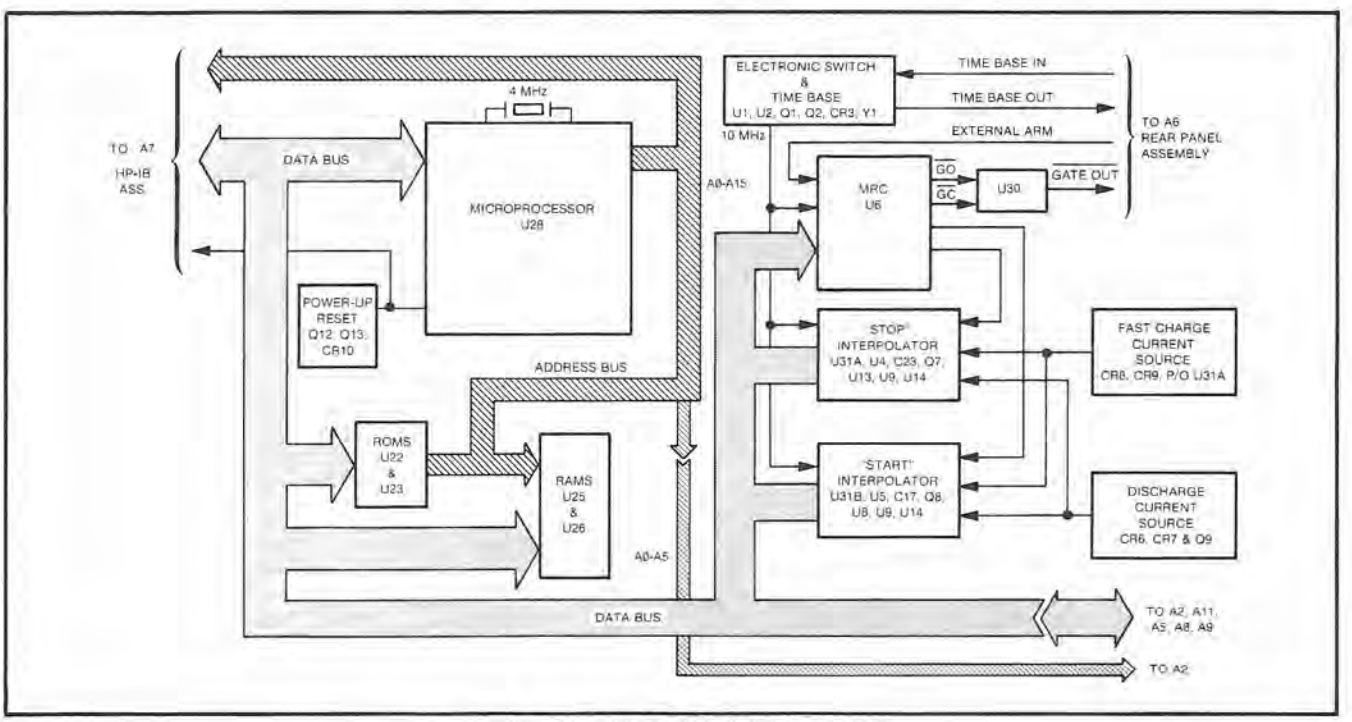


Figure 8-72. A4 Block Diagram

b. Connect a jumper between the test points marked "SA" and "G", located between A4U12 and A4U21. This will set the Microprocessor in the "FREE-RUN" mode.

c. Press the 5335A power key to STBY then ON. The first signature to be verified is +5V signature (0003). If this signature is correct, it signifies proper connection of the signature analyzer.

d. Verify the A4U28 Signatures in *Table 8-15*.

e. Verify signatures in *Table 8-16*.

Table 8-15. A4U28 Signatures, Logic States, and Voltages

PIN	STATUS	PIN	STATUS	PIN	STATUS	PIN	STATUS
1	GND	11	A2 8484	21	GND	31	D2 HI
2	$\overline{\text{HALT}}$ HI (+5V)	12	P763	22	A12 4FCA	32	D1 HI
3	MR 0003-C	13	A4 IUSP	23	A13 4868	33	D0 HI
4	$\overline{\text{IRQ}}$ HI	14	A5 0356	24	A14 9UPI	34	R/$\overline{\text{W}}$ HI
5	VMA HI	15	A6 U759	25	A15 0001	35	+5V
6	$\overline{\text{NMI}}$ HI	16	A7 6F9A	26	D7 LO	36	RE GND
7	BA LO	17	A8 7791	27	D6 HI	37	E 1 MHz CLOCK
8	+5V	18	A9 6321	28	D5 LO	38	4 MHz Sine wave
9	A0 UUUU	19	A10 37C5	29	D4 HI	39	4 MHz Sine wave
10	A1 FFFF	20	A11 6U28	30	D3 HI	40	$\overline{\text{Reset}}$ HI
	V_{cc}=0003		GND=0000				

NOTE: Normal Operation, RE #36 should be high.

Table 8-16. A4 Signatures

PIN	U10	U11	U12	U19	U20	U21	PIN
1	9AAC	P50C	0003	FFFF	4FC9	0003	1
2	0356	4868	0000	8484	P50C	0003-C*	2
3	U759	9UP1	4FCA	P763	P50C	0000-C*	3
4	4534	0000	4FC9	0000-C*	0003-C*	00003-C*	4
5	2002	0003	01H7 (099C)	PU4A	4FCA	0000	5
6	PU4A	0003	01H4	0003	3714	0003	6
7	01H4	0000	0000	27FP	0000	0000	7
8	0000	0000-C*	099C (0000)	0000	48C7	0000-C*	8
9	3282	01H4	01H7	7FH1	UHU5	0003-C*	9
10	AH63	01H7	0003	FH24	P50C	0003	10
11	7APA	4FCA	0000	H27U	0003	0003	11
12	P508	6F9A	0003-C*	27F0	9AAC	48C7	12
13	9UP1	UHU5	0000-C*	7F30	6F9A	0000	13
14	4868	0003	0003	F33U	0003	0003	14
15	0000-C*			33F2			15
16	0003						16
17							17
18				UHU5			18
19							19
20							20
21							21
22							22
23							23
24							24

Signatures with "C" are active nodes and are not V_{cc} or "ground".

Table 8-16. A4 Signatures (Continued)

PIN	U22	U23	U24	U25	U26	U27	PIN
1	6F9A	6F9A	0003	P763	P763	GND	1
2	U759	U759	X	8484	8484	4FCA	2
3	0356	0356	X	FFFF	FFFF	FFFF	3
4	1U5P	1U5P	X	UUUU	UUUU	6F9A	4
5	P763	P763	X	0356	0356	UUUU	5
6	8484	8484	X	U759	U759	0356	6
7	FFFF	FFFF	X	6F9A	6F9A	8484	7
8	UUUU	UUUU	X	GND	GND	1U5P	8
9	X	X	X	3714	3714	P763	9
10	X	X	GND	3714	3714	GND	10
11	X	X	0000	X	X	P763	11
12	GND	GND	0003	X	X	1U5P	12
13	X	X	0000	X	X	8484	13
14	X	X	X	0003	X	0356	14
15	X	X	0003	7791	7791	UUUU	15
16	X	X	0003	0003	0003	6F9A	16
17	X	X	0003	1U5P	1U5P	FFFF	17
18	6U28	6U28	0003	0003	0003	4FCA	18
19	37C5	37C5	0003			GND	19
20	AH63	3282	+5V			+5V	20
21	4FCA	4FCA					21
22	6321	6321		X=Don't care signatures (Unstable)			22
23	7791	7791					23
24	+5V	+5V	V_{cc}=0003	GND=0000			24

f. Verify the following signatures on A7 (HP-IB Logic Assembly). Ensure the Signature Analyzer CLOCK (CK1), START, and STOP keys are negative (⌝).

TEST POINT	SIGNATURES
A7U1(4)	P546
7U2(5)	U867
A7U2(11)	7APA

g. If the above signatures are correct at the specified key points, proceed to check the ROMs.

8-409. Use the following procedure to test the ROMs (A4U22 and A4U23) using signature analysis, with the microprocessor set in the FREERUN mode.

a. Connect the Signature Analyzer START and STOP leads to the appropriate test pins next to the A4U28 microprocessor, marked "S". The CLOCK Pod lead should be connected to the test pin marked "CK2" (located next to A4U23), and to "CK3" (located next to AU22) when testing A4U22.

b. Set the Signature Analyzer keys as follows:

START and STOP .....⌝(neg.)
CLOCK .....⌟(pos.)

c. Connect a jumper between test points marked "SA" and "G", located between A4U12 and A4U21. This will set the processor in the "FREERUN" mode.

d. Verify the *Table 8-17* signatures on the A4U23 ROM. Ensure the Signature Analyzer CLOCK (CK2) key is set (⌟) positive, and the START and STOP keys are set negative (⌝).

Table 8-17. A4U23 Signatures

PIN NO.	DATA LINE	SIGNATURE
9	0	F847
10	1	UP57
11	2	C058
13	3	3867
14	4	2C79
15	5	08C4
16	6	FP12
17	7	5770

e. Verify the *Table 8-18* signatures on the A4U22 ROM. Ensure the Signature Analyzer CLOCK (CK3) key is set positive (⎍), and the START and STOP keys are set negative ( ).

Table 8-18. A4U22 Signatures

PIN NO.	DATA LINE	SIGNATURE
9	0	964C
10	1	1F42
11	2	5A38
13	3	F9A5
14	4	U94H
15	5	11F0
16	6	C1C3
17	7	2PA0

f. If the signatures are correct, go to the next step for the Signature Analysis of the output ports in "STIMULUS" mode. If any signatures are incorrect, suspect a faulty data bus (check for shorts), A4U10 the 2-to-4 decoder, A4U12A and A4U12E the inverters, A4U21 and A4U24 the bidirectional buffers, A4U27 buffer, or A4U28 the microprocessor.

8-410. Troubleshooting the A4 Assembly Using "STIMULUS MODE" and Signature Analysis

8-411. Diagnostic #2 is designed to test all output ports. The circuitry is tested using signature analysis with the 5335A set in the STIMULUS MODE. To avoid mistakes in setting up the diagnostic, the input ports are not tested. The output ports tested in this procedure are:

a. Gate Range/Output control flip-flops, A4U17 and A4U18.

b. Keyboard/Display control latch, A5U4.

c. Keyboard/Display Data latch, A5U5.

d. HP-IB Data Output Ports, A7U1, A7U4, A7U7, and A14J3.

e. DVM option control latch, A8U3.

8-412. One of the following two methods can be used to enable Diagnostic #2:

a. By software: If the processor can communicate with the keyboard press: SCALE, SMOOTH, 9, 9, ENTER. Wait 5 seconds, press: SCALE, 2, ENTER. The 5335A will display "dIAG 02", enabling the stimulus mode.

b. By hardware: Press the 5335A Power Switch to STBY. Place A6 on the HP-IB Address Switch (A14S1A6) in the "1" position (UP). Connect a jumper between the two plated-through holes marked "1" located between A14J2 and A14A1 (marked "SW1"). Press the 5335A Power Switch ON. If the jumper has been connected properly all display annunciator lamps will turn ON and stay ON enabling the stimulus mode.

8-413. Signature Analysis of the 5335A in the STIMULUS MODE

8-414. Use the following procedure to perform STIMULUS MODE signature analysis:

a. Connect the Signature Analyzer START, STOP, and CLOCK leads to the appropriate test pins next to the A4U28 microprocessor chip. Set the START, STOP, and CLOCK keys on the Signature Analyzer to the negative edge (⎍). Ensure that the Signature Analyzer CLOCK pod lead is connected to the test pin marked "CK1".

b. Verify the +5V characteristic signature is 6PCU. If so, the Signature Analyzer is connected properly.

c. Verify the following Key Signatures at the Output Ports:

1. Gate Range/Output control flip-flops on A4 (Main Assy):

   A4U18(9) A95H
   A4U18(11) 9558
   A4U17(9) A95H
   A4U17(11) 9558

2. Keyboard/Display Control Latch on A5 (Keyboard and Display Assembly):

   A5U4(2,7,10,15) 1A95
   A5U4(9) 4101

3. Keyboard/Display Control Latch on A5 (Keyboard and Display Assembly):

   A5U5(2,5,6,9,12,l6,19) F1A9
   A5U5(11) 2F44

4. HP-IB Data Output port on A7 (HP-IB Logic Assy) and A14J3 (HP-IB connector):

   A7U1(29 through 36) 02A5
   A7U4(2,3,5,6,10,11,13,14) 02A5
   A7U7(2,3,5,6,10,11,13,14) 02A5
   A14J3(1 thru 4 & 13 thru 16 .. 02A5

5. DVM Option Control Latch on A8 (DVM Assy):

   A8U3(2,7,10,15) 95H2
   A8U3(9) H0F8

d. If any of these "key-point" signatures are not correct, proceed to back-trace the signatures. Sus-

pect the RAMS A4U25 or A4U26, the D flip-flops A4U17 or A4U18, or the microprocessor (A4U28). (Check for shorted components).

NOTE

To exit diagnostic #2 the 5335A POWER switch must be set to STBY.

8-415. START and STOP Interpolators Troubleshooting

8-416. The START and STOP Interpolators allow the 5335A to resolve measurements down to one nanosecond. Both interpolators utilize two current sources: a fast charge current source and a slow discharge current source (by a factor of about 200). Refer to *Figure 8-73.*

8-417. Special Diagnostic subroutines #11, #12, and #13 can be used to verify the proper operation, or to troubleshoot the START and STOP interpolators in the 5335A. Proper functioning of the analog portion of the interpolators is verified by observing waveforms at key points on the Main Logic Assembly (A4).

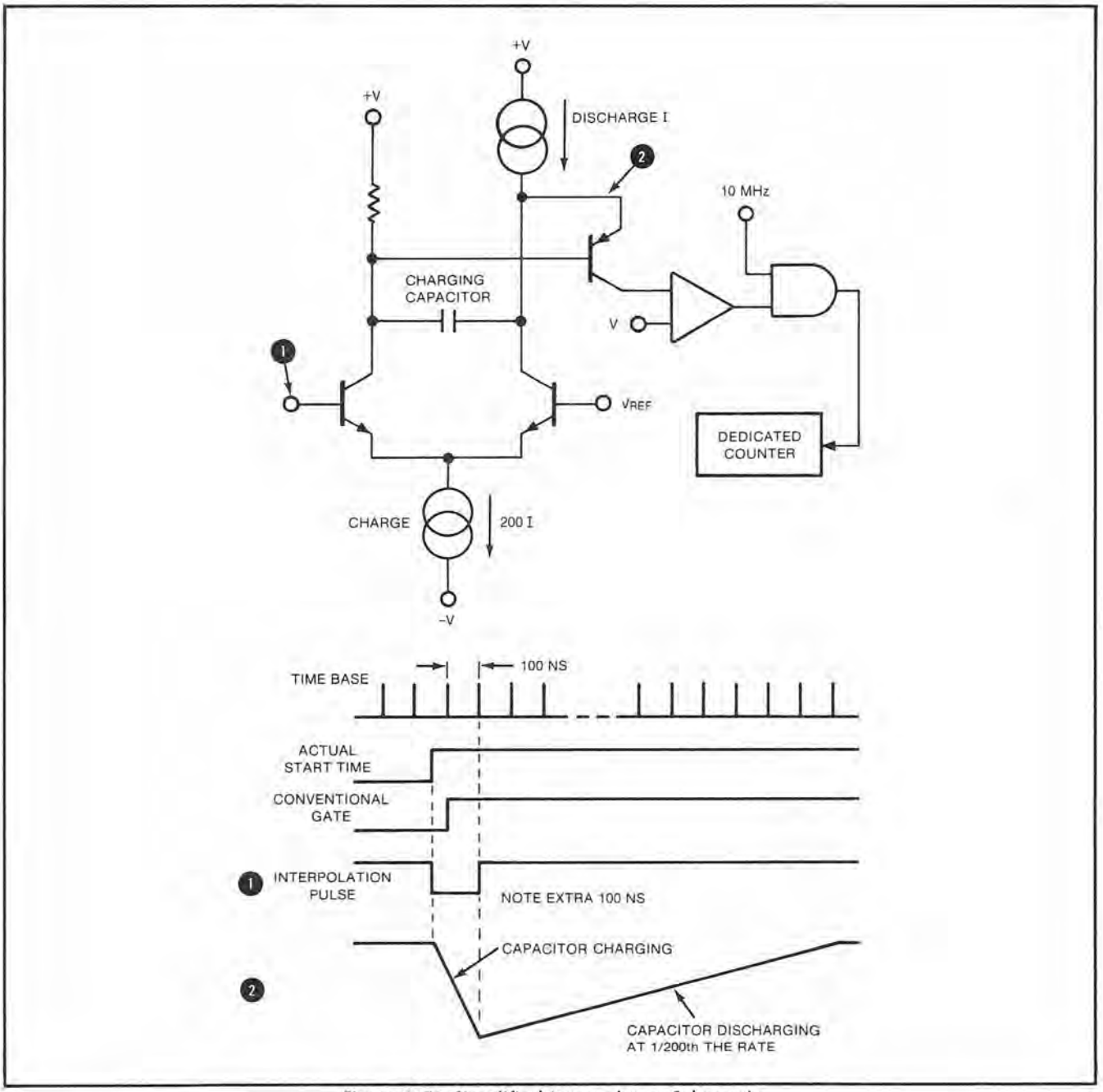


Figure 8-73. Simplified Interpolators Schematic

8-418. Diagnostic #11 is used exclusively for observing the waveforms at specified key points. The numbers in the interpolator counters are not displayed. The 5335A display will show: "dIAG 11".

8-419. Diagnostic #12 displays two groups of 3-digit numbers. The number on the left side of the display shows the count in the START interpolator, and the number on the right side of the display shows the count in the STOP interpolator. Both numbers should be approximately ±10 counts of each other.

8-420. Diagnostic #13 also displays two groups of 3-digit numbers, showing the counts in both the START and STOP interpolators. The counts displayed should be approximately 26 to 86 counts less than the counts displayed by Diagnostic #12.

NOTE

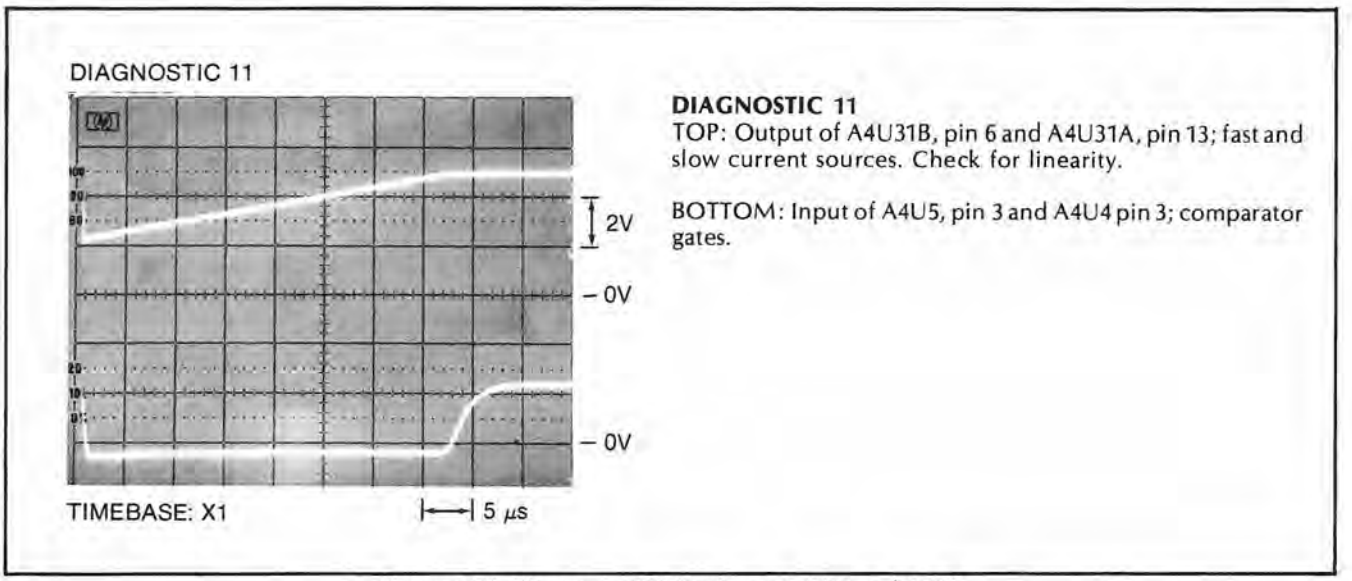
The number displayed is the interpolator count minus 256. An 8-bit counter is used as a 9-bit counter in this mode; the ninth bit is assumed.

8-421. Both Diagnostics #12 and #13 can also be used to observe waveforms at specified points on the A4 Assembly. Since the circuitry for both the START and STOP interpolators is identical, the waveforms shown apply to both circuits.

8-422. To access Diagnostics #11, #12, or #13 put the 5335A in the diagnostic mode by calling up Special Function 99. This can be done by pressing the 5335A keys: SCALE, SMOOTH, 9, 9, ENTER. Wait 5 seconds before selecting the diagnostic, then to access one of the following diagnostics proceed as indicated:

Diagnostic #11, press: SCALE, 11, ENTER.
Diagnostic #12, press: SCALE, 12, ENTER.
Diagnostic #13, press: SCALE, 13, ENTER.

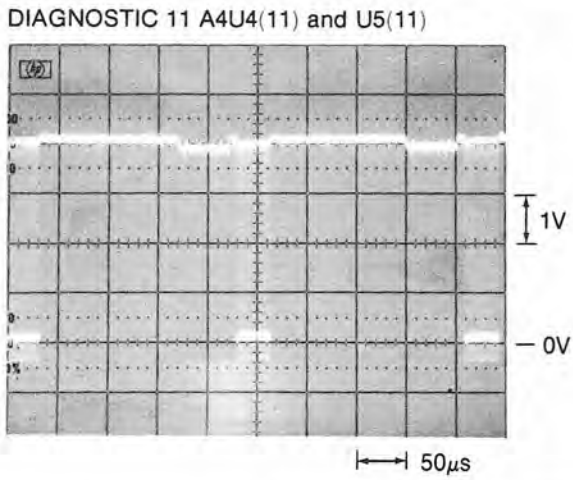
Refer to *Figure 8-74* through *8-79* for diagnostic waveforms.



DIAGNOSTIC 11
TOP: Output of A4U31B, pin 6 and A4U31A, pin 13; fast and slow current sources. Check for linearity.

BOTTOM: Input of A4U5, pin 3 and A4U4 pin 3; comparator gates.

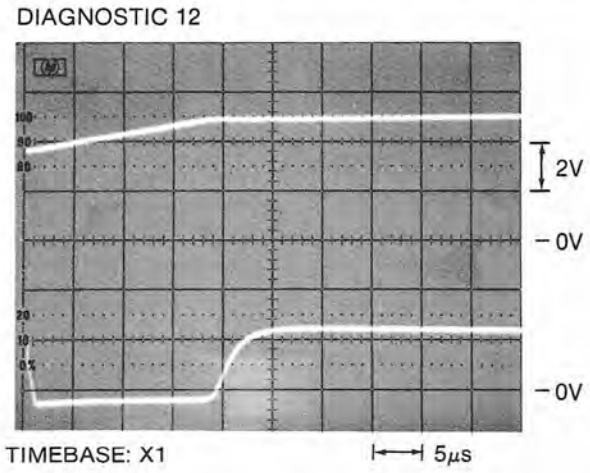
Figure 8-74. Diagnostic 11 Waveform, A4U31 and A4U5



DIAGNOSTIC 11

Output of A4U4 pin 11, and A4U5 pin 11; comparator gates.

Figure 8-75. Diagnostic 11 Waveform, A4U4 and A4U5

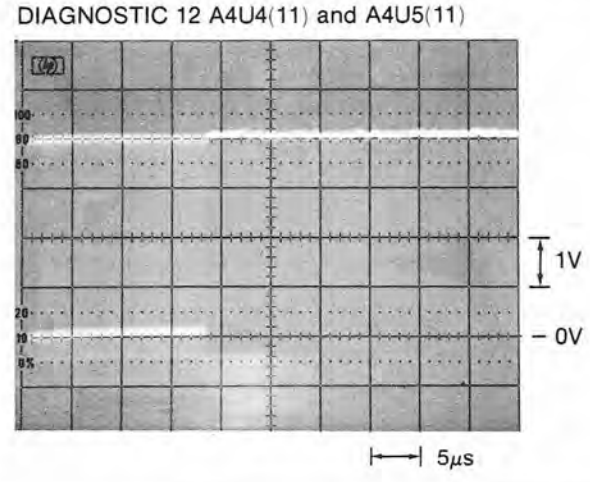


DIAGNOSTIC 12

TOP: Output of A4U31B, pin 6, and A4U31A pin 13; fast and slow current sources. Check for linearity.

BOTTOM: Input of A4U5, pin 3, and A4U4, pin 3; comparator gates.

Figure 8-76. Diagnostic 12 Waveform, A4U31, A4U5, and A4U4



DIAGNOSTIC 12

Output of A4U4, pin 11, and A4U5, pin 11; comparator gates.

Figure 8-77. Diagnostic 12 Waveform, A4U5 and A4U4

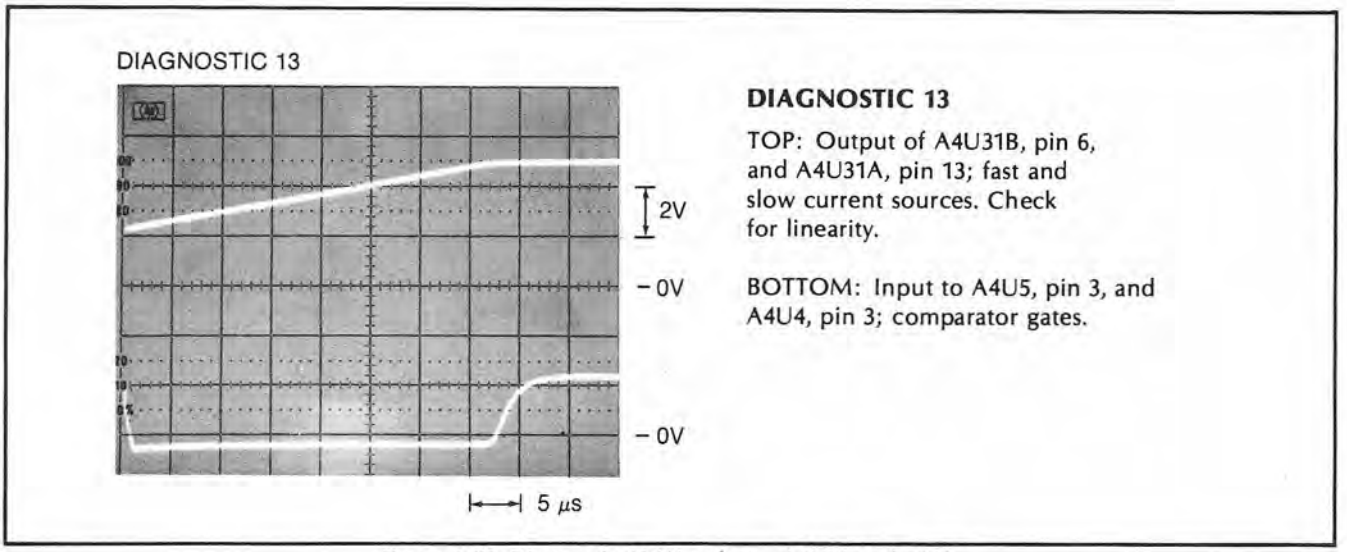


Figure 8-78. Diagnostic 13 Waveform, A4U31 and A4U5

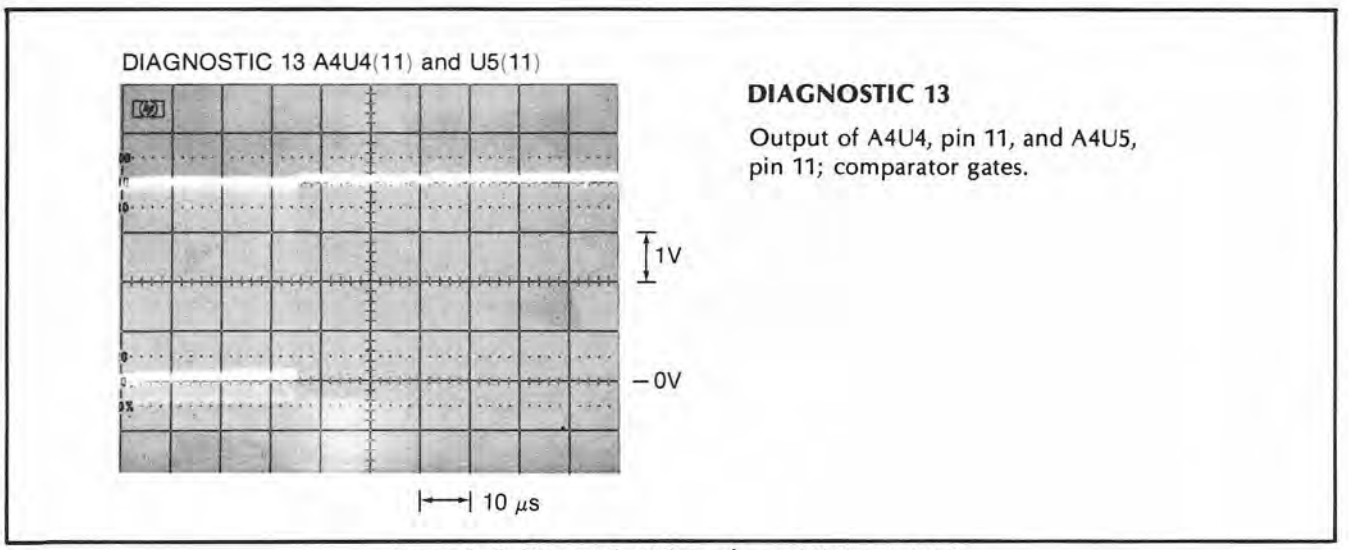


Figure 8-79. Diagnostic 13 Waveform, A4U4 and A4U5

8-423. Time Base Troubleshooting

8-424. There are two oscillators in the A4 assembly: the 10 MHz time base and the 4 MHz processor oscillator; the processor oscillator is divided down to 1 MHz and it is the main enabling signal of the microprocessor system. This 1 MHz signal is the first one to be checked out, as without this signal, the microprocessor system will not operate.

8-425. 4 MHz Microprocessor Oscillator Troubleshooting

a. Verify that the 4 MHz Microprocessor Oscillator signal is present at A4U28(39) and compare with the typical waveform shown in *Figure 8-80.*

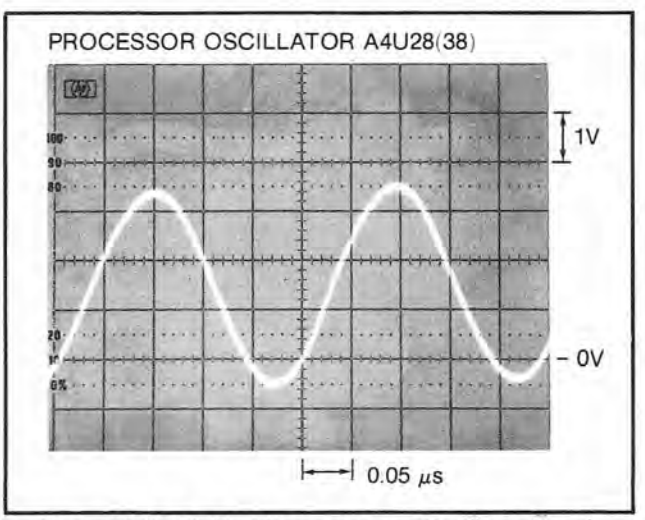


Figure 8-80. 4 MHz Microprocessor Oscillator Signal

b. If the 4 MHz signal is not present at A4U28(39), suspect A4Y2. If the 4 MHz signal is present, verify that the 1 MHz signal at A4U28(37) is present and that it is similar to the waveform in *Figure 8-81*.

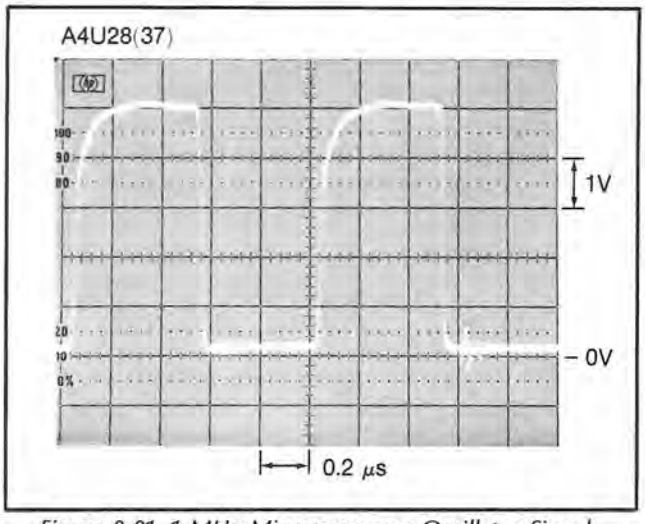


Figure 8-81. 1 MHz Microprocessor Oscillator Signal

c. If the 1 MHz signal is not present at A4U28(37), suspect A4U28.

8-426. 10 MHz Time Base Oscillator Troubleshooting

a. To verify the proper operation of the 10 MHz time base oscillator (Y1) on the Main Logic Assembly (A4), and the associated circuitry, check for the presence of the 10 MHz signal at Test Point marked "CLK" [same as A4U6(21)], and compare with the typical waveform in *Figure 8-82*.

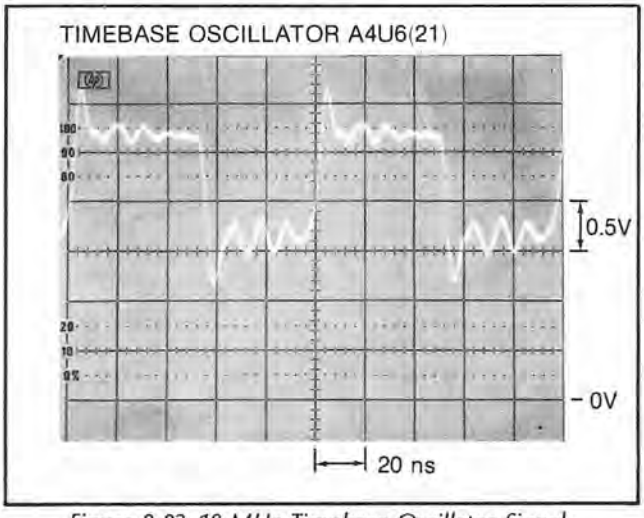


Figure 8-82. 10 MHz Timebase Oscillator Signal

b. If the internal 10 MHz signal is not present at test point "CLK", or A4U6(21), back-trace to determine if the signal is present at A4Y1, A4U2B, and A4U1.

c. If the Option 010 temperature-controlled oscillator is installed, and the 10 MHz signal is not present at test point "CLK" or A4U6(21), check to see if the signal is present at A4U1(6). If the 10 MHz signal is not present at A4U1, check the voltage regulator (A4U29) for +12.15V at pin (1), and +24.5V at pin (3). If the voltages are present at A4U29(1 and 3), suspect the Option 010 oscillator.

8-427. Power-Up Reset Troubleshooting

8-428. The power-up reset circuit, composed of A4CR10, C42, Q12 and Q13, provides a reset pulse to the A4U28 microprocessor of about 140 milliseconds as shown in *Figure 8-83*.

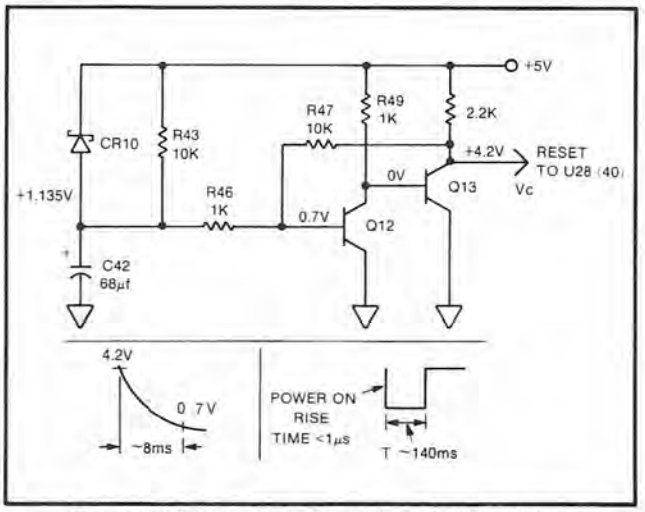


Figure 8-83. Power-Up Reset Circuit Waveform

8-429. A5 AND A10 KEYBOARD AND DISPLAY TROUBLESHOOTING

8-430. The A5 and A10 assemblies are composed of three annunciators and segment drivers (U1, U7 ands U2), 14 seven-segment displays (DS1 through DS14), a driver selector U4, data latch U5, a key status buffer U6, a keyboard interrupt U3, and a total of 46 momentary switches (including A10.) The A10 keyboard, which is only installed with Option 040, has 12 momentary pushbutton switches with LED lights. The annunciator-driver, A5U2, powers the A10 LED's.

8-431. Troubleshooting these assemblies is fairly easy with the aid of the A5 block diagram, *Figure 8-84*, and Diagnostic #15. *Table 8-19* lists the A5 connector pins and signal names. Failures on single LED's and seven-segment displays are detected by using the

front panel "CHECK" function or by enabling Diagnostic #15 as follows:

Press: SCALE, SMOOTH 9, 9, ENTER.
Wait about 5 seconds, then press: SCALE, 15, ENTER.

Table 8-19. A5 Keyboard and Display Connector Pins

A4J3 PIN	A5P2 PIN	DESCRIPTION
1	1	Ground
2	2	N.C. (Connector Key)
3	3	Data Line 5
4	4	Data Line 7
5	5	Data Line 4
6	6	Data Line 6
7	7	Data Line 0
8	8	Data Line 3
9	9	Data Line 1
10	10	Data Line 2
11	11	MTN
12	12	Keyboard IRQ
13	13	E2 (Keyboard Display Control)
14	14	E1 (Keyboard Display Data Out)
15	15	E0 (Keyboard Status)
16	16	+5V

8-432. All LED's and seven-segments will light up and will remain on enabling the technician to visually inspect all annunciators. The seven-segments can be accessed and replaced by just removing the 5335A front panel window.

8-433. Each driver/decoder drives 8 digits. U1 drives the eight left-most digits, U7 drives the six right-most digits plus the HP-IB annunciators and some of the function annunciators; U2 drives the balance of the annunciators plus the Option 040 annunciators. Therefore, look for groups of eight or six bad seven-segment displays or sections of blank LED's. If one group is defective, the trouble is probably in the driver for that group.

8-434. A shorted or open data bus line will affect more than one group of seven-segments or LED's. A loose key spring could bridge across a couple of data lines and be the major cause of shorts. The key caps can be removed with certain amount of difficulty, by pulling the caps out. This will enable the access to the key internal structure.

8-435. If a key pressed does not "access the function", check for pulses going "high" at A5U3(8); then you can trace back to the "stuck" key, back to the output of the A5U5 data latch.

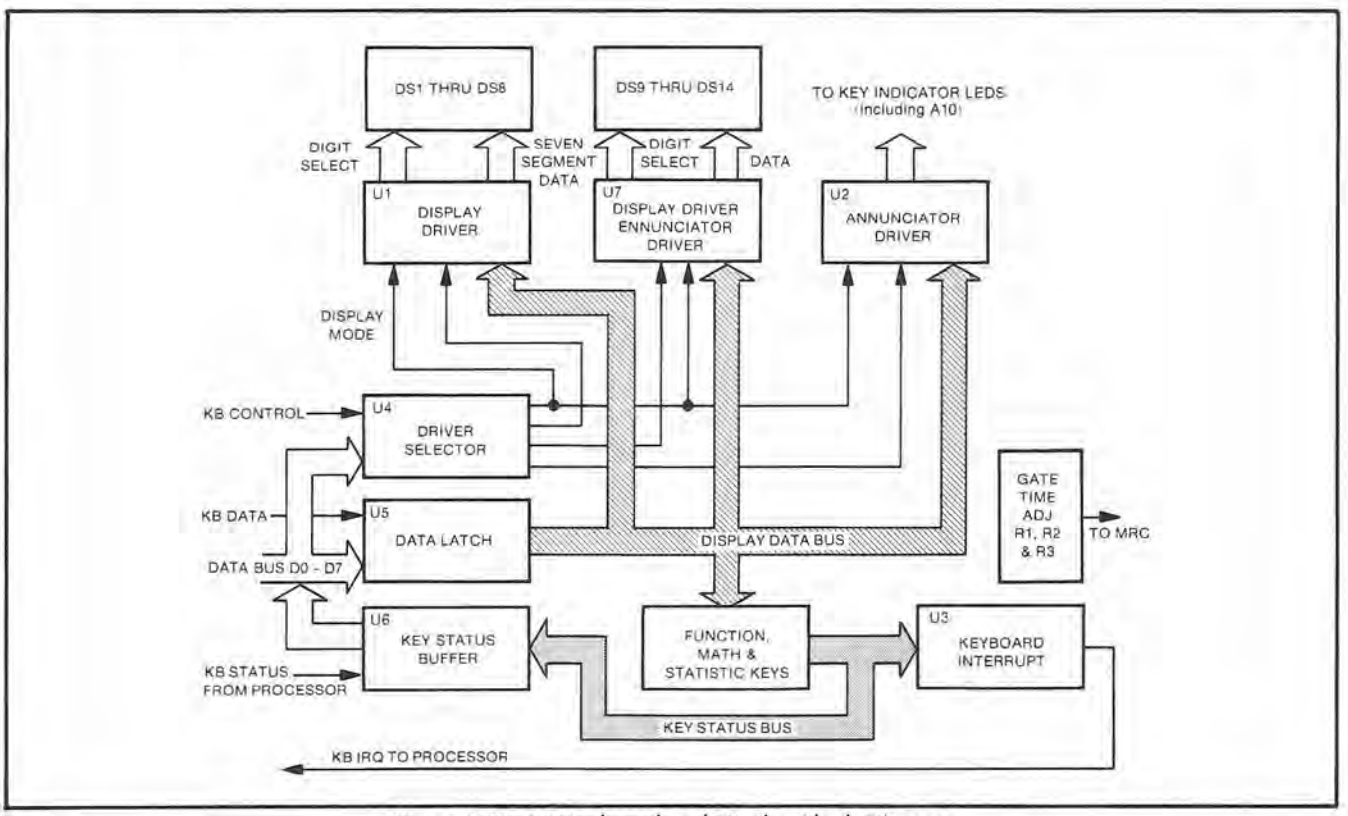


Figure 8-84. A5 Keyboard and Display Block Diagram

8-436. A6 REAR PANEL ASSEMBLY TROUBLESHOOTING

8-437. The A6 Rear Panel assembly is composed basically of four blocks: The GATE OUT level shifter, the External Arm overvoltage protection circuitry, the Time Base Multiplier circuit, and the External Arm switches. The Trigger Level Out signals from the A2/A11 support boards, are fed directly (through A4) to the rear panel BNC connector A6J1 and J4. *Figure 8-85* is the A6 block diagram and *Table 8-20 lists the connector pins and signals.*

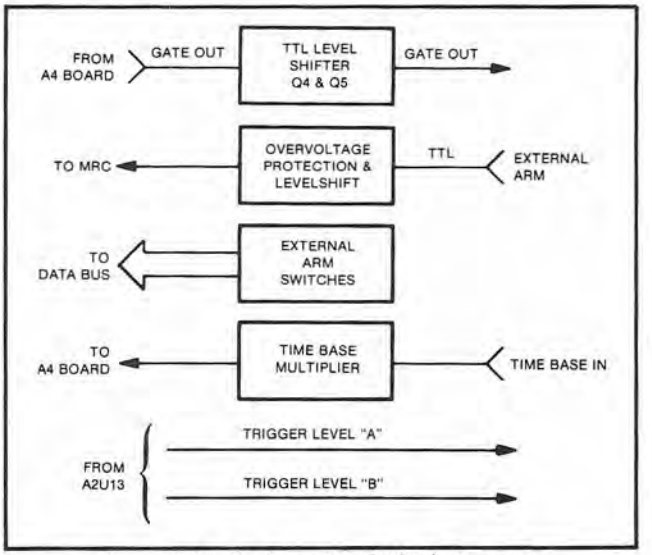


Figure 8-85. A6 Rear Panel Block Diagram

Table 8-20. A6 Rear Panel Board Connector Pins

A4J1 PIN	A6J7 PIN	DESCRIPTION
1	1	+3V
2	2	TLB (Trigger Level B)
3	3	Stop ⨍
4	4	Gate Output
5	5	GND (clean)
6	6	Ext time base in
7	7	Start ⨍
8	8	Osc Out (Time Base Out)
9	9	+5V
10	10	Stop ⨏
11	11	Ground (clean)
12	12	Start ⨏
13	13	Ground (clean)
14	14	-5.2V
15	15	TLA (Trigger Level A)
16	16	Ext Arm (to MRC)

8-438. GATE OUT Circuitry Troubleshooting

8-439. The GATE OUT circuitry is a level shifter and an amplifier that can drive TTL loads as well as 50 ohm loads. To troubleshoot this circuitry, enable the GATE TIME function on the 5335A, and set the gate time to about 20 milliseconds at NORMAL cycle. Verify that the waveforms in *Figures 8-86* through *8-89* are obtained at the specified points.

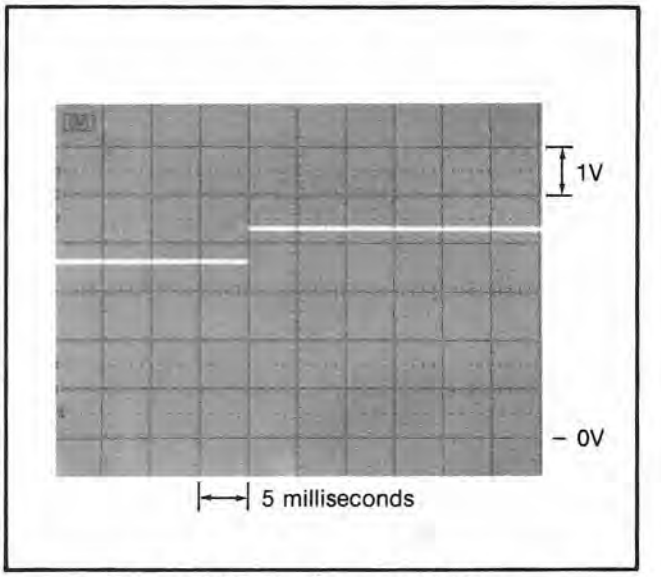


Figure 8-86. Waveform at A6Q4 Base

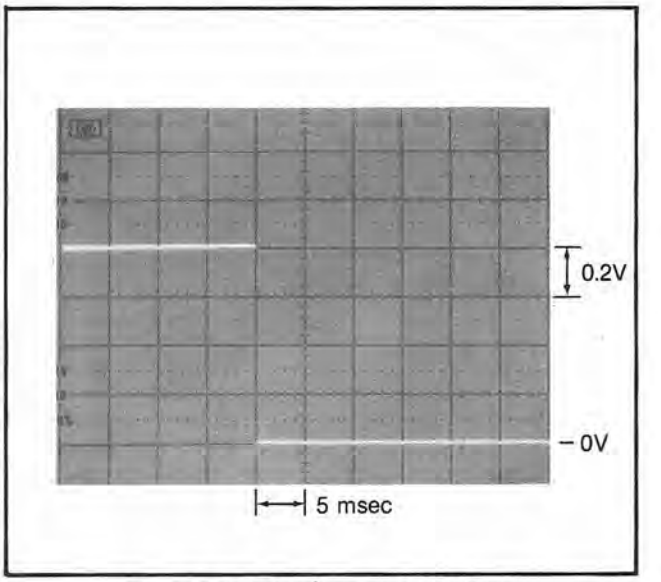


Figure 8-87. Waveform at A6Q5 Base

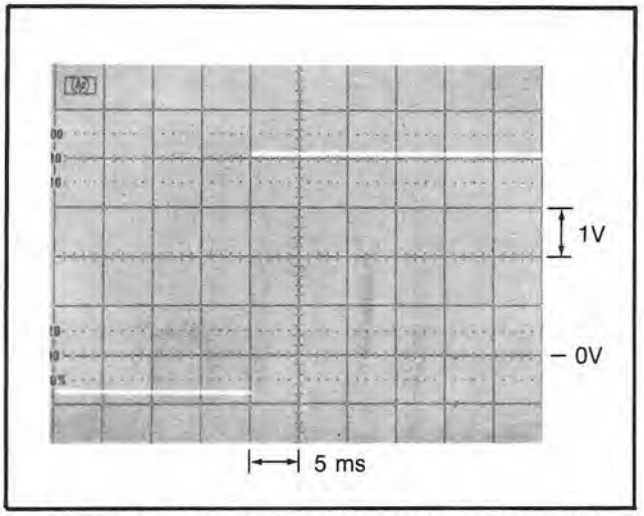


Figure 8-88. Waveform at A6Q5 Collector (Into 1Ω)

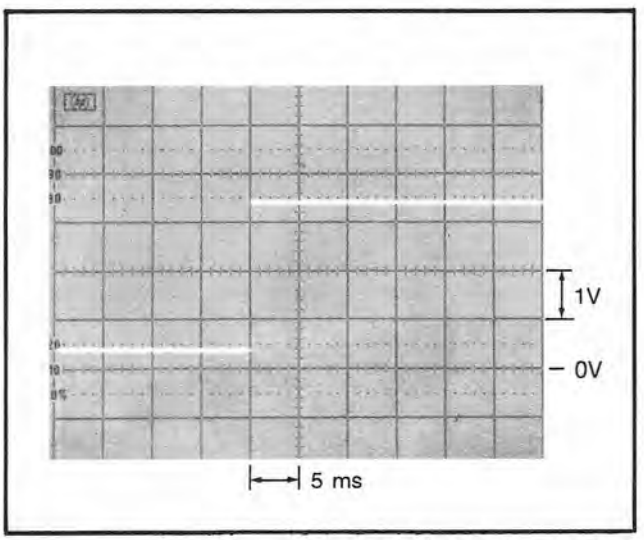


Figure 8-89. Waveform at A6Q5 Collector (Into 50Ω)

8-440. External Arm Input Circuitry Troubleshooting

8-441. The External Arm input circuitry is a differential pair (A6Q1 and Q2) with overvoltage protection; A6CR1 protects against negative voltages (<0V), and A6Q1 protects against voltages >5 volts. To troubleshoot this circuitry, apply a TTL type signal to the External Arm Input similar to the one shown in the top portion of *Figure 8-90*; insure that the EXTERNAL ARM ADJUST pot is in the cw position (TTL). The bottom portion of the figure is the resulting signal that goes into the A4U6(17).

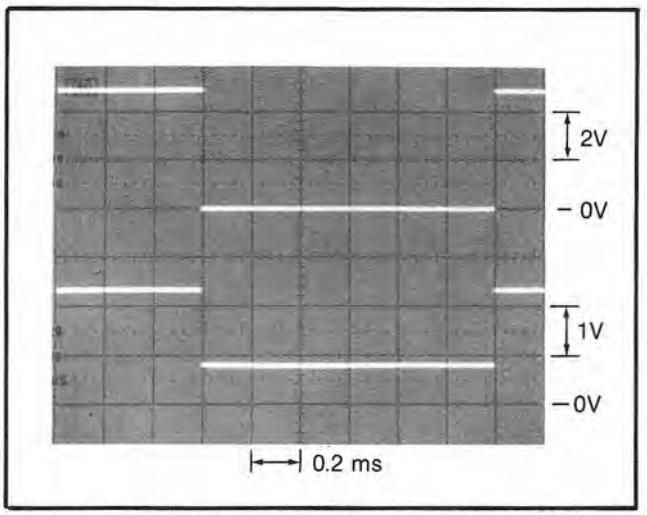


Figure 8-90. A6 External Arm Test Waveforms

8-442. Time Base Multiplier Troubleshooting

8-443. The external time base input circuitry is a three-stage tank filter, set at 10 MHz, with clipping diodes to help produce harmonics to the tanks. The tank components have a 1% tolerance, and therefore do not need adjustments. The ECL output level is fed to an ECL receiver on the A4 Main board (A4U2A).

$$\text{Resonant Frequency} = \frac{1}{2\pi\sqrt{LC}} = 10\ \text{MHz}$$

(L = 1 μH, C = 250 pF)

8-444. To troubleshoot the A6 time base multiplier, apply a 5 MHz signal at about 350 mV peak-to-peak to the 5335A rear panel TIME BASE IN connector. *Figure 8-91* shows a typical satisfactory waveform.

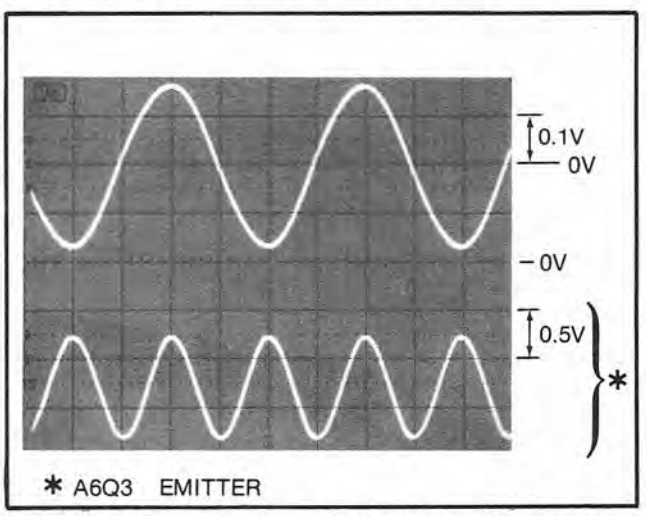


Figure 8-91. A6 Timebase Multiplier Test Waveforms

8-445. EXTERNAL ARM Switches Troubleshooting

8-446. The EXTERNAL ARM switches indicate to the processor which edge of either START or STOP of the external arming signal is to be selected, when the EXT ARM ENABLE function switch on the 5335A front panel has been selected. *Table 8-21* indicates the state of data line as a function of the arming switches:

Table 8-21. External Arm Data Lines States

START	STOP	START ⨍ A6R5(3)	START ⨏ A6R5(5)	STOP ⨍ A6R5(4)	STOP ⨏ A6R5(6)
OFF	OFF	1	1	1	1
⨍	⨍	0	1	0	1
⨏	⨏	1	0	1	0
This data goes into A4U15 in the A4 Main Logic Board.					

8-447. A7 HP-IB ASSEMBLY TROUBLESHOOTING

8-448. The HP-IB Interface Logic Assembly serves as an interface between the 5335A and an external controller, via the Hewlett-Packard Interface Bus. The circuitry includes bus buffers (A7U3, U4, U6, U7), decoding ROMS and an LSI HP-IB Interface IC (A7U1). These circuits perform the handshake and interpret commands, data, interrupts, etc. Refer to *Figure 8-92* A7 Block Diagram and *Tables 8-22, 8-23* and *8-24*.

Table 8-22. HP-IB Assembly Pin Connections (A4/A7)

A4XA7 Pin	A7P1 Pin	Description	A4XA7 Pin	A7P1 Pin	Description
1	1	A1	$\overline{1}$	$\overline{1}$	A2
2	2	A3	$\overline{2}$	$\overline{2}$	A2
3	3	A5	$\overline{3}$	$\overline{3}$	A4
4	4	A7	$\overline{4}$	$\overline{4}$	A6
5	5	A9	$\overline{5}$	$\overline{5}$	A8
6	6	A11	$\overline{6}$	$\overline{6}$	A10
7	7	A13	$\overline{7}$	$\overline{7}$	A12
8	8	Reset	$\overline{8}$	$\overline{8}$	A14
9	9	E(1MHz)	$\overline{9}$	$\overline{9}$	$\overline{\text{NMI}}$
10	10	$\overline{\text{IRQ}}$	$\overline{10}$	$\overline{10}$	RAM ENABLE
11	11	VMA	$\overline{11}$	$\overline{11}$	$\overline{\text{VMA.E}}$
12	12	R/$\overline{\text{W}}$	$\overline{12}$	$\overline{12}$	A15
13	13	Ground	$\overline{13}$	$\overline{13}$	Ground
14	14	+5V	$\overline{14}$	$\overline{14}$	-5.2 V
15	15	D1	$\overline{15}$	$\overline{15}$	D0
16	16	D3	$\overline{16}$	$\overline{16}$	D2
17	17	D5	$\overline{17}$	$\overline{17}$	D4
18	18	D7	$\overline{18}$	$\overline{18}$	D6

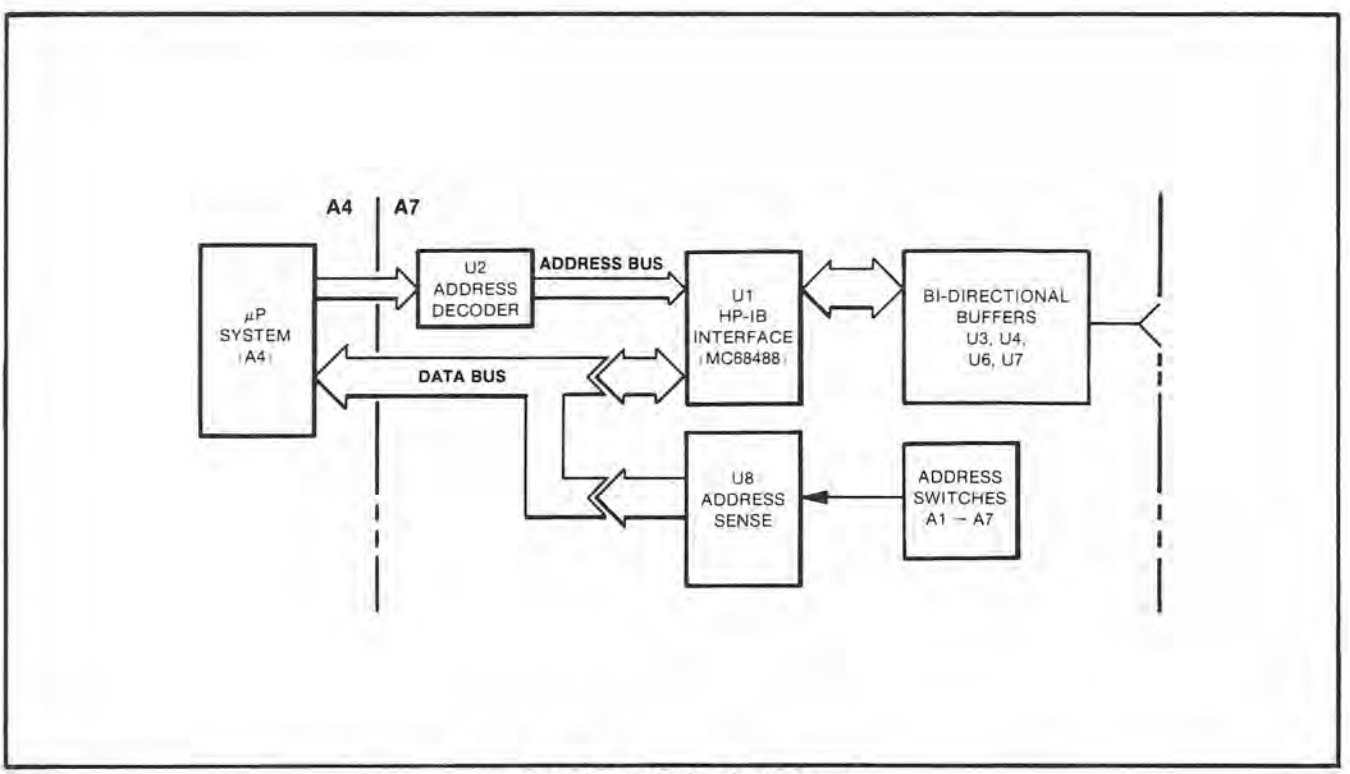


Figure 8-92. A7 HP-IB Block Diagram

Table 8-23. HP-IB Assembly Pin Connections (A7/A14)

A7J1 Pin	A14J1 Pin	Description	A7J1 Pin	A14J2 Pin	Description
1	1	EO1	1	1	Ground
2	2	DAV	2	2	A1
3	3	RFD	3	3	A2
4	4	DAC	3	3	A3
5	5	IFC	3	3	DIO1
6	6	SRQ	6	6	DIO2
7	7	ATN	7	7	DIO3
8	8	N.C.	8	8	DIO4
9	9	Ground	9	9	DIO8
10	10	Ground	10	10	DIO7
11	11	Ground	11	11	DIO6
12	12	Ground	12	12	DIO5
13	13	Ground	13	13	A7 (Talk)
14	14	Ground	14	14	A6 (Listen)
15	15	Ground	15	15	A5
16	16	REN	16	16	A4

Table 8-24. HP-IB Interface Connector Signals

HP-IB Pin	Connectors Signals
1	DIO1
2	DIO2
3	DIO3
4	DIO4
5	EOI
6	DAV
7	NRFD
8	NDAC
9	IFC
10	SRQ
11	ATN
12	SHIELD CHASSIS GROUND
13	DIO5
14	DIO6
15	DIO7
16	DIO8
17	REN
18	P/O Twisted Pair with Pin 6
19	P/O Twisted Pair with Pin 7
20	P/O Twisted Pair with Pin 8
21	P/O Twisted pair with Pin 9
22	P/O Twisted Pair with Pin 10
23	P/O Twisted Pair with Pin 11
24	ISOLATED DIGITAL GROUND

8-449. To troubleshoot the A7 assembly, setup the counter (microprocessor system) for signature analysis in its FREERUN mode. Setup:

a. Connect the Signature Analyzer START, STOP, and CLOCK pod leads to corresponding test pins next to the A4U28 microprocessor. Ensure that the CLOCK test lead is connected to the test pin marked "CK1".

b. Set the START, STOP, and CLOCK switches on the Signature Analyzer to the negative edge (⎿).

c. Connect a jumper between the test pins marked "SA" and "G", located between A4U12 and A4U21. This will set the microprocessor in its "FREERUN" mode.

d. Set the 5335A power switch from STBY to ON. The 5335A display should be blank with the only possible exception of the Channel A and B trigger lights. Verify the characteristics power supply signature as being: 0003; if this signature is correct, it signifies proper connection of the Signature Analyzer.

e. Verify the signatures at the following key test points:

TEST POINT	SIGNATURE
A7U2(1,11)	7APA
A7U2(2)	6U28
A7U2(3)	4FCA
A7U2(5)	U867
A7U2(13)	9UP1
A7U2(14)	4868
A7U1(4)	P546

f. If any of these "key test point" signatures are not correct, proceed to back-trace the signatures into the A4 Main Logic board. Refer to paragraph 8-404 to check out the microprocessor system and associated hardware key signature, and to paragraph 8-409 to verify proper operation with the ROMs.

g. If signatures are correct, proceed to paragraph 8-410, which provides the procedure to check out the microprocessor system output ports, with the 5335A setup in its "STIMULUS MODE".

8-450. A8 DIGITAL VOLTMETER TROUBLESHOOTING

8-451. The A8 Digital DC Voltmeter assembly contains the Input/Amplifier buffer U11 with selectable gain feedback paths (Q4, Q5 and Q6), the reference (U4, U5), voltage multiplexer (U7), the voltage-to-frequency converter (U6 and U8), the input switching control (U3, U9, U10, U12, U13, Q2, Q3, Q7), and the power supply (T1, CR1, U1). Refer to the A8 block diagram (*Figure 8-93*) and the A8 schematic diagram to troubleshoot this assembly. *Table 8-25* lists the connector functions.

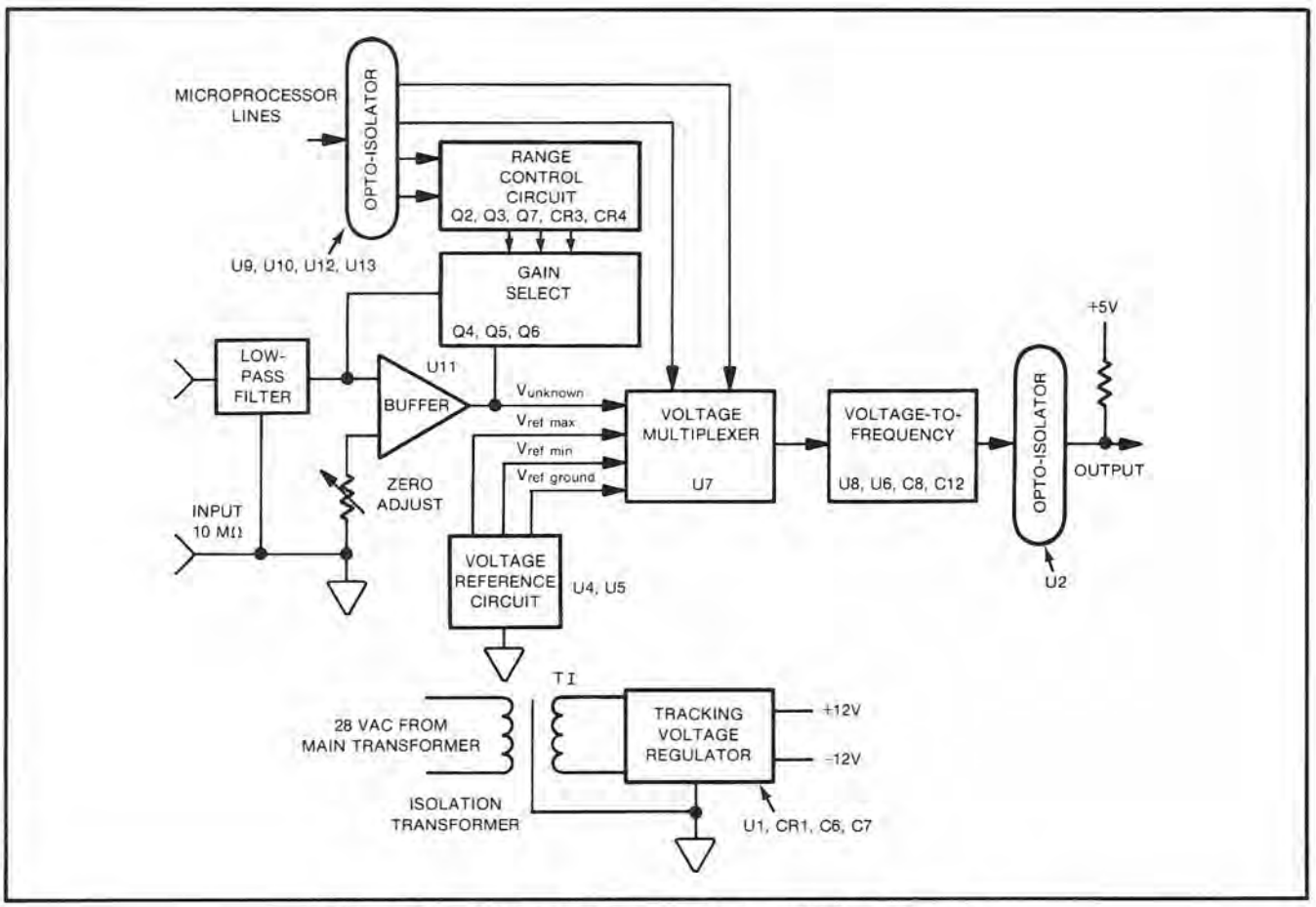


Figure 8-93. A8 Digital Voltmeter (Option 020) Block Diagram

Table 8-25. A8 Connector Pin Functions

A2XA8 Pin	A8P1 Pin	Description
1	1	Ground
2	2	AC Supply (18.5V rms)
3	3	Enable
4	4	+5 VOLTS
5	5	Ground (Option IN)
6	6	Ground
$\overline{1}$	$\overline{1}$	DVM Output (Freq)
$\overline{2}$	$\overline{2}$	AC Supply (18.5V rms)
$\overline{3}$	$\overline{3}$	Data Line 5
$\overline{4}$	$\overline{4}$	Data Line 6
$\overline{5}$	$\overline{5}$	Data Line 7
$\overline{6}$	$\overline{6}$	Data Line 4

8-452. There are six software diagnostic subroutines to help in the troubleshooting of the Option 020 assembly. They are:

DIAGNOSTIC	DESCRIPTION
#20) DVM	Mux — -5V Ref (Freq Out ~ 800 Hz)
#21) DVM	Mux — Gnd Ref (Freq Out ~ 6 KHz)
#22) DVM	Mux — +5V Ref (Freq Out ~ 11 KHz)
#23) INPUT	VOLTAGE RANGE SELECT (LOW)
	10V RANGE SELECT (Min Freq ~ 150 Hz)
#24) INPUT	VOLTAGE RANGE SELECT (MID)
	100V RANGE SELECT
#25) INPUT	VOLTAGE RANGE SELECT (HIGH)
	1000V RANGE SELECT

8-453. To access anyone of the diagnostics listed above, follow these procedures:

a. Press: SCALE, SMOOTH, 9, 9, ENTER; wait 5 seconds, (enables diagnotic mode).

b. Press: SCALE, 2, 0, through 2,5, ENTER.

NOTE

Set "RANGE HOLD" **ON** when using these diagnostic subroutines for stable output frequencies at A1TP3 "FREQ OUT".

8-454. Diagnostic Subroutines #20, #21, #22 are designed to set up the DVM option to measure and display the voltage and frequency of the -5V, GND, +5V references. These routines verify all the A8 DVM circuitry with the exception of the Range Select circuits (A8U11, U12, U13).

8-455. Diagnotic Subroutines #23, #24, #25 force the DVM option into its LOW, MED, and HIGH range, respectively. By inputting a known dc voltage to the DVM input, the input amplifier A8U11, the FETs and transistors, which select the different ranges can be tested. The autorange feature of the DVM is disabled in these tests.

8-456. Input Amplifier and Range Control Troubleshooting

8-457. U11 is the Input amplifier buffer with selectable gain feedback loops. There are three feedback resistor loops, selectable by the microprocessor via Q4, Q6, and Q5 FETs. These loops set up gains of -1/2 (Low) -1/20 (Medium), and -1/200 (High), respectively, with one loop selected at the time; they are selected so that U11(6) output volts is within ±5 volts. *Table 8-26* lists Q4, Q5, and Q6 states for diagnostics #23, #24, and #25.

Table 8-26. A8Q4, Q5, and Q6 States in Diagnostics #23, #24, and #25

DIAG #	RANGE SELECT		
	HIGH Q5(G)	MEDIUM Q6(G)	LOW Q4(G)
23	OFF	OFF	ON
24	OFF	ON	OFF
25	ON	OFF	OFF
ON = 0 volts OFF = -12 volts			

8-458. To troubleshoot feedback loops, apply a 4-volt dc level to the Option 020 DVM input. With a DVM, monitor the voltage at TP1, as diagnostic #23, #24 and #25 is selected. *Table 8-27* lists the correct voltages at TP1.

Table 8-27. A8TP1 Voltages for Diagnostics #23, #24, and #25

DVM INPUT VOLTAGE	VOLTAGE AT TP1		
	DIAG #23	DIAG #24	DIAG #25
+4V	-2V	-0.2V	-0.02V
-4V	+-2V	+0.2V	+0.02V

8-459. Reference and Voltage Multiplexer Troubleshooting

8-460. A8U4 and A8U5 provide the +5V, Ground, and -5V references to the input of A8U7 multiplexer. The microprocessor utilizes these three voltage references to compute the unknown input voltage. The U7 control bits originate in U9 and U10 optic-isolators. See *Table 8-28*.

Table 8-28. A8U7 States in Diagnostics #20-#25

DIAG #	A8U7		TP2	TP3
	Pin 16	Pin 1		
20	0	0	-5V	~800Hz
21	0	1	0V	~6KHz
22	1	0	+5V	~11KHz
23, 24, 25	1	1	Vinput	

8-461. Voltage-to-Frequency Converter Troubleshooting

8-462. The voltage-to-frequency converter circuit is composed of A8U6 V-to-F, U8 unity gain buffer, C12 the integrating capacitor, C8 the one-shot capacitor, and U2 optic-isolator (converts the floating frequency output to a chassis-referenced output). Use *Table 8-29* to troubleshoot this section.

NOTE

A8U6(1) voltage is always equal to **zero**.

Table 8-29. A8 Voltage-to-Frequency Conversion

INPUT VOLTAGE (V)	OUTPUT FREQUENCY (Hz)
+10	800
+9	1.31K
+8	1.82K
+7	2.33K
+6	2.84K
+5	3.35K
+4	3.86K
+3	4.36K
+2	4.87K
+1	5.38K
0	5.89K
-1	6.40K
-2	6.91K
-3	7.42K
-4	7.93K
-5	8.43K
-6	8.94K
-7	9.45K
-8	9.96K
-9	10.47K
-10	10.98K

NOTE: The output frequency will vary slightly from instrument to instrument. The above table is for information **ONLY**, and gives only an approximation of the voltage-to-frequency relationship.

8-463. Input Logic Switching Control Troubleshooting

8-464. The Input Logic Switching Control circuitry consists of A8U3 register, that latches four bits from the microprocessor controlled data bus, U9, U10, U12, U13 optic-isolators, and A8Q2, Q3, and Q7, which decodes and provides range selection information, as well as control bits for U7, the reference multiplexer.

8-465. To troubleshoot this section, check the dc levels of the circuit per *Table 8-30.*

8-466. Power Supply Troubleshooting

8-467. Transformer T1 (1:1 ratio), full wave rectifier CR1, and U1 dual-tracking regulator, form the floating power supply of A8.

8-468. A9 CHANNEL C (OPTION 030) TROUBLESHOOTING

8-469. The A9 Channel C assembly contains the Overload/Limiter/Pin Diode Attenuator circuits, the U1 Amplifier, a level detector (CR5, CR14), a U2 Decade, and U3 Binary divider blocks. Refer to the A9 block diagram (*Figure 8-94*) to troubleshoot the Option 030 C Channel.

8-470. To troubleshoot the A9 assembly, first refer to Section III to check for an open input fuse. If the fuse is open replace the fuse.

8-471. If fuse is good, and all power supplies are present (+5V, -5.2V, and +15.7V), then the next thing to check is the self oscillating frequency, use the following procedure:

a. Set **L** pot to the clockwise position.

b. Connect a jumper between -5.2V and TP2.

c. Enable FREQ C; 5335A should display: 1.0 GHz ±60 MHz.

d. Vary the **H** pot and check for a variation in the display of about 500 MHz. If no response, check signal through Q1.

8-472. If self oscillation frequency is not OK, then set the self oscillating frequency per procedure in Section V.

8-473. Apply a 150 MHz signal at 400 mV p-p to INPUT C, with the 5335A Channel C function enabled. Set GATE TIME to about 200 milliseconds. Refer to the A9 schematic diagram and check that the proper waveform exists at the indicated points. *Figure 8-95* shows A9 test point waveforms.

Table 8-30. A8 Input Logic Switching Troubleshooting

	DIAGNOSTIC					
	#20	**#21**	**#22**	**#23**	**#24**	**#25**
U3 PIN 2)	LO	LO	LO	HI	HI	LO
7)	LO	LO	LO	HI	LO	HI
10)	LO	LO	HI	HI	HI	HI
15)	LO	HI	LO	HI	HI	HI
U9-5)	0V	0V	+12V	+12V	+12V	+12V
U10-5)	0V	+12V	0V	+12V	+12V	+12V
U12-5)	-12V	-12V	-12V	0V	0V	-12V
U13-5)	-12V	-12V	-12V	0V	-12V	0V
Q7 Collector C-Q2	-12V	-12V	-12V	0V	-12V	-12V
Q7 Collector C-Q3	0V	0V	0V	-12V	-12V	0V
Q7 Collector C-Q7	0V	0V	0V	-12V	0V	-12V
Voltage Select	-5V Ref	Gnd Ref	+5 Ref	Vin	Vin	Vin
Range Select	Don't Care	Don't Care	Don't Care	X10	X100	X1000

NOTE: When collector of Q3, Q2, Q7 is low (0V), it will turn on their respect FET, only one range is on at any one time. (Except when Diagnostics #20, #21, and #22 are accessed.)

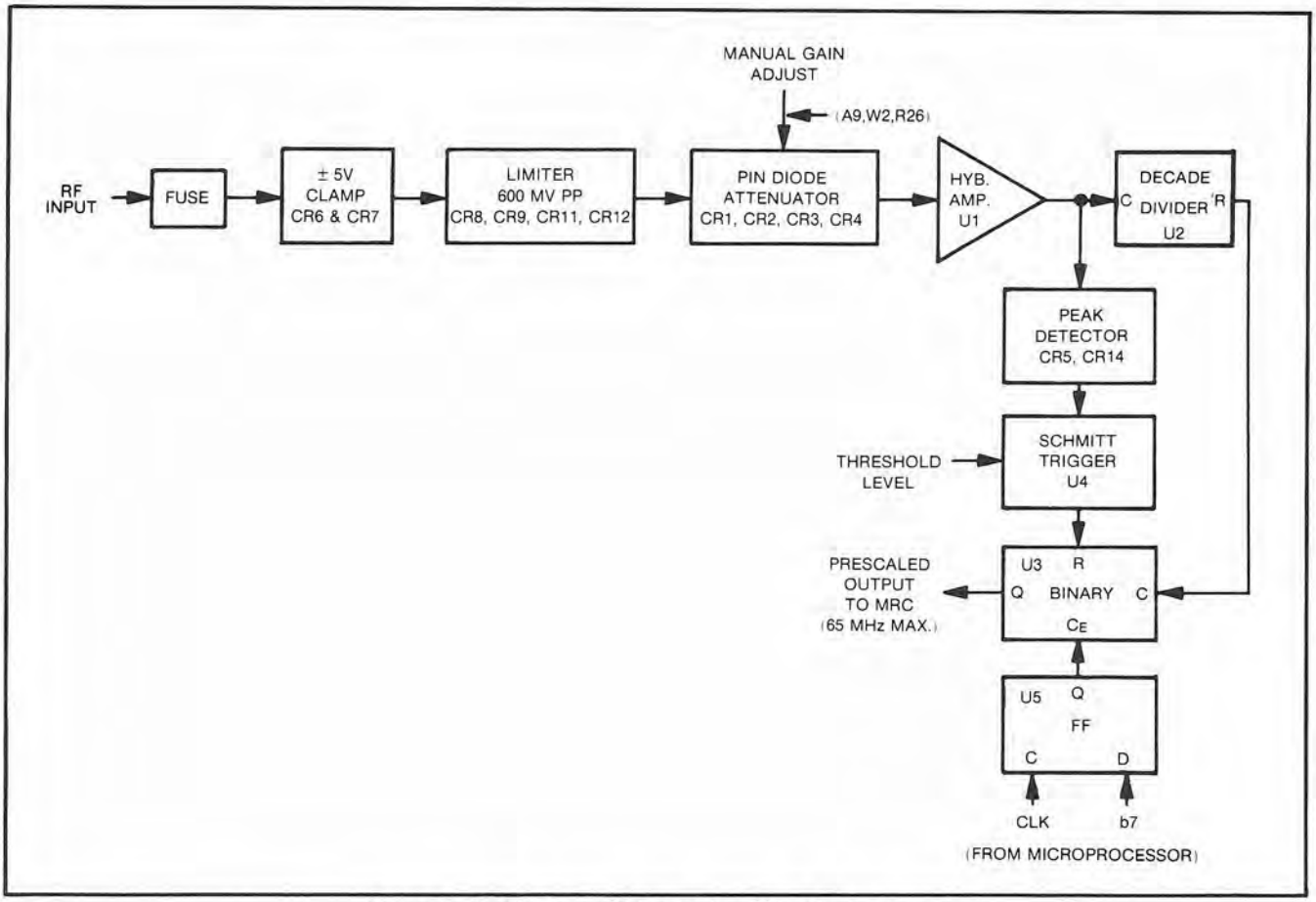


Figure 8-94. A9 Channel C (Option 030) Block Diagram

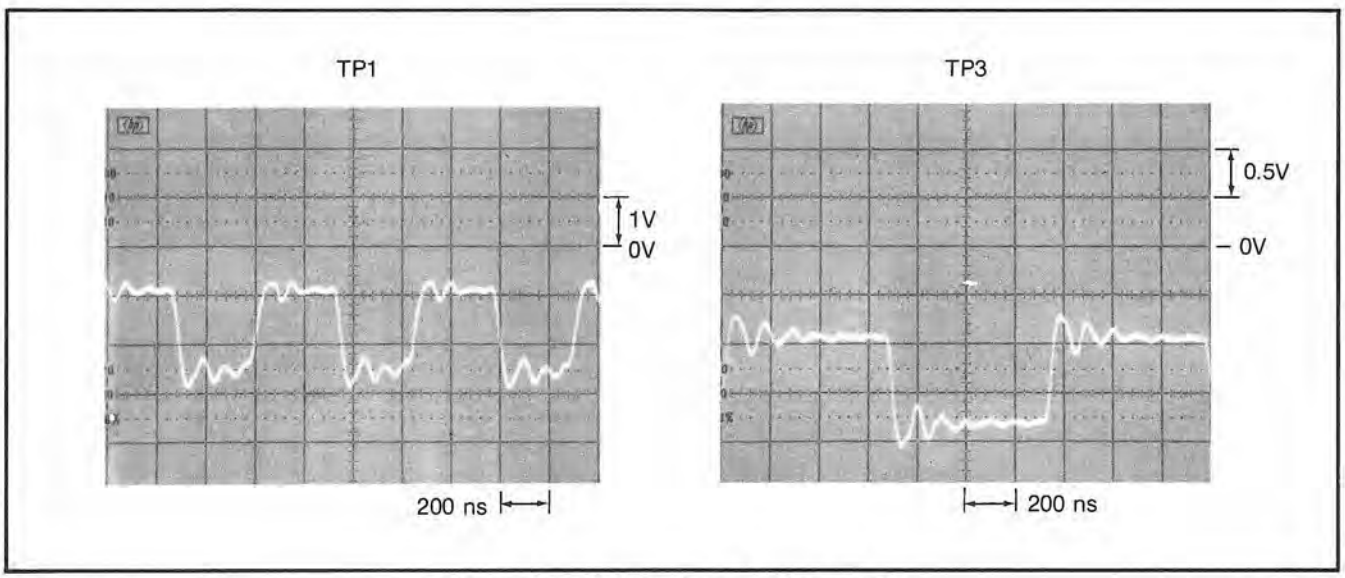


Figure 8-95. A9 Waveforms at TP1 and TP3

8-474. A11 AMPLIFIER SUPPORT TROUBLESHOOTING

8-475. The A11 Amplifier Support Assembly contains the Channel A and B Trigger Level selector, the Digital-to-Analog Converters (DACs), the Trigger Level Voltmeter, the Signal Selector Multiplexer, and the Front End latch control circuitry. The Trigger Level Selector and the Front End latch control circuits complements the peak detector operation in the A12 Programmable Input Buffer assembly.

8-476. Trigger Level Selector Troubleshooting

8-477. Channel A Trigger Level Selector Multiplexer (A11U2) selects among the different input signals (Channel A trigger level pot, the 10%, 50%, and 90% of peak of signal, ground, and –5.2V), a trigger level that is fed back to the A12 assembly. This multiplexer is controlled by the microprocessor, by way of A11U14 and A11U15. *Table 8-31* lists the A11U2 control bits.

NOTE

"RANGE HOLD" must be **ON** during this test.

Table 8-31. A11U2 Analog Multiplexer Control Bits

C1 U2(15)	C12 U2(16)	C11 U2(1)	FUNCTION
0	0	0	Freq A, Manual Trigger Adj
0	0	1	DACs (Diagnostic #34)
0	1	0	Freq A, Manual Trig Preset
0	1	1	Diag #33 (–5.2V)
1	0	0	Freq A, Auto Adjust
1	0	1	SLEW Rate A, ⌐
1	1	0	Freq A, Auto Preset
1	1	1	SLEW Rate A, ¬

CAUTION

The assemblies and components involved in the following steps are all static sensitive, and should be handled at a static free work area, and in accordance with approved procedures.

8-478. If A11U2 bits are not set properly, check the Front End latch controls A11U15 and U14, by enabling Diagnostics #3 and #4.

8-479. Front End Latch Control Troubleshooting

8-480. Diagnostics #3 and #4 are designed to aid in the troubleshooting of A11U15 and U14, and related circuitry, including A12K1 through K9.

8-481. To enable Diagnostic #3, press: SCALE, SMOOTH, 9, 9, ENTER; wait 5 seconds, then press: SCALE, 3, ENTER. The 5335A will display: "dIAG 03".

8-482. Diagnostic #3 sets the A11U15 and A1U14 latches output to a TTL "LOW". With a logic probe oscilloscope, or a voltmeter, verify the state of the latches output per *Table 8-32*.

Table 8-32. Troubleshooting A11U14 and A11U15

REF. DESIG.	PIN #	NOMEN.	DIAG. #3	DIAG. #4
A11U15	1	+5V		
	2	C1	Low	High
	3	D0	1.45V	1.45V
	4	D1	1.45V	1.45V
	5	C2	Low	High
	6	D2	1.45V	1.45V
	7	C3	Low	High
	8	GND		
	9	*U697	4.5V	4.5V
	10	C4	Low	High
	11	D3	1.45V	1.45V
	12	C5	Low	High
	13	D6	1.45V	1.45V
	14	D7	5.0V	5.0V
	15	C6	Low	High
	16	+5V		
A11U14	1	+5V		
	2	C7	Low	High
	3	D0	1.45V	1.45V
	4	D1	1.45V	1.45V
	5	C8	Low	High
	6	D2	1.45V	1.45V
	7	C9	Low	High
	8	GND		
	9	*HA50	4.5V	4.5V
	10	C10	Low	High
	11	D3	1.45V	1.45V
	12	C11	Low	High
	13	D4	1.45V	1.45V
	14	D5	1.45V	1.45V
	15	C12	Low	High
	16	+5V		

* = FREERUN Signature [START, STOP, CLOCK (CK1)]

8-483. To enable Diagnostic #4, press: SCALE, 4, ENTER. This diagnostic sets the latches output to a TTL "HIGH"; verify their state per *Table 8-32*.

8-484. Troubleshooting the A11U5 Multiplexer

8-485. A11U5 plays a combined role with A11U2 (channel A trigger level selector), and A11U11 (channel B trigger level selector), to select the Trigger Level for the appropriate channel.

8-486. To troubleshoot A11U5, verify the control signal status, by enabling and disabling the AUTO TRIG in FREQ A, and by enabling diagnostic #34. *Table 8-33* lists the control signals for A11U5.

Table 8-33. A11U5 Control Signals

CHANNEL A&B TRIGGER LEVELS (ATL and BTL)	U5(1)	U5(16)
Manual Trigger	0	0
Auto Trigger	1	1
DAC's	1	0

8-487. To enable diagnostic #34, press: SCALE, SMOOTH, 9, 9, ENTER. Wait 5 seconds, then press: SCALE, 3, 4, ENTER. The 5335A display will show: "dIAG 34".

8-488. Troubleshooting the Relay Drivers

8-489. To check out the relay drivers A11Q1 through Q9, exit diagnostic mode by pressing FREQ A. Verify the collector voltages in *Table 8-34*, and the outputs of A11U18, by enabling and disabling the corresponding input conditioning controls:

Table 8-34.A11 Relay Driver Collector Voltages

Relay Driver	Description	Voltages	A11U18
Q1	CH B 50Ω/1 MΩ	-12V/0V	Pin #2: 0.280V/5V
Q2	CH B AC/DC	-12V/0V	Pin #5: 0.280V/5V
Q3	CH B Filter ON/OFF	-12V/0V	Pin #6: 0.280V/5V
Q4	CH B Attenuator	-12V/0V	Pin #9: 0.280V/5V
Q5	CH A 50Ω/1 MΩ	-12V/0V	Pin #12: 0.280V/5V
Q6	CH A Filter ON/OFF	-12V/0V	Pin #15: 0.280V/5V
Q8	CH A AC/DC	-12V/0V	Pin #16: 0.280V/5V
Q9	CH A Attenuator	-12V/0V	Pin #19: 0.28V/5V
Q7	COM A/Separate	0V/-12V	U15(5): 0.170V/4.5V

8-490. Digital-to-Analog Converter Troubleshooting

8-491. The Digital-to-Analog Converter (DAC's) circuitry is composed of A11U23 (Channel A), U21 (Channel B), both 10-bit D/A ICs, U16, U17, U24 data latches, and U5 Manual/Auto/DAC multiplexer.

8-492. To troubleshoot this circuitry, first verify the functional operation of the DAC's by enabling Diagnostic #34 as follows:

Press: SCALE, SMOOTH, 9, 9, ENTER (If not already in diagnostic mode); wait 5 seconds, then press: SCALE, 3, 4, ENTER. 5335A display will show: "dIAG 34".

8-493. For a visual display of DAC's functional operation, connect the suspected channel trigger level (A or B), from the 5335A rear panel to an oscilloscope. The level will vary from -5.11 volts to +5.11 volts continuosly. If a problem exist in the DAC's, a "jump" will be noticed in the scope's display, i. e., the sweep on the scope display will not be a smooth one.

8-494. Connect the unused trigger level signal from the 5335A rear panel to the scope, and verify its operation against the defective one. If the display of the DAC's output is not smooth in one channel, but O.K. in the other, exchange U21 with U23 and check if problem travels with IC. If it does, replace deffective IC. If it does not, the problem may be located in the data latches U16, U17, or U24.

8-495. To verify proper operation of the DAC's data latches, remove A11U21 an U23 from their sockets, and enable Diagnostic #18 and #19. The logic level of the output of U16, U17, and U24 data latches should be as shown in *Table 8-35*.

Table 8-35. A11 Data Latch Logic Levels

DEVICE	DIAG #18 (0 Volt)	DIAG #19 (-5.12 Volts)
CHANNEL A		
U17(2)	0	0
(5)	0	0
(6)	0	0
(9)	0	0
(12)	0	0
(15)	0	0
(16)	0	0
(19)	0	0
U24(11)	0	0
(13)	1	0
CHANNEL B		
U16(2)	0	0
(5)	0	0
(6)	0	0
(9)	0	0
(12)	0	0
(15)	0	0
(16)	0	0
(19)	0	0
U24(3)	0	0
(5)	1	0

8-496. Troubleshooting the Data Latch Enablers U19 and U20

8-497. A11U19 and U20 are three-to-eight decoders that clock the following devices: A11U18 relay driver data latch, A11U14 and U15 Front End latch controls, and U16, U17, U24 DACs data latch.

8-498. To verify that U19 and U20 are working properly, set the 5335A to its FREERUN mode. Follow the procedure in paragraph 8-406. Verify the signatures in *Figure 8-96*.

8-499. If A11U19 and U20 input signatures are not correct, trace back to the microprocessor system signatures in A4; see *Table 8-15*. If input signatures are good, but output signatures are bad, suspect U14, U15, U16, U17, U18, U24, and last, U19 and U20.

8-500. Trigger Level Voltmeter Troubleshooting

8-501. This section of A11 is composed of A11U4 multiplexer, U10 voltage-to-frequency converter; it is referenced to a very precise +10 volts supply from A1 power supply assembly. U9B uses the precise +10 volt reference to generate a −5 volt reference used in both U10 and U4. See the Trigger Level Voltmeter Block Diagram, *Figure 8-97*.

8-502. To troubleshoot the Trigger Level DVM, first check U4 control bit pattern; Diagnostics #26 through #33 are used to set up these bit patterns. To enable these diagnostics, press:

a. SCALE, SMOOTH, 9, 9, ENTER; wait 5 seconds.

b. press: SCALE, (26 thru 33), ENTER

8-503. After entering SUPER CHECK, select any one of the diagnostics desired. Verify the bit patterns of A11U4 per *Table 8-36*.

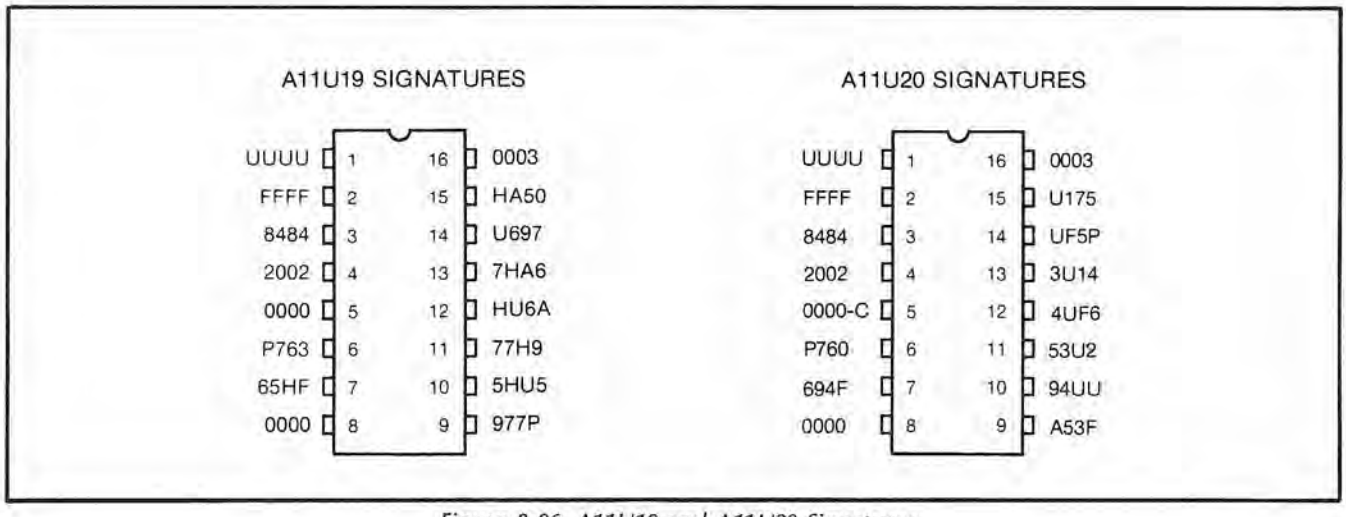


Figure 8-96. A11U19 and A11U20 Signatures

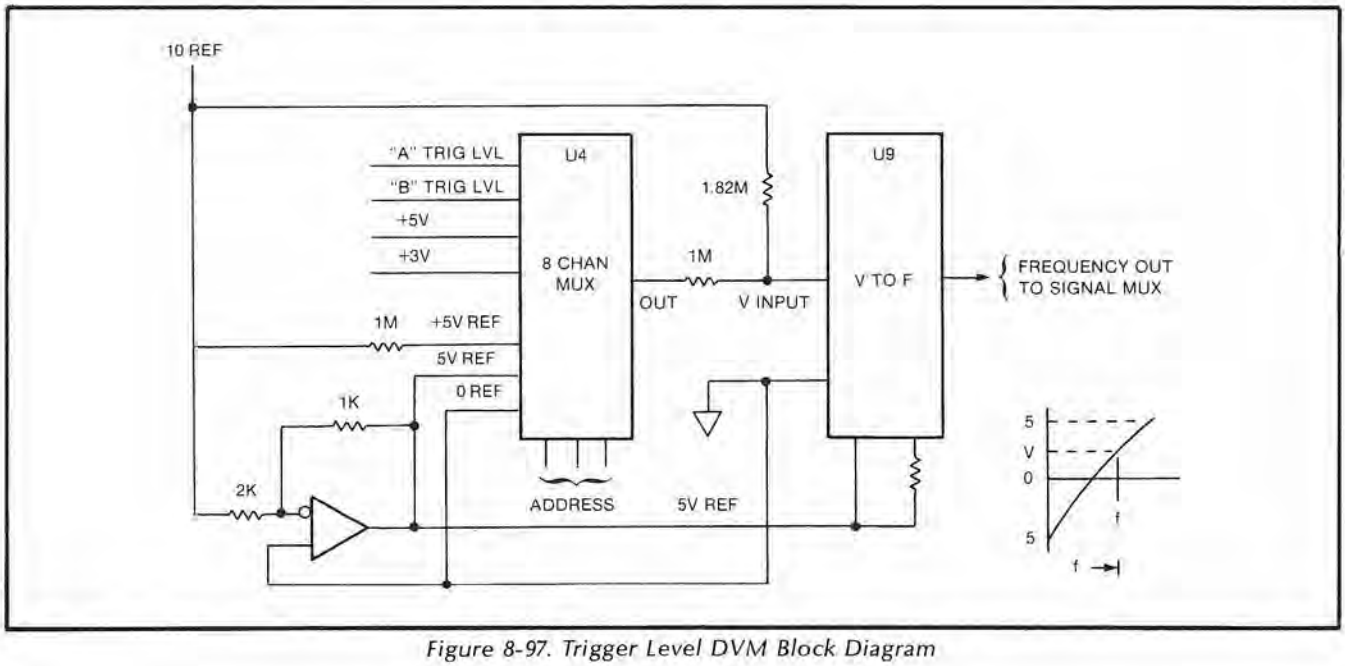


Figure 8-97. Trigger Level DVM Block Diagram

Table 8-36. A11U4 Analog Multiplexer Control Bits

U4(15) C5	U4(16) C4	U4(1) C6	FUNCTION	DIAG	APPROXIMATE FREQUENCY (at TP11)
0	0	0	Trig Lvl A	29	−5.2V 100 Hz 0V 1.87 kHz +5.2V 3.62 kHz
0	0	1	Trig Lvl B	30	Same as DIAG −29
0	1	0	+5V Supply	31	3.57 kHz
0	1	1	+5V Ref.	28	3.56 kHz
1	0	0	+3V Supply	32	2.83 kHz
1	0	1	Gnd. Ref.	27	1.86 kHz
1	1	0	−5V Ref.	26	170 Hz
0	0	0	−5.2V Supply	33	90 Hz

NOTE

"RANGE HOLD" must be set **ON** during these tests.

8-504. While in these diagnostics, with the RANGE HOLD function enabled, the 5335A will display the actual frequency that is counted in the MRC, out of A11U10(10). The approximate frequency given in the previous table will vary from unit to unit.

8-505. In Diagnostic #33 the microprocessor selects U4(4) which is TRIGGER LEVEL A, and A11U2(7), which is the −5.2 volt supply.

Table 8-37. Input Voltage vs Output Frequency

U4(8) Input Voltage (V)	Output Frequency (Hz) TP11
−5	162
−4	515
−3	874
−2	1.18K
−1	1.52K
0	1.86K
+1	2.21K
+2	2.54K
+3	2.88K
+4	3.22K
+5	3.56K

NOTE

The output frequency will vary slightly from instrument to instrument. The above table is for information **ONLY**, and gives only an approximation of the voltage-to-frequency relationship.

NOTE

The +10V reference from A1 assembly should be verified to be within **±0.01V** before troubleshooting the trigger level DVM, since this reference is not correct, the trigger level DVM will not operate correctly.

8-506. If A11U4 bit patterns are verified and U4 input and output correlates, but no corresponding frequency (per *Table 8-37*) at TP11 [U10(10)], suspect U10 or level translator U8. If everything checks out through the Trigger Level DMV, then check out A11U7, the signal selector multiplexer and associated circuitry.

8-507. Signal Selector Multiplexer Troubleshooting

8-508. A11U7 is a dual 4-to-1 Multiplexer, and it selects which signal is counted into the MRC by way of the microprocessor; the control bits originates in the A11U14, and they are translated to ECL levels by U8. A11U12 is a divide-by-two flip-flop, (controlled by bit C6); used to extend Channel A frequency range for Frequency A, Ratio A/B, and Ratio C/A functions. See *Figure 8-98*.

8-509. The outputs of A11U7(2 & 15), TP13 and TP12, respectively, as a function of control bits C9 and C10 selected 5335A front panel function, are as listed in *Table 8-38*.

8-510. Prescaler Troubleshooting

8-511. A11U12 prescales input signal to Channel A by a factor of two. It is enabled by control bit C6, from U15(15). Refer to prescaler in *Figure 8-67*.

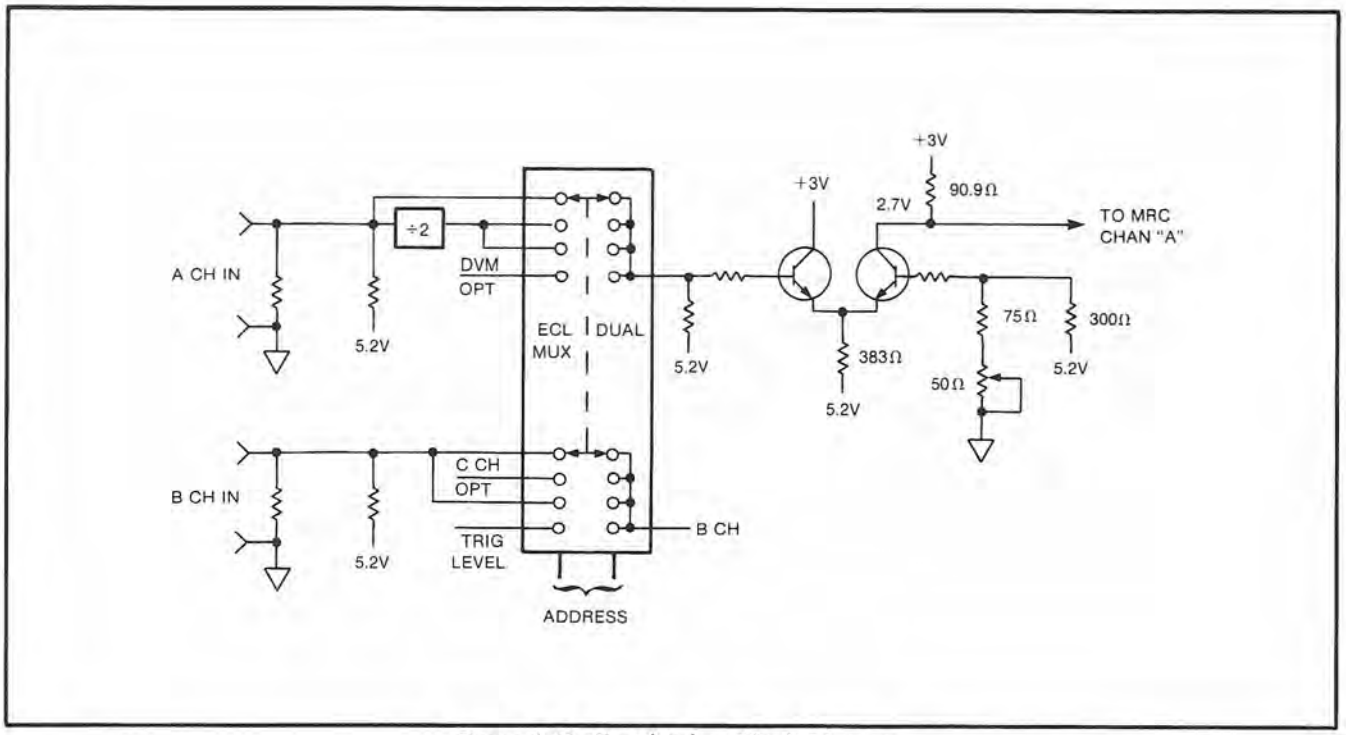


Figure 8-98. Signal Select Block Diagram

Table 8-38. A11U7 Outputs Related to Control Bits C9 and C10

PANEL FUNCTIONS	U15(15) C6	U14(7) C9	U14(10) C10	U7(2) X	U7(15) Y
FREQ A	0	0	1	A/2	B
TIME A→B	1	0	0	A	B
TOT A	1	0	0	A	B
RATIO A/B	0	0	1	A/2	B
FREQ C	0	1	0		C/20
1/TIME A→B	1	0	0	A	B
PULSE A	1	0	0	A	B
RATIO C/A	0	1	0	A/2	C/20
PER A	1	0	0	A	B
RISE A (⎍)	1	0	0	A	A
FALL A (⎏)	1	0	0	A	A
SLEW A (⎍.)	1/0	0/1	0/1	A/DVM	B/Trig Lvl
SLEW A (⎏)	1/0	0/1	0/1	A/DVM	B/Trig Lvl
DUTY CYCLE A	1	0	0	A	B
GATE TIME	SAME AS PRECEDING FUNCTION				
TRIG LVL	0	1	1	DVM	Trig Lvl
VOLTS	0	1	1	DVM	Trig Lvl
PHASE A rel B	0/1	0	1/0	A/DVM	B/Trig Lvl
FREQ B (17)	0	0	1	A/2	B
TIME B→A (18)	1	0	0	A	B
TOT A–B (19)	1	0	0	A	B
PULSE B (20)	1	0	0	A	B

8-512. A12 INPUT AMPLIFIER TROUBLESHOOTING

8-513. The A12 Amplifier Buffer Assembly consist of Input Offset buffer, the Bridge Limiter, the Peak Detectors, and the Amplifier Schmitt, for both channels A and B.

8-514. Input Offset Buffer Troubleshooting

8-515. The Input Offset Buffer is a split band amplifier, one path buffering the high frequency signals, and the other buffers the low frequency signals (below 10 kilohertz). To troubleshoot the Input Offset Buffer, check the **dc values** at key points, such as:

CHANNEL A

A12U4 pins 2, 3 and 6 (inputs and output),
A12U4 pins 1 and 8 (both sides of C35)
A12Q9, Q10, and Q11 (base emitter collector)

8-516. This check **MUST** be done with **NO INPUT SIGNAL** and **AUTO TRIG** disabled; typical values are shown in *Figure 8-99.*

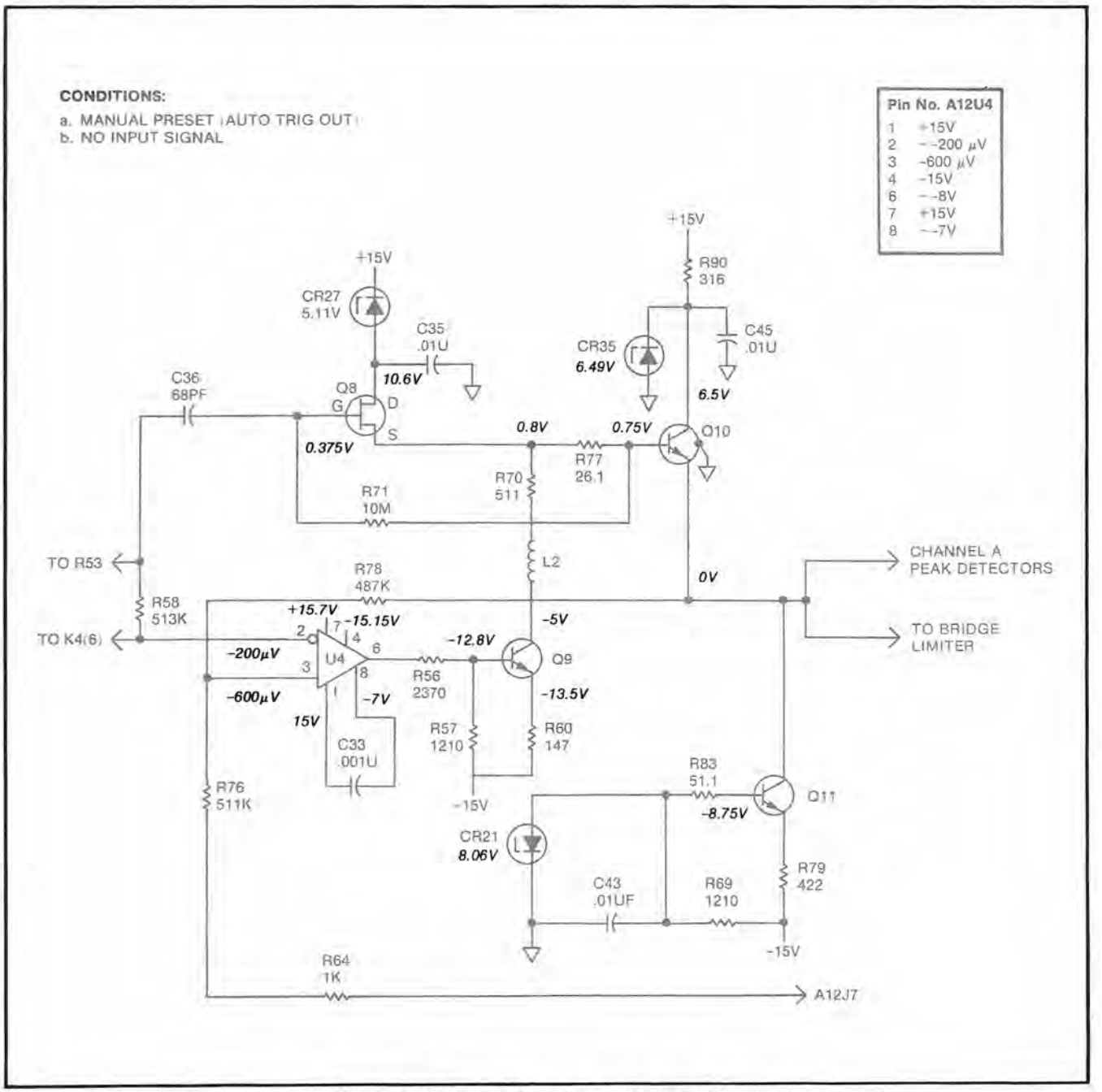


Figure 8-99. Channel A Input Buffer DC Voltages

8-517. These dc values are **very** critical for maintaining the Q points of A12U4 (Channel A) and A12U3 (Channel B). If the values are not present, suspect A12U4, Q8, Q9, Q10, and Q11 (for Channel A). The Input Offset Buffer circuitry for Channel B is identical to Channel A, and it could be used for comparison basis.

8-518. Peak Detectors Troubleshooting

8-519. The Peak Detector circuitry is designed to be used during the AUTO TRIG mode only; they are used to detect the maximum amplitude of the input signal, and the microprocessor will figure out the 10%, 50% and 90% points of input signal, through A11U2 and A11U11. There are two peak detectors per channel: a positive and a negative peak detector. During manual mode of operation, the positive and negative peak detectors are tied to ±5.2 volts, respectively. The diodes used in the peak detectors are a closely matched set. Refer to Section VI for the part number of the four matched diodes.

8-520. The peak detectors in the A12 assembly complements the channels A and B Trigger Level selector multiplexers, and the peak detector enabling circuitry, which are located in the A11 Amplifier Support assembly. *Figure 8-100* is the Peak Detector Block Diagram.

8-521. The peak detector circuits are contained in two assemblies: in A12 Amplifier Buffer assembly and in A11 Amplifier Support assembly. The peak detectors themselves are located in the A12 Assembly. The signals that enable and disable the peak detectors originate on the A11 assembly, U15 through U1A, B, C, and D. *Table 8-39* lists the signals that control the peak detectors.

Table 8-39. Peak Detector Control Signals

PEAK DETECTOR CONDITION U1 (PIN)	SIGNALS AND INTEGRATED CIRCUITS			
	ANE (8)	APE (14)	BNE (1)	BPE (7)
ENABLED	−12.5V	+15.0V	−12.5V	+15.0V
DISABLED	+5.2V	−5.2V	+5.2V	−5.2V

ANE = "A" NEGATIVE ENABLE (Enables channel A Positive Peak Detector)
APE = "A" POSITIVE ENABLE (Enables channel A Negative Peak Detector)
BNE = "B" NEGATIVE ENABLE (Enables channel B Positive Peak Detector)
BPE = "B" POSITIVE ENABLE (Enables channel B Negative Peak Detector)

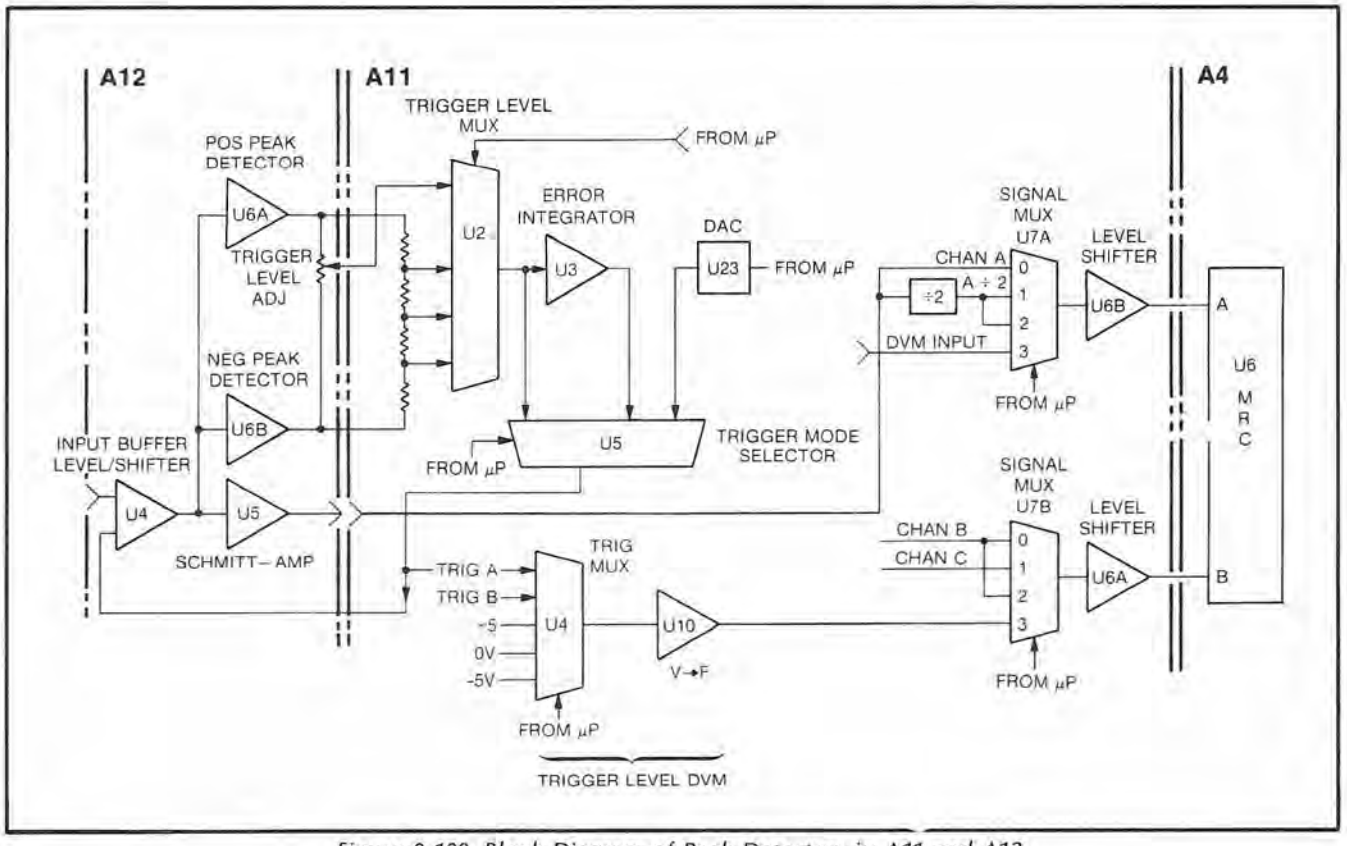


Figure 8-100. Block Diagram of Peak Detectors in A11 and A12

8-522. A12 Troubleshooting Accessories

8-523. To facilitate the troubleshooting of the A12 assembly (outside the counter) procure the following accessories:

a. Two multiribbon cable assembly, P/N 8120-2463.

b. Two 50-ohm cable assembly, P/N 05335-60112.

c. Two SMC male-to-male adapter, P/N 1250-0827.

8-524. A12 Troubleshooting Out-of-Cabinet Setup

a. Remove the A12 assembly from mainframe.

b. Replace both multiribbon cable assembly 8120-2867 with longer version, P/N 8120-2463.

c. Connect two 50-ohm cable assemblies end-to-end, P/N 05335-60112, with a SMC male-to-male adapter, P/N 1250-0827, for both channels A and B. These new connections will facilitate access to key points in the A12 assembly.

8-525. Troubleshooting Peak Detectors in Manual Mode

8-526. To troubleshoot the Peak Detectors, first check their operation in MANUAL mode. To do this, set the 5335A Auto Trigger mode to the OFF condition. Enable TRIG LVL function, and vary the front panel trigger level controls for both channels from ccw to cw positions. The displayed voltage for both channels should be between ±5.2 volts; the key point is that both peak detectors should display the same readings, ±10 millivolts.

8-527. In the manual mode, the peak detector outputs are tied to ±5.2 volts; Verify this voltage at TP "ATL" or at A11U5(8), the ATL line, by varying the channel A trigger level pot on the 5335A front panel. If voltage is not present, back trace through A11U5, A11U2 (channel A trigger level selector), to the APL line.

8-528. Also, verify that peak detectors are truly disabled; check A11U1(8), (14), (1), (7).

8-529. When checking the forward voltage drop of the peak detector diodes, verify that all diodes within each peak detector are matched to within less than 5 mV; if they are not, replace all three diodes.

8-530. Troubleshooting Peak Detectors in Auto Mode

8-531. To troubleshoot peak detectors in AUTO mode, apply a 1 kHz square wave of 500 mV p-p to the 5335A INPUT A. See *Figure 8-101*. Set the 5335A to AUTO TRIG, and COM A, 50 ohms, X1, dc coupling.

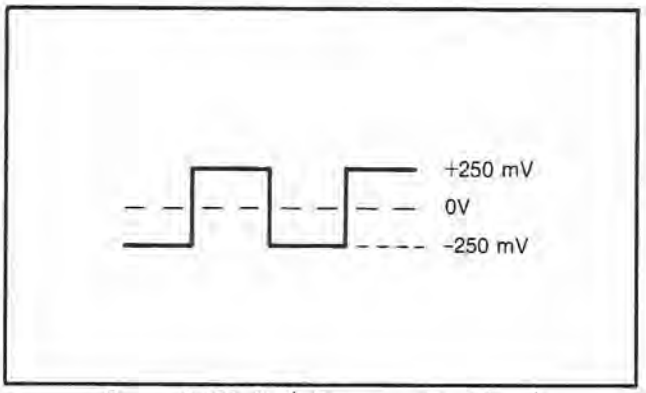


Figure 8-101. Peak Detectors Test Signal

a. Enable TRIG LVL function; rotate the trigger level controls for channel A and B to the ccw position (not in PRESET). Observe the 5335A displaying the peak of signal, –0.24V ±0.01V. Rotate the trigger level pots to the full cw position and verify a display of +0.24 ±0.01 volt.

b. Ground the ATL line (connect a jumper from either side of A12R64 to ground). This will force a feedback trigger level of zero volts to A12U4(3), and remove the effect of the peak detectors back into A12U4.

c. Rotate both trigger level pots to the ccw position.

d. Verify the APD line (channel A positive peak detector output) and AND line (channel A negative peak detector output), reflect the true peaks of signal, i.e., about +230 mV ±10 mV, and –230 mV ±10 mV, respectively. If this voltage is not present, check the voltages of A12U6 per *Figure 8-102* (in volts).

e. To obtain the readings of A12U1 as listed above, ground the BTL line (connect a jumper from either side of A12R47 to ground).

f. If these voltages are not attained, verify that the peak detectors are fully enabled by A11U1. If they are not fully enabled, suspect A11U1. If they are enabled by proper voltage, try adjusting peak detectors; refer to adjustment procedure in Section V.

g. If they cannot be adjusted, suspect A12U6; also replace matched set of diodes A12CR31, CR32 and CR36 ("A" positive peak detector), A12CR33, CR34, CR37 ("A" negative peak detector), C52, C53, C55, C55, C55, C59.

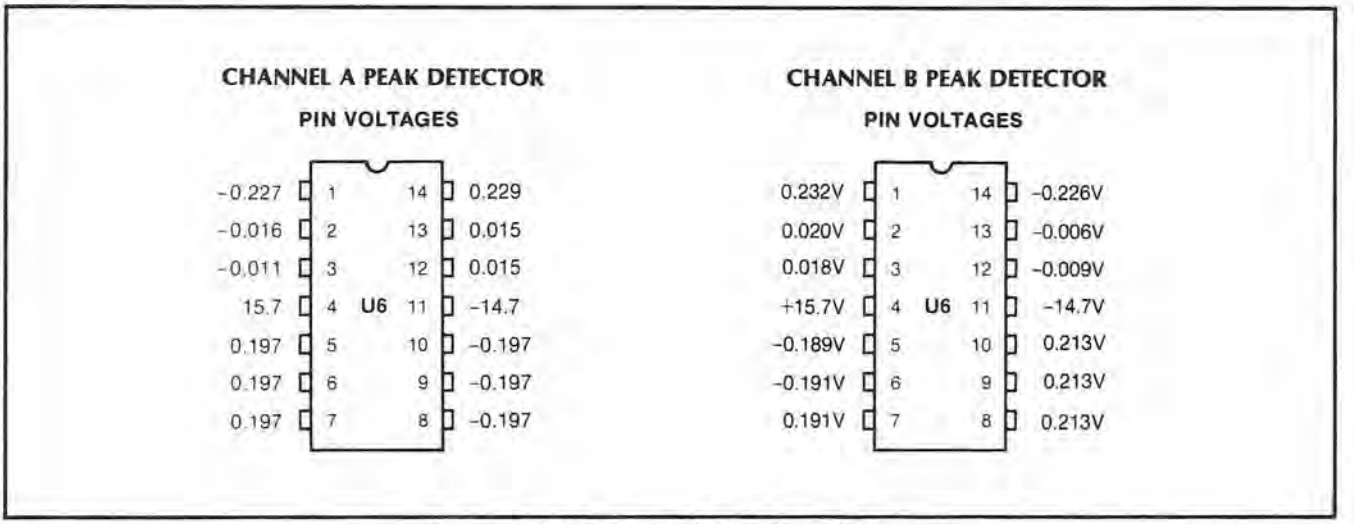


Figure 8-102. A12U6 and A12U1 Pin Voltages

8-532. Schmitt Amplifier Troubleshooting

8-533. The best way to verify the proper operation of the Schmitt amplifier is by checking its hysteresis. Refer to Input Amplifier adjustment procedure. The amplifier must be adjustable to between 18 and 20 mV peak-to-peak; refer to paragraphs 8-398 and 8-400 if amplifier cannot be adjusted to these limits; also suspect A12U5 (channel A) or A12U2 (channel B).

8-534. Bridge Limiter Troubleshooting

8-535. The bridge limiter is composed of A12CR25, 26, 29, 30, and it serves to protect the A12U5 Schmitt amplifier (Channel A) from overvoltage without distorting the signal on the receiving end.

8-536. Check that the forward voltage drop across each diode is matched within less than 5 mV of each other.

8-537. The four diodes are a closely matched set, and if one or more diode has to be replaced, all four MUST be replaced; see Section VI.

8-538. DIAGRAMS AND PHOTOS

8-539. Block Diagrams, schematic diagrams, and component locator photographs for physical assemblies in the 5335A are on the following foldout pages.

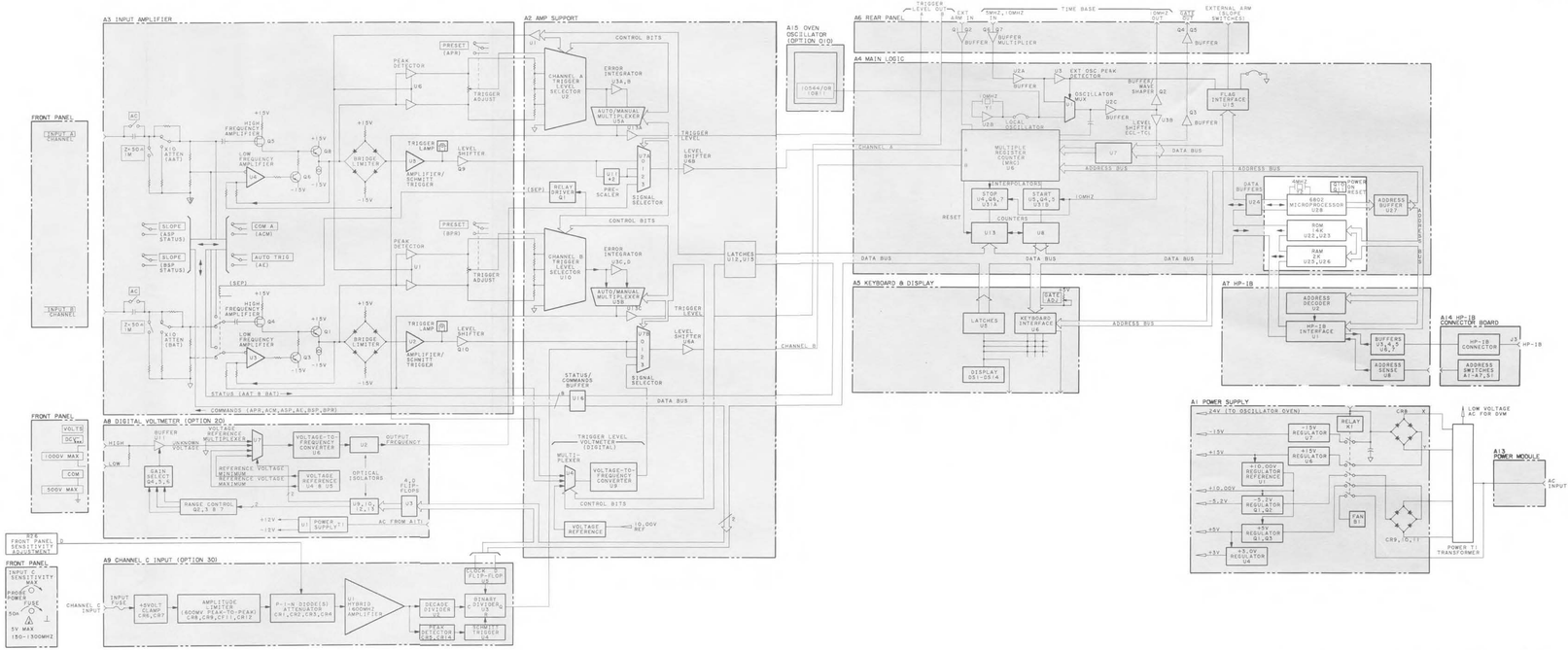


Figure 8-103. 5335A Block Diagram with Options 010, 020, and 030

Figure 8-103
5335A BLOCK DIAGRAM WITH OPTIONS 010, 020, AND 030

(See Page 8-97)

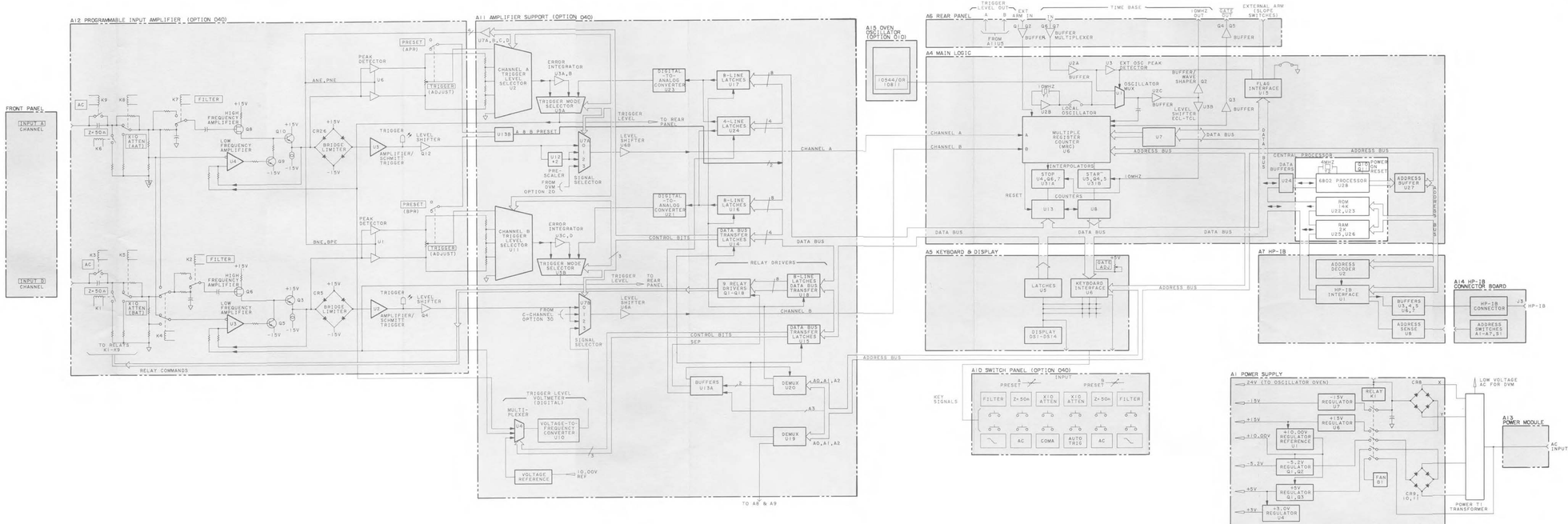


Figure 8-104. 5335A Block Diagram with Option 040

Figure 8-104
5335A BLOCK DIAGRAM WITH OPTION 040

(See Page 8-99)

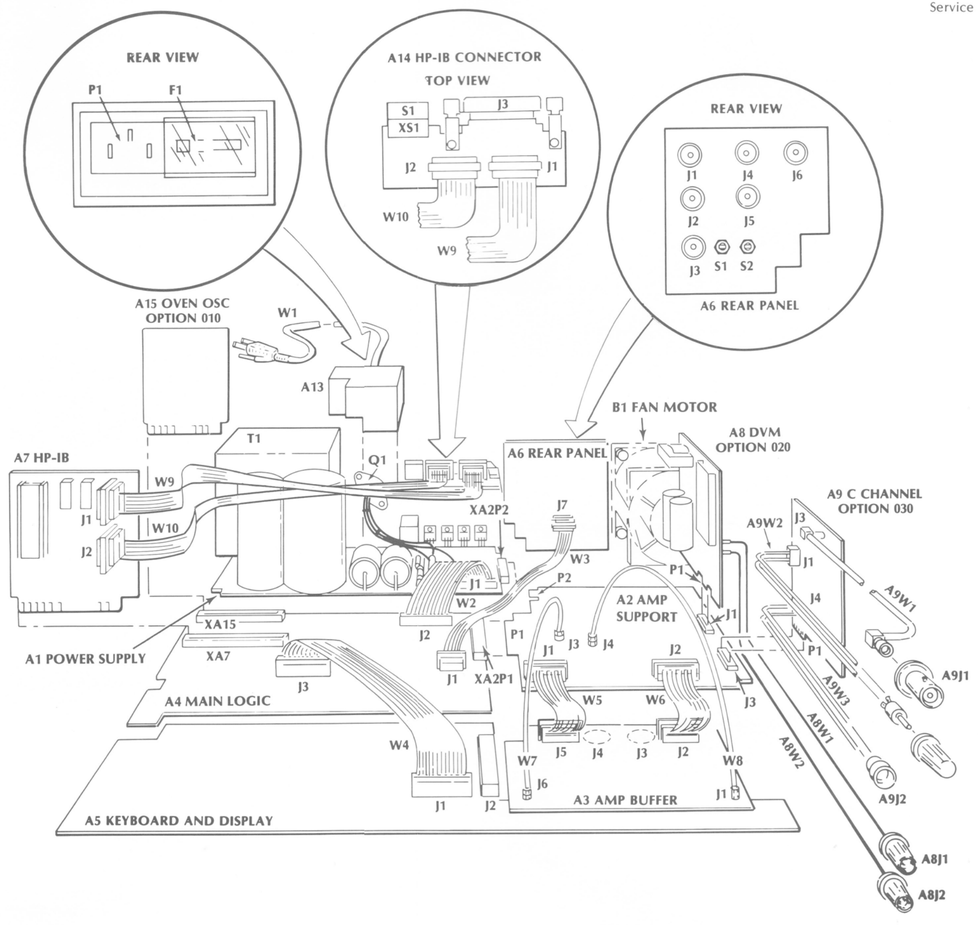


Figure 8-105. Assembly and Cable Locator with Options 010, 020, and 030

Figure 8-105
ASSEMBLY AND CABLE LOCATOR WITH OPTIONS 010, 020, AND 030

(See Page 8-101)

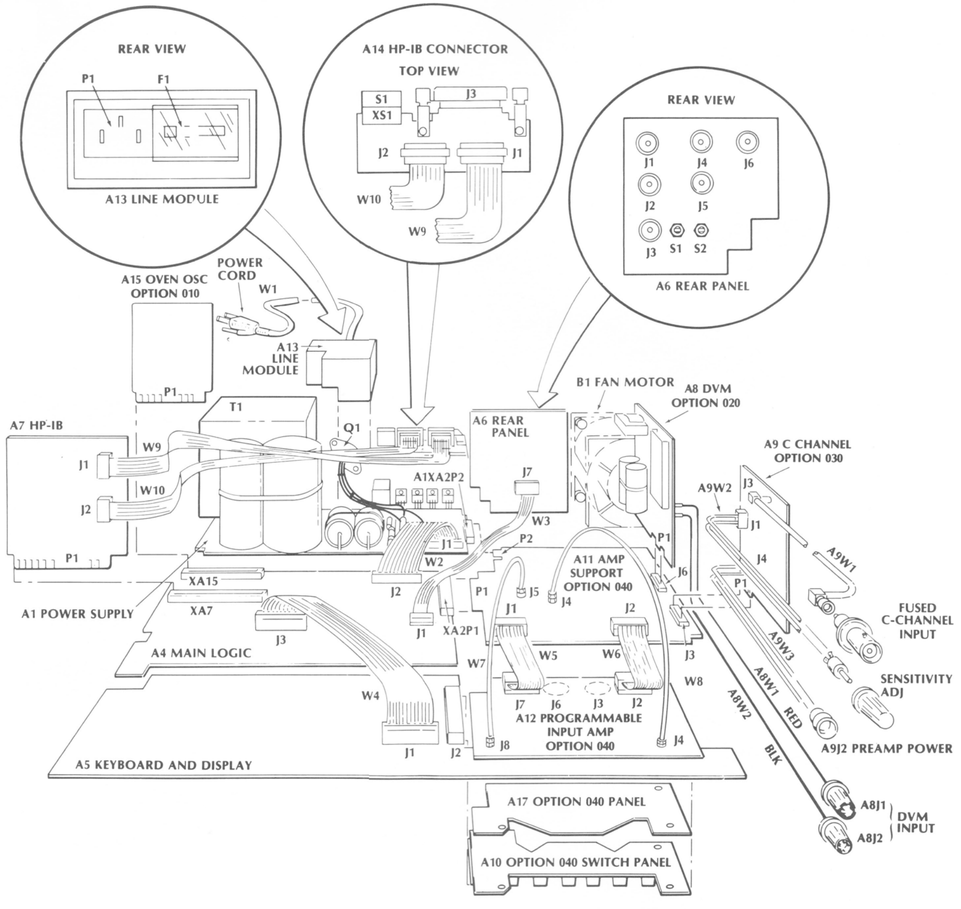
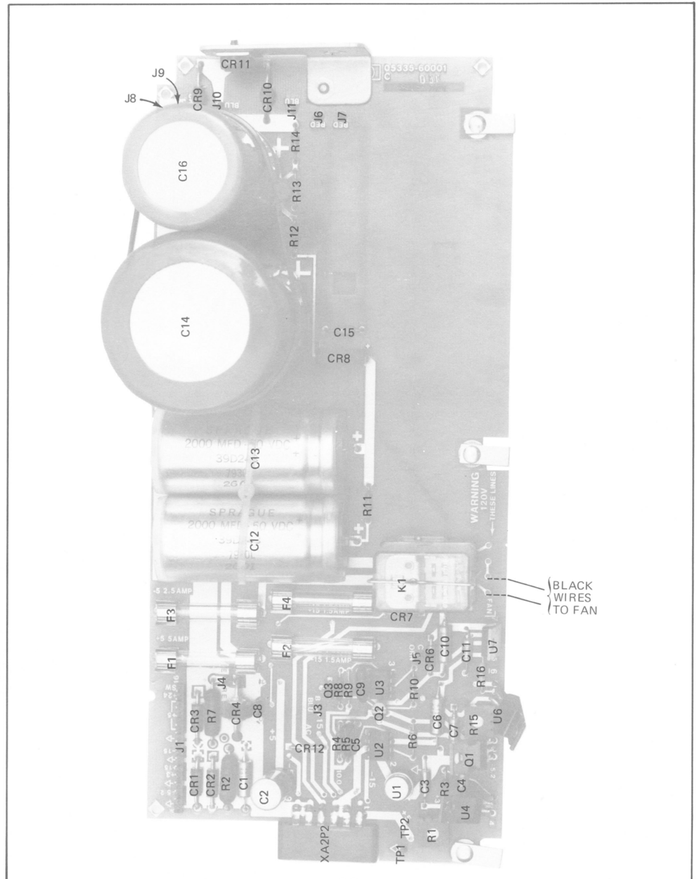


Figure 8-106. Assembly and Cable Locator with Option 040



Part of Figure 8-107. A1 Power Support and A13 Line Module Assembly

Figure 8-106
ASSEMBLY AND CABLE LOCATOR WITH OPTION 040

(See Page 8-103)

NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR A COMPLETE REFERENCE DESIGNATION.
2. UNLESS OTHERWISE INDICATED:
   RESISTANCE IN OHMS
   CAPACITANCE IN FARADS
   INDUCTANCE IN HENRIES
3. ASTERISK (*) INDICATES FACTORY SELECTED COMPONENT VALUE. AVERAGE VALUE SHOWN. PART MAY NOT BE IN ALL INSTRUMENTS.

A1 REFERENCE DESIGNATORS

A1C1-C16
A1CR1-CR4, CR6-CR12
A1F1-F4
A1J1-J11
A1K1
A1Q1-Q3
A1R1-R16
A1TP1,TP2
A1U1-U7

A1 ACTIVE COMPONENTS

REFERENCE	HP PART NO.
A1CR1,CR3	1902-0522
A1CR2	1902-0632
A1CR4	1901-0662
A1CR5	NOT ASSIGNED
A1CR6	1901-0731
A1CR7,CR12	1901-0050
A1CR8	1906-0096
A1CR9,CR10	1901-0673
A1CR11	1906-0213
A1Q1	1853-0454
A1Q2	1853-0036
A1Q3	1854-0215
A1U1	1826-0216
A1U2,U3	1820-0477
A1U4	1826-0393
A1U5	NOT ASSIGNED
A1U6	1826-0607
A1U7	1826-0214

CONNECTOR PIN TABLES:

A1–A2 CONNECTIONS

A1XA2	A2P2	DESCRIPTION
1	1	+5 Volts
2	2	GROUND
3	3	GROUND
4	4	AC DVM Supply
5	5	GROUND
6	6	GROUND
7	7	-15 Volts
8	8	+10 Volt Reference
9	9	+15.7 Volts
10	10	AC DVM Supply
11	11	GROUND
12	12	-5.2 Volts

A1–A4 CONNECTIONS

A1J1	A4J2	DESCRIPTION
1	1	GROUND (Clean)
2	2	N.C. (Key)
3	3	-5.2 Volts
4	4	GROUND (Clean)
5	5	+3 Volts
6	6	+15 Volts
7	7	GROUND
8	8	-15 Volts
9	9	GROUND
10	10	GROUND
11	11	+5 Volts
12	12	+5 Volts
13	13	+5 Volts
14	14	+5 Volts
15	15	+24 Volts (to Osc)
16	16	+24 Volts - Power Switch

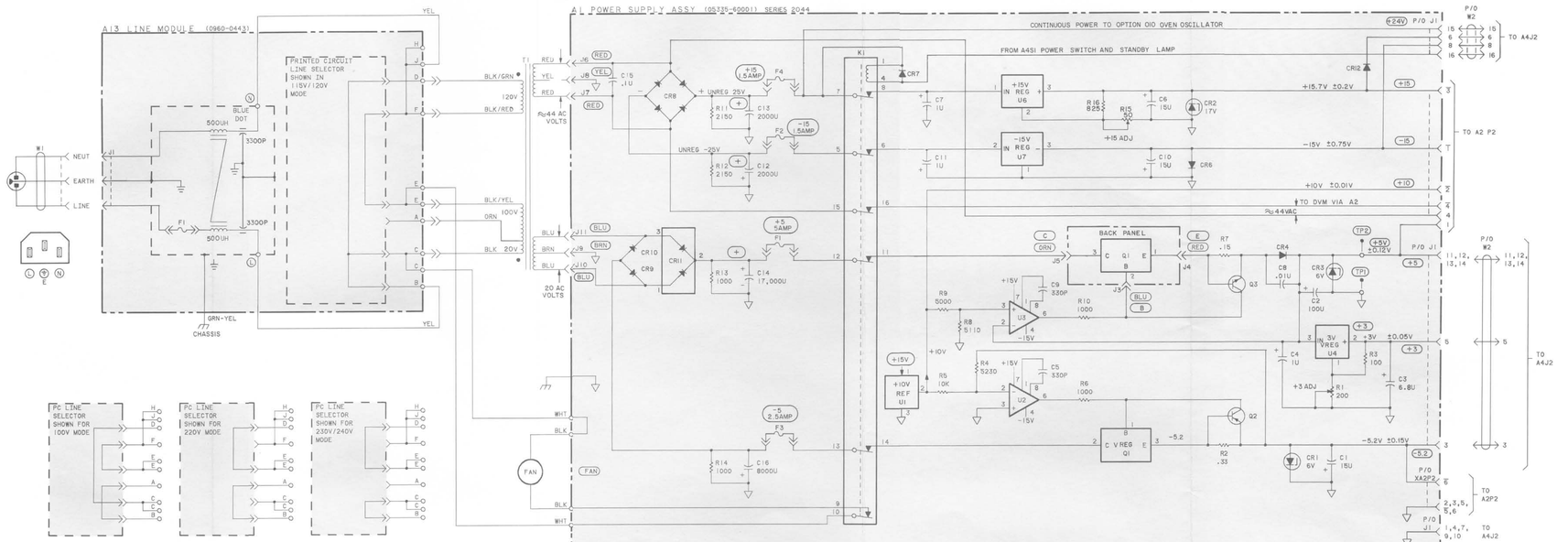
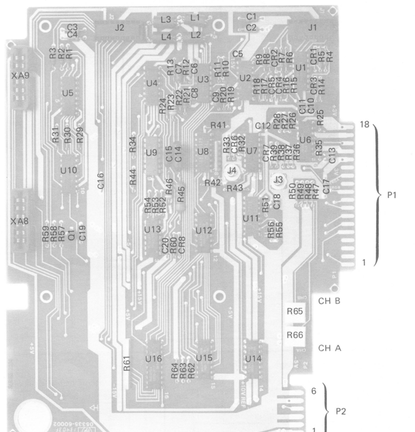


Figure 8-107. A1 Power Supply Assembly and A13 Line Module

Figure 8-107
A1 POWER SUPPLY ASSEMBLY AND A13 LINE MODULE

(See Page 8-105)



A2

Part of Figure 8-108. A2 Amplifier Support Assembly

NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR A COMPLETE REFERENCE DESIGNATION.
2. UNLESS OTHERWISE INDICATED:
   RESISTANCE IN OHMS
   CAPACITANCE IN FARADS
   INDUCTANCE IN HENRIES
3. ASTERISK (*) INDICATES FACTORY SELECTED COMPONENT VALUE. AVERAGE VALUE SHOWN. PART MAY NOT BE IN ALL INSTRUMENTS.
4. W7 AND W8 ARE 50-OHM COAXIAL CABLES.

A2 REFERENCE DESIGNATORS

A2C1-C20
A2CR1-CR8
A2J1-J4
A2L1-L4
A2Q1
A2R1-R66
A2U1-U16
A2W1,W2

A2 ACTIVE COMPONENTS

REFERENCE	HP PART NO.
A2CR1,CR2	1901-0376
A2CR3,CR5,CR8	1901-0050
A2CR6,CR7	NOT ASSIGNED
A2Q1	1854-0246
A2U1,U3,U13	1826-0315
A2U2,U4,U10	1826-0609
A2U5	1826-0610
A2U6	1858-0040
A2U7	1820-1359
A2U8	1820-1173
A2U9	1826-0575
A2U11	1820-0794
A2U12,U15	1820-1196
A2U14	1820-1240
A2U16	1820-1917

CONNECTOR PIN TABLES:

A2--A1 CONNECTIONS

A2P2	A1XA2	DESCRIPTION
1	1	+5 Volts
2	2	GROUND
3	3	GROUND
4	4	AC DVM Supply
5	5	GROUND
6	6	GROUND
1	1	+15 Volts
2	2	+10 Volt Reference
3	3	+15.7 Volts
4	4	AC DVM Supply
5	5	GROUND
6	6	-5.2 Volts

A2--A3 CONNECTIONS

A2	A3	DESCRIPTION
		SEE A3 PAGE 8-109

A2--A4 CONNECTIONS

A2P1	A4XA2P1	DESCRIPTION
1	1	LAOE
2	2	R/W (not used)
3	3	A5 (not used)
4	4	A4 (not used)
5	5	A3
6	6	D7
7	7	D5
8	8	D3
9	9	D1
10	10	BTL
11	11	NC
12	12	ATL
13	13	NC
14	14	+3 Volts
15	15	CH B to MRC
16	16	+3 Volts
17	17	CH A to MRC
18	18	+3 Volts
1	1	L-VMAE
2	2	LBOE (not used)
3	3	A2
4	4	A1
5	5	A0
6	6	D6
7	7	D4
8	8	D2
9	9	D0
10	10	GROUND
11	11	NC
12	12	NC
13	13	NC
14	14	+3 Volts
15	15	+3 Volts
16	16	+3 Volts
17	17	+3 Volts
18	18	+3 Volts

A2--A8 CONNECTIONS

A2XA8	A8P1	DESCRIPTION
1	1	GROUND
2	2	AC Supply (18.5V rms)
3	3	ENABLE
4	4	+5 Volts
5	5	GROUND (Option IN)
6	6	GROUND
1	1	DVM Output (Freq)
2	2	AC Supply (18.5V rms)
3	3	Data Line 5
4	4	Data Line 6
5	5	Data Line 7
6	6	Data Line 4

A2--A9 CONNECTIONS

A2XA9	A9P1	DESCRIPTION
1	1	GROUND
2	2	ENABLE
3	3	+15.7 Volts
4	4	Channel C Output
5	5	-5.2 Volts
6	6	GROUND
1	1	NC
2	2	NC
3	3	NC
4	4	+5 Volts
5	5	D6
6	6	D7

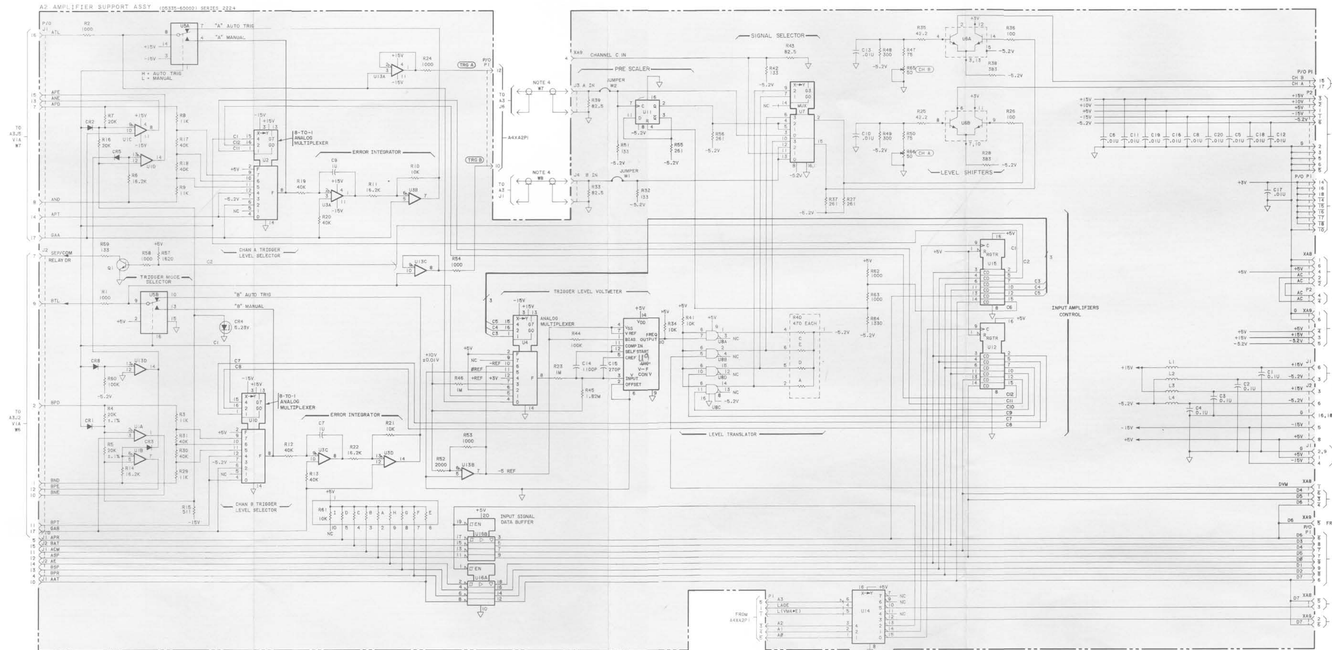
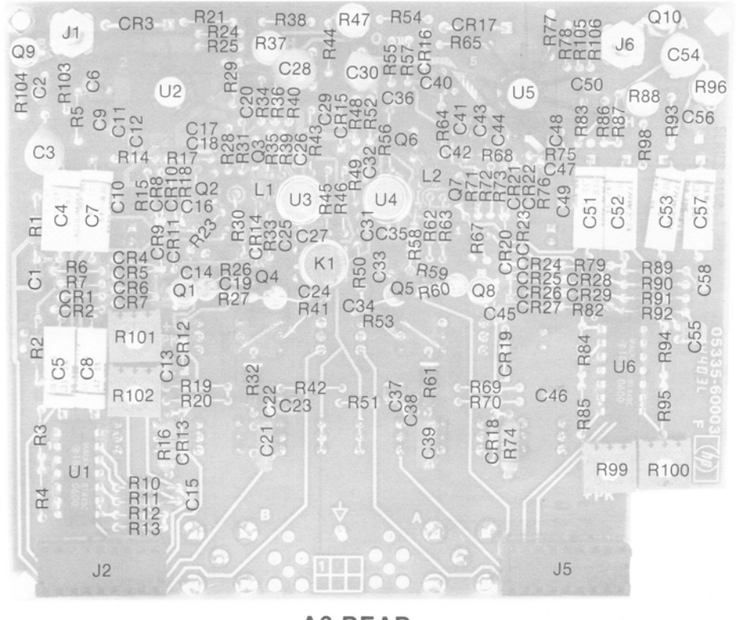


Figure 8-108. A2 Amplifier Support Assembly

A3 FRONT



A3 REAR

Part of Figure 8-109. A3 Input Amplifier Buffer Assembly

Figure 8-108
A2 AMPLIFIER SUPPORT ASSEMBLY

(See Page 8-107)

NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR A COMPLETE REFERENCE DESIGNATION.
2. UNLESS OTHERWISE INDICATED:
   RESISTANCE IN OHMS
   CAPACITANCE IN FARADS
   INDUCTANCE IN HENRIES
3. ASTERISK (*) INDICATES FACTORY SELECTED COMPONENT VALUE. AVERAGE VALUE SHOWN. PART MAY NOT BE IN ALL INSTRUMENTS.
4. MATCHED SETS OF DIODES; CR1,4,5,; CR2,6,7; CR8-11; CR20-23; CR24,25,28; CR26,27,29.
5. R1, R11, R89; & R90 ALTERNATE VALUE IS 3.16M.
6. PIN CONNECTIONS FOR ACTIVE ELEMENTS:

BOTTOM VIEWS

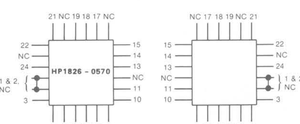
Q4, Q5

Q2, Q3, Q6, Q7

Q1, Q8

S2 -S10, S12

7. A3U5 AND U2 PIN DESIGNATION: PINS 1, 2, 6, 8, 12, 16, 20, 23 ARE NOT CONNECTED.



TOP VIEW BOTTOM VIEW

U2 AND U5

A3 REFERENCE DESIGNATORS

A3C1-C58, C60
A3CR1-CR29
A3DS1, DS2
A3J1-J6
A3K1
A3L1,L2
A3Q1-Q10
A3R1-R6,R9-R79,R82-R106
A3S1-S12
A3U1-U6

A3 ACTIVE COMPONENTS

REFERENCE	HP PART NO.
A3CR1,CR4,CR5	05335-80003*
A3CR2,CR6,CR7	05335-80003*
A3CR3	NOT ASSIGNED
A3CR8-CR11	05335-80003*
A3CR12,CR19	1902-0041
A3CR13,CR18	1902-0057
A3CR14	1901-0050
A3CR15,CR16	1902-3136
A3CR17	1901-1080
A3CR20-CR23	05335-80003*
A3CR24,CR25,CR28	05335-80003*
A3CR26,CR27,CR29	05335-80003*
A3DS1,DS2	1990-0487
A3Q1,Q8-Q10	1854-0686
A3Q2,Q3,Q6,Q7	1854-0636
A3Q4,Q5	1855-0300 or 1855-0212
A3U1,U6	1826-0600
A3U2,U5	1826-0570
A3U3,U4	1826-0035

*Matched Set of Four Diodes

NOTES

CONNECTOR PIN TABLES:

CONNECTIONS A3 to A2

A3J1	A2J5	MNEMONIC	FUNCTION
(1)	(1)	+5	+5 Volt Supply
(2)	(2)	GND	Ground Return
(3)	(3)	-5.2	-5.2 Volt Supply
(4)	(4)	-15	-15 Volt Supply
(5)	(5)	APR	Ch "A" preset switch status (PRESET/non PRESET = 5V/0V)
(6)	(6)	+15	+15 volt supply
(7)	(7)	APD	Channel "A" positive peak detector output
(8)	(8)	AND	Channel "A" negative peak detector output
(9)	(9)	GND	Ground Return
(10)	(10)	AAT	Channel "A" Atten. 0V/5V = X10/X1
(11)	(11)	ACM	Channel A Common
(12)	(12)	ASP	Channel A Slope (/ = 5V/0V)
(13)	(13)	ANE	Channel A positive peak detector enable
(14)	(14)	APT	Channel A Trigger Level Pot
(15)	(15)	APE	Channel A Negative Peak Detector Enable
(16)	(16)	ATL	Trigger Level to A Channel
(17)	(17)	GAA	Analog Ground A Channel
(18)	(18)	N/C	
A3J2	**A2J2**		
(1)	(1)	BND	Channel B negative peak detector output
(2)	(2)	BPD	Channel B positive peak detector output
(3)	(3)	+15	+15 volt supply
(4)	(4)	BPR	Channel B preset switch status (PRESET/non PRESET = 5V/0V)
(5)	(5)	-15	-15 volt supply
(6)	(6)	-5.2	-5.2 volt supply
(7)	(7)	SEP	Common/separate relay (3.5V/15.5V = SEP/COM)
(8)	(8)	+5	+5 volt supply
(9)	(9)	BTL	Trigger Level to B Channel
(10)	(10)	BNE	Channel B positive peak detector enable
(11)	(11)	BPT	Channel B Trigger Level Pot
(12)	(12)	BPE	Channel B negative peak detector enable
(13)	(13)	BSP	Channel B Slope (/ = 5V/0V)
(14)	(14)	AE	AUTO TRIG enable (ON/OFF = 0V/5V)
(15)	(15)	BAT	Channel "B" Attenuator (0V/5V = X10/X1)
(16)	(16)	GND	Ground Return
(17)	(17)	GAB	Analog Ground B Channel
(18)	(18)	GND	Ground Return

A2J1 to A3J5 Channel A output
A2J2 to A3J2 Channel B output

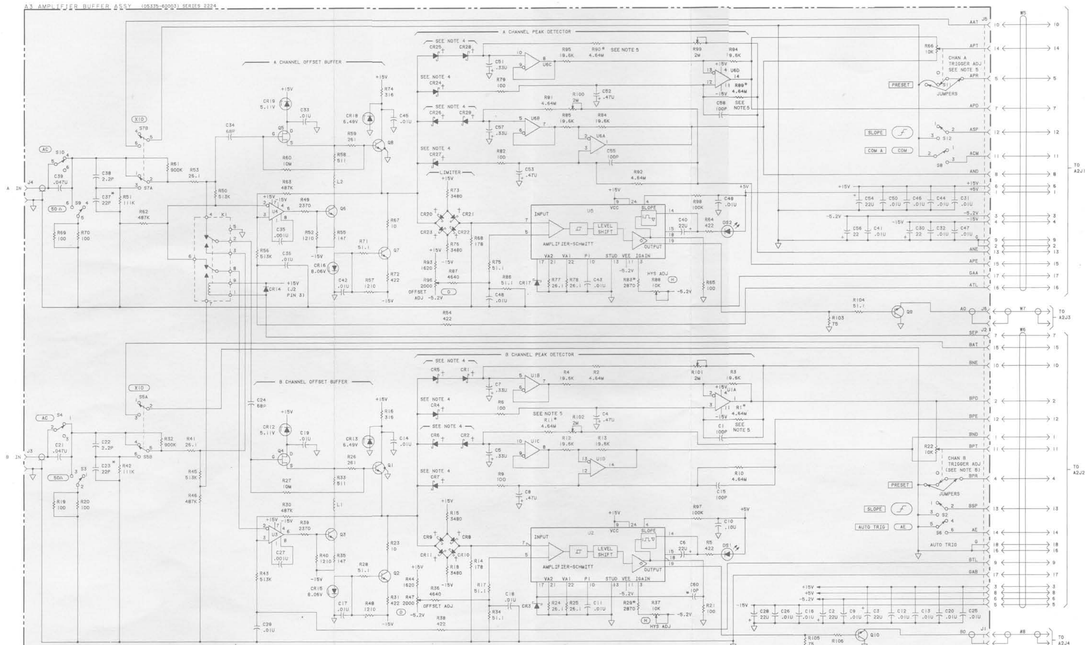
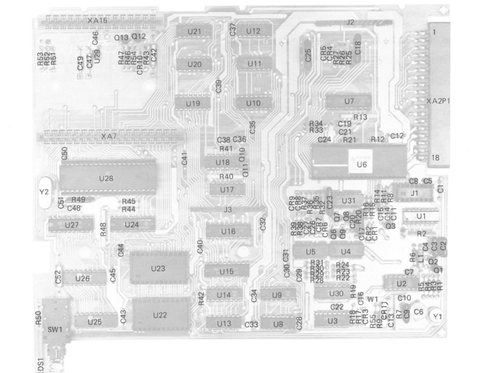


Figure 8-109. A3 Amplifier Buffer Assembly

Figure 8-109
A3 AMPLIFIER BUFFER ASSEMBLY

(See Page 8-109)



Part of Figure 8-110. A4 Main Logic Assembly

NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR A COMPLETE REFERENCE DESIGNATION.
2. UNLESS OTHERWISE INDICATED:
   RESISTANCE IN OHMS
   CAPACITANCE IN FARADS
   INDUCTANCE IN HENRIES
3. ASTERISK (*) INDICATES FACTORY SELECTED COMPONENT VALUE. AVERAGE VALUE SHOWN. PART MAY NOT BE IN ALL INSTRUMENTS.
4. WHEN TEST POINTS "D" AND "G" ARE SHORTED TOGETHER, DIAGNOSTIC 17 IS INVOKED.
5. JUMPER W1 MUST BE REMOVED WHEN OVEN OSCILLATOR (OPTION 010) IS INSTALLED.

A4 REFERENCE DESIGNATORS

A4C1-C52
A4CR1-CR11
A4DS1
A4J1-J3
A4Q1-Q3,Q6-Q13
A4S1
A4U1-U31
A4W1
A4Y1,Y2

A4 ACTIVE COMPONENTS

REFERENCE	HP PART NO.
A4CR1,CR2,CR4-CR9	1901-0050
A4CR3,CR10,CR11	1901-0535
A4DS1	1990-0627
A4Q1-Q3,Q10	1854-0215
A4Q4,Q5	NOT ASSIGNED
A4Q6-Q9	1853-0015
A4U1	1820-0802
A4U2	1820-0810
A4U3	1820-1052
A4U4,U5	1826-0210
A4U6	1820-2312
A4U7	1820-2075
A4U8,U13	1820-1989
A4U9,U14	1820-1438
A4U10	1820-1281
A4U11	1820-1144
A4U12	1820-1416
A4U15,U27	1820-2024
A4U16,U24	1820-2866
A4U17,U18	1820-1112
A4U19	1820-1240
A4U20	1820-1202
A4U21	1820-1197
A4U22	1818-1249
A4U23	1818-1250
A4U25,U26	1818-0381
A4U28	1820-2099
A4U29	1826-0275
A4U30	1858-0040
A4U31	1858-0063
A4Y1	0410-0423
A4Y2	0410-0465

NOTES

CONNECTOR PIN TABLES:

A4–A1 CONNECTIONS

A4J2	A1J1	DESCRIPTION
1	1	GROUND (Clean)
2	2	N.C. (Key)
3	3	-5.2 Volts
4	4	GROUND (Clean)
5	5	+3 Volts
6	6	+15 Volts
7	7	GROUND
8	8	-15 Volts
9	9	GROUND
10	10	GROUND
11	11	+5 Volts
12	12	+5 Volts
13	13	+5 Volts
14	14	+5 Volts
15	15	+24 Volts (to Osc)
16	16	+24 Volts - Power Switch

A4–A2 CONNECTIONS*

A4XA2P1	A2P1	DESCRIPTION
(1)	(1)	LAOE
(2)	(2)	R/$\overline{W}$ (not used)
(3)	(3)	A5 (not used)
(4)	(4)	A4 (not used)
(5)	(5)	A3
(6)	(6)	D7
(7)	(7)	D5
(8)	(8)	D3
(9)	(9)	D1
(10)	(10)	BTL
(11)	(11)	NC
(12)	(12)	ATL
(13)	(13)	NC
(14)	(14)	+3 Volts
(15)	(15)	CH B to MRC
(16)	(16)	+3 Volts
(17)	(17)	CH A to MRC
(18)	(18)	+3 Volts
(1)	(1)	LVMAE
(2)	(2)	LBOE (not used)
(3)	(3)	A2
(4)	(4)	A1
(5)	(5)	A0
(6)	(6)	D6
(7)	(7)	D4
(8)	(8)	D2
(9)	(9)	D0
(10)	(10)	GROUND
(11)	(11)	NC
(12)	(12)	NC
(13)	(13)	NC
(14)	(14)	+3 Volts
(15)	(15)	+3 Volts
(16)	(16)	+3 Volts
(17)	(17)	+3 Volts
(18)	(18)	+3 Volts

*See A11 Schematic for A4–A11 connections.

CONNECTOR PIN TABLES (CONTINUED):

A4–A5 CONNECTIONS

A4J3	A5P2	DESCRIPTION
1	1	GROUND (Clean)
2	2	N.C. (Key)
3	3	Data Line 5
4	4	Data Line 7
5	5	Data Line 4
6	6	Data Line 6
7	7	Data Line 0
8	8	Data Line 3
9	9	Data Line 1
10	10	Data Line 2
11	11	MTN
12	12	KB IRQ
13	13	E_2 (Key/Display Control)
14	14	E_1 (Key/Display Data Out)
15	15	E_0 (Keyboard Status)
16	16	+5V

A4–A7 CONNECTIONS

A4XA7	A7P1	DESCRIPTION	A4XA7	A7P1	DESCRIPTION
1	1	A1	$\overline{1}$	$\overline{1}$	A0
2	2	A3	$\overline{2}$	$\overline{2}$	A2
3	3	A5	$\overline{3}$	$\overline{3}$	A4
4	4	A7	$\overline{4}$	$\overline{4}$	A6
5	5	A9	$\overline{5}$	$\overline{5}$	A8
6	6	A11	$\overline{6}$	$\overline{6}$	A10
7	7	A13	$\overline{7}$	$\overline{7}$	A12
8	8	Reset	$\overline{8}$	$\overline{8}$	A14
9	9	E (1 MHz)	$\overline{9}$	$\overline{9}$	NMI
10	10	$\overline{IRQ}$	$\overline{10}$	$\overline{10}$	RAM Enable
11	11	VMA	$\overline{11}$	$\overline{11}$	VMA-E
12	12	R/$\overline{W}$	$\overline{12}$	$\overline{12}$	A15
13	13	GROUND	$\overline{13}$	$\overline{13}$	GROUND
14	14	+5V	$\overline{14}$	$\overline{14}$	-5.2V
15	15	D1	$\overline{15}$	$\overline{15}$	D0
16	16	D3	$\overline{16}$	$\overline{16}$	D2
17	17	D5	$\overline{17}$	$\overline{17}$	D4
18	18	D7	$\overline{18}$	$\overline{18}$	D6

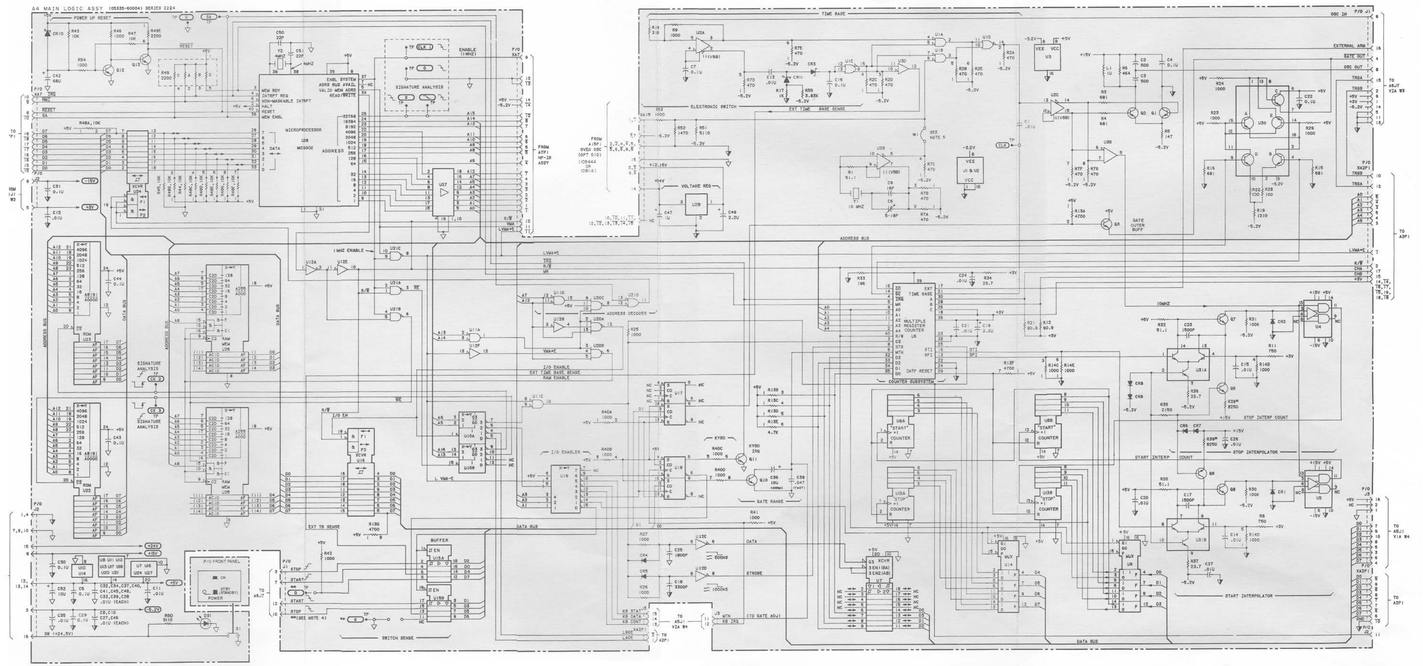
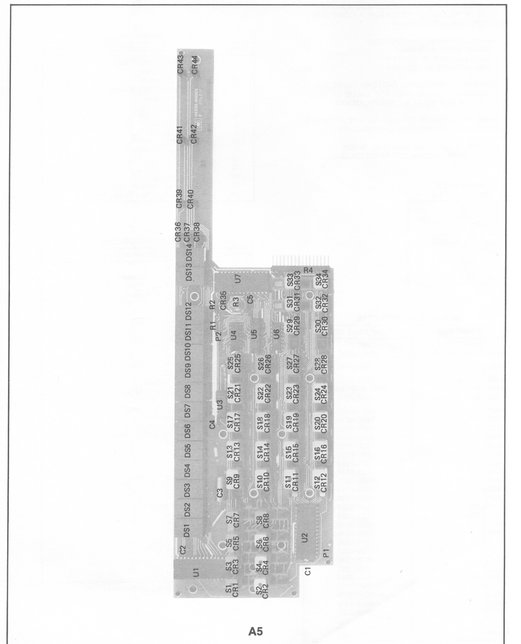


Figure 8-110. A4 Main Logic Assembly

Figure 8-110
A4 MAIN LOGIC ASSEMBLY

(See Page 8-111)



Part of Figure 8-111. A5 Keyboard and Display Assembly

NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR A COMPLETE REFERENCE DESIGNATION.
2. UNLESS OTHERWISE INDICATED:
   RESISTANCE IN OHMS
   CAPACITANCE IN FARADS
   INDUCTANCE IN HENRIES
3. ASTERISK (*) INDICATES FACTORY SELECTED COMPONENT VALUE. AVERAGE VALUE SHOWN. PART MAY NOT BE IN ALL INSTRUMENTS.

A5 REFERENCE DESIGNATORS

A5C2-C6
A5DS1-DS58
A5J1,J2
A5R1-R5
A5S1-S34
A5U1-U7
A5W1

A5 ACTIVE COMPONENTS

REFERENCE	HP PART NO.
A5DS1-DS12,DS14	1990-0574
A5DS13	1990-0681
A5DS15-DS48	1990-0851
A5DS49-DS58	1990-0486
A5U1,U2,U7	1820-2132
A5U3	1820-1207
A5U4	1820-1195
A5U5	1820-1858
A5U6	1820-1641

CONNECTOR PIN TABLES:

A5—A4 CONNECTIONS

A5P2	A4J3	DESCRIPTION
1	1	GROUND (Clean)
2	2	N.C. (Key)
3	3	Data Line 5
4	4	Data Line 7
5	5	Data Line 4
6	6	Data Line 6
7	7	Data Line 0
8	8	Data Line 3
9	9	Data Line 1
10	10	Data Line 2
11	11	MTN
12	12	KB IRQ
13	13	E_2 (Key/Display Control)
14	14	E_1 (Key/Display Data Out)
15	15	E_0 (Keyboard Status)
16	16	+5V

A5—A10 CONNECTIONS

A5J2	A10J1	DESCRIPTION
(1)	(1)	D6
(2)	(2)	N/C
(3)	(3)	D7
(4)	(4)	A5U2(2)
(5)	(5)	A5U2(26)
(6)	(6)	A5U2(4)
(7)	(7)	A5U2(24)
(8)	(8)	A5U2(20)
(9)	(9)	A5U2(21)
(10)	(10)	A5U2(22)
(11)	(11)	A5U3(1)
(12)	(12)	A5U3(4)
(13)	(13)	A5U3(6)
(14)	(14)	A5U3(2)
(15)	(15)	A5U3(3)
(16)	(16)	A5U3(5)

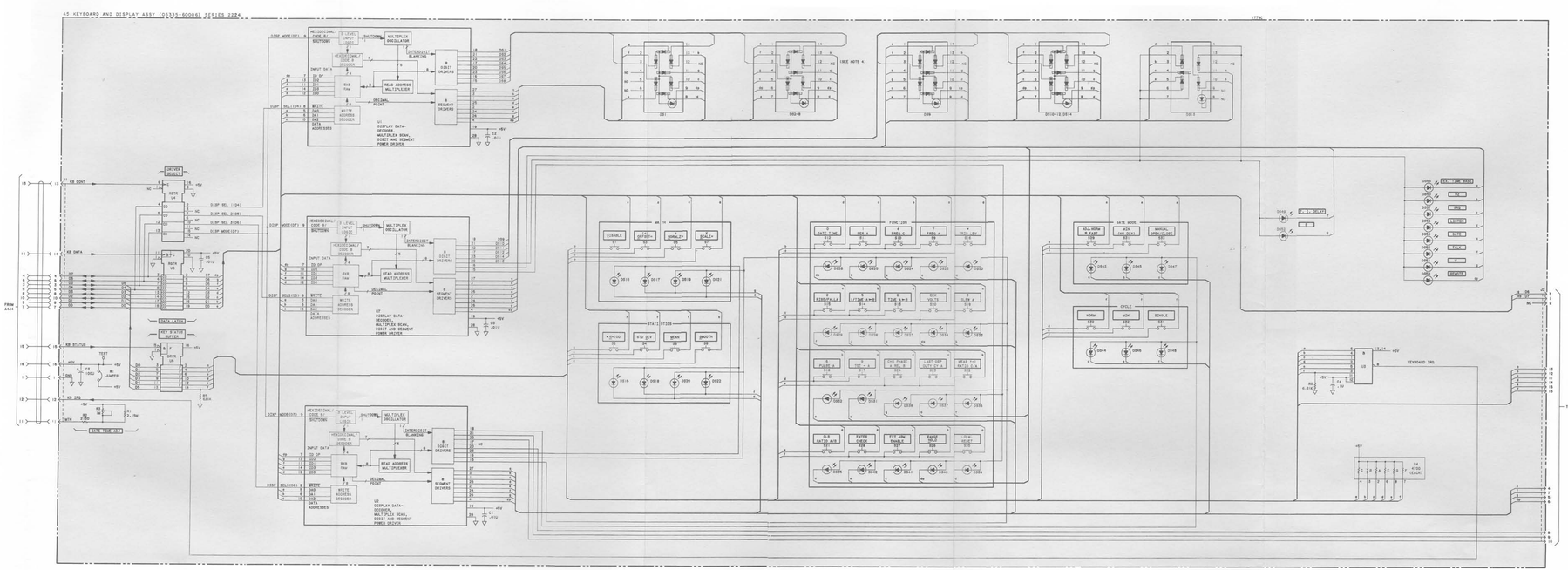
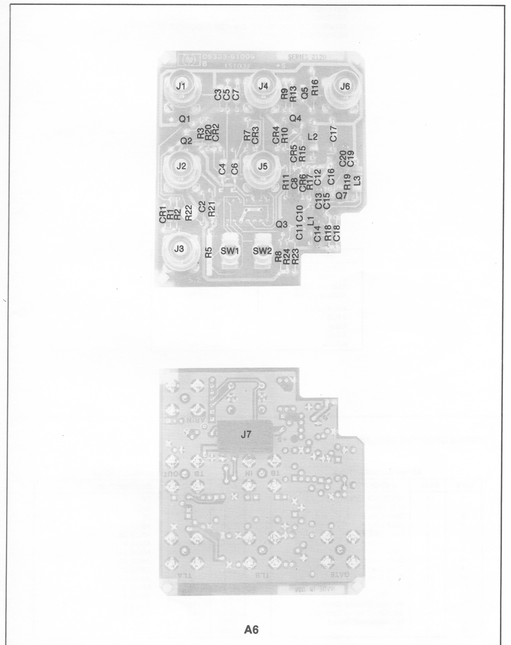


Figure 8-111. A5 Keyboard and Display Assembly

Figure 8-111
A5 KEYBOARD AND DISPLAY ASSEMBLY

(See Page 8-113)



Part of Figure 8-112. A6 Rear Panel Assembly

NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR A COMPLETE REFERENCE DESIGNATION.
2. UNLESS OTHERWISE INDICATED:
   RESISTANCE IN OHMS
   CAPACITANCE IN FARADS
   INDUCTANCE IN HENRIES
3. ASTERISK (*) INDICATES FACTORY SELECTED COMPONENT VALUE. AVERAGE VALUE SHOWN. PART MAY NOT BE IN ALL INSTRUMENTS.
4. S1 AND S2 ARE SPDT CENTER-OFF TOGGLE SWITCHES.

A6 REFERENCE DESIGNATORS

A6C1-C20
A6CR1-CR6
A6J1-J7
A6L1-L3
A6Q1-Q7
A6R1-R3,R5
A6R7-R11, R13
A6R15-R24
A6S1,S2

A6 ACTIVE COMPONENTS

REFERENCE	HP PART NO.
A6CR1,CR3-CR6	1901-0050
A6CR2	1901-0535
A6Q1-Q3,Q5-Q7	1854-0215
A6Q4	1854-0036

CONNECTOR PIN TABLES:

A6—A4 CONNECTIONS

A6J1	A4J7	DESCRIPTION
1	1	+3
2	2	TLB (Trigger Level B)
3	3	Stop
4	4	Gate Output
5	5	GND (clean)
6	6	Ext Time Base Ins
7	7	Start
8	8	Osc Out (Time Base Out)
9	9	+5V
10	10	Stop
11	11	Ground (clean)
12	12	Start
13	13	Ground (clean)
14	14	-5.2V
15	15	TLA (Trigger Level A)
16	16	Ext Arm (to MRC)

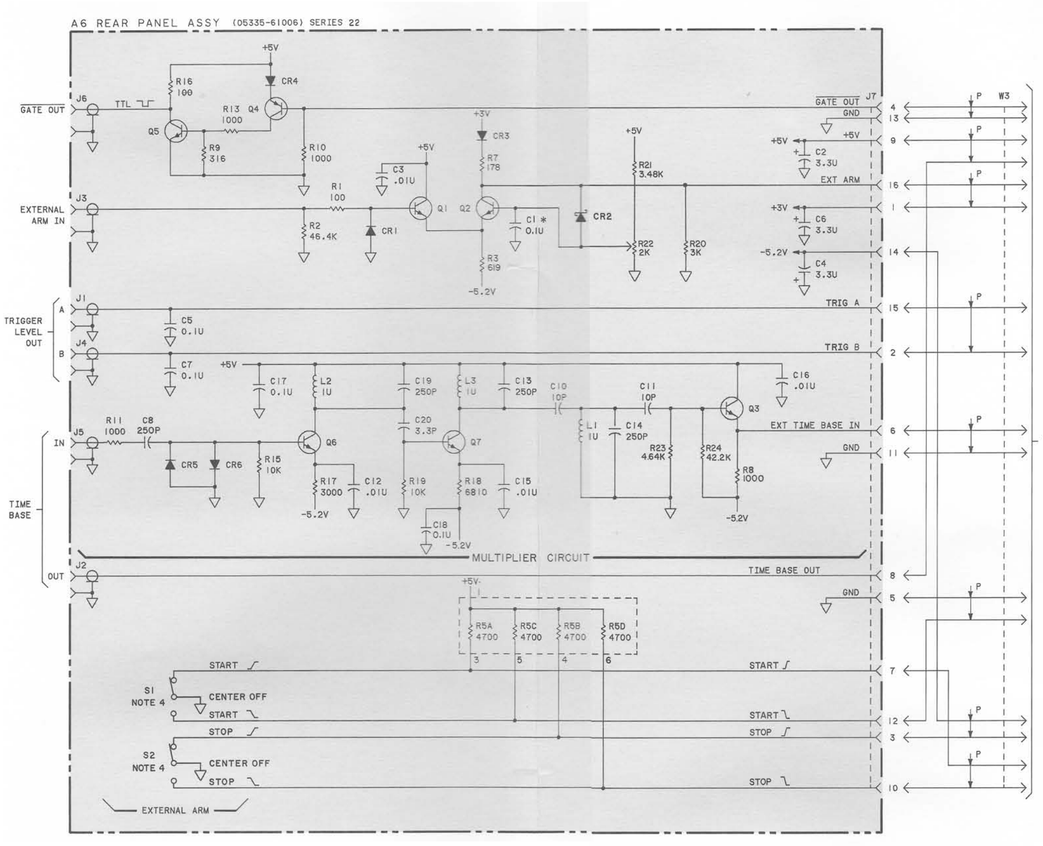
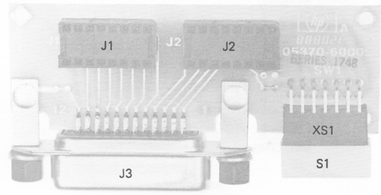


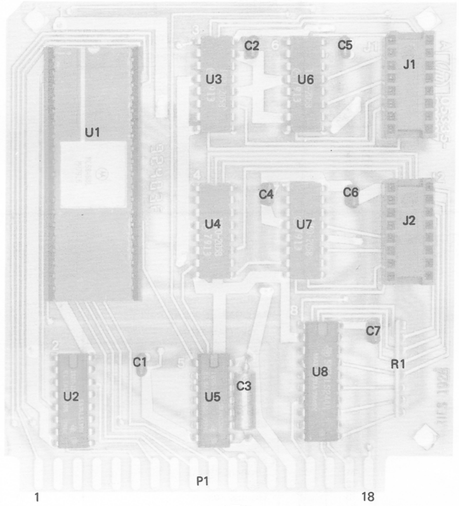
Figure 8-112. A6 Rear Panel Assembly

Figure 8-112
A6 REAR PANEL ASSEMBLY

(See Page 8-115)



A14



A7

Part of Figure 8-113. A7 HP-IB Logic and A14 HP-IB Connector Assembly

NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR A COMPLETE REFERENCE DESIGNATION.
2. UNLESS OTHERWISE INDICATED:
   RESISTANCE IN OHMS
   CAPACITANCE IN FARADS
   INDUCTANCE IN HENRIES
3. ASTERISK (*) INDICATES FACTORY SELECTED COMPONENT VALUE. AVERAGE VALUE SHOWN. PART MAY NOT BE IN ALL INSTRUMENTS.
4. WHEN CONNECTED, PROVIDES SA STIMULUS MODE (SAME AS DIAG. 02); A14S1A6 MUST BE IN "1" POSITION.

A7 REFERENCE DESIGNATORS

A7C1-C6
A7J1,J2
A7R1
A7U1-U8

A7 ACTIVE COMPONENTS

REFERENCE	HP PART NO.
A7U1	1820-2219
A7U2	1820-1281
A7U3,U4,U6,U7	1820-2058
A7U5	1820-1199
A7U8	1820-2024

A14 HP-IB CONNECTOR BOARD REFERENCE DESIGNATORS

A14J1-J3
A14S1
A14XS1

NOTES

CONNECTOR PIN TABLES:

HP-IB CONNECTIONS (A4/A7)

A4XA7	A7P1	DESCRIPTION	A4XA7	A7P1	DESCRIPTION
1	1	A1	$\overline{1}$	$\overline{1}$	A0
2	2	A3	$\overline{2}$	$\overline{2}$	A2
3	3	A5	$\overline{3}$	$\overline{3}$	A4
4	4	A7	$\overline{4}$	$\overline{4}$	A6
5	5	A9	$\overline{5}$	$\overline{5}$	A8
6	6	A11	$\overline{6}$	$\overline{6}$	A10
7	7	A13	$\overline{7}$	$\overline{7}$	A12
8	8	Reset	$\overline{8}$	$\overline{8}$	A14
9	9	E (1 MHz)	$\overline{9}$	$\overline{9}$	$\overline{\text{NMI}}$
10	10	$\overline{\text{IRQ}}$	$\overline{10}$	$\overline{10}$	RAM ENABLE
11	11	VMA	$\overline{11}$	$\overline{11}$	VMA-E
12	12	R/$\overline{\text{W}}$	$\overline{12}$	$\overline{12}$	A15
13	13	Ground	$\overline{13}$	$\overline{13}$	Ground
14	14	+5V	$\overline{14}$	$\overline{14}$	-5.2V
15	15	D1	$\overline{15}$	$\overline{15}$	D0
16	16	D3	$\overline{16}$	$\overline{16}$	D2
17	17	D5	$\overline{17}$	$\overline{17}$	D4
18	18	D7	$\overline{18}$	$\overline{18}$	D6

HP-IB CONNECTIONS A7/A14

A7J1	A14J1	DESCRIPTION	A7J2	A14J2	DESCRIPTION
1	1	EO1	1	1	Ground
2	2	DAV	2	2	A1
3	3	RFD	3	3	A2
4	4	DAC	4	4	A3
5	5	IFC	5	5	DIO1
6	6	SRQ	6	6	DIO2
7	7	ATN	7	7	DIO3
8	8	N.C.	8	8	DIO4
9	9	Ground	9	9	DIO6
10	10	Ground	10	10	DIO7
11	11	Ground	11	11	DIO6
12	12	Ground	12	12	DIO5
13	13	Ground	13	13	A7 (Talk)
14	14	Ground	14	14	A6 (Listen)
15	15	Ground	15	15	A5
16	16	REN	16	16	A4

HP-IB INTERFACE CONNECTOR SIGNALS

HP-IB Pin	Connectors Signals
1	DIO1
2	DIO2
3	DIO3
4	DIO4
5	EOI
6	DAV
7	NRFD
8	NDAC
9	IFC
10	SRQ
11	ATN
12	SHIELD CHASSIS GROUND
13	DIO5
14	DIO6
15	DIO7
16	DIO8
17	REN
18	P/O Twisted Pair with Pin 6
19	P/O Twisted Pair with Pin 7
20	P/O Twisted Pair with Pin 8
21	P/O Twisted Pair with Pin 9
22	P/O Twisted Pair with Pin 10
23	P/O Twisted Pair with Pin 11
24	ISOLATED DIGITAL GROUND

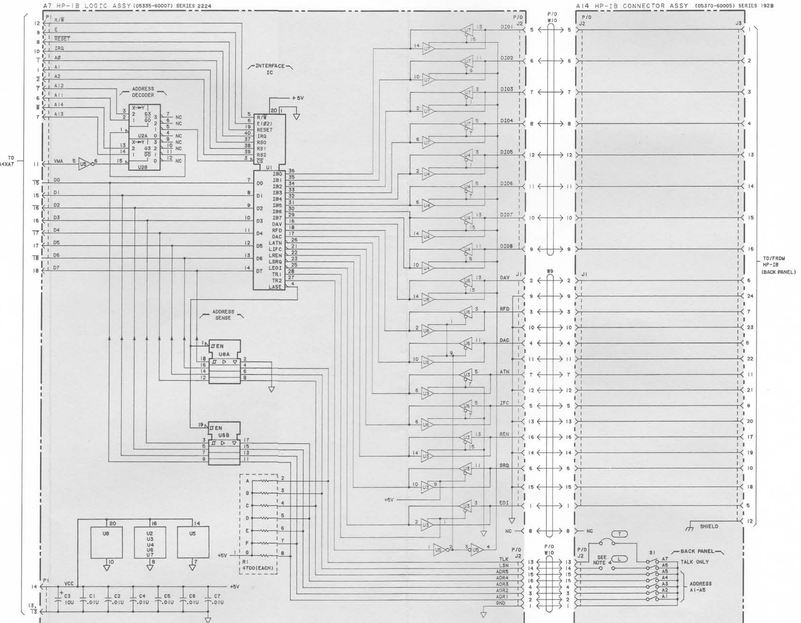
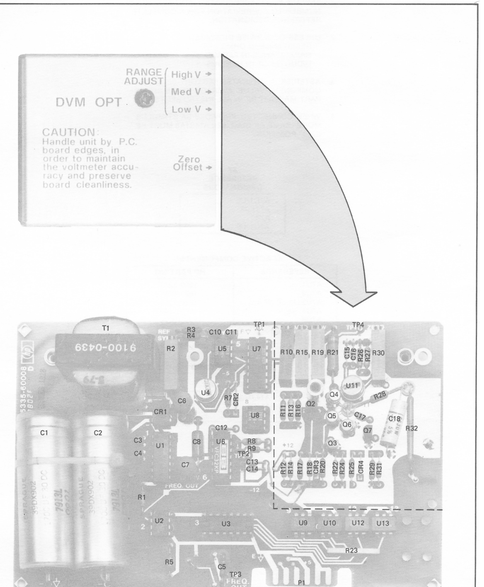


Figure 8-113. A7 HP-IB Logic Assembly and A14 HP-IB Connector Assembly

Figure 8-113
A7 HP-IB LOGIC ASSEMBLY AND A14 HP-IB CONNECTOR ASSEMBLY

(See Page 8-117)



Part of Figure 8-114. A8 Digital Voltmeter (Option 020) Assembly

NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR A COMPLETE REFERENCE DESIGNATION.
2. UNLESS OTHERWISE INDICATED:
   RESISTANCE IN OHMS
   CAPACITANCE IN FARADS
   INDUCTANCE IN HENRIES
3. ASTERISK (*) INDICATES FACTORY SELECTED COMPONENT VALUE. AVERAGE VALUE SHOWN. PART MAY NOT BE IN ALL INSTRUMENTS.
4. ⏚E CHASSIS COMMON
   ▽ FLOATING COMMON
   ⏚ INSTRUMENT COMMON (NOISE FREE).

A8 REFERENCE DESIGNATORS

A8C1-C8,C10-C18
A8CR1-CR4
A8Q2-Q7
A8R1-R32
A8TP1-TP4
A8U1-U13

A8 OPTION 020 DVM ACTIVE COMPONENTS

REFERENCE	HP PART NO.
A8CR1	1906-0069
A8CR2	1901-0033
A8CR3,CR4	1901-0050
A8Q2	1854-0215
A8Q3,Q7	1853-0036
A8Q4-Q6	1855-0368
A8U1	1826-0625
A8U2	1990-0429
A8U3	1820-1195
A8U4	1826-0650
A8U5,U8	1826-0635
A8U6	1826-0624
A8U7	1826-0610
A8U9,U10,U12,U13	1990-0543
A8U11	1826-0627

CONNECTOR PIN TABLES:

A8→A2 CONNECTIONS

A8P1	A2XA8	DESCRIPTION
1	1	GROUND
2	2	AC Supply (18.5V rms)
3	3	Enable
4	4	+5 Volts
5	5	Ground (Option IN)
6	6	Ground
$\overline{1}$	$\overline{1}$	DVM Output (Freq)
$\overline{2}$	$\overline{2}$	AC Supply (18.5V rms)
$\overline{3}$	$\overline{3}$	Data Line 5
$\overline{4}$	$\overline{4}$	Data Line 6
$\overline{5}$	$\overline{5}$	Data Line 7
$\overline{6}$	$\overline{6}$	Data Line 4

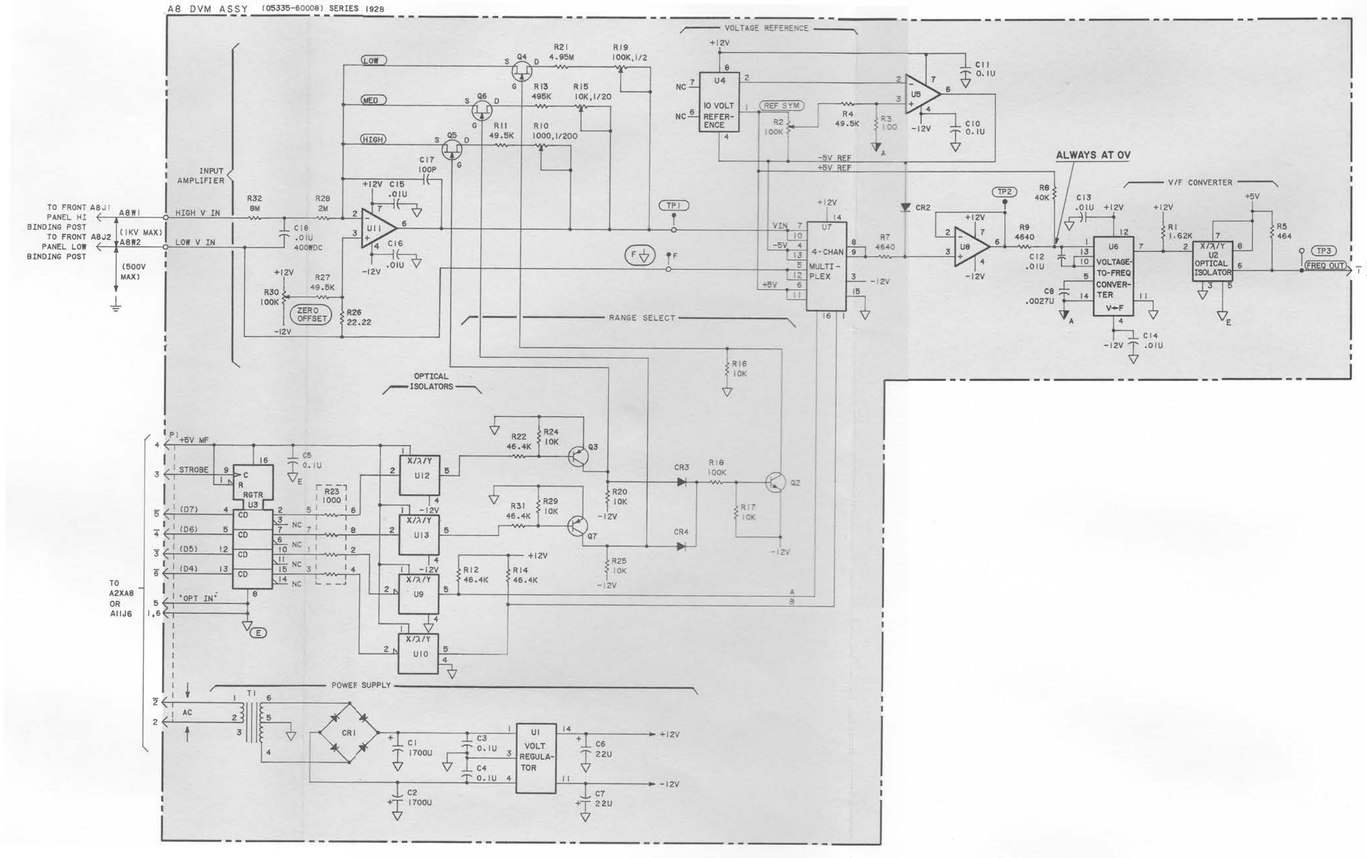
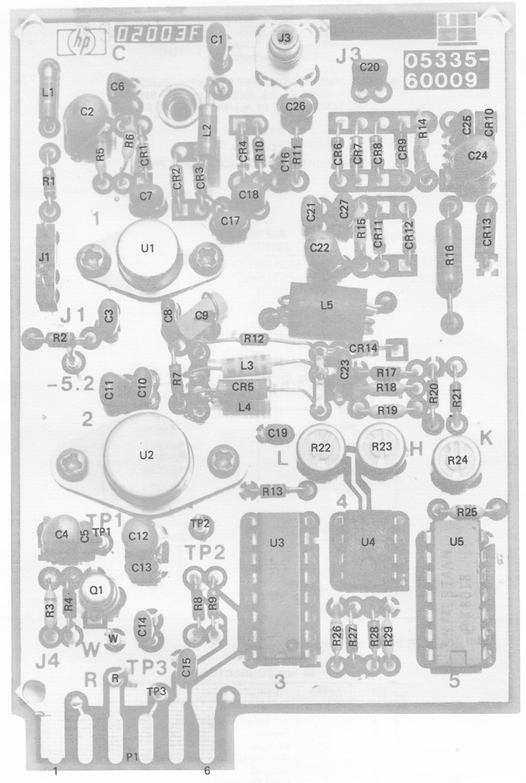


Figure 8-114. A8 Digital Voltmeter (Option 020) Assembly

Figure 8-114
A8 DIGITAL VOLTMETER (OPTION 020) ASSEMBLY

(See Page 8-119)



Part of Figure 8-115. A9 Channel C (Option 030) Assembly

NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR A COMPLETE REFERENCE DESIGNATION.
2. UNLESS OTHERWISE INDICATED:
   RESISTANCE IN OHMS
   CAPACITANCE IN FARADS
   INDUCTANCE IN HENRIES
3. ASTERISK (*) INDICATES FACTORY SELECTED COMPONENT VALUE. AVERAGE VALUE SHOWN. PART MAY NOT BE IN ALL INSTRUMENTS.
4. CR5 AND CR14 MATCHED SET OF DIODES (P/N 05335-80005).

A9 REFERENCE DESIGNATORS

A9C1-C28
A9CR1-CR14
A9J1-J3
A9Q1
A9R1-R29
A9U1-U5
A9W1,W2
A9W2R1
A9W3
A9W3J2

A9 OPTION 030 "C" CHANNEL ACTIVE COMPONENTS

REFERENCE	HP PART NO.
A9CR1-CR4	1901-0639
A9CR5,CR14	05335-80005
A9CR6,CR7	1901-0050
A9CR8,CR9,CR11,CR12	1901-1068
A9CR10,CR13	1902-0551
A9Q1	1854-0345
A9U1	5088-7036
A9U2	1820-2382
A9U3	1820-1225
A9U4	1826-0412
A9U5	1820-1112

CONNECTOR PIN TABLES:

A9—A2 CONNECTIONS

A9P1	A2XA9	DESCRIPTION
1	1	GROUND
2	2	Enable
3	3	+15.7 Volts
4	4	Channel C Output
5	5	-5.2 Volts
6	6	Ground
1	1	N/C
2	2	N/C
3	3	N/C
4	4	+5 Volts
5	5	D6
6	6	D7

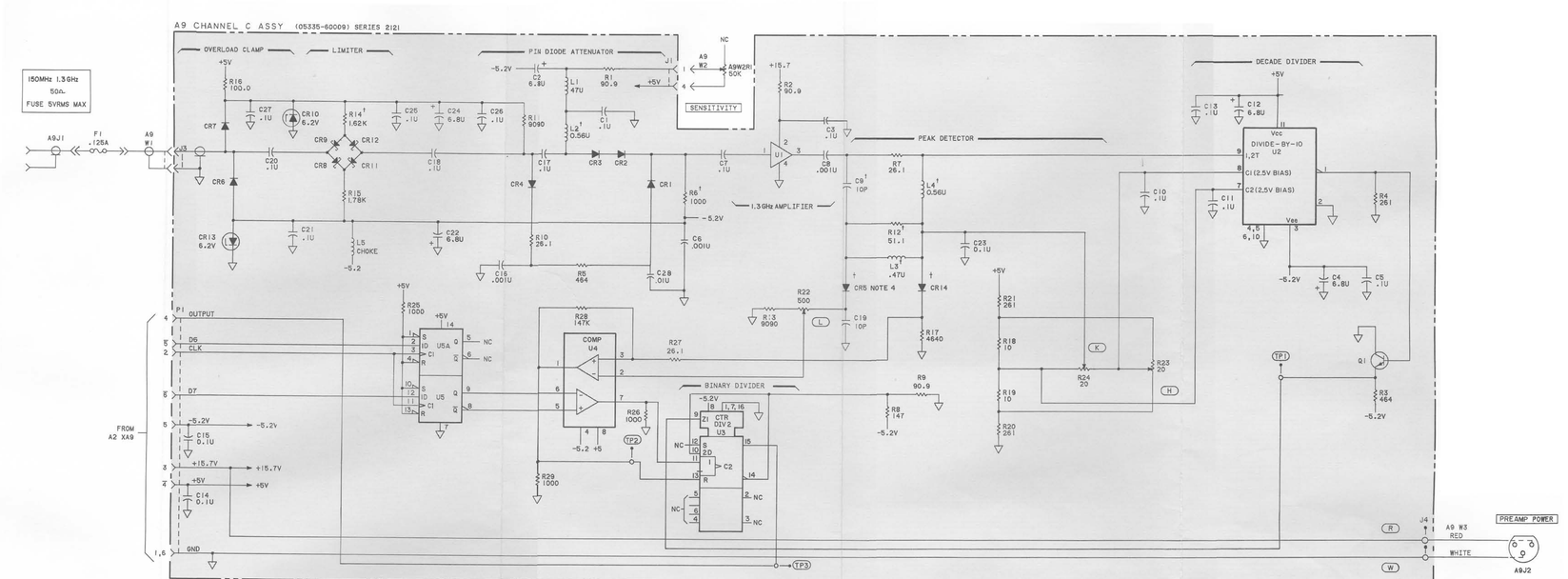
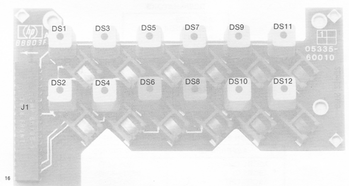


Figure 8-115. A9 Channel C (Option 030) Assembly

Figure 8-115
A9 CHANNEL C (OPTION 030) ASSEMBLY

(See Page 8-121)



Part of Figure 8-116. A10 Switch Panel (Option 040) Assembly

NOTES

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

A10 REFERENCE DESIGNATORS

A10DS1-DS12 A10J1 A10S1-S12

A10 OPTION 040 ACTIVE COMPONENTS

REFERENCE	HP PART NO.
A10DS1-DS12	1990-0851

CONNECTOR PIN TABLES:

A10–A5 CONNECTIONS

A10J1	A5J2	DESCRIPTION
(1)	(1)	D6
(2)	(2)	N/C
(3)	(3)	D7
(4)	(4)	A5U2(2)
(5)	(5)	A5U2(26)
(6)	(6)	A5U2(4)
(7)	(7)	A5U2(24)
(8)	(8)	A5U2(20)
(9)	(9)	A5U2(21)
(10)	(10)	A5U2(22)
(11)	(11)	A5U3(1)
(12)	(12)	A5U3(4)
(13)	(13)	A5U3(6)
(14)	(14)	A5U3(2)
(15)	(15)	A5U3(3)
(16)	(16)	A5U3(5)

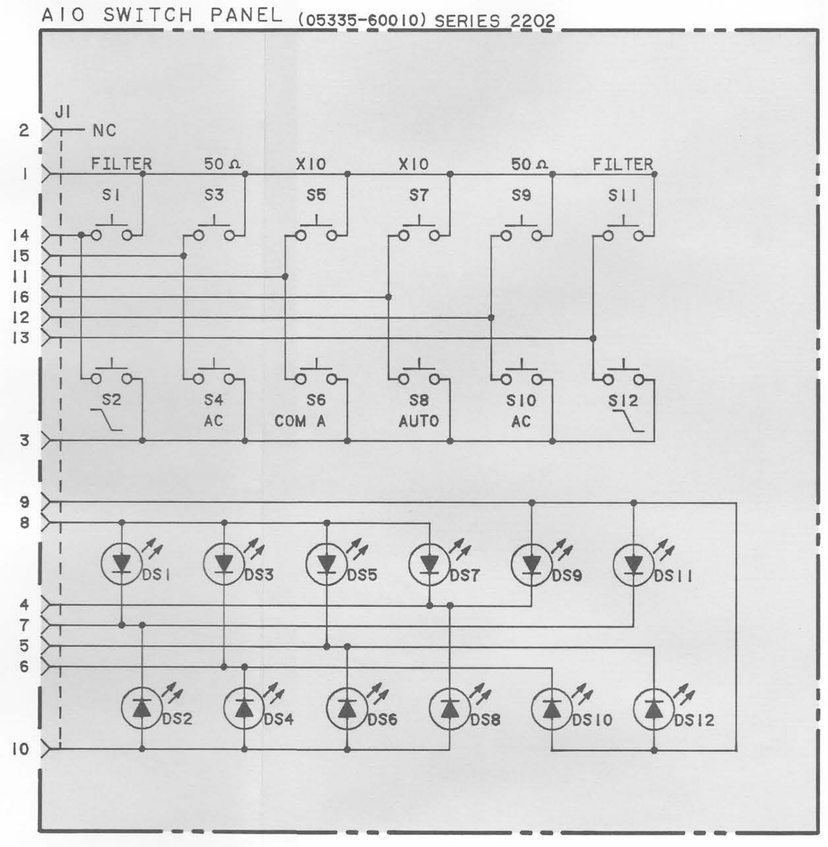
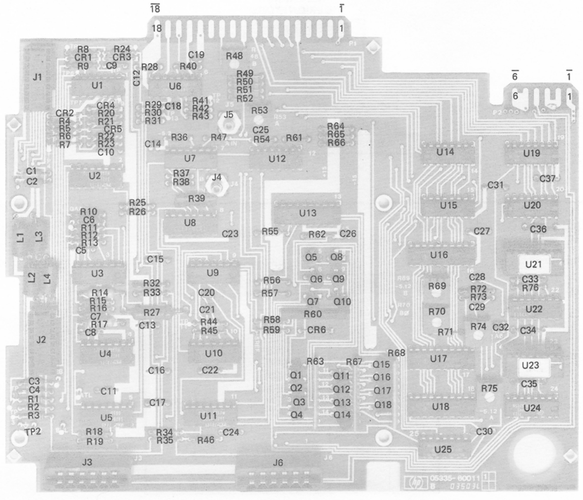


Figure 8-116. A10 Switch Panel (Option 040) Assembly

Figure 8-116
A10 SWITCH PANEL (OPTION 040) ASSEMBLY

(See Page 8-123)



A11

Part of Figure 8-117. A11 Amplifier Support (Option 040) Assembly

NOTES

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

2. UNLESS OTHERWISE INDICATED:
   RESISTANCE IN OHMS
   CAPACITANCE IN FARADS
   INDUCTANCE IN HENRIES

3. ASTERISK (*) INDICATES FACTORY SELECTED COMPONENT VALUE. AVERAGE VALUE SHOWN. PART MAY NOT BE IN ALL INSTRUMENTS.

A11 REFERENCE DESIGNATORS

A11C1-C37
A11CR1-CR6
A11J1-J6
A11L1-L4
A11Q1-Q18
A11R1-R76
A11U1-U25

A11 OPTION 040 ACTIVE COMPONENTS

REFERENCE	HP PART NO.
A11CR1,CR2	1901-0376
A11CR3,CR5,CR6	1901-0050
A11CR4	1902-3097
A11Q1-Q9	1854-0246
A11Q10-Q18	1853-0036
A11U1,U3,U9	1826-0315
A11U2,U4,U11	1826-0609
A11U5	1826-0610
A11U6	1858-0040
A11U7	1820-1359
A11U8	1820-1173
A11U10	1826-0575
A11U12	1820-0794
A11U13	1820-1917
A11U14,U15	1820-1196
A11U16-U18	1820-1858
A11U19,U20	1820-1240
A11U21,U23	1820-1984
A11U22	1826-0135
A11U24	1820-1445
A11U25	1820-1197

CONNECTOR PIN TABLES:

A11—A4 CONNECTIONS

A11P1	A4XA11	DESCRIPTION
1	1	LAOE
2	2	NC
3	3	NC
4	4	NC
5	5	A3
6	6	D7
7	7	D5
8	8	D3
9	9	D1
10	10	BTL
11	11	NC
12	12	ATL
13	13	NC
14	14	+3 Volts
15	15	CHB to MRC
16	16	+3 Volts
17	17	CHA to MRC
18	18	+3 Volts
A	A	L(VMAE)
B	B	NC
C	C	A2
D	D	A1
E	E	A0
F	F	A6
H	H	D4
J	J	J2
K	K	D0
L	L	Ground
M	M	NC
N	N	NC
P	P	NC
R	R	+3 Volts
S	S	+3 Volts
T	T	+3 Volts
U	U	+3 Volts
V	V	+3 Volts

A11—A1,A8,A9 CONNECTIONS

A11J3	A9P1	DESCRIPTION
1	1	GROUND
2	2	Enable
3	3	+15 Volts
4	4	"C" CH Output
5	5	-5.2 Volts
6	6	Ground
A	A	NC F1
B	B	NC F2
C	C	NC
D	D	+5 Volts
E	E	D6
F	F	D7
A11J6	**A8P1**	**DESCRIPTION**
1	1	GROUND
2	2	AC Supply
3	3	Enable
4	4	+5 Volts
5	5	Ground (Option IN)
6	6	Ground
A	A	DVM Output (Freq)
B	B	AC Supply
C	C	D5
D	D	D6
E	E	D7
F	F	D4
A11P2	**A1P1**	**DESCRIPTION**
1	1	+5 Volts
2	2	GROUND
3	3	GROUND
4	4	AC DVM Supply
5	5	GROUND
6	6	GROUND
A	A	+15 Volts
B	B	+10 Volts Reference
C	C	+15 Volts
D	D	AC DVM Supply
E	E	GROUND
F	F	-5.2 Volts

NOTES

CONNECTOR PIN TABLES (CONTINUED):

CONNECTIONS A11 to A12

A11J1	A12J7	MNEMONIC	FUNCTION
(1)	(1)	+5	+5 Volt Supply
(2)	(2)	GND	GROUND RETURN
(3)	(3)	-5.2	-5.2 Volt Supply
(4)	(4)	-15	-15 Volt Supply
(5)	(5)	APR	"A" Preset Switch Status Preset = 1
(6)	(6)	+15	+15 Volt Supply
(7)	(7)	APD	"A" + Peak Det. Output
(8)	(8)	AND	"A" - Peak Det. Output
(9)	(9)	GND	GROUND RETURN
(10)	(10)	AAT	"A" Atten. Relay -12V/0V = X10/X1
(11)	(11)	AAC	A AC Relay -12V/0V = AC/DC
(12)	(12)	A50	A50 Ohm Relay -12V/0V = 50/1M
(13)	(13)	ANE	NEGATIVE ENABLE, A Peak Det. -13V/AUTO
(14)	(14)	APT	TRIGGER LEVEL POT A Channel
(15)	(15)	APE	Positive Enable A Peak Det. +13V/AUTO
(16)	(16)	ATL	Trigger Level to A Channel
(17)	(17)	GAA	ANALOG GROUND A Channel
(18)	(18)	AD	A Filter Relay -12V/0V = Filter ON/OFF
A11J2	**A12J2**		
(1)	(1)	BND	B -Peak Det. Output
(2)	(2)	BPD	B +Peak Det. Output
(3)	(3)	+15	+15 Volt Supply
(4)	(4)	BPR	B Preset Switch Status Preset = 1
(5)	(5)	-15	-15 Volt Supply
(6)	(6)	-5.2	-5.2 Volt Supply
(7)	(7)	SEP	Common/Separate Relay -12V/0V = SEP/COM
(8)	(8)	+5	+5 Volt Supply
(9)	(9)	BTL	TRIGGER LEVEL to B Channel
(10)	(10)	BNE	NEGATIVE ENABLE, B Peak Det. -13V/AUTO
(11)	(11)	BPT	TRIGGER LEVEL POT B Channel
(12)	(12)	BPE	POSITIVE ENABLE B Peak Det. +13V/AUTO
(13)	(13)	B50	B50 Ohm Relay -12V/0V = 50/1M
(14)	(14)	BAT	B ATTEN Relay -12V/0V = X10/X1
(15)	(15)	BAC	B AC Relay -12V/0V = AC/DC
(16)	(16)	BF	B Filter Relay -12V/0V = Filter ON/OFF
(17)	(17)	GAB	ANALOG GROUND B Channel
(18)	(18)	GND	GROUND RETURN

A11J5 to A12J4 A Channel Output
A11J4 to A12J8 B Channel Output

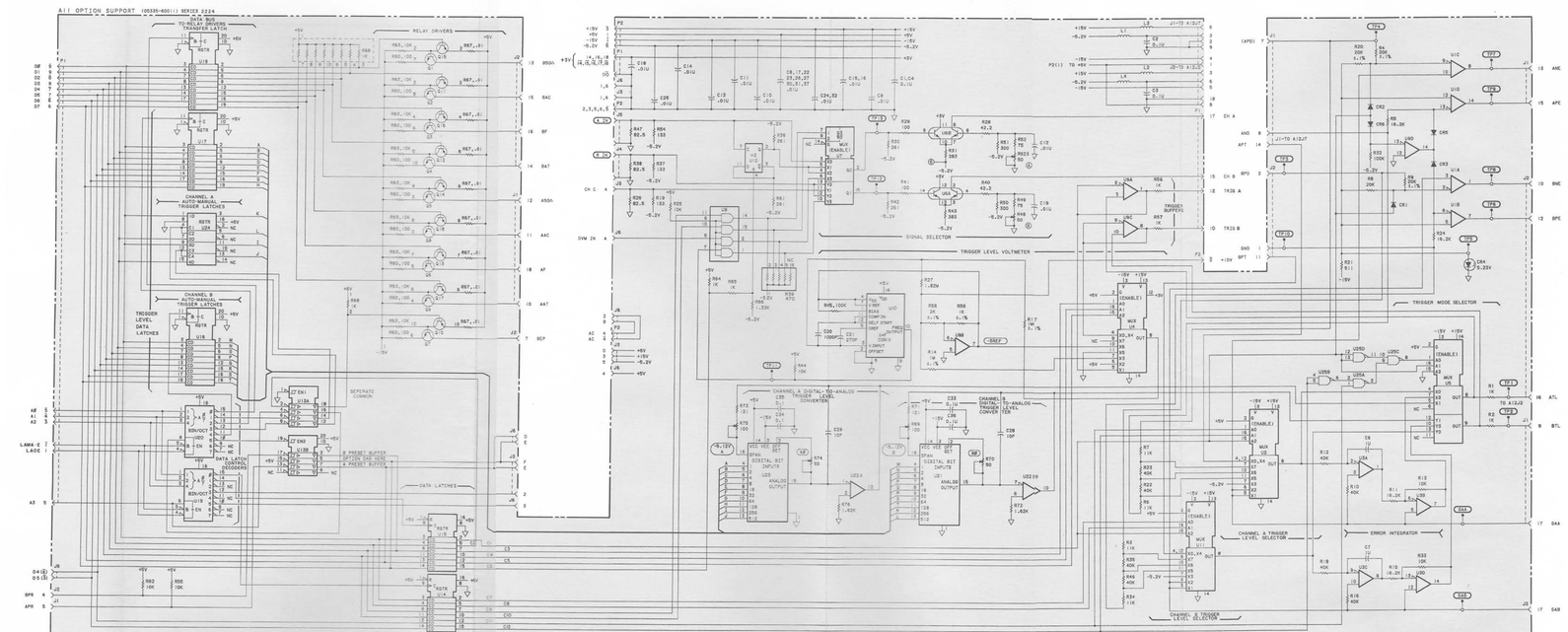
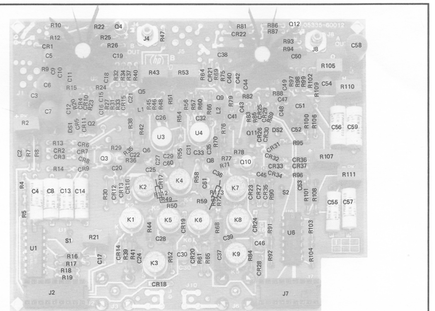
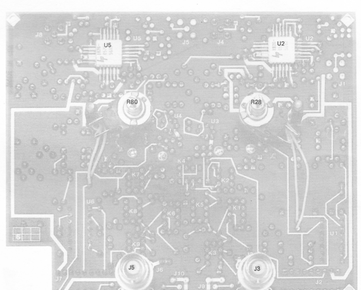


Figure 8-117. A11 Amplifier Support (Option 040) Assembly

Figure 8-117
A11 AMPLIFIER SUPPORT (OPTION 040) ASSEMBLY

(See Page 8-127)





A12

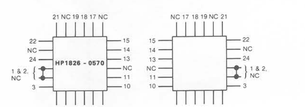
Part of Figure 8-118. A12 Programmable Input Amplifier (Option 040) Assembly

NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR A COMPLETE REFERENCE DESIGNATION.
2. UNLESS OTHERWISE INDICATED:
   RESISTANCE IN OHMS
   CAPACITANCE IN FARADS
   INDUCTANCE IN HENRIES
3. ASTERISK (*) INDICATES FACTORY SELECTED COMPONENT VALUE. AVERAGE VALUE SHOWN. PART MAY NOT BE IN ALL INSTRUMENTS.
4. MATCHED SETS OF DIODES: CR2,6,7; CR3,8,9; CR4,5,10,11; CR25,26,29,30; CR31,32,36; CR33,34,37.
5. R7, R8, R100 & R106 ALTERNATE VALUE IS 3.16M.
6. PIN CONNECTION FOR ACTIVE ELEMENTS:

BOTTOM VIEWS

Q6, Q8 | Q2, Q5, Q9, Q11 | Q3, Q4, Q10, Q12 | S2 - S10, S12



TOP VIEW | BOTTOM VIEW

U2 AND U5

A12 REFERENCE DESIGNATORS

A12C2-C61
A12CR1-CR37
A12DS1,DS2
A12J2-J8
A12K1-K9
A12L1,L2
A12Q2-Q6,Q8-Q12
A12R2-R5,R7-R110, A12R12-R72,R75-R113
A12S1,S2
A12U1-U6

A12 OPTION 040 ACTIVE COMPONENTS

REFERENCE	HP PART NO.
A12CR1,CR22	1901-1080
A12CR2,CR6,CR7	05335-80003*
A12CR3,CR8,CR9	05335-80003*
A12CR4,CR5,CR10,CR11	05335-80003*
A12CR12,CR35	1902-0057
A12CR13,CR27	1902-0041
A12CR14,CR16-CR20, A12CR23, CR24,CR28	1901-0050
A12CR15,CR21	1902-3136
A12CR25,CR26,CR29,CR30	05335-80003*
A12CR31,CR32,CR36	05335-80003*
A12CR33,CR34,CR37	05335-80003*
A12Q,Q5,Q9,Q11	1854-0636
A12Q3,Q4,Q10,Q12	1854-0686
A12Q6,Q8	1855-0212 or 1855-0300
A12U1,U6	1826-0600
A12U2,U5	1826-0570
A12U3,U4	1826-0035

*Matched Set of Four Diodes

NOTES

CONNECTOR PIN TABLES:

CONNECTIONS A12 to A11

A12J7	A11J1	MNEMONIC	FUNCTION
(1)	(1)	+5	+5 Volt Supply
(2)	(2)	GND	GROUND RETURN
(3)	(3)	-5.2	-5.2 Volt Supply
(4)	(4)	-15	-15 Volt Supply
(5)	(5)	APR	"A" Preset Switch Status Preset = 1
(6)	(6)	+15	+15 Volt Supply
(7)	(7)	APD	"A" = Peak Det. Output
(8)	(8)	AND	"A" = Peak Det. Output
(9)	(9)	GND	GROUND RETURN
(10)	(10)	AAT	"A" Atten. Relay -12V/0V = X10/X1
(11)	(11)	AAC	A AC Relay -12V/0V = AC/DC
(12)	(12)	A50	A50 Ohm Relay -12V/0V = 50/1M
(13)	(13)	ANE	NEGATIVE ENABLE, A Peak Det. -13V/AUTO
(14)	(14)	APT	TRIGGER LEVEL POT A Channel
(15)	(15)	APE	Positive Enable A Peak Det. +13V/AUTO
(16)	(16)	ATL	Trigger Level to A Channel
(17)	(17)	GAA	ANALOG GROUND A Channel
(18)	(18)	AD	A Filter Relay -12V/0V = Filter ON/OFF
A12J2	**A11J2**		
(1)	(1)	BND	B -Peak Det. Output
(2)	(2)	BPD	B +Peak Det. Output
(3)	(3)	+15	+15 Volt Supply
(4)	(4)	BPR	B Preset Switch Status Preset = 1
(5)	(5)	-15	-15 Volt Supply
(6)	(6)	-5.2	-5.2 Volt Supply
(7)	(7)	SEP	Common/Separate Relay -12V/0V = SEP/COM
(8)	(8)	+5	+5 Volt Supply
(9)	(9)	BTL	TRIGGER LEVEL to B Channel
(10)	(10)	BNE	NEGATIVE ENABLE, B Peak Det. -13V/AUTO
(11)	(11)	BPT	TRIGGER LEVEL POT B Channel
(12)	(12)	BPE	POSITIVE ENABLE B Peak Det. +13V/AUTO
(13)	(13)	B50	B50 Ohm Relay -12V/0V = 50/1M
(14)	(14)	BAT	B ATTEN Relay -12V/0V = X10/X1
(15)	(15)	BAC	B AC Relay -12V/0V = AC/DC
(16)	(16)	BF	B Filter Relay -12V/0V = Filter ON/OFF
(17)	(17)	GAB	ANALOG GROUND B Channel
(18)	(18)	GND	GROUND RETURN

A11J5 to A12J4 A Channel Output
A11J4 to A12J8 B Channel Output

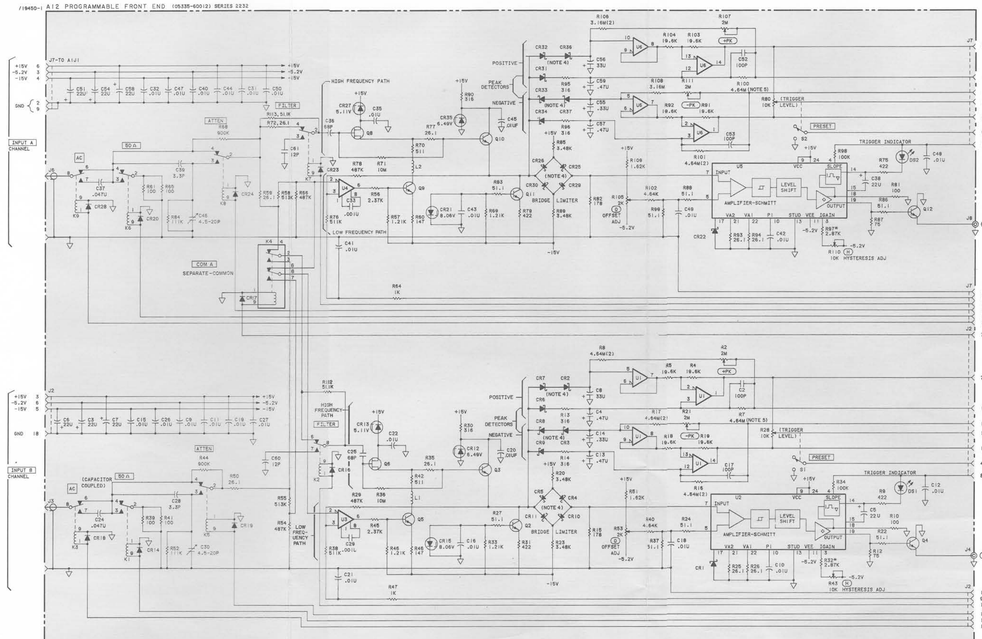


Figure 8-118. A12 Programmable Input Amplifier (Option 040) Assembly

Figure 8-118
A12 PROGRAMMABLE INPUT AMPLIFIER (OPTION 040) ASSEMBLY

(See Page 8-129)

A15

Part of Figure 8-119. A15 10 MHz Oscillator (Option 010)

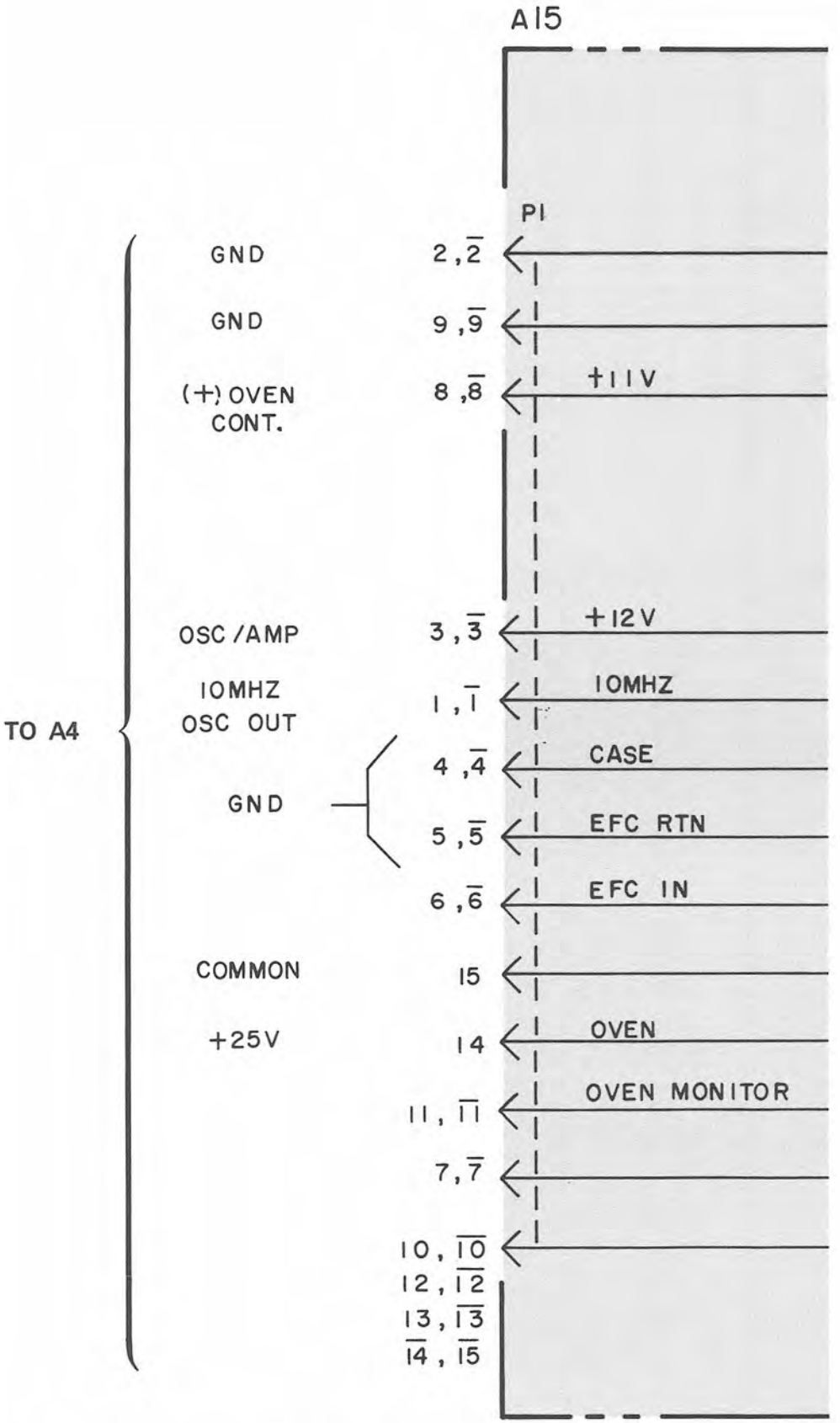


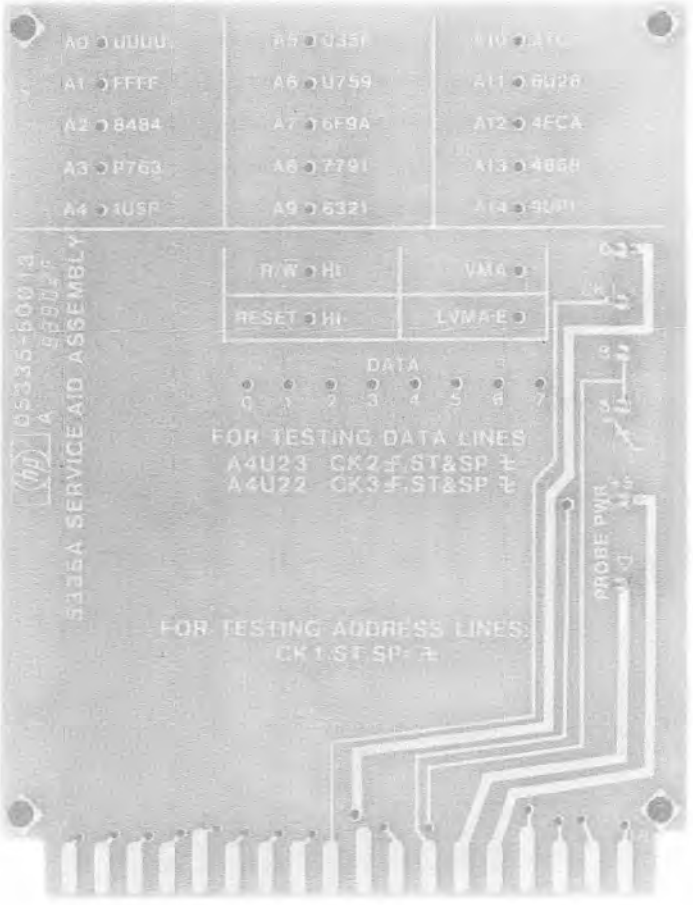
Figure 8-119. A15 10 MHz Oscillator (Option 010) Assembly

NOTES

CONNECTOR PIN TABLES:

A16P1 Connections

PIN #	DESCRIPTION	PIN #	DESCRIPTION
1	A1	$\overline{1}$	A0
2	A3	$\overline{2}$	A2
3	A5	$\overline{3}$	A4
4	A7	$\overline{4}$	A6
5	A9	$\overline{5}$	A8
6	A11	$\overline{6}$	A10
7	A13	$\overline{7}$	A12
8	RESET	$\overline{8}$	A14
9	CLOCK (1 MHz)	$\overline{9}$	N/C
10	N/C	$\overline{10}$	SA-MEM ENABLE (GND)
11	VMA	$\overline{11}$	LVMA·E
12	R/$\overline{W}$	$\overline{12}$	START/STOP (A15)
13	GND	$\overline{13}$	N/C
14	+5 VOLTS	$\overline{14}$	N/C
15	D1	$\overline{15}$	D0
16	D3	$\overline{16}$	D2
17	D5	$\overline{17}$	D4
18	D7	$\overline{18}$	D6



A16

Figure 8-120. A16 Service Aid Board

A17

Figure 8-121. A17 Shield Board (Option 040)