Errata

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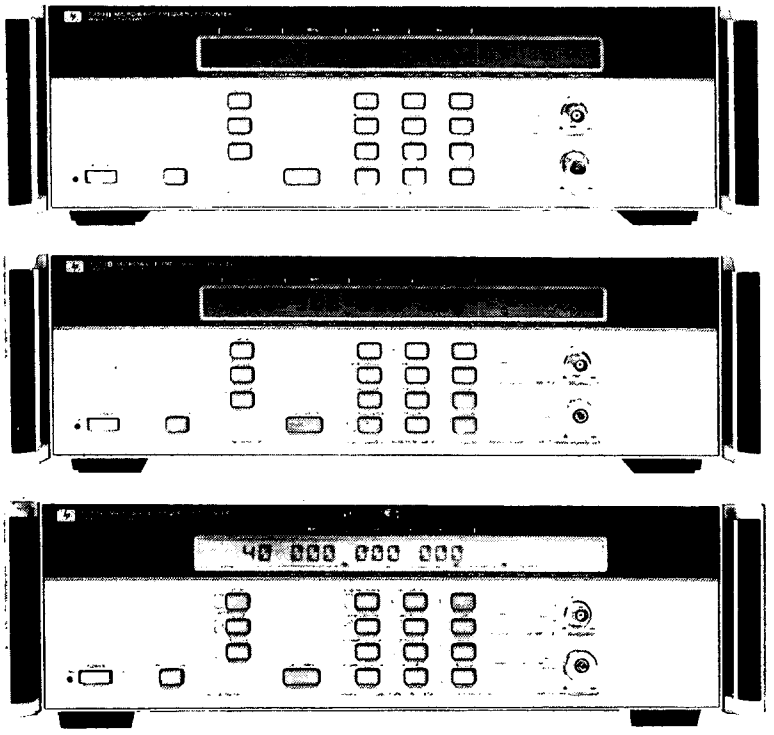
DESIGNED FOR HP-IB SYSTEMS

5350B
5351B
5352B

Microwave Frequency Counters



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HP 5350B/5351B/5352B

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HEWLETT PACKARD

SERVICE MANUAL

HP 5350B, 5351B and 5352B Microwave Frequency Counters

SERIAL NUMBERS

This manual applies directly to instruments with serial numbers prefixed 2713A, unless accompanied by a Manual Change Sheet indicating otherwise.

For additional information about serial numbers, refer to INSTRUMENT AND MANUAL IDENTIFICATION in Section I.

IMPORTANT NOTICE

The operating and service information for this instrument is contained in two manuals, as follows:

HP 5350B/5351B/5352B Operating and Programming Manual (HP P/N 05350-90025):

I	General Information
II	Installation
III	Operation And Programming
IV	Performance Tests

HP 5350B/5351B/5352B Service Manual (HP P/N 05350-90021):

IV	Performance Tests (duplicate)
V	Adjustments
VI	Replaceable Parts
VII	Manual Changes
VIII	Service

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MANUAL PART NUMBER 05350-90021
Microfiche Part Number 05350-90022

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PREFACE

This manual contains the information required by the user to effectively service and maintain the Hewlett-Packard Model 5350B, 5351B and 5352B Microwave Frequency Counters. The organization of this manual is designed to make quick reference of information easy, while still providing the overall depth of detail required by operating and service personnel.

The manual is divided into five sections, each relating to a specific topic. Each section is as self-contained as possible. Some sections provide 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 are arranged to fold out from the manual to allow 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 is assumed. A variety of additional related documentation is available. The materials listed below provide in-depth coverage of specific areas of interest, and should be used to supplement this manual.

HP 5350B/5351B/5352B OPERATING AND PROGRAMMING MANUAL	05350-90025
AN 200 FUNDAMENTALS OF ELECTRONIC COUNTERS	5952-7506
AN 200-1 FUNDAMENTALS OF MICROWAVE FREQUENCY COUNTERS	5952-7484
LOGIC SYMBOLOGY	5951-6116
HP-IB TUTORIAL	59300-90007

IMPORTANT NOTICE

This manual includes *Table 1-1, Model 5350B/5351B/5352B Specifications,* on page xvi, and *Table 1-5, Recommended Test Equipment,* on page xviii. These tables are duplicates of those in the HP 5350B/5351B/5352B Operating and Programming Manual, and are included in this manual for ease of reference.

SAFETY CONSIDERATIONS

GENERAL

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

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

BEFORE APPLYING POWER

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

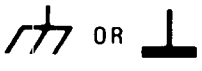
SAFETY EARTH GROUND

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

SAFETY SYMBOLS

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

Indicates hazardous voltages.



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

Alternating current.

Direct current.

WARNING

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

CAUTION

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

SAFETY INFORMATION

WARNING

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

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

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

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

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

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

SAFETY CONSIDERATIONS

CAUTION

LINE VOLTAGE SELECTION

BEFORE CONNECTING POWER TO THE INSTRUMENT, make sure that the line voltage selector card (in the rear panel power module) is set to the correct voltage level for the ac voltage being applied, and that the correct fuse is installed. Refer to Section II, Installation.

MAXIMUM INPUT SIGNAL POWER

TO PREVENT DAMAGE TO THE INSTRUMENT, make sure that signals applied to the input do not exceed the input damage level specified for the instrument. Refer to Section I, Specifications.

ELECTROSTATIC DISCHARGE

Electronic components and assemblies can be permanently degraded or damaged by electrostatic discharge. Use the following precautions:

ENSURE that static-sensitive devices or assemblies are serviced at static-safe work stations providing proper grounding for service personnel.

ENSURE that static-sensitive devices or assemblies are stored in static-shielding containers.

DO NOT wear clothing subject to static charge buildup, such as wool or synthetic materials.

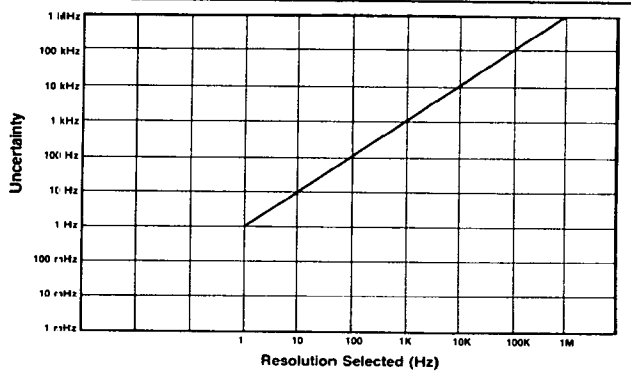
DO NOT handle components or assemblies in carpeted areas.

DO NOT remove a component or assembly from its static-shielding protection until you are ready to install it.

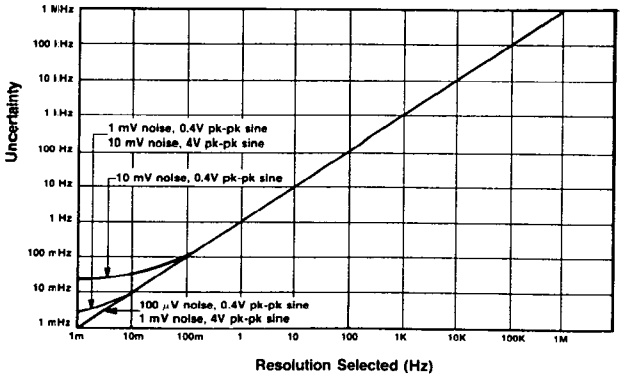
AVOID touching component leads. (Handle by the packaging only.)

Table 1-1. Model 5350B/5351B/5352B Specifications

INPUT CHARACTERISTICS			
INPUT 1:	**HP 5350B**	**HP 5351B**	**HP 5352B**
Frequency Range:	500 MHz - 20.0 GHz	500 MHz - 26.5 GHz	500 MHz - 40 GHz
Sensitivity: Full Operating Environment 500 MHz to 12.4 GHz 12.4 GHz to 20.0 GHz 20.0 GHz to 26.5 GHz 26.5 GHz to 40 GHz @ 25°C (typical) 500 MHz to 12.4 GHz 12.4 GHz to 20.0 GHz 20.0 GHz to 26.5 GHz 26.5 GHz to 40 GHz	 -32 dBm -27 dBm N/A -40 dBm -35 dBm N/A	 -32 dBm -27 dBm -16 dBm -40 dBm -35 dBm -28 dBm N/A	 -25 dBm -25 dBm -25 dBm dBm = 0.741 f(GHz) -44.6 -30 dBm -30 dBm -30 dBm dBm = 0.741 f(GHz) -49.6
Maximum Input:	+7 dBm	+7 dBm	+7 dBm
Damage Level:	+25 dBm, peak	+25 dBm, peak	+25 dBm, Peak
Impedance:	50Ω nominal	50Ω nominal	50Ω nominal
Connector:	Precision Type N female	APC-3.5 male with collar, SMA compatible	
SWR: 500 MHz - 10 GHz 10 GHz - 20 GHz 20 GHz - 26.5 GHz 26.5 GHz - 40 GHz	 <2:1 typical <3:1 typical N/A N/A	 <2:1 typical <3:1 typical <3:1 typical N/A	 <2:1 typical <3:1 typical <3:1 typical <3.5:1 typical
Coupling:	dc to 50Ω termination, ac to instrument		
Accuracy:	±1 LSD ±time base error × frequency (See Graphs 1,2,3)		
Residual Stability:	When counter and source use common 10 MHz time base or counter uses external higher stability time base, .3 LSD rms typical for resolution 1 Hz - 1 kHz at 25°C; HP 5352B only .7 LSD typical 26.5 - 40 GHz; LSD = least significant digit.		
Resolution:	Selectable 1 Hz to 1 MHz		

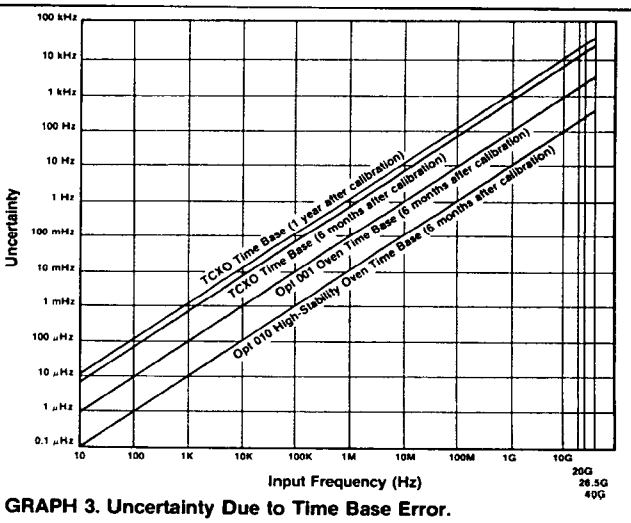


GRAPH 1. Input 1 Uncertainty Due to Resolution Selected.

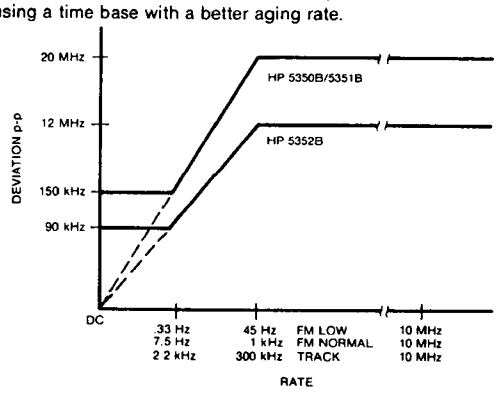


GRAPH 2. Input 2 Uncertainty Due to Trigger Error and Resolution Selected.

NOTE:
Input 1 accuracy = resolution uncertainty (Graph 1) + time base uncertainty (Graph 3).
Input 2 accuracy = resolution and trigger uncertainty (Graph 2) + time base uncertainty (Graph 3).



GRAPH 3. Uncertainty Due to Time Base Error.
Time Base Error can be reduced by calibrating the time base more frequently, or by using a time base with a better aging rate.



GRAPH 4. FM Rate Tolerance.

Table 1-1. Model 5350B/5351B/5352B Specifications (Continued)

INPUT 1: HP 5350B/5351B/5352B

Modes of Operation:
Automatic: Counter automatically acquires and displays highest level signal within sensitivity range.
Manual: Center frequency must be entered to within ± 20 MHz of input frequency; ±3 MHz worst case below 1 GHz; increases measurement and data output rate.

Automatic Amplitude Discrimination: Automatically measures the largest of all signals present, providing that signal is >6 dB (typical) above any signal within 500 MHz; > 20 dB (typical) above any signal within 500 MHz to 20 (40) GHz.

FM Tolerance (See Graph 4):
Automatic Mode: 20 MHz p-p (12 MHz, HP 5352B).
Manual Mode: 60 MHz p-p (55 MHz, HP 5352B), when center frequency is entered within ±1 MHz of input signal.
Maximum FM Rate: 10 MHz.

Tracking Speed:
Fast-Acquisition Track: 1 GHz/s.
Normal FM Rate: 1 MHz/s.
Low FM Rate: 80 kHz/s.

Acquisition Time:
Automatic Mode:
Fast-Acquisition Track: < 60 ms.
Normal FM Rate: <125 ms.
Low FM Rate: <1.25s.
Manual Mode: <20 ms

AM Tolerance: Any modulation index provided the minimum signal level is not less than the sensitivity specification.

Gate Time: For 1 Hz resolution

500 MHz-5.7 GHz	200 ms
5.7-11.3 GHz	400 ms
11.3-16.9 GHz	600 ms
16.9-22.5 GHz	800 ms
>22.5 GHz	1000 ms

INPUT 2: HP 5350B/5351B/5352B

Frequency Range: 10 Hz to 525 MHz.

Mode of Operation:
50Ω: 10 MHz to 525 MHz.
1 MΩ: 10 Hz to 80 MHz.

Sensitivity:
Full Operating Environment:
50Ω: 10 MHz to 525 MHz, 25 mV rms.
1 MΩ: 10 Hz to 80 MHz, 25 mV rms.
@ 25°C (typical):
50Ω: 10 MHz to 525 MHz, 15 mV rms.
1 MΩ: 10 Hz to 80 MHz, 15 mV rms.

Gate Time = 1/Resolution 1 ms minimum.

Resolution: selectable 1 Hz to 1 MHz.

High Resolution: 1 MΩ mode: 0.001 Hz for <100 kHz input; 0.01 Hz for < 1 MHz input; 0.1 Hz for <10 MHz input; 1 Hz for >10 MHz input: 1 second gate.

Accuracy: ± 1 LSD ±

$$\left(\frac{1.4 \times \text{Trigger Error}\,①}{\text{Gate Time}} \pm \text{Time base error}\right) \times \text{Freq.}$$

(See Graphs 1, 2, and 3)

Impedance:
Selectable: 1 MΩ nominal shunted by <70 pF or 50Ω nominal.
Coupling: ac.
Connector: Replaceable fuse, Type BNC female.
Maximum Input:
50Ω: + 10 dBm; 1 MΩ: 1V rms.
Damage Level: 50Ω or 1 MΩ
dc - 5 kHz: 250V (dc + ac peak);
>5 kHz: 5.5V rms (+28 dBm) + 1.25 × 10^6 V rms/FREQ.
Panel Label: 5.5 V rms (+ 28 dBm).

TCXO TIME BASE

Crystal Frequency: 10 MHz.
Stability:
Aging Rate: <1 × 10^{-7} per month.
Short Term: <1 × 10^{-9} for 1 s averaging time.
Temperature: <1 × 10^{-6}, 0-50°, if referenced to +25°C and set to the offset frequency.
Line Variation: <1 × 10^{-7} for 10% change from nominal.
Time Base Output: 10 MHz and 1 MHz, >2.4V square wave ac coupled into 1 kΩ: >1.5V p-p into 50Ω; available from rear panel BNC connectors whenever the instrument has ac power connected.
External Time Base: 1, 2, 5 or 10 MHz, 0.7V min. to 8V max. p-p sine wave or square wave into >1 kΩ shunted by <30 pF, via rear panel BNC connector.
External reference automatically selected when signal is present, an indicator (▼) appears in the display. TCXO power turned off, oven heater on, oscillator signal disconnected.

OPTIONAL OVEN TIME BASE OPTION 001④

Crystal Frequency: 10 MHz.
Stability:
Aging Rate: <5 × 10^{-10}/day after 24-hour warm-up; <1 × 10^{-7}/year for continuous operation ②.
Short-Term: <1 × 10^{-10} for 1 s average.
Temperature: <7 × 10^{-9}, 0-50°C
Line Variation: <1 × 10^{-10} for 10% change from nominal.
Warm-Up: <5 × 10^{-9} of final value 10 minutes after turn-on at 25°C ②.

OPTIONAL REAR PANEL INPUTS OPTION 002③

All specifications are the same except Input 1:

Sensitivity:
Sensitivity is reduced by:
1 dBm, 500 MHz to 12.4 GHz
2 dBm, 12.4 GHz to 20.0 GHz
3 dBm, 20.0 GHz to 26.5 GHz
SWR:
500 MHz -10 GHz (<2.5:1 typical)
10 GHz - 20 GHz (<3.5:1 typical)
20 GHz - 26.5 GHz (<3.5:1 typical, 5351B)

OPTIONAL INCREASED DAMAGE LEVEL OPTION 006③

Protects Input 1 from damage by limiting high level signals. All specifications are the same except Input 1:

Damage Level

500 MHz to 6 GHz	+39 dBm (8 Watts)
6 GHz to 18 GHz	+36 dBm (4 Watts)
18 GHz to 26.5 GHz	+34.8 dBm (3 Watts)

Sensitivity:
Sensitivity is reduced by:
3 dBm, 500 MHz to 12.4 GHz
4 dBm, 12.4 GHz to 20.0 GHz
5 dBm, 20.0 GHz to 26.5 GHz
SWR:
500 MHz - 10 GHz (<2.5:1 typical)
10 GHz - 20 GHz (<3.5:1 typical)
20 GHz - 26.5 GHz (<3.5:1 typical, 5351B)

OPTIONAL HIGH STABILITY OVEN TIME BASE OPTION 010④

Crystal Frequency: 10 MHz.
Stability:
Aging Rate: <7 × 10^{-10}/week after 24 hrs; <1 × 10^{-10}/day (typical) after 30 days; <2 × 10^{-8}/year for continuous operation.
Short-Term: <1 × 10^{-10} for 1 s average.
Temperature: <7 × 10^{-9}, 0-50°C.
Line Variation: <1 × 10^{-10} for 10% change from nominal.
Warm-Up: <5 × 10^{-9} of final value 10 minutes after turn-on at 25°C ②.

GENERAL

Display: Segmented 24 character alpha-numeric LCD with 24 annunciators (backlighted); lockout (see Diagnostics).
Keyboard: Set up stored in STBY mode; lockout (see Diagnostics).
Self-Check: Tests for correct circuit operation using LO frequency divided by ten.
Diagnostics: Front panel or HP-IB selectable, Display and Keyboard Lockout, Service Diagnostics and User Information.
Data Output: Over HP-IB bus; varies with Frequency and Resolution.
Automatic Mode: 100 readings per second.
Manual Mode: 120 readings per second. (10 kHz resolution, no math functions "DUMP MODE").

Math Functions: Result = **measurement × scale + offset.**
Offset: Measurement is offset by entered value.
Scale: Measurement is multiplied by entered value.
Smooth: Displayed resolution is determined using exponential averaging; Displays only stable digits.
Sample Rate: Variable from less than 50 ms between measurements to HOLD, which holds the display indefinitely or until **Trigger** occurs.
Display Rate: 5/s, 1 kHz resolution.
Overload Indication: "OVRLOAD" A user message; External pad or signal attenuation should be used to avoid damage.

Sleep Mode: Input 1 emissions reduced to <-70 dBm typical when sleep mode or input 2 is selected.
IF Output: Rear panel BNC provides 30-110 MHz down-converted microwave signal at >-20 dBm into 50Ω, ac coupled.
HP-IB: Functions and diagnostics are programmable; address settable from front panel. Default switches on rear panel; Teach/Learn programming; IEEE 728 compatible command structure; Function subset SH1, AH1, T5, L4, SR1, RL1, PP0, DC1, DT1, C0, E1.
Reset/local: returns to local control.

Operating Temperature: 0°C to 50°C.
Power Requirements: 100 VA max.
Line Select:
100 V (90-105 VAC rms; 47.5-440 Hz).
115/120 V (104-126 VAC rms; 47.5-440 Hz).
220 V (198-231 VAC rms; 47.5-66 Hz).
230/240 V (207-252 VAC rms; 47.5-66 Hz).
Accessories Furnished: Power cord, manual
Size: D/133 mmH × 407 mmW × 358 mmD (5 ¼ in. H × 16 in. W × 14 in. D).
Weight: 11 kg (24 lb)

Footnotes:

① **Trigger Error:**

$$\frac{\sqrt{e_i^2 + e_n^2}}{\text{Input Slew Rate in V/s at Trigger point}} \text{ s rms}$$

Where e_i = Effective rms noise of counter's input channel. (100 μV typical)
e_n = rms noise of the input signal for a 500 MHz bandwidth.

② For oscillator off time less than 24 hours. Final value is defined as frequency 24 hours after turn on; an indicator (▼) appears in the display until the oven reaches operating temperature.
③ Available with HP 5350B/5351B only.
④ Options 001 and 010 are mutually exclusive.

Table 1-5. Recommended Test Equipment

Instrument	Required Characteristics	Use*	Recommended Model
Oscilloscope	275 MHz bandwidth Delayed sweep capability	T,A	HP 1725A
Oscilloscope Probe (2 required)	High impedance (10:1) Minimal capacitance (8-10 pF)	T,A	HP 10017A
Active Probe	≥350 MHz 100:1 divide capability	T	HP 1120A
High Impedance Oscilloscope Probe	10MΩ or greater	T	HP 10014A
Storage Oscilloscope	100 MHz bandwidth Storage capability	T	HP 1744A
Sweep Oscillator	.01-20 GHz [26.5 GHz] Frequency Modulation capability 20 MHz p-p	OV,P	HP 8350B mainframe/ HP 83595A plug-in
Synthesized Signal Generator	10 MHz to 2.6 GHz 5% Amplitude Modulation 200 kHz FM p-p -40 dBm to +10 dBm	T,A	HP 8660C mainframe/ HP 86603A plug-in/ HP 86632B plug-in
Synthesizer Sweeper	10 MHz to 26.5 GHz	A	HP 8340B
Synthesizer	2 GHz to 26.5 GHz 1 Hz accuracy +4 dBm output	P	HP 8673B
Synthesizer	10 Hz to 10 MHz -20 dBm to +5 dBm	OV,P	HP 3325A
Millimeter-wave Source Module	+5 dBm -15 dBc harmonic and subharmonic suppression	OV,P	HP 83554A
Spectrum Analyzer	RF inputs from 1 MHz to 500 MHz	T,P	HP 8565A
Digital Voltmeter	4 ½ digit AC/DC	T,A	HP 3466A
Variable Transformer	120V/240V	T	Allied Electronics P/N 927-6010(120V) P/N 927-6120(240V)
Signature Analyzer	TTL compatible QUAL mode required	T	HP 5005B
Power Meter	50 MHz to 40 GHz	A,OV,P	HP 436A
Power Sensor	50 MHz to 26.5 GHz -30 to +10 dBm	A,OV,P	HP 8485A
Power Sensor	26.5-40 GHz -30 to +10 dBm	OV,P	HP R8486A

*T = Troubleshooting
A = Adjustments
OV = Operation Verification
P = Full Performance Testing

Table 1-5. Recommended Test Equipment (Continued)

Instrument	Required Characteristics	Use*	Recommended Model
Frequency Counter	9-digit resolution	A	HP 5384A
Waveguide Attenuator	26.5-40 GHz	P	HP R382A
Amplifier	13.5-20 GHz +17 dBm output minimum 12 dB gain minimum	P	HP 8349B (Option 002)
Waveguide Directional Coupler	26.5-40 GHz 10 dB coupling	P	HP R752C
Waveguide-to-Coax Adapter	UG599/U to APC 3.5 female	P	Maury U230A
Power Supply	480 mA @ 20V	T	HP 6216A
Sampling Voltmeter	±3% accuracy at 10 MHz	T	HP 3406A
Controller	IEEE-488 Interface compatible BASIC compatible	T,OV,P	HP-85B HP 82937A Interface HP 82936A ROM Drawer HP 82903A 16K Memory Module Advanced Programming ROM HP P/N 00085-15005
Power Splitter	DC to 26.5 GHz	OV,P	HP 11667B
50Ω Termination	DC to 26.5 GHz	P	HP 909D
50Ω Feedthrough Termination	BNC male to BNC female	OV,P	HP 10100C
Step Attenuator	DC to 26.5 GHz	OV,P	HP 8495D
Fixed Attenuator	10 dB ±1 dB	P	HP 8493C (Option 010, Option 890)
Fixed Attenuator	20 dB Attenuation	A	HP 8491A Option 20
Extender Boards (2 required)	50 pin (2 X 25)	T	HP P/N 5060-0175
Extender Cable	SMB male to SMB female	T	HP P/N 05350-60102
IF Test Cable	90° SMB female to BNC male	T	HP P/N 05350-60121
LO Test Cable	90° SMB male to BNC male	T	HP P/N 05350-60120
HP-IB Verification Tape	Rev. H or later	T,OV,P	HP P/N 59300-10002

*T = Troubleshooting
A = Adjustments
OV = Operation Verification
P = Full Performance Testing

SECTION IV
PERFORMANCE TESTS

4-1. INTRODUCTION

4-2. This section contains procedures for testing the electrical performance of the HP 5350B, 5351B and 5352B Microwave Frequency Counters, using the specifications listed in *Table 1-1* as performance standards. All test procedures in this section apply to all three models unless otherwise indicated. Specifications which apply only to an individual model are indicated in the following procedures by being enclosed in brackets, [ ].

4-3. OPERATION VERIFICATION

4-4. The Operation Verification procedure, beginning at paragraph 4-17, is an abbreviated series of tests that may be performed to give a high degree of confidence that the instrument is operating properly without performing the complete Performance Test. An Operation Verification should be useful for incoming inspection, routine maintenance, and after instrument repair.

4-5. PERFORMANCE TEST

4-6. The complete Performance Test procedures begin at paragraph 4-30. All tests can be performed without access to the inside of the instrument.

4-7. HP-IB VERIFICATION

4-8. An HP-IB verification program, described in paragraph 4-24, exercises the instrument through the majority of its command set via the HP-IB interface. The program is written for an HP-85B as the controller. If the instrument successfully completes all phases of the verification program, there is a very high probability that the HP-IB interface and the counter are working properly. The HP-IB program is available on a cassette, HP Part No. 59300-10002 (Revision H or later).

4-9. EQUIPMENT REQUIRED

4-10. The equipment required for all test procedures in this section is listed in *Table 1-5*. Any equipment that satisfies the required characteristics given in the table may be substituted for the recommended models.

4-11. CALIBRATION CYCLE

4-12. The HP 5350B/51B/52B requires periodic verification of operation. Depending on the use and environmental conditions, the counter should be checked using the Operation Verification procedure at least once every year. A full calibration procedure, including adjustments and a full Performance Test, should be performed at least once every 6 months for instruments equipped with the standard TCXO timebase, at least once a year for instruments equipped with the Option 001 Oven Oscillator Timebase, and once every 5 years for instruments equipped with the Option 010 High Stability Timebase, in order to maintain kHz accuracy of the HP 5350B/51B/52B.

4-13. TEST RECORD

4-14. Results of the operation verification should be recorded on a copy of the Operation Verification Record, *Table 4-3*, located at the end of the procedure. Results of the Performance Tests should be recorded on a copy of the Performance Test Record, *Table 4-4*, located at the end of this section.

4-15. OPTION TEST SPECIFICATIONS

4-16. The Operation Verification and Performance Tests described in this section are intended for testing of the standard HP 5350B/51B/52B. If Option 002 (Rear Panel Inputs) or Option 006 (Limiter) is installed in the 5350B or 5351B, the sensitivity specifications of the counter will be different from the standard instrument. An HP 5350B or 5351B equipped with either, or both, options should be tested using the same procedures as for the standard instrument, using the option specifications listed in Section I as performance standards. Refer to *Table 1-1, Specifications*, and Section III, paragraphs 3-47 and 3-49, for information on Option 002 and 006 specifications.

NOTE

The following operation verification and performance test procedures require measurement of the actual input sensitivity of the 5350B/5351B/5352B. The actual sensitivity MUST be measured as follows:

1. Before measuring, be sure to calibrate the power meter according to the frequency calibration data provided on the power sensor to be used in the test.

2. To measure actual sensitivity, decrease the input level to the counter until it stops counting, then slowly increase the input level until the counter measures the input properly (as defined by the particular procedure being performed).

4-17. OPERATION VERIFICATION PROCEDURE

4-18. Power-Up Self Test

a. Before connecting the power cord and switching on the instrument, be sure that the line voltage selector is properly set, the correct fuse is installed, and all safety precautions have been observed.

b. Set the POWER switch to the ON position and verify the Power-Up Self Test routine, as follows:

1. Immediately after switching the power on, the counter performs a display test in which all segments of the liquid crystal display are turned on. The display should remain in this state for about three seconds. Check that no segments are missing.

2. If any of the internal tests fail, the results of the first test failing will be displayed after the display test. Pressing the RESET/LOCAL key will display the next test, if any, failing. When all failing tests have been displayed, the HP-IB address will be displayed for about two seconds. If all tests pass, the HP-IB address will be displayed immediately after the display test.

3. After the HP-IB address is displayed, the counter should go into the measurement mode last selected (if the counter had previously been left in Standby), or into the Auto mode with FM Rate/Track set to NORMAL (if AC power had previously been disconnected from the counter).

4. If a FAIL message is displayed during the Power-Up Self Test, refer to troubleshooting procedures in Section VIII, Service, for information about specific diagnostic failures.

c. Enter results of the Power-Up Self Test on the Operation Verification Record (*Table 4-3*).

4-19. INPUT 2, Gating and Counting Check

a. Set the counter to the INPUT 2, 50Ω impedance mode by pressing the 50Ω key.

b. Connect the rear panel 10MHZ OUT BNC to the front panel INPUT 2. Verify that the instrument displays: 10 000 000 (±1 Hz).

c. Enter results on the Operation Verification Record.

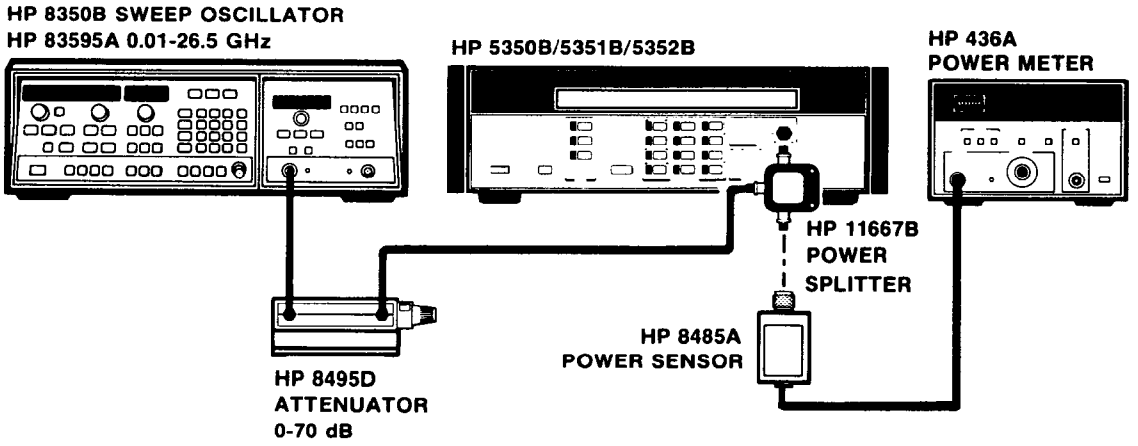
4-20. INPUT 2, 10 Hz-525 MHz Input Sensitivity Test

4-21. The following test is in two parts, Setup 1 for 50 MHz to 525 MHz, and Setup 2 for 10 Hz to 20 MHz.

Specification: 50Ω: 10 MHz-525 MHz, 25 mV rms
1MΩ: 10 Hz-80 MHz, 25 mV rms

Description: The counter is set to the 10 MHz-525 MHz range, 50Ω impedance, and a 25 mV rms (-19.3 dBm) signal is applied to INPUT 2. The test generator is set to selected frequencies and the 5350B/51B/52B is checked for proper counting. The counter is next set for 1MΩ impedance, a 25 mV rms (-19.3 dBm) 80 MHz signal is applied to INPUT 2 through a 50Ω feedthrough, and the counter is checked for proper counting. The test setup is changed to Setup 2 to test the 10 Hz-20 MHz range.

Setup 1: INPUT 2, 50 MHz-525 MHz



a. Set the counter to the 10 MHz-525 MHz range, 50Ω impedance, by pressing the 50Ω key.

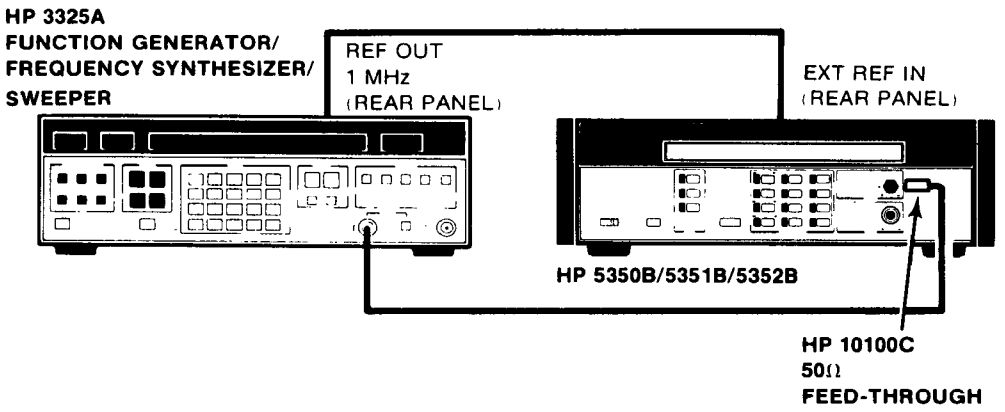
b. Set the 8350B to 50 MHz, and the 83595A and 8495D for an output level of 25 mV rms (-19.3 dBm) as measured on the 436A Power Meter. Measure actual sensitivity and verify that the 5350B/51B/52B counts properly at 50 MHz, 100 MHz, 250 MHz, and 525 MHz. (Note that exact frequencies may not be achieved due to the frequency stability characteristics of the 8350B source.) Enter the results in the Operation Verification Record (*Table 4-3*).

c. Insert a 50Ω feedthrough between the 11667B power splitter and INPUT 2 of the counter. Press the 1MΩ key on the counter to select the 1MΩ impedance, 10 Hz-80 MHz input.

d. Set the 8350B to 80 MHz, and set the 83595A for a level of 25 mV rms (-19.3 dBm) as measured on the 436A Power Meter.

e. Verify that the 5350B/51B/52B counts properly at 80 MHz at 25 mV rms, and enter the result in the Operation Verification Record.

Setup 2: INPUT 2, 10 Hz-20 MHz



a. 5350B/51B/52B settings are the same as in the 80 MHz test (INPUT 2, 1MΩ).

b. Connect the 3325A to INPUT 2 of the counter via a 50Ω feedthrough. Set the 3325A for an output of 25 mV rms (-19.3 dBm) at 10 Hz.

c. Verify that the counter counts properly at 10 Hz, 50 kHz, 1 MHz, 10 MHz, and 20 MHz. Enter results in the Operation Verification Record.

4-22. INPUT 1, 500 MHz-20 GHz [26.5 GHz, 40 GHz] Input Sensitivity Test

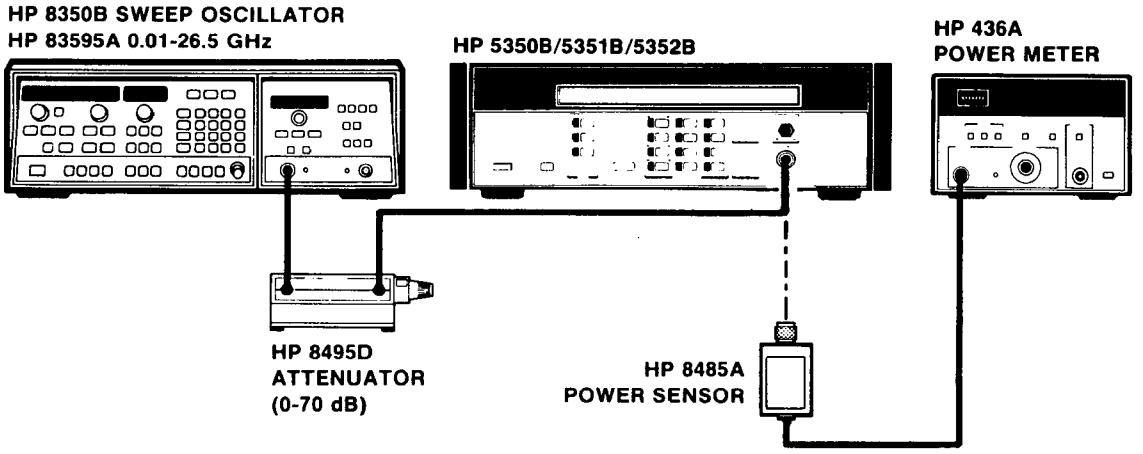
4-23. The following test is in two parts, Setup 1 for 500 MHz to 20 [26.5] GHz, and Setup 2 for 26.5 GHz to 40 GHz [5352B only].

Specifications:

5350B sensitivity	=	-32 dBm, 500 MHz-12.4 GHz
	=	-27 dBm, 12.4 GHz-20 GHz
5351B sensitivity	=	-32 dBm, 500 MHz-12.4 GHz
	=	-27 dBm, 12.4 GHz-20 GHz
	=	-16 dBm, 20 GHz-26.5 GHz
5352B sensitivity	=	-25 dBm, 500 MHz-26.5 GHz
	=	0.741 × freq. in GHz - 44.6 dBm, for frequencies greater than 26.5 GHz. (-15 dBm at 40 GHz)

Description: The counter is set to the 500 MHz-20 GHz [26.5 GHz, 40 GHz] range and the appropriate input signal is applied to INPUT 1. The generator is set to selected frequencies and levels appropriate to the model being tested, and the actual sensitivity of the HP 5350B/51B/52B is measured up to 20 GHz [26.5 GHz, 5351B/5352B]. Setup 2 is used to measure the actual sensitivity of the 5352B at selected frequencies up to 40 GHz.

Setup 1: 500 MHz-20 GHz [26.5 GHz]



a. Set the counter to INPUT 1, Automatic mode by pressing the AUTO key.

b. Connect the equipment as shown in Setup 1.

c. Set the 8350B to 500 MHz, and set the 83595A and 8495D for -32 dBm [-25 dBm, 5352B], as measured on the 436A.

d. Measure the actual sensitivity at 500 MHz, 1 GHz, 5 GHz, and 12.4 GHz. (Verify the signal level with the 436A Power Meter at each of these frequencies.) Enter the actual sensitivity result in the Operation Verification Record.

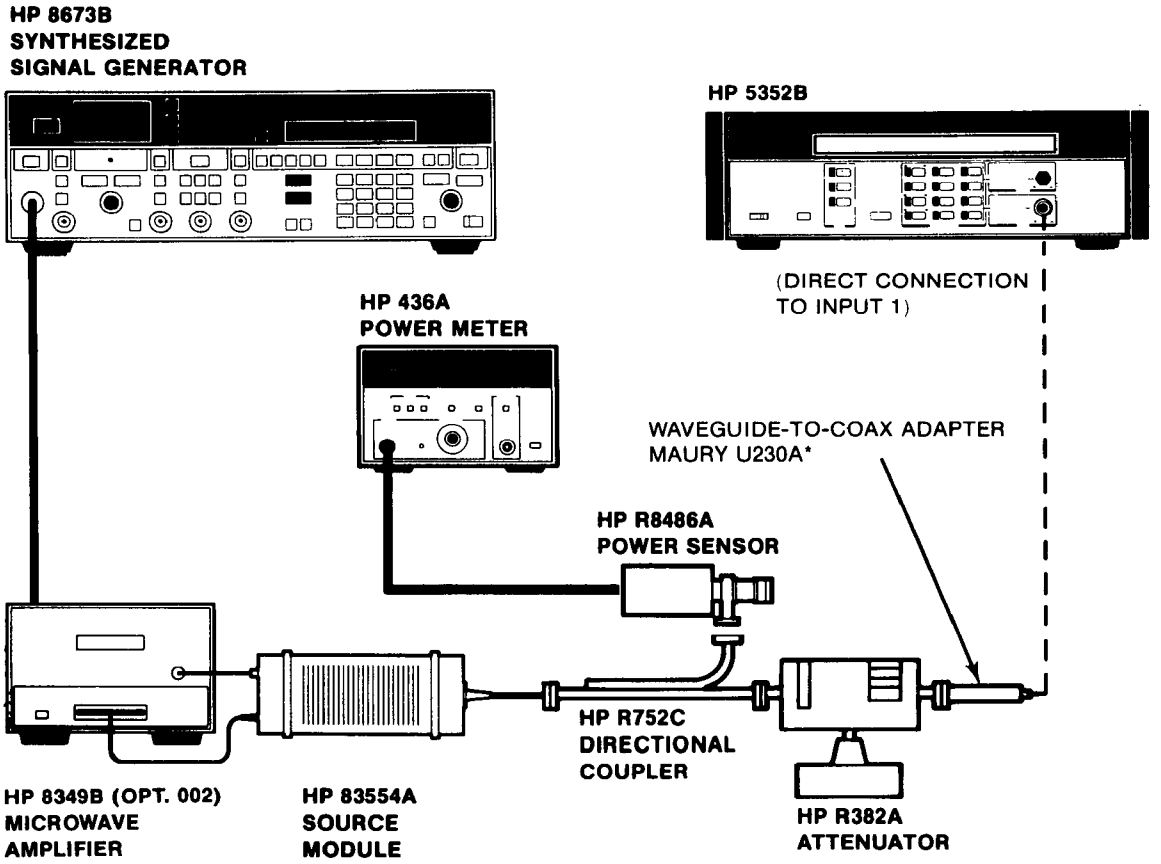
e. Set the 8350B to 18 GHz. Set the 83595A and 8495D for -27 dBm [-25 dBm, 5352B] as measured on the 436A.

f. Measure the actual sensitivity at 18 GHz and 20 GHz. (Verify the signal level with the 436A Power Meter at each of these frequencies.) Enter the actual sensitivity result in the Operation Verification Record.

g. If a 5351B is being tested, set the 83595A and 8495D for -16 dBm at 22 GHz. Measure the actual sensitivity at 22 GHz and 26.5 GHz. Enter the actual sensitivity result in the Operation Verification Record.

h. If a 5352B is being tested, leave the 83595A and 8495D set to -25 dBm at 22 GHz. Measure the actual sensitivity at 22 GHz and 26.5 GHz. Enter the actual sensitivity result in the Operation Verification Record.

Setup 2: 26.5 GHz-40 GHz [5352B]



*Available from: Maury Microwave Corporation, 8610 Helms Avenue, Cucamonga, CA 91730.

a. Set the 5352B to INPUT 1, Automatic mode by pressing the AUTO key.

b. Connect the equipment as shown in Setup 2.

c. Measure the actual sensitivity at 26.5 GHz, 30 GHz, 34 GHz, and 40 GHz, as follows:

1. Set the 8673B to 13.25 GHz, and set the level for a +17 dBm output from the 8349B Amplifier (as indicated on the 8349B front panel display).

2. Add attenuation by adjusting the R382A Precision Attenuator until the counter stops measuring, then decrease the attenuation until the counter measures the input properly.

3. Note the doubled frequency (26.5 GHz) power reading on the 436A, add +10 dB to the reading, and subtract the value of the R382A attenuator setting to obtain the sensitivity level of the counter.

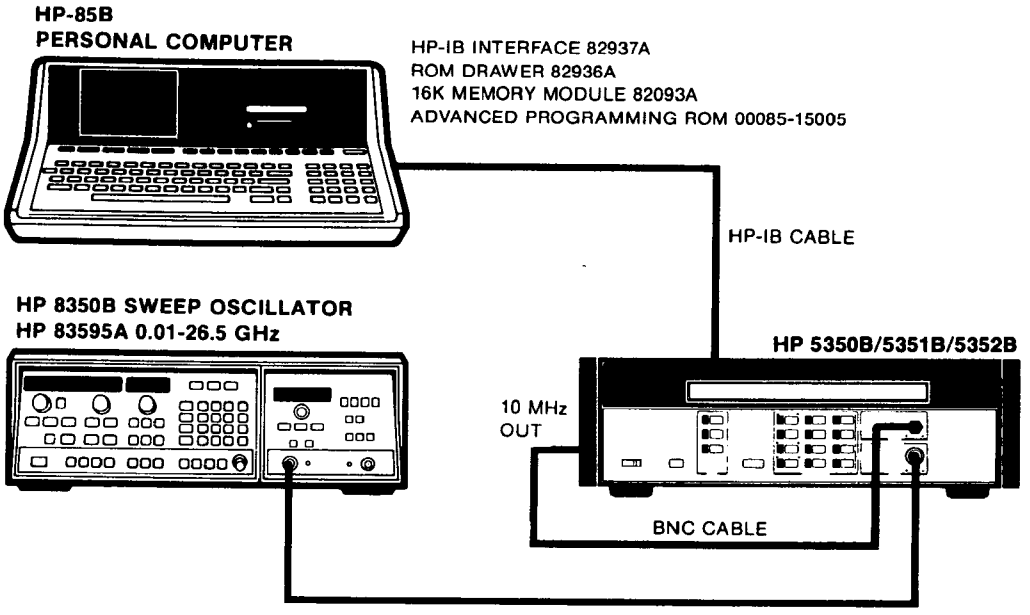
4. Repeat the above steps at 30 GHz, 34 GHz, and 40 GHz (15, 17, and 20 GHz input to the source module, respectively).

d. Enter the actual sensitivity result in the Operation Verification Record.

4-24. HP-IB VERIFICATION

4-25. The HP-85 program listed in *Table 4-1* exercises the HP 5350B/51B/52B through various operating modes via the counter's HP-IB interface. If the counter successfully completes all phases of the verification program, there is a high probability that the HP-IB interface (A11 Assembly) is operating correctly. This program is not intended to be an automated test system for operation verification of the entire counter, but rather an aid to verify that the HP-IB interface is handshaking properly, sending valid data to the controller, and controlling the counter properly. If the HP 5350B/51B/52B does not respond as described, refer to A11 HP-IB Interface Assembly troubleshooting in Section VIII.

4-26. To perform the verification, set up the HP 5350B/51B/52B, HP-85B, and signal source as shown below. The program will function with any valid HP-IB address set for the counter.



NOTE

If using an HP-85A, a Mass Storage ROM (HP P/N 00085-15001) and I/O ROM (HP P/N 00085-15003) will be required to run the verification program.

4-27. The program listed in *Table 4-1* may be keyed into the HP-85B, or may be loaded from an HP-IB Verification Cassette, HP P/N 59300-10002, (Revision H or later). To run the program on the cassette, insert the cassette into the HP-85B, load the program "505152", and press RUN.

4-28. The program goes through 16 checkpoints, including a test to verify remote response at all legal addresses (Checkpoint 16). At the conclusion of each checkpoint, the operator is requested to enter the results of the current checkpoint. These results are stored and can be printed upon completion of the program. *Table 4-2* is a sample printout of the results of the HP-IB Verification program. The printed listing of results should be attached to the Operation Verification Record (*Table 4-3*).

4-29. Various checkpoints throughout the program ask the operator to verify that the counter's GATE annunciator is on, as well as other annunciators. Note that if a signal is present at the appropriate input, the GATE annunciator should be flashing at a rate proportional to the sample rate.

Table 4-1. HP-85 Program Listing

```
5 ! ***HP 5350/5351/5352**
10 !    HP-IB OPERATION
15 !  VERIFICATION PROGRAM
20 !
25 ! BJG, SM
30 ! DATE: 12 JUNE 1986
35 ! REVISION C
40 !
45 ! This program exercises
50 ! 5350/5351/5352 through the
55 ! majority of its command
60 ! code set via HP-IB.  The
65 ! program consists of 16
70 ! checkpoints, and provides
75 ! the user with the ability
80 ! to execute and repeat
85 ! these tests in any order.
90 ! Also provided are options
95 ! to print the checkpoint
100 ! summary and results.  The
105 ! program relies on
110 ! subroutines in addition
115 ! to arrays and simple
120 ! variables.
125 !
130 ! Dimension and initialize
135 ! string variable arrays.
140 PRINTER IS 2
145 OPTION BASE 1
150 DIM A$[32],B$[32],D$[24],F$[32],G$[32]
155 DIM H$[32],I$[32],N$[7],R$[15],R(16)
160 DIM S$[68],D(30),D1(30)
165 D=0
170 T=0
175 ! VARIABLE TABLE
180 ! A=Address of counter
185 ! C=CRT(1) or PRINTER(2)
190 ! D=Desired checkpoint
195 ! T=Test$
200 ! I=Do Loop Index
205 ! M=Measmt data (real)
210 ! M1=Measmt data (real)
215 ! K=Address failure counter
220 ! J=Address pass counter
225 ! D(30)=Failed address array
230 ! D1(30)=Passed address array
235 ! R(16)=Array to store test results
240 A$="Press CONT to perform test."
245 B$="Press CONT when ready."
250 ! D$= ASCII data
255 N$="" ! ID of counter
260 F$="Press CONT for next display."
265 G$="          CHECKPOINT "
270 H$="********************************"
275 ! R$="PASS" or "FAIL"
280 ! S$=Front panel set-up data
285 !
290 ! Initialize test
295 ! results array
300 FOR I=1 TO 16
305 R(I)=2
310 NEXT I
315 CRT IS 1
320 C=1
325 ENABLE KBD 1+32
330 !
335 ! DISPLAY TITLE, CHECKPOINT LIST AND
340 ! SETUP INSTRUCTIONS
345 CLEAR
350 DISP USING "5/,"
355 DISP H$
360 DISP
365 DISP "5350/5351/5352 HP-IB OPERATION "
370 DISP "        VERIFICATION PROGRAM"
375 DISP
380 DISP H$
385 DISP
390 WAIT 2500
395 CLEAR
400 DISP USING "5/,"
405 DISP H$
410 DISP
415 DISP H$
420 DISP
425 DISP "       CHECKPOINT SUMMARY"
430 DISP
435 DISP H$
440 DISP
445 ! IF PRINTER(2) THEN SKIP
450 ! WAIT AND CLEAR
455 IF C=2 THEN 470
460 WAIT 2000
465 CLEAR
470 DISP " 1 Remote,Local Lockout, Local"
475 DISP " 2 Self Check ('TEST?')"
480 DISP " 3 'DISPLAY'"
485 DISP " 4 'INIT' & 'RESET'"
490 DISP " 5 'REF' & 'OVEN'"
495 DISP " 6 'ERR?'"
500 DISP " 7 'SET' & 'SET?'"
505 DISP " 8 'LOWZ' & 'HIGHZ'"
510 DISP " 9 'SAMPLE' & 'TRIGGER'"
515 DISP " 10 'RESOL' & 'HIRESOL'"
520 DISP " 11 'OFFSET', 'SCALE' & 'SMOOTH'"
525 DISP " 12 'AUTO' & 'MANUAL'"
530 DISP " 13 'FMRATE'"
535 DISP " 14 'SRQMASK'"
540 DISP " 15 'DUMP'"
545 WAIT 3000
550 CLEAR
555 DISP " 16 CHECK ALL ADDRESSES"
560 ! IF PRINTING,CONTINUE
565 IF C=2 THEN GOTO 665
570 DISP
575 DISP F$
580 PAUSE
585 CLEAR
590 DISP "Would you like a printed version"
595 DISP "of the checkpoint summary?"
600 DISP USING "3/,"
605 DISP "YES-Press K1 to receive a"
610 DISP "printed version."
615 DISP
620 DISP "NO-Press K4 to proceed"
625 ON KEY$ 1,"YES" GOTO 645
630 ON KEY$ 4,"    NO" GOTO 680
635 KEY LABEL
640 GOTO 640
645 CLEAR ! YES PRINTOUT
650 CRT IS 2
655 C=2
660 GOTO 405 ! GO BACK AND PRINT
665 DISP USING "5/,"
670 CRT IS 1
675 C=1
680 CLEAR ! NO PRINTOUT
685 DISP "The HP 85B should have an "
690 DISP "Advanced Prgrm Rom in its ROM"
695 DISP "Drawer and an 82937A HP-IB"
700 DISP "Interface Card/Cable."
705 DISP "Connect the HP-IB Interface to"
710 DISP "the rear panel of the HP 5350"
715 DISP "5351, or 5352 and power-up the"
720 DISP "instrument.  A source capable"
```

Table 4-1. HP-85 Program Listing (Continued)

```
725 DISP "of outputting 1 GHz from -10"
730 DISP "dBm to +10 dBm will also be"
735 DISP "needed to complete this"
740 DISP "verification."
745 WAIT 10000
750 CLEAR
755 DISP
760 DISP "Consult the HP 5350/5351/5352"
765 DISP "Operating and Service Manual"
770 DISP "for additional information."
775 DISP
780 DISP B$
785 PAUSE
790 !
795 ! SEARCH FOR 5350/5351/5352
800 !       ADDRESS
805 CLEAR
810 DISP USING "3/,"
815 DISP "Searching for counter address..."
820 SET TIMEOUT 7;1000
825 ON TIMEOUT 7 GOTO 905
830 FOR A=700 TO 730
835 ! 721 = ADDRESS OF CONTROLLER
840 IF A=721 THEN 915
845 REMOTE A
850 OUTPUT A ;"ID?"
855 ENTER A ; N$
860 IF N$="HP5350A" THEN 965
865 IF N$="HP5351A" THEN 965
870 IF N$="HP5352A" THEN 965
875 IF N$="HP5350B" THEN 965
880 IF N$="HP5351B" THEN 965
885 IF N$="HP5352B" THEN 965
890 IF N$="HP5350M" THEN 965
895 IF N$="HP5351M" THEN 965
900 IF N$="HP5352M" THEN 965
905 ABORTIO 7
910 CLEAR A
915 NEXT A
920 BEEP 250,25
925 WAIT .1
930 BEEP 250,25
935 DISP
940 DISP "Address not found."
945 DISP
950 DISP B$
955 PAUSE
960 GOTO 805 ! TRY AGAIN
965 DISP
970 DISP N$;" found at address";A;"."
975 BEEP 250,25
980 WAIT 250
985 BEEP 250,25
990 WAIT 2000
995 SET TIMEOUT 7;0
1000 ! IF CKPT 16 THEN RETURN TO
1005 ! IT
1010 IF T=16 THEN GOTO 6095
1015 GOSUB 6500 ! CHOOSE 1ST CHKPT
1020 GOTO 6440 ! GOTO CHECKPOINT
1025 !
1030 !  CHECKPOINT 1
1035 T=1
1040 I$="REMOTE, LOCAL LOCKOUT AND LOCAL"
1045 GOSUB 6100 ! DISPLAY TITLE
1050 DISP
1055 DISP "Checkpoint 1 tests the"
1060 DISP "REMOTE, LOCAL LOCKOUT,"
1065 DISP "and LOCAL HP-IB commands."
1070 DISP "Each command will be "
1075 DISP "programmed and the operator"
1080 DISP "will be prompted as to what"
1085 DISP "conditions should be verified."
1090 DISP
1095 DISP B$
1100 PAUSE
1105 CLEAR
1110 LOCAL A
1115 REMOTE A
1120 OUTPUT A ;"INIT"
1125 DISP
1130 DISP "             REMOTE"
1135 DISP
1140 DISP "Verify that the REM,LSN,FM NORM"
1145 DISP "and AUTO annunciators are on."
1150 DISP
1155 DISP B$
1160 PAUSE
1165 CLEAR
1170 DISP
1175 DISP "        LOCAL LOCKOUT"
1180 DISP
1185 DISP "Verify that pressing any of the"
1190 DISP "front panel keys other than"
1195 DISP "POWER will not affect the "
1200 DISP N$;"."
1205 DISP USING "2/,"
1210 DISP B$
1215 LOCAL LOCKOUT 7
1220 PAUSE
1225 CLEAR
1230 DISP
1235 DISP "              LOCAL"
1240 DISP
1245 DISP "Verify that the REM annunciator"
1250 DISP "is no longer on, and the ";N$
1255 DISP "responds to front panel entries."
1260 LOCAL 7
1265 DISP USING "2/,"
1270 DISP B$
1275 PAUSE
1280 REMOTE A
1285 GOTO 6185 ! RECORD RESULTS
1290 !
1295 !  CHECKPOINT 2
1300 T=2
1305 I$="     SELF CHECK ('TEST?')"
1310 GOSUB 6100 ! DISPLAY TITLE
1315 DISP
1320 DISP "Checkpoint 2 tests the 'TEST?'"
1325 DISP "HP-IB command.  The results of"
1330 DISP "the SELF CHECK will be sent over"
1335 DISP "the bus and displayed on the"
1340 DISP "controller CRT."
1345 DISP
1350 DISP B$
1355 PAUSE
1360 CLEAR
1365 REMOTE A
1370 OUTPUT A ;"INIT"
1375 OUTPUT A ;"TEST?"
1380 ENTER A ; D$
1385 DISP "The results of SELF CHECK are:"
1390 DISP
1395 DISP "   ";D$
1400 DISP
1405 IF D$[1,4]="PASS" THEN 1445
1410 DISP "The ";N$;" failed the SELF"
1415 DISP "CHECK.  It is recommended that"
1420 DISP "the fault on the ";D$[18,19];" or"
1425 DISP "associated assemblies be "
```

Table 4-1. HP-85 Program Listing (Continued)

```
1430 DISP "corrected before continuing with"
1435 DISP "the HP-IB verification."
1440 DISP
1445 DISP "Press CONT to record the results"
1450 PAUSE
1455 GOTO 6185 ! RECORD RESULTS
1460 !
1465 !   CHECKPOINT 3
1470 T=3
1475 I$="        'DISPLAY' COMMAND"
1480 GOSUB 6100 ! DISPLAY TITLE
1485 DISP
1490 DISP "Checkpoint 3 tests the 'DISPLAY'"
1495 DISP "HP-IB command."
1500 DISP
1505 DISP B$
1510 OUTPUT A ;"INIT"
1515 PAUSE
1520 CLEAR
1525 DISP USING "3/,"
1530 DISP "Verify that the "¡N$¡" display"
1535 DISP "shows 'HP-IB VERIFICATION'."
1540 OUTPUT A ;"DISPLAY,'   HP-IB  VERIFICATION'"
1545 DISP
1550 DISP "Press CONT to record results."
1555 PAUSE
1560 OUTPUT A ;"DISPLAY,''"
1565 GOTO 6185 ! RECORD RESULTS
1570 !
1575 !    CHECKPOINT 4
1580 T=4
1585 I$="        'INIT' & 'RESET'"
1590 GOSUB 6100 ! DISPLAY TITLE
1595 DISP
1600 DISP "Checkpoint 4 tests the 'INIT'"
1605 DISP "and 'RESET' HP-IB commands."
1610 DISP
1615 DISP B$
1620 OUTPUT A ;"INIT"
1625 ! SET UP INSTRUMENT STATE
1630 ! TO BE INITIALIZED
1635 OUTPUT A ;"OFFSET,ON¡SCALE,ON¡SMOOTH,ON"
1640 PAUSE
1645 REMOTE A
1650 OUTPUT A ;"INIT"
1655 CLEAR
1660 DISP USING "2/,"
1665 DISP "            'INIT'"
1670 DISP
1675 DISP "Verify that the REM, LSN, FM"
1680 DISP "NORM and AUTO annunciators are "
1685 DISP "on and that the display shows"
1690 DISP
1695 DISP "       00 000 000 000"
1700 DISP
1705 DISP "without an input."
1710 DISP
1715 DISP B$
1720 PAUSE
1725 ! SET UP ERROR CONDITION
1730 ! MANUAL FREQ 9E+99 IS OUT
1735 ! OF RANGE
1740 OUTPUT A ;"MANUAL,9E+99"
1745 CLEAR
1750 DISP USING "3/,"
1755 DISP "             'RESET'"
1760 DISP
1765 DISP "Verify that the "¡N$[1,7]¡" exhibits"
1770 DISP
1775 DISP "   OUT OF RANGE  3 ERROR"
1780 DISP
1785 DISP "Press CONT to send the 'RESET'"
1790 DISP "command.  Verify that the error"
1795 DISP "message is cleared and the"
1800 DISP "REM,LSN,AUTO,and FM NORM"
1805 DISP "annunciators are on."
1810 PAUSE
1815 OUTPUT A ;"RESET"
1820 DISP
1825 DISP "Press CONT to record results."
1830 PAUSE
1835 GOTO 6185 ! RECORD RESULTS
1840 !
1845 !         CHECKPOINT 5
1850 T=5
1855 I$="         'OVEN?' & 'REF?'"
1860 GOSUB 6100 ! DISPLAY TITLE
1865 DISP
1870 DISP "Checkpoint 5 tests the 'OVEN?'"
1875 DISP "and 'REF?' HP-IB commands."
1880 DISP
1885 DISP B$
1890 PAUSE
1895 CLEAR
1900 DISP "             'REF?'"
1905 DISP
1910 DISP "Disconnect the external"
1915 DISP "reference if one is connected."
1920 DISP
1925 DISP B$
1930 PAUSE
1935 REMOTE A
1940 OUTPUT A ;"INIT"
1945 ! ENTER THE STATUS OF THE REFERENCE
1950 OUTPUT A ;"REF?"
1955 ENTER A ; D$
1960 CLEAR
1965 DISP "           'REF?'"
1970 DISP
1975 DISP "Verify that the OVEN and EXT REF"
1980 DISP "annunciators are off."
1985 DISP
1990 DISP B$
1995 PAUSE
2000 CLEAR
2005 DISP "           'REF?'"
2010 DISP
2015 DISP "The "¡N$¡" has returned its"
2020 DISP "timebase reference status as "
2025 DISP
2030 DISP "            "¡D$¡"ERNAL"
2035 DISP
2040 IF D$="INT" THEN 2055 ELSE 2045
2045 DISP "RETURNED HP-IB DATA INCORRECT"
2050 DISP
2055 DISP B$
2060 PAUSE
2065 CLEAR
2070 DISP "           'REF?'"
2075 DISP
2080 DISP "Connect an external timebase,"
2085 DISP "to the external reference on the"
2090 DISP "rear panel."
2095 DISP
2100 DISP B$
2105 PAUSE
2110 OUTPUT A ;"REF?"
2115 ENTER A ; D$
2120 CLEAR
2125 DISP "           'REF?'"
```

Table 4-1. HP-85 Program Listing (Continued)

```
2130 DISP
2135 DISP "Verify that the EXT REF"
2140 DISP "annunciator is on.  The ";N$
2145 DISP "has returned a reference status"
2150 DISP "of"
2155 DISP
2160 DISP "          ";D$;"ERNAL"
2165 DISP
2170 IF D$="EXT" THEN 2180 ELSE 2175
2175 DISP "RETURNED HP-IB DATA INCORRECT"
2180 DISP B$
2185 PAUSE
2190 CLEAR
2195 DISP
2200 DISP
2205 DISP "          'OVEN?'"
2210 DISP
2215 DISP "Disconnect the external timebase"
2220 DISP
2225 DISP "If the ";N$;" has option 001"
2230 DISP "or 010 (ovenized oscillators),"
2235 DISP "the returned status is valid."
2240 DISP "If the counter does not have"
2245 DISP "these options, the returned"
2250 DISP "status will always be 'WARM'."
2255 DISP
2260 DISP "Press CONT to perform test."
2265 PAUSE
2270 OUTPUT A ;"OVEN?"
2275 ENTER A ; D$
2280 DISP
2285 DISP "The oven status is ";D$
2290 DISP
2295 DISP "Press CONT to record results."
2300 PAUSE
2305 GOTO 6185 ! RECORD RESULTS
2310 !
2315 ! CHECKPOINT 6
2320 T=6
2325 I$="            'ERR?'"
2330 GOSUB 6100 ! DISPLAY TITLE
2335 OUTPUT A ;"INIT"
2340 DISP
2345 DISP "Checkpoint 6 tests the 'ERR?'"
2350 DISP "HP-IB command.  An error state"
2355 DISP "will be programmed and the"
2360 DISP "type of error read back to the"
2365 DISP "HP 85."
2370 DISP
2375 DISP B$
2380 PAUSE
2385 ! SET UP ERROR CONDITION
2390 ! 9E99 IS OUT OF RANGE
2395 OUTPUT A ;"MANUAL,9E99"
2400 OUTPUT A ;"ERR?"
2405 ENTER A ; D$
2410 CLEAR
2415 DISP "Verify that the ";N$
2420 DISP "display indicates an error of"
2425 DISP "type 3."
2430 DISP
2435 IF D$[18,18]<>"3" THEN 2440 ELSE 2450
2440 DISP "RETURNED HP-IB DATA INCORRECT."
2445 DISP
2450 DISP "Press CONT to RESET the "
2455 DISP N$;" and record the results."
2460 PAUSE
2465 OUTPUT A ;"RESET"
2470 GOTO 6185 ! RECORD RESULTS
2475 !
2480 !    CHECKPOINT 7
2485 T=7
2490 I$="        'SET' & 'SET?'"
2495 GOSUB 6100 ! DISPLAY TITLE
2500 DISP
2505 DISP "Checkpoint 7 tests the 'SET'"
2510 DISP "and 'SET?' HP-IB commands.  A"
2515 DISP "configuration will be"
2520 DISP "programmed and then saved using"
2525 DISP "the 'SET?' command.  The ";N$
2530 DISP "will be set to the initial"
2535 DISP "power-on condition and then "
2540 DISP "reprogrammed using the the"
2545 DISP "'SET' command."
2550 DISP
2555 DISP B$
2560 PAUSE
2565 REMOTE A
2570 CLEAR
2575 ! SET UP A CONFIGURATION TO
2580 ! BE SAVED
2585 OUTPUT A ;"INIT"
2590 OUTPUT A ;"SMOOTH,ON;SCALE,1,ON;FMRATE,LOW"
2595 DISP "The front panel set-up to be"
2600 DISP "stored has the SCALE,SMOOTH,"
2605 DISP "REM,LSN,FM LOW and AUTO"
2610 DISP "annunciators on."
2615 DISP
2620 DISP "Verify this set-up and press"
2625 DISP "CONT to store this configuration"
2630 DISP "and initialize the ";N$;"."
2635 PAUSE
2640 OUTPUT A ;"SET?"
2645 ! STORE THE SET-UP IN S$
2650 ENTER A ; S$
2655 OUTPUT A ;"INIT"
2660 CLEAR
2665 DISP USING "3/,"
2670 DISP "Verify that the REM,LSN,FM NORM"
2675 DISP "and AUTO annunciators are on."
2680 DISP
2685 DISP B$
2690 PAUSE
2695 OUTPUT A ;"SET,'";S$;"'"
2700 CLEAR
2705 DISP USING "3/,"
2710 DISP "Verify that the SCALE,SMOOTH,"
2715 DISP "REM,LSN,FM LOW and AUTO"
2720 DISP "annunciators are on again."
2725 DISP
2730 DISP B$
2735 PAUSE
2740 GOTO 6185 ! RECORD RESULTS
2745 !
2750 !    CHECKPOINT 8
2755 T=8
2760 I$="        'LOWZ' & 'HIGHZ'"
2765 GOSUB 6100 ! DISPLAY TITLE
2770 DISP
2775 DISP "Checkpoint 8 tests the 'LOWZ'"
2780 DISP "and 'HIGHZ' HP-IB commands."
2785 DISP "Connect the rear panel 10 MHz"
2790 DISP "OUT to input 2 of the ";N$;"."
2795 DISP
2800 DISP B$
2805 PAUSE
2810 REMOTE A
2815 OUTPUT A ;"INIT"
2820 OUTPUT A ;"LOWZ"
2825 ENTER A ; M
2830 CLEAR
2835 DISP
2840 DISP "          'LOWZ'"
2845 DISP
2850 DISP "Verify that the 50 ohm"
2855 DISP "annunciator is on as well as"
2860 DISP "the REM and TLK annunciators."
2865 DISP "The GATE annunciator should be"
```

Table 4-1. HP-85 Program Listing (Continued)

```
2870 DISP "flashing.  The display should"
2875 DISP "read:"
2880 DISP
2885 DISP "          10 000 000"
2890 DISP
2895 IF M<>10000000 THEN 2900 ELSE 2915
2900 DISP "RETURNED HP-IB DATA INCORRECT"
2905 DISP
2910 DISP "         ";M
2915 DISP
2920 DISP B$
2925 PAUSE
2930 OUTPUT A ;"HIGHZ"
2935 ENTER A ; M
2940 CLEAR
2945 DISP "             'HIGHZ'"
2950 DISP
2955 DISP "Verify that the REM, TLK, and"
2960 DISP "1 megohm annunciators are"
2965 DISP "on.  The GATE annunciator"
2970 DISP "should be flashing. The display"
2975 DISP "should read:"
2980 DISP
2985 DISP "          10 000 000"
2990 DISP
2995 IF M<>10000000 THEN 3000 ELSE 3020
3000 DISP "RETURNED HP-IB DATA INCORRECT"
3005 DISP
3010 DISP "          ";M
3015 DISP
3020 DISP "Press CONT to record results"
3025 PAUSE
3030 GOTO 6185 ! RECORD RESULTS
3035 !
3040 !    CHECKPOINT 9
3045 T=9
3050 I$="      'SAMPLE & TRIGGER'"
3055 GOSUB 6100 ! DISPLAY TITLE
3060 DISP
3065 DISP "Checkpoint 9 tests the"
3070 DISP "'SAMPLE' and 'TRIGGER' HP-IB"
3075 DISP "commands.  Connect the rear"
3080 DISP "panel 10 MHz OUT to input 2."
3085 DISP
3090 DISP B$
3095 PAUSE
3100 OUTPUT A ;"INIT"
3105 OUTPUT A ;"SAMPLE,HOLD;HIGHZ"
3110 CLEAR
3115 DISP "Verify that the HOLD,REM,"
3120 DISP "LSN, and 1 megohm annunciators"
3125 DISP "are on.  The display should"
3130 DISP "read"
3135 DISP
3140 DISP "          HOLDING---"
3145 DISP
3150 DISP "Press CONT to trigger the"
3155 DISP "counter and take a measurement."
3160 PAUSE
3165 OUTPUT A ;"TRIGGER"
3170 ENTER A ; M
3175 CLEAR
3180 DISP "The measurement should be:"
3185 DISP
3190 DISP "       10 000 000"
3195 DISP
3200 IF M<>10000000 THEN 3205 ELSE 3225
3205 DISP "RETURNED HP-IB DATA INCORECT"
3210 DISP
3215 DISP "      ";M
3220 DISP
3225 DISP "Press CONT to record results"
3230 PAUSE
3235 GOTO 6185 ! RECORD RESULTS
3240 !
3245 !    CHECKPOINT 10
3250 T=10
3255 I$="       'RESOL' & 'HIRESOL'"
3260 GOSUB 6100 ! DISPLAY TITLE
3265 DISP "Checkpoint 10 tests the 'RESOL'"
3270 DISP "and 'HIRESOL' HP-IB commands."
3275 DISP "Connect the rear panel 10 MHz"
3280 DISP "OUT to Input 2."
3285 DISP
3290 DISP B$
3295 PAUSE
3300 ! START WITH RESOLUTION OF
3305 ! 1 MHZ (RESOL,6)
3310 OUTPUT A ;"INIT"
3315 OUTPUT A ;"HIGHZ;RESOL,6"
3320 CLEAR
3325 DISP "            'RESOL'"
3330 DISP "Verify that the current reading"
3335 DISP "is to 1 MHz resolution."
3340 DISP "Pressing CONT will program"
3345 DISP "another decade of resolution."
3350 DISP
3355 DISP "Continue pressing CONT until"
3360 DISP "the counter displays the"
3365 DISP "measurement with 1 Hz resolution"
3370 DISP
3375 DISP B$
3380 PAUSE
3385 ! LOOP TO INCREASE RESOLUTION
3390 ! BY 1 DECADE WITH EACH CONT
3395 FOR I=5 TO 0 STEP -1
3400 OUTPUT A ;"RESOL,";I
3405 PAUSE
3410 NEXT I
3415 CLEAR
3420 OUTPUT A ;"HIRESOL,ON"
3425 DISP "Verify that the REM,LSN,"
3430 DISP "1 megohm, and HIGH RESOL"
3435 DISP "annunciators are on, the"
3440 DISP "GATE annunciator is flashing"
3445 DISP "and the display reads:"
3450 DISP
3455 DISP "     10 000 000. 0**"
3460 DISP
3465 DISP "Press CONT to record results"
3470 PAUSE
3475 GOTO 6185 ! RECORD RESULTS
3480 !
3485 !
3490 !    CHECKPOINT 11
3495 T=11
3500 I$="   'OFFSET'/'SCALE'/'SMOOTH'"
3505 GOSUB 6100 ! DISPLAY TITLE
3510 DISP
3515 DISP "Checkpoint 11 tests the 'OFFSET'"
3520 DISP "'SCALE', and 'SMOOTH' HP-IB"
3525 DISP "commands. Connect the rear panel"
3530 DISP "10 MHz OUT to Input 2."
3535 DISP
3540 DISP B$
3545 PAUSE
3550 REMOTE A
3555 ! SUBTRACT 5MHZ FROM THE
3560 ! 10 MHZ READING=5MHZ
3565 OUTPUT A ;"INIT"
```

Table 4-1. HP-85 Program Listing (Continued)

```
3570 OUTPUT A ;"OFFSET,-5E6,ON;HIGHZ"
3575 CLEAR
3580 DISP "          'OFFSET'"
3585 DISP "Verify that the OFFSET,REM,"
3590 DISP "TLK, and 1 megohm annunciators"
3595 DISP "are on.  The GATE light should"
3600 DISP "be flashing.  The display"
3605 DISP "should read:"
3610 DISP
3615 DISP "           5 000 000"
3620 ENTER A ; M
3625 ! CHECK MEASUREMENT
3630 IF M<>5000000 THEN 3635 ELSE 3655
3635 DISP
3640 DISP "RETURNED HP-IB DATA IS INCORRECT"
3645 DISP
3650 DISP "         ";M;"Hz"
3655 DISP
3660 DISP B$
3665 PAUSE
3670 ! MULTIPLY THE 10 MHZ
3675 ! READING BY 2=20 MHZ
3680 OUTPUT A ;"OFFSET,OFF;SCALE,2,ON"
3685 CLEAR
3690 DISP "           'SCALE'"
3695 DISP "Verify that the SCALE,REM,"
3700 DISP "TLK, and 1 megohm annunciators"
3705 DISP "are on.  The GATE annunciator"
3710 DISP "should be flashing.  The"
3715 DISP "display should read:"
3720 DISP
3725 DISP "        20 000 000"
3730 ENTER A ; M
3735 ! CHECK MEASUREMENT
3740 IF M<>20000000 THEN 3745 ELSE 3765
3745 DISP
3750 DISP "RETURNED HP-IB DATA INCORRECT"
3755 DISP
3760 DISP "         ";M;"Hz"
3765 DISP
3770 DISP B$
3775 PAUSE
3780 CLEAR
3785 DISP "           'SMOOTH'"
3790 DISP "After pressing CONT to"
3795 DISP "program the counter, verify"
3800 DISP "that the SMOOTH, REM,LSN,"
3805 DISP "and 1 megohm annunciators"
3810 DISP "are on.  The GATE annunciator"
3815 DISP "should be flashing.  The"
3820 DISP "display should initially show"
3825 DISP
3830 DISP "         10 000"
3835 DISP
3840 DISP "and increase the resolution"
3845 DISP "to 1 Hz."
3850 DISP
3855 PAUSE
3860 OUTPUT A ;"SMOOTH,ON;HIGHZ;SCALE,OFF"
3865 DISP
3870 DISP "Press CONT to record results"
3875 PAUSE
3880 OUTPUT A ;"SMOOTH,OFF"
3885 GOTO 6185 ! RECORD RESULTS
3890 !
3895 !    CHECKPOINT 12
3900 T=12
3905 I$="         AUTO & MANUAL"
3910 GOSUB 6100 ! DISPLAY TITLE
3915 DISP
3920 DISP "Checkpoint 12 tests the 'AUTO'"
3925 DISP "and 'MANUAL' HP-IB commands."
3930 DISP "Input a 1 GHz signal at"
3935 DISP "-5 dBm to Input 1 of the ";N$
3940 DISP
3945 DISP B$
3950 PAUSE
3955 REMOTE A
3960 ! SET UP AUTO MODE FOR
3965 ! SINGLE MEASUREMENT
3970 OUTPUT A ;"INIT"
3975 OUTPUT A ;"SAMPLE,HOLD;TRIGGER"
3980 ENTER A ; M
3985 IF M=1.E38 THEN GOTO 4220
3990 CLEAR
3995 DISP USING "3/,"
4000 DISP "           'AUTO'"
4005 DISP
4010 DISP "Verify that the HOLD, REM,"
4015 DISP "TLK, FM NORM and AUTO"
4020 DISP "annunciators are on and the"
4025 DISP N$;" is displaying"
4030 DISP
4035 DISP "      ";M;" Hz"
4040 DISP
4045 DISP "If the ";N$;" display does not"
4050 DISP "match the above reading, then"
4055 DISP "an error occurred in the HP-IB"
4060 DISP "transfer."
4065 DISP
4070 DISP B$
4075 PAUSE
4080 CLEAR
4085 DISP "         'MANUAL'"
4090 DISP
4095 DISP "Press CONT to trigger the ";N$[1,7];"."
4100 PAUSE
4105 OUTPUT A ;"MANUAL,LASTF"
4110 OUTPUT A ;"SAMPLE,HOLD;TRIGGER"
4115 ENTER A ; M1
4120 ! CHECK FOR NO ACQUISITION
4125 IF M1=1.E38 THEN GOTO 4220
4130 CLEAR
4135 DISP USING "3/,"
4140 DISP "             'MANUAL'"
4145 DISP
4150 DISP "Verify that the HOLD, REM, TLK,"
4155 DISP "and MAN annunciators are on"
4160 DISP "and the ";N$;" is displaying"
4165 DISP
4170 DISP "      ";M1;" Hz"
4175 DISP
4180 DISP "If the ";N$;" display does not"
4185 DISP "match the above reading, then"
4190 DISP "an error occurred in the HP-IB"
4195 DISP "transfer."
4200 DISP
4205 DISP "Press CONT to record the results."
4210 PAUSE
4215 GOTO 4255 ! SKIP FAIL MESG
4220 DISP
4225 DISP N$;" failed to acquire a"
4230 DISP "signal."
4235 DISP
4240 DISP B$
4245 DISP
4250 PAUSE
4255 GOTO 6185 ! RECORD RESULTS
4260 !
4265 !    CHECKPOINT 13
4270 T=13
4275 I$="            'FMRATE'"
4280 OUTPUT A ;"INIT"
4285 GOSUB 6100 ! DISPLAY TITLE
```

Table 4-1. HP-85 Program Listing (Continued)

```
4290 REMOTE A
4295 DISP
4300 DISP "Checkpoint 13 tests the 'FMRATE'"
4305 DISP "HP-IB command."
4310 DISP
4315 DISP "Input a 1 GHz signal at"
4320 DISP "-5 dBm to Input 1 of the ";N$
4325 DISP
4330 DISP B$
4335 PAUSE
4340 OUTPUT A ;"AUTO;FMRATE,NORMAL"
4345 CLEAR
4350 DISP "         'FMRATE',NORMAL"
4355 DISP
4360 DISP "Verify that the REM,LSN,"
4365 DISP "FM NORM, and AUTO annunciators"
4370 DISP "are on.  The GATE annunciator"
4375 DISP "should be flashing."
4380 DISP
4385 DISP B$
4390 PAUSE
4395 OUTPUT A ;"FMRATE,LOW"
4400 CLEAR
4405 DISP "         'FMRATE',LOW"
4410 DISP
4415 DISP "Verify that the REM,LSN,"
4420 DISP "FM LOW and AUTO annunciators"
4425 DISP "are on.  The GATE annunciator"
4430 DISP "should be flashing."
4435 DISP
4440 DISP "Press CONT to record results"
4445 PAUSE
4450 GOTO 6185 ! RECORD RESULTS
4455 !
4460 !    CHECKPOINT 14
4465 T=14
4470 I$="           'SRQMASK'"
4475 OUTPUT A ;"INIT"
4480 GOSUB 6100 ! DISPLAY TITLE
4485 REMOTE A
4490 DISP
4495 DISP "Checkpoint 14 tests the"
4500 DISP "'SRQMASK' HP-IB command."
4505 DISP
4510 DISP B$
4515 PAUSE
4520 CLEAR
4525 DISP "          OVERLOAD bit"
4530 DISP
4535 DISP "This section tests the"
4540 DISP "overload bit of the status byte"
4545 DISP "of the ";N$
4550 DISP
4555 DISP "Press CONT to set up the mask."
4560 DISP
4565 PAUSE
4570 OUTPUT A ;"SRQMASK,8"
4575 CLEAR
4580 DISP "Set the signal source to output"
4585 DISP "a 1 GHz signal at a level of"
4590 DISP "+10 dBm.  This will create the"
4595 DISP "overload condition."
4600 DISP
4605 DISP B$
4610 PAUSE
4615 ON INTR 7 GOTO 4650
4620 ENABLE INTR 7;8
4625 WAIT 3000
4630 OFF INTR 7
4635 DISP N$;" FAILED the OVERLOAD"
4640 DISP "bit test."
4645 GOTO 4680
4650 OFF INTR 7
4655 STATUS 7,1 ; B
4660 S=SPOLL(A)
4665 IF BIT(S,3) THEN 4670 ELSE 4635
4670 DISP N$;" PASSED the OVERLOAD"
4675 DISP "bit test."
4680 DISP
4685 DISP "Set the signal source output"
4690 DISP "level to -5 dBm."
4695 DISP
4700 BEEP 250,25
4705 WAIT .1
4710 BEEP 250,25
4715 DISP B$
4720 PAUSE
4725 CLEAR
4730 DISP "  MEASUREMENT COMPLETED bit"
4735 DISP
4740 DISP "This section tests the"
4745 DISP "measurement completed bit of"
4750 DISP "the status byte of the ";N$
4755 DISP
4760 DISP "Press CONT to set up the mask"
4765 DISP "and test the bit."
4770 DISP
4775 PAUSE
4780 OUTPUT A ;"SAMPLE,HOLD;SRQMASK,2"
4785 ON INTR 7 GOTO 4830
4790 ENABLE INTR 7;8
4795 OUTPUT A ;"TRIGGER"
4800 WAIT 2000
4805 OFF INTR 7
4810 DISP N$;" FAILED the MEASUREMENT"
4815 DISP "COMPLETED bit test."
4820 GOTO 4855
4825 OFF INTR 7
4830 STATUS 7,1 ; B
4835 S=SPOLL(A)
4840 IF BIT(S,1) THEN 4845 ELSE 4810
4845 DISP N$;" PASSED the MEASUREMENT"
4850 DISP "COMPLETED bit test."
4855 DISP
4860 DISP B$
4865 PAUSE
4870 CLEAR
4875 DISP "           LOCAL bit"
4880 DISP
4885 DISP "This section tests the local"
4890 DISP "bit of the status byte of the"
4895 DISP N$;"."
4900 DISP
4905 DISP "Press CONT to set up the mask."
4910 DISP "and test the bit."
4915 DISP
4920 PAUSE
4925 OUTPUT A ;"SRQMASK,16"
4930 ON INTR 7 GOTO 4970
4935 ENABLE INTR 7;8
4940 LOCAL A ! SHOULD SET LCL BIT
4945 WAIT 1000
4950 OFF INTR 7
4955 DISP N$;" FAILED the LOCAL bit"
4960 DISP "test."
4965 GOTO 5000
4970 OFF INTR 7
4975 STATUS 7,1 ; B ! CLEAR 85 REG
4980 S=SPOLL(A)
4985 IF BIT(S,4) THEN 4990 ELSE 4955
4990 DISP N$;" PASSED the LOCAL bit"
4995 DISP "test."
5000 DISP
5005 DISP B$
```

Table 4-1. HP-85 Program Listing (Continued)

```
5010 PAUSE
5015 CLEAR
5020 CLEAR
5025 DISP "           ERROR bit"
5030 DISP
5035 DISP "This section tests the ERROR"
5040 DISP "bit of the status byte of the"
5045 DISP N$;"."
5050 DISP
5055 DISP "Press CONT to set up and test"
5060 DISP "this bit."
5065 PAUSE
5070 REMOTE A
5075 OUTPUT A ;"SRQMASK,4"
5080 ON INTR 7 GOTO 5135
5085 ENABLE INTR 7;8
5090 ! MANUAL FREQUENCY 9E+99 IS
5095 ! OUT OF RANGE
5100 OUTPUT A ;"MANUAL,9E+99"
5105 WAIT 1000
5110 OFF INTR 7
5115 DISP
5120 DISP N$;" FAILED the ERROR bit"
5125 DISP "test."
5130 GOTO 5170
5135 OFF INTR 7
5140 STATUS 7,1 ; B ! CLEAR 85 REG
5145 S=SPOLL(A)
5150 IF BIT(S,2) THEN 5160 ELSE 5120
5155 DISP
5160 DISP N$;" PASSED the ERROR bit"
5165 DISP "test."
5170 OUTPUT A ;"RESET"
5175 DISP
5180 DISP B$
5185 PAUSE
5190 CLEAR
5195 DISP "   OUTPUT DATA READY bit"
5200 DISP
5205 DISP "This section tests the OUTPUT"
5210 DISP "DATA READY bit of the status"
5215 DISP "byte of the ";N$;" ."
5220 DISP
5225 DISP "Press CONT to set up and test"
5230 DISP "this bit."
5235 PAUSE
5240 OUTPUT A ;"SRQMASK,1"
5245 ON INTR 7 GOTO 5290
5250 ENABLE INTR 7;8
5255 OUTPUT A ;"ID?"
5260 WAIT 1000
5265 OFF INTR 7
5270 DISP
5275 DISP N$;" FAILED the OUTPUT"
5280 DISP "DATA READY bit test."
5285 GOTO 5325
5290 OFF INTR 7
5295 ENTER A ; M$ ! Must read data
5300 STATUS 7,1 ; B ! CLEAR 85 REG
5305 S=SPOLL(A)
5310 IF BIT(S,0) THEN 5315 ELSE 5275
5315 DISP N$;" PASSED the OUTPUT"
5320 DISP "DATA READY bit test."
5325 DISP
5330 DISP "Press CONT to record results"
5335 PAUSE
5340 OUTPUT A ;"SRQMASK,4"
5345 GOTO 6185 ! RECORD RESULTS
5350 !
5355 !    CHECKPOINT 15
5360 I=15
5365 I$="             'DUMP'"
5370 OUTPUT A ;"INIT"
5375 GOSUB 6100 ! DISPLAY TITLE
5380 REMOTE A
5385 DISP
5390 DISP "Checkpoint 15 tests the"
5395 DISP "'DUMP' HP-IB command."
5400 DISP
5405 DISP "Input a 1 GHz signal at"
5410 DISP "-5 dBm to Input 1 of the"
5415 DISP N$;"."
5420 DISP
5425 DISP B$
5430 PAUSE
5435 CLEAR
5440 DISP "Press CONT to begin DUMPING"
5445 DISP "data from the ";N$;" to the"
5450 DISP "HP85. 10 measurements will be"
5455 DISP "taken and displayed."
5460 PAUSE
5465 CLEAR
5470 REMOTE A
5475 ENTER A ; M
5480 IF M=1.E38 THEN GOTO 5405
5485 OUTPUT A ;"MANUAL,LASTF;RESOL,4;DUMP,ON"
5490 DISP "MEAS$                DATA FORMAT"
5495 DISP "                      (GGMMMKK)"
5500 FOR I=1 TO 10
5505 ENTER A USING "%,%K" ; D$
5510 DISP I,D$
5515 NEXT I
5520 DISP
5525 DISP "Press CONT to record results"
5530 PAUSE
5535 OUTPUT A ;"DUMP,OFF"
5540 GOTO 6185 ! RECORD RESULTS
5545 !
5550 !    CHECKPOINT 16
5555 I=16
5560 I$="      CHECK ALL ADDRESSES"
5565 REMOTE A
5570 OUTPUT A ;"INIT"
5575 GOSUB 6100 ! DISPLAY TITLE
5580 DISP
5585 DISP "Checkpoint 16 tests all"
5590 DISP "of the valid HP-IB addresses"
5595 DISP "except 21 which is the"
5600 DISP "address of the controller."
5605 DISP
5610 DISP B$
5615 PAUSE
5620 CLEAR
5625 K=0 ! Reset failure ctr
5630 J=0 ! Reset pass ctr
5635 FOR A=700 TO 730
5640 IF A=721 THEN 5935
5645 I=A-700
5650 CLEAR
5655 LOCAL 7
5660 DISP "Press 'SET','HP-IB ADDRESS',"
5665 DISP I;", 'ENTER'."
5670 DISP
5675 ON KEY# 1,"INCR" GOTO 5920
5680 ON KEY# 2,"EXIT" GOTO 5940
5685 ON KEY# 3,"TEST" GOTO 5740
5690 DISP "Press EXIT to terminate this"
5695 DISP "checkpoint."
5700 DISP
5705 DISP "Press INCR to skip to the next"
5710 DISP "HP-IB address."
5715 DISP
5720 DISP "Press TEST to test the current"
5725 DISP "HP-IB address."
```

Table 4-1. HP-85 Program Listing (Continued)

```
5730 KEY LABEL
5735 GOTO 5735
5740 CLEAR
5745 OFF KEY# 1
5750 OFF KEY# 2
5755 OFF KEY# 3
5760 SET TIMEOUT 7;1000
5765 ON TIMEOUT 7 GOTO 5840
5770 REMOTE A
5775 OUTPUT A ;"ID?"
5780 ENTER A ; D$
5785 IF D$<>N$ THEN GOTO 5840
5790 SET TIMEOUT 7;0
5795 K=K+1 ! Increment failure ctr
5800 D1(K)=A ! Store failed addrs
5805 DISP
5810 DISP N$;" responds at address ";A
5815 DISP
5820 DISP "Press NEXT to continue"
5825 ON KEY# 4,"NEXT" GOTO 5920
5830 KEY LABEL
5835 GOTO 5835
5840 SET TIMEOUT 7;0
5845 ABORTIO 7
5850 CLEAR A
5855 DISP
5860 DISP N$;" does not respond at"
5865 DISP "address ";A
5870 BEEP 250,25
5875 WAIT .1
5880 BEEP 250,25
5885 DISP
5890 DISP "Press NEXT to continue."
5895 ON KEY# 4,"NEXT" GOTO 5910
5900 KEY LABEL
5905 GOTO 5905
5910 J=J+1 ! Increment pass ctr
5915 D(J)=A ! Store pass addrss
5920 ABORTIO 7
5925 CLEAR A
5930 OFF KEY# 4
5935 NEXT A
5940 ABORTIO 7
5945 CLEAR A
5950 IF J=0 THEN 5995
5955 CLEAR
5960 DISP "The ";N$;" failed to"
5965 DISP "respond at the following"
5970 DISP "addresses:"
5975 FOR I=1 TO J
5980 DISP "          ";D(I)
5985 NEXT I
5990 GOTO 6050
5995 CLEAR
6000 IF K=0 THEN GOTO 6040
6005 DISP
6010 DISP N$;" responds at addresses:"
6015 DISP
6020 FOR I=1 TO K
6025 DISP "          ";D1(I)
6030 NEXT I
6035 GOTO 6050
6040 DISP
6045 DISP "No addresses were tested."
6050 DISP
6055 DISP B$
6060 SET TIMEOUT 7;0
6065 PAUSE
6070 OFF KEY# 1
6075 OFF KEY# 2
6080 OFF KEY# 3
6085 OFF KEY# 4
6090 GOTO 790 ! DET ADDRESS
6095 GOTO 6180 ! RECORD RESULTS
6100 !
6105 !
6110 !  DISPLAY CHECKPOINT TITLE
6115 CLEAR
6120 DISP USING "5/,"
6125 DISP H$
6130 DISP
6135 DISP "          CHECKPOINT";T
6140 DISP I$
6145 DISP
6150 DISP H$
6155 DISP USING "3/,"
6160 DISP A$
6165 PAUSE
6170 CLEAR
6175 RETURN
6180 !
6185 ! RECORD TEST RESULTS
6190 CLEAR
6195 DISP USING "3/,"
6200 DISP " Press the appropriate softkey"
6205 DISP "     to record the result of"
6210 DISP
6215 DISP "          CHECKPOINT";T
6220 ON KEY# 1,"PASS" GOTO 6240
6225 ON KEY# 4,"FAIL" GOTO 6250
6230 KEY LABEL
6235 GOTO 6235
6240 R(T)=1 ! 1=PASS
6245 GOTO 6255
6250 R(T)=0 ! 0=FAIL
6255 CLEAR
6260 ! DETERMINE NEXT CHECKPOINT
6265 ! TO BE EXECUTED
6270 CLEAR
6275 DISP "Press the appropriate soft key"
6280 DISP "to select the desired checkpoint..."
6285 DISP
6290 DISP
6295 DISP "NEXT- Press K1 to perform the"
6300 DISP "next checkpoint."
6305 DISP "EXIT-Press K2 to end the"
6310 DISP "program."
6315 DISP "REPEAT- Press K3 to repeat this"
6320 DISP "checkpoint."
6325 DISP "GOTO#- Press K4 to select an"
6330 DISP "arbitrary checkpoint."
6335 ON KEY# 1,"NEXT" GOTO 6365
6340 ON KEY# 2," EXIT" GOTO 6375
6345 ON KEY# 3,"  REPEAT" GOTO 6385
6350 ON KEY# 4,"  GOTO#" GOTO 6395
6355 KEY LABEL
6360 GOTO 6360
6365 D=T+1
6370 GOTO 6420
6375 D=0
6380 GOTO 6420
6385 D=T
6390 GOTO 6420
6395 CLEAR
6400 DISP "Enter checkpoint number desired"
6405 DISP "(1 to 16), and press END LINE"
6410 INPUT D
6415 IF D<1 OR D>16 THEN 6395
6420 OFF KEY# 1
6425 OFF KEY# 2
6430 OFF KEY# 3
6435 OFF KEY# 4
6440 !
6445 ! BRANCH EXECUTION TO
```

Table 4-1. HP-85 Program Listing (Continued)

```
6450 ! DESIRED CHECKPOINT
6455 IF D=0 THEN 6650
6460 IF D>7 THEN 6470
6465 ON D GOTO 1025,1290,1460,1570,1840,2310,2475
6470 D=D-7
6475 IF D=10 THEN GOTO 6650
6480 ON D GOTO 2745,3035,3240,3480,3890,4260,4455,5350,5545
6485 !
6490 ! SUBROUTINE TO DETERMINE
6495 ! FIRST CHECKPOINT EXECUTED
6500 CLEAR
6505 DISP "Press the soft key to  select"
6510 DISP "the desired checkpoint..."
6515 DISP USING "2/,"
6520 DISP "FIRST- Press K1 to perform the"
6525 DISP "first checkpoint."
6530 DISP
6535 DISP "EXIT- Press K2 to end the"
6540 DISP "program."
6545 DISP
6550 DISP "GOTO$- Press K4 to select an"
6555 DISP "arbitrary checkpoint."
6560 ON KEY$ 1,"FIRST" GOTO 6585
6565 ON KEY$ 2," EXIT" GOTO 6595
6570 ON KEY$ 4,"  GOTO$" GOTO 6605
6575 KEY LABEL
6580 GOTO 6580
6585 D=T+1
6590 GOTO 6630
6595 D=0
6600 GOTO 6630
6605 CLEAR
6610 DISP "Enter checkpoint number desired"
6615 DISP "(1 to 16), and press END LINE"
6620 INPUT D
6625 IF D<1 OR D>16 THEN 6395
6630 OFF KEY$ 1
6635 OFF KEY$ 2
6640 OFF KEY$ 4
6645 RETURN
6650 !
6655 !      PRINTOUT CHECKPOINT
6660 !             RESULTS
6665 CLEAR
6670 DISP "Do you wish to have a"
6675 DISP "printout of the results?"
6680 ON KEY$ 1,"YES" GOTO 6700
6685 ON KEY$ 4,"NO" GOTO 6825
6690 KEY LABEL
6695 GOTO 6695
6700 CLEAR
6705 PRINT H$
6710 PRINT
6715 PRINT "     HP-IB VERIFICATION"
6720 PRINT "           RESULTS"
6725 PRINT
6730 PRINT H$
6735 PRINT
6740 PRINT "CHECKPOINT         RESULTS"
6745 CLEAR
6750 FOR T=1 TO 9
6755 IF R(T)=1 THEN R$="    PASS"
6760 IF R(T)=0 THEN R$="    FAIL"
6765 IF R(T)=2 THEN R$=" NOT PERFORMED"
6770 PRINT "   ";T;"          ";R$
6775 NEXT T
6780 FOR T=10 TO 16
6785 IF R(T)=1 THEN R$="   PASS"
6790 IF R(T)=0 THEN R$="   FAIL"
6795 IF R(T)=2 THEN R$="NOT PERFORMED"
6800 PRINT "   ";T;"          ";R$
6805 NEXT T
6810 FOR I=1 TO 5
6815 PRINT
6820 NEXT I
6825 OUTPUT A ;"INIT"
6830 CLEAR
6835 OFF KEY$ 1
6840 OFF KEY$ 4
6845 LOCAL 7
6850 DISP USING "5/,"
6855 DISP "  HP-IB VERIFICATION COMPLETED"
6860 END
```

Table 4-2. Sample HP-IB Verification Printout

```
**********************************

**********************************

      CHECKPOINT SUMMARY

**********************************

 1 Remote,Local Lockout, Local
 2 Self Check ('TEST?')
 3 'DISPLAY'
 4 'INIT' & 'RESET'
 5 'REF' & 'OVEN'
 6 'ERR?'
 7 'SET' & 'SET?'
 8 'LOWZ' & 'HIGHZ'
 9 'SAMPLE' & 'TRIGGER'
 10 'RESOL' & 'HIRESOL'
 11 'OFFSET', 'SCALE' & 'SMOOTH'
 12 'AUTO' & 'MANUAL'
 13 'FMRATE'
 14 'SRQMASK'
 15 'DUMP'
 16 CHECK ALL ADDRESSES



**********************************

     HP-IB VERIFICATION
           RESULTS

**********************************

CHECKPOINT          RESULTS
     1               PASS
     2               PASS
     3               PASS
     4               PASS
     5               PASS
     6               PASS
     7           NOT PERFORMED
     8               PASS
     9               PASS
     10              PASS
     11              PASS
     12              PASS
     13              PASS
     14              PASS
     15              PASS
     16          NOT PERFORMED
```

Table 4-3. Operation Verification Record

Hewlett-Packard Model 5350B/5351B/5352B Microwave Frequency Counter — Tested by _____

Serial No. _____ Date _____

PARA. NO.	TEST	RESULTS	SPECIFICATION
4-18	Power-Up Self Test	Pass ____ Fail ____	
4-19	INPUT 2, Gating and Counting Check	Pass ____ Fail ____	
4-20	INPUT 2, 10 Hz-525 MHz Input Sensitivity Test (50Ω/1MΩ):	(record actual sensitivity)	
	50Ω: 50 MHz	_____	25 mV rms (-19.3 dBm)
	100 MHz	_____	
	250 MHz	_____	
	525 MHz	_____	
	1MΩ: 80 MHz	_____	
	1MΩ: 10 Hz	_____	
	50 kHz	_____	
	1 MHz	_____	
	10 MHz	_____	
	20 MHz	_____	
4-22	INPUT 1, 500 MHz-20 GHz [26.5 GHz, 40 GHz] Input Sensitivity Test:		
	500 MHz	_____	-32 dBm [-25 dBm, 5352B]
	1 GHz	_____	
	5 GHz	_____	
	12.4 GHz	_____	
	18 GHz	_____	-27 dBm [-25 dBm, 5352B]
	20 GHz	_____	
	[5351B, 5352B] 22 GHz	_____	-16 dBm [-25 dBm, 5352B]
	26.5 GHz	_____	
	[5352B] 30 GHz	_____	0.741f(GHz) - 44.6 dBm
	34 GHz	_____	
	40 GHz	_____	-15 dBm
4-24	HP-IB Verification	Pass ____ Fail ____	

4-30. PERFORMANCE TEST PROCEDURE

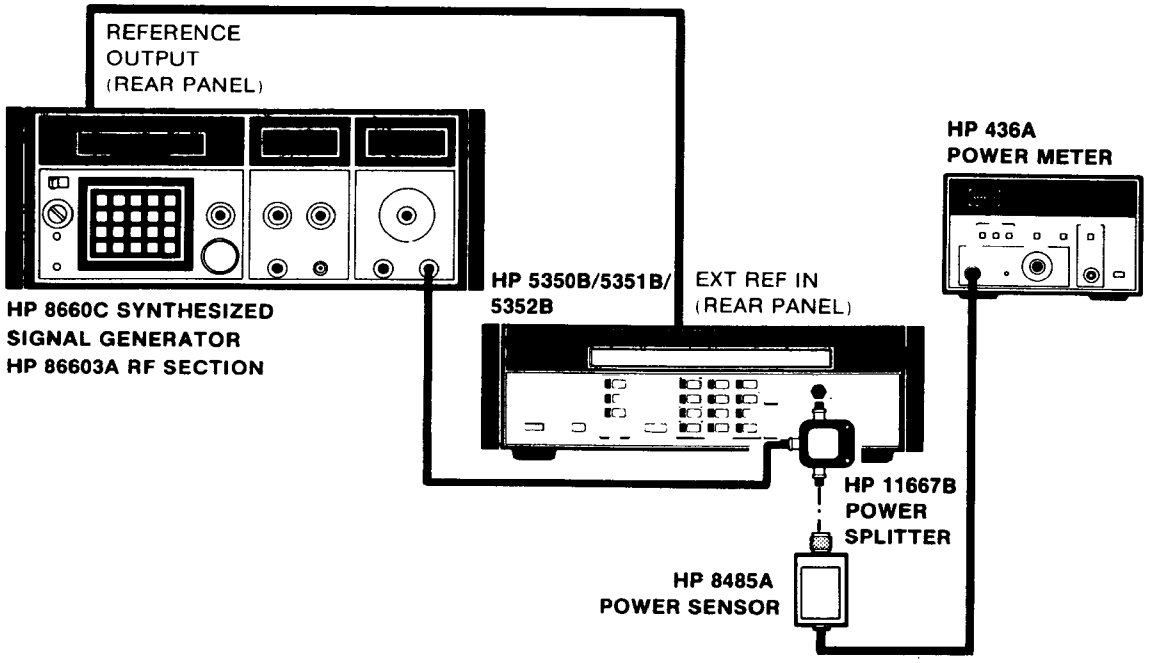
4-31. INPUT 2, 10 Hz-525 MHz Input Sensitivity Test

4-32. The following test is in two parts, Setup 1 for 10 MHz to 525 MHz, and Setup 2 for 10 Hz to 10 MHz.

Specification: 50Ω: 10 MHz-525 MHz, 25 mV rms
1MΩ: 10 Hz-80 MHz, 25 mV rms

Description: The counter is set to the 10 MHz-525 MHz range, 50Ω impedance, and a -19.3 dBm signal is applied to INPUT 2. The test generator is set to selected frequencies and the 5350B/51B/52B is checked for proper counting. The counter is next set for 1MΩ impedance, a -19.3 dBm signal is applied to INPUT 2 through a 50Ω feedthrough, and the counter is checked for proper counting at 50 MHz and 80 MHz. The test setup is changed to Setup 2 to test the 10 Hz-10 MHz range.

Setup 1: INPUT 2, 50 MHz-525 MHz



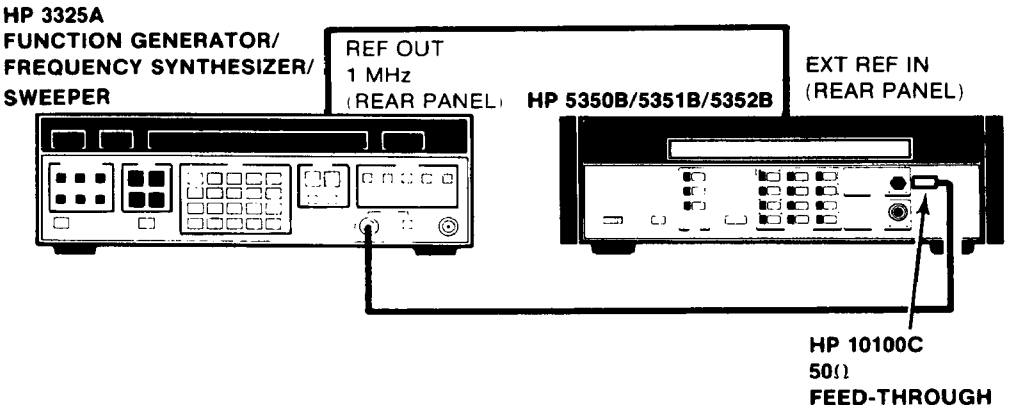
a. Set the counter to the 10 MHz-525 MHz range, 50Ω impedance, by pressing the 50Ω key.

b. Set the 8660C to 50 MHz, and the 86603A for an output level of 25 mV rms (-19.3 dBm) as measured on the 436A Power Meter. Verify that the counter counts 50 MHz, 100 MHz, 200 MHz, 400 MHz, and 525 MHz, ±1 Hz. Record the actual sensitivity at each frequency in the Performance Test Record (*Table 4-4*).

c. Connect the 11667B to INPUT 2 of the counter via a 50Ω feedthrough. Press the 1MΩ key on the 5350B/51B/52B.

d. Verify that the 5350B/51B/52B counts 50 MHz and 80 MHz, ±1Hz, at 25 mV rms (-19.3 dBm). Enter the results in the Performance Test Record.

Setup 2: INPUT 2, 10 Hz-10 MHz



a. 5350B/51B/52B settings are the same as in the 50/80 MHz test (INPUT 2, 1MΩ).

b. Connect the 3325A to INPUT 2 of the counter via a 50Ω feedthrough. Set the 3325A for an output of 25 mV rms (-19.3 dBm) at 10 Hz.

c. Verify that the counter counts properly at 10 Hz, 1 kHz, 500 kHz, 1 MHz, and 10 MHz, ±1 Hz. Record the actual sensitivity in the Performance Test Record.

4-33. If the counter fails any of the above sensitivity tests, refer to Section V, Adjustments, and verify the INPUT 2 sensitivity adjustment (Peak Detector Adjustment, A2R1). If this adjustment is correct, and the counter continues to fail the sensitivity tests, refer to Section VIII, Service, for troubleshooting procedures for the following assemblies, in the order shown:

A2 Low Frequency Input Assembly

A3 Counter Assembly

4-34. INPUT 1, 500 MHz-20 GHz [26.5 GHz, 40 GHz] Input Sensitivity Test

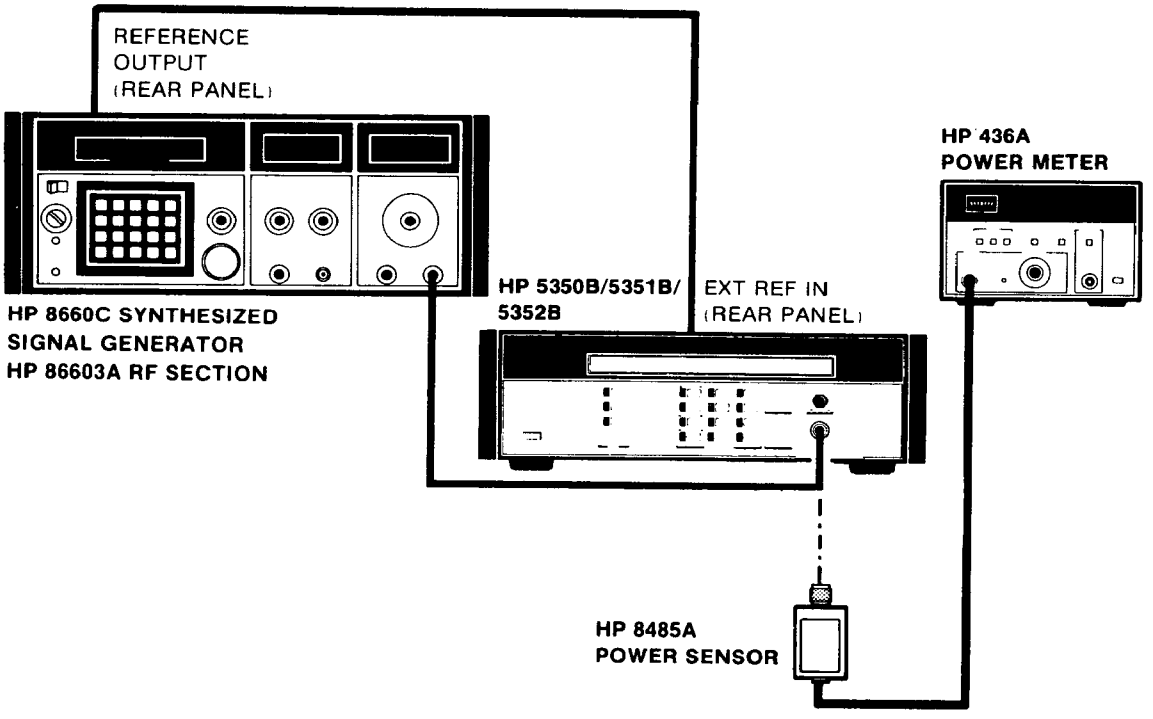
4-35. The following test is in three parts, Setup 1 for 500 MHz to 1 GHz, Setup 2 for 2.5 GHz to 20 GHz [26.5 GHz], and Setup 3 for 26.5 GHz to 40 GHz.

Specifications:

5350B sensitivity	=	-32 dBm, 500 MHz-12.4 GHz
	=	-27 dBm, 12.4 GHz-20 GHz
5351B sensitivity	=	-32 dBm, 500 MHz-12.4 GHz
	=	-27 dBm, 12.4 GHz-20 GHz
	=	-16 dBm, 20 GHz-26.5 GHz
5352B sensitivity	=	-25 dBm, 500 MHz-26.5 GHz
	=	0.741 × freq. in GHz - 44.6 dBm, for frequencies greater than 26.5 GHz. (-15 dBm at 40 GHz)

Description: The counter is set to the 500 MHz-20 GHz [26.5 GHz, 40 GHz] range and the appropriate input signal is applied to INPUT 1. The generator is set to selected frequencies up to 1 GHz, and the actual sensitivity of the 5350B/51B/52B is measured. The test setup is changed to Setup 2 to measure sensitivity in the 2.5 GHz-20 GHz [26.5 GHz] range. If a 5351B or 5352B is being tested, the generator is set to the appropriate test level, and actual sensitivity is measured at selected frequencies up to 26.5 GHz. If a 5352B is being tested, the test setup is changed to Setup 3 to measure sensitivity in the 26.5 GHz-40 GHz range.

Setup 1: 500 MHz-1 GHz:



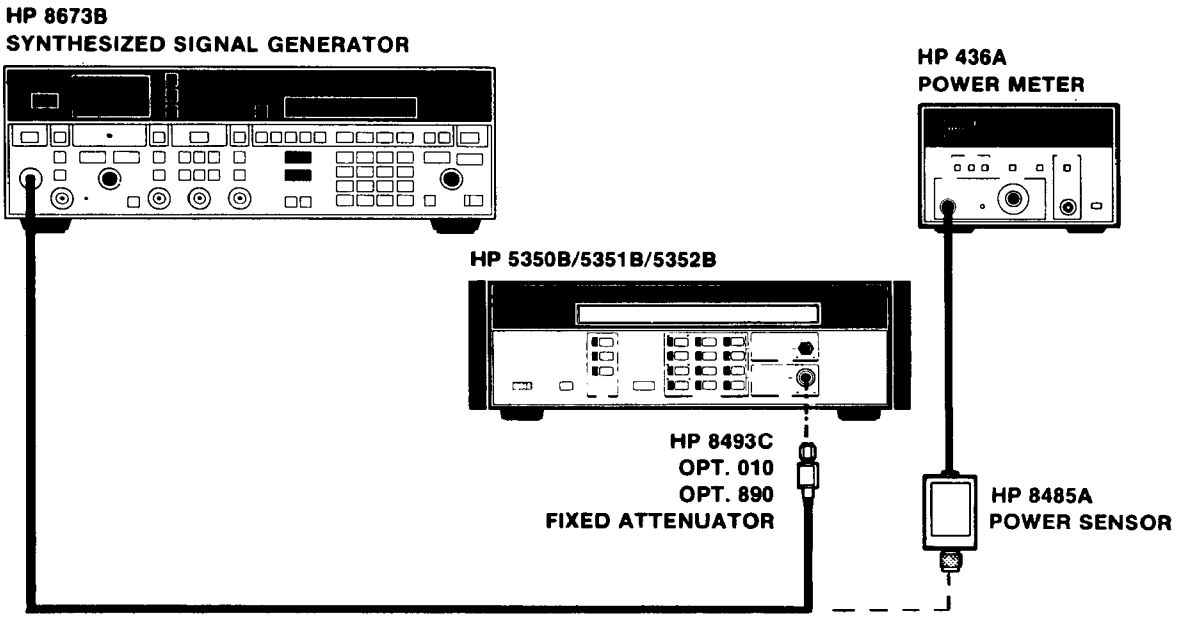
a. Set the counter to INPUT 1, Automatic mode by pressing the AUTO key.

b. Connect the equipment as shown in Setup 1.

c. Set the 8660C to 500 MHz, and set the 86603A to -32 dBm [-25 dBm, 5352B], as measured on the 436A.

d. Measure the actual sensitivity at 500 MHz and 1 GHz. (The counter should measure these frequencies to ±4 Hz). Verify the signal levels with the 436A Power Meter at each frequency. Enter the result on the Performance Test Record.

Setup 2: INPUT 1, 2.5 GHz-20 GHz [26.5 GHz]



a. 5350B/51B/52B settings are the same as in Setup 1 (INPUT 1, Auto).

b. Connect the equipment as shown in Setup 2.

c. Set the 8673B to 2.5 GHz at a level of -32 dBm [-25 dBm, 5352B], as measured on the 436A.

d. Measure actual sensitivity at 2.5, 5, 10, and 12.4 GHz, by first verifying the signal level with the 436A, and then verifying that each of the frequencies is counted to ±4 Hz.

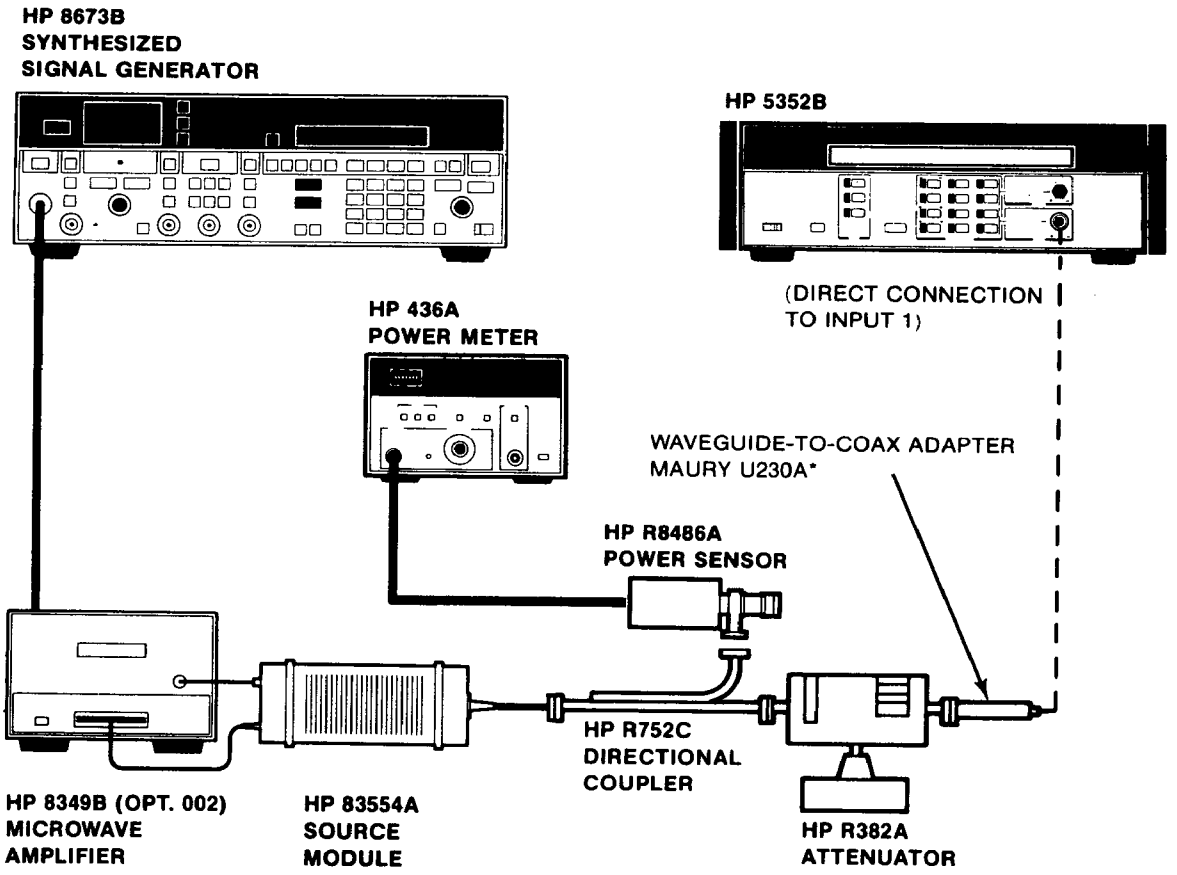
e. Set the 8673B to 18 GHz at a level of -27 dBm [-25 dBm, 5352B], as measured on the 436A.

f. Measure actual sensitivity at 18, 19, and 20 GHz, by first verifying the signal level with the 436A, and then verifying that each of the frequencies is counted to ±4 Hz.

g. If a 5351B or 5352B is being tested, repeat the above procedure for 20-26.5 GHz at the appropriate input level [-16 dBm for the 5351B, -25 dBm for the 5352B]. Measure actual sensitivity at 22 GHz, 24 GHz, and 26.5 GHz [±4 Hz, 5351B and 5352B].

h. Enter the results in the Performance Test Record.

Setup 3: INPUT 1, 26.5 GHz-40 GHz [5352B]



*Available from: Maury Microwave Corporation, 8610 Helms Avenue, Cucamonga, CA 91730.

a. 5352B settings are the same as for Setup 1 (INPUT 1, Auto).

b. Connect the equipment as shown in Setup 3.

c. Measure the actual sensitivity at 26.5 GHz, 30 GHz, 34 GHz, and 40 GHz, as follows:

1. Set the 8673B to 13.25 GHz, and set the level for a +17 dBm output from the 8349B Amplifier (as indicated on the 8349B front panel display).

2. Add attenuation by adjusting the R382A Precision Attenuator until the counter stops measuring, then decrease the attenuation until the counter measures the input frequency within ±5 Hz.

3. Note the doubled frequency (26.5 GHz) power reading on the 436A, add +10 dB to the reading, and subtract the value of the R382A attenuator setting to obtain the sensitivity level of the counter.

4. Repeat the above steps at 30 GHz, 34 GHz, and 40 GHz (15, 17, and 20 GHz input to the source module, respectively).

d. Enter the actual sensitivity results in the Performance Test Record.

4-36. If the counter fails any of the above sensitivity tests, refer to Section V, Adjustments, and verify the A6 IF Amplifier/Detector Assembly adjustments. If these adjustments are correct, and the counter continues to fail the above tests, refer to Section VIII, Service, for troubleshooting procedures for the following assemblies:

Microwave Module (A12 Microwave Assembly/U1 Sampler)

A6 IF Amplifier/Detector Assembly

A3 Counter Assembly

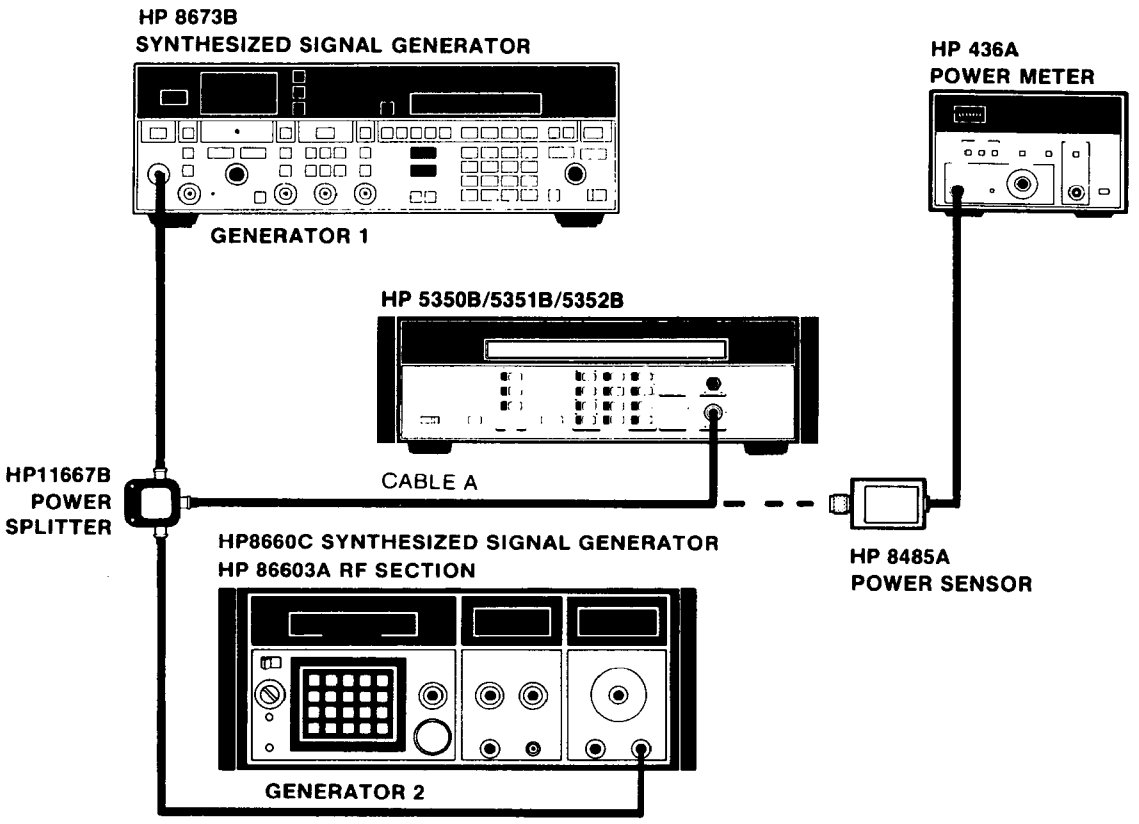
A5 Synthesizer Assembly

4-37. Automatic Amplitude Discrimination Test

Specification: The 5350B/51B/52B measures the largest of all signals present, provided that the signal is 6 dB (typical) above any signal within 500 MHz; 20 dB (typical) above any signal, 500 MHz to 20 GHz [26.5 GHz, 40 GHz].

Description: Two microwave generators are used to provide two signals to the 5350B/51B/52B. The relative level of the two signals is adjusted to the specification and the 5350B/51B/52B must count the higher amplitude signal.

Setup:



NOTE

The second frequency source is not required to have a wideband capability. The frequency range of generator 2 need only be 500 MHz to 2 GHz.

a. Set generator 1 for an 18 GHz output at a level to deliver –5 dBm to the 5350B/51B/52B. To set this level, disconnect generator 2 from the 11667B and terminate that port of the 11667B with a 909D 50Ω termination. Connect the 8485A to the 5350B/51B/52B end of cable A and adjust the 8673B output for a –5 dBm reading.

b. Set generator 2 for a 500 MHz output at a level to deliver – 25 dBm to the 5350B/51B/52B. To set this level, disconnect generator 1 from the 11667B input (reconnect generator 2 to the 11667B) and terminate the generator 1 port of the 11667B with the 909D 50Ω termination. Connect the 8485A to the 5350B/51B/52B end of cable A and adjust the 86603A for a – 25 dBm reading.

c. Connect both generators to the 11667B inputs. Connect cable A to INPUT 1 of the counter. Verify that the 5350B/51B/52B counts 18 GHz. Increase the level of generator 2 until the 5350B/51B/52B counts incorrectly; measure that level (using the procedure described above) and enter the result on the Performance Test Record.

d. Set generator 1 for a 2.5 GHz output at a level to deliver −5 dBm to the 5350B/51B/52B using the technique previously described. Set generator 2 for a 2.0 GHz output at a level to deliver −11 dBm to the 5350B/51B/52B using the same technique. Connect both generators to the 11667B, and cable A to the 5350B/51B/52B. Verify that the 5350B/51B/52B counts 2.5 GHz. Increase the generator 2 level until the 5350B/51B/52B counts incorrectly; measure that level and enter the result on the Performance Test Record.

4-38. If the counter fails the Automatic Amplitude Discrimination tests, refer to Section VIII, Service, for troubleshooting procedures for the following assemblies:

A6 IF Amplifier/Detector Assembly

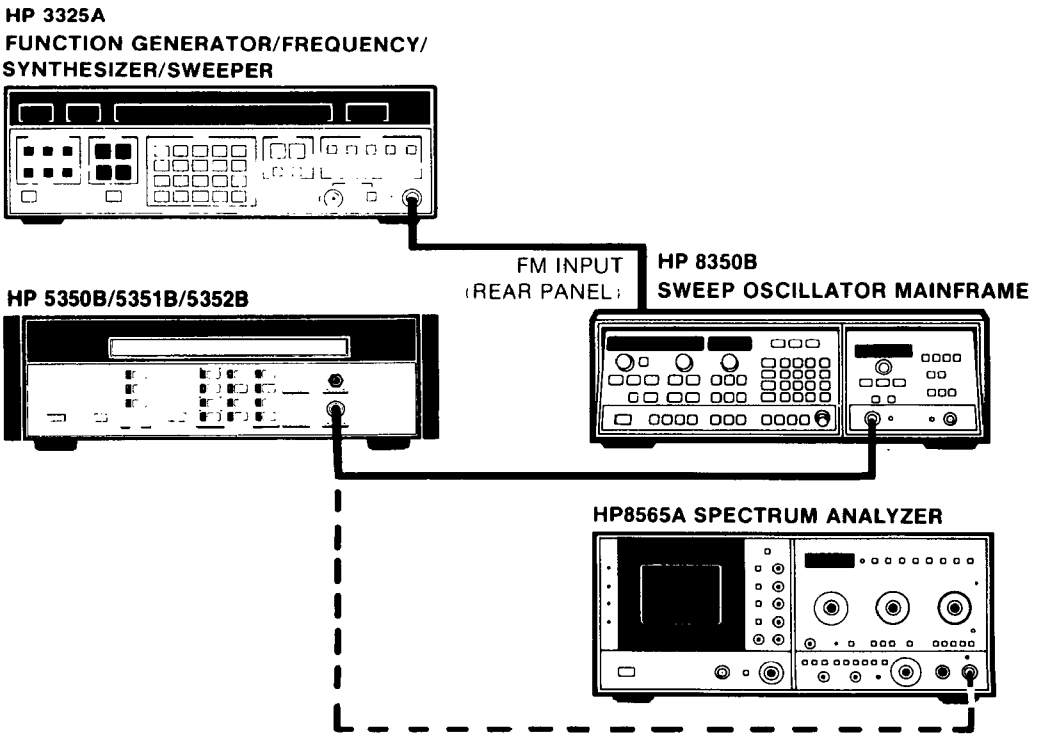
Microwave Module (A12 Microwave Assembly/U1 Sampler)

4-39. FM Tolerance Test

Specification: 5350B/5351B: 20 MHz maximum peak-to-peak deviation
5352B: 12 MHz maximum peak-to-peak deviation

Description: The FM peak-to-peak deviation specification indicates the worst case FM deviation which can be present on a carrier that the counter can acquire and count. The counter averages out the deviations and displays a carrier frequency. In addition, the 5350B/51B/52B offers a choice of FM rate modes. This test will verify that the counter performs properly in all three modes.

Setup:



a. Set the 8350B to 1 GHz and the 83595A to -5 dBm.

b. Set the 3325A to 1 kHz.

c. Using the 8565A Spectrum Analyzer to verify the width of the FM deviation at the output of the 83595A, set the amplitude of the 3325A output to achieve a peak-to-peak width of 20 MHz [12 MHz, 5352B].

d. Set the 5350B/51B/52B to the Automatic measurement mode by pressing the AUTO key. Be sure that the counter is set for Normal FM Rate (FM NORM annunciator lit).

e. Verify that the counter acquires and counts the modulated input correctly. Enter the results in the Performance Test Record.

f. Set the 5350B/51B/52B to Diagnostic 6 by pressing SET/ENTER, DIAGNOSTICS, 6, SET/ENTER. The counter will display the determined harmonic number, including the fractional portion. Verify that the fractional portion of the displayed harmonic number does not deviate more than 0.30 from the integer value. (For example, a harmonic number of 3 should not deviate to less than 2.70, or greater than 3.30.)

g. Set the 3325A to 45 Hz. Set the 5350B/51B/52B for Low FM Rate (LOW annunciator on) by pressing the FM RATE/TRACK key. Verify that the fractional portion of the displayed harmonic number still does not deviate more than 0.30 from the integer value. Press the RESET/LOCAL key, and verify that the displayed count matches that of the Normal FM Rate mode. Enter the results in the Performance Test Record.

h. Set the 3325A to 300 kHz. Set the 5350B/51B/52B for Track Rate (TRACK annunciator on) by pressing the FM RATE/TRACK key. Set the counter to Diagnostic 6 by pressing the DIAGNOSTICS key. Verify that the fractional portion of the displayed harmonic number still does not deviate more than 0.30 from the integer value. Press the RESET/LOCAL key, and verify that the displayed count matches that of the Normal FM Rate mode. Enter the results in the Performance Test Record.

4-40. If the counter fails the FM Tolerance test, refer to Section V, Adjustments, and verify the A6 IF Amplifier/Detector Assembly adjustments. If the adjustments are correct and the counter continues to fail, refer to Section VIII, Service, for troubleshooting procedures for the following assemblies:

A6 IF Amplifier/Detector Assembly

Microwave Module (A12 Microwave Assembly/U1 Sampler)

4-41. HP-IB Verification Test

4-42. Perform the HP-IB Verification Test procedures at paragraph 4-24. After completion of the program, a printout should be attached to the Performance Test Record (*Table 4-4*).

Table 4-4. Performance Test Record

Hewlett-Packard Model 5350B/5351B/5352B Microwave Frequency Counter — Tested by _____

Serial No. _____ — Date _____

PARA. NO.	TEST		ACTUAL SENSITIVITY	SPECIFICATION
4-31	INPUT 2, 10 MHz-525 MHz			
	Input Sensitivity (50Ω):	50 MHz	_____	25 mV rms
		100 MHz	_____	(-19.3 dBm)
		200 MHz	_____	
		400 MHz	_____	
		525 MHz	_____	
	INPUT 2, 10 Hz-80 MHz			
	Input Sensitivity (1MΩ):	10 Hz	_____	25 mV rms
		1 kHz	_____	(-19.3 dBm)
		500 kHz	_____	
		1 MHz	_____	
		10 MHz	_____	
		50 MHz	_____	
		80 MHz	_____	
4-34	INPUT 1, 500 MHz-20 GHz [26.5 GHz, 40 GHz]			
	Input Sensitivity:	500 MHz	_____	-32 dBm [-25 dBm, 5352B]
		1 GHz	_____	
		2.5 GHz	_____	
		5 GHz	_____	
		10 GHz	_____	
		12.4 GHz	_____	
		16 GHz	_____	-27 dBm [-25 dBm, 5352B]
		18 GHz	_____	
		19 GHz	_____	
		20 GHz	_____	
	[5351B, 5352B]	22 GHz	_____	-16 dBm [-25 dBm, 5352B]
		24 GHz	_____	
		26.5 GHz	_____	
	[5352B]	30 GHz	_____	0.741f(GHz) - 44.6 dBm
		34 GHz	_____	
		40 GHz	_____	-15 dBm
4-37	Automatic Amplitude Discrimination:		(record actual separation)	
		17.5 GHz separation	_____ dB	20 dB (typical)
		500 MHz separation	_____ dB	6 dB (typical)
4-39	FM Rate Tolerance:	Normal Rate (1 kHz)	Pass ____ Fail ____	
		Low Rate (45 Hz)	Pass ____ Fail ____	
		Track Rate (300 kHz)	Pass ____ Fail ____	
4-41	HP-IB Verification		Pass ____ Fail ____	

SECTION V
ADJUSTMENTS

5-1. INTRODUCTION

5-2. This section describes the adjustments required to maintain the HP 5350B, 5351B and 5352B operating characteristics within specification. Adjustments should be made when required, such as after a performance test failure or when components are replaced that may affect an adjustment. If the adjustments are to be considered valid, the HP 5350B/51B/52B line input voltage must be within +5% to -10% of normal.

5-3. *Table 5-1* lists the adjustment procedures and the recommended order of performance, and identifies the adjustable components involved.

5-4. EQUIPMENT REQUIRED

5-5. The test equipment required for the adjustment procedures is listed in *Table 1-5, Recommended Test Equipment.* Substitute test equipment may be used if it meets or exceeds the required characteristics listed in the table.

5-6. ADJUSTMENT LOCATIONS

5-7. Adjustment locations are identified in *Figure 5-1.* Note that all adjustments, except for the TCXO standard timebase adjustment, must be made with the top cover removed. The TCXO adjustment is made through the rear panel hole labeled TCXO ADJUST.

5-8. SAFETY CONSIDERATIONS

5-9. This section contains warnings and cautions that must be followed for your protection and to avoid damage to the equipment.

WARNING

MAINTENANCE DESCRIBED HEREIN IS PERFORMED WITH POWER SUPPLIED TO THE INSTRUMENT, AND PROTECTIVE COVERS REMOVED. SUCH MAINTENANCE SHOULD BE PERFORMED ONLY BY SERVICE-TRAINED PERSONNEL WHO ARE AWARE OF THE HAZARDS 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.

CAUTION

Electronic components and assemblies can be permanently degraded or damaged by electrostatic discharge while performing the maintenance described herein. Ensure that instrument maintenance procedures are performed only at static safe work stations providing proper grounding for service personnel.

Table 5-1. Adjustments

Name	Reference Designation	Purpose	Order of Performance
1. MRC Power Supply Adjustment	A3R4	Sets +3V Supply for MRC (A3U7).	1
2. Peak Detector Adjustment	A2R1	Sets maximum sensitivity of low frequency input circuitry (INPUT 2).	2
3. IF Amplifier Adjustments	A6R25	Sets sensitivity of the IF bandpass.	3
	A6C7	Sets frequency response of the 175 MHz elliptic filter.	4
	A6C14	Sets the width of the IF bandpass.	5
	A6R7	Sets overload indicator threshold.	6
4. TCXO Timebase Adjustments (A10 Standard)	A10Y1	Sets TCXO timebase to exact specified frequency.	May be performed anytime.
5. Oven Oscillator Timebase (A10 Option 001 or 010)	A10C1	Sets oven oscillator timebase to exact specified frequency.	May be performed anytime.

5-10. ADJUSTMENT PROCEDURES

5-11. MRC Supply Adjustment

5-12. The only power supply in the 5350B/51B/52B which requires adjustment is the +3 volt supply for the MRC (U7) on the A3 Counter Assembly. To perform this adjustment, proceed as follows:

a. Connect the negative terminal of a DVM (HP 3466A) to chassis ground of the counter. Connect the positive terminal of the DVM to the +3V test point located at the top of the A3 assembly.

b. Adjust A3R4 for a DVM reading of 3.000 Vdc (± 20 mV).

5-13. If the MRC supply cannot be adjusted to the required level, check the voltages at the Power Supply Test connector (A8J7) to confirm that the other power supplies voltages of the counter are at their proper levels. Refer to Section VIII, Service, for the specified voltage levels for all instrument power supply voltages.

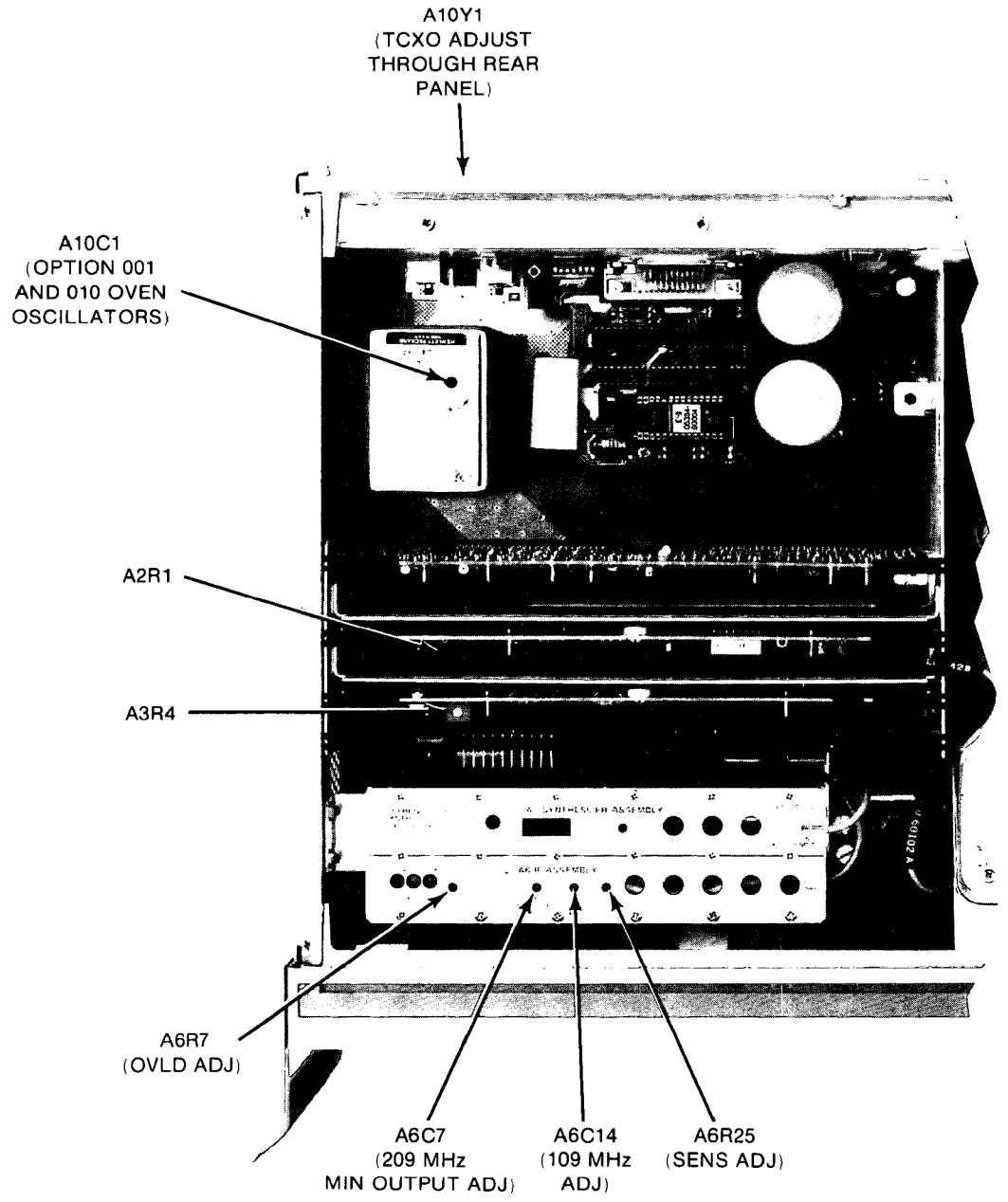


Figure 5-1. HP 5350B/5351B/5352B Adjustment Locations

5-14. Peak Detector Adjustment (INPUT 2, 50Ω)

5-15. Potentiometer A2R1 adjusts the peak detector circuitry for the 50Ω portion of INPUT 2. The peak detector determines the sensitivity of the input circuitry. To perform this adjustment, proceed as follows:

a. Connect the negative terminal of the HP 3466A DVM to chassis ground of the counter. Connect the positive terminal of the DVM to TP1 at the top of the A2 assembly.

b. Set a synthesizer (HP 8660C/86603A/86632B) for an output of 17 mV (-22.4 dBm) at 400 MHz. Connect the synthesizer output to INPUT 2 of the 5350B/51B/52B.

c. Connect the REFERENCE OUTPUT connector on the rear panel of the synthesizer to the rear panel EXT REF IN connector of the counter.

d. Select INPUT 2 (50Ω impedance) on the 5350B/51B/52B by pressing the **50Ω** key.

e. Adjust A2R1 clockwise until the counter just begins to gate and display the 400 MHz signal. It is easiest to find this transition point by noting where the voltage at the test point jumps above 4.5 volts. At this point, the counter should be gating and displaying the 400 MHz signal.

f. To verify the adjustment, set the synthesizer output to -23 dBm at 400 MHz, and verify that the 5350B/51B/52B displays all zeroes: 00 000 000 000. Slowly increase the synthesizer level to -22 dBm and verify that the counter displays 400 MHz correctly.

5-16. IF Amplifier Adjustments

5-17. The IF amplifier adjustments consist of 4 separate adjustments, A6R25, A6C7, A6C14 and A6R7. Potentiometer A6R25 (SENS ADJ) is adjusted first to set the sensitivity of the A6 IF bandpass. Next, the frequency response of the 175 MHz elliptic filter is tuned by adjusting A6C7 (209 MHz MIN OUTPUT ADJ). The width of the A6 IF bandpass is then set by adjusting A6C14 (109 MHz ADJ). Finally, the overload indicator threshold is set by adjusting A6R7. The effects of the IF bandpass adjustments (A6R25, A6C14) are shown in *Figure 5-2.*

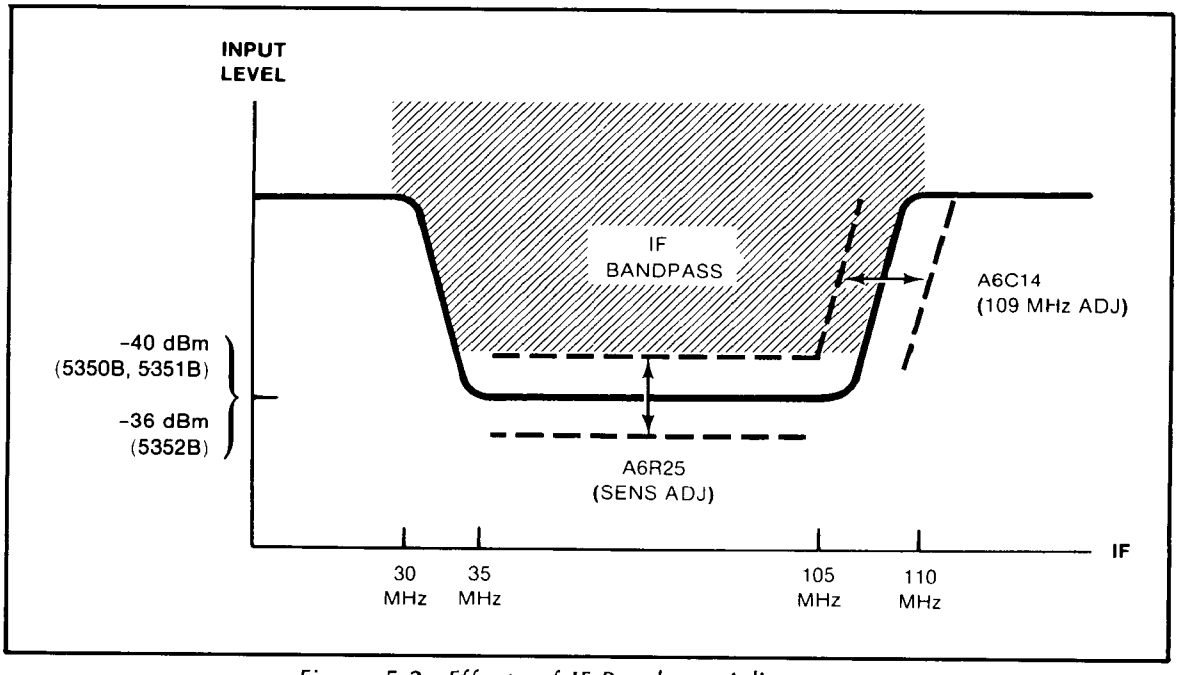


Figure 5-2. Effects of IF Bandpass Adjustments

5-18. **IF BANDPASS SENSITIVITY ADJUSTMENT.** To adjust A6R25 (SENS ADJ) for IF bandpass sensitivity, proceed as follows:

a. Set the 5350B/51B/52B to Manual mode with a center frequency of 670 MHz by pressing the following key sequence: SET/ENTER, MANUAL, 6, 7, 0, SET/ENTER. This will set the LO frequency to 300 MHz.

b. Set up the counter and the test equipment as shown in *Figure 5-3.*

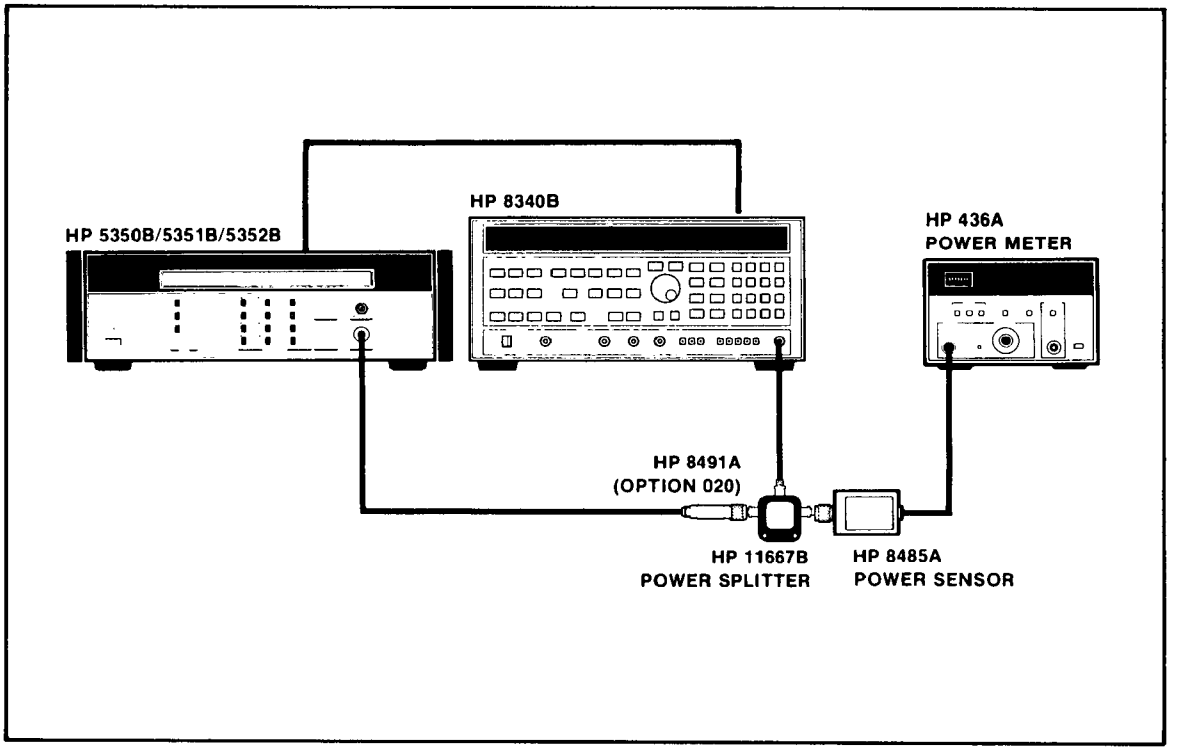


Figure 5-3. IF Bandpass Sensitivity Adjustment Setup

c. Set the HP 8340B Synthesized Sweeper for a 12.37 GHz frequency, at an output level of -20 dBm [-16.5 dBm, 5352B], as measured on the HP 436A Power Meter.

NOTE

The output level set in step c. above will result in a -40 dBm [-36.5 dBm, 5352B] input level to the counter due to the HP 8491A (Option 20) Attenuator. The 12.37 GHz frequency to the counter will result in an IF of 70 MHz in the 5350B/51B/52B (using the second harmonic of the 300 MHz LO frequency).

NOTE

If calibration data is available for the attenuator, the power level in step c. must be modified accordingly. For example, if the attenuation at 12.37 GHz is actually -19.8 dB according to the attenuator's calibration data, the generator should be set for a -20.2 dBm reading on the power meter.

d. Set the HP 8340B for AM Modulation of 5%.

e. If the green LED (IF OK) on the A6 assembly is on, adjust A6R25 (SENS ADJ) until the yellow LED (NO IF LATCH) is on and the green LED is off.

f. Continue to adjust A6R25 clockwise until both the green and yellow LED's are on with equal brightness.

g. Turn off the Amplitude Modulation on the HP 8340B. Press the RESET/LOCAL key on the 5350B/51B/52B.

h. To verify the adjustment, perform the following steps:

1. Set the output level of the HP 8340B to -40.5 dBm [-37.0 dBm, 5352B] and verify that the yellow LED (NO IF LATCH) is on and the green LED (IF OK) is off.

2. Set the HP 8340B level to -39.5 dBm [-36.0 dBm, 5352B] and verify that the green LED (IF OK) is on and the yellow LED (NO IF LATCH) is off.

3. Set the 5350B/51B/52B to Diagnostic 63 and verify that the correct IF frequency (70 MHz) is displayed.

The IF Bandpass Sensitivity Adjustment is now completed.

5-19. **175 MHZ ELLIPTIC FILTER ADJUSTMENT.** Capacitor A6C7 (209 MHz MIN OUTPUT ADJ) is adjusted to set the frequency response of the 175 MHz elliptic filter on the A6 IF Amplifier/ Detector Assembly. The filter will be adjusted to have maximum attenuation at 209 MHz, thus causing the response of the filter to be approximately 8 dB down at 175 MHz. To adjust A6C7, proceed as follows:

a. Set the HP 8660C/86603A synthesizer to 0 dBm at 209 MHz, verifying the output with the HP 436A Power Meter and HP 8485A Power Sensor.

b. Connect the synthesizer output to INPUT 1 of the 5350B/51B/52B through the HP 8491A 20 dB attenuator. Connect the power meter and power sensor to the IF OUT connector on the rear panel of the counter. See *Figure 5-4.*

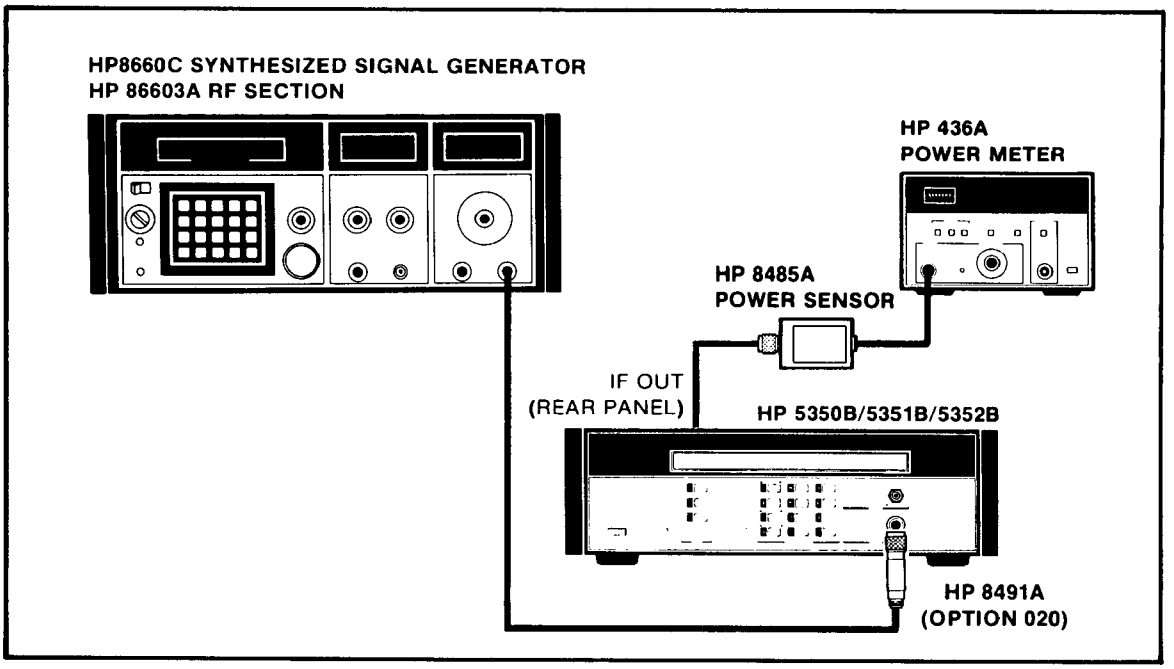


Figure 5-4. 175 MHz Elliptic Filter Adjustment Setup

c. Set the 5350B/51B/52B to Diagnostic 97 by pressing the following key sequence: SET/ENTER, DIAGNOSTICS, 9, 7, SET/ENTER. Diagnostic 97 disables the A5 Synthesizer Assembly. The counter display should read: "ADJUST IF 175 FILTER D97".

d. While monitoring the rear panel IF OUT with the power meter, adjust A6C7 (209 MHz MIN OUTPUT ADJ) for minimum signal level. By adjusting A6C7 through its full rotation, two positions of minimum signal level can be found. Either of these positions is acceptable.

e. The A6C7 adjustment is now completed. Power down the 5350B/51B/52B (POWER switch to STBY) momentarily to exit Diagnostic 97. Power up the counter to continue with the next adjustment procedure.

5-20. **IF BANDPASS WIDTH ADJUSTMENT.** To adjust A6C14 (109 MHz ADJ) for IF bandpass width, proceed as follows:

a. Leave the synthesizer connected to the 5350B/51B/52B as in the previous adjustment procedure. The power meter will not be needed, and can be disconnected.

b. Set the counter to the Manual mode with a center frequency of 770 MHz by pressing the following key sequence: SET/ENTER, MANUAL, 7, 7, 0, SET/ENTER.

c. Set the synthesizer for an output of +5 dBm at 809 MHz. This signal will generate an IF of 109 MHz in the 5350B/51B/52B. The red overload (OVLD) LED indicator may be on at this time. The overload condition is acceptable, as the IF circuitry must be driven sufficiently for the filter adjustment.

d. Set the 86632B for Frequency Modulation of 200 kHz deviation.

e. Adjust A6C14 (109 MHz ADJ) clockwise until both the green and yellow LED's are on with equal brightness. By adjusting A6C14 through its full rotation, two positions of equal LED brightness can be found. Either of these positions is acceptable.

f. As a check, turn off the Frequency Modulation on the synthesizer, and set the synthesizer frequency to 808.5 MHz. The green LED should be on. Change the synthesizer frequency to 809.5 MHz and verify that the yellow LED is now on. The IF Bandpass Width Adjustment is now completed.

5-21. **OVERLOAD INDICATOR THRESHOLD ADJUSTMENT.** To adjust A6R7 (OVLD ADJ) for overload indicator threshold, proceed as follows:

a. Leave the 5350B/51B/52B in the Manual mode with a center frequency of 770 MHz, as in the previous procedure, to obtain an LO frequency of 350 MHz.

b. Set the synthesizer to +4.0 dBm at 2.03 GHz, verifying the output at the end of the cable with the HP 436A Power Meter and HP 8485A Power Sensor. The 2.03 GHz frequency to the counter will result in an IF of 70 MHz in the 5350B/51B/52B (using the sixth harmonic of the 350 MHz LO frequency).

c. Connect the synthesizer output to INPUT 1 of the 5350B/51B/52B. Adjust A6R7 (OVLD ADJ) clockwise until the red LED (OVLD) on the A6 assembly turns on.

d. Disconnect the synthesizer from the counter and set the synthesizer level to +2.5 dBm, verifying the output at the end of the cable with the power meter.

e. Reconnect the synthesizer output to INPUT 1 of the counter and verify that the red LED (OVLD) is off.

5-22. TCXO Adjustment (A10 Standard Timebase)

5-23. Two procedures are given for the adjustment of the TCXO standard timebase. If the operation of the counter will be solely at 25°C (78°F), then adjust the oscillator frequency as close as possible to 10 MHz, using the procedure beginning at paragraph 5-24. If the operation of the counter will be over the full temperature range of 0°C to 50°C, then the TCXO must be offset by the amount labeled on its cover, using the procedure beginning at paragraph 5-25. The offset is necessary to keep the TCXO frequency within the manufacturer's temperature specifications. The TCXO standard timebase is factory-set for use at 25°C.

NOTE

Allow the TCXO in the instrument to warm up for a minimum of 30 minutes before making either TCXO adjustment.

5-24. To adjust the TCXO Timebase for 25°C, proceed as follows:

a. Connect a house standard (1, 2, 5, or 10 MHz reference frequency) to the EXTERNAL SYNC INPUT of an oscilloscope and set the oscilloscope to EXTERNAL SYNC. Connect the 5350B/51B/52B rear panel 10MHZ OUT to the Channel A input of the oscilloscope. (See *Figure 5-5.*)

b. Insert a tuning wand through the TCXO ADJUST hole in the rear panel of the 5350B/51B/52B and into the tuning screw of the TCXO (Y1) on the TCXO Assembly. Adjust the TCXO for a minimum sideways movement of the signal on the oscilloscope display.

c. By timing the sideways movement (in cm/second) of the signal on the oscilloscope display, the accuracy of the timebase can be determined based on the oscilloscope sweep speed, as shown in *Table 5-2.* This completes the adjustment of the TCXO for use at 25°C.

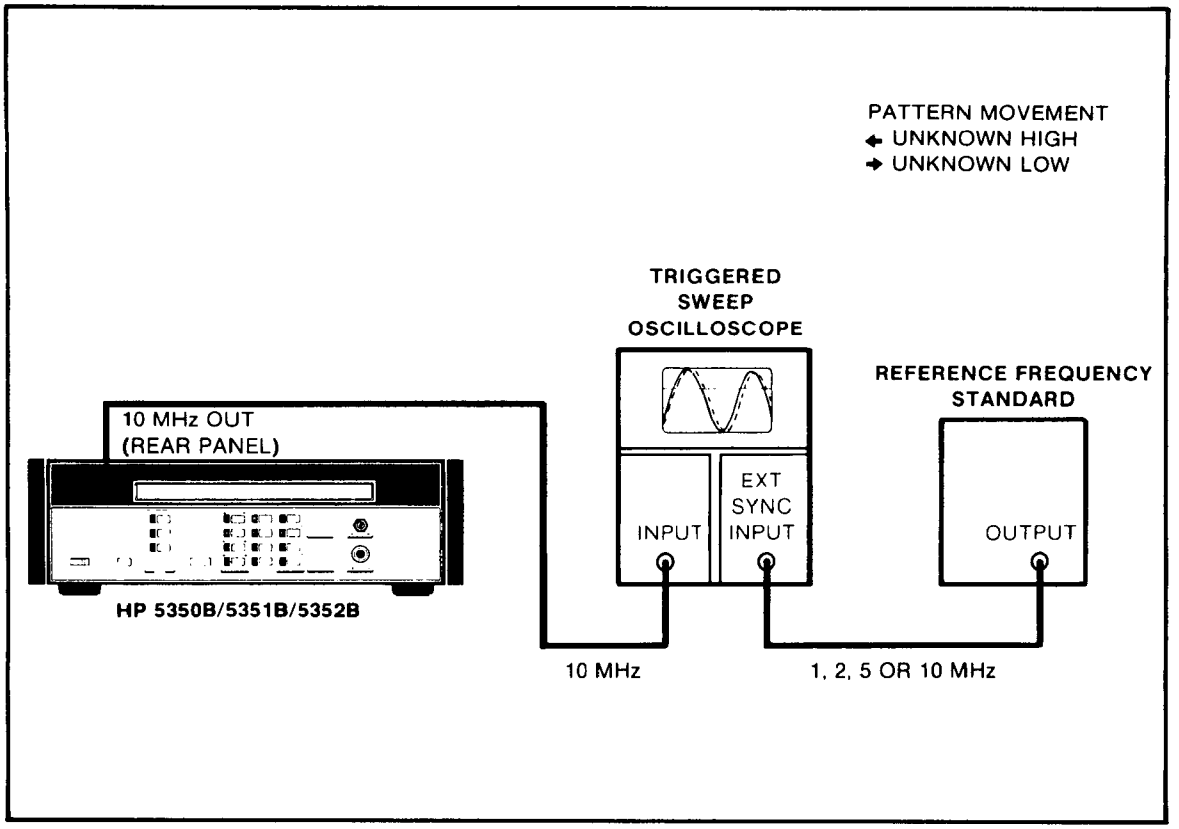


Figure 5-5. Oscillator Adjustment Setup

Table 5-2. Sweep Movement Versus Calibration Accuracy

Movement	Sweep Speed			Notes
	1 μs/cm	0.1 μs/cm	0.01 μs/cm	
1 cm/s	1×10^{-6}	1×10^{-7}	1×10^{-8}	Time scope trace movement with second hand of watch or clock.
1 cm/10s	1×10^{-7}	1×10^{-8}	1×10^{-10}	
1 cm/100s	1×10^{-8}	1×10^{-9}	1×10^{-10}	

5-25. To adjust the TCXO Timebase with offset (0°C to 50°C), proceed as follows:

a. Connect a house standard (1, 2, 5, or 10 MHz reference frequency) to the external reference input of a high resolution counter such as an HP 5384A Frequency Counter (10MHZ IN/OUT BNC connector).

b. Connect the 5350B/51B/52B 10MHZ OUT on the rear panel to the 5384A Channel A Input BNC connector.

c. Set the 5384A to FREQ A, 1 second GATE TIME.

d. Insert a tuning wand through the TCXO ADJUST hole in the rear panel of the 5350B/51B/52B and into the tuning screw of the TCXO (Y1) on the A10 Assembly. Adjust the TCXO frequency to 10 MHz ± the offset labeled on the cover of the TCXO. For example, if the offset is labeled +3.5 Hz, the TCXO should be adjusted for a frequency of 10.0000035 MHz on the 5384A display at a room temperature of 25°C. This completes the adjustment of the TCXO with offset for use at 0°C to 50°C.

5-26. OVEN OSCILLATOR ADJUSTMENT (A10 OPTION 001 or 010 Timebase)

5-27. The following procedure describes the adjustment of the Oven Oscillator Timebase (Option 001) and the High Stability Timebase (Option 010). To perform the adjustment, proceed as follows:

NOTE

Allow the oven oscillator to warm up for a minimum of 24 hours before making this adjustment.

a. Connect a house standard (1, 2, 5, or 10 MHz reference frequency) to the EXTERNAL SYNC INPUT of an oscilloscope and set the oscilloscope to EXTERNAL SYNC. Connect the 5350B/51B/52B rear panel 10MHZ OUT to the Channel A input of the oscilloscope. (See *Figure 5-4.*)

b. Remove the top cover of the instrument and locate the adjustment (A10C1) on the top of the oven oscillator, as shown in *Figure 5-1.*

c. Adjust the oscillator for minimum sideways movement of the signal displayed on the oscilloscope. Increase the oscilloscope sweep speed for greater resolution.

d. By timing the sideways movement (in cm/second) of the signal on the oscilloscope display, the approximate offset can be determined based on the oscilloscope sweep speed, as shown in *Table 5-2.* For example, if the trace moves 5 cm in 10 seconds and the sweep speed is 0.01 μs/cm, the oscillator's signal is within 5×10^{-9} of the reference frequency. The calculation can also be made as follows:

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

$$\frac{\Delta f}{f} = \frac{5 \times 0.01\ \mu s/cm}{10s} = 5 \times 10^{-9}$$

- where:

$\frac{\Delta f}{f}$ is the normalized frequency difference between the oscillator and the reference signal

Δt is the change observed in the oscilloscope

t is the time required for Δt to occur

e. After adjustment, the oven oscillator (Option 001 or 010) should be within 5×10^{-9} of the reference frequency. The Oven Oscillator adjustment for the Option 001 or 010 Timebase is now completed.

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION

6-2. This section contains information for ordering parts. *Table 6-1* is a list of exchange assemblies, and *Table 6-2* lists abbreviations and reference designations used in the parts list and throughout the manual. *Table 6-3* lists all replaceable parts for the standard HP 5350B, 5351B and 5352B in reference designation order. *Table 6-4* lists all replaceable parts for Options 001, 002, 006, and 010. *Table 6-5* contains the names and addresses that correspond to the manufacturer's code numbers given in the parts list.

6-3. EXCHANGE ASSEMBLIES

6-4. *Table 6-1* lists assemblies within the instrument that may be replaced on an exchange basis. Factory repaired and tested exchange assemblies are available only on a trade-in basis; therefore, the defective assemblies must be returned for credit. For this reason, assemblies required for spare parts stock must be ordered by the "new assembly" part number.

Table 6-1. Exchange Assemblies

Assembly	New Assembly HP Part No.	Exchange Assembly HP Part No.
U1 Sampler (5350B/5351B)	05350-60113	05350-60114
U1 Sampler (5352B)	05352-60101	05352-60102

6-5. ABBREVIATIONS AND REFERENCE DESIGNATIONS

6-6. *Table 6-2* lists abbreviations and reference designations used in the parts list, schematics, and throughout the manual. In some cases, two forms of the abbreviations are used, one all in capital letters, and one with partial or no capitals. This occurs because the abbreviations in the parts list are in capital letters only, while other abbreviation forms, with lower case and upper case letters, are used in the schematics and other parts of the manual.

6-7. REPLACEABLE PARTS LIST

6-8. *Tables 6-3* and *6-4* are lists of the replaceable parts and are organized as follows:

a. Electrical assemblies and their components in alphanumeric order by reference designation.
b. Chassis-mounted electrical parts in alphanumeric order by reference designation.
c. Chassis hardware and mechanical parts in alphanumeric order by reference designation.

6-9. The information given for each part consists of the following:

a. The Hewlett-Packard part number.
b. Part number check digit (CD).
c. The total quantity (Qty) in each individual assembly.
d. The description of the part.
e. A typical manufacturer of the part in a five-digit code.
f. The manufacturer's part number for the part.

6-10. The total quantity for each part used within an assembly is given only once at the first appearance of the part number in the list for that assembly.

6-11. ORDERING INFORMATION

6-12. To order a part listed in the replaceable parts list, quote the Hewlett-Packard part number, the check digit, indicate the quantity required, and address the order to the nearest Hewlett-Packard office. The check digit will ensure accurate and timely processing of your order.

6-13. To order a part that is not listed in the replaceable parts list, 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.

6-14. DIRECT MAIL ORDER SYSTEM

6-15. 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.

6-16. 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.

6-17. CABINET PARTS AND HARDWARE

6-18. To locate and identify miscellaneous cabinet and chassis parts and instrument hardware, refer to *Figures 6-1* through *6-9*. These figures provide various exploded views of the instrument, with the parts identified by reference designations. Most of the illustrations are accompanied by a table containing part number, description, and quantity information for each reference designation shown. The quantity indicated represents the total used within the instrument.

6-19. SPECIAL PARTS REPLACEMENT CONSIDERATIONS

6-20. Certain mechanical parts and electrical components require special considerations, as follows:

a. Display Module: The Display Module consists of the Liquid Crystal Display, two display driver boards and the A9 Backlight Assembly. The Display Module is not a repairable assembly. If any portion of the Module is defective, a new Display Module must be ordered (HP P/N 05350-60106). The W3 and W4 cables (HP P/N 05350-60107) are not included, and must be ordered separately.

b. Option 010 High Stability Timebase: The Option 010 High Stability Oven Oscillator (HP P/N 10811-60211) is not a field repairable assembly. If service is required, the Option 010 Oscillator must be returned to the factory for repair.

Table 6-2. Reference Designations and Abbreviations

REFERENCE DESIGNATIONS

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

ABBREVIATIONS

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

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 6-3. Standard Instrument Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1	05350-60013	0	1	TIMEBASE BUFFER/POWER SUPPLY CONTROL ASSEMBLY	28480	05350-60013
A1C1	0160-0576	5	8	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C2	0140-0222	6	3	CAPACITOR-FXD 240PF +-1% 300VDC MICA	72136	DM15F241F0300WV1C
A1C3	0140-0222	6		CAPACITOR-FXD 240PF +-1% 300VDC MICA	72136	DM15F241F0300WV1C
A1C4	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C5	0180-0562	1	4	CAPACITOR-FXD 33UF+-20% 10VDC TA	56289	199D1120
A1C6	0180-0562	1		CAPACITOR-FXD 33UF+-20% 10VDC TA	56289	199D1120
A1C7	0180-0418	6	1	CAPACITOR-FXD 1UF+-20% 35VDC TA	28480	0180-0418
A1C8	0160-4557	0	4	CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A1C9	0160-4554	7	4	CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C10	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C11	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A1C12	0180-0374	3	1	CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A1C13	0180-0197	8	1	CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1C14	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A1C15	0160-4791	4	4	CAPACITOR-FXD 10PF +-5% 100VDC CER 0+-30	28480	0160-4791
A1C16	0160-4791	4		CAPACITOR-FXD 10PF +-5% 100VDC CER 0+-30	28480	0160-4791
A1C17	0160-4791	4		CAPACITOR-FXD 10PF +-5% 100VDC CER 0+-30	28480	0160-4791
A1C18	0160-3879	7	4	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A1C19	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C20	0140-0222	6		CAPACITOR-FXD 240PF +-1% 300VDC MICA	72136	DM15F241F0300WV1C
A1C21	0160-4787	8	2	CAPACITOR-FXD 22PF +-5% 100VDC CER 0+-30	28480	0160-4787
A1C22	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C23	0180-0562	1		CAPACITOR-FXD 33UF+-20% 10VDC TA	56289	199D1120
A1C24	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C25				NOT ASSIGNED		
A1C26	0160-4801	7	3	CAPACITOR-FXD 100PF +-5% 100VDC CER	28480	0160-4801
A1C27	0160-4801	7		CAPACITOR-FXD 100PF +-5% 100VDC CER	28480	0160-4801
A1C28	0180-0562	1		CAPACITOR-FXD 33UF+-20% 10VDC TA	56289	199D1120
A1C29	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C30	0180-2818	4	2	CAPACITOR-FXD 2.2UF+-20% 35VDC TA	28480	0180-2818
A1C31	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A1C32	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C33	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C34				NOT ASSIGNED		
A1C35	0160-4791	4		CAPACITOR-FXD 10PF +-5% 100VDC CER 0+-30	28480	0160-4791
A1C36	0160-4497	7	1	CAPACITOR-FXD 82PF +-5% 200VDC CER 0+-30	28480	0160-4497
A1C37	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A1C38	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A1C39	0180-2818	4		CAPACITOR-FXD 2.2UF+-20% 35VDC TA	28480	0180-2818
A1C40	0180-2617	1	1	CAPACITOR-FXD 6.8UF+-10% 35VDC TA	25088	D6R8GS1B35K
A1C41	0160-4801	7		CAPACITOR-FXD 100PF +-5% 100VDC CER	28480	0160-4801
A1C42	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A1C43	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C44	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A1C45	0160-4547	8	1	CAPACITOR-FXD 150PF +-5% 200VDC CER	28480	0160-4547
A1CR1	1902-0040	3	1	DIODE-ZNR 14V 5% DO-35 PD=.4W TC=+.056%	28480	1902-0040
A1CR2	1902-0057	2	1	DIODE-ZNR 6.49V 5% DO-35 PD=.4W	28480	1902-0057
A1CR3	1901-0841	0	2	DIODE-SCHOTTKY SM SIG	28480	HSCH-1001
A1CR4	1901-0050	3	22	DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A1CR5	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A1CR6	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A1CR7	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A1CR8	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A1CR9	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A1CR10	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A1CR11	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A1CR12	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A1CR13	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A1CR14	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A1CR15	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A1CR16	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A1CR17	1901-0047	8	3	DIODE-SWITCHING 20V 75MA 10NS	28480	1901-0047
A1CR18	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A1CR19	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A1CR20	1901-0047	8		DIODE-SWITCHING 20V 75MA 10NS	28480	1901-0047

See introduction to this section for ordering information

Table 6-3. Standard Instrument Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1CR21	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A1CR22	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A1CR23	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A1CR24	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A1CR25	1902-0050	5	1	DIODE-ZNR 8.66V 5% DO-35 PD=.4W	28480	1902-0050
A1CR26	1901-0841	0		DIODE-SCHOTTKY SM SIG	28480	HSCH-1001
A1CR27	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A1CR28	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A1CR29	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A1CR30	1901-0047	8		DIODE-SWITCHING 20V 75MA 10NS	28480	1901-0047
A1CR31	1901-0539	3	1	DIODE-SM SIG SCHOTTKY	28480	1901-0539
A1DS1	1990-1022	8	1	LED-LAMP LUM-INT=4MCD IF=25MA-MAX BVR=5V	28480	HLMP-5030
A1H1	2360-0286	0	3	SCREW-MACH 6-32 .25-IN-LG BDG-HD-SLT	00000	ORDER BY DESCRIPTION
A1H2	2420-0014	0	3	NUT-HEX-DBL-CHAM 6-32-THD .125-IN-THK	00000	ORDER BY DESCRIPTION
A1L1	9100-0348	2	3	INDUCTOR RF-CH-MLD 1UH 1%	28480	9100-0348
A1L2	9100-0348	2		INDUCTOR RF-CH-MLD 1UH 1%	28480	9100-0348
A1L3	9100-2268	9	2	INDUCTOR RF-CH-MLD 22UH 10%	28480	9100-2268
A1L4	9100-0549	5	2	INDUCTOR RF-CH-MLD 22UH 10% .23DX.57LG	28480	9100-0549
A1L5	9100-2268	9		INDUCTOR RF-CH-MLD 22UH 10%	28480	9100-2268
A1L6	9100-0549	5		INDUCTOR RF-CH-MLD 22UH 10% .23DX.57LG	28480	9100-0549
A1L7	9140-0906	2	1	INDUCTOR 1MH 10% .172D-INX.43LG-IN Q=60	28480	9140-0906
A1L8	9100-0348	2		INDUCTOR RF-CH-MLD 1UH 1%	28480	9100-0348
A1L9	9140-0634	3	1	INDUCTOR RF-CH-MLD 10UH 10% .22DX.56LG	28480	9140-0634
A1MP1	1480-0116	8	2	PIN-GRV .062-IN-DIA .25-IN-LG STL	28480	1480-0116
A1MP2	4040-0748	3	2	EXTR-PC BD BLK POLYC .062-IN-BD-THKNS	28480	4040-0748
A1MP3	2110-0269	0	2	FUSEHOLDER-CLIP TYPE.25D-FUSE	28480	2110-0269
A1P1A	1251-7986	9	2	CONN-POST TYPE .100-PIN-SPCG 50-CONT	28480	1251-7986
A1P1B	1251-7986	9		CONN-POST TYPE .100-PIN-SPCG 50-CONT	28480	1251-7986
A1Q1	1854-0215	1	7	TRANSISTOR NPN SI TO-92 PD=350MW	04713	2N3904
A1Q2	1854-0215	1		TRANSISTOR NPN SI TO-92 PD=350MW	04713	2N3904
A1Q3	1854-0092	2	2	TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A1Q4	1854-0092	2		TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A1Q5	1853-0036	2	5	TRANSISTOR PNP SI PD=310MW FT=250MHZ	27014	2N3906
A1Q6	1853-0036	2		TRANSISTOR PNP SI PD=310MW FT=250MHZ	27014	2N3906
A1Q7	1853-0036	2		TRANSISTOR PNP SI PD=310MW FT=250MHZ	27014	2N3906
A1Q8	1853-0281	9	4	TRANSISTOR PNP 2N2907A SI TO-18 PD=400MW	04713	2N2907A
A1Q9	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD=400MW	04713	2N2907A
A1Q10	1854-0215	1		TRANSISTOR NPN SI TO-92 PD=350MW	04713	2N3904
A1Q11				NOT ASSIGNED		
A1Q12	1853-0036	2		TRANSISTOR PNP SI PD=310MW FT=250MHZ	27014	2N3906
A1Q13	1854-0215	1		TRANSISTOR NPN SI TO-92 PD=350MW	04713	2N3904
A1Q14				NOT ASSIGNED		
A1Q15	1853-0036	2		TRANSISTOR PNP SI PD=310MW FT=250MHZ	27014	2N3906
A1Q16	1854-0215	1		TRANSISTOR NPN SI TO-92 PD=350MW	04713	2N3904
A1Q17	1853-0352	5	1	TRANSISTOR PNP SI TO-92 PD=350MW FT=1GHZ	28480	1853-0352
A1Q18				NOT ASSIGNED		
A1Q19	1854-0215	1		TRANSISTOR NPN SI TO-92 PD=350MW	04713	2N3904
A1Q20	1854-0215	1		TRANSISTOR NPN SI TO-92 PD=350MW	04713	2N3904
A1Q21	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD=400MW	04713	2N2907A
A1Q22	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD=400MW	04713	2N2907A
A1R1	0698-3158	4	2	RESISTOR 23.7K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2372-F
A1R2	0757-0442	9	3	RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1002-F
A1R3				NOT ASSIGNED		
A1R4	0698-3158	4		RESISTOR 23.7K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2372-F
A1R5	0757-0199	3	5	RESISTOR 21.5K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2152-F
A1R6	0698-3441	8	2	RESISTOR 215 1% .125W F TC=0+-100	24546	CT4-1/8-T0-215R-F
A1R7	0757-0280	3	4	RESISTOR 1K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1001-F
A1R8	0757-0416	7	4	RESISTOR 511 1% .125W F TC=0+-100	24546	CT4-1/8-T0-511R-F
A1R9	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	CT4-1/8-T0-511R-F
A1R10	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1001-F

See introduction to this section for ordering information

Table 6-3. Standard Instrument Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1R11	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	CT4-1/8-T0-511R-F
A1R12	0698-0084	9	5	RESISTOR 2.15K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2151-F
A1R13	0699-0069	2	1	RESISTOR 2.15M 1% .125W F TC=0+-100	28480	0699-0069
A1R14	0757-0199	3		RESISTOR 21.5K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2152-F
A1R15	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1001-F
A1R16	0698-3154	0	1	RESISTOR 4.22K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-4221-F
A1R17	0698-5852	9	1	RESISTOR 500 1% .125W F TC=0+-100	24546	CT4-1/8-T0-500R-F
A1R18	0757-0199	3		RESISTOR 21.5K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2152-F
A1R19	0698-3441	8		RESISTOR 215 1% .125W F TC=0+-100	24546	CT4-1/8-T0-215R-F
A1R20	0757-0274	5	1	RESISTOR 1.21K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1211-F
A1R21	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1002-F
A1R22	0698-0084	9		RESISTOR 2.15K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2151-F
A1R23	0698-0084	9		RESISTOR 2.15K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2151-F
A1R24	0757-0438	3	3	RESISTOR 5.11K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-5111-F
A1R25				NOT ASSIGNED		
A1R26	0757-0199	3		RESISTOR 21.5K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2152-F
A1R27	0757-0199	3		RESISTOR 21.5K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2152-F
A1R28	1810-0406	0	5	NETWORK-RES 8-SIP 10.0K OHM X 4	11236	750-83-R10K
A1R29	1810-0207	9	1	NETWORK-RES 8-SIP 22.0K OHM X 7	11236	750-81-R22K
A1R30	1810-0406	0		NETWORK-RES 8-SIP 10.0K OHM X 4	11236	750-83-R10K
A1R31	0698-6264	9	2	RESISTOR 400 .5% .125W F TC=0+-100	28480	0698-6264
A1R32	0698-3458	7	1	RESISTOR 348K 1% .125W F TC=0+-100	28480	0698-3458
A1R33	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-5111-F
A1R34	0698-0084	9		RESISTOR 2.15K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2151-F
A1R35	1810-0223	9	1	NETWORK-RES 8-SIP 1.0M OHM X 7	91637	CSC08C01-105J/MSP10C01-
A1R36	1810-0406	0		NETWORK-RES 8-SIP 10.0K OHM X 4	11236	750-83-R10K
A1R37	1810-0444	6	1	NETWORK-RES 8-SIP100.0K OHM X 4	01121	208B104
A1R38	1810-0374	1	1	NETWORK-RES 8-SIP 1.0K OHM X 4	11236	750-83-R1K
A1R39	0757-1094	9	1	RESISTOR 1.47K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1471-F
A1R40	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-5111-F
A1R41	0698-6360	6	5	RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A1R42	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A1R43	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A1R44	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A1R45	1810-0406	0		NETWORK-RES 8-SIP 10.0K OHM X 4	11236	750-83-R10K
A1R46	1810-0406	0		NETWORK-RES 8-SIP 10.0K OHM X 4	11236	750-83-R10K
A1R47	1810-0347	8	1	NETWORK-RES 8-SIP 2.2K OHM X 4	11236	750-83-R2.2K
A1R48	0698-0085	0	1	RESISTOR 2.61K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2611-F
A1R49	0757-0418	9	1	RESISTOR 619 1% .125W F TC=0+-100	24546	CT4-1/8-T0-619R-F
A1R50	0757-0401	0	1	RESISTOR 100 1% .125W F TC=0+-100	24546	CT4-1/8-T0-101-F
A1R51	0698-3429	2	1	RESISTOR 19.6 1% .125W F TC=0+-100	03888	PME55-1/8-T0-19R6-F
A1R52	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A1R53	0698-6264	9		RESISTOR 400 .5% .125W F TC=0+-100	28480	0698-6264
A1R54	0757-0463	4	1	RESISTOR 82.5K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-8252-F
A1R55	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1002-F
A1R56	0757-0424	7	1	RESISTOR 1.1K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1101-F
A1R57	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1001-F
A1R58				NOT ASSIGNED		
A1R59	0698-7212	9	2	RESISTOR 100 1% .05W F TC=0+-100	24546	C3-1/8-T0-100R-F
A1R60	0698-7212	9		RESISTOR 100 1% .05W F TC=0+-100	24546	C3-1/8-T0-100R-F
A1R61	0698-7188	8	1	RESISTOR 10 1% .05W F TC=0+-100	24546	C3-1/8-T0-10R-F
A1TP1	1251-0600	0	7	CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A1TP2	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A1TP3	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A1TP4	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A1TP5	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A1TP6	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A1TP7	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A1U1	1826-0718	0	1	IC V RGLTR-V-REF-ADJ 4.95/5.05V 8-DIP-C	28480	1826-0718
A1U2	1826-0772	6	1	IC V RGLTR-ADJ-POS 1.2/32V TO-92 PKG	28480	1826-0772
A1U3	1820-1437	0	1	IC MV TTL LS MONOSTBL DUAL	01295	SN74LS221N
A1U4	1820-1425	6	2	IC SCHMITT-TRIG TTL LS NAND QUAD 2-INP	01295	SN74LS132N
A1U5	1820-1423	4	1	IC MV TTL LS MONOSTBL RETRIG DUAL	01295	SN74LS123N

See introduction to this section for ordering information

Table 6-3. Standard Instrument Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1U6	1820-1442	7	1	IC CNTR TTL LS DECD ASYNCHRO	01295	SN74LS290N
A1U7	1826-0138	8	2	IC COMPARATOR GP QUAD 14-DIP-P PKG	01295	LM339N
A1U8	1826-0138	8		IC COMPARATOR GP QUAD 14-DIP-P PKG	01295	LM339N
A1U9	1820-1074	1	1	IC DRVR TTL NOR QUAD 2-INP	01295	SN74128N
A1U10	1820-1425	6		IC SCHMITT-TRIG TTL LS NAND QUAD 2-INP	01295	SN74LS132N
A1U11	1826-0904	6	2	IC-LM330T-5.0	28480	1826-0904
A1U12	1826-0904	6		IC-LM330T-5.0	28480	1826-0904
A1U13	1826-0147	9	1	IC 7812 V RGLTR TO-220	04713	MC7812CP
A1U14	1826-0161	7	1	IC OP AMP GP QUAD 14-DIP-P PKG	04713	MLM324P

See introduction to this section for ordering information

Table 6-3. Standard Instrument Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A2	05350-60002	7	1	LOW FREQUENCY INPUT ASSEMBLY	28480	05350-60002
A2C1	0160-3879	7	11	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C2	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C3	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C4	0160-4787	8	1	CAPACITOR-FXD 22PF +-5% 100VDC CER 0+-30	28480	0160-4787
A2C5	0160-4554	7	8	CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A2C6	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C7	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A2C8	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A2C9	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A2C10	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C11	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A2C12	0160-0576	5	3	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A2C13	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A2C14				NOT ASSIGNED		
A2C15	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C16	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C17	0160-4557	0	3	CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A2C18	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A2C19				NOT ASSIGNED		
A2C20	0160-4804	0	1	CAPACITOR-FXD 56PF +-5% 100VDC CER 0+-30	28480	0160-4804
A2C21	0180-2929	8	1	CAPACITOR-FXD 68UF+-10% 10VDC TA	28480	0180-2929
A2C22	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C23	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A2C24	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A2C25	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C26	0160-5649	3	1	CAPACITOR-FXD 100PF +-5% 500VDC CER	28480	0160-5649
A2C27	0160-4704	9	1	CAPACITOR-FXD .01UF +-10% 500VDC CER	28480	0160-4704
A2C28	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C29	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A2C30	0160-4204	4	1	CAPACITOR-FXD .033UF +-10% 500VDC CER	72982	8131-M500-W5R-333K
A2C31	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A2C32	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C33	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A2CR1	1901-0539	3	10	DIODE-SM SIG SCHOTTKY	28480	1901-0539
A2CR2	1901-0539	3		DIODE-SM SIG SCHOTTKY	28480	1901-0539
A2CR3	1901-0539	3		DIODE-SM SIG SCHOTTKY	28480	1901-0539
A2CR4	1901-0539	3		DIODE-SM SIG SCHOTTKY	28480	1901-0539
A2CR5	1901-0539	3		DIODE-SM SIG SCHOTTKY	28480	1901-0539
A2CR6	1901-0539	3		DIODE-SM SIG SCHOTTKY	28480	1901-0539
A2CR7	1901-0539	3		DIODE-SM SIG SCHOTTKY	28480	1901-0539
A2CR8	1901-0539	3		DIODE-SM SIG SCHOTTKY	28480	1901-0539
A2CR9	1901-0539	3		DIODE-SM SIG SCHOTTKY	28480	1901-0539
A2CR10	1901-0539	3		DIODE-SM SIG SCHOTTKY	28480	1901-0539
A2CR11	1901-0050	3	2	DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A2CR12	1901-0376	6	2	DIODE-GEN PRP 35V 50MA DO-35	9N171	1N3595
A2CR13	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A2CR14	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	9N171	1N3595
A2L1	9135-0072	2	1	INDUCTOR 56NH 5.893% 2.6D-MMX6.6LG-MM	28480	9135-0072
A2L2	9100-1788	6	4	CORE-FERRITE CHOKE-WIDEBAND;IMP:>680	28480	9100-1788
A2L3	9100-1788	6		CORE-FERRITE CHOKE-WIDEBAND;IMP:>680	28480	9100-1788
A2L4	9100-0368	6	1	INDUCTOR RF-CH-MLD 330NH 10%	28480	9100-0368
A2L5	9100-1788	6		CORE-FERRITE CHOKE-WIDEBAND;IMP:>680	28480	9100-1788
A2L6	9100-1788	6		CORE-FERRITE CHOKE-WIDEBAND;IMP:>680	28480	9100-1788
A2MP1	1480-0116	8	2	PIN-GRV .062-IN-DIA .25-IN-LG STL	28480	1480-0116
A2MP2	4040-0748	3	2	EXTR-PC BD BLK POLYC .062-IN-BD-THKNS	28480	4040-0748
A2MP3	0403-0026	6	1	PLUG-HOLE BDR-HD FOR .187-D-HOLE NYL	02768	207-120241-03-0101
A2MP4	1205-0554	6	1	HEAT SINK SGL DIP	28480	1205-0554
A2P1	1251-7986	9	1	CONN-POST TYPE .100-PIN-SPCG 50-CONT	28480	1251-7986

See introduction to this section for ordering information

Table 6-3. Standard Instrument Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A2Q1	1854-0092	2	2	TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A2Q2	1854-0092	2		TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A2Q3	1853-0036	2	3	TRANSISTOR PNP SI PD=310MW FT=250MHZ	27014	2N3906
A2Q4	1853-0036	2		TRANSISTOR PNP SI PD=310MW FT=250MHZ	27014	2N3906
A2Q5	1854-0215	1	4	TRANSISTOR NPN SI TO-92 PD=350MW	04713	2N3904
A2Q6	1853-0354	7	1	TRANSISTOR PNP SI TO-92 PD=350MW	28480	1853-0354
A2Q7	1854-0215	1		TRANSISTOR NPN SI TO-92 PD=350MW	04713	2N3904
A2Q8	1854-0215	1		TRANSISTOR NPN SI TO-92 PD=350MW	04713	2N3904
A2Q9	1855-0327	8	1	TRANSISTOR J-FET 2N4416 N-CHAN D-MODE	01295	2N4416
A2Q10	1853-0036	2		TRANSISTOR PNP SI PD=310MW FT=250MHZ	27014	2N3906
A2Q11	1854-0215	1		TRANSISTOR NPN SI TO-92 PD=350MW	04713	2N3904
A2R1	2100-2489	9	1	RESISTOR-TRMR 5K 10% C SIDE-ADJ 1-TRN	73138	82PAR5K
A2R2	0757-0442	9	11	RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1002-F
A2R3	0698-3441	8	4	RESISTOR 215 1% .125W F TC=0+-100	24546	CT4-1/8-T0-215R-F
A2R4	0698-4037	0	2	RESISTOR 46.4 1% .125W F TC=0+-100	28480	0698-4037
A2R5	0699-0073	8	1	RESISTOR 10M 1% .125W F TC=0+-150	28480	0699-0073
A2R6	0698-3441	8		RESISTOR 215 1% .125W F TC=0+-100	24546	CT4-1/8-T0-215R-F
A2R7	0757-1094	9	2	RESISTOR 1.47K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1471-F
A2R8	0757-0458	7	2	RESISTOR 51.1K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-5112-F
A2R9	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1002-F
A2R10	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1002-F
A2R11	0757-0458	7		RESISTOR 51.1K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-5112-F
A2R12	0698-3155	1	1	RESISTOR 4.64K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-4641-F
A2R13	0698-3437	2	1	RESISTOR 133 1% .125W F TC=0+-100	24546	CT4-1/8-T0-133R-F
A2R14	0757-1094	9		RESISTOR 1.47K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1471-F
A2R15	0757-0421	4	3	RESISTOR 825 1% .125W F TC=0+-100	24546	CT4-1/8-T0-825R-F
A2R16	0698-3443	0	2	RESISTOR 287 1% .125W F TC=0+-100	24546	CT4-1/8-T0-287R-F
A2R17	0698-3440	7	1	RESISTOR 196 1% .125W F TC=0+-100	24546	CT4-1/8-T0-196R-F
A2R18	0698-3439	4	2	RESISTOR 178 1% .125W F TC=0+-100	24546	CT4-1/8-T0-178R-F
A2R19	0757-0403	2	1	RESISTOR 121 1% .125W F TC=0+-100	24546	CT4-1/8-T0-121R-F
A2R20	0698-3158	4	2	RESISTOR 23.7K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2372-F
A2R21	0757-0401	0	3	RESISTOR 100 1% .125W F TC=0+-100	24546	CT4-1/8-T0-101-F
A2R22	0698-3441	8		RESISTOR 215 1% .125W F TC=0+-100	24546	CT4-1/8-T0-215R-F
A2R23	0698-3441	8		RESISTOR 215 1% .125W F TC=0+-100	24546	CT4-1/8-T0-215R-F
A2R24	0757-0727	3	2	RESISTOR 562 1% .25W F TC=0+-100	24546	NA5-1/4-T0-562R-F
A2R25	0698-3158	4		RESISTOR 23.7K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2372-F
A2R26	1810-0203	5	1	NETWORK-RES 8-SIP 470.0 OHM X 7	11236	750-81-R470
A2R27	0698-3431	6	1	RESISTOR 23.7 1% .125W F TC=0+-100	03888	PME55-1/8-T0-23R7-F
A2R28	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1002-F
A2R29	0757-0439	4	1	RESISTOR 6.81K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-6811-F
A2R30	0757-0727	3		RESISTOR 562 1% .25W F TC=0+-100	24546	NA5-1/4-T0-562R-F
A2R31	1810-0541	4	1	NETWORK-RES 6-SIP MULTI-VALUE	28480	1810-0541
A2R32	1810-0219	3	1	NETWORK-RES 8-SIP 220.0 OHM X 4	11236	750-83-R220
A2R33	0757-0421	4		RESISTOR 825 1% .125W F TC=0+-100	24546	CT4-1/8-T0-825R-F
A2R34	0698-3443	0		RESISTOR 287 1% .125W F TC=0+-100	24546	CT4-1/8-T0-287R-F
A2R35	0698-3439	4		RESISTOR 178 1% .125W F TC=0+-100	24546	CT4-1/8-T0-178R-F
A2R36	0757-0317	7	1	RESISTOR 1.33K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1331-F
A2R37	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	CT4-1/8-T0-101-F
A2R38	0698-0082	7	2	RESISTOR 464 1% .125W F TC=0+-100	24546	CT4-1/8-T0-4640-F
A2R39	0757-0280	3	3	RESISTOR 1K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1001-F
A2R40	0757-0400	9	1	RESISTOR 90.9 1% .125W F TC=0+-100	24546	CT4-1/8-T0-90R9-F
A2R41	0698-4037	0		RESISTOR 46.4 1% .125W F TC=0+-100	28480	0698-4037
A2R42	0698-0082	7		RESISTOR 464 1% .125W F TC=0+-100	24546	CT4-1/8-T0-4640-F
A2R43	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1002-F
A2R44	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1002-F
A2R45	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1002-F
A2R46	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	CT4-1/8-T0-101-F
A2R47	0757-0421	4		RESISTOR 825 1% .125W F TC=0+-100	24546	CT4-1/8-T0-825R-F
A2R48	0757-1108	6	1	RESISTOR 300 1% .125W F TC=0+-100	24546	CT4-1/8-T0-301-F
A2R49	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1001-F
A2R50	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1002-F
A2R51	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1001-F
A2R52	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1002-F
A2R53	0698-8827	4	2	RESISTOR 1M 1% .125W F TC=0+-100	28480	0698-8827
A2R54	0698-8827	4		RESISTOR 1M 1% .125W F TC=0+-100	28480	0698-8827
A2R55	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1002-F

See introduction to this section for ordering information

Table 6-3. Standard Instrument Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A2R56	0757-0178	8	1	RESISTOR 100 1% .25W F TC=0+-100	24546	NA5-1/4-T0-101-F
A2R57	0757-0463	4	1	RESISTOR 82.5K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-8252-F
A2R58	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1002-F
A2R59	0757-0422	5	1	RESISTOR 909 1% .125W F TC=0+-100	24546	CT4-1/8-T0-909R-F
A2R60	0698-7200	5	1	RESISTOR 31.6 1% .05W F TC=0+-100	24546	C3-1/8-T0-31R6-F
A2TP1	1251-0600	0	2	CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A2TP2	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A2U1	1820-1780	6	1	IC PRESCR ECL	07263	11C90DC
A2U2	1826-0139	9	1	IC OP AMP GP DUAL 8-DIP-P PKG	3L585	CA1458G
A2U3	1820-2823	0	2	IC GATE ECL/10KH NOR QUAD 2-INP	04713	MC10H102P
A2U4	1813-0215	5	2	IC WIDEBAND AMPL TO-39 PKG	04713	MWA220
A2U5	1813-0215	5		IC WIDEBAND AMPL TO-39 PKG	04713	MWA220
A2U6	1820-3075	6	1	IC RCVR ECL/10KH LINE RCVR TPL	04713	MC10H116L
A2U7	1813-0214	4	1	IC WIDEBAND AMPL TO-39 PKG	04713	MWA210
A2U8	1820-2823	0		IC GATE ECL/10KH NOR QUAD 2-INP	04713	MC10H102P
A2U9	1826-0346	0	1	IC OP AMP GP DUAL 8-DIP-P PKG	27014	LM358N
A2W1	05350-60103	9	1	CBL AY-LOW FREQUENCY	28480	05350-60103

See introduction to this section for ordering information

Table 6-3. Standard Instrument Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A3	05350-60003	8	1	COUNTER ASSEMBLY	28480	05350-60003
A3C1	0160-4557	0	2	CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A3C2	0180-0210	6	1	CAPACITOR-FXD 3.3UF+-20% 15VDC TA	56289	150D335X0015A2
A3C3	0180-0229	7	2	CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2
A3C4	0160-4554	7	17	CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A3C5	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A3C6	0160-4810	8	1	CAPACITOR-FXD 330PF +-5% 100VDC CER	28480	0160-4810
A3C7	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A3C8	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A3C9	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A3C10	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A3C11	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A3C12	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A3C13	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A3C14	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A3C15	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A3C16	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A3C17	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A3C18	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A3C19	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A3C20	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A3C21	0160-4556	9	2	CAPACITOR-FXD 1000PF +-20% 100VDC CER	16299	CAC02X7R102M100A
A3C22	0180-0229	7		CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2
A3C23	0160-4556	9		CAPACITOR-FXD 1000PF +-20% 100VDC CER	16299	CAC02X7R102M100A
A3C24	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A3C25	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A3CR1	1901-0050	3	2	DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A3CR2	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A3H1	2360-0286	0	1	SCREW-MACH 6-32 .25-IN-LG BDG-HD-SLT	00000	ORDER BY DESCRIPTION
A3H2	2420-0014	0	1	NUT-HEX-DBL-CHAM 6-32-THD .125-IN-THK	00000	ORDER BY DESCRIPTION
A3L1	9100-1788	6	2	CORE-FERRITE CHOKE-WIDEBAND;IMP:>680	28480	9100-1788
A3L2	9100-1788	6		CORE-FERRITE CHOKE-WIDEBAND;IMP:>680	28480	9100-1788
A3L3	9100-2247	4	1	INDUCTOR RF-CH-MLD 100NH 10%	28480	9100-2247
A3MP1	1480-0116	8	2	PIN-GRV .062-IN-DIA .25-IN-LG STL	28480	1480-0116
A3MP2	4040-0748	3	2	EXTR-PC BD BLK POLYC .062-IN-BD-THKNS	28480	4040-0748
A3MP3	0403-0026	6	1	PLUG-HOLE BDR-HD FOR .187-D-HOLE NYL	02768	207-120241-03-0101
A3P1	1251-7986	9	1	CONN-POST TYPE .100-PIN-SPCG 50-CONT	28480	1251-7986
A3Q1	1854-0591	6	2	TRANSISTOR NPN SI PD=180MW FT=4GHZ	25403	BFR90
A3Q2	1854-0591	6		TRANSISTOR NPN SI PD=180MW FT=4GHZ	25403	BFR90
A3R1	0757-0418	9	4	RESISTOR 619 1% .125W F TC=0+-100	24546	CT4-1/8-T0-619R-F
A3R2	0757-0418	9		RESISTOR 619 1% .125W F TC=0+-100	24546	CT4-1/8-T0-619R-F
A3R3	0698-3159	5	2	RESISTOR 26.1K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2612-F
A3R4	2100-3351	6	1	RESISTOR-TRMR 500 10% C SIDE-ADJ 1-TRN	28480	2100-3351
A3R5	0757-0438	3	3	RESISTOR 5.11K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-5111-F
A3R6	0698-3132	4	2	RESISTOR 261 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2610-F
A3R7	0698-3132	4		RESISTOR 261 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2610-F
A3R8	0757-0416	7	2	RESISTOR 511 1% .125W F TC=0+-100	24546	CT4-1/8-T0-511R-F
A3R9	0698-3151	7	3	RESISTOR 2.87K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2871-F
A3R10	0698-3159	5		RESISTOR 26.1K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2612-F
A3R11	0698-3441	8	1	RESISTOR 215 1% .125W F TC=0+-100	24546	CT4-1/8-T0-215R-F
A3R12	0757-0280	3	4	RESISTOR 1K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1001-F
A3R13	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1001-F
A3R14	0757-0418	9		RESISTOR 619 1% .125W F TC=0+-100	24546	CT4-1/8-T0-619R-F
A3R15	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-5111-F
A3R16	0757-0421	4	2	RESISTOR 825 1% .125W F TC=0+-100	24546	CT4-1/8-T0-825R-F
A3R17	0757-0421	4		RESISTOR 825 1% .125W F TC=0+-100	24546	CT4-1/8-T0-825R-F
A3R18	0698-3460	1	1	RESISTOR 422K 1% .125W F TC=0+-100	28480	0698-3460
A3R19	0698-3151	7		RESISTOR 2.87K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2871-F
A3R20	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-5111-F

See introduction to this section for ordering information

Table 6-3. Standard Instrument Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A3R21				NOT ASSIGNED		
A3R22	0698-3151	7		RESISTOR 2.87K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2871-F
A3R23	0698-3446	3	3	RESISTOR 383 1% .125W F TC=0+-100	24546	CT4-1/8-T0-383R-F
A3R24	0698-3437	2	3	RESISTOR 133 1% .125W F TC=0+-100	24546	CT4-1/8-T0-133R-F
A3R25	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1001-F
A3R26	0757-0418	9		RESISTOR 619 1% .125W F TC=0+-100	24546	CT4-1/8-T0-619R-F
A3R27	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1001-F
A3R28	0698-3437	2		RESISTOR 133 1% .125W F TC=0+-100	24546	CT4-1/8-T0-133R-F
A3R29	0698-3446	3		RESISTOR 383 1% .125W F TC=0+-100	24546	CT4-1/8-T0-383R-F
A3R30	0698-3446	3		RESISTOR 383 1% .125W F TC=0+-100	24546	CT4-1/8-T0-383R-F
A3R31	0757-0400	9	3	RESISTOR 90.9 1% .125W F TC=0+-100	24546	CT4-1/8-T0-90R9-F
A3R32	0757-0400	9		RESISTOR 90.9 1% .125W F TC=0+-100	24546	CT4-1/8-T0-90R9-F
A3R33	0698-3437	2		RESISTOR 133 1% .125W F TC=0+-100	24546	CT4-1/8-T0-133R-F
A3R34	0757-0401	0	2	RESISTOR 100 1% .125W F TC=0+-100	24546	CT4-1/8-T0-101-F
A3R35	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	CT4-1/8-T0-101-F
A3R36	0757-0398	4	1	RESISTOR 75 1% .125W F TC=0+-100	24546	CT4-1/8-T0-75R0-F
A3R37	0757-0400	9		RESISTOR 90.9 1% .125W F TC=0+-100	24546	CT4-1/8-T0-90R9-F
A3R38	0757-0394	0	2	RESISTOR 51.1 1% .125W F TC=0+-100	24546	CT4-1/8-T0-51R1-F
A3R39	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	CT4-1/8-T0-511R-F
A3R40	0757-0394	0		RESISTOR 51.1 1% .125W F TC=0+-100	24546	CT4-1/8-T0-51R1-F
A3R41	0698-4037	0	1	RESISTOR 46.4 1% .125W F TC=0+-100	28480	0698-4037
A3R42	0699-1542	8	1	RESISTOR 51 1% .125W F TC=0+-50	28480	0699-1542
A3TP1	1251-0600	0	2	CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP2	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3U1	1826-0393	7	1	IC V RGLTR-ADJ-POS 1.2/37V TO-220 PKG	28480	1826-0393
A3U2	1826-0065	0	1	IC COMPARATOR PRCN 8-DIP-P PKG	27014	LM311N
A3U3	1820-1425	6	1	IC SCHMITT-TRIG TTL LS NAND QUAD 2-INP	01295	SN74LS132N
A3U4	1820-2096	9	1	IC CNTR TTL LS BIN DUAL 4-BIT	01295	SN74LS393N
A3U5	1858-0054	4	1	TRANSISTOR ARRAY 16-PIN PLSTC DIP	28480	1858-0054
A3U6	1820-2724	0	1	IC LCH TTL ALS TRANSPARENT OCTL	01295	SN74ALS573BN
A3U7	1820-2312	2	1	IC MISC	28480	1DA9-2902
A3U8	1826-0346	0	1	IC OP AMP GP DUAL 8-DIP-P PKG	27014	LM358N
A3W1	8159-0005	0	1	RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A3XU1-A3XU6				NOT ASSIGNED		
A3XU7	1200-0682	1	1	SOCKET-IC 40-CONT DIP DIP-SLDR	28480	1200-0682

See introduction to this section for ordering information

Table 6-3. Standard Instrument Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A4	05350-60014	1	1	MICROPROCESSOR ASSEMBLY (5350B/5351B) NOTE THE FOLLOWING A4 PARTS LIST APPLIES ONLY TO THE 05350-60014 ASSEMBLY INSTALLED IN THE 5350B AND 5351B. REFER TO THE SECOND A4 PARTS LIST IMMEDIATELY FOLLOWING THIS LIST FOR 5352B A4 PARTS.	28480	05350-60014
A4C1	0160-4787	8	2	CAPACITOR-FXD 22PF +-5% 100VDC CER 0+-30	28480	0160-4787
A4C2	0160-4557	0	18	CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A4C3	0160-4787	8		CAPACITOR-FXD 22PF +-5% 100VDC CER 0+-30	28480	0160-4787
A4C4	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A4C5	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A4C6	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A4C7	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A4C8	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A4C9	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A4C10	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A4C11	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A4C12	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A4C13	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A4C14	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A4C15				NOT ASSIGNED		
A4C16	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A4C17	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A4C18	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A4C19	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A4C20				NOT ASSIGNED		
A4C21				NOT ASSIGNED		
A4C22	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A4C23	0180-0197	8	1	CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A4C24	0160-4808	4	1	CAPACITOR-FXD 470PF +-5% 100VDC CER	28480	0160-4808
A4C25				NOT ASSIGNED		
A4C26	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A4C27	0180-0562	1	2	CAPACITOR-FXD 33UF+-20% 10VDC TA	56289	199D1120
A4C28	0180-0562	1		CAPACITOR-FXD 33UF+-20% 10VDC TA	56289	199D1120
A4CR1	1901-0050	3	3	DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A4CR2	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A4CR3				NOT ASSIGNED		
A4CR4				NOT ASSIGNED		
A4CR5	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A4J1	1251-4775	8	1	CONNECTOR 10-PIN M POST TYPE	28480	1251-4775
A4L1	9140-0990	4	1	INDUCTOR 1UF SHLDD	28480	9140-0990
A4L2	9100-0541	7	1	INDUCTOR RF-CH-MLD 250UH 10%	28480	9100-0541
A4MP1	1480-0116	8	2	PIN-GRV .062-IN-DIA .25-IN-LG STL	28480	1480-0116
A4MP2	4040-0748	3	2	EXTR-PC BD BLK POLYC .062-IN-BD-THKNS	28480	4040-0748
A4P1A	1251-7986	9	2	CONN-POST TYPE .100-PIN-SPCG 50-CONT	28480	1251-7986
A4P1B	1251-7986	9		CONN-POST TYPE .100-PIN-SPCG 50-CONT	28480	1251-7986
A4R1	0757-0449	6	2	RESISTOR 20K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2002-F
A4R2	0757-0449	6		RESISTOR 20K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2002-F
A4R3	1810-0398	9	1	NETWORK-RES 10-SIP 22.0K OHM X 9	11236	750-101-R22K
A4R4	0757-0283	6	3	RESISTOR 2K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2001-F
A4R5	0757-0283	6		RESISTOR 2K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2001-F
A4R6	0757-0442	9	3	RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1002-F
A4R7	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1002-F
A4R8	0757-0283	6		RESISTOR 2K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2001-F
A4R9				NOT ASSIGNED		
A4R10				NOT ASSIGNED		

See introduction to this section for ordering information

Table 6-3. Standard Instrument Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A4R11				NOT ASSIGNED		
A4R12	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1002-F
A4U1	1820-2724	0	4	IC LCH TTL ALS TRANSPARENT OCTL	01295	SN74ALS573BN
A4U2	1820-3159	7	1	IC-MPU;CLK FREQ=2MHZ;8-BITS;64K-ADDRESS	04713	MC68B03L
A4U3	1820-1246	9	1	IC GATE TTL LS AND QUAD 2-INP	01295	SN74LS09N
A4U4	1820-2634	1	1	IC INV TTL ALS HEX	01295	SN74ALS04BN
A4U5	1820-3100	8	2	IC DCDR TTL ALS BIN 3-T0-8-LINE 3-INP	01295	SN74ALS138N
A4U6	1820-2775	1	1	IC GATE TTL ALS NAND TPL 3-INP	01295	SN74ALS10N
A4U7	1820-3100	8		IC DCDR TTL ALS BIN 3-T0-8-LINE 3-INP	01295	SN74ALS138N
A4U8				NOT ASSIGNED		
A4U9	1820-1858	9	3	IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A4U10	1820-3121	3	1	IC TRANSCEIVER TTL ALS BUS OCTL	01295	SN74ALS245AN
A4U11	1820-1858	9		IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A4U12	1820-2724	0		IC LCH TTL ALS TRANSPARENT OCTL	01295	SN74ALS573BN
A4U13	1820-1858	9		IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A4U14	05350-80016	5	1	NMOS 27128A ROM	28480	05350-80016
A4U15				NOT ASSIGNED		
A4U16	1820-2724	0		IC LCH TTL ALS TRANSPARENT OCTL	01295	SN74ALS573BN
A4U17	05350-80017	0	1	NMOS 27128A ROM	28480	05350-80017
A4U18	1820-2724	0		IC LCH TTL ALS TRANSPARENT OCTL	01295	SN74ALS573BN
A4U19				NOT ASSIGNED		
A4U20	1818-1790	3	1	IC CMOS 16384 (16K) STAT RAM 120-NS 3-S	S4013	HM6116LP-2
A4XU1-7				NOT ASSIGNED		
A4XU8	1200-0639	8	2	SOCKET-IC 20-CONT DIP DIP-SLDR	28480	1200-0639
A4XU9				NOT ASSIGNED		
A4XU10	1200-0639	8		SOCKET-IC 20-CONT DIP DIP-SLDR	28480	1200-0639
A4XU11-13				NOT ASSIGNED		
A4XU14	1200-0567	1	2	SOCKET-IC 28-CONT DIP DIP-SLDR	28480	1200-0567
A4XU15-16				NOT ASSIGNED		
A4XU17	1200-0567	1		SOCKET-IC 28-CONT DIP DIP-SLDR	28480	1200-0567
A4Y1	0410-1386	8	1	CRYSTAL-QUARTZ 8.00000 MHZ HC-18/U-HLDR	28480	0410-1386

See introduction to this section for ordering information

Table 6-3. Standard Instrument Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A4	05352-60014	3	1	MICROPROCESSOR ASSEMBLY (5352B)	28480	05352-60014
				NOTE THE FOLLOWING A4 PARTS LIST APPLIES ONLY TO THE 05352-60014 ASSEMBLY INSTALLED IN THE 5352B. REFER TO THE A4 PARTS LIST IMMEDIATELY PRECEDING THIS LIST FOR 5350B AND 5351B A4 PARTS.		
A4C1	0160-4787	8	2	CAPACITOR-FXD 22PF +-5% 100VDC CER 0+-30	28480	0160-4787
A4C2	0160-4557	0	18	CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A4C3	0160-4787	8		CAPACITOR-FXD 22PF +-5% 100VDC CER 0+-30	28480	0160-4787
A4C4	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A4C5	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A4C6	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A4C7	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A4C8	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A4C9	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A4C10	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A4C11	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A4C12	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A4C13	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A4C14	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A4C15				NOT ASSIGNED		
A4C16	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A4C17	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A4C18	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A4C19	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A4C20				NOT ASSIGNED		
A4C21				NOT ASSIGNED		
A4C22	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A4C23	0180-0197	8	1	CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A4C24	0160-4808	4	1	CAPACITOR-FXD 470PF +-5% 100VDC CER	28480	0160-4808
A4C25				NOT ASSIGNED		
A4C26	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A4C27	0180-0562	1	2	CAPACITOR-FXD 33UF+-20% 10VDC TA	56289	199D1120
A4C28	0180-0562	1		CAPACITOR-FXD 33UF+-20% 10VDC TA	56289	199D1120
A4CR1	1901-0050	3	3	DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A4CR2	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A4CR3				NOT ASSIGNED		
A4CR4				NOT ASSIGNED		
A4CR5	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A4J1	1251-4775	8	1	CONNECTOR 10-PIN M POST TYPE	28480	1251-4775
A4L1	9140-0990	4	1	INDUCTOR 1UF SHLDD	28480	9140-0990
A4L2	9100-0541	7	1	INDUCTOR RF-CH-MLD 250UH 10%	28480	9100-0541
A4MP1	1480-0116	8	2	PIN-GRV .062-IN-DIA .25-IN-LG STL	28480	1480-0116
A4MP2	4040-0748	3	2	EXTR-PC BD BLK POLYC .062-IN-BD-THKNS	28480	4040-0748
A4P1A	1251-7986	9	2	CONN-POST TYPE .100-PIN-SPCG 50-CONT	28480	1251-7986
A4P1B	1251-7986	9		CONN-POST TYPE .100-PIN-SPCG 50-CONT	28480	1251-7986
A4R1	0757-0449	6	2	RESISTOR 20K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2002-F
A4R2	0757-0449	6		RESISTOR 20K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2002-F
A4R3	1810-0398	9	1	NETWORK-RES 10-SIP 22.0K OHM X 9	11236	750-101-R22K
A4R4	0757-0283	6	3	RESISTOR 2K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2001-F
A4R5	0757-0283	6		RESISTOR 2K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2001-F
A4R6	0757-0442	9	3	RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1002-F
A4R7	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1002-F
A4R8	0757-0283	6		RESISTOR 2K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2001-F
A4R9				NOT ASSIGNED		
A4R10				NOT ASSIGNED		

Table 6-3. Standard Instrument Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A4R11				NOT ASSIGNED		
A4R12	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1002-F
A4U1	1820-2724	0	4	IC LCH TTL ALS TRANSPARENT OCTL	01295	SN74ALS573BN
A4U2	1820-3159	7	1	IC-MPU;CLK FREQ=2MHZ;8-BITS;64K-ADDRESS	04713	MC68B03L
A4U3	1820-1246	9	1	IC GATE TTL LS AND QUAD 2-INP	01295	SN74LS09N
A4U4	1820-2634	1	1	IC INV TTL ALS HEX	01295	SN74ALS04BN
A4U5	1820-3100	8	2	IC DCDR TTL ALS BIN 3-TO-8-LINE 3-INP	01295	SN74ALS138N
A4U6	1820-2775	1	1	IC GATE TTL ALS NAND TPL 3-INP	01295	SN74ALS10N
A4U7	1820-3100	8		IC DCDR TTL ALS BIN 3-TO-8-LINE 3-INP	01295	SN74ALS138N
A4U8				NOT ASSIGNED		
A4U9	1820-1858	9	3	IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A4U10	1820-3121	3	1	IC TRANSCEIVER TTL ALS BUS OCTL	01295	SN74ALS245AN
A4U11	1820-1858	9		IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A4U12	1820-2724	0		IC LCH TTL ALS TRANSPARENT OCTL	01295	SN74ALS573BN
A4U13	1820-1858	9		IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A4U14	05352-80018	9	1	NMOS 27128A ROM	28480	05352-80018
A4U15				NOT ASSIGNED		
A4U16	1820-2724	0		IC LCH TTL ALS TRANSPARENT OCTL	01295	SN74ALS573BN
A4U17	05352-80019	0	1	NMOS 27128A ROM	28480	05352-80019
A4U18	1820-2724	0		IC LCH TTL ALS TRANSPARENT OCTL	01295	SN74ALS573BN
A4U19				NOT ASSIGNED		
A4U20	1818-1790	3	1	IC CMOS 16384 (16K) STAT RAM 120-NS 3-S	S4013	HM6116LP-2
A4XU1-7				NOT ASSIGNED		
A4XU8	1200-0639	8	2	SOCKET-IC 20-CONT DIP DIP-SLDR	28480	1200-0639
A4XU9				NOT ASSIGNED		
A4XU10	1200-0639	8		SOCKET-IC 20-CONT DIP DIP-SLDR	28480	1200-0639
A4XU11-13				NOT ASSIGNED		
A4XU14	1200-0567	1	2	SOCKET-IC 28-CONT DIP DIP-SLDR	28480	1200-0567
A4XU15-16				NOT ASSIGNED		
A4XU17	1200-0567	1		SOCKET-IC 28-CONT DIP DIP-SLDR	28480	1200-0567
A4Y1	0410-1386	8	1	CRYSTAL-QUARTZ 8.00000 MHZ HC-18/U-HLDR	28480	0410-1386

See introduction to this section for ordering information

Table 6-3. Standard Instrument Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A5	05350-60005	0	1	SYNTHESIZER ASSEMBLY	28480	05350-60005
A5C1	0170-0066	9	1	CAPACITOR-FXD .027UF +-10% 200VDC POLYE	28480	0170-0066
A5C2	0160-3879	7	19	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A5C3	0160-4040	6	8	CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A5C4	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A5C5	0180-0116	1	5	CAPACITOR-FXD 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A5C6	0180-0210	6	4	CAPACITOR-FXD 3.3UF+-20% 15VDC TA	56289	150D335X0015A2
A5C7	0180-0229	7	7	CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2
A5C8	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A5C9	0180-0210	6		CAPACITOR-FXD 3.3UF+-20% 15VDC TA	56289	150D335X0015A2
A5C10	0160-0576	5	1	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A5C11	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A5C12				NOT ASSIGNED		
A5C13	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A5C14	0160-4389	6	21	CAPACITOR-FXD 100PF +-5PF 200VDC CER	28480	0160-4389
A5C15				NOT ASSIGNED		
A5C16	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A5C17	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A5C18	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A5C19	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A5C20	0160-4389	6		CAPACITOR-FXD 100PF +-5PF 200VDC CER	28480	0160-4389
A5C21				NOT ASSIGNED		
A5C22	0160-4389	6		CAPACITOR-FXD 100PF +-5PF 200VDC CER	28480	0160-4389
A5C23	0160-4389	6		CAPACITOR-FXD 100PF +-5PF 200VDC CER	28480	0160-4389
A5C24	0180-0116	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A5C25	0180-0116	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A5C26	0180-0116	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A5C27	0180-1731	8	1	CAPACITOR-FXD 4.7UF+-10% 50VDC TA	56289	150D475X9050B2
A5C28	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A5C29	0160-4481	9	1	CAPACITOR-FXD 270PF +-5% 100VDC CER	51642	150-100-NP0-271J
A5C30	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A5C31	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A5C32	0160-4389	6		CAPACITOR-FXD 100PF +-5PF 200VDC CER	28480	0160-4389
A5C33	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A5C34	0180-0229	7		CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2
A5C35	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A5C36	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A5C37	0160-3874	2	1	CAPACITOR-FXD 10PF +-.5PF 200VDC CER	28480	0160-3874
A5C38	0160-4389	6		CAPACITOR-FXD 100PF +-5PF 200VDC CER	28480	0160-4389
A5C39	0170-0019	2	1	CAPACITOR-FXD .1UF +-5% 200VDC POLYE	28480	0170-0019
A5C40	0180-0229	7		CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2
A5C41	0180-0229	7		CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2
A5C42	0180-0229	7		CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2
A5C43	0180-0210	6		CAPACITOR-FXD 3.3UF+-20% 15VDC TA	56289	150D335X0015A2
A5C44	0160-4389	6		CAPACITOR-FXD 100PF +-5PF 200VDC CER	28480	0160-4389
A5C45	0160-4492	2	1	CAPACITOR-FXD 18PF +-5% 200VDC CER 0+-30	28480	0160-4492
A5C46	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A5C47	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A5C48	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A5C49	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A5C50	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A5C51	0160-4389	6		CAPACITOR-FXD 100PF +-5PF 200VDC CER	28480	0160-4389
A5C52	0160-4389	6		CAPACITOR-FXD 100PF +-5PF 200VDC CER	28480	0160-4389
A5C53	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A5C54	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A5C55	0160-4389	6		CAPACITOR-FXD 100PF +-5PF 200VDC CER	28480	0160-4389
A5C56	0160-4389	6		CAPACITOR-FXD 100PF +-5PF 200VDC CER	28480	0160-4389
A5C57	0160-4389	6		CAPACITOR-FXD 100PF +-5PF 200VDC CER	28480	0160-4389
A5C58	0180-0229	7		CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2
A5C59	0160-4389	6		CAPACITOR-FXD 100PF +-5PF 200VDC CER	28480	0160-4389
A5C60	0160-4389	6		CAPACITOR-FXD 100PF +-5PF 200VDC CER	28480	0160-4389

See introduction to this section for ordering information

Table 6-3. Standard Instrument Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A5C61	0180-0116	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A5C62	0180-0229	7		CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2
A5C63	0160-4389	6		CAPACITOR-FXD 100PF +-5PF 200VDC CER	28480	0160-4389
A5C64	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A5C65	0160-4389	6		CAPACITOR-FXD 100PF +-5PF 200VDC CER	28480	0160-4389
A5C66	0160-4389	6		CAPACITOR-FXD 100PF +-5PF 200VDC CER	28480	0160-4389
A5C67	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A5C68	0160-4389	6		CAPACITOR-FXD 100PF +-5PF 200VDC CER	28480	0160-4389
A5C69	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A5C70	0160-4389	6		CAPACITOR-FXD 100PF +-5PF 200VDC CER	28480	0160-4389
A5C71	0180-0210	6		CAPACITOR-FXD 3.3UF+-20% 15VDC TA	56289	150D335X0015A2
A5C72	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A5C73	0160-4389	6		CAPACITOR-FXD 100PF +-5PF 200VDC CER	28480	0160-4389
A5C74	0160-4389	6		CAPACITOR-FXD 100PF +-5PF 200VDC CER	28480	0160-4389
A5CR1	1901-0050	3	11	DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A5CR2	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A5CR3	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A5CR4	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A5CR5	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A5CR6	1901-0734	0	1	DIODE-PWR RECT 1N5818 30V 1A	04713	1N5818
A5CR7	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A5CR8	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A5CR9	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A5CR10	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A5CR11	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A5CR12	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A5CR13	0122-0161	4	1	DIODE-VVC 2.15PF 7% BVR=30V	25403	BB405B
A5DS1	1990-1022	8	1	LED-LAMP LUM-INT=4MCD IF=25MA-MAX BVR=5V	28480	HLMP-5030
A5J1	1252-0121	2	1	CONN-POST TYPE .100-PIN-SPCG 14-CONT	28480	1252-0121
A5J2	1250-1314	3	1	CONNECTOR-RF SM-SLD FEM PC 50-OHM	28480	1250-1314
A5L1	9140-0906	2	4	INDUCTOR 1MH 10% .172D-INX.43LG-IN Q=60	28480	9140-0906
A5L2	9140-0906	2		INDUCTOR 1MH 10% .172D-INX.43LG-IN Q=60	28480	9140-0906
A5L3	9140-0906	2		INDUCTOR 1MH 10% .172D-INX.43LG-IN Q=60	28480	9140-0906
A5L4	9140-0906	2		INDUCTOR 1MH 10% .172D-INX.43LG-IN Q=60	28480	9140-0906
A5L5	9100-0541	7	2	INDUCTOR RF-CH-MLD 250UH 10%	28480	9100-0541
A5L6	9100-0541	7		INDUCTOR RF-CH-MLD 250UH 10%	28480	9100-0541
A5L7	9100-0654	3	1	CORE-FERRITE CHOKE-WIDEBAND;IMP:>800	28480	9100-0654
A5L8	9100-2258	7	5	INDUCTOR RF-CH-MLD 1.2UH 10%	28480	9100-2258
A5L9	9100-2258	7		INDUCTOR RF-CH-MLD 1.2UH 10%	28480	9100-2258
A5L10	9135-0076	6	1	INDUCTOR RF-CH-MLD 39NH 6%	28480	9135-0076
A5L11	9100-2258	7		INDUCTOR RF-CH-MLD 1.2UH 10%	28480	9100-2258
A5L12	9100-2258	7		INDUCTOR RF-CH-MLD 1.2UH 10%	28480	9100-2258
A5L13	9100-2258	7		INDUCTOR RF-CH-MLD 1.2UH 10%	28480	9100-2258
A5MP1	5000-9043	6	1	PIN EXTRACTOR	28480	5000-9043
A5MP2	5040-6852	3	1	EXTRACTOR-ORN	28480	5040-6852
A5MP3	05350-00014	5	1	GROUND STRAP-RIGHT	28480	05350-00014
A5MP4	05350-00015	6	1	GROUND STRAP-LEFT	28480	05350-00015
A5MP5	1205-0316	8	1	HEAT SINK SGL TO-5/TO-39-CS	28480	1205-0316
A5MP6	1205-0554	6	2	HEAT SINK SGL DIP	28480	1205-0554
A5P1	1251-7986	9	1	CONN-POST TYPE .100-PIN-SPCG 50-CONT	28480	1251-7986
A5Q1	1855-0540	7	2	TRANSISTOR J-FET P-CHAN D-MODE TO-18 SI	27014	2N5115(SEL)
A5Q2	1855-0540	7		TRANSISTOR J-FET P-CHAN D-MODE TO-18 SI	27014	2N5115(SEL)
A5Q3	1854-0215	1	1	TRANSISTOR NPN SI TO-92 PD=350MW	04713	2N3904
A5Q4	1853-0036	2	2	TRANSISTOR PNP SI PD=310MW FT=250MHZ	27014	2N3906
A5Q5	1853-0036	2		TRANSISTOR PNP SI PD=310MW FT=250MHZ	27014	2N3906
A5Q6	1854-0591	6	1	TRANSISTOR NPN SI PD=180MW FT=4GHZ	25403	BFR90
A5Q7	1854-0345	8	1	TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW	04713	2N5179
A5R1	0757-0442	9	2	RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1002-F
A5R2	0698-3155	1	1	RESISTOR 4.64K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-4641-F
A5R3	0698-3156	2	1	RESISTOR 14.7K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1472-F
A5R4	0757-0279	0	3	RESISTOR 3.16K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-3161-F
A5R5	0698-3454	3	2	RESISTOR 215K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2153-F

See introduction to this section for ordering information

Table 6-3. Standard Instrument Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A5R6	0698-0084	9	3	RESISTOR 2.15K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2151-F
A5R7	0698-0084	9		RESISTOR 2.15K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2151-F
A5R8	1810-0478	6	1	NETWORK-RES 8-SIP22.0K OHM X 4	28480	1810-0478
A5R9	0757-0420	3	1	RESISTOR 750 1% .125W F TC=0+-100	24546	CT4-1/8-T0-751-F
A5R10	0757-0317	7	2	RESISTOR 1.33K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1331-F
A5R11	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-3161-F
A5R12				NOT ASSIGNED		
A5R13	1810-0488	8	1	NETWORK-RES 8-SIP4.7K OHM X 4	28480	1810-0488
A5R14	0757-0401	0	1	RESISTOR 100 1% .125W F TC=0+-100	24546	CT4-1/8-T0-101-F
A5R15	0698-0082	7	2	RESISTOR 464 1% .125W F TC=0+-100	24546	CT4-1/8-T0-4640-F
A5R16	0698-3454	3		RESISTOR 215K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2153-F
A5R17	1810-0406	0	1	NETWORK-RES 8-SIP 10.0K OHM X 4	11236	750-83-R10K
A5R18	0698-3162	0	1	RESISTOR 46.4K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-4642-F
A5R19	1810-0398	9	1	NETWORK-RES 10-SIP 22.0K OHM X 9	11236	750-101-R22K
A5R20	0757-0439	4	1	RESISTOR 6.81K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-6811-F
A5R21	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-3161-F
A5R22	0757-0465	6	2	RESISTOR 100K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1003-F
A5R23	0757-0317	7		RESISTOR 1.33K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1331-F
A5R24	0698-3444	1	1	RESISTOR 316 1% .125W F TC=0+-100	24546	CT4-1/8-T0-316R-F
A5R25				NOT ASSIGNED		
A5R26	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1003-F
A5R27	0698-3441	8	1	RESISTOR 215 1% .125W F TC=0+-100	24546	CT4-1/8-T0-215R-F
A5R28	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1002-F
A5R29	0698-0082	7		RESISTOR 464 1% .125W F TC=0+-100	24546	CT4-1/8-T0-4640-F
A5R30	1810-0445	7	3	NETWORK-RES 6-SIP100.0 OHM X 3	11236	750-63-R100
A5R31	1810-0203	5	1	NETWORK-RES 8-SIP 470.0 OHM X 7	11236	750-81-R470
A5R32	1810-0708	5	1	NETWORK-RES 6-SIP 1.5K OHM X 5	28480	1810-0708
A5R33	1810-0445	7		NETWORK-RES 6-SIP100.0 OHM X 3	11236	750-63-R100
A5R34	1810-0445	7		NETWORK-RES 6-SIP100.0 OHM X 3	11236	750-63-R100
A5R35	0757-0395	1	2	RESISTOR 56.2 1% .125W F TC=0+-100	24546	CT4-1/8-T0-56R2-F
A5R36	0757-0395	1		RESISTOR 56.2 1% .125W F TC=0+-100	24546	CT4-1/8-T0-56R2-F
A5R37	0698-0084	9		RESISTOR 2.15K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2151-F
A5R38	0757-0283	6	1	RESISTOR 2K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2001-F
A5TP1	1251-0600	0	5	CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A5TP2	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A5TP3	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A5TP4	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A5TP5	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A5U1	1826-0685	0	1	IC OP AMP LOW-BIAS-H-IMPD TO-99 PKG	27014	LF351H
A5U2	1826-0412	1	1	IC COMPARATOR PRCN DUAL 8-DIP-P PKG	27014	LM393N
A5U3	1820-3405	6	1	IC MISC CMOS 4-BIT	04713	MC145146P
A5U4	1820-2724	0	1	IC LCH TTL ALS TRANSPARENT OCTL	01295	SN74ALS573BN
A5U5	1826-1099	2	1	IC V RGLTR-ADJ-NEG TO-92 PKG	27014	LM337LZ
A5U6	1826-0372	2	1	IC MISC 8-DIP-P PKG	28480	A251-0100
A5U7	1820-1383	5	1	IC CNTR ECL BCD POS-EDGE-TRIG	04713	MC10138L
A5U8	1820-3340	8	1	IC GATE ECL/10KH OR-AND-INV	04713	MC10H121P
A5U9	1813-0213	3	1	IC WIDEBAND AMPL TO-39 PKG	04713	MWA130
A5U10	1820-1888	5	1	IC PRESCR ECL	04713	MC12013L
A5W1	8159-0005	0	2	RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A5W2	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005

See introduction to this section for ordering information

Table 6-3. Standard Instrument Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A6	05350-60006	1	1	IF AMPLIFIER/DETECTOR ASSY	28480	05350-60006
A6C1	0160-4554	7	6	CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A6C2	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A6C3	0160-4385	2	1	CAPACITOR-FXD 15PF +-5% 200VDC CER 0+-30	28480	0160-4385
A6C4	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A6C5	0160-3879	7	26	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C6	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C7	0121-0036	0	1	CAPACITOR-V TRMR-CER 5.5-18PF 350V	73899	DV11PR18A
A6C8	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C9	0160-4493	3	2	CAPACITOR-FXD 27PF +-5% 200VDC CER 0+-30	28480	0160-4493
A6C10	0160-4389	6	1	CAPACITOR-FXD 100PF +-5PF 200VDC CER	28480	0160-4389
A6C11	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C12	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C13	0160-4511	6	1	CAPACITOR-FXD 220PF +-5% 200VDC CER	28480	0160-4511
A6C14	0121-0059	7	1	CAPACITOR-V TRMR-CER 2-8PF 350V PC-MTG	73899	DV11PR8A
A6C15	0160-3874	2	3	CAPACITOR-FXD 10PF +-.5PF 200VDC CER	28480	0160-3874
A6C16	0160-3872	0	2	CAPACITOR-FXD 2.2PF +-.25PF 200VDC CER	28480	0160-3872
A6C17	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C18	0160-0576	5	2	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A6C19	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C20	0160-4387	4	3	CAPACITOR-FXD 47PF +-5% 200VDC CER 0+-30	28480	0160-4387
A6C21	0160-4493	3		CAPACITOR-FXD 27PF +-5% 200VDC CER 0+-30	28480	0160-4493
A6C22	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C23	0160-4492	2	1	CAPACITOR-FXD 18PF +-5% 200VDC CER 0+-30	28480	0160-4492
A6C24	0160-3872	0		CAPACITOR-FXD 2.2PF +-.25PF 200VDC CER	28480	0160-3872
A6C25	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C26	0160-4547	8	1	CAPACITOR-FXD 150PF +-5% 200VDC CER	28480	0160-4547
A6C27	0160-4527	4	1	CAPACITOR-FXD 56PF +-5% 200VDC CER 0+-30	28480	0160-4527
A6C28	0160-4804	0	1	CAPACITOR-FXD 56PF +-5% 100VDC CER 0+-30	28480	0160-4804
A6C29	0160-4521	8	2	CAPACITOR-FXD 12PF +-5% 200VDC CER 0+-30	28480	0160-4521
A6C30	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C31	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A6C32	0180-2662	6	3	CAPACITOR-FXD 10UF+-10% 10VDC TA	25088	D4R7GS1A10K
A6C33	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A6C34	0160-4491	1	2	CAPACITOR-FXD 8.2PF +-.5PF 200VDC CER	28480	0160-4491
A6C35	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C36	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C37	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C38				NOT ASSIGNED		
A6C39	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A6C40	0160-4521	8		CAPACITOR-FXD 12PF +-5% 200VDC CER 0+-30	28480	0160-4521
A6C41	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C42	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C43	0160-4491	1		CAPACITOR-FXD 8.2PF +-.5PF 200VDC CER	28480	0160-4491
A6C44	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C45	0180-2662	6		CAPACITOR-FXD 10UF+-10% 10VDC TA	25088	D4R7GS1A10K
A6C46	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C47	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C48	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C49	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C50	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C51	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C52	0160-4387	4		CAPACITOR-FXD 47PF +-5% 200VDC CER 0+-30	28480	0160-4387
A6C53	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C54	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C55	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C56	0160-4387	4		CAPACITOR-FXD 47PF +-5% 200VDC CER 0+-30	28480	0160-4387
A6C57	0180-0562	1	1	CAPACITOR-FXD 33UF+-20% 10VDC TA	56289	199D1120
A6C58	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C59	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A6C60	0160-3874	2		CAPACITOR-FXD 10PF +-.5PF 200VDC CER	28480	0160-3874

See introduction to this section for ordering information

Table 6-3. Standard Instrument Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A6C61	0180-2662	6		CAPACITOR-FXD 10UF+-10% 10VDC TA	25088	D4R7GS1A10K
A6C62	0160-3874	2		CAPACITOR-FXD 10PF +-.5PF 200VDC CER	28480	0160-3874
A6CR1	1901-0535	9	8	DIODE-SM SIG SCHOTTKY	28480	1901-0535
A6CR2	1901-0535	9		DIODE-SM SIG SCHOTTKY	28480	1901-0535
A6CR3	1901-0535	9		DIODE-SM SIG SCHOTTKY	28480	1901-0535
A6CR4	1901-0535	9		DIODE-SM SIG SCHOTTKY	28480	1901-0535
A6CR5	1901-0535	9		DIODE-SM SIG SCHOTTKY	28480	1901-0535
A6CR6	1901-0535	9		DIODE-SM SIG SCHOTTKY	28480	1901-0535
A6CR7	1902-3059	0	1	DIODE-ZNR 3.83V 5% DO-35 PD=.4W	28480	1902-3059
A6CR8	1901-0535	9		DIODE-SM SIG SCHOTTKY	28480	1901-0535
A6CR9	1901-0535	9		DIODE-SM SIG SCHOTTKY	28480	1901-0535
A6DS1	1990-1022	8	1	LED-LAMP LUM-INT=4MCD IF=25MA-MAX BVR=5V	28480	HLMP-5030
A6DS2	1990-1024	0	1	LED-LAMP LUM-INT=6MCD BVR=5V	28480	1990-1024
A6DS3	1990-0966	7	1	LED-LAMP LUM-INT=3MCD IF=20MA-MAX BVR=5V	28480	HLMP-5050
A6E1	9170-0029	3	1	CORE-SHIELDING BEAD	28480	9170-0029
A6L1	9135-0074	4	2	INDUCTOR RF-CH-MLD 47NH 6.17%	28480	9135-0074
A6L2	9135-0076	6	1	INDUCTOR RF-CH-MLD 39NH 6%	28480	9135-0076
A6L3	9135-0078	8	2	INDUCTOR RF-CH-MLD 82NH 5.61%	28480	9135-0078
A6L4	9135-0074	4		INDUCTOR RF-CH-MLD 47NH 6.17%	28480	9135-0074
A6L5	9135-0068	6	1	INDUCTOR RF-CH-MLD 33NH 6.36%	28480	9135-0068
A6L6	9135-0081	3	1	INDUCTOR RF-CH-MLD 68NH 5%	28480	9135-0081
A6L7	9140-0551	3	3	INDUCTOR RF-CH-MLD 10UH 5% .105DX.26LG	28480	9140-0551
A6L8	9140-0477	2	2	INDUCTOR RF-CH-MLD 270NH 1% .105DX.26LG	28480	9140-0477
A6L9	9140-0353	3	1	INDUCTOR RF-CH-MLD 430NH 1% .105DX.26LG	28480	9140-0353
A6L10	9140-0516	0	1	INDUCTOR RF-CH-MLD 160NH 5% .105DX.26LG	28480	9140-0516
A6L11	9135-0078	8		INDUCTOR RF-CH-MLD 82NH 5.61%	28480	9135-0078
A6L12	9100-0541	7	2	INDUCTOR RF-CH-MLD 250UH 10%	28480	9100-0541
A6L13	9140-0352	2	1	INDUCTOR RF-CH-MLD 330NH 1% .105DX.26LG	28480	9140-0352
A6L14	9140-0551	3		INDUCTOR RF-CH-MLD 10UH 5% .105DX.26LG	28480	9140-0551
A6L15	9140-0529	5	1	INDUCTOR RF-CH-MLD 130NH 5% .105DX.26LG	28480	9140-0529
A6L16	9140-0528	4	2	INDUCTOR RF-CH-MLD 120NH 5% .105DX.26LG	28480	9140-0528
A6L17	9100-1788	6	4	CORE-FERRITE CHOKE-WIDEBAND;IMP:>680	28480	9100-1788
A6L18	9140-0477	2		INDUCTOR RF-CH-MLD 270NH 1% .105DX.26LG	28480	9140-0477
A6L19	9100-1788	6		CORE-FERRITE CHOKE-WIDEBAND;IMP:>680	28480	9100-1788
A6L20	9100-0541	7		INDUCTOR RF-CH-MLD 250UH 10%	28480	9100-0541
A6L21	9100-0654	3	1	CORE-FERRITE CHOKE-WIDEBAND;IMP:>800	28480	9100-0654
A6L22	9100-1788	6		CORE-FERRITE CHOKE-WIDEBAND;IMP:>680	28480	9100-1788
A6L23	9140-0551	3		INDUCTOR RF-CH-MLD 10UH 5% .105DX.26LG	28480	9140-0551
A6L24	9140-0528	4		INDUCTOR RF-CH-MLD 120NH 5% .105DX.26LG	28480	9140-0528
A6L25	9140-0537	5	1	INDUCTOR RF-CH-MLD 2.2UH 5% .105DX.26LG	28480	9140-0537
A6L26	9100-2817	4	5	INDUCTOR RF-CH-MLD 100NH 5%	28480	9100-2817
A6L27	9100-2817	4		INDUCTOR RF-CH-MLD 100NH 5%	28480	9100-2817
A6L28	9100-2817	4		INDUCTOR RF-CH-MLD 100NH 5%	28480	9100-2817
A6L29	9100-2817	4		INDUCTOR RF-CH-MLD 100NH 5%	28480	9100-2817
A6L30	9100-2817	4		INDUCTOR RF-CH-MLD 100NH 5%	28480	9100-2817
A6L31	9100-1788	6		CORE-FERRITE CHOKE-WIDEBAND;IMP:>680	28480	9100-1788
A6MP1	5000-9043	6	1	PIN EXTRACTOR	28480	5000-9043
A6MP2	5040-6852	3	1	EXTRACTOR-ORN	28480	5040-6852
A6MP3	05350-00014	5	1	GROUND STRAP-RIGHT	28480	05350-00014
A6MP4	05350-00015	6	1	GROUND STRAP-LEFT	28480	05350-00015
A6P1	1251-7986	9	1	CONN-POST TYPE .100-PIN-SPCG 50-CONT	28480	1251-7986
A6Q1	1853-0036	2	3	TRANSISTOR PNP SI PD=310MW FT=250MHZ	27014	2N3906
A6Q2	1854-0215	1	2	TRANSISTOR NPN SI TO-92 PD=350MW	04713	2N3904
A6Q3	1853-0036	2		TRANSISTOR PNP SI PD=310MW FT=250MHZ	27014	2N3906
A6Q4	1854-0215	1		TRANSISTOR NPN SI TO-92 PD=350MW	04713	2N3904
A6Q5	1853-0036	2		TRANSISTOR PNP SI PD=310MW FT=250MHZ	27014	2N3906
A6Q6	1853-0352	5	1	TRANSISTOR PNP SI TO-92 PD=350MW FT=1GHZ	28480	1853-0352
A6Q7	1854-0345	8	1	TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW	04713	2N5179
A6Q8	1854-0591	6	4	TRANSISTOR NPN SI PD=180MW FT=4GHZ	25403	BFR90
A6Q9	1854-0591	6		TRANSISTOR NPN SI PD=180MW FT=4GHZ	25403	BFR90
A6Q10	1854-0591	6		TRANSISTOR NPN SI PD=180MW FT=4GHZ	25403	BFR90

See introduction to this section for ordering information

Table 6-3. Standard Instrument Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A6Q11	1854-0591	6		TRANSISTOR NPN SI PD=180MW FT=4GHZ	25403	BFR90
A6R1	0757-0405	4	5	RESISTOR 162 1% .125W F TC=0+-100	24546	CT4-1/8-T0-162R-F
A6R2	0757-0442	9	5	RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1002-F
A6R3	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1002-F
A6R4	0757-0405	4		RESISTOR 162 1% .125W F TC=0+-100	24546	CT4-1/8-T0-162R-F
A6R5	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1002-F
A6R6	0757-0279	0	6	RESISTOR 3.16K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-3161-F
A6R7	2100-3354	9	1	RESISTOR-TRMR 50K 10% C SIDE-ADJ 1-TRN	28480	2100-3354
A6R8	0757-0465	6	2	RESISTOR 100K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1003-F
A6R9	0757-0417	8	2	RESISTOR 562 1% .125W F TC=0+-100	24546	CT4-1/8-T0-562R-F
A6R10	0757-0417	8		RESISTOR 562 1% .125W F TC=0+-100	24546	CT4-1/8-T0-562R-F
A6R11	0757-0280	3	2	RESISTOR 1K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1001-F
A6R12	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1003-F
A6R13	0698-3446	3	2	RESISTOR 383 1% .125W F TC=0+-100	24546	CT4-1/8-T0-383R-F
A6R14	0698-3454	3	2	RESISTOR 215K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2153-F
A6R15	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1002-F
A6R16	0698-3454	3		RESISTOR 215K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2153-F
A6R17				NOT ASSIGNED		
A6R18	0699-0073	8	1	RESISTOR 10M 1% .125W F TC=0+-150	28480	0699-0073
A6R19	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-3161-F
A6R20	0757-0123	3	1	RESISTOR 34.8K 1% .125W F TC=0+-100	28480	0757-0123
A6R21	0757-0398	4	1	RESISTOR 75 1% .125W F TC=0+-100	24546	CT4-1/8-T0-75R0-F
A6R22	0757-0401	0	8	RESISTOR 100 1% .125W F TC=0+-100	24546	CT4-1/8-T0-101-F
A6R23	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-3161-F
A6R24	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1001-F
A6R25	2100-3351	6	1	RESISTOR-TRMR 500 10% C SIDE-ADJ 1-TRN	28480	2100-3351
A6R26	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-3161-F
A6R27	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1002-F
A6R28	0757-0394	0	2	RESISTOR 51.1 1% .125W F TC=0+-100	24546	CT4-1/8-T0-51R1-F
A6R29	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	CT4-1/8-T0-101-F
A6R30	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-3161-F
A6R31	0757-0180	2	3	RESISTOR 31.6 1% .125W F TC=0+-100	28480	0757-0180
A6R32	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	CT4-1/8-T0-101-F
A6R33	0698-3446	3		RESISTOR 383 1% .125W F TC=0+-100	24546	CT4-1/8-T0-383R-F
A6R34	0757-0405	4		RESISTOR 162 1% .125W F TC=0+-100	24546	CT4-1/8-T0-162R-F
A6R35	0757-0394	0		RESISTOR 51.1 1% .125W F TC=0+-100	24546	CT4-1/8-T0-51R1-F
A6R36	0757-0180	2		RESISTOR 31.6 1% .125W F TC=0+-100	28480	0757-0180
A6R37	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-3161-F
A6R38	0698-7212	9	1	RESISTOR 100 1% .05W F TC=0+-100	24546	C3-1/8-T0-100R-F
A6R39	0699-1542	8	4	RESISTOR 51 1% .125W F TC=0+-50	28480	0699-1542
A6R40	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	CT4-1/8-T0-101-F
A6R41	0699-1542	8		RESISTOR 51 1% .125W F TC=0+-50	28480	0699-1542
A6R42	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	CT4-1/8-T0-101-F
A6R43	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	CT4-1/8-T0-101-F
A6R44	0757-0405	4		RESISTOR 162 1% .125W F TC=0+-100	24546	CT4-1/8-T0-162R-F
A6R45	0699-1542	8		RESISTOR 51 1% .125W F TC=0+-50	28480	0699-1542
A6R46	0699-1542	8		RESISTOR 51 1% .125W F TC=0+-50	28480	0699-1542
A6R47	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	CT4-1/8-T0-101-F
A6R48	0757-0180	2		RESISTOR 31.6 1% .125W F TC=0+-100	28480	0757-0180
A6R49	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	CT4-1/8-T0-101-F
A6R50	0757-0405	4		RESISTOR 162 1% .125W F TC=0+-100	24546	CT4-1/8-T0-162R-F
A6TP1	1251-0600	0	4	CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A6TP2	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A6TP3	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A6TP4	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A6U1	1820-1197	9	1	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A6U2	1826-0412	1	1	IC COMPARATOR PRCN DUAL 8-DIP-P PKG	27014	LM393N
A6U3	1813-0211	1	2	IC WIDEBAND AMPL TO-39 PKG	04713	MWA110
A6U4	1813-0211	1		IC WIDEBAND AMPL TO-39 PKG	04713	MWA110
A6W1	05350-60101	7	1	CBL AY-COAX TOPC	28480	05350-60101
A6W2	8159-0005	0	3	RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A6W3	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A6W4	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005

See introduction to this section for ordering information

Table 6-3. Standard Instrument Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A7	05350-60007	2	1	KEYBOARD/DISPLAY LOGIC ASSEMBLY	28480	05350-60007
A7C1	0160-4554	7	10	CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A7C2	0160-4556	9	2	CAPACITOR-FXD 1000PF +-20% 100VDC CER	16299	CAC02X7R102M100A
A7C3	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A7C4	0180-0116	1	1	CAPACITOR-FXD 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A7C5	0160-4556	9		CAPACITOR-FXD 1000PF +-20% 100VDC CER	16299	CAC02X7R102M100A
A7C6				NOT ASSIGNED		
A7C7	0180-0228	6	1	CAPACITOR-FXD 22UF+-10% 15VDC TA	56289	150D226X9015B2
A7C8	0180-0291	3	2	CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A7C9	0160-4557	0	3	CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A7C10	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A7C11	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A7C12	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A7C13	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A7C14	0160-4808	4	2	CAPACITOR-FXD 470PF +-5% 100VDC CER	28480	0160-4808
A7C15	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A7C16	0180-0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A7C17	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A7C18	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A7C19	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A7C20	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A7C21	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A7C22	0160-4808	4		CAPACITOR-FXD 470PF +-5% 100VDC CER	28480	0160-4808
A7DS1	1990-0486	6	1	LED-LAMP LUM-INT=2MCD IF=25MA-MAX BVR=5V	28480	HLMP-1301
A7J1	1200-0607	0	3	SOCKET-IC 16-CONT DIP DIP-SLDR	28480	1200-0607
A7J2	1200-0607	0		SOCKET-IC 16-CONT DIP DIP-SLDR	28480	1200-0607
A7J3	1200-0607	0		SOCKET-IC 16-CONT DIP DIP-SLDR	28480	1200-0607
A7L1	9100-1788	6	2	CORE-FERRITE CHOKE-WIDEBAND;IMP:>680	28480	9100-1788
A7L2	9100-1788	6		CORE-FERRITE CHOKE-WIDEBAND;IMP:>680	28480	9100-1788
A7MP1	5041-0310	8	16	KEYCAP-BLANK	28480	5041-0310
A7MP2	5041-0312	0	1	KEYCAP-SDQ	28480	5041-0312
A7MP3	4040-1615	5	1	STANDOFF-LED .196-IN-WD .196-IN-LG BLK	28480	4040-1615
A7MP4	3131-0496	0	1	ACTUATOR-ROCKER SWITCH CHINA WHITE	28480	3131-0496
A7R1	0698-3155	1	3	RESISTOR 4.64K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-4641-F
A7R2	0757-0442	9	3	RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1002-F
A7R3	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1002-F
A7R4	0698-3155	1		RESISTOR 4.64K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-4641-F
A7R5	1810-0690	4	1	NETWORK-RES 6-SIP 22.0K OHM X 5	28480	1810-0690
A7R6	1810-0279	5	1	NETWORK-RES 10-SIP 4.7K OHM X 9	91637	CSC10A01-472G/MSP10A01-
A7R7	0698-3132	4	1	RESISTOR 261 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2610-F
A7R8	0698-3152	8	1	RESISTOR 3.48K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-3481-F
A7R9	0757-0427	0	1	RESISTOR 1.5K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1501-F
A7R10	0698-0084	9	3	RESISTOR 2.15K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2151-F
A7R11	0698-0084	9		RESISTOR 2.15K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2151-F
A7R12	0698-0084	9		RESISTOR 2.15K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2151-F
A7R13	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1002-F
A7R14	0757-0288	1	1	RESISTOR 9.09K 1% .125W F TC=0+-100	19701	5033R-1/8-T0-9091-F
A7R15	0837-0220	1	1	THERMISTOR ROD 10K-OHM TC=-3.83%/C-DEG	28480	0837-0220
A7R16	0698-3155	1		RESISTOR 4.64K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-4641-F
A7S1	3101-2713	5	1	SWITCH-RKR SUBMIN SPDT .02A 20PC	28480	3101-2713
A7S2	5060-9436	7	17	PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A7S3	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A7S4	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A7S5	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A7S6	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A7S7	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A7S8	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A7S9	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A7S10	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436

Table 6-3. Standard Instrument Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A7S11	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A7S12	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A7S13	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A7S14	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A7S15	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A7S16	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A7S17	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A7S18	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A7U1	1820-1437	0	1	IC MV TTL LS MONOSTBL DUAL	01295	SN74LS221N
A7U2	1820-3270	3	1	IC GATE TTL ALS NAND QUAD 2-INP	01295	SN74ALS03AN
A7U3	1820-3638	7	1	IC BFR TTL ALS INV OCTL	01295	SN74ALS466AN
A7U4	1820-2309	7	1	IC ENCDR CMOS	27014	MM74C923N
A7U5	1820-2488	3	1	IC FF TTL ALS D-TYPE POS-EDGE-TRIG	01295	SN74ALS74AN
A7U6	1820-1417	6	2	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS26N
A7U7	1820-1417	6		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS26N
A7U8	1826-0772	6	1	IC V RGLTR-ADJ-POS 1.2/32V TO-92 PKG	28480	1826-0772
A7U1				NOT ASSIGNED		
A7U2	05350-60104	0	1	CBL AY-LED BOARD	28480	05350-60104

See introduction to this section for ordering information

Table 6-3. Standard Instrument Replaceable Parts (Continued)

Reference Designation	HP Part Number	CD	Qty	Description	Mfr Code	Mfr Part Number
A8	05350-60008	3	1	MOTHERBOARD/POWER SUPPLY REGULATOR ASSEMBLY	28480	05350-60008
A8C1	0180-2662	6	2	CAPACITOR-FXD 10UF+-10% 10VDC TA	25088	D4R7GS1A10K
A8C2	0180-2662	6		CAPACITOR-FXD 10UF+-10% 10VDC TA	25088	D4R7GS1A10K
A8C3	0180-3485	3	1	CAPACITOR-FXD 6300UF+75-10% 40VDC AL	28480	0180-3485
A8C4	0180-3486	4	1	CAPACITOR-FXD 6300UF+75-10% 60VDC AL	28480	0180-3486
A8C5	0160-3879	7	2	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A8C6	0180-2827	5	2	CAPACITOR-FXD 47UF+100-10% 40VDC AL	28480	0180-2827
A8C7	0180-2865	1	1	CAPACITOR-FXD 100UF+100-10% 15VDC AL	28480	0180-2865
A8C8	0180-2864	0	1	CAPACITOR-FXD 1000UF+100-10% 15VDC AL	28480	0180-2864
A8C9	0180-2827	5		CAPACITOR-FXD 47UF+100-10% 40VDC AL	28480	0180-2827
A8C10	0180-0418	6	1	CAPACITOR-FXD 1UF+-20% 35VDC TA	28480	0180-0418
A8C11	0180-0630	4	2	CAPACITOR-FXD 4.7UF+-20% 50VDC TA	28480	0180-0630
A8C12	0180-0630	4		CAPACITOR-FXD 4.7UF+-20% 50VDC TA	28480	0180-0630
A8C13	0180-3143	0	1	CAPACITOR-FXD 3.3UF+-10% 75VDC TA	28480	0180-3143
A8C14	0160-4557	0	1	CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A8C15	0160-0970	3	1	CAPACITOR-FXD .47UF +-10% 80VDC POLYE	28480	0160-0970
A8C16				NOT ASSIGNED		
A8C17				NOT ASSIGNED		
A8C18	0180-3484	2	1	CAPACITOR-FXD .017F+75-10% 15VDC AL	28480	0180-3484
A8C19	0180-3483	1	1	CAPACITOR-FXD .062F+75-10% 15VDC AL	28480	0180-3483
A8CR1	1901-1080	1	1	DIODE-SCHOTTKY 20V 1A	04713	1N5817(RELAXED)
A8CR2	1901-0050	3	3	DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A8CR3	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A8CR4	1901-0731	7	3	DIODE-PWR RECT 400V 1A	14433	1N4004G
A8CR5	1902-0939	9	2	VOLTAGE SUPPRESSOR VR=5.0V,VC=8V	11961	1N5908
A8CR6	1902-0939	9		VOLTAGE SUPPRESSOR VR=5.0V,VC=8V	11961	1N5908
A8CR7	1902-0632	9	1	DIODE-ZNR 1N5354B 17V 5% PD=5W TC=+75%	04713	1N5354B
A8CR8	1901-0731	7		DIODE-PWR RECT 400V 1A	14433	1N4004G
A8CR9	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A8CR10	1901-0731	7		DIODE-PWR RECT 400V 1A	14433	1N4004G
A8CR11	1901-0673	6	2	DIODE-PWR RECT 100V 5A SUS	03508	A15A
A8CR12	1901-0673	6		DIODE-PWR RECT 100V 5A SUS	03508	A15A
A8CR13	1906-0096	7	1	DIODE-FW BRDG 200V 2A	04713	MDA202
A8CR14	1906-0079	6	1	DIODE-FW BRDG 100V 10A	1B546	VJ148X
A8CR15	1906-0286	7	1	DIODE-CT-S-BARR 35V 20A	04713	MBR2035CT
A8F1	2110-0343	1	1	FUSE .25A 125V NTD .281X.093	28480	2110-0343
A8F2	2110-0447	6	1	FUSE 3A 125V .281X.093	28480	2110-0447
A8H1	0535-0004	9	3	NUT-HEX DBL-CHAM M3 X 0.5 2.4MM-THK	00000	ORDER BY DESCRIPTION
A8H2	2190-0584	0	3	WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
A8J1	1250-1935	4	4	CONNECTOR-RF BNC FEM PC 50-OHM	28480	1250-1935
A8J2	1250-1935	4		CONNECTOR-RF BNC FEM PC 50-OHM	28480	1250-1935
A8J3	1250-1935	4		CONNECTOR-RF BNC FEM PC 50-OHM	28480	1250-1935
A8J4	1250-1935	4		CONNECTOR-RF BNC FEM PC 50-OHM	28480	1250-1935
A8J5	1252-0032	4	1	CONN-UTIL P-&-SKT 2-CKT 2-CONT	28480	1252-0032
A8J6	1251-7684	4	1	CABLE ASSY 14 POST	28480	1251-7684
A8J7	1252-0034	6	2	CONN-POST TYPE .100-PIN-SPCG 16-CONT	28480	1252-0034
A8J8	1252-0033	5	1	CONN-UTIL P-&-SKT 4-CKT 4-CONT	28480	1252-0033
A8J9	1251-8339	8	1	CONN-UTIL P-&-SKT 3-CKT 3-CONT	28480	1251-8339
A8J10	1252-0034	6		CONN-POST TYPE .100-PIN-SPCG 16-CONT	28480	1252-0034
A8J11	1251-8535	6	1	CONN-POST TYPE .100-PIN-SPCG 10-CONT	28480	1251-8535
A8JMP1-A8JMP7	1251-4541	6	1	CONNECTOR 14-PIN M POST TYPE	28480	1251-4541
A8L1	9100-2616	1	1	TRANSFORMER-PULSE BIFILAR WOUND; 18.0 MM	28480	9100-2616
A8MP1				NOT ASSIGNED		
A8MP2				NOT ASSIGNED		
A8MP3	1205-0498	7	1	HEAT SINK SGL TO-3-CS	28480	1205-0498
A8MP4	1205-0579	5	1	HEAT SINK SGL TO-220-CS	28480	1205-0579

See introduction to this section for ordering information

Table 6-3. Standard Instrument Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A8Q1	1853-0347	8	1	TRANSISTOR PNP SI DARL PD=40W FT=1MHZ	04713	MJE700
A8Q2	1854-0365	2	1	TRANSISTOR NPN SI PD=310MW FT=60MHZ	04713	2N4410
A8Q3	1854-0215	1	2	TRANSISTOR NPN SI TO-92 PD=350MW	04713	2N3904
A8Q4	1853-0036	2	1	TRANSISTOR PNP SI PD=310MW FT=250MHZ	27014	2N3906
A8Q5	1854-0215	1		TRANSISTOR NPN SI TO-92 PD=350MW	04713	2N3904
A8Q6	1853-0478	6	2	TRANSISTOR PNP 2N6490 TO-220AB PD=1.8W	04713	2N6490
A8Q7	1853-0478	6		TRANSISTOR PNP 2N6490 TO-220AB PD=1.8W	04713	2N6490
A8Q8	1854-0884	0	2	TRANSISTOR NPN 2N6488 TO-220AB PD=1.8W	3L585	2N6488
A8Q9	1854-0884	0		TRANSISTOR NPN 2N6488 TO-220AB PD=1.8W	3L585	2N6488
A8Q10	1854-0697	3	1	TRANSISTOR NPN 2N5886 SI TO-3 PD=200W	04713	2N5886
A8R1	1810-0429	7	3	NETWORK-RES 10-SIP22.0K OHM X 5	01121	210B223
A8R2	1810-0429	7		NETWORK-RES 10-SIP22.0K OHM X 5	01121	210B223
A8R3	1810-0398	9	1	NETWORK-RES 10-SIP 22.0K OHM X 9	11236	750-101-R22K
A8R4	0698-0082	7	2	RESISTOR 464 1% .125W F TC=0+-100	24546	CT4-1/8-T0-4640-F
A8R5	0698-3155	1	1	RESISTOR 4.64K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-4641-F
A8R6	0698-3440	7	1	RESISTOR 196 1% .125W F TC=0+-100	24546	CT4-1/8-T0-196R-F
A8R7	0698-3158	4	1	RESISTOR 23.7K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-2372-F
A8R8	0811-1826	1	1	RESISTOR .05 5% 3W PW TC=0+-250	28480	0811-1826
A8R9	0698-0082	7		RESISTOR 464 1% .125W F TC=0+-100	24546	CT4-1/8-T0-4640-F
A8R10	0811-1831	8	1	RESISTOR 2 5% 3W PW TC=0+-50	28480	0811-1831
A8R11	0811-1668	9	1	RESISTOR 1 5 5% 2W PW TC=0+-400	75042	BWH2-1R5-J
A8R12	0757-0279	0	1	RESISTOR 3.16K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-3161-F
A8R13	0757-0442	9	1	RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1002-F
A8R14	1810-0347	8	1	NETWORK-RES 8-SIP 2.2K OHM X 4	11236	750-83-R2.2K
A8R15	0757-0317	7	1	RESISTOR 1.33K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1331-F
A8R16	1810-0542	5	1	NETWORK-RES 10-SIP10.0K OHM X 5	28480	1810-0542
A8R17	0698-5880	3	1	RESISTOR 14.7 1% .25W F TC=0+-100	24546	C5-1/4-T0-15R0-J
A8R18	0757-0401	0	1	RESISTOR 100 1% .125W F TC=0+-100	24546	CT4-1/8-T0-101-F
A8R19	0698-4645	6	1	RESISTOR 4.22K 1% .25W F TC=0+-100	24546	NA5-1/4-T0-4221-F
A8R20	1810-0429	7		NETWORK-RES 10-SIP22.0K OHM X 5	01121	210B223
A8R21	0757-0180	2	2	RESISTOR 31.6 1% .125W F TC=0+-100	28480	0757-0180
A8R22	0757-0180	2		RESISTOR 31.6 1% .125W F TC=0+-100	28480	0757-0180
A8TP1	1251-0600	0	2	CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A8TP2	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A8U1	1826-0527	9	1	IC 337 V RGLTR TO-220	27014	LM337T
A8W1	8159-0005	0	2	RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A8W2	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A8XA1A	1251-7300	1	8	CONN-POST TYPE .100-PIN-SPCG 50-CONT	28480	1251-7300
A8XA1B	1251-7300	1		CONN-POST TYPE .100-PIN-SPCG 50-CONT	28480	1251-7300
A8XA2	1251-7300	1		CONN-POST TYPE .100-PIN-SPCG 50-CONT	28480	1251-7300
A8XA3	1251-7300	1		CONN-POST TYPE .100-PIN-SPCG 50-CONT	28480	1251-7300
A8XA4A	1251-7300	1		CONN-POST TYPE .100-PIN-SPCG 50-CONT	28480	1251-7300
A8XA4B	1251-7300	1		CONN-POST TYPE .100-PIN-SPCG 50-CONT	28480	1251-7300
A8XA5	1251-7300	1		CONN-POST TYPE .100-PIN-SPCG 50-CONT	28480	1251-7300
A8XA6	1251-7300	1		CONN-POST TYPE .100-PIN-SPCG 50-CONT	28480	1251-7300
A8XA7				NOT ASSIGNED		
A8XA8				NOT ASSIGNED		
A8XA9				NOT ASSIGNED		
A8XA10	1251-1633	1	1	CONNECTOR-PC EDGE 15-CONT/ROW 1-ROW	28480	1251-1633

See introduction to this section for ordering information

Table 6-3. Standard Instrument Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A9	SEE NOTE	7	1	BACKLIGHT ASSEMBLY NOTE THE A9 BACKLIGHT ASSEMBLY IS PART OF THE DISPLAY MODULE AND IS NOT FIELD REPAIRABLE. THE FOLLOWING PARTS ARE LISTED FOR ELECTRICAL REFERENCE ONLY. REFER TO CHASSIS ELECTRICAL PARTS FOR THE PART NUMBER FOR ORDERING THE DISPLAY MODULE.	28480	SEE NOTE
A9DS1	1990-1012	6	10	LED-LAMP LUM-INT=80MCD IF=20MA-MAX	28480	HLMP-3850(SEL)
A9DS2	1990-1012	6		LED-LAMP LUM-INT=80MCD IF=20MA-MAX	28480	HLMP-3850(SEL)
A9DS3	1990-1012	6		LED-LAMP LUM-INT=80MCD IF=20MA-MAX	28480	HLMP-3850(SEL)
A9DS4	1990-1012	6		LED-LAMP LUM-INT=80MCD IF=20MA-MAX	28480	HLMP-3850(SEL)
A9DS5	1990-1012	6		LED-LAMP LUM-INT=80MCD IF=20MA-MAX	28480	HLMP-3850(SEL)
A9DS6	1990-1012	6		LED-LAMP LUM-INT=80MCD IF=20MA-MAX	28480	HLMP-3850(SEL)
A9DS7	1990-1012	6		LED-LAMP LUM-INT=80MCD IF=20MA-MAX	28480	HLMP-3850(SEL)
A9DS8	1990-1012	6		LED-LAMP LUM-INT=80MCD IF=20MA-MAX	28480	HLMP-3850(SEL)
A9DS9	1990-1012	6		LED-LAMP LUM-INT=80MCD IF=20MA-MAX	28480	HLMP-3850(SEL)
A9DS10	1990-1012	6		LED-LAMP LUM-INT=80MCD IF=20MA-MAX	28480	HLMP-3850(SEL)
A9J1	1252-0263	3	1	CONN-2P RTANGPCMT	28480	1252-0263
A9R1	1810-0366	1	2	NETWORK-RES 6-SIP 220.0 OHM X 5	11236	750-61-R220
A9R2	1810-0366	1		NETWORK-RES 6-SIP 220.0 OHM X 5	11236	750-61-R220

Table 6-3. Standard Instrument Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A10	05350-60010	7	1	TEMPERATURE COMPENSATED CRYSTAL OSCILLATOR (TCXO) ASSEMBLY NOTE THE A10 DESIGNATION IS ALSO USED AS A PREFIX FOR THE OPTION 001 OVEN OSCILLATOR PARTS. REFER TO TABLE 6-4, OPTION 001 REPLACEABLE PARTS.	28480	05350-60010
A10C1	0160-3879	7	1	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A10C2	0180-2865	1	1	CAPACITOR-FXD 100UF+100-10% 15VDC AL	28480	0180-2865
A10L1	9140-0928	8	1	INDUCTOR 100UH 10% .172D-INX.43LG-IN	28480	9140-0928
A10MP1	5000-9043	6	1	PIN EXTRACTOR	28480	5000-9043
A10MP2	5040-6852	3	1	EXTRACTOR-ORN	28480	5040-6852
A10R1	0757-0442	9	1	RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1002-F
A10Y1	0960-0394	1	1	CRYSTAL OSCILLATOR 10.0 MHZ; 0-55 DEG C	28480	0960-0394

Table 6-3. Standard Instrument Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A11	05350-60011	8	1	HP-IB INTERFACE ASSEMBLY	28480	05350-60011
A11C1	0180-0229	7	1	CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2
A11C2	0160-4554	7	1	CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A11C3	0160-4557	0	2	CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A11C4	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A11H1	0361-0146	1	2	RIVET-SEMITUB OVH .123 DIA .25 LG	00000	ORDER BY DESCRIPTION
A11J1	1252-0268	8	1	CONN-RECT MICRORBN 24-CKT 24-CONT	28480	1252-0268
A11J2	8120-3671	1	1	FLAT RIBBON ASSY 14-COND	28480	8120-3671
A11J2W1			5	NOTE: A11J2W1 IS PART OF J2.		
A11L1	9100-1788	6	1	CORE-FERRITE CHOKE-WIDEBAND;IMP:>680	28480	9100-1788
A11L2	9100-1637	4	1	INDUCTOR RF-CH-MLD 120UH 5%	28480	9100-1637
A11R1	0698-3155	1	2	RESISTOR 4.64K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-4641-F
A11R2	0698-0082	7	2	RESISTOR 464 1% .125W F TC=0+-100	24546	CT4-1/8-T0-4640-F
A11R3	0698-3155	1		RESISTOR 4.64K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-4641-F
A11R4	0698-0082	7		RESISTOR 464 1% .125W F TC=0+-100	24546	CT4-1/8-T0-4640-F
A11R5	1810-0247	7	1	NETWORK-RES 16-DIP 220.0 OHM X 8	11236	761-3-R220
A11R6				NOT ASSIGNED		
A11R7	0698-3441	8	2	RESISTOR 215 1% .125W F TC=0+-100	24546	CT4-1/8-T0-215R-F
A11R8	0698-3441	8		RESISTOR 215 1% .125W F TC=0+-100	24546	CT4-1/8-T0-215R-F
A11S1	3101-2215	2	1	SWITCH-RKR DIP-RKR-ASSY 7-1A .05A 30VDC	28480	3101-2215
A11TP1	1251-8096	4	1	HEADER ASSY 7PIN	28480	1251-8096
A11U1	1820-2461	2	2	IC TRANSCEIVER TTL INSTR-BUS IEEE-488	04713	MC3447P3
A11U2	1820-2461	2		IC TRANSCEIVER TTL INSTR-BUS IEEE-488	04713	MC3447P3
A11U3	1820-1198	0	1	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS03N
A11U4	1820-1440	5	1	IC LCH TTL LS QUAD	01295	SN74LS279AN
A11U5	1820-3970	0	1	IC-MCU, 4MHZ, WITH ROM AND RAM	50088	MK3870/42N

Table 6-3. Standard Instrument Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A12	05350-60012	9	1	MICROWAVE ASSEMBLY (5350B/5351B)	28480	05350-60012
				NOTE THE FOLLOWING A12 PARTS LIST APPLIES ONLY TO THE 05350-60012 ASSEMBLY INSTALLED IN THE 5350B AND 5351B. REFER TO THE SECOND A12 PARTS LIST IMMEDIATELY FOLLOWING THIS LIST FOR 5352B A12 PARTS.		
				NOTE THE A12 MICROWAVE ASSEMBLY DOES NOT INCLUDE THE U1 SAMPLER. REFER TO CHASSIS ELECTRICAL PARTS.		
A12C1	0160-0576	5	13	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A12C2	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A12C3	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A12C4	0160-3875	3	2	CAPACITOR-FXD 22PF +-5% 200VDC CER 0+-30	28480	0160-3875
A12C5	0160-4492	2	1	CAPACITOR-FXD 18PF +-5% 200VDC CER 0+-30	28480	0160-4492
A12C6				NOT ASSIGNED		
A12C7	0160-4557	0	1	CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A12C8	0160-4786	7	1	CAPACITOR-FXD 27PF +-5% 100VDC CER 0+-30	28480	0160-4786
A12C9	0160-3879	7	2	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C10	0160-4386	3	1	CAPACITOR-FXD 33PF +-5% 200VDC CER 0+-30	28480	0160-4386
A12C11	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A12C12	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C13	0160-4040	6	2	CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A12C14	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A12C15	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A12C16	0160-3875	3		CAPACITOR-FXD 22PF +-5% 200VDC CER 0+-30	28480	0160-3875
A12C17	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A12C18	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A12C19	0160-4491	1	2	CAPACITOR-FXD 8.2PF +-.5PF 200VDC CER	28480	0160-4491
A12C20	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A12C21	0160-4491	1		CAPACITOR-FXD 8.2PF +-.5PF 200VDC CER	28480	0160-4491
A12C22	0160-6428	8	1		28480	0160-6428
A12C23	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A12C24	0160-3874	2	2	CAPACITOR-FXD 10PF +-.5PF 200VDC CER	28480	0160-3874
A12C25	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A12C26	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A12C27	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A12C28	0160-4383	0	1	CAPACITOR-FXD 6.8PF +-.5PF 200VDC CER	20932	5024E0200RD689D
A12C29	0160-3874	2		CAPACITOR-FXD 10PF +-.5PF 200VDC CER	28480	0160-3874
A12C30	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A12J1	1250-1611	3	2	CONNECTOR-RF SMB M PC 50-OHM	28480	1250-1611
A12J2	1250-1611	3		CONNECTOR-RF SMB M PC 50-OHM	28480	1250-1611
A12J3	1251-6939	0	3	CONNECTOR-SGL CONT SKT .032-IN-BSC-SZ	28480	1251-6939
A12J4	1251-6939	0		CONNECTOR-SGL CONT SKT .032-IN-BSC-SZ	28480	1251-6939
A12J5	1251-6939	0		CONNECTOR-SGL CONT SKT .032-IN-BSC-SZ	28480	1251-6939
A12J6	1252-0233	7	4	CONNECTOR-SGL CONT SKT .039-IN-BSC-SZ	28480	1252-0233
A12J7	1252-0233	7		CONNECTOR-SGL CONT SKT .039-IN-BSC-SZ	28480	1252-0233
A12J8	1252-0233	7		CONNECTOR-SGL CONT SKT .039-IN-BSC-SZ	28480	1252-0233
A12J9	1252-0233	7		CONNECTOR-SGL CONT SKT .039-IN-BSC-SZ	28480	1252-0233
A12L1	9140-0520	6	2	INDUCTOR RF-CH-MLD 240NH 5% .105DX.26LG	28480	9140-0520
A12L2	9135-0072	2	2	INDUCTOR 56NH 5.893% 2.6D-MMX6.6LG-MM	28480	9135-0072
A12L3	9135-0078	8	1	INDUCTOR RF-CH-MLD 82NH 5.61%	28480	9135-0078
A12L4	9135-0072	2		INDUCTOR 56NH 5.893% 2.6D-MMX6.6LG-MM	28480	9135-0072
A12L5	9135-0074	4	3	INDUCTOR RF-CH-MLD 47NH 6.17%	28480	9135-0074
A12L6	9135-0074	4		INDUCTOR RF-CH-MLD 47NH 6.17%	28480	9135-0074
A12L7				NOT ASSIGNED		
A12L8	9140-0531	9	6	INDUCTOR RF-CH-MLD 1UH 5% .105DX.26LG	28480	9140-0531
A12L9	9140-0531	9		INDUCTOR RF-CH-MLD 1UH 5% .105DX.26LG	28480	9140-0531
A12L10	9135-0074	4		INDUCTOR RF-CH-MLD 47NH 6.17%	28480	9135-0074

See introduction to this section for ordering information

Table 6-3. Standard Instrument Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A12L11	9140-0531	9		INDUCTOR RF-CH-MLD 1UH 5% .105DX.26LG	28480	9140-0531
A12L12	9140-0531	9		INDUCTOR RF-CH-MLD 1UH 5% .105DX.26LG	28480	9140-0531
A12L13	9140-0531	9		INDUCTOR RF-CH-MLD 1UH 5% .105DX.26LG	28480	9140-0531
A12L14	9135-0080	2	1	INDUCTOR 27NH 5.556% 2.6D-MMX6.6LG-MM	28480	9135-0080
A12L15	9135-0076	6	1	INDUCTOR RF-CH-MLD 39NH 6%	28480	9135-0076
A12L16	9140-0518	2	1	INDUCTOR RF-CH-MLD 200NH 5% .105DX.26LG	28480	9140-0518
A12L17	9135-0068	6	1	INDUCTOR RF-CH-MLD 33NH 6.36%	28480	9135-0068
A12L18	9140-0520	6		INDUCTOR RF-CH-MLD 240NH 5% .105DX.26LG	28480	9140-0520
A12L19	9140-0531	9		INDUCTOR RF-CH-MLD 1UH 5% .105DX.26LG	28480	9140-0531
A12MP1	1205-0213	4	1	HEAT SINK SGL TO-5/TO-39-CS	28480	1205-0213
A12Q1	1854-1003	7	1	TRANSISTOR NPN SI PD=200MW	S0562	2SC2876
A12Q2	1854-0990	9	1	TRANSISTOR NPN SI TO-39 PD=8.75W	04713	MRF630
A12R1	0698-7229	8	1	RESISTOR 511 1% .05W F TC=0+-100	24546	C3-1/8-T0-511R-F
A12R2	0757-0280	3	1	RESISTOR 1K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1001-F
A12R3	0757-0400	9	3	RESISTOR 90.9 1% .125W F TC=0+-100	24546	CT4-1/8-T0-90R9-F
A12R4	0757-0400	9		RESISTOR 90.9 1% .125W F TC=0+-100	24546	CT4-1/8-T0-90R9-F
A12R5	0698-7215	2	2	RESISTOR 133 1% .05W F TC=0+-100	24546	C3-1/8-T0-133R-F
A12R6	0698-7205	0	1	RESISTOR 51.1 1% .05W F TC=0+-100	24546	C3-1/8-T0-51R1-F
A12R7	0698-7277	6	1	RESISTOR 51.1K 1% .05W F TC=0+-100	24546	C3-1/8-T0-5112-F
A12R8	0757-0400	9		RESISTOR 90.9 1% .125W F TC=0+-100	24546	CT4-1/8-T0-90R9-F
A12R9	0698-0083	8	1	RESISTOR 1.96K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1961-F
A12R10	0698-7215	2		RESISTOR 133 1% .05W F TC=0+-100	24546	C3-1/8-T0-133R-F
A12U1	1813-0211	1	2	IC WIDEBAND AMPL TO-39 PKG	04713	MWA110
A12U2	1813-0211	1		IC WIDEBAND AMPL TO-39 PKG	04713	MWA110

See introduction to this section for ordering information

Table 6-3. Standard Instrument Replaceable Parts (Continued)

Reference Designation	HP Part Number	CD	Qty	Description	Mfr Code	Mfr Part Number
A12	05352-60012	1	1	MICROWAVE ASSEMBLY (5352B)	28480	05352-60012
				NOTE THE FOLLOWING A12 PARTS LIST APPLIES ONLY TO THE 05352-60012 ASSEMBLY INSTALLED IN THE 5352B. REFER TO THE A12 PARTS LIST IMMEDIATELY PRECEDING THIS LIST FOR 5350B AND 5351B A12 PARTS.		
				NOTE THE A12 MICROWAVE ASSEMBLY DOES NOT INCLUDE THE U1 SAMPLER. REFER TO CHASSIS ELECTRICAL PARTS.		
A12C1	0160-0576	5	13	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A12C2	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A12C3	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A12C4	0160-3875	3	2	CAPACITOR-FXD 22PF +-5% 200VDC CER 0+-30	28480	0160-3875
A12C5	0160-4492	2	1	CAPACITOR-FXD 18PF +-5% 200VDC CER 0+-30	28480	0160-4492
A12C6				NOT ASSIGNED		
A12C7	0160-4557	0	1	CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A12C8	0160-4786	7	1	CAPACITOR-FXD 27PF +-5% 100VDC CER 0+-30	28480	0160-4786
A12C9	0160-3879	7	2	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C10	0160-4386	3	1	CAPACITOR-FXD 33PF +-5% 200VDC CER 0+-30	28480	0160-4386
A12C11	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A12C12	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C13	0160-4040	6	2	CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A12C14	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A12C15	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A12C16	0160-3875	3		CAPACITOR-FXD 22PF +-5% 200VDC CER 0+-30	28480	0160-3875
A12C17	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A12C18	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A12C19	0160-4491	1	2	CAPACITOR-FXD 8.2PF +-.5PF 200VDC CER	28480	0160-4491
A12C20	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A12C21	0160-4491	1		CAPACITOR-FXD 8.2PF +-.5PF 200VDC CER	28480	0160-4491
A12C22	0160-6428	8	1		28480	0160-6428
A12C23	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A12C24	0160-3874	2	2	CAPACITOR-FXD 10PF +-.5PF 200VDC CER	28480	0160-3874
A12C25	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A12C26	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A12C27	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A12C28	0160-4383	0	1	CAPACITOR-FXD 6.8PF +-.5PF 200VDC CER	20932	5024E0200RD689D
A12C29	0160-3874	2		CAPACITOR-FXD 10PF +-.5PF 200VDC CER	28480	0160-3874
A12C30	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A12J1	1250-1611	3	2	CONNECTOR-RF SMB M PC 50-OHM	28480	1250-1611
A12J2	1250-1611	3		CONNECTOR-RF SMB M PC 50-OHM	28480	1250-1611
A12J3	1251-6939	0	3	CONNECTOR-SGL CONT SKT .032-IN-BSC-SZ	28480	1251-6939
A12J4	1251-6939	0		CONNECTOR-SGL CONT SKT .032-IN-BSC-SZ	28480	1251-6939
A12J5	1251-6939	0		CONNECTOR-SGL CONT SKT .032-IN-BSC-SZ	28480	1251-6939
A12J6	1252-0233	7	4	CONNECTOR-SGL CONT SKT .039-IN-BSC-SZ	28480	1252-0233
A12J7	1252-0233	7		CONNECTOR-SGL CONT SKT .039-IN-BSC-SZ	28480	1252-0233
A12J8	1252-0233	7		CONNECTOR-SGL CONT SKT .039-IN-BSC-SZ	28480	1252-0233
A12J9	1252-0233	7		CONNECTOR-SGL CONT SKT .039-IN-BSC-SZ	28480	1252-0233
A12L1	9140-0520	6	2	INDUCTOR RF-CH-MLD 240NH 5% .105DX.26LG	28480	9140-0520
A12L2	9135-0072	2	2	INDUCTOR 56NH 5.893% 2.6D-MMX6.6LG-MM	28480	9135-0072
A12L3	9135-0078	8	1	INDUCTOR RF-CH-MLD 82NH 5.61%	28480	9135-0078
A12L4	9135-0072	2		INDUCTOR 56NH 5.893% 2.6D-MMX6.6LG-MM	28480	9135-0072
A12L5	9135-0074	4	3	INDUCTOR RF-CH-MLD 47NH 6.17%	28480	9135-0074
A12L6	9135-0074	4		INDUCTOR RF-CH-MLD 47NH 6.17%	28480	9135-0074
A12L7				NOT ASSIGNED		
A12L8	9140-0531	9	6	INDUCTOR RF-CH-MLD 1UH 5% .105DX.26LG	28480	9140-0531
A12L9	9140-0531	9		INDUCTOR RF-CH-MLD 1UH 5% .105DX.26LG	28480	9140-0531
A12L10	9135-0074	4		INDUCTOR RF-CH-MLD 47NH 6.17%	28480	9135-0074

See introduction to this section for ordering information

Table 6-3. Standard Instrument Replaceable Parts (Continued)

Reference Designation	HP Part Number	CD	Qty	Description	Mfr Code	Mfr Part Number
A12L11	9140-0531	9		INDUCTOR RF-CH-MLD 1UH 5% .105DX.26LG	28480	9140-0531
A12L12	9140-0531	9		INDUCTOR RF-CH-MLD 1UH 5% .105DX.26LG	28480	9140-0531
A12L13	9140-0531	9		INDUCTOR RF-CH-MLD 1UH 5% .105DX.26LG	28480	9140-0531
A12L14	9135-0080	2	1	INDUCTOR 27NH 5.556% 2.6D-MMX6.6LG-MM	28480	9135-0080
A12L15	9135-0076	6	1	INDUCTOR RF-CH-MLD 39NH 6%	28480	9135-0076
A12L16	9140-0518	2	1	INDUCTOR RF-CH-MLD 200NH 5% .105DX.26LG	28480	9140-0518
A12L17	9135-0068	6	1	INDUCTOR RF-CH-MLD 33NH 6.36%	28480	9135-0068
A12L18	9140-0520	6		INDUCTOR RF-CH-MLD 240NH 5% .105DX.26LG	28480	9140-0520
A12L19	9140-0531	9		INDUCTOR RF-CH-MLD 1UH 5% .105DX.26LG	28480	9140-0531
A12MP1	1205-0213	4	1	HEAT SINK SGL TO-5/TO-39-CS	28480	1205-0213
A12Q1	1854-1003	7	1	TRANSISTOR NPN SI PD=200MW	S0562	2SC2876
A12Q2	1854-0990	9	1	TRANSISTOR NPN SI TO-39 PD=8.75W	04713	MRF630
A12R1	0698-7229	8	1	RESISTOR 511 1% .05W F TC=0+-100	24546	C3-1/8-TO-511R-F
A12R2	0757-0280	3	1	RESISTOR 1K 1% .125W F TC=0+-100	24546	CT4-1/8-TO-1001-F
A12R3	0757-0400	9	3	RESISTOR 90.9 1% .125W F TC=0+-100	24546	CT4-1/8-TO-90R9-F
A12R4	0757-0400	9		RESISTOR 90.9 1% .125W F TC=0+-100	24546	CT4-1/8-TO-90R9-F
A12R5	0698-7215	2	2	RESISTOR 133 1% .05W F TC=0+-100	24546	C3-1/8-TO-133R-F
A12R6	0698-7205	0	1	RESISTOR 51.1 1% .05W F TC=0+-100	24546	C3-1/8-TO-51R1-F
A12R7	0699-1748	6	1	RESISTOR 287K 1% .05W F TC=0+-100	28480	0699-1748
A12R8	0757-0400	9		RESISTOR 90.9 1% .125W F TC=0+-100	24546	CT4-1/8-TO-90R9-F
A12R9	0698-0083	8	1	RESISTOR 1.96K 1% .125W F TC=0+-100	24546	CT4-1/8-TO-1961-F
A12R10	0698-7215	2		RESISTOR 133 1% .05W F TC=0+-100	24546	C3-1/8-TO-133R-F
A12U1	1813-0211	1	2	IC WIDEBAND AMPL TO-39 PKG	04713	MWA110
A12U2	1813-0211	1		IC WIDEBAND AMPL TO-39 PKG	04713	MWA110

See introduction to this section for ordering information

Table 6-3. Standard Instrument Replaceable Parts (Continued)

Reference Designation	HP Part Number	CD	Qty	Description	Mfr Code	Mfr Part Number
				CHASSIS ELECTRICAL PARTS		
A13	0960-0443	1	1	LINE MODULE-FILTERED	28480	0960-0443
B1	3160-0464	3	1	FAN ASSY WITH MOLEX CONN	28480	3160-0464
C1	0160-3036	8	4	CAPACITOR-FDTHRU 5000PF +80 -20% 200V	28480	0160-3036
C2	0160-3036	8		CAPACITOR-FDTHRU 5000PF +80 -20% 200V	28480	0160-3036
C3	0160-3036	8		CAPACITOR-FDTHRU 5000PF +80 -20% 200V	28480	0160-3036
C4	0160-3036	8		CAPACITOR-FDTHRU 5000PF +80 -20% 200V	28480	0160-3036
F1	2110-0007	4	1	FUSE 1A 250V TD 1.25X.25 UL	75915	313001
F1	2110-0202	1	1	FUSE .5A 250V TD 1.25X.25 UL	75915	313.500
J1	05343-80001	9	1	INPUT 1 CONNECTOR ASSEMBLY (5351B/5352B)	28480	05343-80001
				NOTE THE INPUT 1 CONNECTOR FOR THE 5350B IS PART OF THE W6 CABLE ASSEMBLY.		
J2	1250-1899	9	1	ADAPTER-COAX STR F-BNC M-SMC (INPUT 2)	28480	1250-1899
J2F1	2110-0301	1	1	FUSE .125A 125V .281X.093	28480	2110-0301
T1	9100-4455	0	1	TRANSFORMER	28480	9100-4455
U1	05350-60113	1	1	SAMPLER (5350B/5351B)	28480	05350-60113
U1	05352-60101	9	1	SAMPLER (5352B)	28480	05352-60101
				NOTE AN EXCHANGE ASSEMBLY FOR THE U1 SAMPLER IS AVAILABLE FROM THE FACTORY. REFER TO EXCHANGE ASSEMBLY ORDERING INFORMATION AT THE BEGINNING OF SECTION VI.		
W1	8120-1378	1	1	CABLE ASSY 18AWG 3-CNDCT JGK-JKT	28480	8120-1378
W2	05350-60102	8	1	CBL AY-COAX-SYN	28480	05350-60102
W3	05350-60107	3	2	CBL AY-RBN 16CND	28480	05350-60107
W4	05350-60107	3		CBL AY-RBN 16CND	28480	05350-60107
W5	05350-60115	3	1	CBLAY-SAMPLER PWR	28480	05350-60115
W6	05350-60109	5	1	SEMI-RIGID ASSY-INPUT (5350B)	28480	05350-60109
W7	05350-60119	7	1	CBLAY-HARNESS PRIMARY	28480	05350-60119
W8	05350-60117	5	1	CBLAY-HARNESS SECONDARY	28480	05350-60117
W9				REFER TO TABLE 6-4. (5350B OPTION 002)		
W10				REFER TO TABLE 6-4. (5350B OPTION 006)		
W11	05351-60101	8	1	CBL AY-5351 INPUT (5351B/5352B)	28480	05351-60101
W12				REFER TO TABLE 6-4. (5351B OPTION 002)		
W13	05350-60105	1	1	CBL AY-KEYBOARD	28480	05350-60105
W14	8150-2641	6	1	WIRE 22AWG W/BR/GY 600V PVC 7X30 105C	28480	8150-2641
W15	8150-2640	5	1	WIRE 22AWG W/GY 600V PVC 7X30 105C	28480	8150-2640
W16	8150-2919	1		WIRE 18AWG G/Y 600V PVC 19X30 105C	28480	8150-2919
	05350-60106	2	1	LCD DISPLAY MODULE	28480	05350-60106

See introduction to this section for ordering information

Table 6-3. Standard Instrument Replaceable Parts (Continued)

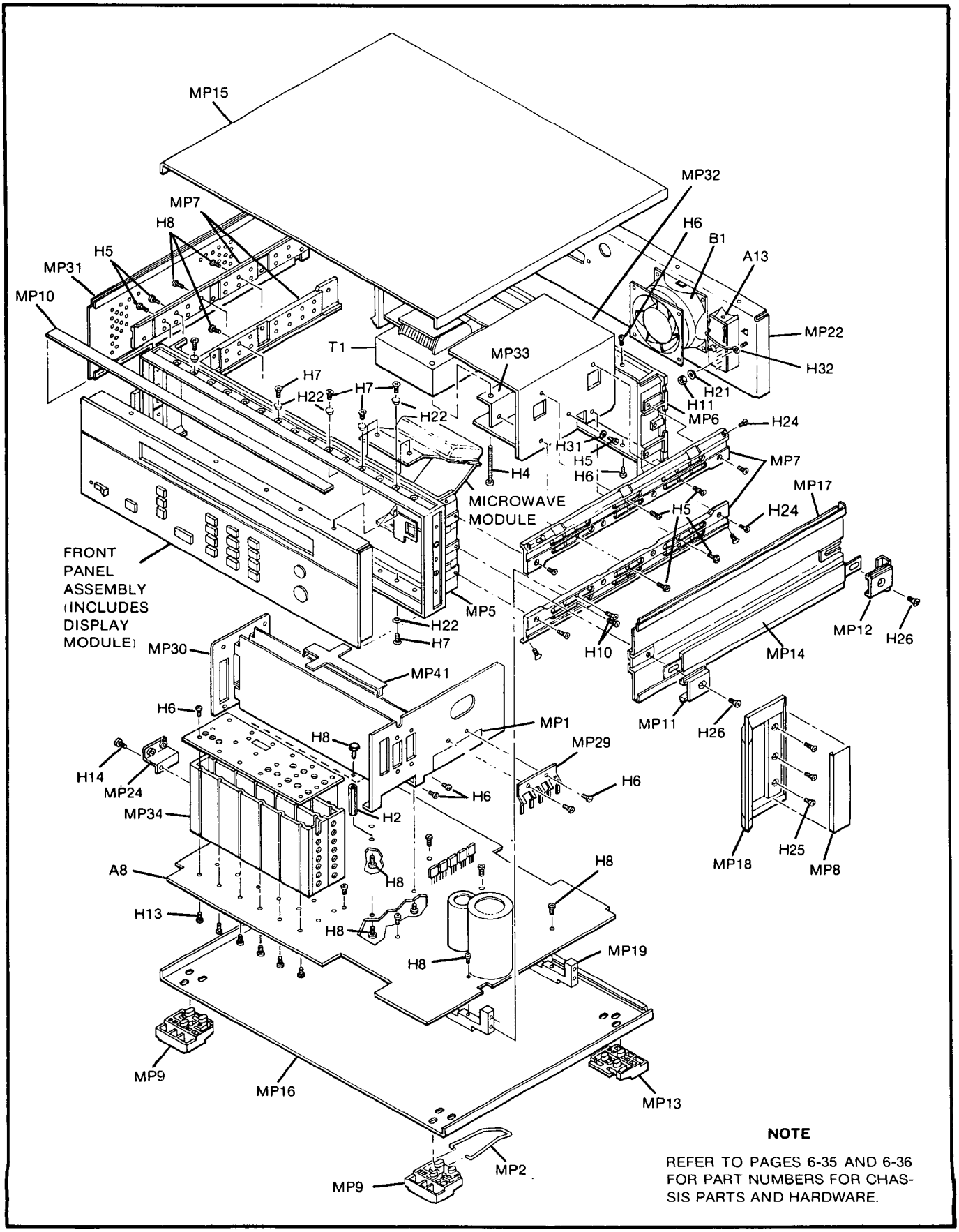
Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
				CHASSIS HARDWARE PARTS		
H1	0380-1332	9	2	STANDOFF-HEX .18-IN-LG 6-32-THD	28480	0380-1332
H2	0380-1663	9	1	STANDOFF-HEX 32-MM-LG M3.0 X 0.5-THD	05791	NY5083-3050-320-00
H3	0510-1148	2	5	RETAINER-PUSH ON KB-TO-SHFT EXT	28480	0510-1148
H4	0515-0125	3	2	SCREW-MACH M5 X 0.8 45MM-LG PAN-HD	28480	0515-0125
H5	0515-0885	2	7	SCREW-MACH M4 X 0.7 8MM-LG PAN-HD	28480	0515-0885
H6	0515-0886	3	18	SCREW-MACH M3 X 0.5 6MM-LG PAN-HD	28480	0515-0886
H7	0515-0890	9	7	SCREW-MACH M3 X 0.5 6MM-LG 90-DEG-FLH-HD	28480	0515-0890
H8	0515-0897	6	26	SCREW-MACH M3 X 0.5 8MM-LG PAN-HD	28480	0515-0897
H9	0515-1060	7	2	SCREW-MACH M3 X 0.5 25MM-LG PAN-HD	28480	0515-1060
H10	0515-1232	5	8	SCREW-MACH M3.5 X 0.6 8MM-LG PAN-HD	28480	0515-1232
H11	0535-0004	9	8	NUT-HEX DBL-CHAM M3 X 0.5 2.4MM-THK	00000	ORDER BY DESCRIPTION
H12	0590-0505	1	1	NUT-KNRLD-R 5/8-24-THD .125-IN-THK	00000	ORDER BY DESCRIPTION
H13	0624-0100	5	36	SCREW-TPG 4-40 .5-IN-LG PAN-HD-POZI STL	00000	ORDER BY DESCRIPTION
H14	0624-0227	7	1	SCREW-TPG 4-40 .25-IN-LG PAN-HD-POZI STL	00000	ORDER BY DESCRIPTION
H15	0624-0324	5	14	SCREW-TPG 4-20 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
H16	2190-0068	5	5	WASHER-LK INTL T 1/2 IN .505-IN-ID	28480	2190-0068
H17	2190-0084	5	1	WASHER-LK INTL T 1/4 IN .256-IN-ID	28480	2190-0084
H18	2190-0124	4	3	WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
H19	2190-0577	1	2	WASHER-LK HLCL NO. 10 .194-IN-ID	28480	2190-0577
H20	2190-0587	3	2	WASHER-LK HLCL 5.0 MM 5.1-MM-ID	28480	2190-0587
H21	2190-0644	3	4	INTERNAL STAR WASHER	28480	2190-0644
H22	2190-0650	1	8	WASHER-LK 90 CTSK EXT T-B 3.0 MM	28480	2190-0650
H23	3030-0033	7	3	SCREW-SET 6-32 .188-IN-LG SMALL CUP-PT	00000	ORDER BY DESCRIPTION
H24	0515-1331	5	8	SCREW-METRIC SPECIALTY M4 X 0.7 THD; 6	28480	0515-1331
H25	0515-0896	5	6	SCREW-MACH M4 X 0.7 10MM-LG	28480	0515-0896
H26	0515-1132	4	2	SCREW-MACH M5 X 0.8 10MM-LG	28480	0515-1132
H27	2940-0256	4	5	NUT-HEX-DBL-CHAM 1/2-28-THD .095-IN-THK	00000	ORDER BY DESCRIPTION
H28	2950-0078	9	3	NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
H29	2950-0196	2	1	NUT-HEX-DBL-CHAM 1/4-36-THD .06-IN-THK	28480	2950-0196
H30	3050-0891	7	4	WASHER-FL MTLC 3.0 MM 3.3-MM-ID	28480	3050-0891
H31	3050-0001	1	1	WASHER-FL MTLC NO. 8 .172-IN-ID	28480	3050-0001
H32	0360-1610	4	1	TERMINAL-SLDR LUG PL-MTG FOR-#6-SCR	79963	608.136H
H33	0515-1124	4	3	SCREW-MACH M3 X 0.5 4MM-LG 90-DEG-FLH-HD	28480	0515-1124
U1H1	0624-0097	9	2	SCREW-TPG 4-40 .188-IN-LG PAN-HD-POZI	28480	0624-0097

See introduction to this section for ordering information

Table 6-3. Standard Instrument Replaceable Parts (Continued)

Reference Designation	HP Part Number	CD	Qty	Description	Mfr Code	Mfr Part Number
				CHASSIS PARTS		
MP1	0340-1101	6	1	INSULATOR THRM-CNDCT	28480	0340-1101
MP2	1460-1345	5	2	TILT STAND SST	28480	1460-1345
MP3	6960-0002	4	1	PLUG-HOLE DOME-HD FOR .5-D-HOLE STL	28480	6960-0002
MP4	6960-0010	4	1	PLUG-HOLE DOME-HD FOR .625-D-HOLE STL	28480	6960-0010
MP5	5021-5803	2	1	FRAME-FRONT	28480	5021-5803
MP6	5021-5804	3	1	FRAME-REAR	28480	5021-5804
MP7	5021-5835	0	4	STRUT-CORNER	28480	5021-5835
MP8	5020-8896	7	2	HANDLE TRIM, FR	28480	5020-8896
MP9	5040-7201	8	2	FOOT	28480	5040-7201
MP10	5040-7202	9	1	TOP TRIM	28480	5040-7202
MP11	5041-6819	4	1	STRP-HDLE CAP FR	28480	5041-6819
MP12	5041-6820	7	1	STRP-HDLE CAP R	28480	5041-6820
MP13	5040-7222	3	2	FOOT NON-SKID	28480	5040-7222
MP14	5060-9802	1	1	STRAP HANDLE	28480	5060-9802
MP15	5061-9433	6	1	COVER-TOP	28480	5061-9433
MP16	5061-9445	0	1	COVER-BOTTOM	28480	5061-9445
MP17	5060-9878	1	1	COVER-SIDE	28480	5060-9878
MP18	5061-9499	4	2	SYS II HANDLES	28480	5061-9499
MP19	05334-40003	6	2	CROSS MEMBER	28480	05334-40003
MP20	05350-00023	6	1	PANEL-FRONT	28480	05350-00023
MP21	05350-00002	1	2	PANEL-SUB	28480	05350-00002
MP22	05350-00003	2	1	PANEL-REAR	28480	05350-00003
MP23	05350-00005	4	1	COVER-RF CAVITY	28480	05350-00005
MP24	05350-00006	5	1	BRACKET-RF CAV	28480	05350-00006
MP25	05350-00007	6	1	SHIELD-DISPLAY	28480	05350-00007
MP26	05350-00008	7	1	MTG BKT-SAMPLER	28480	05350-00008
MP27	05350-00009	8	1	COVER-SAMPLER	28480	05350-00009
MP28	05350-00010	1	1	BASE-COVER	28480	05350-00010
MP29	05350-00012	3	1	CLAMP-TO-220	28480	05350-00012
MP30	05350-00016	7	1	CARD CAGE	28480	05350-00016
MP31	05350-00022	5	1	SIDE COVER-PERF	28480	05350-00022
MP32	05350-00018	9	1	SHIELD-XFORM	28480	05350-00018
MP33	05350-00019	0	1	BKT-XFORM	28480	05350-00019
MP34	05350-20202	5	1	RF CAVITY	28480	05350-20202
MP35	05350-20203	6	1	WINDOW	28480	05350-20203
MP36	05350-20204	7	1	SPACER	28480	05350-20204
MP37	05343-20204	8	1	CONNECTOR-COLLAR (5351B/5352B)	28480	05343-20204
MP38	05350-20201	4	1	SPACER-THREADED (5351B/5352B)	28480	05350-20201
MP39	05351-00002	2	1	PANEL-FRONT (5351B ONLY)	28480	05351-00002
MP40	1258-0141	8	1	JUMPER-REMOVABLE FOR 0.025 IN SQ PINS	28480	1258-0141
MP41	05350-00002	1		PC BOARD RETAINER	28480	05350-00002
MP42	05352-00002	3	1	PANEL-FRONT (5352B ONLY)	28480	05352-00002

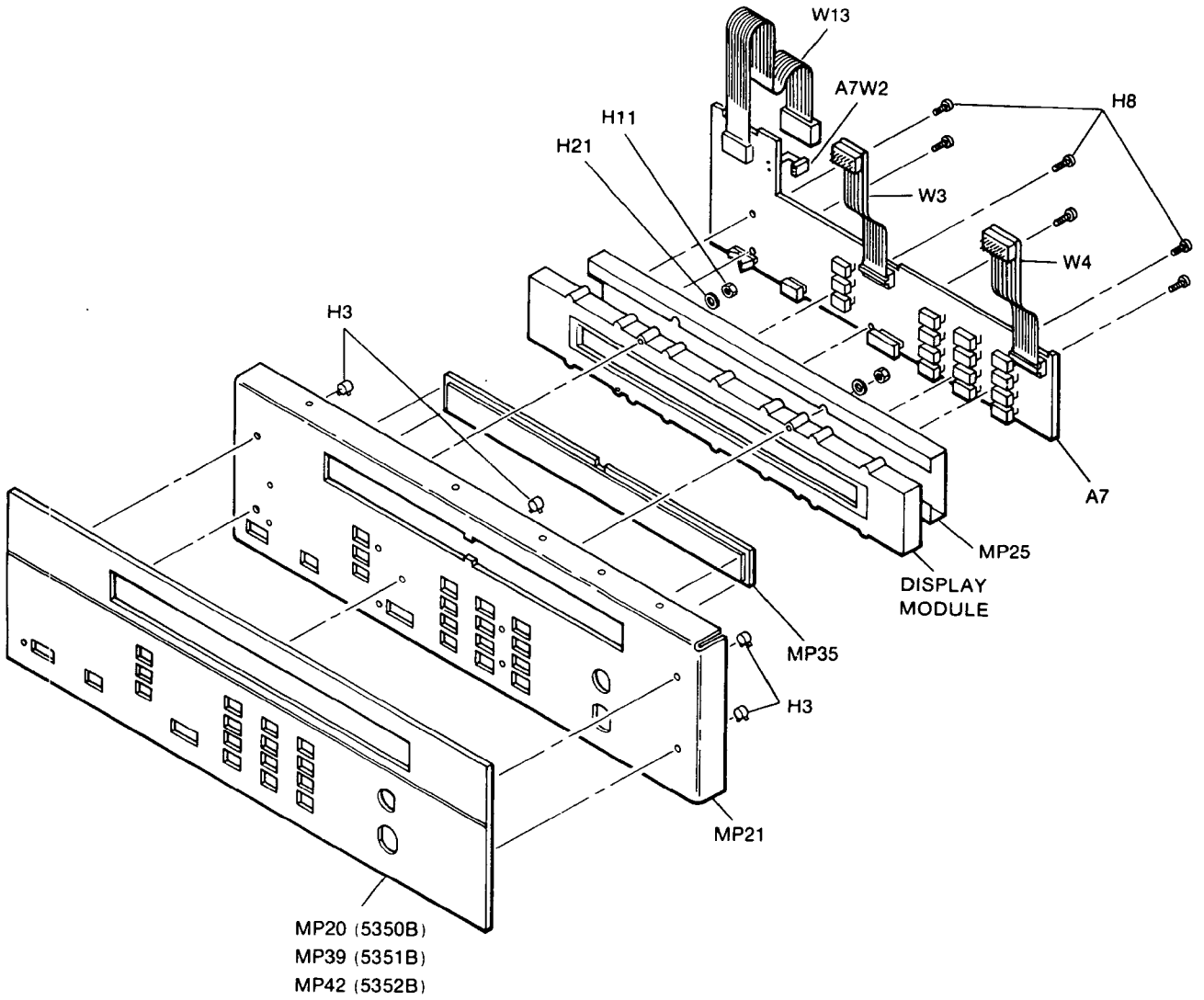
See introduction to this section for ordering information



NOTE

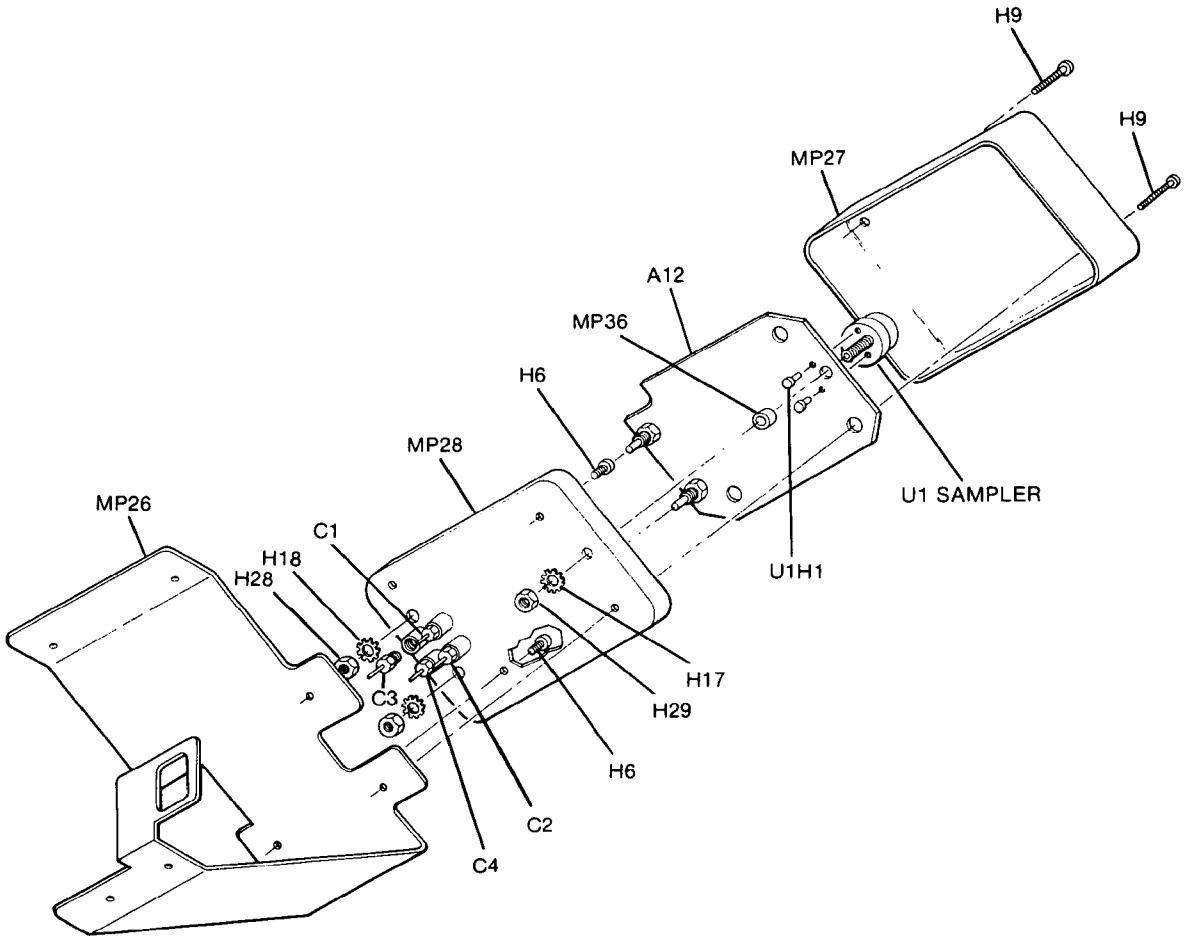
REFER TO PAGES 6-35 AND 6-36 FOR PART NUMBERS FOR CHASSIS PARTS AND HARDWARE.

Figure 6-1. 5350B/5351B/5352B Exploded View



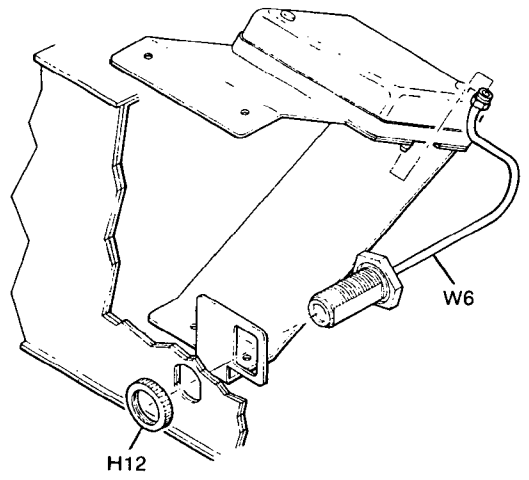
Reference Designation	HP Part Number	CD	Description
A7	05350-60007	2	KEYBOARD/DISPLAY LOGIC ASSEMBLY
A7W2	05350-60104	0	CBL AY-LED BOARD
H3	0510-1148	2	RETAINER-PUSH ON KB-TO-SHIFT EXT
H8	0515-0897	6	SCREW-MACH M3 × 0.5 8MM-LG PAN-HD
H11	0535-0004	9	NUT-HEX DBL-CHAM M3 × 0.5 2.4MM-THK
H21	2190-0644	3	INTERNAL STAR WASHER
MP20	05350-00023	6	PANEL-FRONT (5350B ONLY)
MP21	05350-00002	1	PANEL-SUB
MP25	05350-00007	6	SHIELD DISPLAY
MP35	05350-20203	6	WINDOW
MP39	05351-00002	2	PANEL-FRONT (5351B ONLY)
MP42	05352-00002	3	PANEL-FRONT (5352B ONLY)
W3	05350-60107	3	CBL AY-RBN 16 CND
W4	05350-60107	3	CBL AY-RBN 16 CND
W13	05350-60105	1	CBL AY-KEYBOARD
NONE	05350-60106	2	LCD DISPLAY MODULE

Figure 6-2. Front Panel Parts



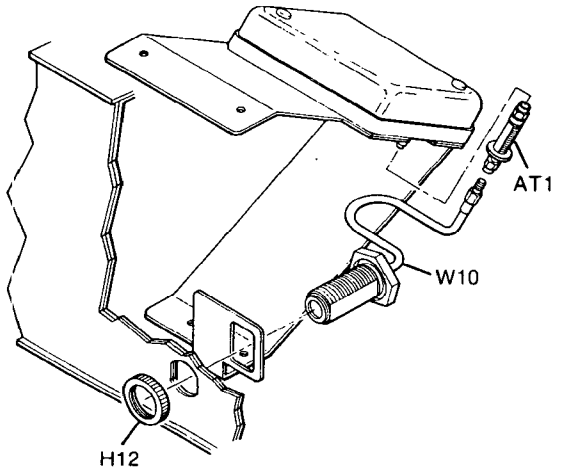
Reference Designation	HP Part Number	CD	Description
A12	05350-60012	9	MICROWAVE ASSEMBLY (5350B/5351B)
A12	05352-60012	1	MICROWAVE ASSEMBLY (5352B)
C1	0160-3036	8	CAPACITOR-FDTHRU 5000PF +80 -20% 200V
C2	0160-3036	8	CAPACITOR-FDTHRU 5000PF +80 -20% 200V
C3	0160-3036	8	CAPACITOR-FDTHRU 5000PF +80 -20% 200V
C4	0160-3036	8	CAPACITOR-FDTHRU 5000PF +80 -20% 200V
H6	0515-0886	3	SCREW-MACH M3 × 0.5 6MM-LG PAN-HD
H9	0515-1060	7	SCREW-MACH M3 × 0.5 25MM-LG PAN-HD
H17	2190-0084	5	WASHER-LK INTL T 1/4 IN .256-IN-ID
H18	2190-0124	4	WASHER-LK T NO. 10 .195-IN-ID
H28	2950-0078	9	NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK
H29	2950-0196	2	NUT-HEX-DBL-CHAM 1/4-36-THD .06-IN-THK
MP26	05350-00008	7	MTG BKT-SAMPLER
MP27	05350-00009	8	COVER-SAMPLER
MP28	05350-00010	1	BASE-COVER
MP36	05350-20204	7	SPACER
U1	05350-60113	1	SAMPLER (5350B/5351B)
U1	05352-60101	9	SAMPLER (5352B)
U1H1	0624-0097	9	SCREW-TPG 4040 .188-IN-LG PAN-HD-POZI

Figure 6-3. Microwave Module Parts



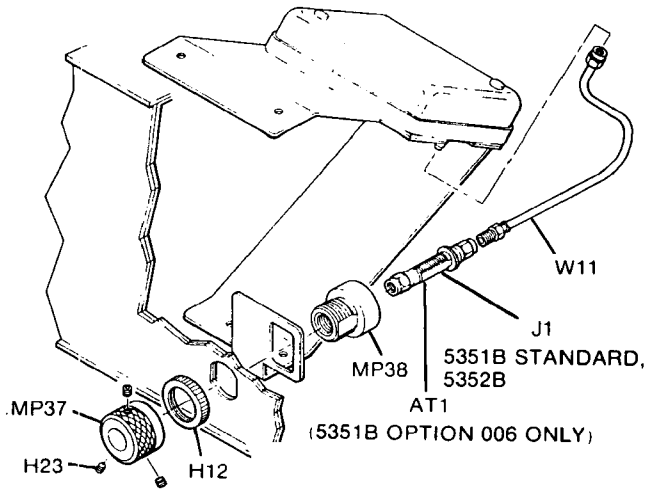
5350B STANDARD

Reference Designation	HP Part Number	CD	Description
H12	0590-0505	1	NUT-KNRLD-R 5/8-24-THD .125-IN-THK
W6	05350-60109	5	SEMI-RIGID ASSY-INPUT (5350B)



5350B OPTION 006

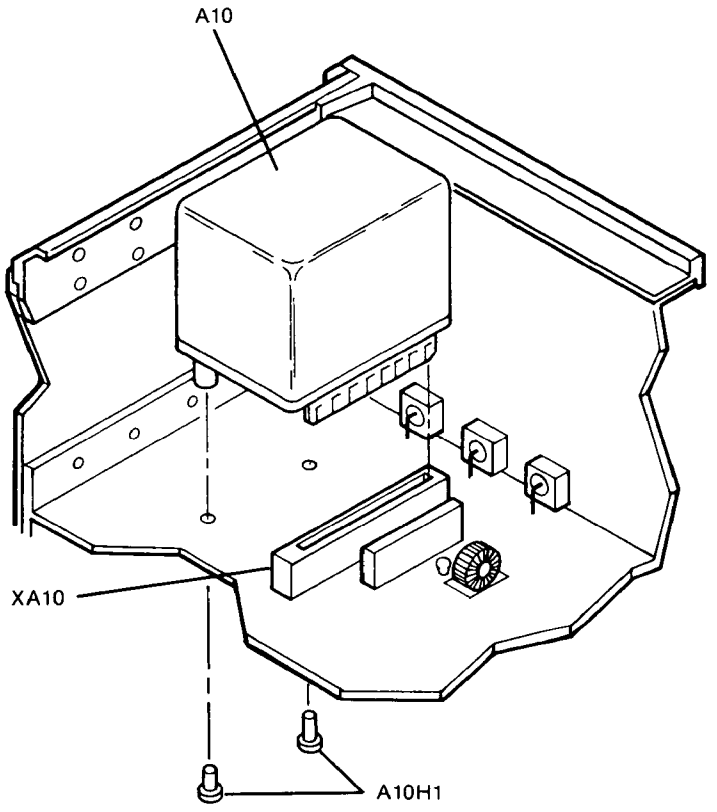
Reference Designation	HP Part Number	CD	Description
AT1	5088-7049	2	26.5 GHZ LIMITER
H12	0590-0505	1	NUT-KNRLD-R 5/8-24-THD .125-IN-THK
W10	05350-60111	9	SEMI-RIGID ASSEMBLY-LIMITER OPTION



5351B STANDARD AND OPTION 006, AND 5352B

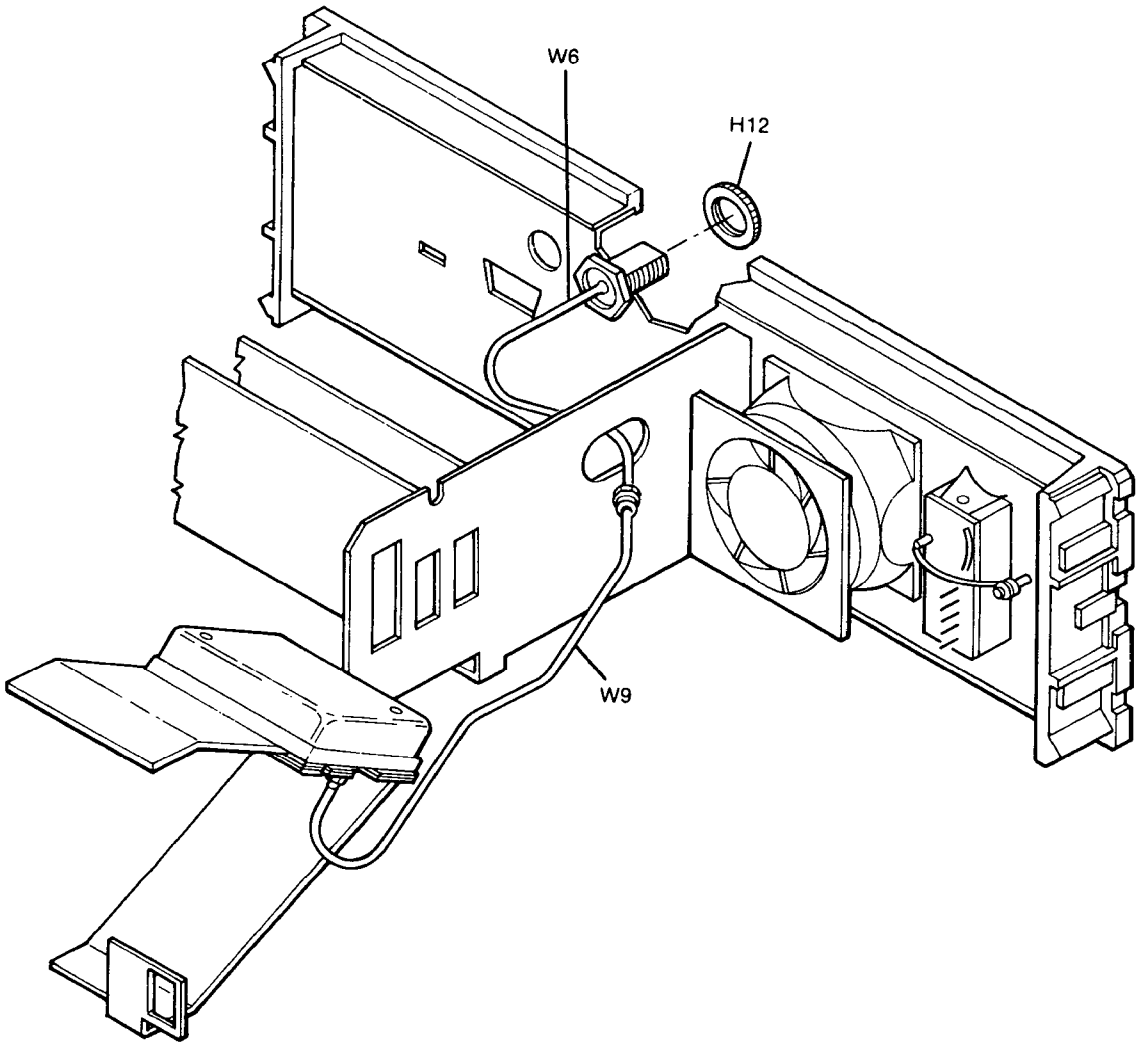
Reference Designation	HP Part Number	CD	Description
AT1	5088-7049	2	26.5 GHZ LIMITER (5350B/5351B ONLY)
H12	0590-0505	1	NUT-KNRLD-R 5/8-24-THD .125-IN-THK
H23	3030-0033	7	SCREW-SET 6-32 .188-IN-LG SMALL CUP-PT
J1	05343-80001	9	INPUT 1 CONNECTOR ASSEMBLY
MP37	05350-20204	8	CONNECTOR-COLLAR
MP38	05350-20201	4	SPACER-THREADED
W11	05351-60101	8	CBL AY-INPUT

Figure 6-4. INPUT 1 Connectors



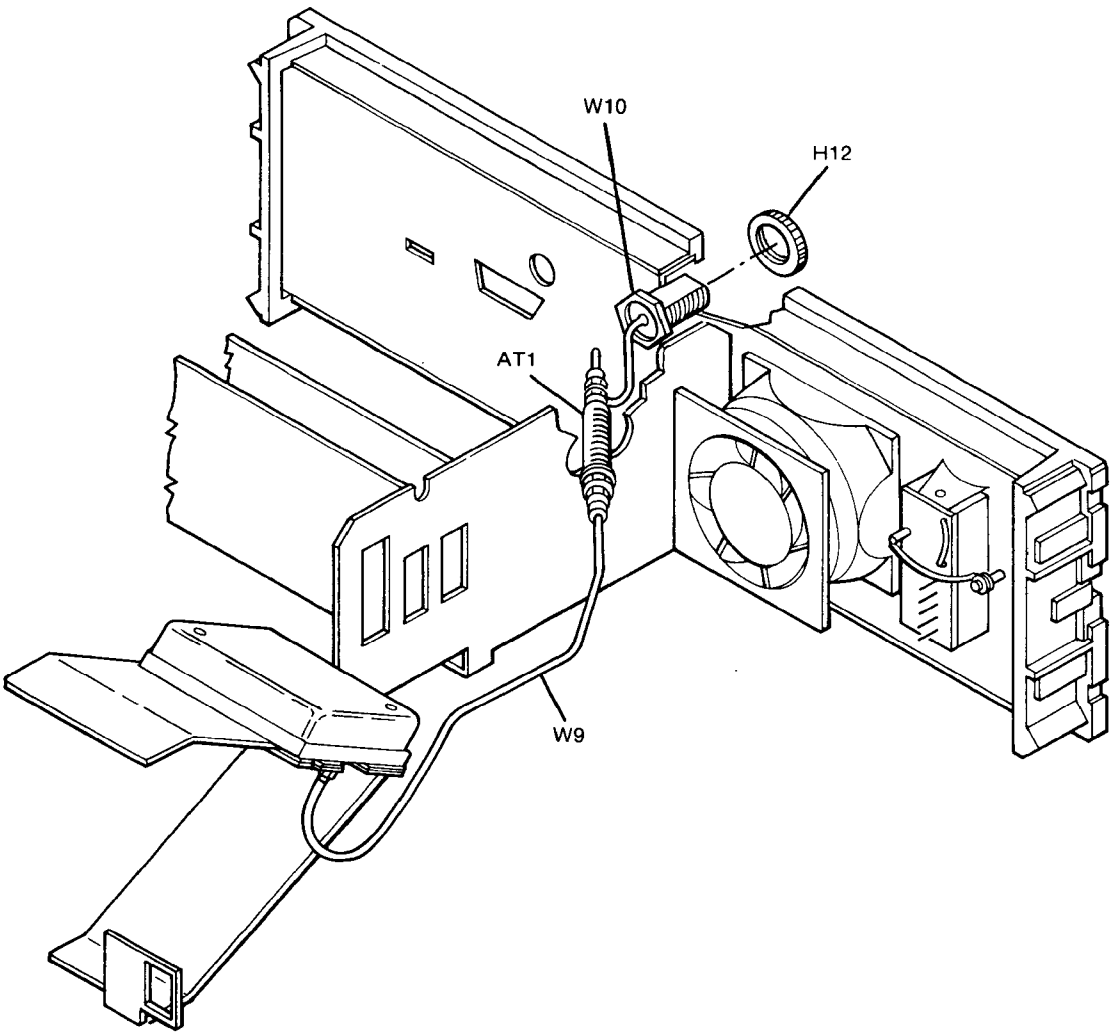
Reference Designation	HP Part Number	CD	Description
A10	10811-60111	8	OPTION 001 OVEN OSCILLATOR
A10	10811-60211	9	OPTION 010 HIGH STABILITY TIMEBASE
A10H1	2360-0115	4	SCREW-MACH 6-32 .312-IN-LG PAN-HD-POZI

Figure 6-5. Option 001 and 010 Oven Oscillators (5350B/5351B/5352B)



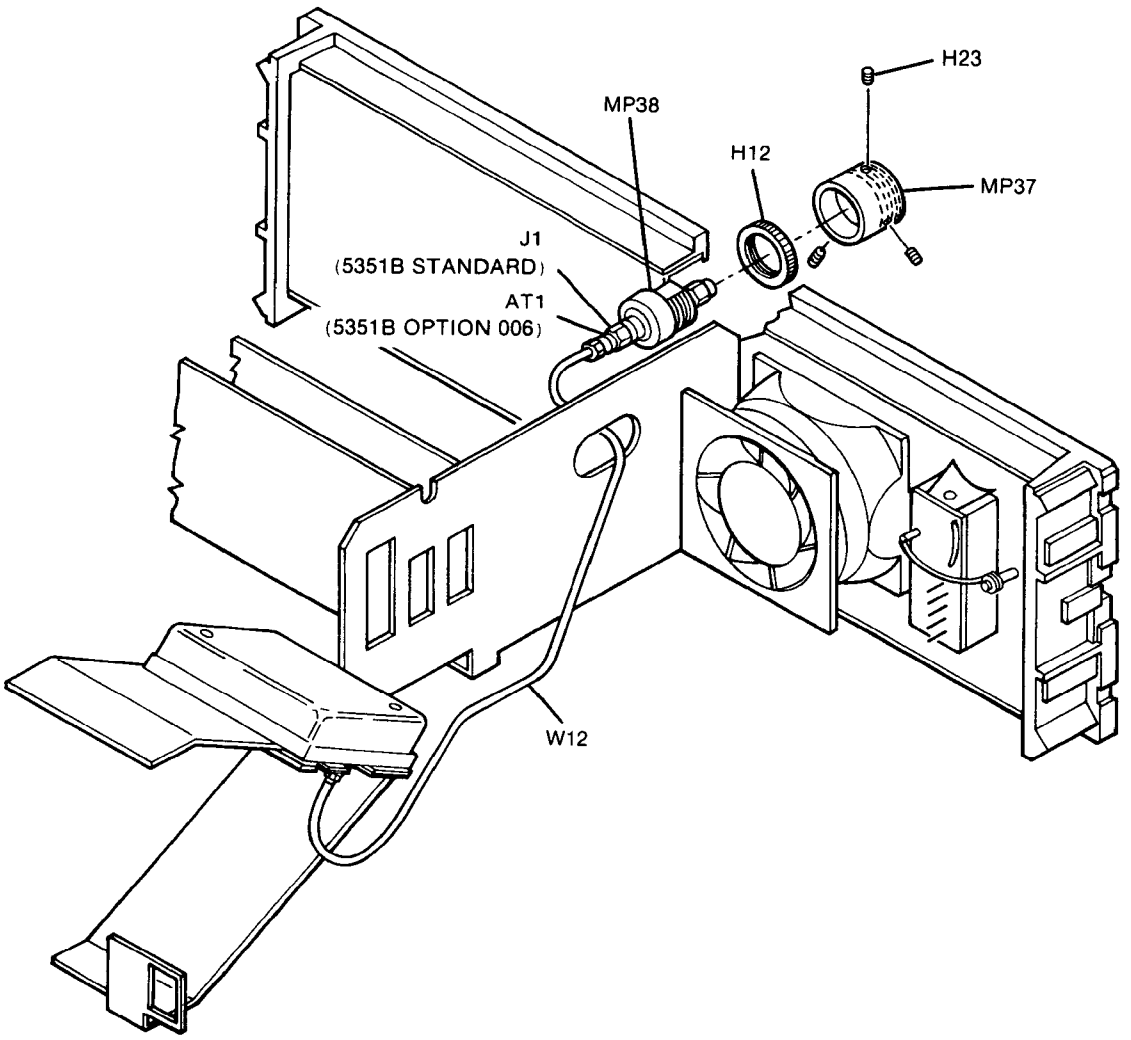
Reference Designation	HP Part Number	CD	Description
H12	0590-0505	1	NUT-KNRLD-R 5/8-24-THD .125-IN-THK
W6	05350-60109	5	SEMI-RIGID ASSY-INPUT (5350B)
W9	05350-60110	8	SEMI-RIGID ASSEMBLY-REAR INPUT

Figure 6-6. 5350B Option 002 Rear Panel Inputs



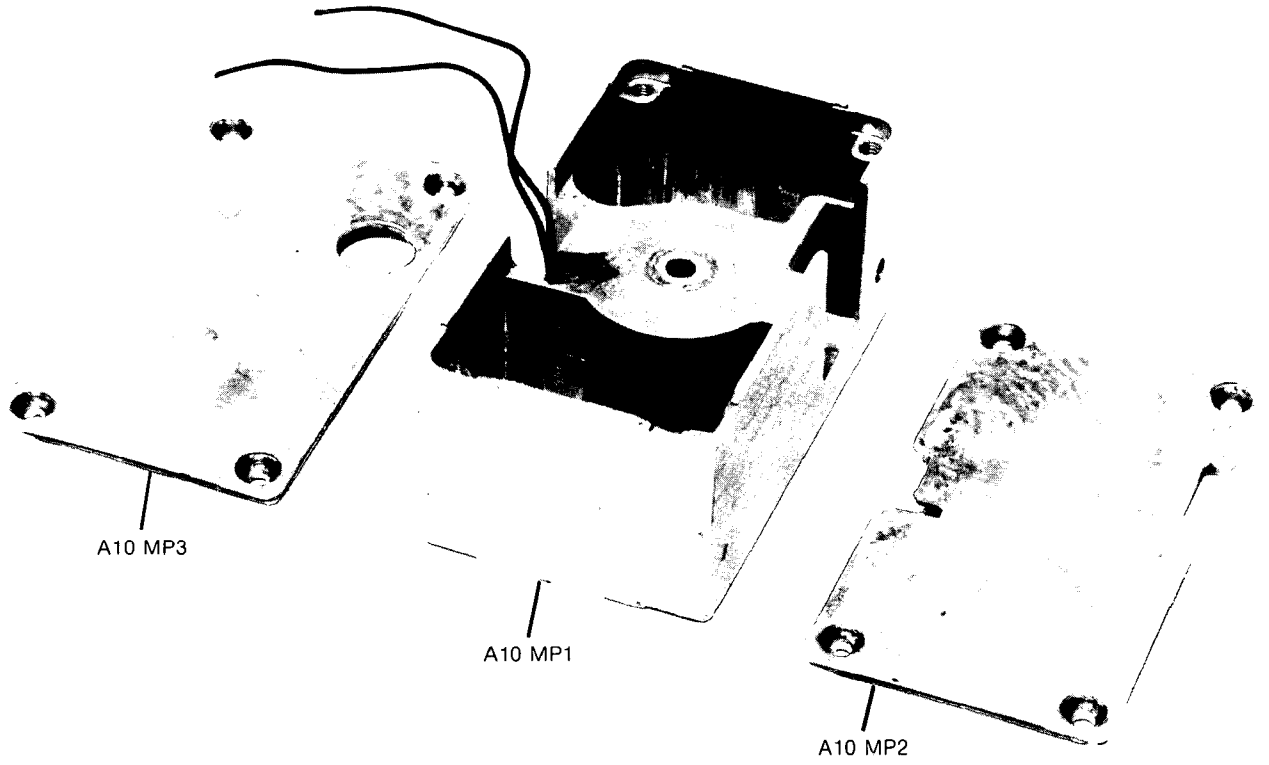
Reference Designation	HP Part Number	CD	Description
AT1	5088-7049	2	26.5 GHZ LIMITER
H12	0590-0505	1	NUT-KNRLD-R $^{5}/_{8}$-24-THD .125-IN-THK
W9	05350-60110	8	SEMI-RIGID ASSEMBLY-REAR INPUT
W10	05350-60111	9	SEMI-RIGID ASSEMBLY-LIMITER OPTION

Figure 6-7. 5350B Combined Options 002/006

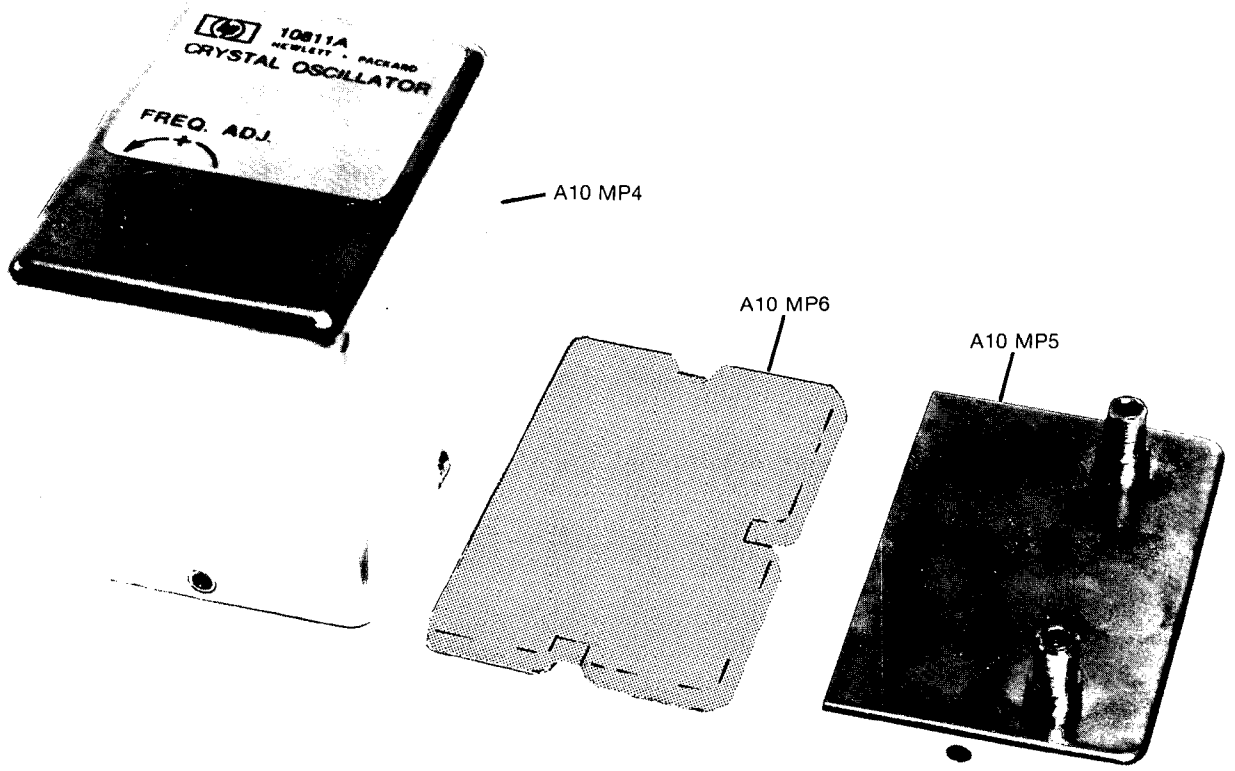


Reference Designation	HP Part Number	CD	Description
AT1	5088-7049	2	26.5 GHZ LIMITER
H12	0590-0505	1	NUT-KNRLD-R 5/8-24-THD .125-IN-THK
H23	3030-0033	7	SCREW-SET 6-32 .188-IN-LG SMALL CUP-PT
J1	05343-80001	9	INPUT 1 CONNECTOR ASSEMBLY
MP37	05343-20204	8	CONNECTOR-COLLAR
MP38	05350-20201	4	SPACER-THREADED
W12	05351-60102	9	CABLE ASSEMBLY-REAR INPUT

Figure 6-8. 5351B Option 002 and Combined Options 002/006



OVEN MASS ASSEMBLY AND COVERS



OVEN OSCILLATOR HOUSING

Figure 6-9. Oven Oscillator Mechanical Parts

Table 6-4. Replaceable Parts for Options

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A10	10811-60111	8	1	OPTION 001 OVEN OSCILLATOR	28480	10811-60111
			1	NOTE SERVICE KIT 10811-60114 IS AVAILABLE FOR SERVICE REPLACEMENT OF THE 10811-60115 CIRCUIT ASSEMBLY. REFER TO THE BEGINNING OF SECTION VI FOR ORDERING INFORMATION.		
A10A1	10811-60115	2	1	OVEN OSCILLATOR CIRCUIT ASSEMBLY	28480	10811-60115
A10A1C1	0121-0511	6	1	TUNING CAPACITOR 1-30 PF	28480	0121-0511
A10A1C2	0160-0576	5	9	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A10A1C3	0160-5109	0	1	CAPACITOR-FXD 15PF +-5% 200VDC CER 0+-30	28480	0160-5109
A10A1C4	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A10A1C5	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A10A1C6	0160-4935	8	1	CAPACITOR-FXD 510PF +-1% 100VDC CER	28480	0160-4935
A10A1C7	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A10A1C8	0160-5110	3	1	CAPACITOR-FXD 62PF +-1% 50VDC CER 0+-30	28480	0160-5110
A10A1C9	0160-4019	9	2	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-4019
A10A1C10	0160-3874	2	2	CAPACITOR-FXD 10PF +-.5PF 200VDC CER	28480	0160-3874
A10A1C11	0160-4019	9		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-4019
A10A1C12	0160-4512	7	2	CAPACITOR-FXD 120PF +-5% 200VDC CER	28480	0160-4512
A10A1C13	0160-3879	7	4	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A10A1C14	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A10A1C15	0180-3066	6	1	CAPACITOR-FXD 6.8UF+-10% 35VDC TA	28480	0180-3066
A10A1C16	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A10A1C17	0160-3874	2		CAPACITOR-FXD 10PF +-.5PF 200VDC CER	28480	0160-3874
A10A1C18	0160-4947	2	1	CAPACITOR-FXD 2UF +-20% 50VDC MET-POLYE	28480	0160-4947
A10A1C19	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A10A1C20	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A10A1C21	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A10A1C22	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A10A1C23	0160-4512	7		CAPACITOR-FXD 120PF +-5% 200VDC CER	28480	0160-4512
A10A1C24	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A10A1C25	0160-3277	9	1	CAPACITOR-FXD .01UF +-20% 50VDC CER	51642	150-050-X7R-103M
A10A1C26	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A10A1C27	0160-3872	0	1	CAPACITOR-FXD 2.2PF +-.25PF 200VDC CER	28480	0160-3872
A10A1CR1	0122-0244	4	1	DIODE-VVC 100PF 5% C4/C25-MIN=2 BVR=30V	28480	0122-0244
A10A1CR2	1901-0869	2	1	DIODE-CUR RGLTR 1N5297 DO-7	04713	1N5297
A10A1CR3	1902-0984	4	1	DIODE-ZNR 6.4V 2% DO-7 PD=.4W TC=+.002%	28480	1902-0984
A10A1CR4	1901-0535	9	3	DIODE-SM SIG SCHOTTKY	28480	1901-0535
A10A1CR5	1901-0535	9		DIODE-SM SIG SCHOTTKY	28480	1901-0535
A10A1CR6	1901-0535	9		DIODE-SM SIG SCHOTTKY	28480	1901-0535
A10A1E1	9170-0029	3	1	CORE-SHIELDING BEAD	28480	9170-0029
A10A1F1	2110-0617	2	1	FUSE-THERMAL	28480	2110-0617
A10A1J1	1200-0868	5	1	SOCKET-STRP 7-CONT DIP-SLDR	28480	1200-0868
A10A1L1	9100-2280	5	5	INDUCTOR RF-CH-MLD 220UH 10%	28480	9100-2280
A10A1L2	9140-0352	2	1	INDUCTOR RF-CH-MLD 330NH 1% .105DX.26LG	28480	9140-0352
A10A1L3	9140-0353	3	1	INDUCTOR RF-CH-MLD 430NH 1% .105DX.26LG	28480	9140-0353
A10A1L4	9100-2276	9	1	INDUCTOR RF-CH-MLD 100UH 10%	28480	9100-2276
A10A1L5	9100-2280	5		INDUCTOR RF-CH-MLD 220UH 10%	28480	9100-2280
A10A1L6	9100-2280	5		INDUCTOR RF-CH-MLD 220UH 10%	28480	9100-2280
A10A1L7	9100-2280	5		INDUCTOR RF-CH-MLD 220UH 10%	28480	9100-2280
A10A1L8	9100-2280	5		INDUCTOR RF-CH-MLD 220UH 10%	28480	9100-2280
A10A1Q1	1854-0853	3	3	TRANSISTOR, SPL 2N5179	28480	1854-0853
A10A1Q2	1854-0853	3		TRANSISTOR, SPL 2N5179	28480	1854-0853
A10A1Q3	1854-0853	3		TRANSISTOR, SPL 2N5179	28480	1854-0853
A10A1Q4	1854-0831	7	2	TRANSISTOR NPN 2N6429A TO-92 PD=625MW	04713	2N6429A
A10A1Q5	1854-0831	7		TRANSISTOR NPN 2N6429A TO-92 PD=625MW	04713	2N6429A

See introduction to this section for ordering information

Table 6-4. Replaceable Parts for Options (Continued)

Reference Designation	HP Part Number	CD	Qty	Description	Mfr Code	Mfr Part Number
A10A1Q6	1854-0023	9	1	TRANSISTOR NPN SI TO-18 PD=360MW	28480	1854-0023
A10A1Q7	1854-0701	0	2	TRANSISTOR NPN SI DARL TO-220AB PD=70W	04713	MJE2100
A10A1Q8	1854-0701	0		TRANSISTOR NPN SI DARL TO-220AB PD=70W	04713	MJE2100
A10A1Q9	1854-0833	9	1	TRANSISTOR NPN PD=600MW FT=600MHZ	28480	1854-0833
A10A1R1	0698-7284	5	5	RESISTOR 100K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1003-F
A10A1R2	0698-7284	5		RESISTOR 100K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1003-F
A10A1R3	0699-0073	8	2	RESISTOR 10M 1% .125W F TC=0+-150	28480	0699-0073
A10A1R4	0699-0073	8		RESISTOR 10M 1% .125W F TC=0+-150	28480	0699-0073
A10A1R5	0698-7263	0	1	RESISTOR 13.3K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1332-F
A10A1R6	2100-2522	1	1	RESISTOR-TRMR 10K 10% C SIDE-ADJ 1-TRN	73138	82PAR10K
A10A1R7	0698-7272	1	1	RESISTOR 31.6K 1% .05W F TC=0+-100	24546	C3-1/8-T0-3162-F
A10A1R8	0698-7232	3	3	RESISTOR 681 1% .05W F TC=0+-100	24546	C3-1/8-T0-681R-F
A10A1R9	0698-7256	1	2	RESISTOR 6.81K 1% .05W F TC=0+-100	24546	C3-1/8-T0-6811-F
A10A1R10	0698-7256	1		RESISTOR 6.81K 1% .05W F TC=0+-100	24546	C3-1/8-T0-6811-F
A10A1R11	0698-7244	7	1	RESISTOR 2.15K 1% .05W F TC=0+-100	24546	C3-1/8-T0-2151-F
A10A1R12	0698-7261	8	1	RESISTOR 11K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1102-F
A10A1R13	0698-7224	3	1	RESISTOR 316 1% .05W F TC=0+-100	24546	C3-1/8-T0-316R-F
A10A1R14	0698-7280	1	1	RESISTOR 68.1K 1% .05W F TC=0+-100	24546	C3-1/8-T0-6812-F
A10A1R15	0698-7284	5		RESISTOR 100K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1003-F
A10A1R16	0698-7235	6	1	RESISTOR 909 1% .05W F TC=0+-100	24546	C3-1/8-T0-909R-F
A10A1R17	0698-7260	7	2	RESISTOR 10K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1002-F
A10A1R18	0698-3903	7	5	RESISTOR 8.6K .1% .05W F TC=0+-10	28480	0698-3903
A10A1R19	0698-3903	7		RESISTOR 8.6K .1% .05W F TC=0+-10	28480	0698-3903
A10A1R20*	0698-7239	0	1	RESISTOR 1.33K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1331-F
A10A1R20*	8159-0005	0	1	RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A10A1R21	0698-3903	7		RESISTOR 8.6K .1% .05W F TC=0+-10	28480	0698-3903
A10A1R22	0698-8827	4	2	RESISTOR 1M 1% .125W F TC=0+-100	28480	0698-8827
A10A1R23	0698-8827	4		RESISTOR 1M 1% .125W F TC=0+-100	28480	0698-8827
A10A1R24	0699-0071	6	1	RESISTOR 4.64M 1% .125W F TC=0+-100	28480	0699-0071
A10A1R25	0698-7273	2	1	RESISTOR 34.8K 1% .05W F TC=0+-100	24546	C3-1/8-T0-3482-F
A10A1R26	0698-3903	7		RESISTOR 8.6K .1% .05W F TC=0+-10	28480	0698-3903
A10A1R27	0698-3903	7		RESISTOR 8.6K .1% .05W F TC=0+-10	28480	0698-3903
A10A1R28	0698-7265	2	1	RESISTOR 16.2K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1622-F
A10A1R29	0698-7260	7		RESISTOR 10K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1002-F
A10A1R30	0698-7267	4	1	RESISTOR 19.6K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1962-F
A10A1R31	0698-7220	9	1	RESISTOR 215 1% .05W F TC=0+-100	24546	C3-1/8-T0-215R-F
A10A1R32	0698-7250	5	2	RESISTOR 3.83K 1% .05W F TC=0+-100	24546	C3-1/8-T0-3831-F
A10A1R33	0698-7284	5		RESISTOR 100K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1003-F
A10A1R34	0698-7247	0	1	RESISTOR 2.87K 1% .05W F TC=0+-100	24546	C3-1/8-T0-2871-F
A10A1R35	0698-7250	5		RESISTOR 3.83K 1% .05W F TC=0+-100	24546	C3-1/8-T0-3831-F
A10A1R36	0698-7284	5		RESISTOR 100K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1003-F
A10A1R37	0698-7232	3		RESISTOR 681 1% .05W F TC=0+-100	24546	C3-1/8-T0-681R-F
A10A1R38	0698-8812	7	2	RESISTOR 1 1% .125W F TC=0+-100	28480	0698-8812
A10A1R39	0698-8812	7		RESISTOR 1 1% .125W F TC=0+-100	28480	0698-8812
A10A1R40	0698-7229	8	1	RESISTOR 511 1% .05W F TC=0+-100	24546	C3-1/8-T0-511R-F
A10A1R41	0698-7215	2	1	RESISTOR 133 1% .05W F TC=0+-100	24546	C3-1/8-T0-133R-F
A10A1R42	0698-7232	3		RESISTOR 681 1% .05W F TC=0+-100	24546	C3-1/8-T0-681R-F
A10A1T1	9100-0423	4	1	TRANSFORMER RF; WIND 9T PRI & 3T SEC	28480	9100-0423
A10A1U1	1826-0611	2	1	IC OP AMP GP DUAL 8-DIP-P PKG	04713	LM2904N
A10A1U2	1826-0316	4	1	V REF TO-5	27014	LH0070-1H
A10A1U3	1826-0072	9	1	IC OP AMP LOW-BIAS-H-IMPD TO-99 PKG	07263	UA208H
A10A1W1	8120-4013	7	1	CBL ASSY 6C 10811	28480	8120-4013
A10A1W2	8120-4014	8	1	CBL ASSY 4C 10811	28480	8120-4014
A10A1XF1	1251-1556	7	2	CONNECTOR-SGL CONT SKT .018-IN-BSC-SZ	28480	1251-1556
A10A1Y1	10811-60108	3	1	CRYSTAL-10MHZ W/R20 TEMP SET (REPAIR ONLY)	28480	10811-60108
	2260-0009	3	1	NUT-HEX-W/LKWR 4-40-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
				NOTE THE Y1 CRYSTAL IS NOT SUPPLIED AS PART OF THE A10A1 CIRCUIT ASSEMBLY, AND MUST BE ORDERED SEPARATELY.		

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

Table 6-4. Replaceable Parts for Options (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
				A10A1 CIRCUIT BOARD MISCELLANEOUS PARTS		
	0340-0092	2	3	TERMINAL-STUD SPCL-FDTHRU PRESS-MTG	28480	0340-0092
	3050-0588	9	1	WASHER-FL NM NO. 6 .145-IN-ID .23-IN-OD	28480	3050-0588
	0360-1682	0	2	TERMINAL-STUD SGL-TUR PRESS-MTG	28480	0360-1682
	10811-40002	4	1	FOAM SHEET-(BELOW OVEN CONTROLLER ASSY)	28480	10811-40002
A10A2	10811-60003	7	1	BD ASSY-EDGE CONN	28480	10811-60003
A10A2W1	8120-3817	7	1	CBL ASSY 7C 10811	28480	8120-3817
A10H1	2360-0115	4	2	SCREW-MACH 6-32 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
				TRANSISTOR MOUNTING HARDWARE		
	2200-0103	2	1	SCREW-MACH 4-40 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	3050-0229	5	1	WASHER-FL MTLC NO. 4 .125-IN-ID	28480	3050-0229
	3050-1021	7	1	WASHER-SHLDR NO.4 .116-IN-ID .215-IN-OD	28480	3050-1021
	0340-0864	6	1	INSULATOR-XSTR THRM-CNDCT	28480	0340-0864
				MASS ASSEMBLY AND COVERS		
A10MP1	10811-60106	1	1	OVEN MASS ASS. W/THERMISTOR	28480	10811-60106
A10MP2	10811-20202	4	1	MASS COVER W/XISTOR CUT-OUTS	28480	10811-20202
A10MP3	10811-20203	5	1	MASS COVER W/TUNING CAP HOLE	28480	10811-20203
	0520-0166	3	1	SCREW-MACH 2-56 .375-IN-LG 82 DEG	00000	ORDER BY DESCRIPTION
				MECHANICAL PARTS		
A10MP4	10811-20206	8	1	OUTER HOUSING (FOAMED)	28480	10811-20206
A10MP5	10811-20211	5	1	BOTTOM COVER	28480	10811-20211
A10MP6	10811-40001	3	1	FOAM COOKIE UNDER BOT COV	28480	10811-40001
				A10 OVEN OSCILLATOR MISCELLANEOUS PARTS		
	2200-0597	8	1	SCREW-MACH 4-40 .188-IN-LG	28480	2200-0597
	5080-0098	1	1	INFO LABEL 10811A	28480	5080-0098
	7121-1577	3	1	INFO LABEL 10811-60101	28480	7121-1577

See introduction to this section for ordering information

Table 6-4. Replaceable Parts for Options (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
				5350B OPTION 002 REAR PANEL INPUTS		
W9	05350-60110	8	1	SEMI-RIGID ASSEMBLY-REAR INPUT	28480	05350-60110
				5351B OPTION 002 REAR PANEL INPUTS		
W12	05351-60102	9	1	CABLE ASSEMBLY-REAR INPUT	28480	05351-60102
				5350B OPTION 006 LIMITER		
AT1	5088-7049	2	1	26.5 GHZ LIMITER (INPUT 1)	28480	5088-7049
W10	05350-60111	9	1	SEMI-RIGID ASSEMBLY-LIMITER OPTION	28480	05350-60111
				5351B OPTION 006 LIMITER		
AT1	5088-7049	2		26.5 GHZ LIMITER (INPUT 1)	28480	5088-7049
				5350B/5351B/5352B OPTION 010 HIGH STABILITY OVEN OSCILLATOR TIMEBASE		
A10	10811-60211	9	1	HIGH STABILITY TIMEBASE NOTE THE OPTION 010 HIGH STABILITY OVEN OSCILLATOR IS NOT A FIELD REPAIRABLE ASSEMBLY. REFER TO THE BEGINNING OF THIS SECTION FOR INFORMATION FOR ORDERING A REPLACEMENT OPTION 010 HIGH STABILITY OSCILLATOR.	28480	10811-60211

Table 6-5. Manufacturer's Code List

Mfr Code	Manufacturer Name	Address	Zip Code
S0545	NEC ELECTRONICS LTD	MTN VIEW CA US	94043
S0562	TOSHIBA CORP	TOKYO JP	
00000	ANY SATISFACTORY SUPPLIER		
01121	ALLEN-BRADLEY CO INC	EL PASO TX US	79935
01295	TEXAS INSTRUMENTS INC	DALLAS TX US	75265
02768	ITW FASTEX	DES PLAINES IL US	60016
03508	GE CO SEMICONDUCTOR PROD DEPT	AUBURN NY US	13201
03888	K D I PYROFILM CORP	WHIPPANY NJ	07981
04713	MOTOROLA INC SEMI-COND PROD	PHOENIX AZ US	85008
05791	LYN-TRON INC	BURBANK CA US	91505
07263	FAIRCHILD CORP	MOUNTAIN VIEW CA US	94042
18546	VARO SEMICONDUCTOR INC	GARLAND TX US	75046
11236	CTS CORP BERNE DIV	BERNE IN US	46711
11961	SEMICON INC	BURLINGTON MA	01803
14433	ITT SEMICONDUCTORS DIV	TUSTIN CA US	92680
16299	CORNING ELECTRONICS	RALEIGH NC US	27604
19701	MEPCO/CENTRALAB INC	WEST PALM BEACH FL US	33407
20932	EMCON DIV ITW	SAN DIEGO CA	92129
24546	CORNING ELECTRONICS	SANTA CLARA CA US	95050
25088	SIEMENS CORP	ISELIN NJ US	08830
25403	NV PHILIPS ELCOMA DEPT	EINDHOVEN HL	02876
27014	NATIONAL SEMICONDUCTOR CORP	SANTA CLARA CA US	95052
28480	HEWLETT-PACKARD CO CORPORATE HQ	PALO ALTO CA	94304
3L585	RCA CORP SOLID STATE DIV	SOMERVILLE NJ	
50088	MOSTEK CORP	CARROLLTON TX US	75006
51642	CENTRE ENGINEERING INC	STATE COLLEGE PA	16801
56289	SPRAGUE ELECTRIC CO	NORTH ADAMS MA	01247
72136	ELECTRO MOTIVE CORP	FLORENCE SC	06226
72982	ERIE TECHNOLOGICAL PRODUCTS INC	ERIE PA	16512
73138	BECKMAN INDUSTRIAL CORP	FULLERTON CA US	92632
73899	J F D ELECTRONICS CORP	BROOKLYN NY	11219
75042	TRW INC PHILADELPHIA DIV	PHILADELPHIA PA	19108
75915	LITTELFUSE INC	DES PLAINES IL US	60016
9N171	UNITRODE CORP	LEXINGTON MA US	02173
91637	DALE ELECTRONICS INC	EL PASO TX US	79936

SECTION VII
MANUAL CHANGES

7-1. INTRODUCTION

7-2. This section contains information necessary to adapt this manual to older versions of the HP 5350B, 5351B, and 5352B for which the contents of the manual may not directly apply. The manual changes necessary for a particular instrument configuration are determined by the serial number prefix or complete serial number on the rear panel of the instrument, or by the ROM firmware version number.

7-3. MANUAL CHANGES

7-4. This manual applies directly to Model 5350B, 5351B, and 5352B Microwave Frequency Counters with serial number prefix 2713A and firmware version number 2650.

7-5. As engineering changes are made, newer instruments may have a serial number prefix higher than 2713A. Manuals for these instruments will be supplied with MANUAL CHANGES sheets containing the required information. Replace affected pages or modify existing manual information as directed in the MANUAL CHANGES pages. Contact the nearest Hewlett-Packard Sales and Support Office (listed at the back of this manual) if the change information is missing.

7-6. OLDER INSTRUMENTS

7-7. To adapt (backdate) this manual to older instruments having a serial number prefix lower than 2713A or firmware version number lower than 2650, refer to *Table 7-1* for the 5350B, *Table 7-2* for the 5351B, and *Table 7-3* for the 5352B, and make the changes indicated for your instrument's serial number prefix, complete serial number, and/or firmware version number, as applicable.

Table 7-1. 5350B Backdating

If your instrument has serial number prefix, serial number, or firmware version number	Make the following changes to your manual
Serial Prefix 2632A	1
Firmware Version 2637	2
Firmware Version 2631	3
Serial Prefix 2627A	1, 4

Table 7-2. 5351B Backdating

If your instrument has serial number prefix, serial number, or firmware version number	Make the following changes to your manual
Serial Prefix 2632A	1
Firmware Version 2637	2
Firmware Version 2631	3
Serial Prefix 2627A	1, 4

Table 7-3. 5352B Backdating

If your instrument has serial number prefix, serial number, or firmware version number	Make the following changes to your manual
Serial Prefix 2632A	1
Firmware Version 2637	2
Firmware Version 2631	3
Serial Prefix 2627A	1, 4

CHANGE 1

Instruments with serial number prefix 2632A and lower included an overvoltage crowbar circuit on the A8 Motherboard. To backdate this manual so it applies to instruments with serial number prefix 2632A, make the following changes:

Section VI, A8 Replaceable Parts (Page 6-25):

Add A8C16, 0160-4389, CAPACITOR-FXD 100PF ±5PF 200VDC CER, 28480, 0160-4389.

Add A8C17, 0160-3879, CAPACITOR-FXD .01UF ±20% 100VDC CER, 28480, 0160-3879.

Add A8CR16, 1884-0258, QTY=1, THYRISTOR-DIAC TRIG IP PULSE=2A MAX, 28480, 1884-0258.

Add A8Q11, 1884-0250, TRIAC 200V 6A TO-220AB, 3L585, T2500B.

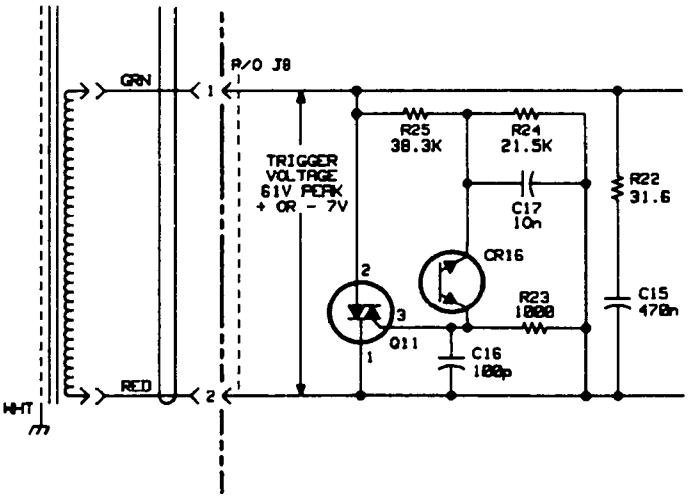
Add A8R23, 0757-0280, RESISTOR 1K 1% .125W F TC=0±100, 24546, C4-1/8-T0-1001-F.

Add A8R24, 0757-0199 RESISTOR 21.5K 1% .125W F TC=0±100, 24546, C4-1/8-T0-2152-F.

Add A8R25, 0698-3161, RESISTOR 38.3K 1% .125W F TC=0±100, 24546, CR-1/8-T0-3832-F.

Section VIII, Figure 8-41, A8 Motherboard/Power Supply Regulator Schematic Diagram:

Add the overvoltage crowbar circuit consisting of C16, C17, CR16, Q11, R23, R24, and R25 as shown in the figure below.



CHANGE 2

Instruments with ROM firmware Version 2637 have a different set of signatures for troubleshooting the A4 Microprocessor board. If your instrument has firmware Version 2637 (as indicated by Diagnostic 40), replace *Figure 8-29A* through *8-33B* with *Figures 7-1A* through *7-5B*, as listed in *Table 7-4*.

Table 7-4. Figures Showing A4 Signatures for Firmware Version 2637

Section VIII figure to be replaced	Figure in this section to be used
8-29A	7-1A
8-29B	7-1B
8-30A	7-2A
8-30B	7-2B
8-31A	7-3A
8-31B	7-3B
8-32A	7-4A
8-32B	7-4B
8-33A	7-5A
8-33B	7-5B

ROM VERSION 2637

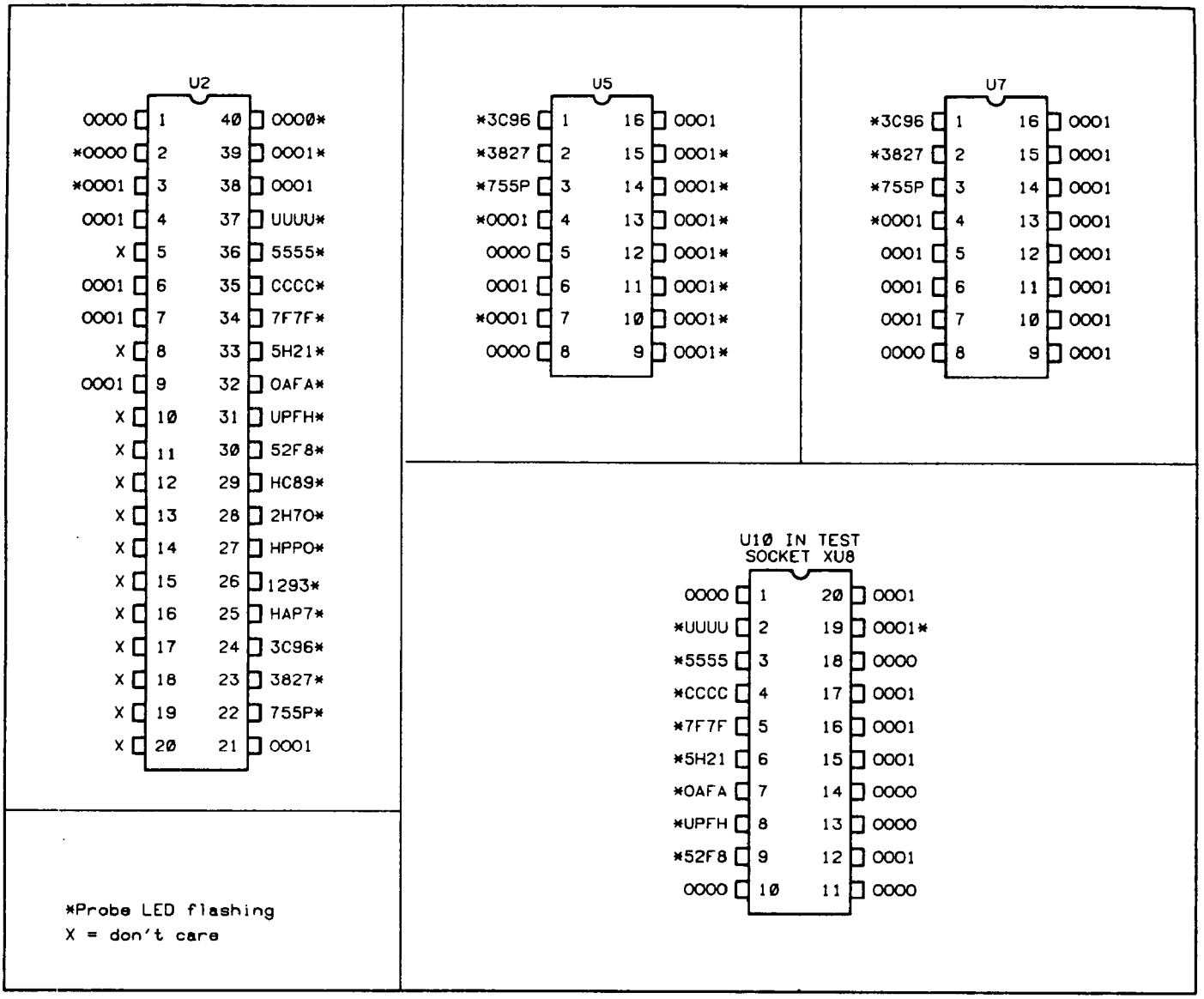


Figure 7-1A. 5350B/5351B A4 Signatures for Mode 1, Setup 1 — Firmware Version 2637

ROM VERSION 2637

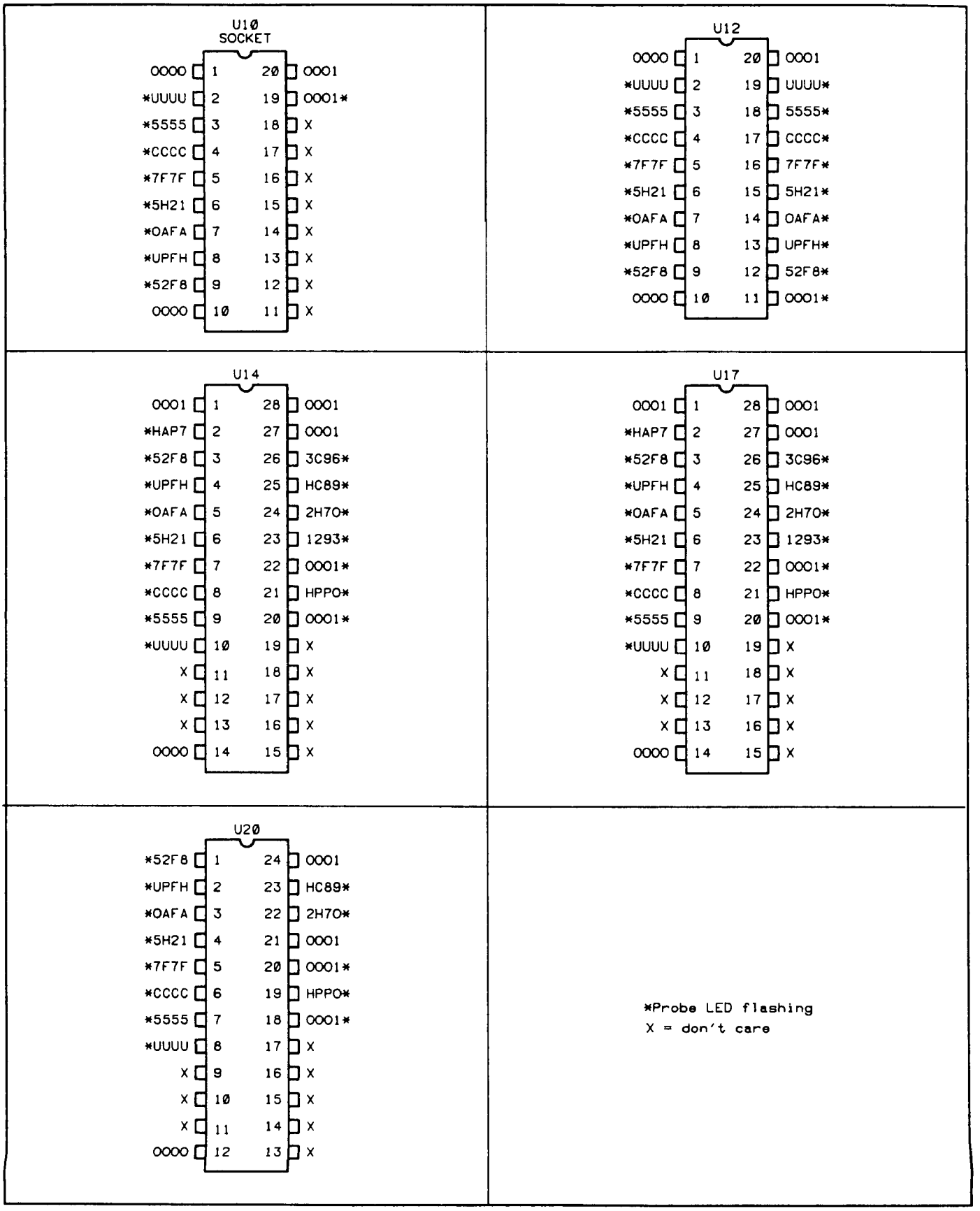


Figure 7-1A. 5350B/5351B A4 Signatures for Mode 1, Setup 1 — Firmware Version 2637 (Continued)

ROM VERSION 2637

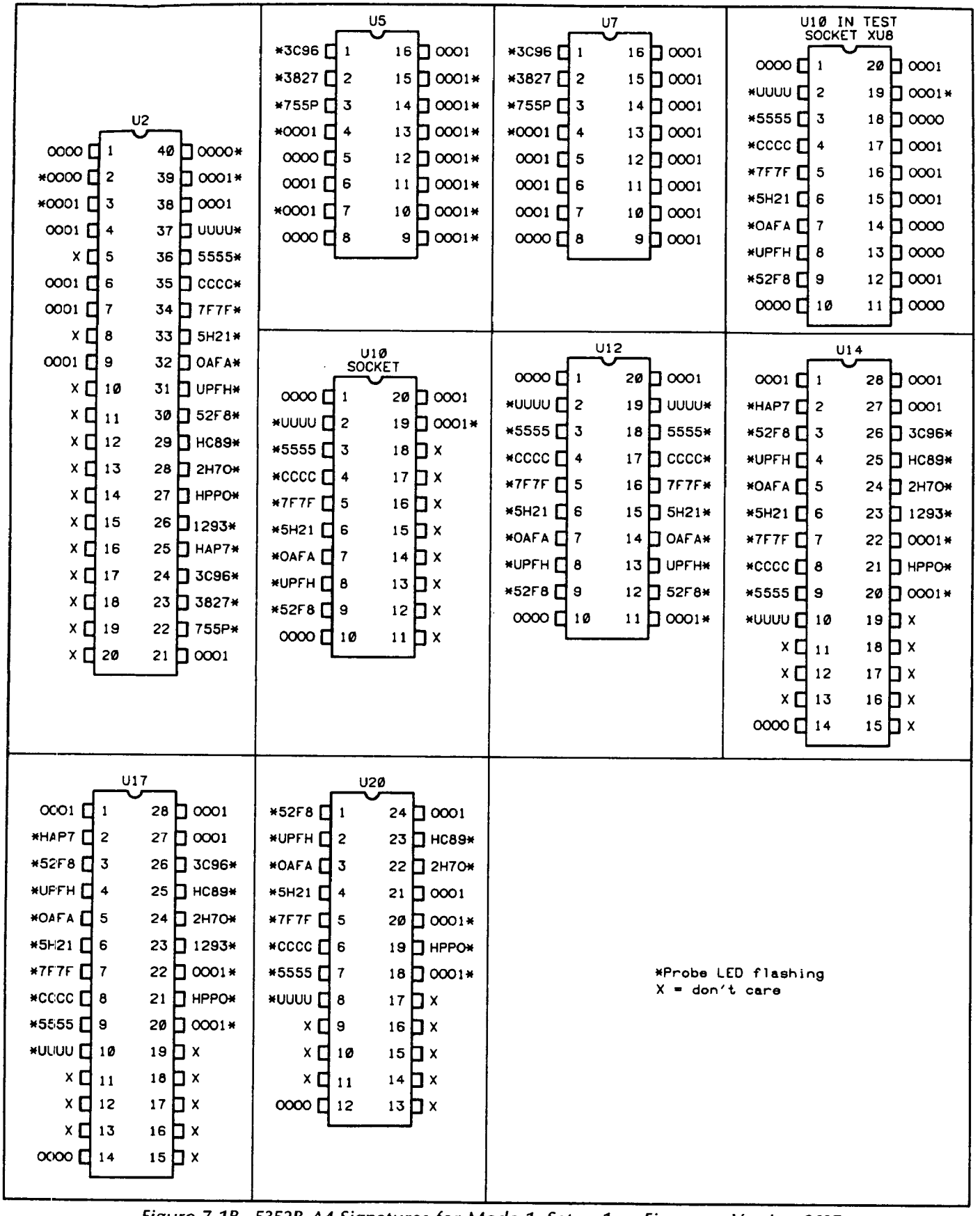


Figure 7-1B. 5352B A4 Signatures for Mode 1, Setup 1 — Firmware Version 2637

ROM VERSION 2637

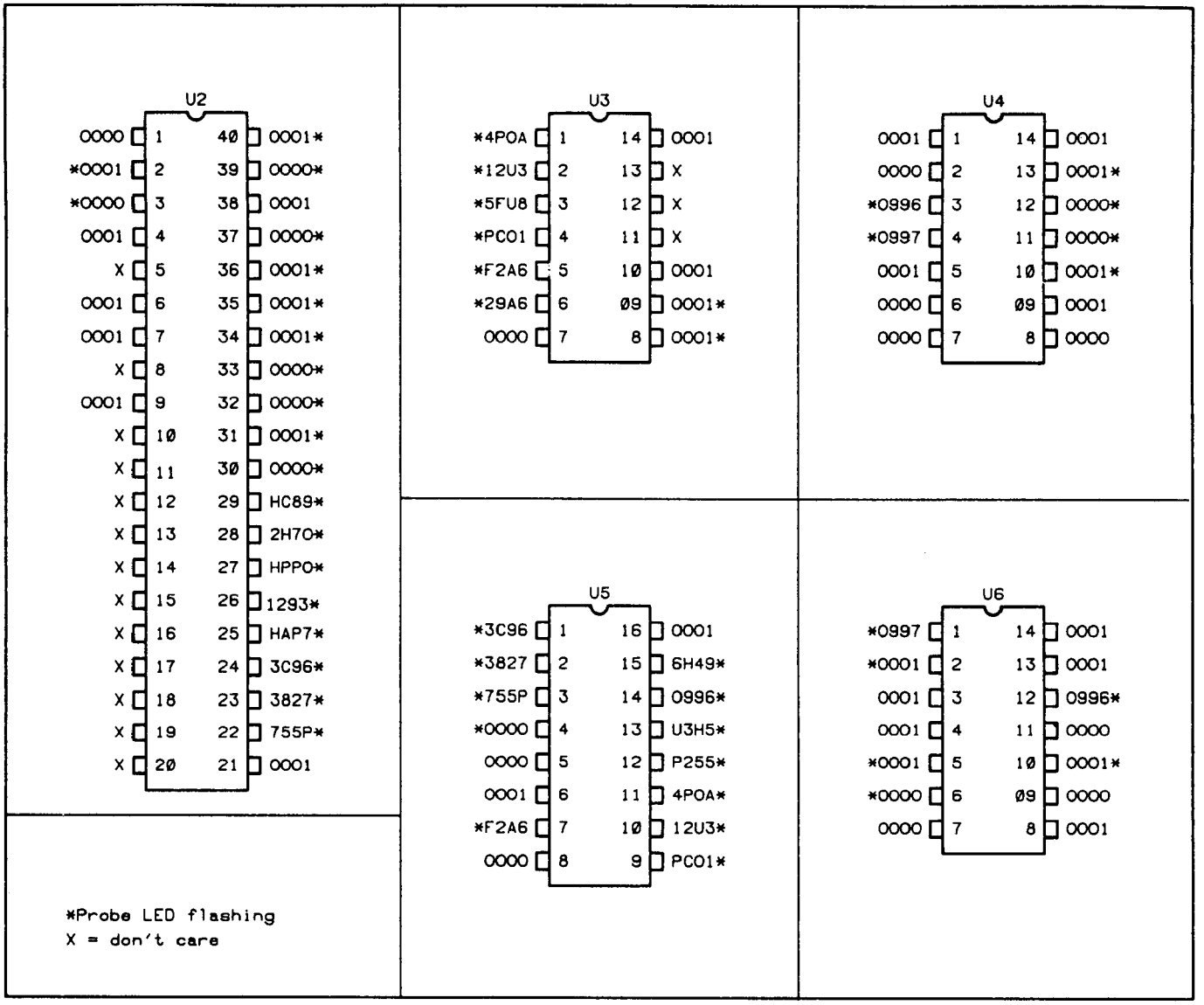


Figure 7-2A. 5350B/5351B A4 Signatures for Mode 1, Setup 2 — Firmware Version 2637

ROM VERSION 2637

U7

*3C96	1	16	0001
*3827	2	15	0001
*755P	3	14	0001
*0000	4	13	0001
0001	5	12	0001
0001	6	11	0001
0001	7	10	0001
0000	8	9	0001

U10 IN TEST SOCKET XU8

0000	1	20	0001
*0000	2	19	0000*
*0001	3	18	0000
*0001	4	17	0001
*0001	5	16	0001
*0000	6	15	0001
*0000	7	14	0000
*0001	8	13	0000
*0000	9	12	0001
0000	10	11	0000

U9

0001	1	20	0001
0001	2	19	0001
X	3	18	X
X	4	17	X
0001	5	16	0001
0001	6	15	0001
X	7	14	X
X	8	13	X
0001	9	12	0001
0000	10	11	0000*

U10 SOCKET

0000	1	20	0001
*0000	2	19	0000*
*0001	3	18	X
*0001	4	17	X
*0001	5	16	X
*0000	6	15	X
*0000	7	14	X
*0001	8	13	X
*0000	9	12	X
0000	10	11	X

U11

0001	1	20	0001
0001	2	19	0001
X	3	18	X
X	4	17	X
0001	5	16	0001
0001	6	15	0001
X	7	14	X
X	8	13	X
0001	9	12	0001
0000	10	11	0000*

U12

0000	1	20	0001
*0000	2	19	UUUU*
*0001	3	18	5555*
*0001	4	17	CCCC*
*0001	5	16	7F7F*
*0000	6	15	5H21*
*0000	7	14	OAFA*
*0001	8	13	UPFH*
*0000	9	12	52F8*
0000	10	11	0000*

U13

0001	1	20	0001
0001	2	19	0001
X	3	18	X
X	4	17	X
0001	5	16	0001
0001	6	15	0001
X	7	14	X
X	8	13	X
0001	9	12	0001
0000	10	11	0000*

U14

0001	1	28	0001
*HAP7	2	27	0001
*52F8	3	26	3C96*
*UPFH	4	25	HC89*
*OAFA	5	24	2H70*
*5H21	6	23	1293*
*7F7F	7	22	29A6*
*CCCC	8	21	HPPO*
*5555	9	20	0000*
*UUUU	10	19	X
X	11	18	X
X	12	17	X
X	13	16	X
0000	14	15	X

*Probe LED flashing
X = don't care

Figure 7-2A. 5350B/5351B A4 Signatures for Mode 1, Setup 2 — Firmware Version 2637 (Continued)

ROM VERSION 2637

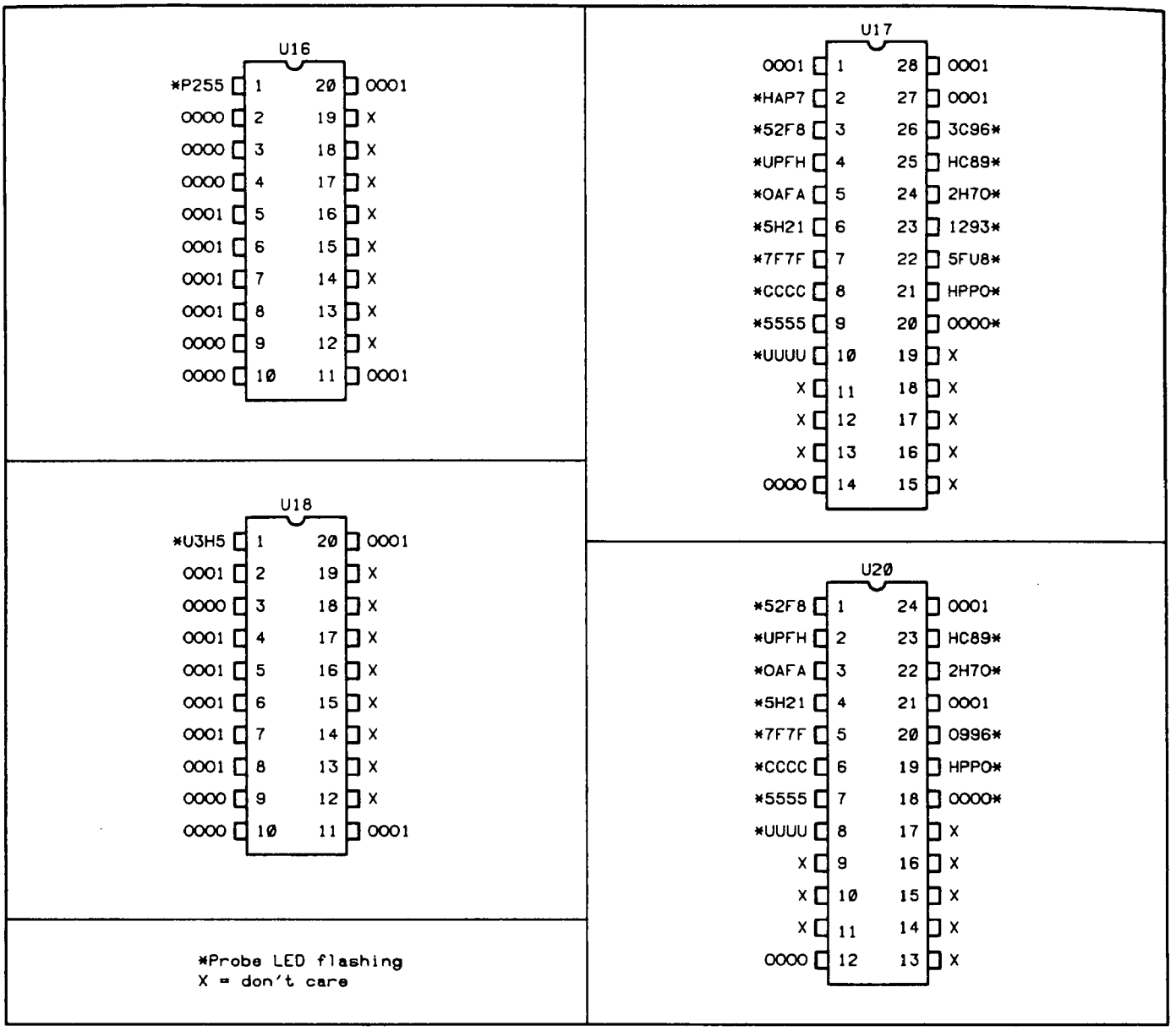


Figure 7-2A. 5350B/5351B A4 Signatures for Mode 1, Setup 2 — Firmware Version 2637 (Continued)

ROM VERSION 2637

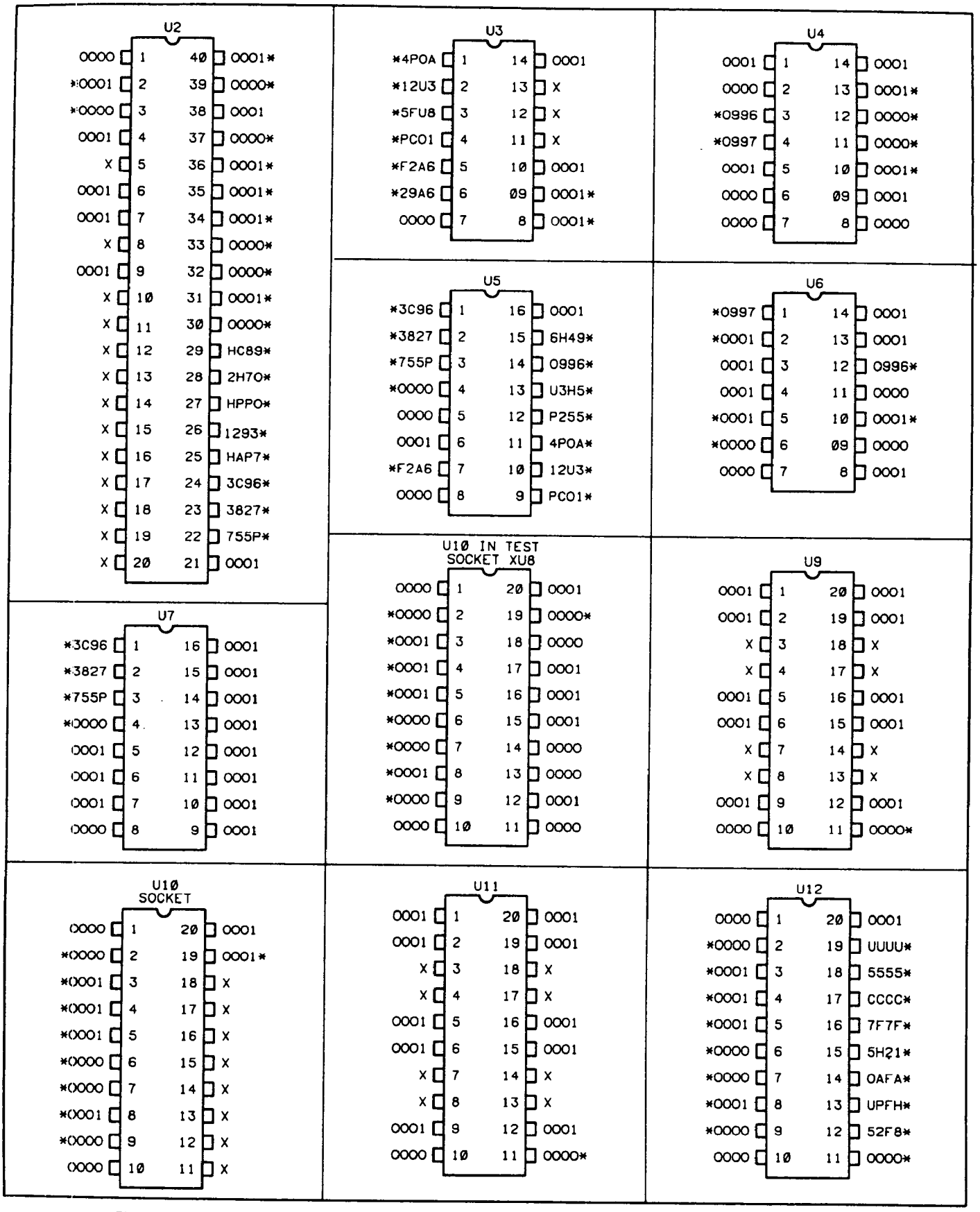


Figure 7-2B. 5352B A4 Signatures for Mode 1, Setup 2 — Firmware Version 2637

ROM VERSION 2637

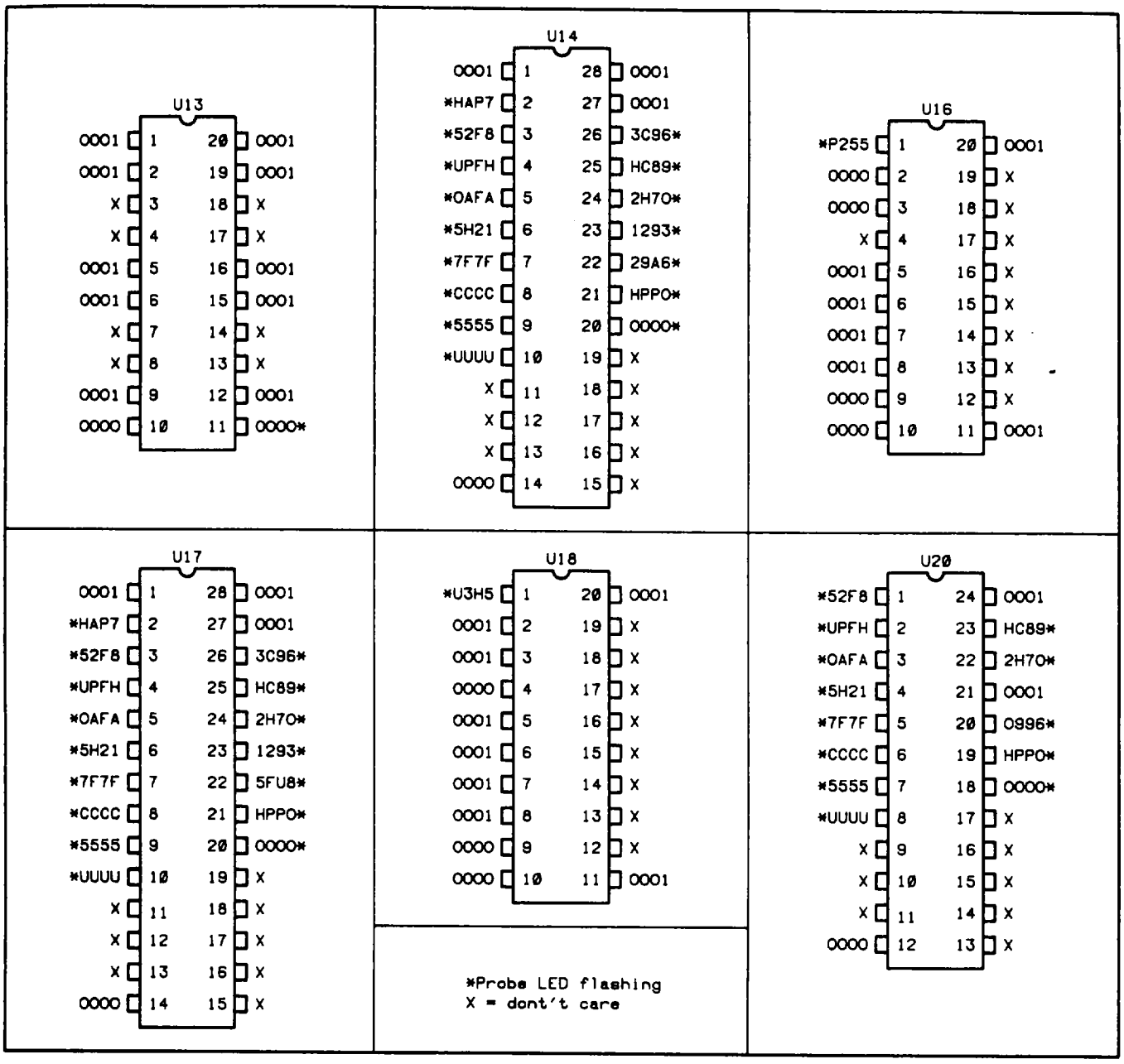


Figure 7-2B. 5352B A4 Signatures for Mode 1, Setup 2 — Firmware Version 2637 (Continued)

ROM VERSION 2637

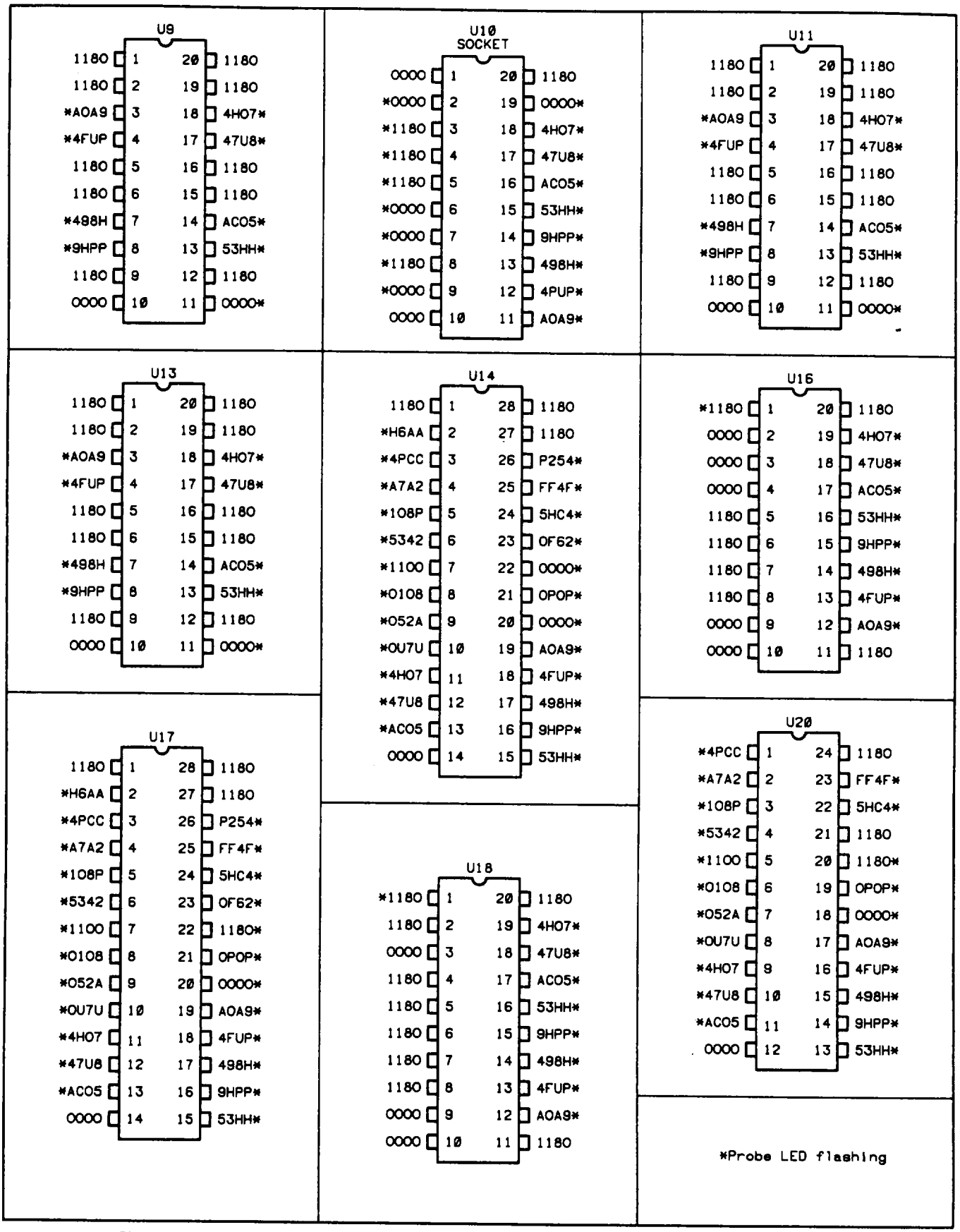


Figure 7-3A. 5350B/5351B A4 Signatures for Mode 1, Setup 3 — Firmware Version 2637

ROM VERSION 2637

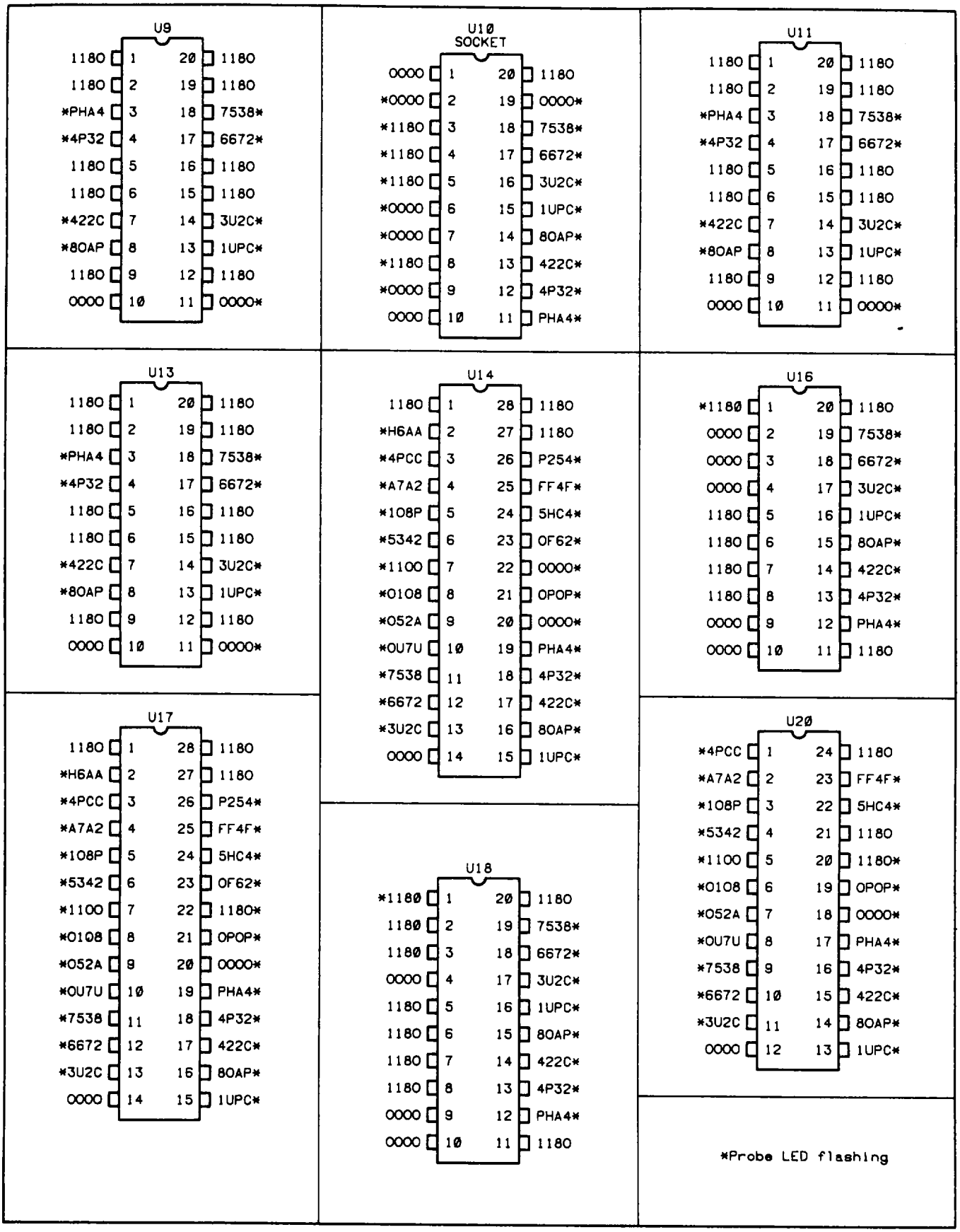


Figure 7-3B. 5352B A4 Signatures for Mode 1, Setup 3 — Firmware Version 2637

ROM VERSION 2637

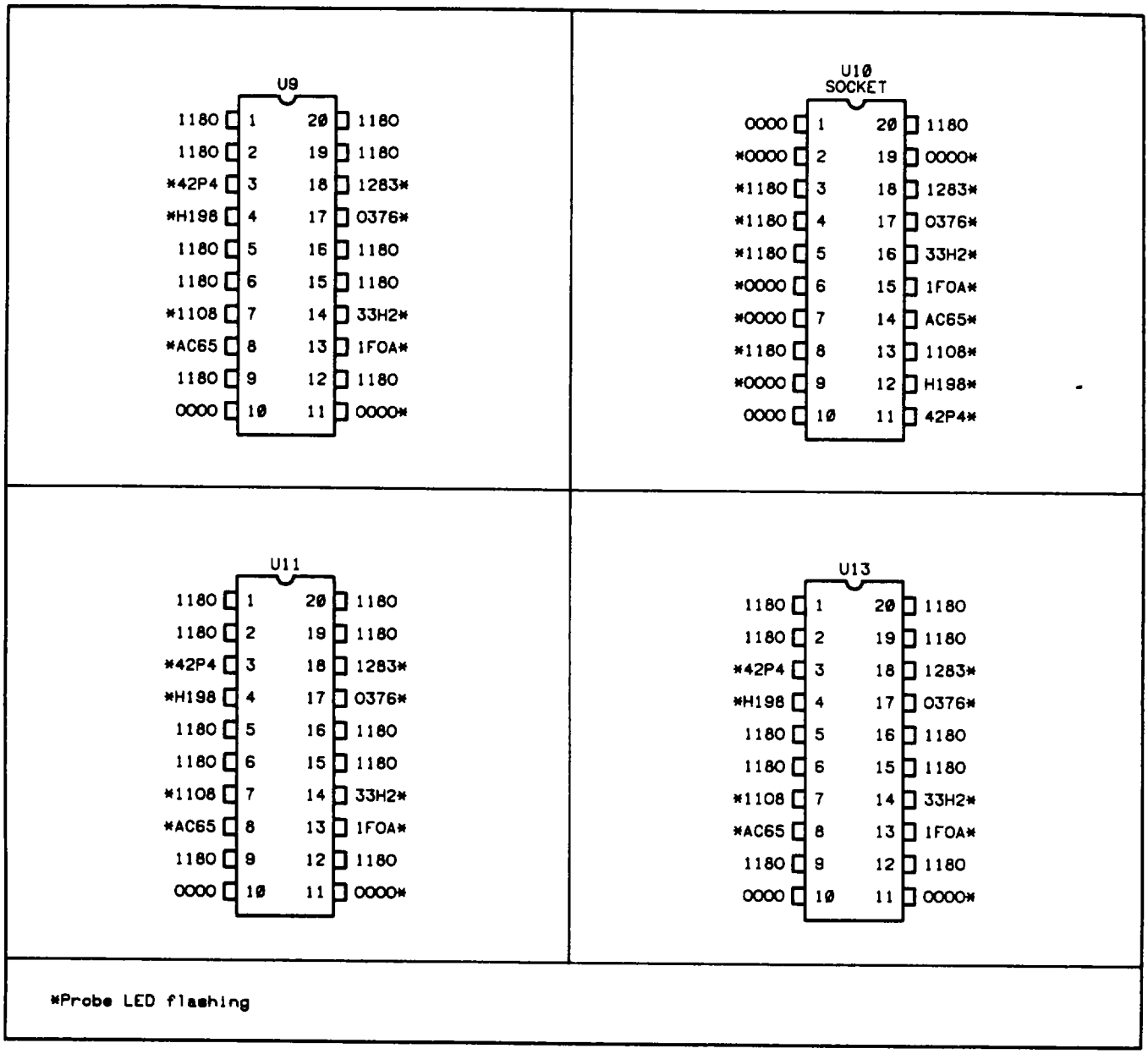


Figure 7-4A. 5350B/5351B A4 Signatures for Mode 1, Setup 4 — Firmware Version 2637

ROM VERSION 2637

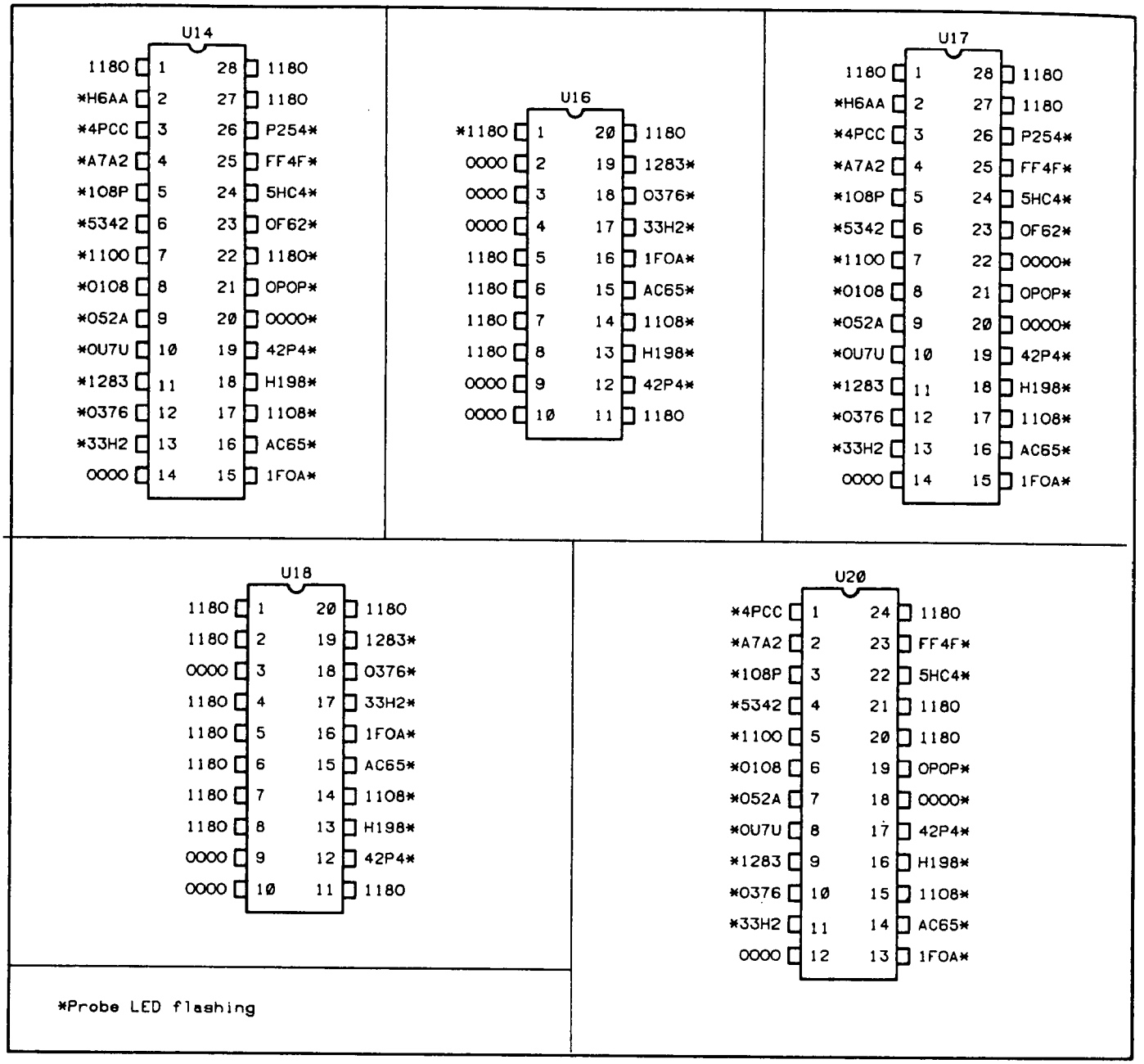


Figure 7-4A. 5350B/5351B A4 Signatures for Mode 1, Setup 4 — Firmware Version 2637 (Continued)

ROM VERSION 2637

U9

1180	1	20	1180
1180	2	19	1180
*2PFH	3	18	90PU*
*0392	4	17	15HF*
1180	5	16	1180
1180	6	15	1180
*3312	7	14	0180*
*H6PA	8	13	200H*
1180	9	12	1180
0000	10	11	0000*

U10 SOCKET

0000	1	20	1180
*0000	2	19	0000*
*1180	3	18	90PU*
*1180	4	17	15HF*
*1180	5	16	0180*
*0000	6	15	200H*
*0000	7	14	H6PA*
*1180	8	13	3312*
*0000	9	12	0392*
0000	10	11	2PFH*

U11

1180	1	20	1180
1180	2	19	1180
*2PFH	3	18	90PU*
*0392	4	17	15HF*
1180	5	16	1180
1180	6	15	1180
*3312	7	14	0180*
*H6PA	8	13	200H*
1180	9	12	1180
0000	10	11	0000*

U13

1180	1	20	1180
1180	2	19	1180
*2PFH	3	18	90PU*
*0392	4	17	15HF*
1180	5	16	1180
1180	6	15	1180
*3312	7	14	0180*
*H6PA	8	13	200H*
1180	9	12	1180
0000	10	11	0000*

U14

1180	1	28	1180
*H6AA	2	27	1180
*4PCC	3	26	P254*
*A7A2	4	25	FF4F*
*108P	5	24	5HC4*
*5342	6	23	OF62*
*1100	7	22	1180*
*0108	8	21	OPOP*
*052A	9	20	0000*
*0U7U	10	19	2PFH*
*90PU	11	18	0392*
*15HF	12	17	3312*
*0180	13	16	H6PA*
0000	14	15	200H*

U16

*1180	1	20	1180
0000	2	19	90PU*
0000	3	18	15HF*
0000	4	17	0180*
1180	5	16	200H*
1180	6	15	H6PA*
1180	7	14	3312*
1180	8	13	0392*
0000	9	12	2PFH*
0000	10	11	1180

U17

1180	1	28	1180
*H6AA	2	27	1180
*4PCC	3	26	P254*
*A7A2	4	25	FF4F*
*108P	5	24	5HC4*
*5342	6	23	OF62*
*1100	7	22	0000*
*0108	8	21	OPOP*
*052A	9	20	0000*
*0U7U	10	19	2PFH*
*90PU	11	18	0392*
*15HF	12	17	3312*
*0180	13	16	H6PA*
0000	14	15	200H*

U18

*1180	1	20	1180
1180	2	19	90PU*
1180	3	18	15HF*
0000	4	17	0180*
1180	5	16	200H*
1180	6	15	H6PA*
1180	7	14	3312*
1180	8	13	0392*
0000	9	12	2PFH*
0000	10	11	1180

U20

*4PCC	1	24	1180
*A7A2	2	23	FF4F*
*108P	3	22	5HC4*
*5342	4	21	1180
*1100	5	20	1180*
*0108	6	19	OPOP*
*052A	7	18	0000*
*0U7U	8	17	2PFH*
*90PU	9	16	0392*
*15HF	10	15	3312*
*9187	11	14	H6PA*
0000	12	13	200H*

*Probe LED flashing

Figure 7-4B. 5352B A4 Signatures for Mode 1, Setup 4 — Firmware Version 2637

ROM VERSION 2637

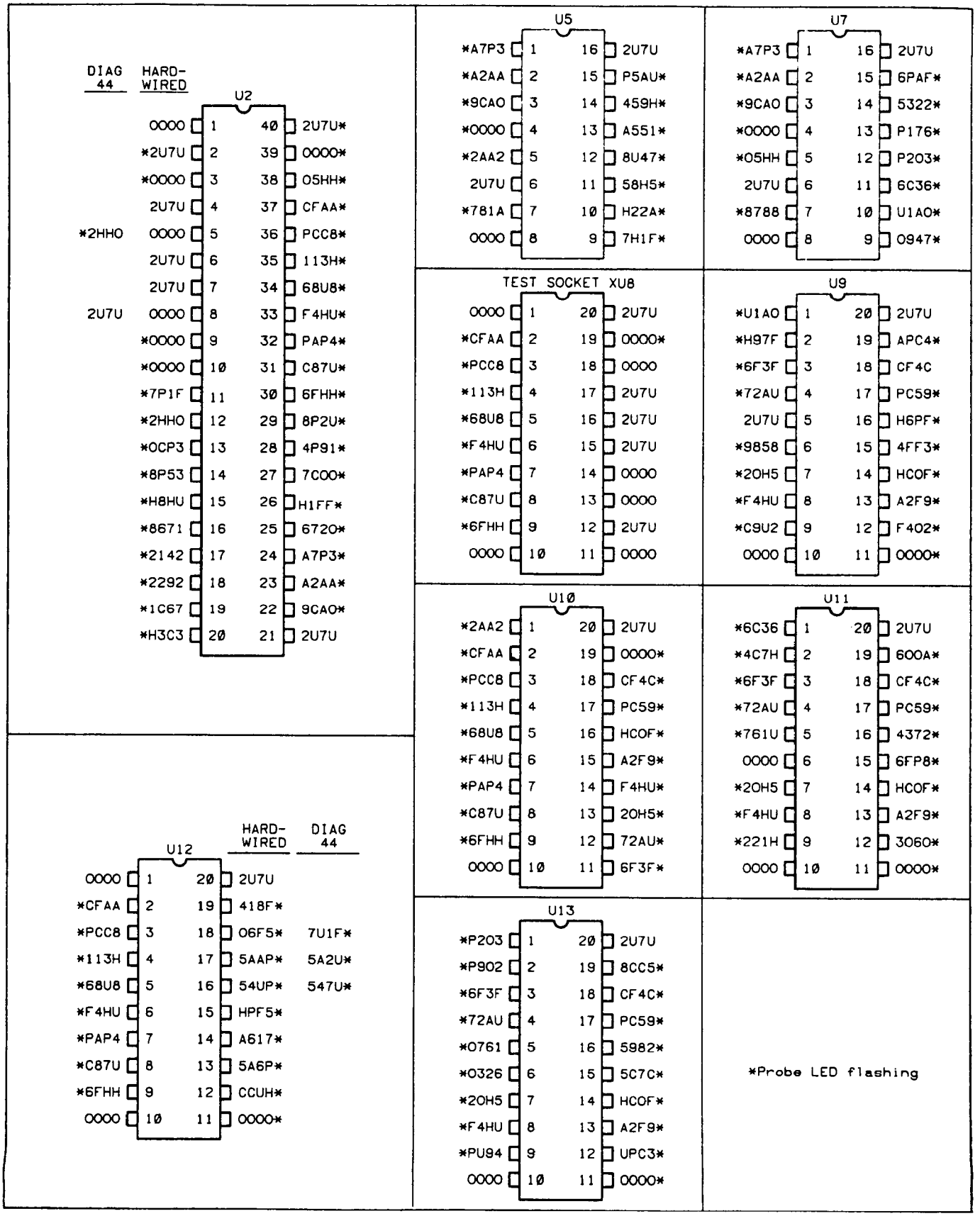


Figure 7-5A. 5350B/5351B A4 Signatures for Mode 2 — Firmware Version 2637

ROM VERSION 2637

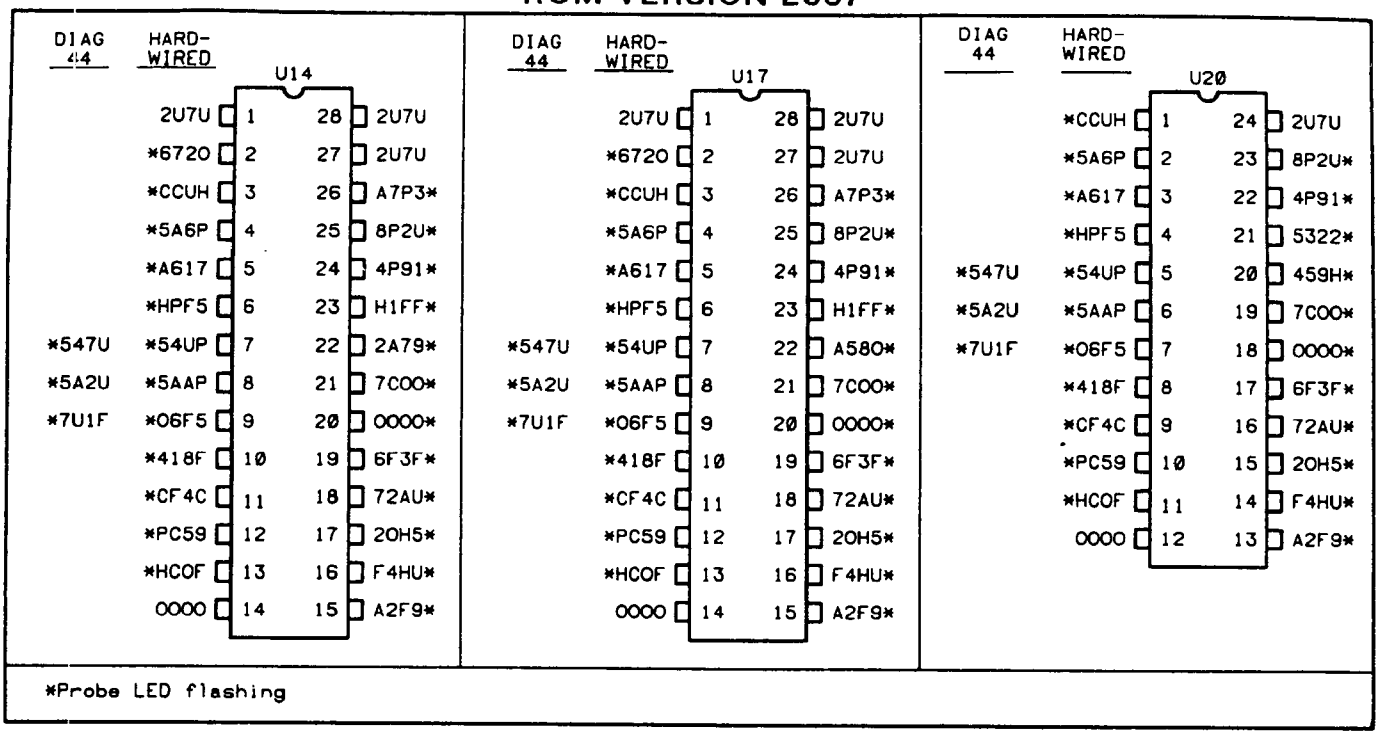


Figure 7-5A. 5350B/5351B A4 Signatures for Mode 2 — Firmware Version 2637 (Continued)

ROM VERSION 2637

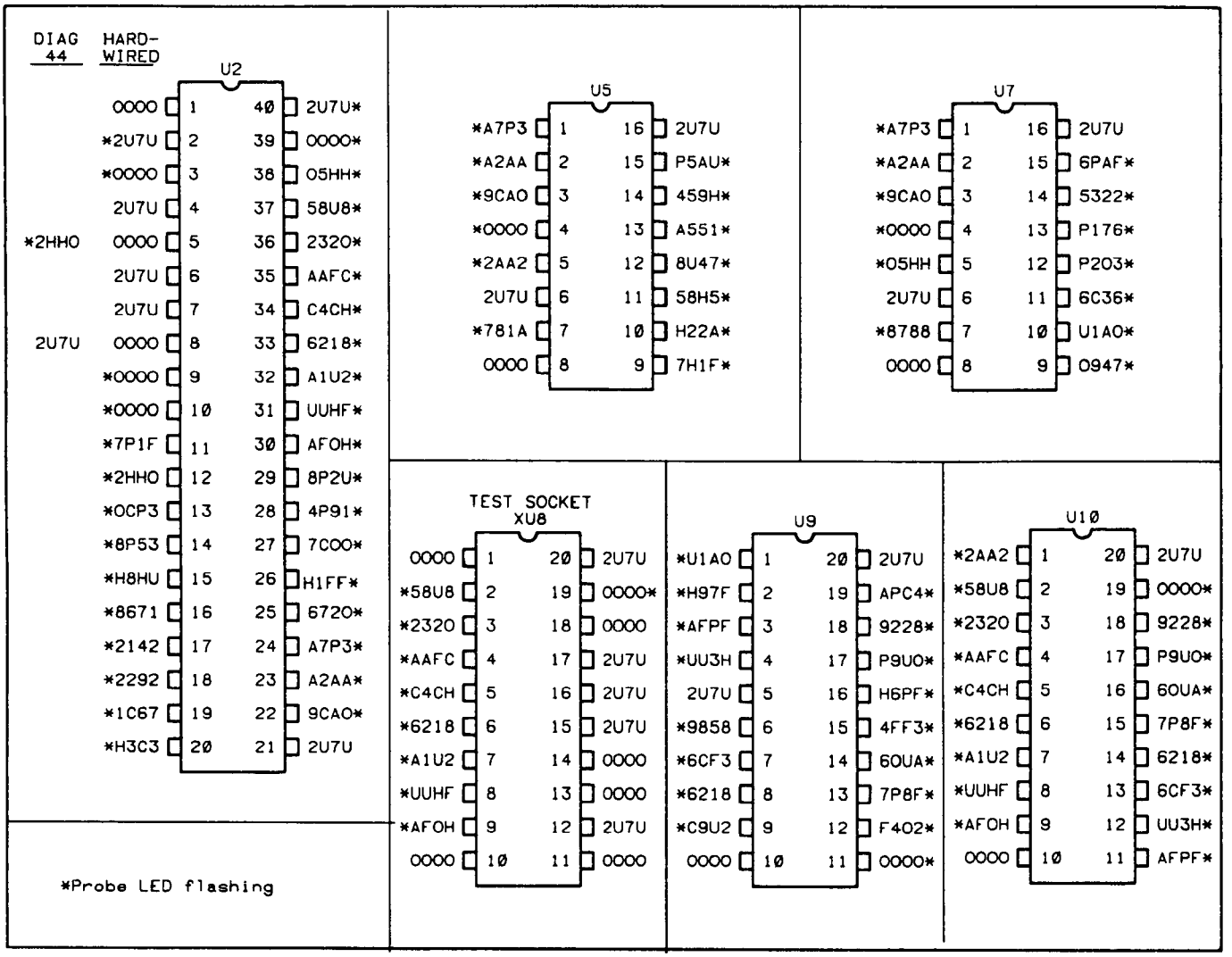


Figure 7-5B. 5352B A4 Signatures for Mode 2 — Firmware Version 2637

ROM VERSION 2637

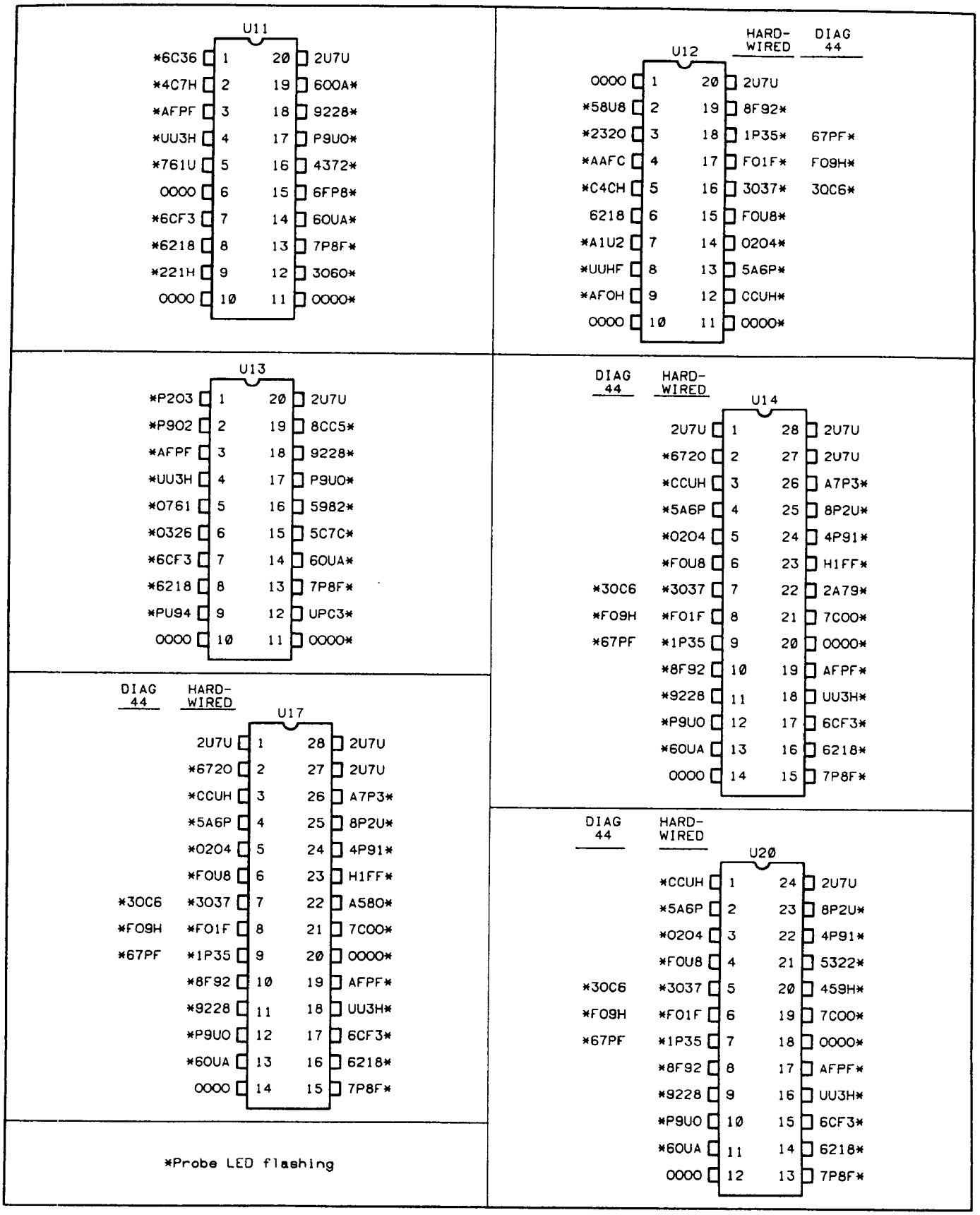


Figure 7-5B. 5352B A4 Signatures for Mode 2 — Firmware Version 2637 (Continued)

CHANGE 3

Instruments with ROM firmware Version 2631 have a different set of signatures for troubleshooting the A4 Microprocessor board. If your instrument has firmware Version 2631 (as indicated by Diagnostic 40), replace *Figures 8-29A* through *8-33B* with *Figures 7-6A* through *7-10B*, as listed in *Table 7-5*.

Table 7-5. Figures Showing A4 Signatures for Firmware Version 2631

Section VIII figure to be replaced	Figure in this section to be used
8-29A	7-6A
8-29B	7-6B
8-30A	7-7A
8-30B	7-7B
8-31A	7-8A
8-31B	7-8B
8-32A	7-9A
8-32B	7-9B
8-33A	7-10A
8-33B	7-10B

ROM VERSION 2631

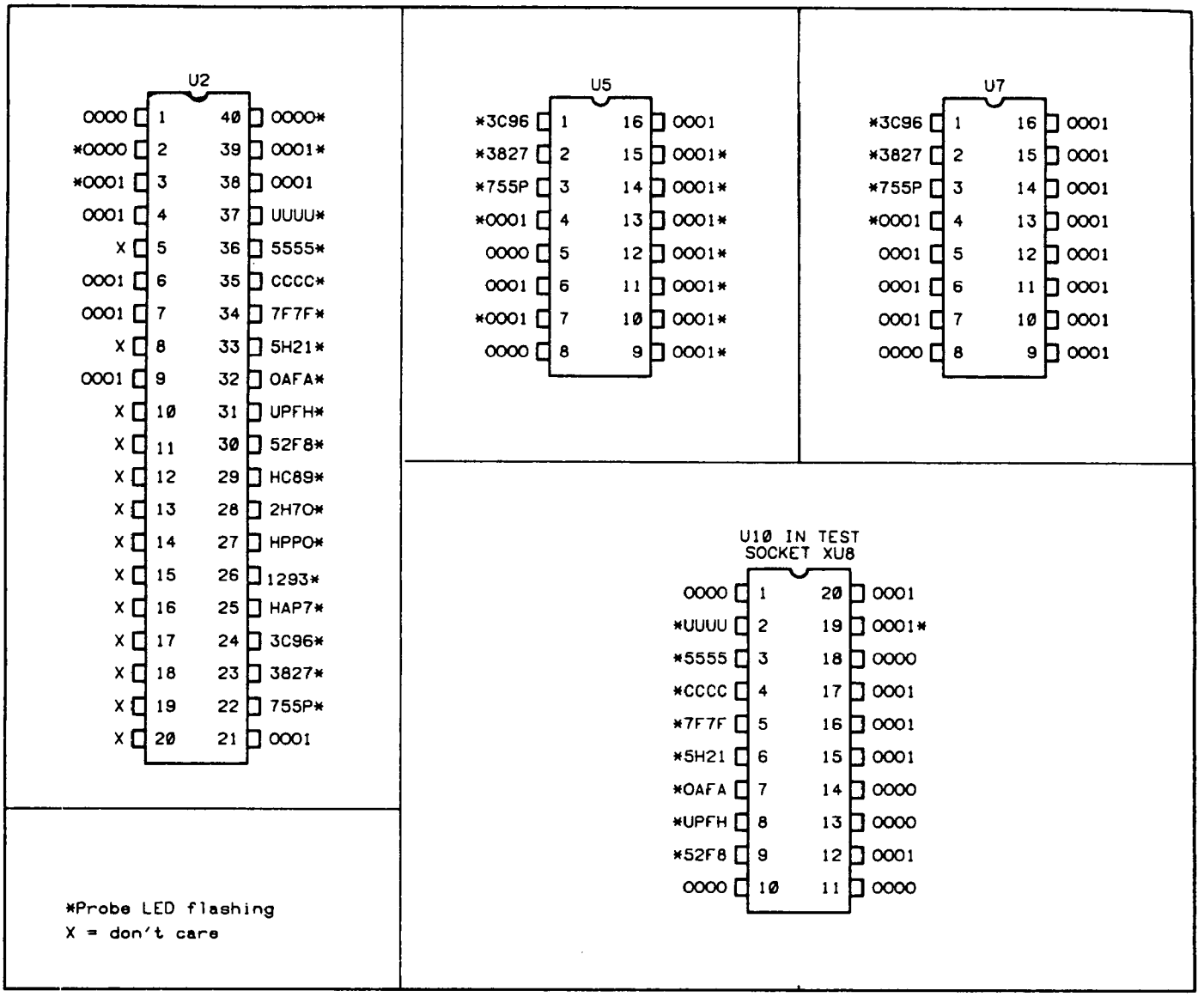


Figure 7-6A. 5350B/5351B A4 Signatures for Mode 1, Setup 1 — Firmware Version 2631

ROM VERSION 2631

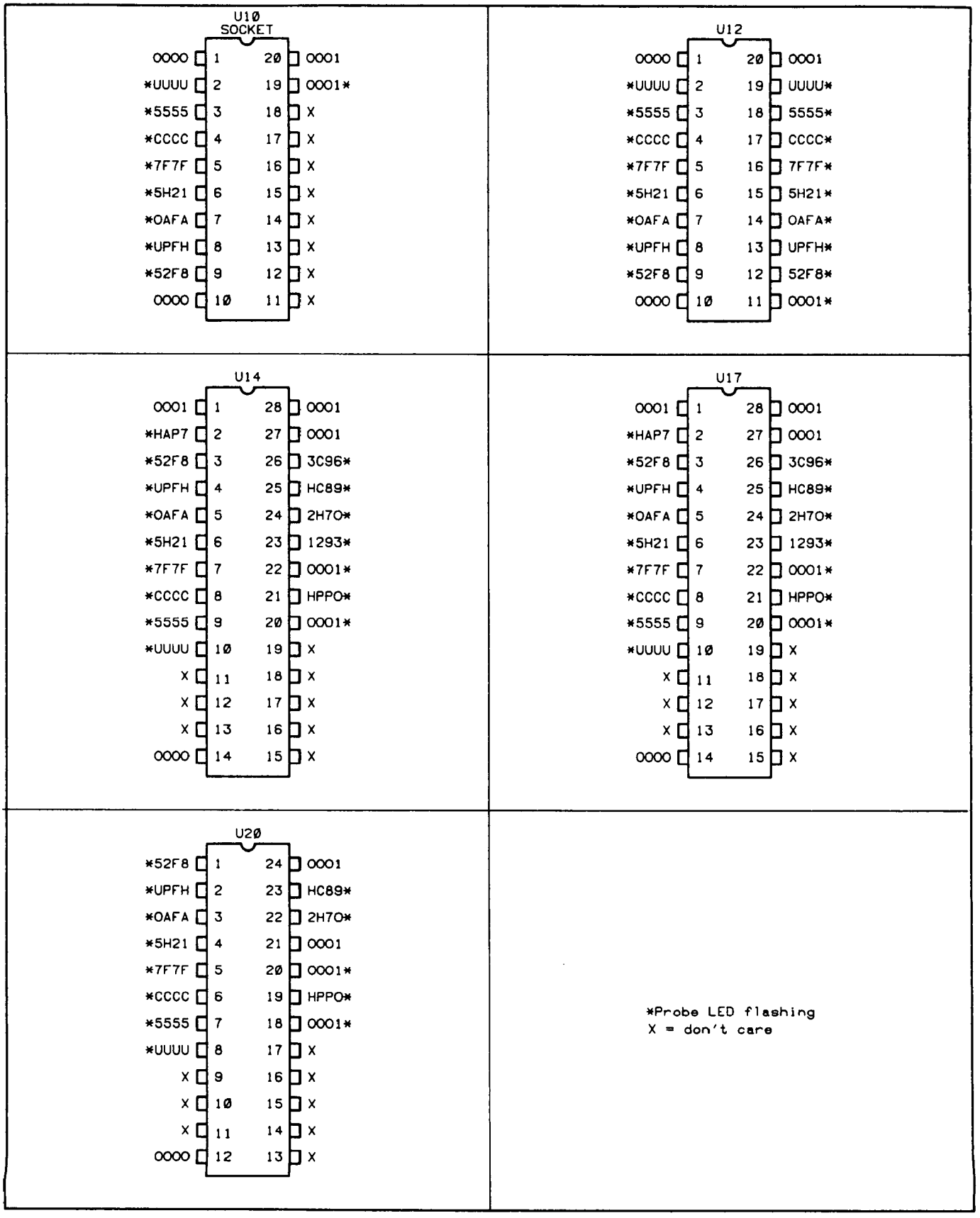


Figure 7-6A. 5350B/5351B A4 Signatures for Mode 1, Setup 1 — Firmware Version 2631 (Continued)

ROM VERSION 2631

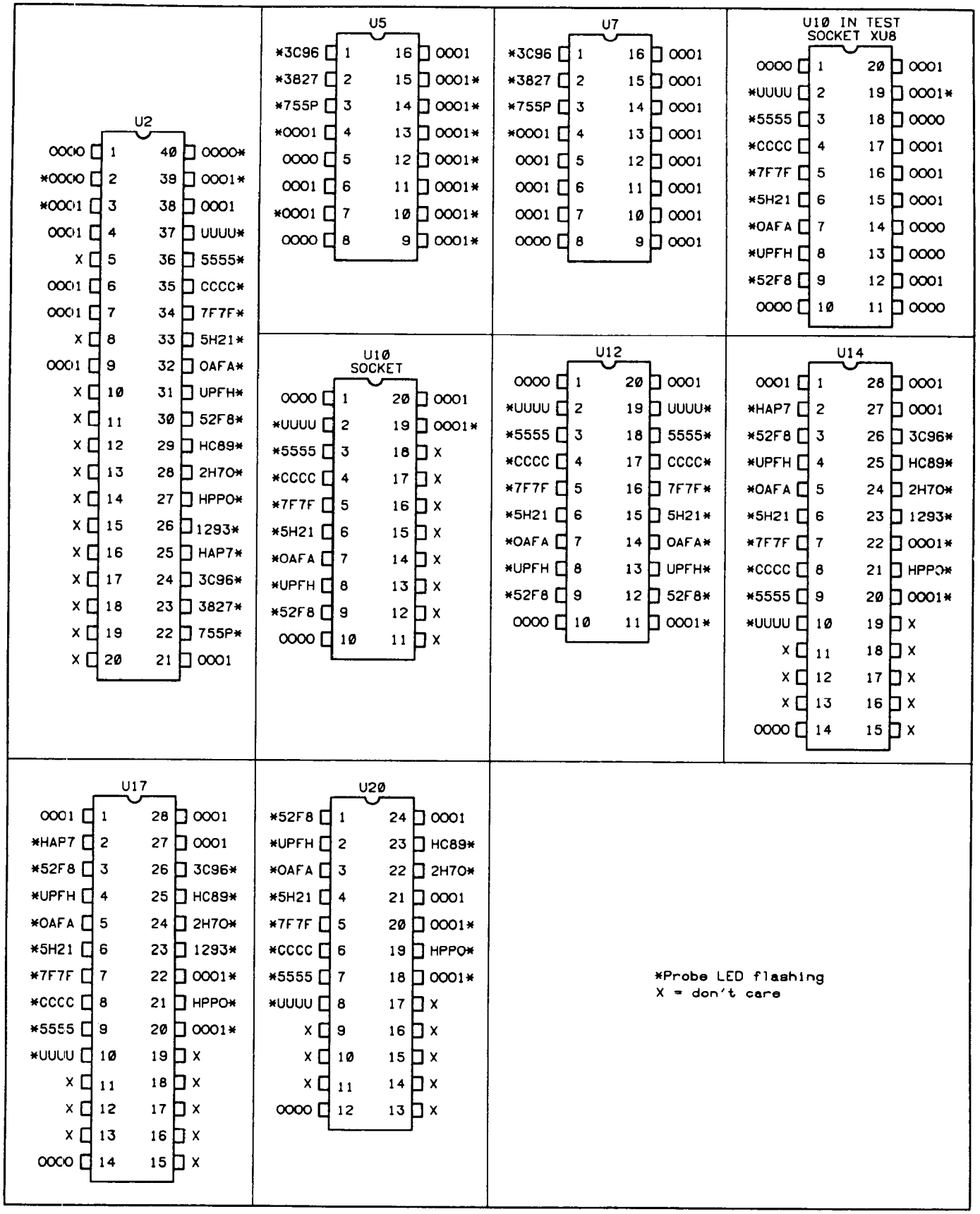


Figure 7-6B. 5352B A4 Signatures for Mode 1, Setup 1 — Firmware Version 2631

ROM VERSION 2631

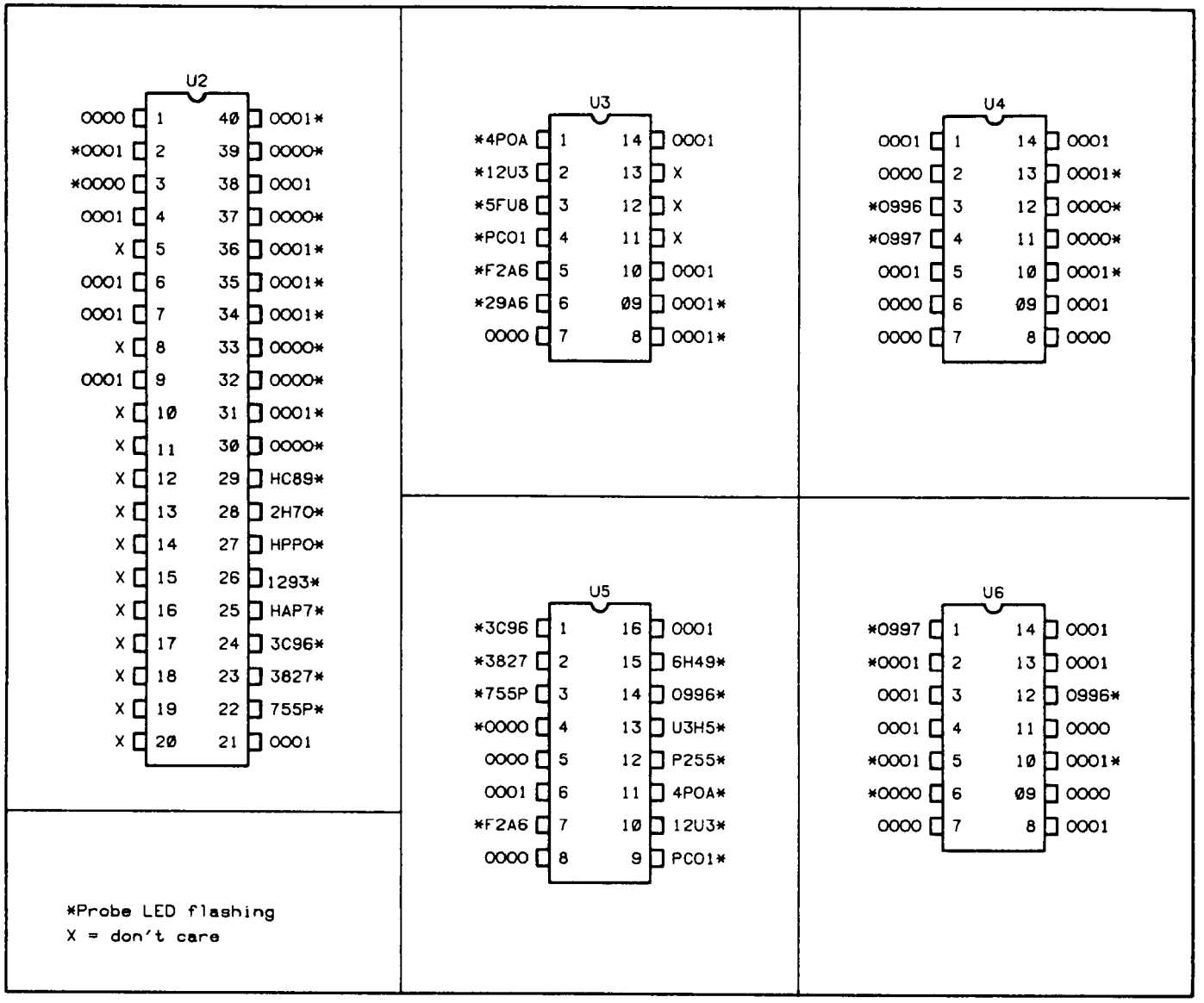


Figure 7-7A. 5350B/5351B A4 Signatures for Mode 1, Setup 2 — Firmware Version 2631

ROM VERSION 2631

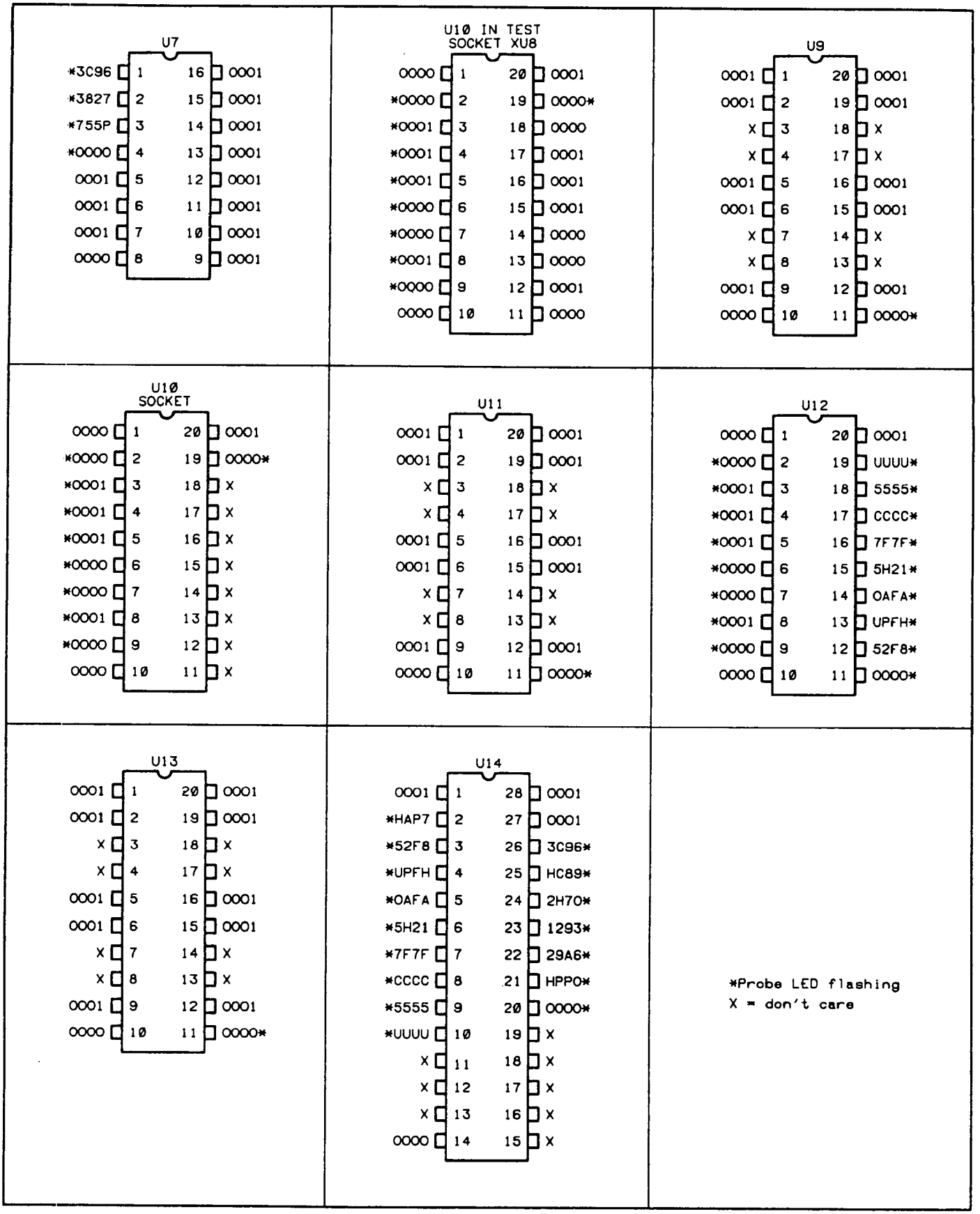


Figure 7-7A. 5350B/5351B A4 Signatures for Mode 1, Setup 2 — Firmware Version 2631 (Continued)

ROM VERSION 2631

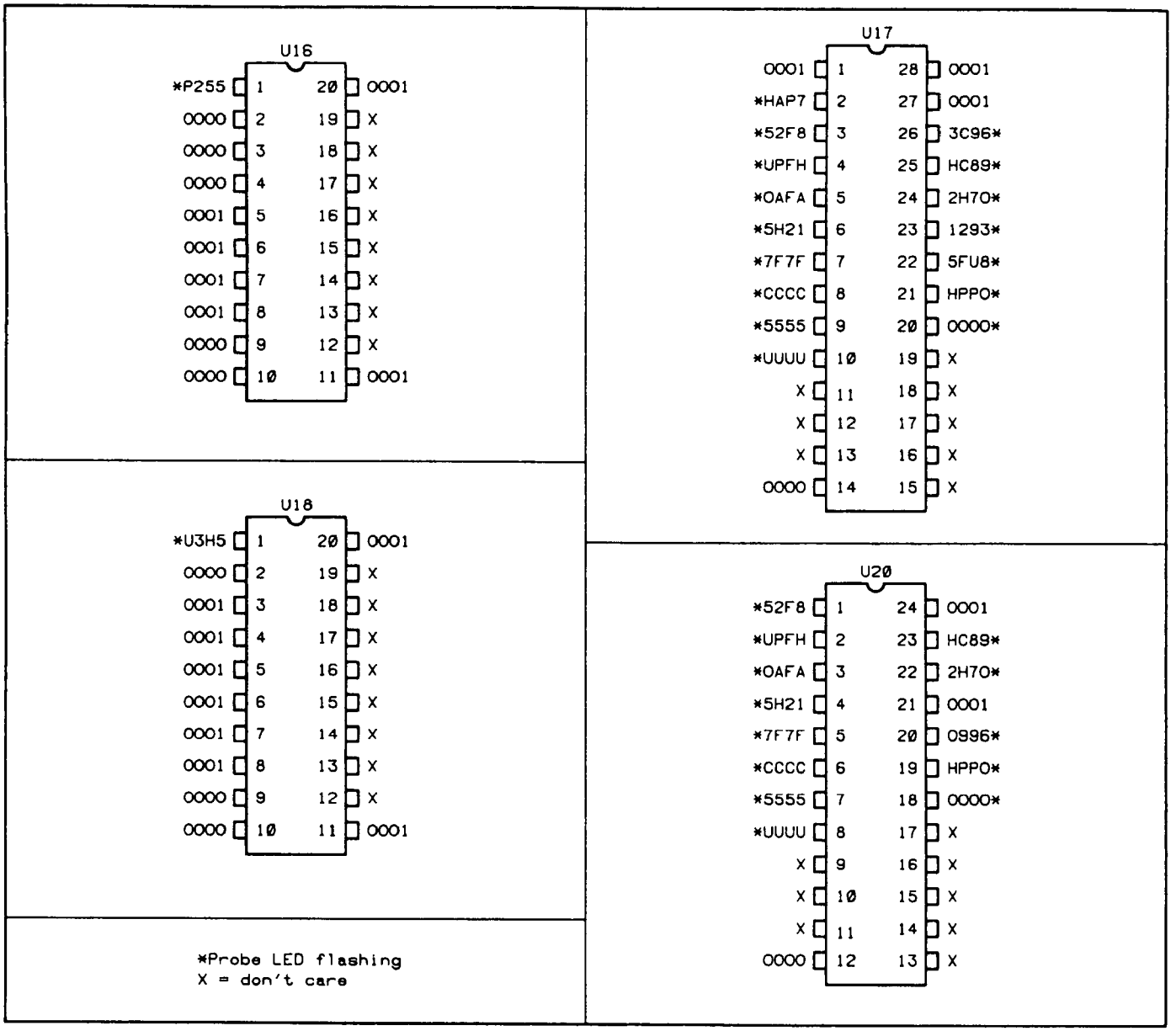


Figure 7-7A. 5350B/5351B A4 Signatures for Mode 1, Setup 2 — Firmware Version 2631 (Continued)

ROM VERSION 2631

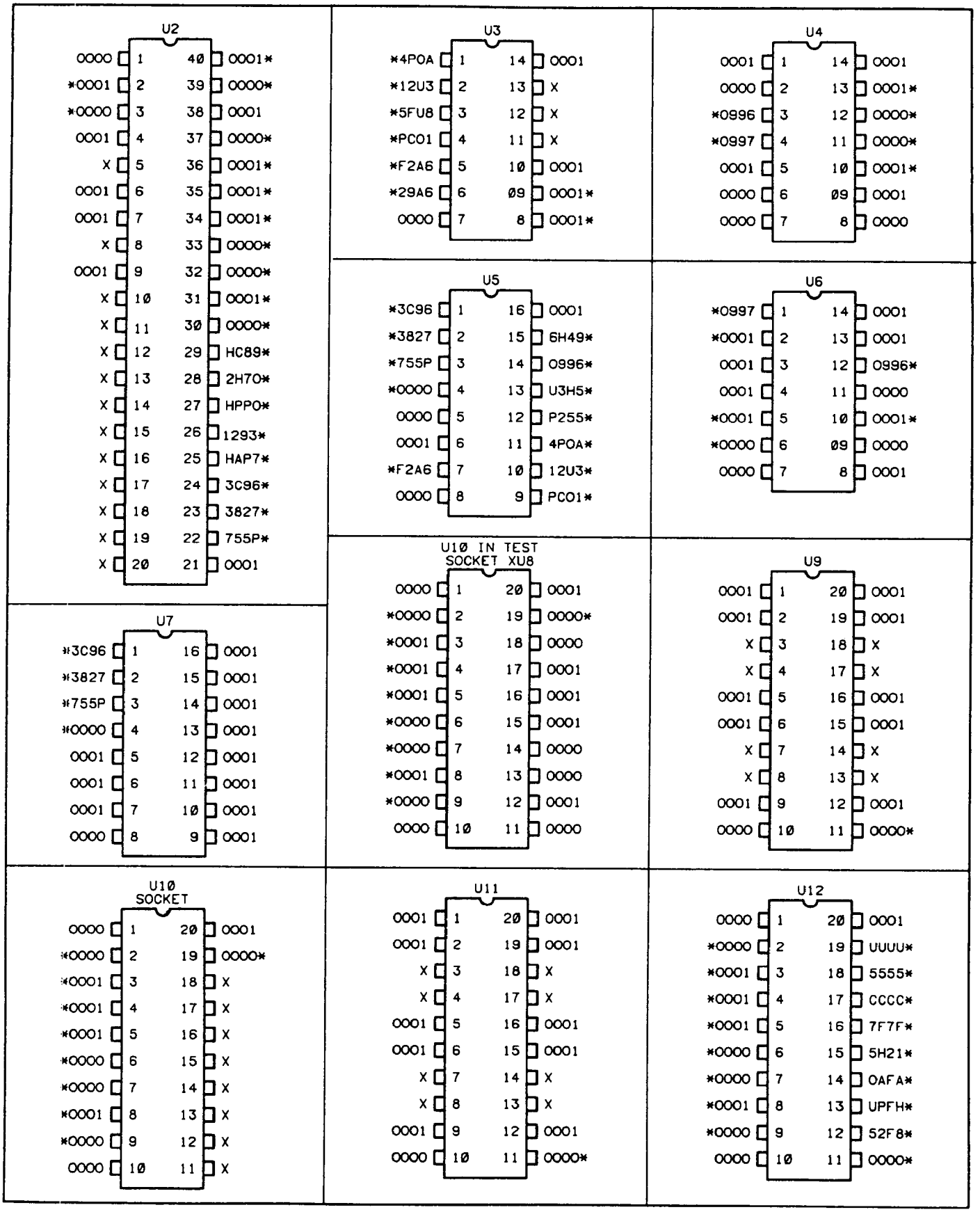


Figure 7-7B. 5352B A4 Signatures for Mode 1, Setup 2 — Firmware Version 2631

ROM VERSION 2631

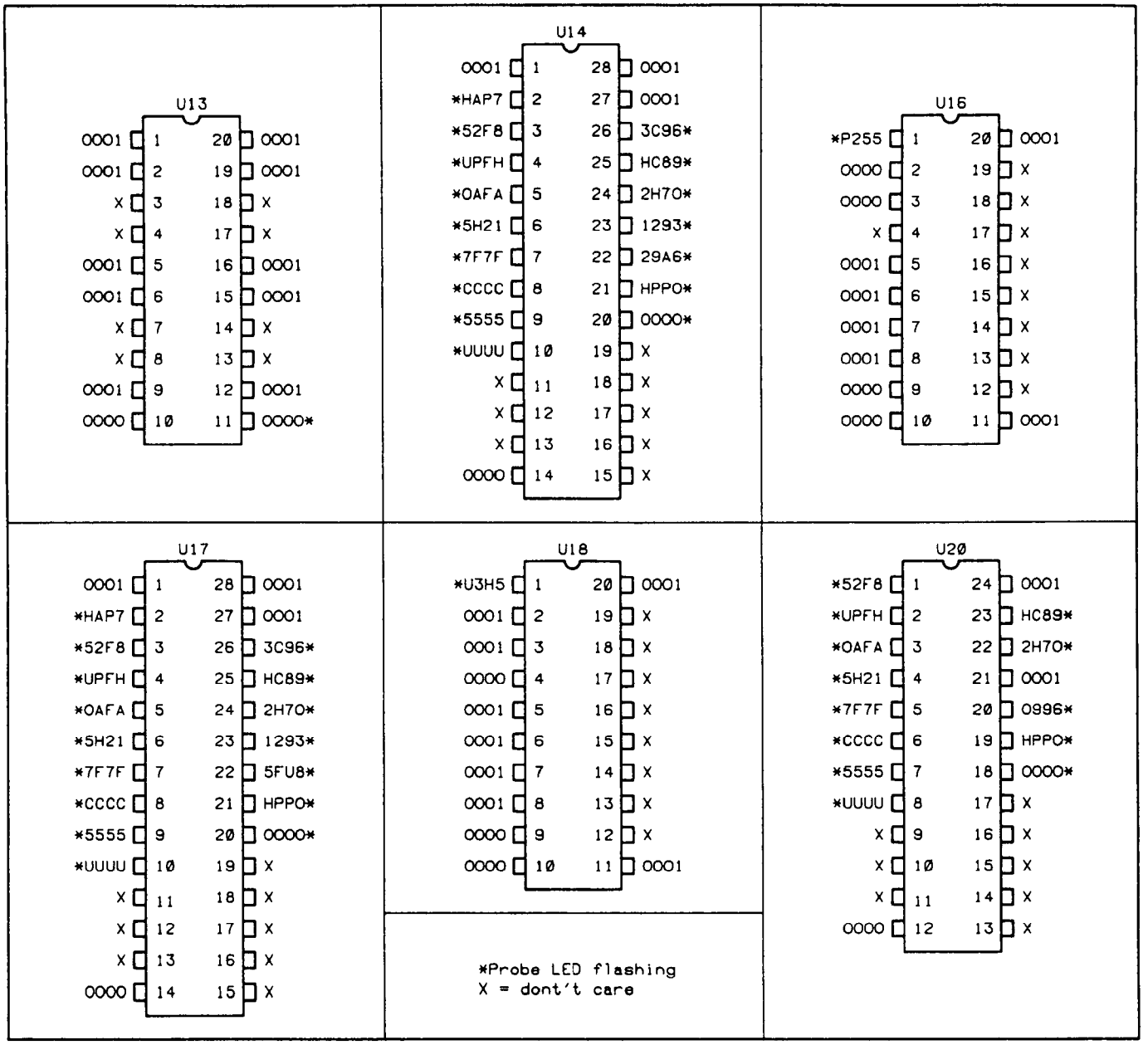


Figure 7-7B. 5352B A4 Signatures for Mode 1, Setup 2 — Firmware Version 2631 (Continued)

ROM VERSION 2631

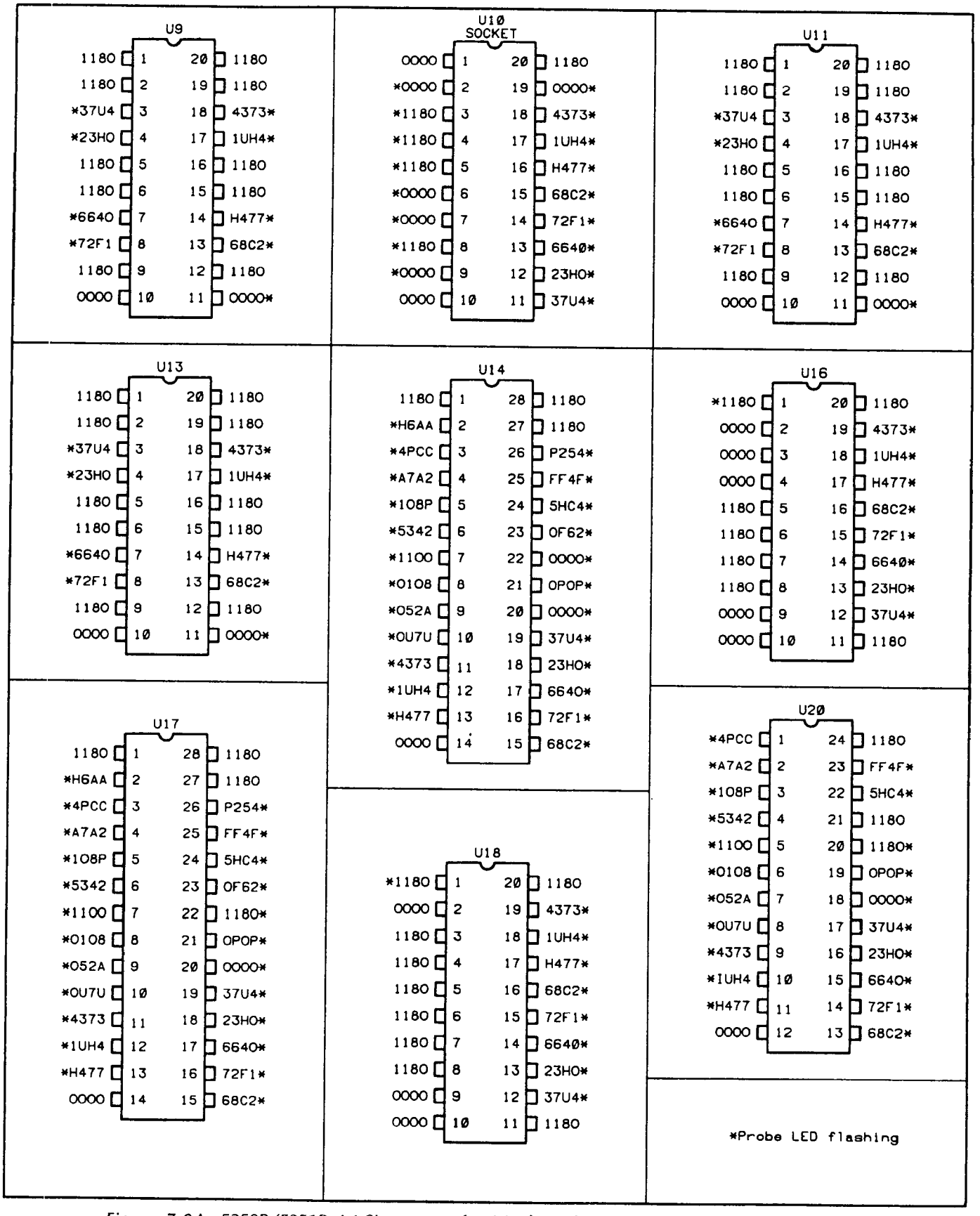


Figure 7-8A. 5350B/5351B A4 Signatures for Mode 1, Setup 3 — Firmware Version 2631

ROM VERSION 2631

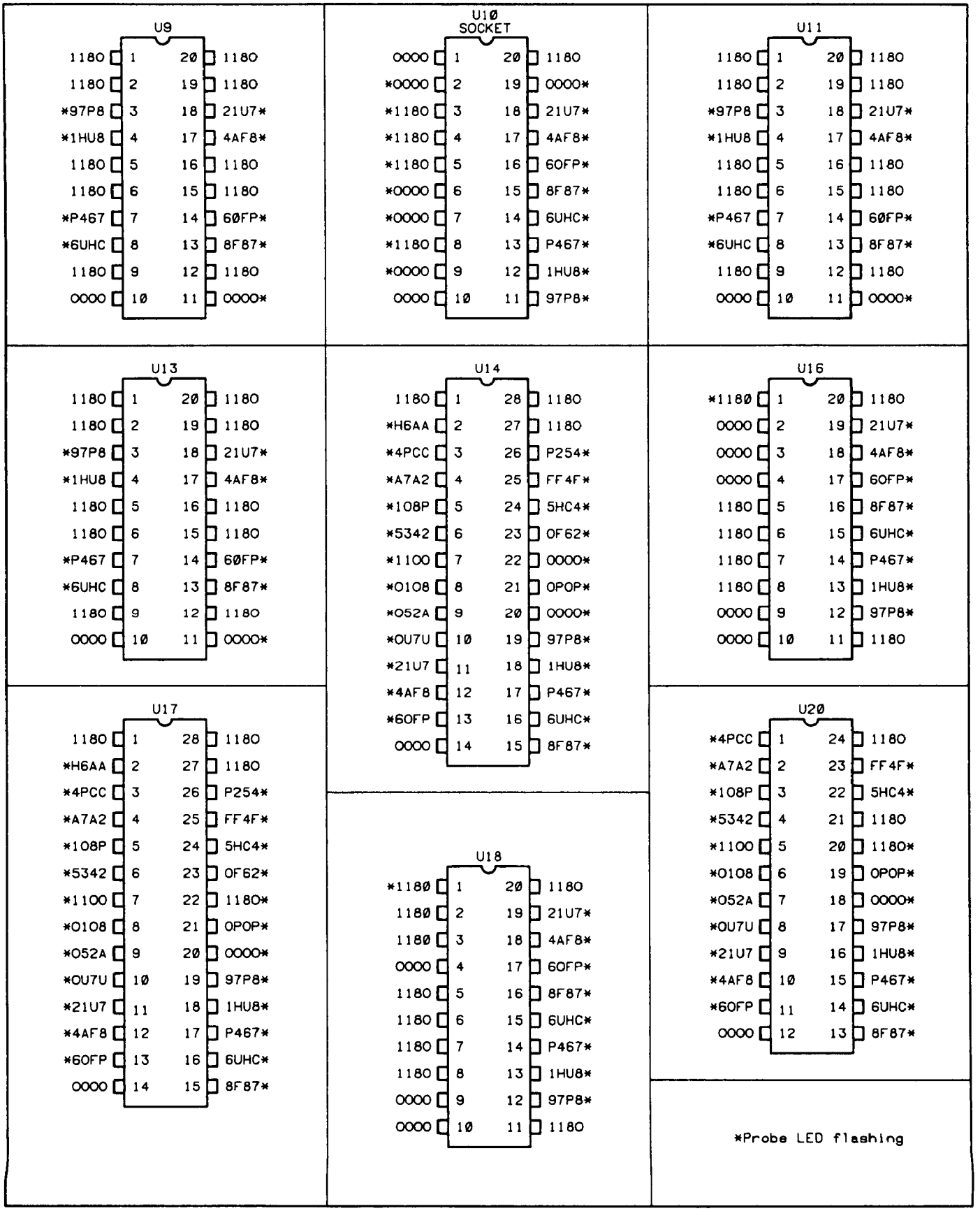


Figure 7-8B. 5352B A4 Signatures for Mode 1, Setup 3 — Firmware Version 2631

ROM VERSION 2631

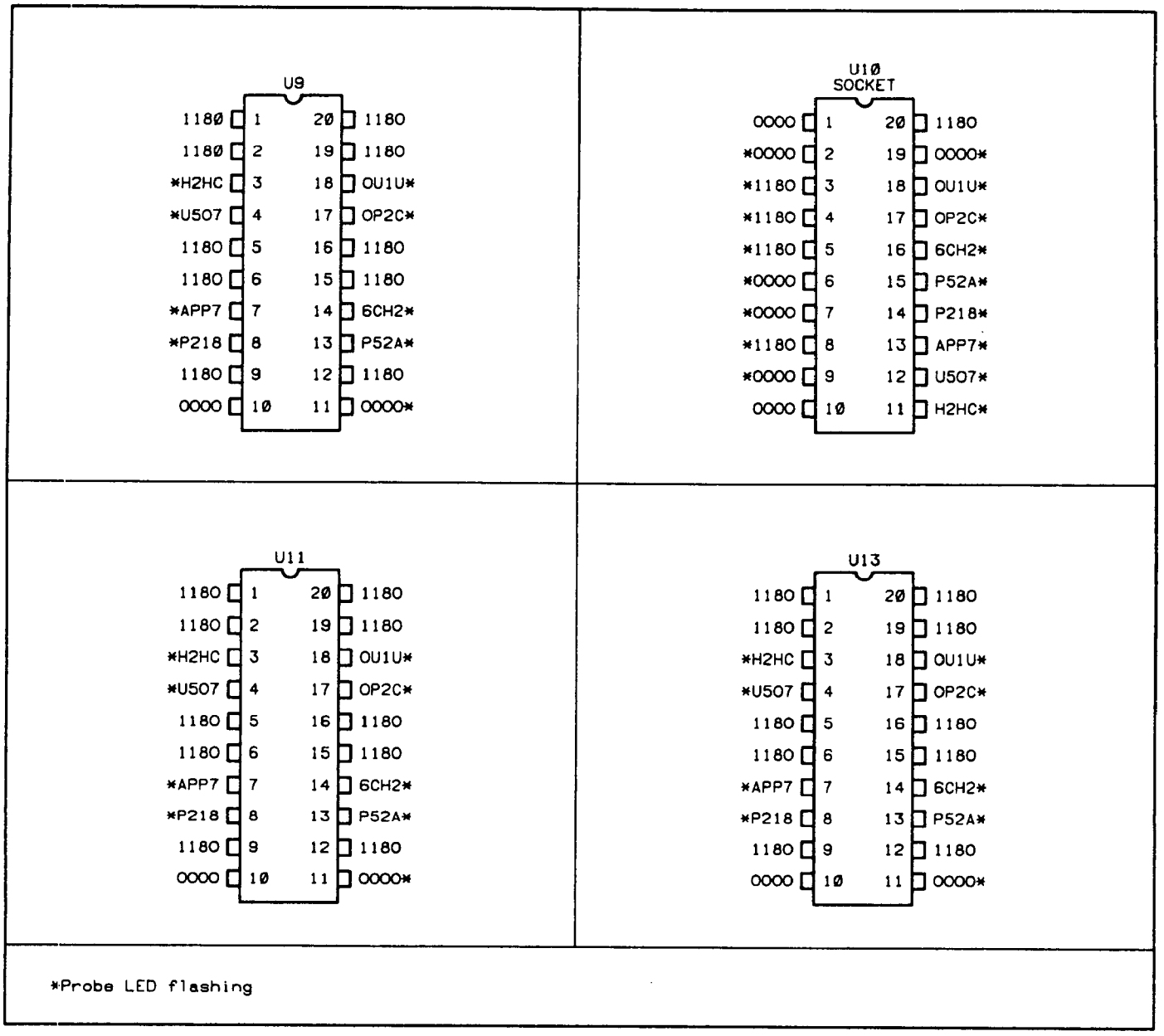


Figure 7-9A. 5350B/5351B A4 Signatures for Mode 1, Setup 4 — Firmware Version 2631

ROM VERSION 2631

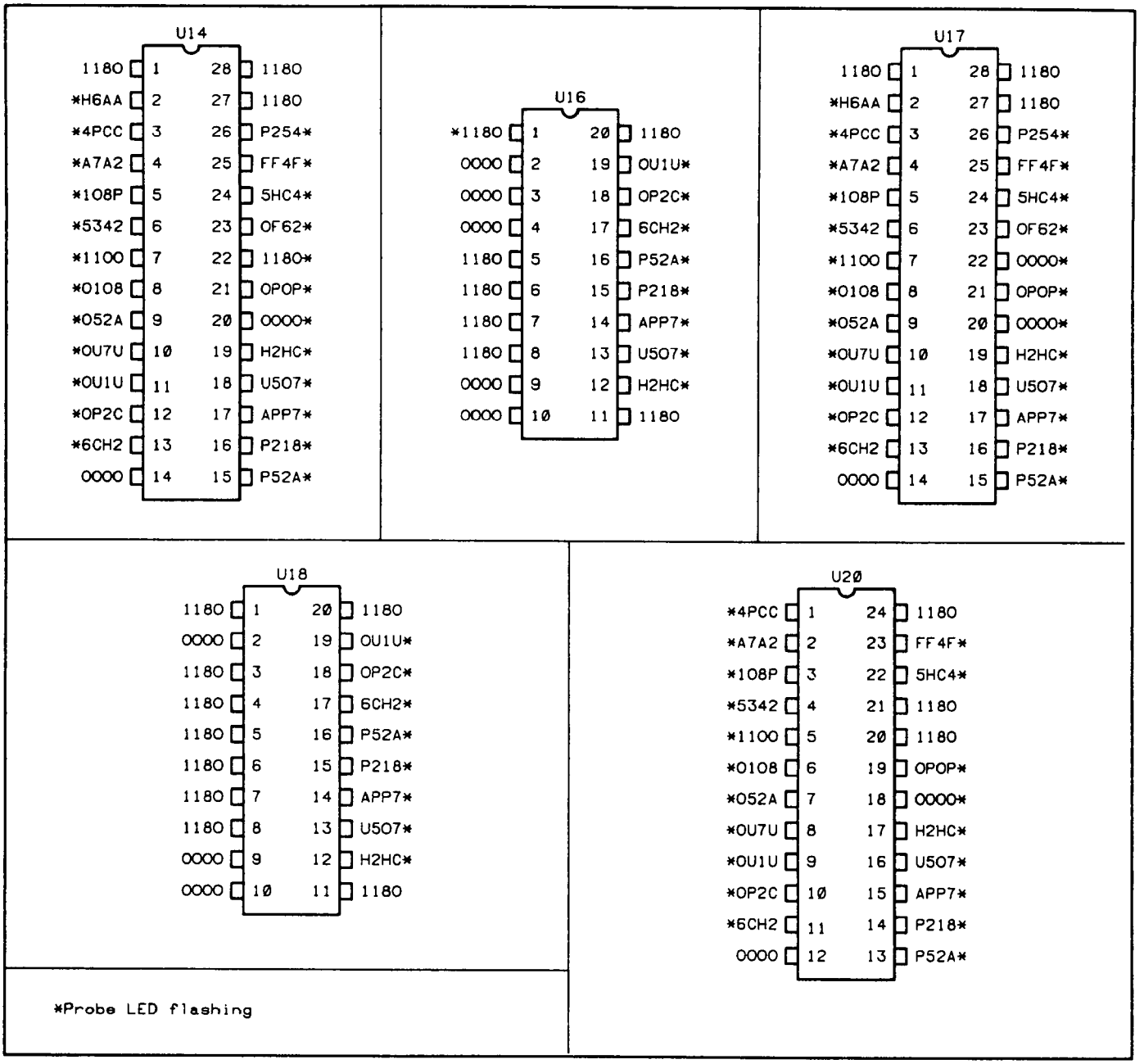


Figure 7-9A. 5350B/5351B A4 Signatures for Mode 1, Setup 4 — Firmware Version 2631 (Continued)

ROM VERSION 2631

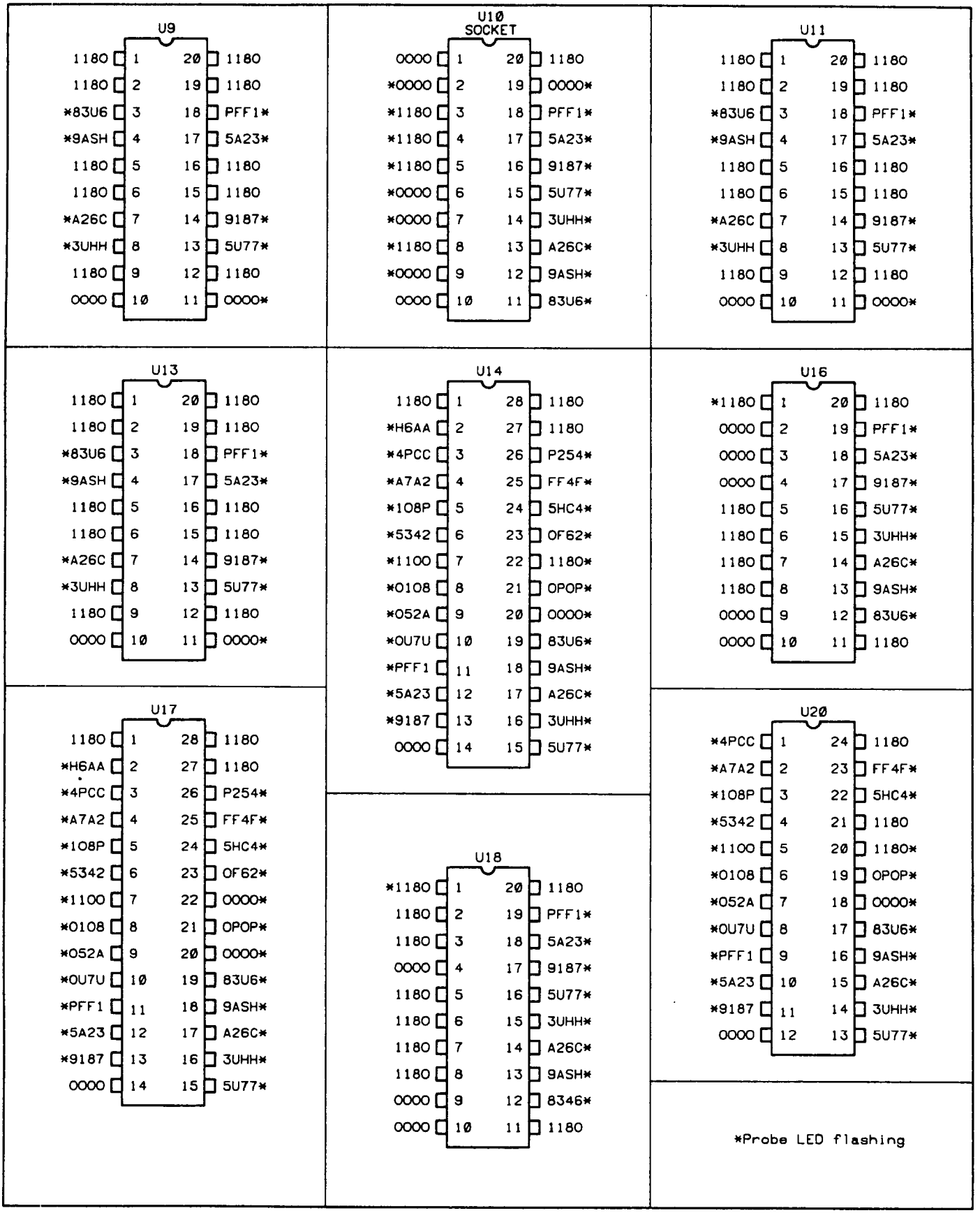


Figure 7-9B. 5352B A4 Signatures for Mode 1, Setup 4 — Firmware Version 2631

ROM VERSION 2631

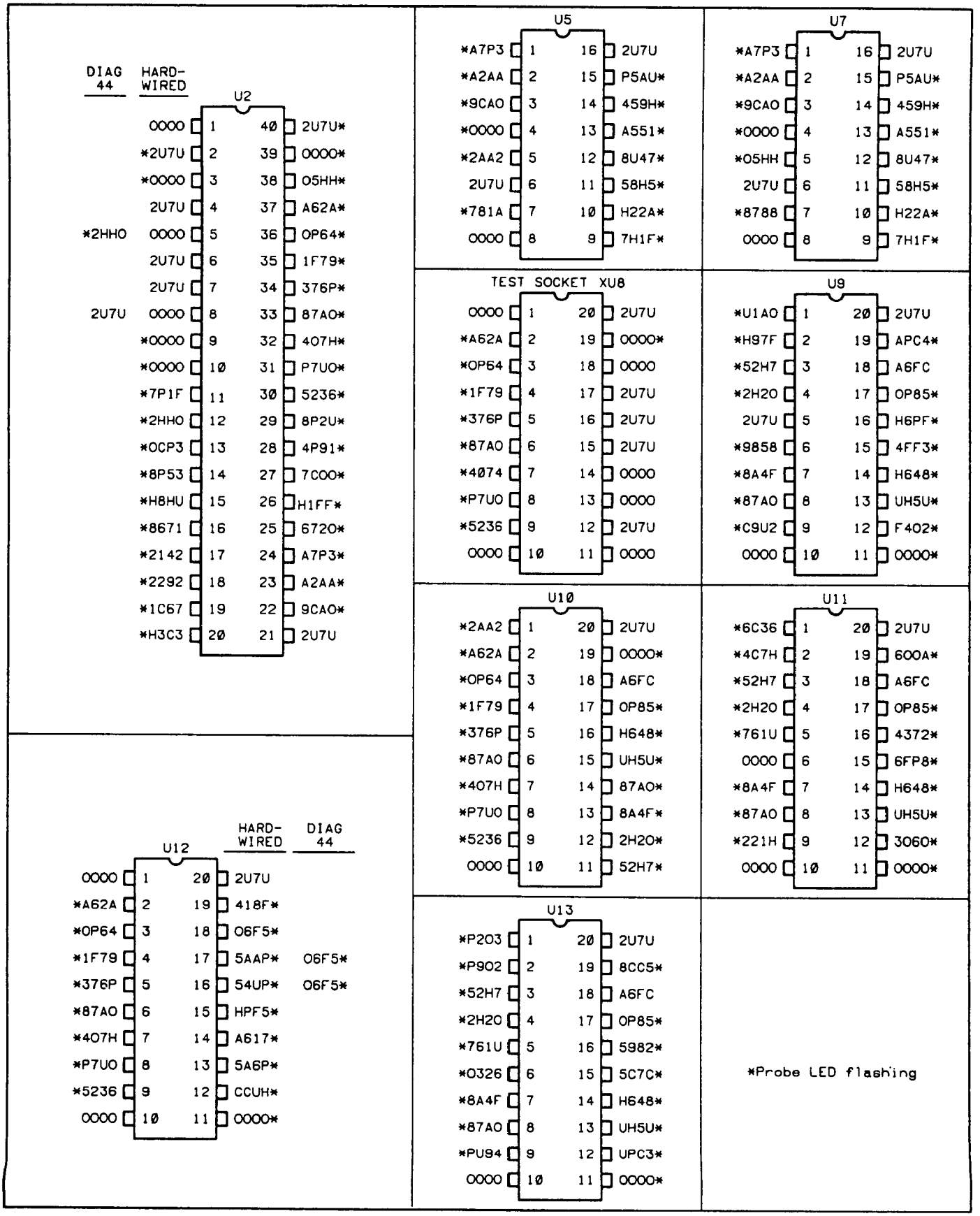


Figure 7-10A. 5350B/5351B A4 Signatures for Mode 2 — Firmware Version 2631

ROM VERSION 2631

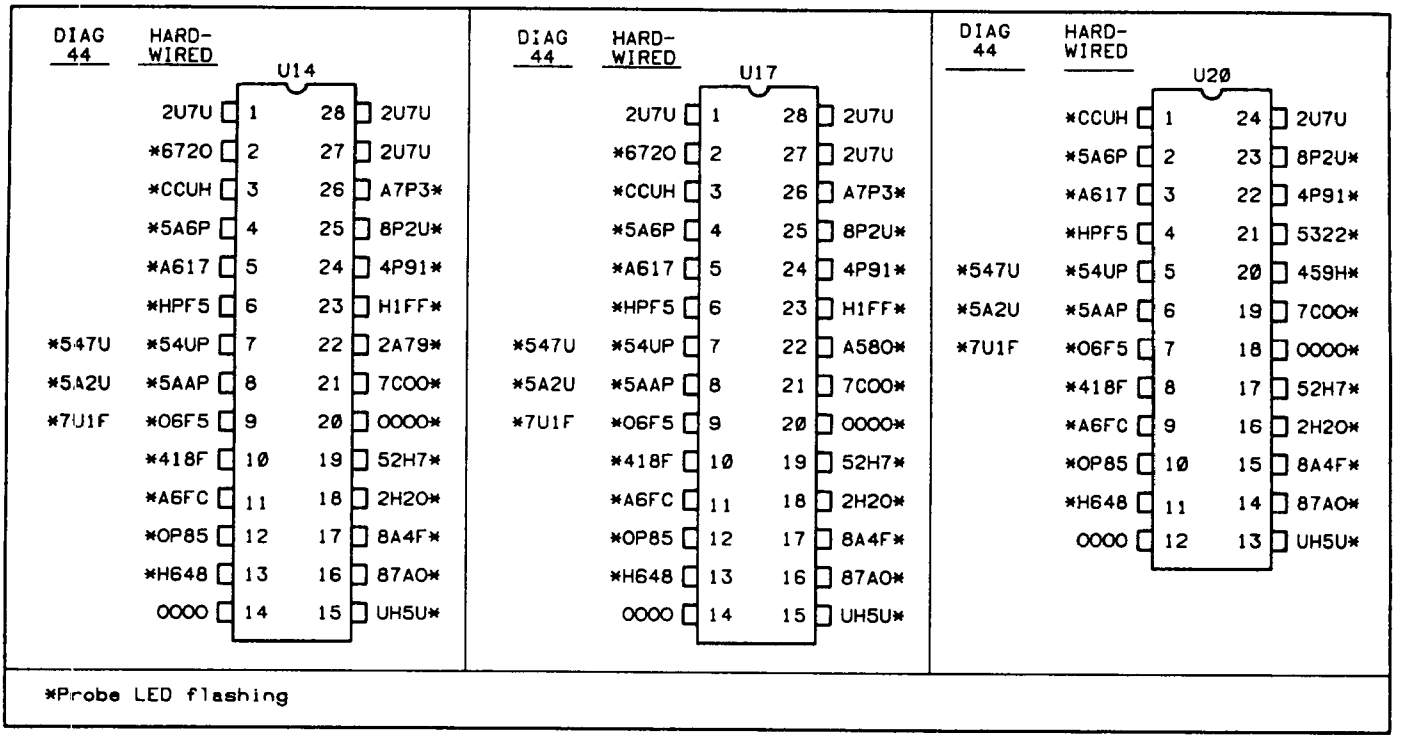


Figure 7-10A. 5350B/5351B A4 Signatures for Mode 2 — Firmware Version 2631 (Continued)

ROM VERSION 2631

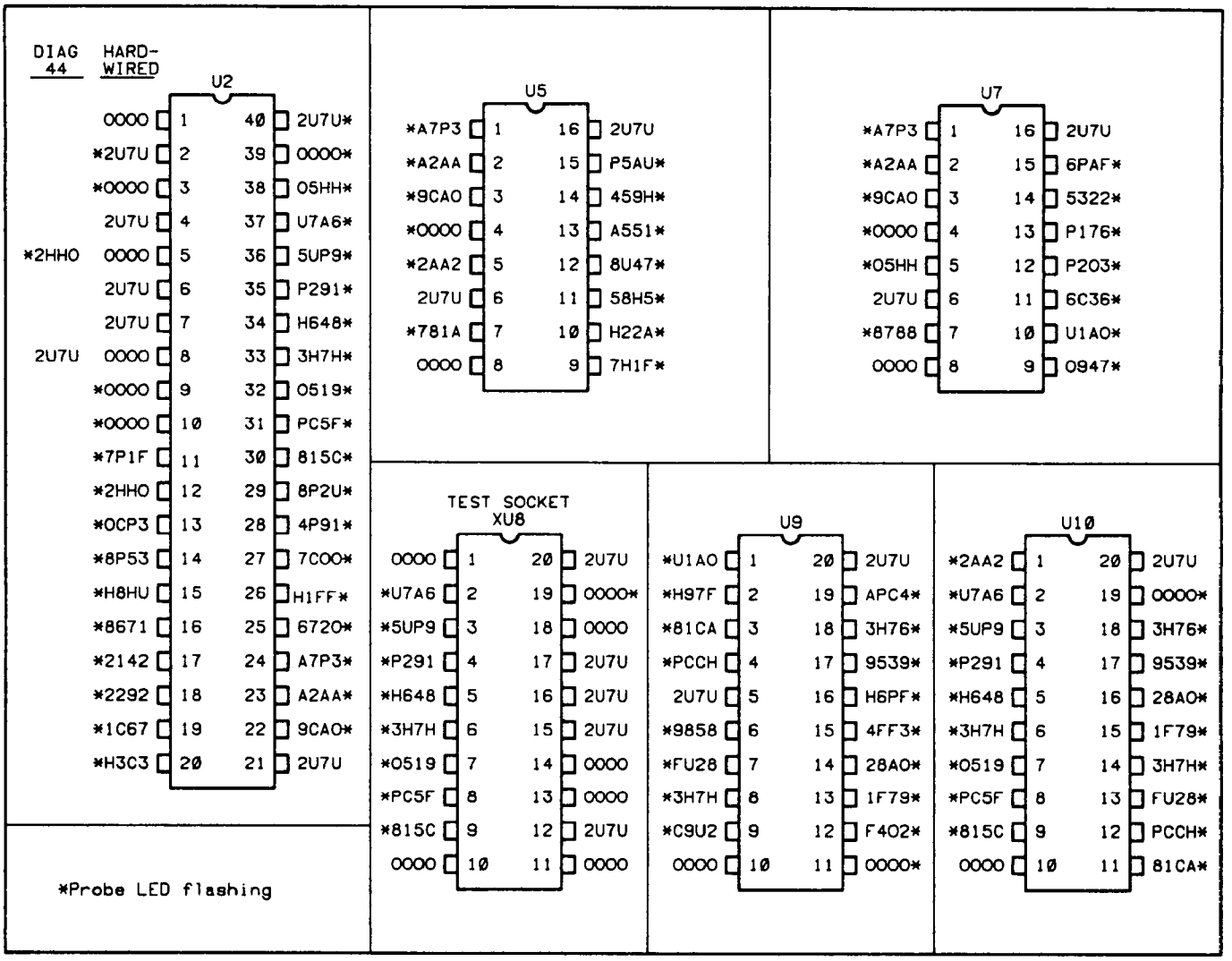


Figure 7-10B. 5352B A4 Signatures for Mode 2 — Firmware Version 2631

ROM VERSION 2631

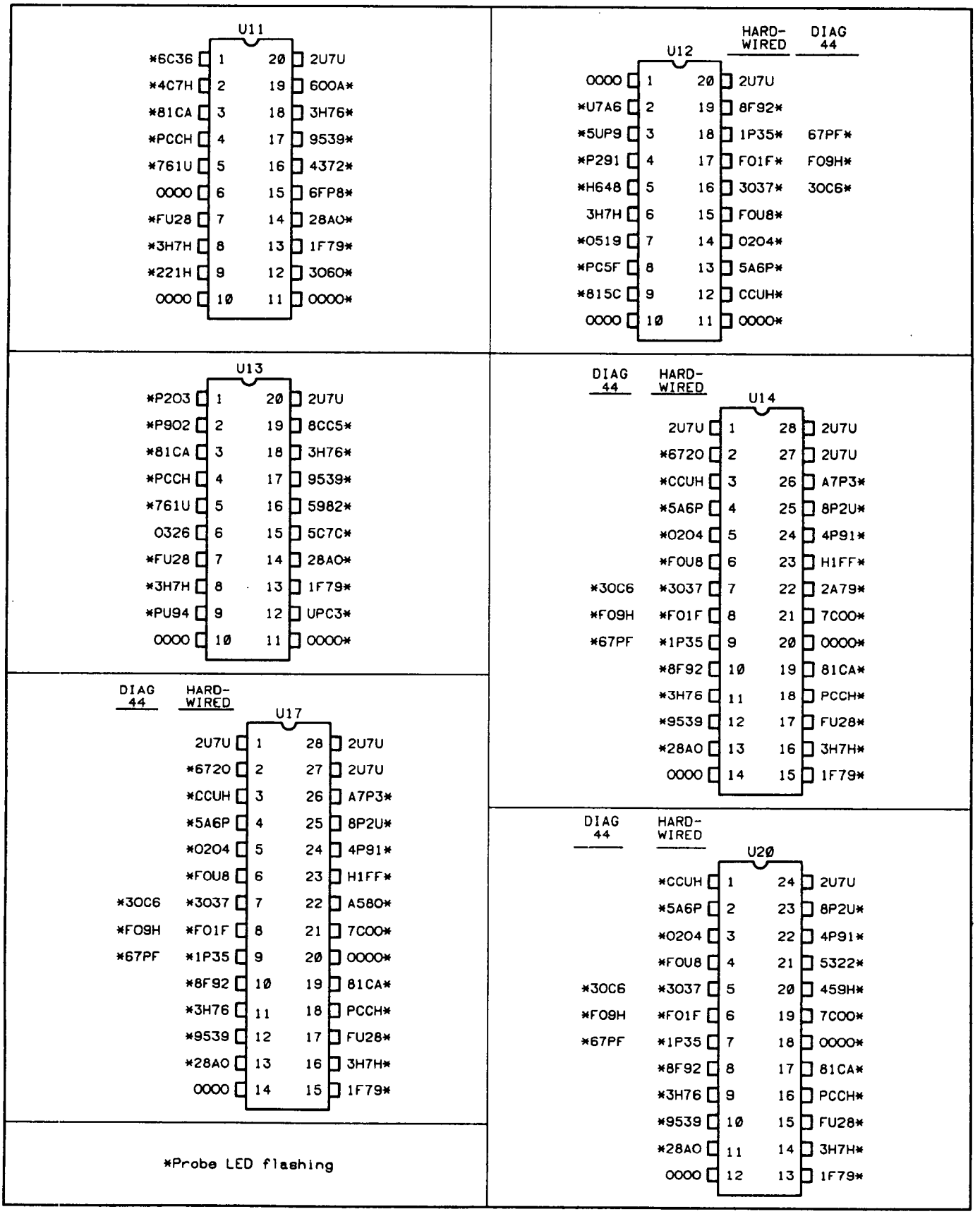


Figure 7-10B. 5352B A4 Signatures for Mode 2 — Firmware Version 2631 (Continued)

CHANGE 4

Instruments with serial number prefix 2627A used the 05350-60001 board for the A1 Timebase Buffer/Power Supply Control Assembly. To backdate this manual so it applies to instruments with serial number prefix 2627A, make the following changes:

Section VI, A1 Replaceable Parts (Pages 6-4 through 6-7):

Change A1 part number to 05350-60001.

Add A1C25, 0160-4787, CAPACITOR-FXD 22PF ±5% 100VDC CER 0±30, 28480, 0160-4787.

Change A1R20 to 0757-0438, RESISTOR 5.11K 1% .125W FTC=0±100, 24546, C4-1/8-T0-5111-F.

Change A1R21 to 0757-0447, RESISTOR 16.2K 1% .125W F TC=0±100, 24546, C4-1/8-T0-1622-F.

Add A1R25, 0698-0084, RESISTOR 2.15K 1% .125W F TC=0±100, 24546, C4-1/8-T0-2151-F.

Add A1R58, 0757-0416, RESISTOR 511 1% .125W F TC=0±100, 24546, C4/1-8-T0-511R-F.

Change A1U4 to 1820-1437, IC MV TTL LS MONOSTBL DUAL, 01295, SN74LS221N.

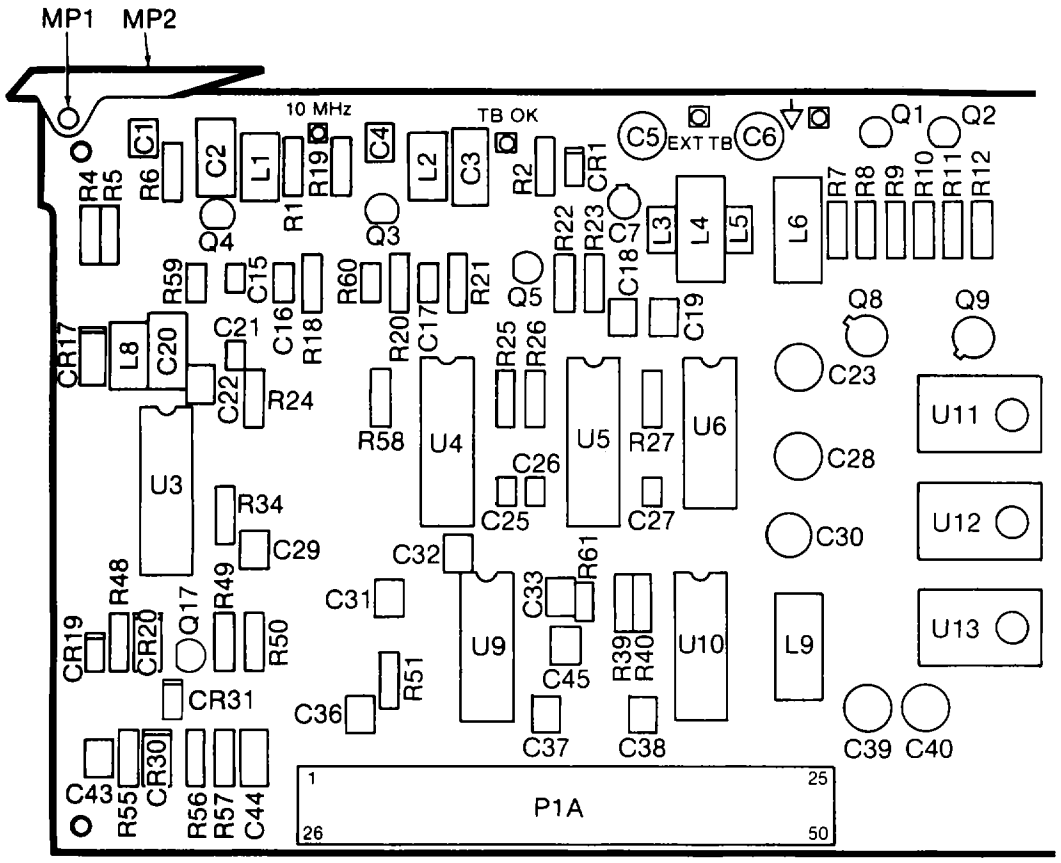
Change A1U10 to 1820-1197, IC GATE TTL LS NAND QUAD 2-INP, 01295, SN74LS00N.

Section VIII, Figure 8-42, Power Supply Control Schematic Diagram:

Change A1 board schematic part number to 05350-60001.

Section VIII, Figure 8-44, Timebase Buffer Schematic Diagram:

Replace Figure 8-44 with Figure 7-11 in this section.



NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.
2. UNLESS OTHERWISE INDICATED:
   RESISTANCE IN OHMS;
   CAPACITANCE IN MICROFARADS;
   INDUCTANCE IN MICROHENRIES.

REFERENCE DESIGNATIONS

A1 ASSEMBLY
C1-C33, C35-C45 CR1-CR31 DS1 L1-L8 P1A, P1B Q1-Q22 R1, R2, R4-R61 U1-U4

A1 ACTIVE COMPONENTS
TIMEBASE BUFFER CIRCUIT

REFERENCE DESIGNATIONS	HP PART NUMBER	MFG. PART NUMBER
CR1	1902-0040	SAME
CR17, CR29, CR30	1901-0047	SAME
CR18	1901-0050	1N4150
CR31	1901-0539	SAME
Q1, Q2	1854-0215	2N3904
Q3, Q4	1854-0092	SAME
Q5	1853-0036	2N3906
Q8, Q9	1853-0281	2N2907A
Q17	1853-0352	SAME
U3	1820-1437	SN74LS221N
U4, U10	1820-1425	74LS132
U5	1820-1423	SN74LS123N
U6	1820-1442	SN74LS290N
U9	1820-1074	SN74128N
U11, U12	1826-0084	SAME
U13	1826-0147	MC7812CP

XR1A
CONNECTOR PINOUT
CIRCUIT SIDE OF MOTHERBOARD
(TIMEBASE BUFFER)

	26	1	EXT REF IN
	27	2	GND, MTHRPLN
	28	3	GND, MTHRPLN
	29	4	10MHz INT SYM
	30	5	GND, MTHRPLN
	31	6	GND, MTHRPLN
	32	7	10MHz INT CTR
	33	8	GND, MTHRPLN
	34	9	GND, MTHRPLN
	35	10	10MHz OUT
	36	11	GND, MTHRPLN
	37	12	GND, MTHRPLN
	38	13	1MHz OUT
	39	14	GND, MTHRPLN
L 10MHz OK	40	15	L EXT REF
	41	16	GND, MTHRPLN
	42	17	10MHz OSC
	43	18	GND, MTHRPLN
OVN TEMP	44	19	L OVN COLD
	45	20	+5V
	46	21	+5V OSC
	47	22	+12V OSC
	48	23	+5VμP
	49	24	+15V UNREG
	50	25	+5V UNREG

NOTE

Refer to *Figure 8-42* for the schematic of the power supply control portion of the A1 board.

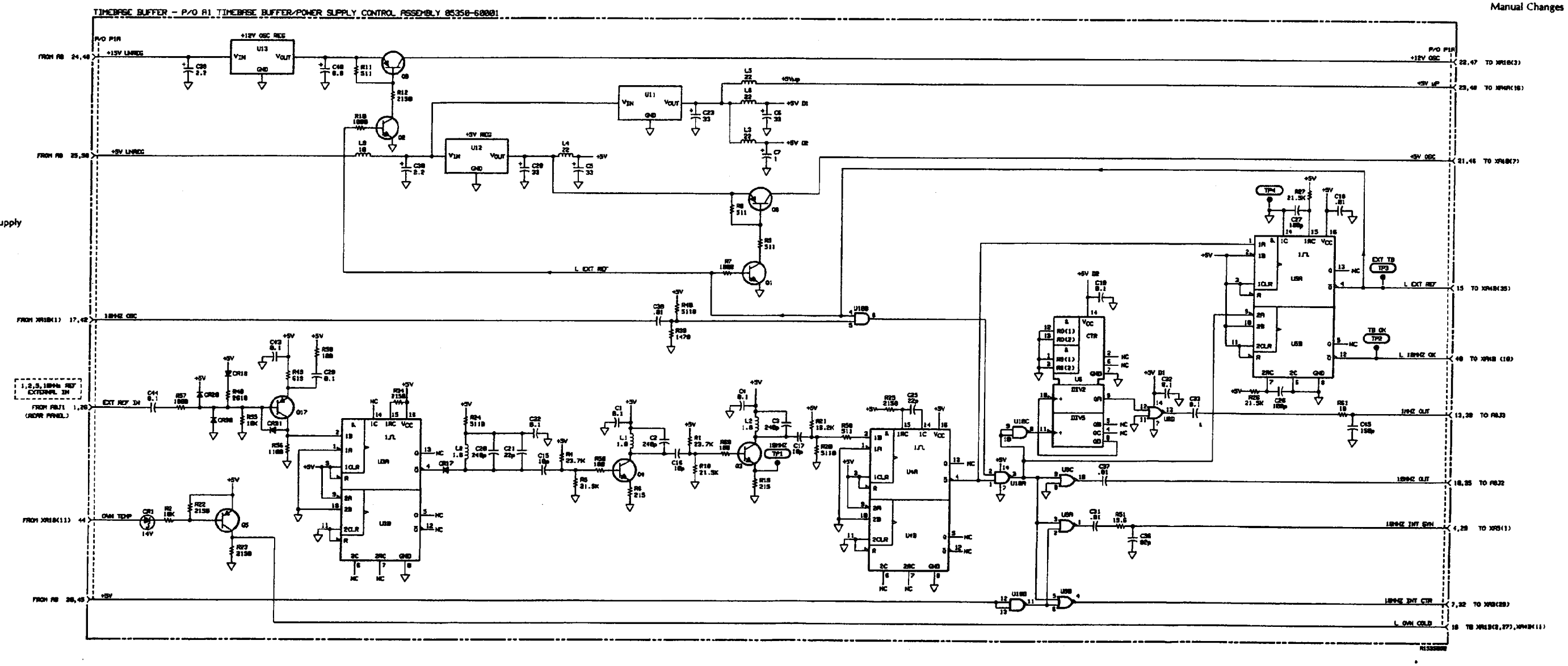


Figure 7-11. Timebase Buffer (Part of A1 Assembly, 05350-60001)

Figure 7-11.
TIMEBASE BUFFER (PART OF A1 ASSEMBLY, 05350-60001)

(See Page 7-41)

SECTION VIII
SERVICE

8-1. INTRODUCTION

8-2. This section contains the information needed to service the HP 5350B, 5351B, and 5352B. Service information includes symbol descriptions, theory of operation, diagnostics, trouble-shooting procedures, and schematic diagrams. The information contained in this section is organized as follows:

a. Safety Considerations, paragraph 8-3: Describes the safety considerations applicable during maintenance, adjustments, and repair.

b. Electrostatic Discharge, paragraph 8-11: Describes the precautions which must be taken to prevent electrostatic damage to instrument assemblies and components.

c. Recommended Test Equipment, paragraph 8-13: Refers to test equipment specified in *Table 1-5.*

d. Schematic Diagram Symbols and Reference Designations, paragraph 8-15: Describes the symbols used on the schematic diagrams and the reference designations used for parts, subassemblies and assemblies.

e. Identification of Boards and Assemblies, paragraph 8-20: Describes the method used by Hewlett-Packard for identifying printed-circuit boards and assemblies, and lists all HP 5350B/51B/52B assemblies and their part numbers.

f. Logic Symbols, paragraph 8-29: Description of logic symbols used on schematics.

g. Signal Names, paragraph 8-48: Lists signal mnemonics, names, sources, destinations, and functions for HP 5350B/51B/52B signals.

h. Disassembly and Reassembly, paragraph 8-50: Describes procedures for removal of covers and assemblies to gain access to parts.

i. Service Accessories, paragraph 8-67: Describes the function and use of extender boards available for testing pc boards.

j. Theory of Operation, paragraph 8-69: Provides a block diagram description of the overall counter operation, detailed circuit descriptions, and special function descriptions.

k. Diagnostics, paragraph 8-393: Lists and describes the built-in diagnostics which can be used to verify various functional subsections of the counter's circuitry.

l. Troubleshooting, paragraph 8-546: Provides troubleshooting information and procedures, including diagnostic, signature analysis, and signal-tracing techniques, designed to isolate trouble to the assembly, and then to the component group level.

m. Schematic Diagrams, paragraph 8-773: Provides a schematic diagram and component locator for each assembly, arranged in order by assembly number.

8-3. SAFETY CONSIDERATIONS

8-4. 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 instructions, and adjustment procedures requiring removal of the instrument top or bottom covers, are for use by service-trained personnel only. To avoid dangerous electric shock, do not perform any servicing or make any adjustments with the covers removed, unless qualified to do so.

WARNING

THE AC POWER CIRCUITS TO TRANSFORMER T1, UNREGULATED DC VOLTAGES ON THE MOTHERBOARD, AND REGULATED DC VOLTAGES FROM THE POWER SUPPLY CIRCUITRY TO THE MICROPROCESSOR BOARD AND THE OSCILLATOR ARE ALWAYS ON WHEN AC POWER IS CONNECTED TO THE INSTRUMENT, EVEN WHEN THE POWER SWITCH IS SET TO STANDBY. CONTACT WITH THESE CIRCUITS CAN RESULT IN PERSONAL INJURY OR DAMAGE TO EQUIPMENT.

WARNING

BEFORE APPLYING AC POWER, THE INSTRUMENT AND 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 GROUNDING CONDUCTOR INSIDE OR OUTSIDE THE INSTRUMENT OR DISCONNECTION OF THE PROTECTIVE EARTH TERMINAL WILL CAUSE A POTENTIAL SHOCK HAZARD THAT COULD RESULT IN PERSONAL INJURY. INTENTIONAL INTERRUPTION IS PROHIBITED.

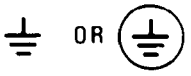
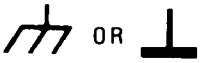
8-5. Any adjustment, maintenance, and repair of the opened instrument under voltage should be avoided as much as possible and, if necessary, should be carried out only by a skilled person who is aware of the hazards involved. Capacitors inside the instrument may still be charged even if the instrument has been disconnected from its source of supply.

8-6. Make sure that only fuses with the required current and voltage ratings, and of the specified type (normal blow, time delay, etc.), are used for replacement. DO NOT USE short-circuited fuseholders or repaired fuses.

8-7. Safety Symbols

8-8. The safety symbols used on equipment and in manuals is shown in *Table 8-1*. This table is a duplicate of *Table 1-2*, and is included here for ease of reference.

Table 8-1. Safety Symbols

	Instruction manual symbol. The product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to prevent damage to the instrument.
	Indicates dangerous voltage at input or output terminals that may exceed 1000 volts.
	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 the equipment.
	Low-noise or noiseless, clean ground (earth) terminal. Used for signal common as well as providing protection against electrical shock in case of fault. A terminal marked with this symbol must be connected to ground as described in Section II Installation in this manual 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.
	Direct current.
WARNING	The WARNING signal denotes a hazard. It calls attention to a procedure or practice which could result in personal injury if not adhered to or correctly performed.
CAUTION	The CAUTION signal denotes a hazard. It calls attention to an operating procedure or practice which could result in damage or destruction to part of or all of the product if not adhered to or correctly performed.

8-9. After Service Product Safety Checks

8-10. The following safety checks must be performed after any troubleshooting and repair procedures have been completed to ensure the safe operation of the instrument.

WARNING

RESISTANCE CHECKS DESCRIBED BELOW REQUIRE THAT THE POWER CORD BE CONNECTED TO THE INSTRUMENT AND THAT AC POWER BE DISCONNECTED. BE SURE THAT THE POWER CORD IS NOT CONNECTED TO POWER BEFORE PERFORMING ANY SAFETY CHECKS.

1. VISUAL INSPECTION. Visually inspect the interior of the instrument for any signs of abnormal internally generated heat, such as discolored printed circuit boards or components, damaged insulation, or evidence of arcing. Determine and remedy the cause of any such condition.

2. GROUND CONTINUITY TEST. Plug the power cord into the rear panel power module. (DO NOT connect the instrument to ac power.) Using a suitable ohmmeter, check resistance from the instrument enclosure (chassis) to the ground pin on the power cord plug. The reading must be less than 1Ω. Flex the power cord while making this measurement to determine whether intermittent discontinuities exist.

3. Check any indicated front or rear panel ground terminals marked, using the above procedure.

4. INSULATION RESISTANCE TEST. Tie the line and neutral pins of the power cord plug together. Measure the resistance from the instrument enclosure (chassis) to the line and neutral pins of the power cord plug. The minimum acceptable resistance is 2MΩ. Replace any component which results in a failure.

5. POWER MODULE CHECK. Check the line fuse and voltage selector card in the rear panel power module to verify that the correctly rated fuse is installed and that the instrument is properly set for the ac power source to be applied.

8-11. ELECTROSTATIC DISCHARGE

8-12. Electronic components and assemblies in the HP 5350B/51B/52B can be permanently degraded or damaged by electrostatic discharge. Use the following precautions when servicing the instrument:

a. ENSURE that static sensitive devices or assemblies are serviced at static safe work stations providing proper grounding for service personnel.

b. ENSURE that static sensitive devices or assemblies are stored in static shielding bags or containers.

c. DO NOT wear clothing subject to static charge buildup, such as wool or synthetic materials.

d. DO NOT handle components or assemblies in carpeted areas.

e. DO NOT remove an assembly or component from its static shielding protection until you are ready to install it.

f. AVOID touching component leads. (Handle by the packaging only.)

8-13. RECOMMENDED TEST EQUIPMENT

8-14. Test equipment recommended for testing and troubleshooting the HP 5350B/51B/52B is listed in *Table 1-5*. Substitute equipment may be used if it meets or exceeds the required characteristics listed in the table.

8-15. SCHEMATIC DIAGRAM SYMBOLS AND REFERENCE DESIGNATIONS

8-16. *Figure 8-1* shows the various common symbols used on the schematic diagrams. At the bottom of *Figure 8-1*, the identification system for reference designations, assemblies, and subassemblies is shown.

8-17. Reference Designations

8-18. Reference designations are assigned to indicate the class and the location of printed-circuit assemblies (boards), subassemblies (if any), and all of the component parts, as shown in the example in *Figure 8-1*. Assemblies are assigned numbers in sequence, A1, A2, etc. Component parts are numbered in sequence, from left to right, top to bottom, according to the physical location on the board.

8-19. Subassemblies within an assembly are given a subordinate A number. For example (see *Figure 8-1*), rectifier subassembly A1 has the complete designation of A25A1. For individual components, the complete designation is determined by adding the assembly number and subassembly number, if any. For example, CR1 on the rectifier assembly would have a complete reference designation of A25A1CR1.

8-20. IDENTIFICATION OF BOARDS AND ASSEMBLIES

8-21. Identification Markings on Printed-Circuit Boards

8-22. Printed-circuit boards in this instrument (see *Figure 8-1*) have three identification numbers: an assembly part number, a revision letter, and a production code. The assembly part number has 10 digits (such as 05350-60001) and is the primary identification. All assemblies with the same part number are interchangeable. When a production change is made on an assembly that makes it incompatible with previous assemblies, the part number is changed.

8-23. 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 layout is changed and the revision letter is incremented to the next letter. The production code is a four-digit seven-segment number used for production purposes.

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

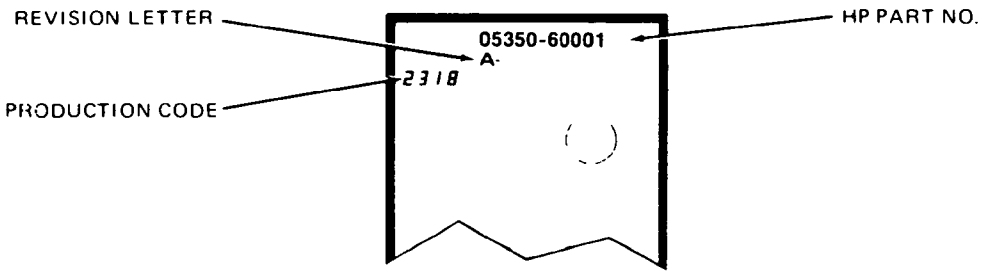
INSTRUCTION MANUAL REFERENCE

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

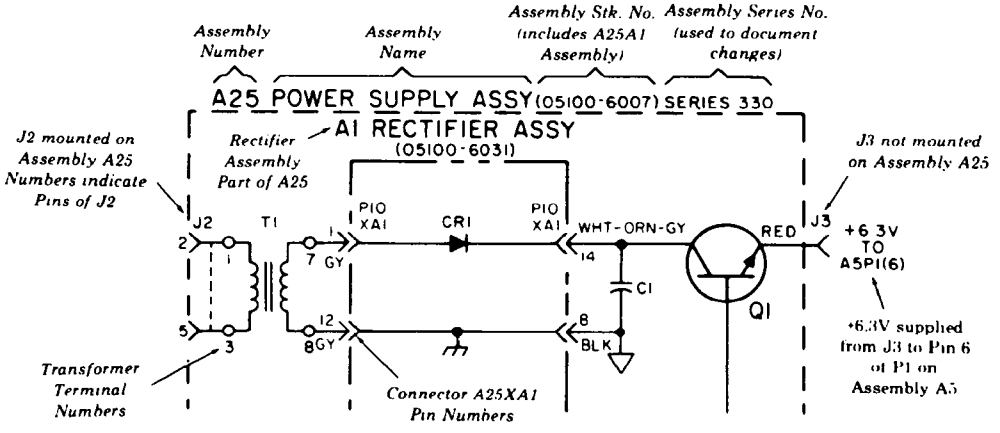


Figure 8-1. Schematic Diagram Notes

8-24. Identification and Repair of Multilayer Circuit Boards

8-25. Multilayer circuit boards with conductors in three or more layers have a rectangular pattern of 4, 6, or 8 windows with single digits visible in the windows when the circuit boards are held over a light. The square windows appear on both sides of the circuit board. The number of identifiable numbers indicates the number of layers in the circuit board. For example, a circuit board having four windows with "1" in one window, "4" in a second window (on the opposite side), a "2" or "3" visible through the third window, and one blank window will have three layers.

CAUTION

The multilayer circuit boards can be damaged if excessive heat or force is used when removing or replacing parts. Static-free vacuum devices that pull the molten solder out of the circuit board holes are required. With the solder removed, parts should be easy to remove without excessive prying or pulling on component leads.

8-26. Assembly Identification and Location

8-27. The assembly number, name and Hewlett-Packard part number of HP 5350B/51B/52B assemblies are listed in *Table 8-2*. A top internal view of the instrument is shown in *Figure 8-40*.

Table 8-2. HP 5350B/5351B/5352B Assembly Identification

Assembly	Name	HP Part No.
A1	Timebase Buffer/Power Supply Control	05350-60013
A2	Low Frequency Input	05350-60002
A3	Counter	05350-60003
A4	Microprocessor (5350B/5351B)	05350-60014
	Microprocessor (5352B)	05352-60014
A5	Synthesizer	05350-60005
A6	IF Amplifier/Detector	05350-60006
A7	Keyboard/Display Logic	05350-60007
A8	Motherboard/Power Supply Regulator	05350-60008
A9	Backlight	05350-60009
A10	Temperature Compensated Crystal Oscillator (TCXO) Timebase	05350-60010
	or Option 001 Oven Oscillator Timebase	10811-60111
	or Option 010 High Stability Oven Oscillator Timebase	10811-60211
A11	HP-IB Interface	05350-60011
A12	Microwave (5350B/5351B)	05350-60012
	Microwave (5352B)	05352-60012

8-28. Note that assembly reference designation A10 is used to refer to any one of three oscillators which may be installed in the instrument. If the counter is equipped with either the Option 001 Oven Oscillator or the Option 010 High Stability Oven Oscillator, the A10 designation will be used as a prefix for all component designations for the oven assembly. Refer to Section VI, Replaceable Parts.

8-29. LOGIC SYMBOLS

8-30. Logic symbols used in this manual conform to the American National Standard ANSI/IEEE Std. 91-1984. This standard supersedes MIL-STD-806B. *Tables 8-3* through *8-8* give a brief summary of the symbols used for logic devices, and the associated qualifiers and indicators. Not all of the symbols listed have been used in this manual, but they are included in the tables for the sake of completeness.*

8-31. General Qualifying Symbols

8-32. *Table 8-3* shows the characters generally used to define the basic function of a device represented by a logic symbol or element. The characters are placed near the top center or geometric center of the symbol or symbol element.

Table 8-3. 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.	SN74ALS86
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/OUT, 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
!G	Synchronously starting astable.	SN74LS624
G!	Astable element that stops with a completed pulse.	•

**Portions of this logic symbology summary are from "1981 Supplement to the TTL Data Book for Design Engineers", copyright ©1981 Texas Instruments Incorporated. Reproduced by permission.*

Table 8-3. General Qualifying Symbols (Continued)

Symbol	Description	Example
SRGm	Shift register. m = number of bits.	SN74LS595
CTRm	Counter. m = number of bits; cycle length = 2^m.	SN54LS590
CTR DIVm	Counter with cycle length = m.	SN74LS668
RCTRm	Asynchronous (ripple-carry) counter; cycle length = 2^m.	•
ROM	Read-only memory.	SN74187
RAM	Random-access read/write memory.	SN74170
FIFO	First-in, first-out memory.	SN74LS222
1=0	Element powers up cleared to 0 state.	SN74AS877
Φ	Highly complex function; "gray box" symbol with limited detail shown under special rules.	SN74LS608

8-33. Gate Symbols

8-34. The ANSI/IEEE standard defines new symbols for the basic gate functions, but also permits the use of the MIL-STD-806B symbols for these gates, as shown in *Figure 8-2*. In this manual, the distinctively shaped AND gate, OR gate, exclusive-OR gate, and inverter symbols will be used for those gates which are not part of a complex logic device. The new symbols will be used for those gates embedded within a logic symbol, signifying that they are one element of a more complex logic device.

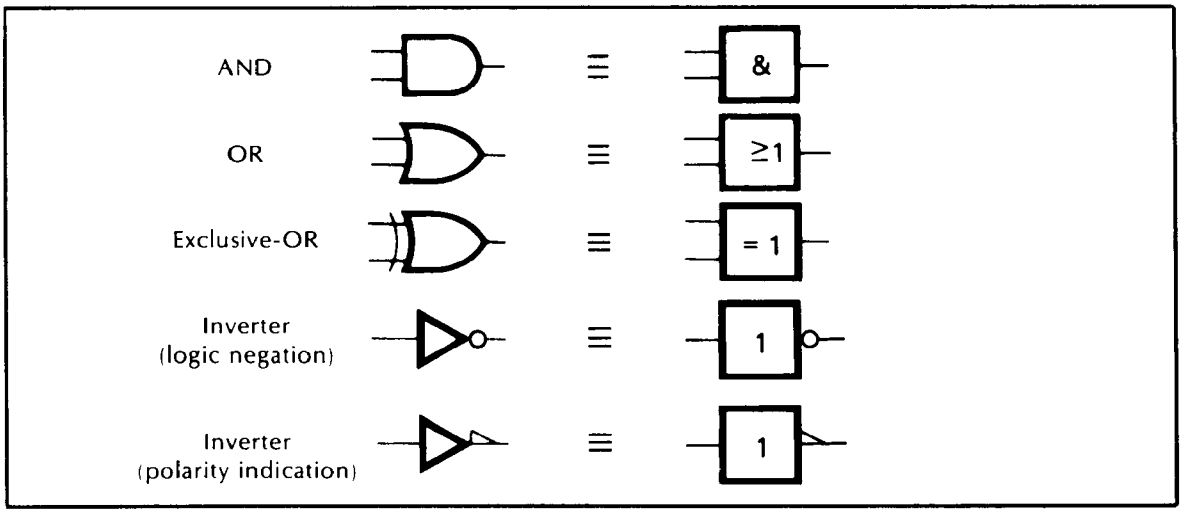
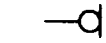
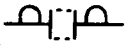


Figure 8-2. Gate Symbols

8-35. Qualifying Symbols for Inputs and Outputs

8-36. The symbols shown in *Table 8-4* are used to indicate the external states of both gate and complex logic devices, and their relationship to internal states.

Table 8-4. Qualifying Symbols for Inputs and Outputs

Symbol	Description
	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 input. The transition from the external 0 state to the external 1 state produces a transitory internal 1 state. At all other times, the internal logic state is 0.
	Nonlogic connection. A label inside the device symbol will usually define the nature of the input or output.
	Analog input or output.

8-37. Qualifying Symbols for Internal Connections

8-38. The internal connections between elements abutted together in a logic symbol are indicated by the symbols shown in *Table 8-5*. Note that the internal (virtual) input is an input originating somewhere else in the device and is not connected directly to a pin. The internal (virtual) output is likewise not connected to a pin.

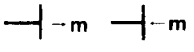
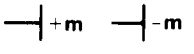
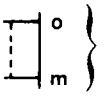
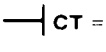
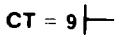
Table 8-5. Qualifying Symbols for Internal Connections

Symbol	Description
	Internal connection. 1 state on left produces 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 affect on an internal input to which it is connected is indicated by dependency notation.

8-39. Symbols Inside the Outline

8-40. *Table 8-6* shows some of the symbols used inside the outline of a logic symbol. Note particularly that open-collector, open-emitter, and three-state outputs have distinctive symbols. Also note that an EN (Enable) input affects all the outputs of the circuit and has no affect 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 (refer to paragraph 8-38).

Table 8-6. Symbols Inside the Outline

Symbol	Description
	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.
	3-state output
	Output with more than usual output capability (symbol is oriented in the direction of signal flow).
	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, 3-state outputs are at normally defined internal logic states and at external high-impedance state, and all other outputs (e.g., totem-poles) are at the internal 0-state.
J, K, R, S, T	Usual meanings associated with flip-flops (e.g., R = reset, T = toggle)
	Data input to a storage element equivalent to:
	Shift right (left) inputs, m = 1, 2, 3 etc. If m = 1, it is usually not shown.
	Counting up (down) inputs, m = 1, 2, 3 etc. If m = 1, it is usually not shown.
	Binary grouping. m is highest power of 2.
	The contents-setting input, when active, causes the content of a register to take on the indicative value.
	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.
	Fixed-state output always stands at its internal 1 state. For example, see SN74185.

8-41. Dependency Notation

8-42. Dependency notation is a way to simplify symbols from complex IC elements by 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. *Table 8-7* contains a summary of the 11 types of dependency notations.

Table 8-7. 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".

8-43. *Table 8-8* contains examples of dependency notation using the "G" (AND) and "C" (Control) dependency symbols. Refer to the ANSI/IEEE Std. 91-1984 for a complete explanation of dependency notation.

Table 8-8. Examples of Dependency Notation

Symbol	Description
G1 1	The input affecting other inputs or outputs with an AND or Control relationship is labeled with a "G" or a "C", followed by an identifying number. The affected input or output is labeled with the same number. In this example, "1" is controlled by "G1".
G1 X_1 OR G1 1X	When the affected input or output already has a functional label (X is used here), that label will be prefixed or subscripted by the identifying number.
C X_C	If a particular device has only one affecting input, then the identifying number may be eliminated and the relationship shown with a subscript.
G1 G2 1,2X	If an input or output is affected by more than one input, then the identifying numbers of each affecting input will appear in the prefix or subscript, separated by commas. In this example "X" is controlled by "G1" and "G2".
G1 G2 $X_{1,2}$	

8-44. Control Blocks

8-45. A common control block is often used in conjunction with an array of related elements (see *Figure 8-3.*) A control block is the point of placement for inputs and outputs associated with more than one elements of the array, or with no element of the array. Such inputs and outputs will be labeled when appropriate. Refer to paragraph 8-46, Logic Device Notation Examples, for examples of the use of control blocks.

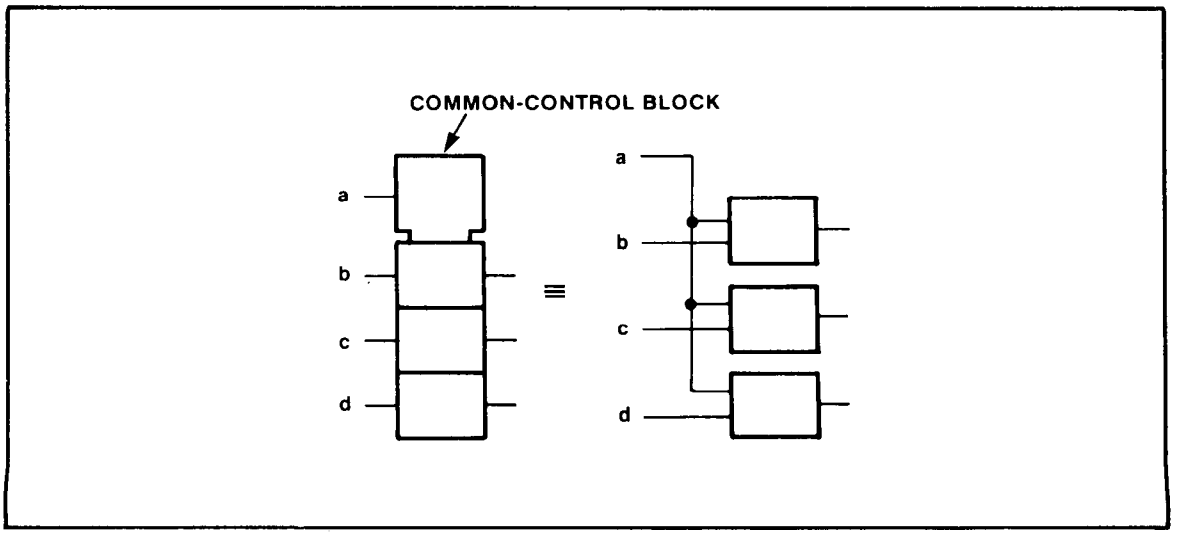


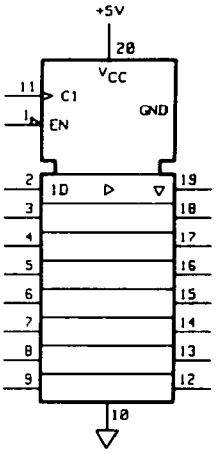
Figure 8-3. Common Control Block

8-46. Logic Device Notation Examples

8-47. The various logic symbols are combined to represent devices that perform more difficult functions. The control block symbol can simplify understanding of many complex devices. Some examples of more complex devices are given here. These examples are typical of the symbols used in schematic diagrams in this manual.

Reference Designation
A3U6, A4U1, A4U12, A4U16, A4U18, A5U4

Part Number
1820-2724
SN74ALS573

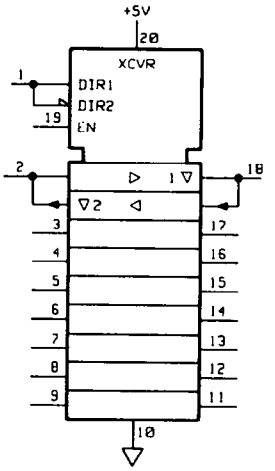


Description: Octal D-Type Transparent Latch With 3-State Outputs

This device consists of eight latches with 3-state outputs buffers. While pin 11 is high and pin 1 is low, the outputs at pins 12-19 will respond to the data inputs at pins 2-9. When pin 11 goes low, the outputs will be latched to retain the data that was set up. Pin 1 is a buffered output-control input which, when high, places the eight outputs in a high impedance state.

Reference Designation
A4U10

Part Number
1820-3121
SN74LS245

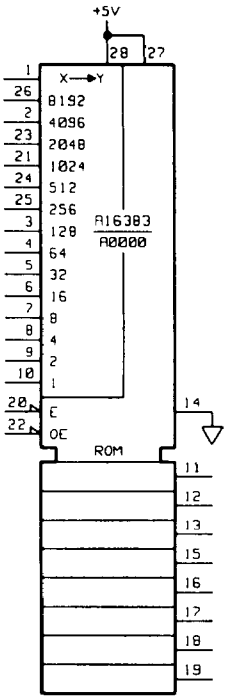


Description: Octal Bus Transceiver With 3-State Outputs

This device is an eight-line bidirectional bus transceiver with 3-state outputs. The direction of data transfer is determined by pin 1: a high at pin 1 sends the data toward direction 1 (pins 11-18), and a low at pin 1 sends the data toward direction 2 (pins 2-9). Data transfer is enabled only when pin 19 is high; when pin 19 is low, data transfer is disabled and both sets of output lines are set to the high impedance state.

Reference Designation
A4U14, A4U17

Part Number
05350-800XX
NMOS 27128A

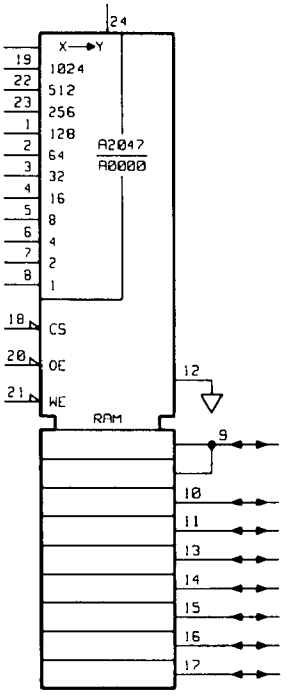


Description: Read Only Memory

Read Only Memory with 16384 addresses. Address selection is determined by the inputs at the 14-bit address input in the upper left corner of the control block (not including pin 1). A low on pin 22 and pin 20 enables the 3-state outputs at pins 11-13, 15-19. A high on either pin 20 or 22 sets the output lines to a high impedance state.

Reference Designation
A4U20

Part Number
1818-1790



Description: Random Access Memory

Random Access Memory with 2048 addresses. Information present at the I/O lines (pins 9-11,13-16) is written into memory when the Chip Select line (pin 18) and the Write Enable line (pin 21) are low and the Output Enable line (pin 20) is high, with the memory location determined by the address input (pins 1-8,19,20,23). Information is read out of the RAM via the I/O lines when pins 18 and 20 are low.

8-48. SIGNAL NAMES

8-49. *Table 8-9* is a list of signal names used in the HP 5350B/51B/52B. The list is in alphanumerical order and includes the mnemonics for cross-reference with the schematic diagram signal names. A description of the function of each signal and the source and destination is included in the table.

Table 8-9. Signal Names

Mnemonic	Name	From	To	Function
AUX A	Auxiliary A	XA5(24,50)	XA2(50) XA3(22, 47) XA6(8, 33)	Balanced test signal from the A5 Synthesizer Assembly to the A2 Low Frequency, A3 Counter, and A6 IF Amplifier/Detector Assemblies.
AUX B	Auxiliary B	XA5(25, 49)	XA2(25) XA3(21, 46) XA6(9, 34)	
DBUS 0	Data Bus 0	XA4A(9)	XA3(6) A11 via A8J6(4)	General purpose bi-directional data bus between A4 microprocessor and A3 Counter, A7 Keyboard/Display Logic, and A11 HP-IB Interface Assemblies.
DBUS 1	Data Bus 1	XA4A(34)	XA3(31) A11 via A8J6(5)	
DBUS 2	Data Bus 2	XA4A(10)	XA3(7) A11 via A8J6(6)	
DBUS 3	Data Bus 3	XA4A(35)	XA3(32) A7 via A8J10(14) A11 via A8J6(7)	
DBUS 4	Data Bus 4	XA4A(11)	XA3(8) A7 via A8J10(7)	
DBUS 5	Data Bus 5	XA4A(36)	XA3(33) A7 via A8J10(15)	
DBUS 6	Data Bus 6	XA4A(12)	XA3(9) A7 via A8J10(8)	
DBUS 7	Data Bus 7	XA4A(37)	XA3(34) A7 via A8J10(16)	

Table 8-9. Signal Names (Continued)

Mnemonic	Name	From	To	Function
EXT REF IN	External Reference Input	A8J1 (rear panel)	XA1A(1,26)	Signal from an external source via rear panel connector to A1 Timebase Buffer circuit.
H GATE	HIGH Gate	XA4A(50)	XA3(15)	Active high signal from A4 microprocessor to control gating of MRC on A3 Counter Assembly.
H INTP RST	HIGH Interpolator Reset	XA4A(47)	XA3(11)	Active high signal from A4 microprocessor that resets the counters in the interpolator circuit on the A3 Counter Assembly.
H LF 50	HIGH Low Frequency 50Ω	XA4A(20)	XA2(23)	Control line from A4 microprocessor to A2 Low Frequency Assembly that goes high to select 50Ω low frequency input mode; signal is low for 1MΩ and high frequency modes.
H MRC CSEL	HIGH Multiple-Register-Counter Chip Select	XA4A(24)	XA3(38)	Active high signal from A4 microprocessor enables the MRC on the A3 Counter Assembly.
H MRC READ	HIGH Multiple-Register-Counter Read	XA4A(25)	XA3(39)	Active high control line from A4 microprocessor to read register contents of the MRC on the A3 Counter Assembly.
H PWRSP OK	HIGH Power Supply OK	XA1B(3,28)	XA4B(36)	Active high signal to the A4 microprocessor indicates that most of the power supplies are functioning.

Table 8-9. Signal Names (Continued)

Mnemonic	Name	From	To	Function
IB DDIR	Interface Bus Data Direction	XA4A(31)	A11 via A8J6(1)	Bidirectional interface lines between the A4 microprocessor and the microprocessor on the A11 HP-IB Interface Assembly.
IB DREC	Interface Bus Data Received	XA4A(7)	A11 via A8J6(2)	
IB DVAL	Interface Bus Data Valid	XA4A(32)	A11 via A8J6(3)	
IF	Intermediate Frequency	XA6(49)	XA3(49)	Output from the A6 IF Amplifier/Detector Assembly to the final IF stage on the A3 Counter Assembly.
IF MON OUT	IF Monitor Output	XA3(25)	A8J4 (rear panel BNC)	IF monitoring signal from final IF stage on A3 Counter Assembly to rear panel BNC connector.
IF MON RTN	IF Monitor Return	XA3(24)	A8J4 ground	Ground return for IF MON OUT signal.
IF RTN	Intermediate Frequency Return	XA6(48)	XA3(50)	Return line for IF signal from A6 IF Amplifier/Detector Assembly to A3 Counter Assembly.
L DSP PWRON	LOW Display Power On	XA4A(43)	A7 via A8J10(5)	Active low control line from A4 microprocessor that enables the front panel display drivers via the A7 Keyboard/ Display Logic Assembly.
L DSP SYNC	LOW Display Synchronization	XA4A(42)	A7 via A8J10(1)	Active low control line from A4 microprocessor to synchronize data transfer to the front panel display drivers.

Table 8-9. Signal Names (Continued)

Mnemonic	Name	From	To	Function
L EXT REF	LOW External Reference	XA1A(15)	XA4B(35)	Active low signal indicates to the A4 microprocessor that an external reference (timebase) is being used.
LF OUT A	Low Frequency Output A	XA2(3)	XA3(43)	Balanced output from A2 Low Frequency Assembly to Channel C of the MRC on A3 Counter Assembly.
LF OUT B	Low Frequency Output B	XA2(2)	XA3(42)	
LF OUT SEL	Low Frequency Output Select	XA4A(45)	XA2(9)	Control line from A4 microprocessor to select output from A2 Low Frequency Assembly: high for 1MΩ, low for 50Ω.
L IB SENSE	LOW Interface Bus Sense	A11 via A8J6(8)	XA4B(15)	Active low line to A4 microprocessor indicates that the A11 HP-IB Interface Assembly is installed.
L IF OFF	LOW Intermediate Frequency Off	XA4B(29)	XA6(12,37)	Active low control line from A4 microprocessor turns off the first two gain stages of the A6 IF Amplifier/Detector Assembly.
L IF TEST	LOW Intermediate Frequency Test	XA4B(4)	XA6(13,38)	Active low control line from the A4 microprocessor gates the AUX A/B signal to the third gain stage of the A6 IF Amplifier/Detector Assembly.
L INTP EN	LOW Interpolator Enable	XA4A(22)	XA3(36)	Active low control line from the A4 microprocessor that enables data output from the interpolator circuit on the A3 Counter Assembly.

Table 8-9. Signal Names (Continued)

Mnemonic	Name	From	To	Function
L JMP 1	LOW Jumper 1	A8	XA4B(40)	Factory-set jumpers for instrument configuration.
L JMP 2	LOW Jumper 2	A8	XA4B(16)	
L JMP 3	LOW Jumper 3	A8	XA4B(41)	
L JMP 4	LOW Jumper 4	A8	XA4B(17)	
L JMP 5	LOW Jumper 5	A8	XA4B(42)	
L JMP 6	LOW Jumper 6,	A8	XA4B(18)	
L JMP 7	LOW Jumper 7	A8	XA4B(43)	
L KB DAVL	LOW Keyboard Data Available	A7 via A8J10(4)	XA4B(12)	Active low signal from the A7 Keyboard/ Display Logic Assembly to the A4 micro-processor indicating that a front panel key is being held down for repeating.
L KB IRQ	LOW Keyboard Interrupt Request	A7 via A8J10(11)	XA4A(33)	Active low signal from the A7 Keyboard/Display Logic Assembly to the A4 microprocessor indicating that a front panel key has been pressed.
L KB READ	LOW Keyboard Read	XA4A(18)	A7 via A8J10(13)	Active low control line from the A4 microprocessor to the A7 Keyboard/Display Logic Assembly enables data transfer from the keyboard to the microprocessor and resets keyboard interrupt circuit.

Table 8-9. Signal Names (Continued)

Mnemonic	Name	From	To	Function
L LF TEST	LOW Low Frequency Test	XA4A(44)	XA2(12)	Active low control line from the A4 microprocessor turns off first stage of 1MΩ path in the A2 Low Frequency Assembly for test purposes.
L MRC STB	LOW Multiple-Register-Counter Strobe	XA4A(23)	XA3(37)	Active low control line from the A4 microprocessor used for functional programming of the MRC on the A3 Counter Assembly.
L NO IF LCH	LOW No Intermediate Frequency Latch	XA6(4,29)	XA4B(38)	Active low latched signal from A6 IF Amplifier/Detector Assembly to the A4 microprocessor to indicate that the IF level in the bandpass was momentarily less than necessary for clean counting.
L NO IF RST	LOW No Intermediate Frequency Reset	XA4B(3)	XA6(5,30)	Active low control line from the A4 microprocessor resets the L NO IF LCH circuit on the A6 IF Amplifier/Detector Assembly.
L OVLD LCH	LOW Overload Latch	XA6(1,26)	XA4B(13)	Active low latched signal from the A6 IF Amplifier/Detector Assembly to the A4 microprocessor indicates a momentary high level IF signal.
L OVLD RST	LOW Overload Reset	XA4B(28)	XA6(3,28)	Active low control line from the A4 microprocessor resets L OVLD LCH circuit on the A6 IF Amplifier/Detector Assembly.

Table 8-9. Signal Names (Continued)

Mnemonic	Name	From	To	Function
L OVN COLD	LOW Oven Cold	XA1A(19)	XA1B(2,27) XA4B(11)	Active low signal from the Timebase Buffer circuit to the A4 microprocessor indicates that the ovenized oscillator is not at the proper operating temperature; also controls the OVN DRIVE circuit on the Power Supply Control half of the A1 Assembly.
L STBY	LOW Standby	A7 via A8J10(12)	XA1B(5,30)	Control line from A7 Keyboard/Display Logic Assembly to Power Supply Control circuit on A1 is grounded when POWER switch is set to STBY, putting power supplies into standby mode.
L TEST 1	LOW Test 1	XA4B(26)	XA5(46)	Active low control lines from the A4 microprocessor to activate AUX A/B test signals from the A5 Synthesizer Assembly to other assemblies.
L TEST 2	LOW Test 2	XA4B(2)	XA5(21)	
L TEST 3	LOW Test 3	XA4B(27)	XA5(22)	
L TEST 4	LOW Test 4	XA4B(1)	XA5(47)	← Also turns off LO
L μP NMI	LOW Microprocessor Non-Maskable Interrupt	XA1B(7,32)	XA4A(15)	Active low signal from the Power Supply Control circuit to the A4 microprocessor at power-down indicates that the contents of internal RAM should be saved.
L μP RST	LOW Microprocessor Reset	XA1B(6,31)	A4A(14) A11 via A8J6(9)	Active low signal from Power Supply Control circuit resets the A4 microprocessor and the A11 HP-IB processor at power-up.

Table 8-9. Signal Names (Continued)

Mnemonic	Name	From	To	Function
L μW OFF	LOW Microwave Off	XA4A(19)	A8	Active low control line from A4 microprocessor turns off the +13V SW and +5V SW dc supplies to the A12 Microwave Assembly via circuit on A8 motherboard.
L 10MHZ OK	LOW 10MHz OK	XA1A(40)	XA4B(10)	Active low signal from Timebase Buffer on A1 to A4 microprocessor indicates that timebase signal is present.
MRC RG 0	Multiple-Register-Counter Register 0	XA4A(48)	XA3(12)	Control signals from A4 microprocessor for MRC register selection during data read from the A3 Counter Assembly.
MRC RG 1	Multiple-Register-Counter Register 1	XA4A(49)	XA3(13)	
OVN TEMP	Oven Temperature	XA10(11) (Option 001 and 010)	XA1A(44)	Analog signal from oven oscillator to Timebase Buffer indicates oven oscillator temperature.
STBY LED	Standby LED	XA1B(4,29)	A7 via A8J10(6)	Line from Power Supply Control circuit on A1 Assembly supplies current to the front panel standby LED (STBY).

Table 8-9. Signal Names (Continued)

Mnemonic	Name	From	To	Function
SYN DATA 0	Synthesizer Data 0	XA4A(1)	XA5(4,29)	Control bus from A4 microprocessor for programming LO frequency of A5 Synthesizer Assembly.
SYN DATA 1	Synthesizer Data 1	XA4A(26)	XA5(5,30)	
SYN DATA 2	Synthesizer Data 2	XA4A(2)	XA5(6,31)	
SYN DATA 3	Synthesizer Data 3	XA4A(27)	XA5(7,32)	
SYN DATA 4	Synthesizer Data 4	XA4A(3)	XA5(8,33)	
SYN DATA 5	Synthesizer Data 5	XA4A(28)	XA5(9,34)	
SYN DATA 6	Synthesizer Data 6	XA4A(4)	XA5(10,35)	
SYN DATA 7	Synthesizer Data 7	XA4A(29)	XA5(11,36)	
SYN LCH	Synthesizer Latch	XA4A(17)	XA5(12,37) XA4(6)	Control line from A4 microprocessor to the A5 Synthesizer Assembly to enable the synthesizer data input latch.
10MHZ INT CTR	10 MHz Internal Counter	XA1A(7,32)	XA3(29)	Reference frequency from the Timebase Buffer circuit on A1 to the MRC on the A3 Counter Assembly.
10MHZ INT SYN	10 MHz Internal Synthesizer	XA1A(4,29)	XA5(1,27)	Reference frequency from the Timebase Buffer circuit on A1 to the A5 Synthesizer Assembly.
10MHZ OSC	10 MHz Oscillator	XA10(1)	XA1A(17,42)	Timebase reference from the TCXO or oven oscillator to the Timebase Buffer circuit on the A1 Assembly.
10MHZ OUT	10 MHz Output	XA1A(10,35)	A8J2 (rear panel)	Reference frequencies from Timebase Buffer circuit on A1 to rear panel BNC connectors.
1MHZ OUT	1 MHz Output	XA1A(13,38)	A8J3 (rear panel)	

8-50. DISASSEMBLY AND REASSEMBLY

8-51. The following procedures are divided into four categories, as follows:

a. Cover removal (paragraph 8-56)

b. Front panel assembly removal (paragraph 8-59)

c. Microwave Module disassembly (paragraph 8-61)

d. Display Module removal and installation (paragraph 8-64)

8-52. The cover removal procedures describe how to open the instrument to gain access to all the serviceable assemblies within the counter. The front panel assembly removal procedure describes how to separate the front panel keyboard and display assembly from the mainframe and the Microwave Module to allow access for service, parts replacement, and option installation. The Microwave Module disassembly procedure describes the steps necessary for replacing the A12 Microwave Assembly or the U1 Sampler, without requiring removal of the front panel assembly. Since the Display Module in the front panel assembly is not repairable, the module must be removed as a unit, as described in the Display Module removal procedure, and a new module must be installed.

8-53. Reassembly procedures for all of the items mentioned above are essentially the reverse of the disassembly procedures. Where applicable, special reassembly instructions are given. Refer to Section VI, Replaceable Parts, for exploded views of all instrument assemblies discussed in the following procedures.

CAUTION

The electrical assemblies and components involved in the following steps are all static sensitive. To prevent electrostatic damage, all assemblies and components should be handled at a static-free work area, and in accordance with the procedures described in paragraph 8-11.

8-54. The following tools are required for these procedures:

a. Large (2 point) Pozidriv screwdriver.
b. Small (1 point) Pozidriv screwdriver.
c. Needle-nose pliers.
d. 1/4 inch open-end wrench.
e. 1/16 inch Allen driver (5351B/5352B only).
f. 3/4 inch knurled nut driver.
g. 5/16 inch open-end wrench.
h. 5.5 mm hex nut driver.
i. Small flat-bladed screwdriver.

8-55. Before performing any disassembly or reassembly procedures, the following steps must be performed:

a. Set POWER switch to STBY position.

b. Remove ac line power cord from rear panel power module.

8-56. Cover Removal

8-57. To remove the top cover, loosen the recessed Pozidriv screw at the rear of the top cover. The screw does not come out of the cover; slide the top cover to the rear 1/4 of an inch and lift off.

8-58. To remove the bottom cover, turn the instrument on its side and loosen the recessed Pozidriv screw at the rear of the bottom cover, in the same way as for the top cover. Slide the bottom cover to the rear until it can be lifted off.

8-59. Front Panel Assembly Removal

8-60. To remove the front panel assembly from the instrument, proceed as follows:

a. Remove the top cover, as described in paragraph 8-56.

b. Remove the top trim strip (MP10) from the top of the front frame (MP5) using a small flat-bladed screwdriver.

c. Remove 5 screws (H7) and 3 lockwashers (H22) from the top of the front frame. Next, remove the two front feet (MP9) from the instrument, and remove 5 screws (H7) and 3 lockwashers (H22) from the bottom of the front frame.

d. Disconnect the RF coaxial cable (A2W1) from the front panel INPUT 2 BNC connector, using a 1/4 inch wrench.

e. With a pair of needle-nose pliers, carefully remove the dc power cable to the Microwave Module (W5) from its motherboard connector (A8J11). Be sure to pull the cable connector straight up when removing it from the motherboard connector to avoid damage to the connector pins.

f. Disconnect the RF coaxial cables (W2,A6W1) connecting the A5 and A6 Assemblies to the Microwave Module RF connectors (A12J1, A12J2). Be sure to pull the cables straight down when removing them from the RF connectors. DO NOT TWIST OR BEND the SMB connections, as doing so may cause damage to the cable or Microwave Module connectors.

g. Pull the front panel assembly, with the attached Microwave Module, about 2 inches away from the instrument and disconnect the keyboard ribbon cable (W13) from its motherboard connector (A8J10).

h. If removing a 5350B front panel assembly, unscrew the knurled nut (H12) from the N-type INPUT 1 connector, using the 3/4 inch knurled nut driver. Separate the Microwave Module from the front panel assembly. This completes the front panel assembly removal for the 5350B.

i. If removing a 5351B or 5352B front panel assembly, loosen three set-screws securing the connector collar (MP37) to the INPUT 1 APC-3.5 connector, using the 1/16 inch Allen driver. Remove the collar and the knurled nut (H12) from the INPUT 1 connector. Separate the Microwave Module from the front panel assembly. This completes the front panel assembly removal for the 5351B/52B.

8-61. Microwave Module Disassembly

CAUTION

The components of the Microwave Module are extremely sensitive to electrostatic discharge, especially the U1 Sampler. Use the following precautions:

ENSURE that all disassembly and reassembly procedures are performed only at static safe work stations providing proper grounding for service personnel.

ENSURE that components and assemblies are stored in static shielding bags or containers.

DO NOT remove components or assemblies from static shielding containers until you are ready to install them.

AVOID touching component leads.

8-62. The following procedure describes how to disassemble the Microwave Module without removing the front panel assembly (see *Figure 6-3*). Proceed as follows:

a. Remove the top cover, as described in paragraph 8-56.

b. Remove right side cover (with attached strap handle) by removing two screws (H26) which hold the strap handle (MP14) and side cover (MP17) to the instrument chassis.

c. Remove two screws (H9) on the top of the Microwave Module cover (MP27), and pull the cover away from the Module.

d. Remove the two screws (H6) which can be seen through holes in the A12 Microwave Assembly. DO NOT REMOVE the A12 Assembly at this time.

e. Loosen the semi-rigid cable (INPUT 1) SMA connection at the input to the U1 Sampler (U1J1) using a $^{5}/_{16}$ inch wrench. (If Option 006 is installed for the 5350B, loosen the end of the AT1 Limiter connected to the U1J1 input.)

f. With a pair of needle-nose pliers, remove the Microwave Module dc power cable (W5) from its motherboard connector (A8J11). Be sure to pull the cable connector straight up when removing it from the motherboard connector to avoid damage to the connector pins.

g. Place your fingers around the bottom half of the Microwave Module cover (MP28) and gently pull up the bottom cover and attached A12 Assembly just far enough to gain access to the coaxial cable SMB connections underneath the Module (A12J1, A12J2). Disconnect the RF coaxial cables (W2, A6W1) from the A12 SMB connectors. Be sure to pull the cables straight down; DO NOT TWIST OR BEND the SMB connections, as doing so may cause damage to the cable or Microwave Module connectors.

h. Separate the A12 Assembly from the bottom cover by removing the two small hex nuts (H28) and lockwashers (H18) from the two SMB RF connectors, and the larger hex nut (H29) and lockwasher (H17) from the SMA sampler input connector.

i. Carefully push the A12 Assembly up out of the bottom cover by pressing on the SMB connectors, taking care not to bend the pins of the four feedthrough capacitors (C1-C4) which are plugged into pin sockets on the A12 board. BE CAREFUL not to lose the plastic spacer (MP36) which fits around the sampler SMA connector, between the A12 Assembly and the bottom cover.

CAUTION

Before performing the following steps, make sure that you are attached to a properly connected static grounding strap.

j. To remove the sampler from the A12 board, hold the sampler body while removing the two small screws (U1H1) which attach the sampler to the board. Pull the sampler straight up off the board, being careful not to bend the sampler leads as they are withdrawn from their pin sockets.

k. Immediately after removal, place the sampler in an anti-static bag or container; the U1 sampler is very static-sensitive, and can be damaged if handled without static protection. AVOID TOUCHING THE SAMPLER LEADS. This completes Microwave Module disassembly and sampler removal.

8-63. The reassembly of the sampler and the Microwave Module is simply the reverse order of the disassembly procedure described above, but the following precautions must be taken:

- When installing the U1 Sampler into the A12 board, be sure to hold the sampler by the body while installing the U1H1 screws. DO NOT TOUCH the sampler leads. Also, be sure to use the new U1H1 screws supplied with the replacement sampler. DO NOT reuse the old screws.

- When replacing the A12 Assembly, with the attached sampler, back into the bottom cover, be sure that the MP36 plastic spacer is placed onto the sampler's SMA connector between the sampler and the bottom cover. Also, be careful to line up the leads of the four feedthrough capacitors (C1-C4) with their sockets on the A12 board. BE CAREFUL not to bend the leads of the capacitors when installing the board.

- The two H18 lockwashers and one H17 lockwasher must be replaced when reinstalling the hex nuts onto the RF connectors. The lockwashers are essential for RFI suppression. Be sure to tighten the hex nuts snugly (about 8-10 inch pounds).

- Be sure that the W2 cable from the A5 Assembly, and the A6W1 cable from the A6 Assembly are correctly connected to the appropriate Microwave Module connector (A12J2 and A12J1, respectively). Refer to connection information described on the top of the Microwave Module's RF shielding can.

- Be sure that the Microwave Module dc power cable (W5) is connected correctly to the four feedthrough capacitor leads between the two SMB connectors, as follows:

Blue	—	-5.2V
Yellow	—	+5V
Gray	—	Ground
Red	—	+13V

8-64. Display Module Removal And Installation

CAUTION

The Display Module is extremely sensitive to electrostatic discharge. Use the following precautions:

ENSURE that all disassembly and reassembly procedures are performed only at static safe work stations providing proper grounding for service personnel.

ENSURE that the Display Module is stored in a static shielding bag or container.

DO NOT remove a replacement Display Module from its static shielding container until you are ready to install it.

AVOID touching circuit traces and component leads.

NOTE

The Display Module is not a repairable assembly. A replacement Display Module assembly (HP P/N 05350-60106) is available from the factory. Refer to Section VI for ordering information.

8-65. To remove the Display Module, proceed as follows (See *Figure 6-2*):

a. Remove the front panel assembly from the instrument, as described in paragraph 8-59, including removal of the Microwave Module.

b. After removal of the Microwave Module, lay the front panel down on a clean surface.

c. Unplug the two display driver ribbon cables (W3,W4) and the two-wire dc power cable (A7W2) connected to the Display Module.

CAUTION

The pins of the W3 and W4 display driver ribbon cables are very fragile. To remove the cables from the A7 board sockets, pull straight up on the plastic tabs attached to the end of each cable. BE CAREFUL not to bend the pins when removing them from the sockets.

d. Remove four nuts (H11) and lockwashers (H21) from the back of the Display Module with a 5.5 mm nut driver.

e. Pull the Display Module, along with the attached display shield (MP25), up off of the rivet-on studs on the sub-panel (MP21). If necessary, the Display Module can be pushed off the studs by pressing against the front of the display window.

f. Remove the MP25 display shield from the Module, being careful not to deform the thin metal of the shield. This completes the Display Module removal procedure.

8-66. To install a replacement Display Module into the front panel assembly, proceed as follows:

a. Wrap the MP25 display shield around the Display Module, being careful not to deform the display shield. Be sure the display shield is oriented correctly so that the holes in the shield are aligned with the holes in the Module.

b. Check the display window (MP35) to be sure it is clean, and located properly in the MP21 sub-panel.

c. Slide the Display Module and attached shield down over the four studs on the sub-panel.

d. Install the four H11 nuts and H21 lockwashers onto the sub-panel studs, and tighten with the 5.5 mm nut driver. DO NOT OVERTIGHTEN THE NUTS.

NOTE

It may be helpful to slip some metal sheet material, approximately 2 mm thick, between the display shield and the top flange of the sub-panel to keep the shield in place while tightening the nuts. This will ensure that after the Display Module is secure, there will be sufficient room for the sampler mounting bracket to fit. DO NOT USE cardboard or other particle generating material for this purpose; use only metal sheet material, such as aluminum.

e. Reattach the A7W2 dc power cable, and the W3 and W4 display driver ribbon cables. BE EXTREMELY CAREFUL when inserting the display driver cables; the W3 and W4 pins are very fragile.

f. This completes the Display Module installation. The Microwave Module and the front panel assembly can now be installed back into the instrument.

8-67. SERVICE ACCESSORIES

8-68. Service accessories designed to aid in troubleshooting the HP 5350B/51B/52B are available from Hewlett-Packard. *Table 8-10* lists the accessories available, HP part number, and a brief description of their use.

Table 8-10. Service Accessories Available

Accessory	HP Part No.	Description and Use
Extender Boards (2 required)	5060-0175	50-pin (2 X 25) printed circuit board with attached insulating pad; Allows assemblies A1 through A6 to be extended from their plug-in connectors for monitoring with appropriate test equipment.
Extender Cable for A5 Assembly	05350-60102	SMB (male) to SMB (female); Identical to W2 cable in the instrument, but is not attached to a metal RF shielding cover. Allows connection of A5 Synthesizer Assembly output (W2) to Microwave Module when A5 Assembly is mounted on an extender board, outside of RF shielding can.
IF Test Cable	05350-60121	90° SMB (female) to BNC (male); Allows viewing of Microwave Module IF output (A12J1) with spectrum analyzer or oscilloscope.
LO Test Cable	05350-60120	90° SMB (male) to BNC (male); Allows viewing of LO output (W2) of A5 Synthesizer Assembly with a spectrum analyzer.

8-69. THEORY OF OPERATION

8-70. The following pages describe the operation of the HP 5350B/51B/52B. The description begins with a discussion of the harmonic heterodyne down-conversion technique, followed by discussions of FM tolerance, automatic amplitude discrimination, and sensitivity. Next, overall counter operation is described, showing the function and relationships of the major assemblies (with a complete block diagram). Finally, a detailed circuit description for each field repairable board assembly is given.

8-71. HARMONIC HETERODYNE TECHNIQUE

8-72. The HP 5350B/51B/52B Microwave Frequency Counter uses a harmonic heterodyne down-conversion technique to convert the microwave input frequency into the range of its internal low frequency counter. This technique combines the best performance characteristics of heterodyne converters and transfer oscillators to achieve high sensitivity, high FM tolerance, and automatic amplitude discrimination.

8-73. All microwave counters must down-convert the unknown microwave frequency to a low frequency signal which is within the counting range of an internal low frequency counter (about 100 MHz). Heterodyne converters down-convert the unknown signal, f_X, by mixing it with the Nth harmonic of an accurately known local oscillator frequency, f_{LO}, such that the difference frequency, f_{IF} (defined as $f_X - N \bullet f_{LO}$ if $f_X > N \bullet f_{LO}$, or as $N \bullet f_{LO} - f_X$ if $f_X < N \bullet f_{LO}$), is within the counting range of the low frequency counter. The counted frequency, f_{IF}, is then added to (or subtracted from, if $f_X < f_{LO}$) the Nth multiple of the local oscillator frequency to determine the input frequency.

8-74. Like heterodyne converters, transfer oscillators also mix the unknown signal with harmonics of an internally generated signal, f_{VCO}. When one of the harmonics of the VCO signal, $N \bullet f_{VCO}$, mixes with the unknown to produce zero beat, the VCO frequency is measured by the low frequency counter. After determining which harmonic produced zero beat, the measured VCO frequency is multiplied by N to determine the input frequency ($f_x = N \bullet f_{VCO}$).

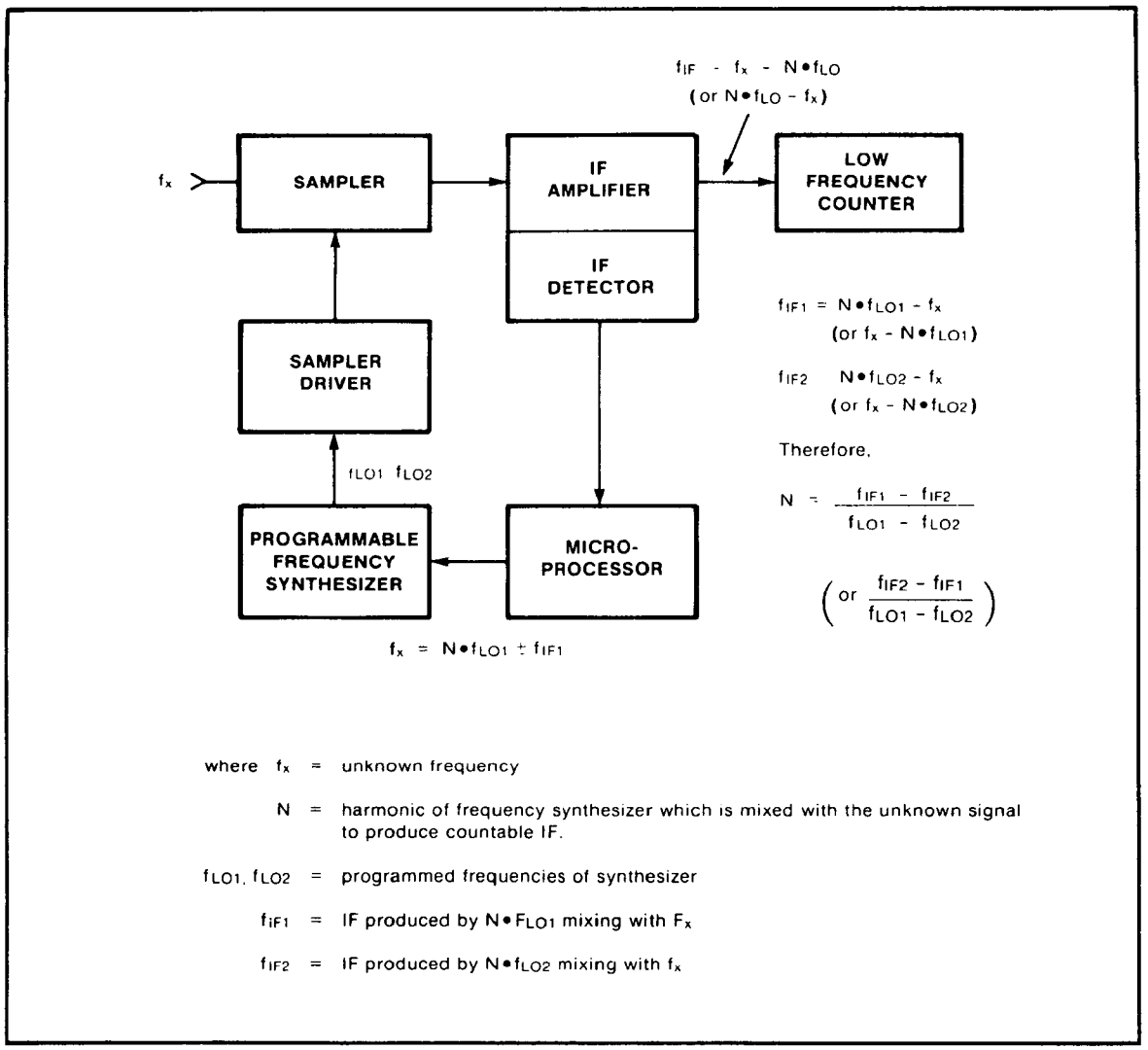


Figure 8-4. Harmonic Heterodyne Technique

8-75. *Figure 8-4* is a simplified block diagram of the harmonic heterodyne technique. In this technique, all of the harmonics of an internal oscillator (a programmable frequency synthesizer locked to the counter's time base) are simultaneously mixed with the unknown signal by the sampler and sampler driver (samplers are like harmonic mixers — the sampling diodes in the HP 5350B/51B/52B sampler conduct only for a few picoseconds during each period of the sampling signal, generating comb lines which span the RF input bandwidth). The output of the sampler consists of sum and difference frequencies produced by each harmonic of the internal oscillator mixing with the unknown. The programmable frequency synthesizer is decremented in frequency until one of the outputs of the sampler is in the counting range of the low frequency counter. The IF detector detects when the IF is in the range of the low frequency counter and sends a signal which causes the microprocessor to stop decrementing the frequency of the frequency synthesizer. The IF is then counted by the low frequency counter.

8-76. The frequency, f_{LO1}, of the programmable synthesizer is known. The IF frequency, f_{IF1}, is known since it is counted by the low frequency counter. Still to be determined are the N number and the sign (±) of the IF (the sign of f_{IF1} will be (+) if $N \bullet f_{LO1}$ is less than f_x; the sign of f_{IF1} will be (–) if $N \bullet f_{LO1}$ is greater than f_x).

8-77. To determine N and the sign of f_{IF1}, one more measurement must be taken with the synthesizer frequency offset from its previous value by a known frequency to produce f_{LO2} ($f_{LO2} = f_{LO1} - \Delta f_{LO}$). This produces an IF, f_{IF2} (guaranteed by the software to be based on the same N number and sideband as f_{IF1}), which is counted by the low frequency counter. N is determined by the following:

$$f_{IF1} = N \bullet f_{LO1} - f_x \qquad \text{(if } N \bullet f_{LO1} > f_x\text{)}$$

$$f_{IF2} = N \bullet f_{LO2} - f_x \qquad \text{(if } N \bullet f_{LO2} > f_x\text{)}$$

$$\text{therefore } N = \frac{f_{IF1} - f_{IF2}}{f_{LO1} - f_{LO2}} \qquad \text{(rounded to the nearest integer)}$$

or, if f_x is greater than $N \bullet f_{LO1}$:

$$f_{IF1} = f_x - N \bullet f_{LO1} \qquad \text{(if } N \bullet f_{LO1} < f_x\text{)}$$

$$f_{IF2} = f_x - N \bullet f_{LO2} \qquad \text{(if } N \bullet f_{LO2} < f_x\text{)}$$

$$\text{therefore } N = \frac{f_{IF2} - f_{IF1}}{f_{LO1} - f_{LO2}} \qquad \text{(rounded to the nearest integer)}$$

8-78. Referring to *Figure 8-5*, it is seen that if f_x is greater than $N \bullet f_{LO1}$, then f_{IF1}, produced by mixing $N \bullet f_{LO1}$ with f_x, will be less than f_{IF2}, produced by mixing $N \bullet f_{LO2}$ with f_x, since f_{LO2} is less than f_{LO1}, by Δf. However, if f_x is less than $N \bullet f_{LO1}$, then f_{IF1} will be greater than f_{IF2}.

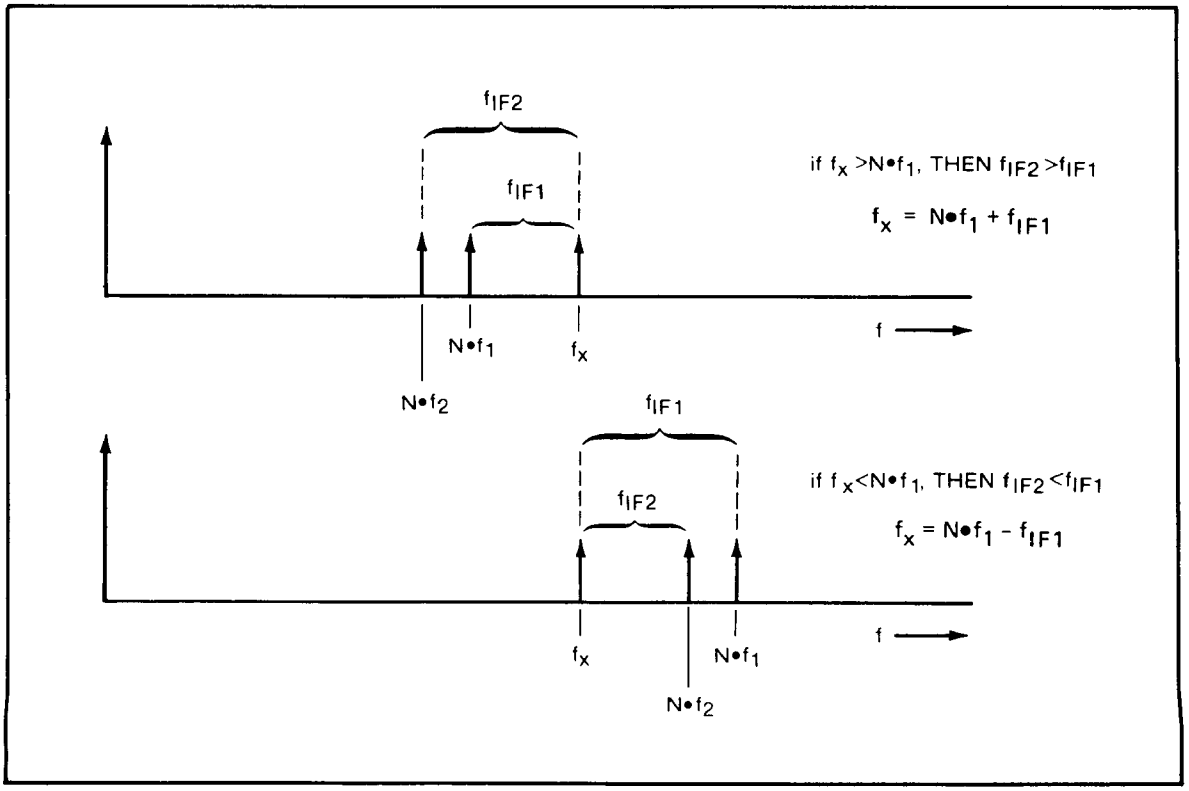


Figure 8-5. Frequency Relationships

8-79. The value of N is computed from:

$$N = \left| \frac{f_{IF1} - f_{IF2}}{f_{LO1} - f_{LO2}} \right|$$

8-80. The unknown frequency is then computed from the following:

$$f_x = N \bullet f_{LO1} - f_{IF1} \qquad (\text{if } f_{IF2} < f_{IF1})$$

$$f_x = N \bullet f_{LO1} + f_{IF1} \qquad (\text{if } f_{IF1} < f_{IF2})$$

8-81. Since the mean frequency of the synthesizer is known to the accuracy of the counter's timebase and the IF is measured to the accuracy of the counter's timebase, the accuracy of the microwave measurement is limited only by the time base error and the residual stability of the synthesizer.

8-82. FM TOLERANCE

8-83. If all signals into the counter could be guaranteed to have little or no FM, the counter could operate quite simply as described previously. However, many signals in the microwave region, such as those originating from microwave radios, have significant amounts of frequency modulation. To prevent FM on the signal from causing an incorrect computation of N, the harmonic heterodyne technique is implemented as described in the following paragraphs. (See *Figure 8-6.*)

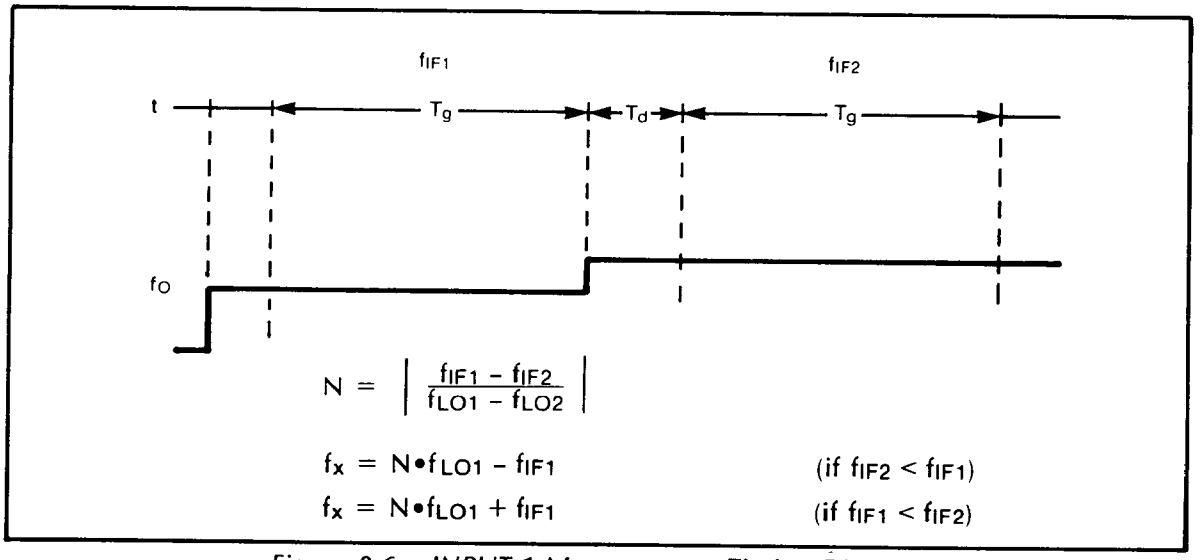


Figure 8-6. INPUT 1 Measurement Timing Diagram

8-84. The LO is swept across the band until the user's signal is found. At this point a dead time takes place for the LO to stabilize. Now the first measurement f_{IF1} is taken during gate time t_g. The LO frequency is now offset by Δf_{LO} during t_d. The dead time t_d must be long enough for the LO to stabilize. After this the second measurement f_{IF2} is taken during gate time t_g.

8-85. If the user signal has FM with peak deviation Δf_x at a rate f, we could have a maximum error in harmonic number ΔN given by:

$$\Delta N = \frac{\Delta f_x}{\Delta f_{LO}} \bullet 2\sin\pi f(t_g + t_d) \bullet \left(\frac{\sin\pi f t_g}{\pi f t_g}\right)$$

where Δf_{LO} = LO frequency offset = $f_{LO1} - f_{LO2}$

Δf_x = peak frequency deviation of user signal

f = rate by which the user signal is frequency modulated

t_d = time interval between the two consecutive measurements

t_g = gate time

8-86. FM Rate Tolerance

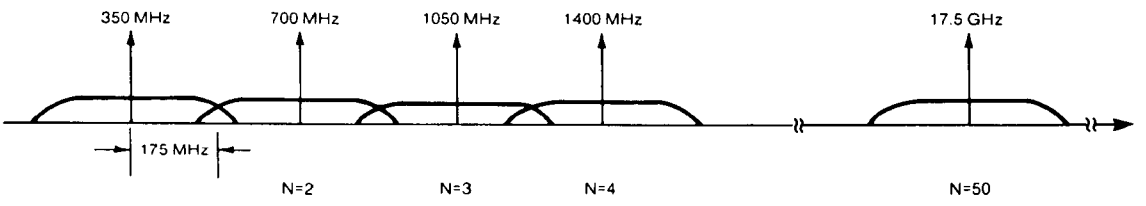
8-87. As long as ΔN is less than 0.5, the correct N can be computed. However, ΔN is selected to be less than 0.3. Using the formula above, the computed values for t_g, t_d, and f_{LO} tolerate a maximum peak deviation Δf_x of 10 MHz down to a minimum FM rate of 1 kHz or 45 Hz, which is selectable using the FM Rate Tolerance function of the HP 5350B/51B/52B. When measuring signals with an FM rate lower than 1 kHz, a longer gate time is used to permit the correct computation of N at the lower rate.

8-88. AUTOMATIC AMPLITUDE DISCRIMINATION

8-89. The HP 5350B/51B/52B has the ability to automatically discriminate against lower amplitude signals in its range of 0.5-20 GHz [26.5 GHz, 40 GHz] in favor of the highest amplitude signal in the range. Thus, if there is 20 dB separation between the highest amplitude signal and any other signal in the 0.5-20 GHz [26.5 GHz, 40 GHz] range, the counter automatically measures the highest amplitude signal.

8-90. Amplitude discrimination is a feature of the HP 5350B/51B/52B as a direct result of two design elements. First, the IF amplifier limits all signals produced by inputs greater than the counter's sensitivity, ensuring that the IF is correctly derived from the largest amplitude signal in the input spectrum; the IF will be phase modulated by the lower amplitude signals. (This AM to PM conversion is a characteristic of limiters. The bandwidth and roll-off of the IF amplifier are chosen so that the PM does not introduce errors into the count.)

8-91. Second, the bandwidth of the IF amplifier is 1/2 of the maximum LO frequency so that for all LO frequencies, any input signal will be mixed down to a frequency within the limiter bandwidth. This guarantees that the largest signal is measured.



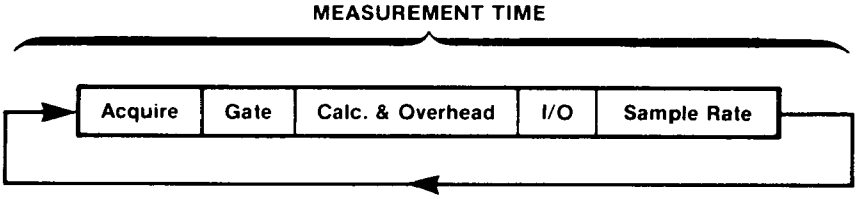
8-92. SENSITIVITY

8-93. The limiting factors in determining the sensitivity of the HP 5350B/51B/52B are the effective noise bandwidth of the IF, and the conversion efficiency of the sampler. The noise bandwidth of the IF determines the noise power, and the sampler conversion efficiency determines the IF signal power (for a fixed input power). The IF signal-to-noise ratio must be kept at a value which insures that there are no noise induced errors in counting the IF signal at the minimum signal input level.

8-94. The microprocessor detects two parameters: the first is the output from the IF detector, which is true if the IF signal is in the range of 35 MHz to 105 MHz and the counter input power level is greater than approximately -30 dBm; the other parameter is from the internal counter, which is true if the IF frequency is in the range of 45 MHz to 95 MHz. The IF detector thus insures that the input signal is sufficiently large to produce an IF with an acceptable signal-to-noise ratio, and that the highest IF frequency is low enough to be correctly counted. The 45 MHz to 95 MHz IF information is used to center the IF in the range of 45 MHz to 95 MHz to achieve the specified FM tolerance.

8-95. MEASUREMENT TIME

8-96. The rate at which complete measurements can be made is called "measurement time." Measurement time consists of acquisition time, gate time, calculation and overhead time, I/O (display and HP-IB) time, and sample rate time, as shown below:



8-97. Measurement time provides a good indication of how quickly results can be obtained from a counter. Acquisition time is the time necessary for a counter to configure its circuitry to measure a signal (i.e. the time to determine the harmonic number). Gate time is the time in which the actual measurement takes place. Note that there is no acquisition time for INPUT 2 measurements.

8-98. In Auto mode, acquisition time is comprised of a Local Oscillator sweep to set the LO to its proper value, and harmonic number and sideband determination. In Manual mode, acquisition time is calculation time for the LO frequency, harmonic number, and sideband, plus time to allow the LO to be programmed and to settle.

8-99. Gate time is a function of the resolution setting. A resolution of 1 Hz denotes a maximum gate time of 1 second. For 1MΩ (INPUT 2) measurements, the High Resolution function may be selected to give a resolution up to 0.001 Hz with a 1 second gate time.

8-100. Calculation and overhead time, and I/O time are dead times during which the microprocessor formats and outputs the results of the latest measurement to the display and the HP-IB.

8-101. Sample rate time is a method for controlling the total measurement time and thus the display update rate. Sample rates for the HP 5350B/51B/52B vary from Fast (allowing the counter to count as frequently as possible) to Hold (allowing the counter to retain the value of the last measurement until the next measurement is triggered). Intermediate sample rate values range from 0.5 seconds to 10 seconds.

8-102. Measurement times for local measurements differ from those for remote measurements. Harmonic number determination during a local measurement is done once during each measurement. In remote operation, harmonic number determination is done once every 10 measurements to increase data throughput.

8-103. HP 5350B/5351B/5352B BLOCK DIAGRAM DESCRIPTION

8-104. *Figure 8-7* is a block diagram of the HP 5350B/51B/52B Microwave Frequency Counter showing all the assemblies of the instrument. The six major sections are: the low frequency input section, the microwave section, the synthesizer section, the IF amplifier/detector section, the counter section, and the control section. Auxiliary sections include: the front panel keyboard/display section, the timebase/timebase buffer section, the power supply section, and the HP-IB interface section. Most of these sections are made up of single-board circuits, except the front panel keyboard/display section (A7 and A9 assemblies), the power supply section (A8 and part of A1 assemblies), and the timebase/timebase buffer section (A10 and part of A1 assemblies). Each section is briefly discussed in the following paragraphs. A component level description of each board assembly is given in the detailed circuit descriptions beginning at paragraph 8-141.

8-105. Low Frequency Input Section (A2 Assembly)

8-106. The A2 Low Frequency Input Assembly accepts signals below 525 MHz. The signals are preconditioned and then sent to the counter section. There are two input settings: a prescaled 50Ω input from 10 MHz to 525 MHz and a direct count 1MΩ input from 10 Hz to 80 MHz. The input signal is applied through a fused BNC connector on the front panel and switched either to the 1MΩ or the 50Ω path by pressing the appropriate front panel key next to the input connector. The low frequency output multiplexer on the A2 Assembly is controlled by the A4 Microprocessor Assembly. The low frequency signal is routed to the Channel C input of the MRC (Multiple Register Counter) on the A3 Counter Assembly. During the time the main gate on the A3 Assembly is enabled from the A4 microprocessor, events pass through the main gate to Channel C of the MRC, where they are totalized. At the conclusion of the gate time, the microprocessor reads the contents of the counter and computes the input frequency. A 35 MHz test signal is routed from the A5 Synthesizer Assembly to the A2 Low Frequency Input Assembly for diagnostic and self test purposes. When the test signal is in operation, the initial gain stages of the A2 Assembly are turned off by the A4 Assembly.

8-107. Microwave Section (A12 Assembly/U1 Sampler)

8-108. The basic function of the microwave section (Microwave Module) in the HP 5350B/51B/52B is to perform the down-conversion of microwave signals in the 500 MHz to 20 GHz [26.5 GHz, 40 GHz] region to the intermediate frequency (IF) region of the counter. The 40 to 100 MHz IF signal can then be detected and amplified by the A6 IF Amplifier/Detector Assembly, and counted by the A3 Counter Assembly. To perform its function, the Microwave Module requires a high power local oscillator (LO) signal from the A5 Synthesizer Assembly.

8-109. The Microwave Module can be divided into three sections: the sampler driver, sampler, and the IF preamplifier. The sampler driver is a medium power, class B power amplifier which accepts the +14 dBm LO signal from the A5 Assembly via a coaxial cable. The signal is amplified by +11 dB, and sent to the sampler.

8-110. The U1 Sampler is the heart of the down-conversion system. The sampler driver signal drives a step-recovery diode (SRD) in the sampler to produce a very narrow voltage pulse. This pulse is used to control the sampling of the microwave signal entering the sampler RF connector (via the front panel INPUT 1 connector). When a harmonic of the LO sampling frequency is close to the microwave input signal frequency, a signal within the IF bandwidth results, and is sent to the IF preamplifier.

8-111. The IF preamplifier performs several functions, including: IF signal amplification, providing a flat IF response for proper automatic amplitude discrimination, controlling dc bias current for the U1 Sampler, impedance matching, and isolating the IF from the LO feedthrough signal and its harmonics. The IF signal passes through matching, filter, and frequency compensation networks, and is amplified +32 dB before it is sent to the A6 Assembly.

8-112. Synthesizer Section (A5 Assembly)

8-113. The A5 Synthesizer Assembly provides the 294.5 to 350.0 MHz local oscillator (LO) signal to the A12 Microwave Assembly. The LO frequency is programmed by the A4 Microprocessor Assembly and is referenced to the 10 MHz timebase signal. The synthesizer circuit is based on a single phaselock loop (PLL), which allows the high frequency wideband tuneable oscillator (VCO) in the synthesizer to have the same frequency accuracy and drift characteristics as the crystal oscillator timebase.

8-114. The 10 MHz signal from the timebase buffer is divided by 100 to obtain a 100 kHz reference for the phaselocked loop. A voltage controlled oscillator (VCO) frequency is divided by the counters which are controlled by the A4 microprocessor. The output of these programmable frequency dividers is compared to a 100 kHz reference in a phase detector. The phase detector output is integrated and filtered, and used to control the frequency of the VCO, forming a closed-loop negative feedback system. The feedback forces the output frequency of the programmable dividers to equal the 100 kHz reference. Thus the VCO frequency will be a programmable multiple of 100 kHz.

8-115. The VCO output signal is amplified to +14 dBm (minimum) and sent to the Microwave Module via a coaxial cable. A 35 MHz auxiliary output signal from the frequency dividers is sent to the counter, IF amplifier/detector, and low frequency boards for diagnostic and self test procedures. This auxiliary output is turned off during normal operation of the instrument.

8-116. IF Amplifier/Detector Section (A6 Assembly)

8-117. The output signal of the +32 dB amplifier on the microwave module assembly is routed to the input of an elliptic 175 MHz low pass filter on the A6 assembly. The filter output is monitored by an overload detection circuit that drives a comparator. A latch holds any overload condition and sends the appropriate overload indication signal to the microprocessor. The output of the 175 MHz filter is then amplified by a +12 dB amplifier.

8-118. A second +12 dB amplifier stage routes the signal through a 200 MHz low pass filter. A differential amplifier stage provides an additional +14 dB of gain. This stage has an input for the test signal which comes from the synthesizer and is controlled by the microprocessor via a diode gate. The IF passes through a diode limiter circuit and an attenuator/matching network before passing through a second +14 dB stage. The IF is then sent to an amplifier on the A3 Counter Assembly.

8-119. A second detection circuit path is used for guardband and acquisition monitoring. At the output of the diode limiter, an emitter-follower circuit routes the signal through a band pass filter to the detector circuit. A comparator monitors the detector output and drives a latch which sends the appropriate IF detection signal to the microprocessor.

8-120. Counter Section (A3 Assembly)

8-121. The A3 Counter Assembly contains the MRC (Multiple Register Counter), an interpolator circuit, and a final +14 dB gain stage for the IF signal. The MRC is clocked by the 10 MHz signal coming from the timebase buffer circuit on the A1 board. The MRC Channel A input counts the IF signal coming from the A6 IF assembly, Channel B counts the 35 MHz test signal from the A5 Synthesizer, and Channel C is used for the low frequency measurements. Gating, channel selection, and all other MRC setups and the interpolator are controlled by the A4 Microprocessor Assembly.

8-122. The general operation of the counter centers on the interaction between the A4 microprocessor and the MRC. The MRC (Multiple Register Counter) is an LSI bipolar IC. 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.

8-123. For a low frequency measurement (< 525 MHz), the microprocessor uses the accumulated Events and Time data directly, calculating the measured frequency by dividing the contents of the Events register by the contents of the Time register. For high frequency measurements (> 525 MHz), the Events/Time data determines the IF frequency, which the microprocessor uses to calculate the frequency of the input to the instrument. The measurement gate time is controlled by the microprocessor.

8-124. For increased measurement resolution, an interpolator circuit measures the uncertainty introduced by the time difference between the actual input events and the opening and closing of the counting gate. The MRC detects the slight error factor, and provides start and stop pulses to the interpolator circuit. The interpolator circuit measures the error factor and sends the data to the microprocessor, which then uses the interpolator data in the measurement calculations to compensate for the uncertainty.

8-125. Microprocessor Section (A4 Assembly)

8-126. The HP 5350B/51B/52B's CPU is designed around an MC6803 8-bit microprocessor, using a memory-mapped architecture. An 8-bit bidirectional data bus is used to control and monitor various circuits and assemblies within the instrument, in a static operating mode. The microprocessor controls the display, reads the keyboard, and receives a signal from a detector on the timebase buffer to indicate if an internal or external source is present and if an ovenized crystal oscillator has stabilized. The processor controls the MRC's gate, sets the MRC control registers, and reads the data over the static data bus.

8-127. The processor receives overload, acquisition, and guardband signals from the IF section, after which the processor programs the dividers on the synthesizer and implements them by a strobe signal. The processor also controls the signal path on the low frequency board. Finally, the A4 microprocessor interacts with the processor on the HP-IB interface board, which controls all commun

8-128. The A4 assembly contains a 2K byte RAM IC and two 16K byte ROM ICs. When the counter is in the standby mode, a +5V standby RAM supply for the microprocessor will stay on, and the instrument's programmed front panel/HP-IB settings and HP-IB address will be retained in the processor's internal RAM as long as ac power is connected to the instrument.

8-129. Since the processor is the center of the instrument, any failure or inconsistency on its part would greatly influence the instrument's performance. The processor assembly has several levels

of diagnostics available for testing and servicing. Very likely none of the other hardware would function if the processor has failed. For this reason, special troubleshooting procedures are provided, as follows:

a. User-Callable Diagnostics (Paragraph 8-399)
(accessible via the front panel or over the HP-IB)

b. Free-Run Signature Analysis (Paragraph 8-647)
(accessible via an on-board test socket)

c. Hardwired diagnostics (Paragraph 8-541), including:
Hardwired Signature Analysis
Hardwired Keyboard Test
Hardwired Display Test
(accessible via motherboard jumpers)

8-130. Keyboard/Display Section (A7 and A9 Assemblies)

8-131. The keyboard/display section consists of the A7 Keyboard/Display Logic Assembly and the Display Module (which contains the A9 Backlight Assembly). The A7 Assembly contains a 17-key keyboard matrix circuit, and encoding and interface circuitry for sending front panel entry data to the A4 microprocessor. The A7 Assembly also contains the display logic and interface circuitry for receiving and displaying data from the processor.

8-132. All data flow to and from the A7 Assembly is over five data bus lines, and three control lines from the microprocessor direct the timing and synchronization of input and display activity. The A7 Assembly also contains the front panel POWER switch circuit; when the POWER switch is set to STBY, the instrument settings are saved and the optional oven oscillator timebase, if present, is kept warm.

8-133. The display consists of a 24-character Liquid Crystal Display, (LCD) backlit by LEDs within the A9 Assembly to provide increased contrast for improved viewing. The LCD displays all measurement information alphanumerically, and can be programmed via the HP-IB to display messages.

8-134. Timebase/Timebase Buffer Section (A10 and part of A1 Assemblies)

8-135. The instrument's standard oscillator is a Temperature Compensated Crystal Oscillator (TCXO). The counter may also be equipped with one of two types of optional timebases: an oven oscillator providing an improved aging rate over that of the standard TCXO, and a high stability oven oscillator providing a greatly improved aging rate allowing increased calibration periods of up to five years. Both the standard TCXO and optional oven oscillators provide a 10 MHz timebase reference frequency to the Timebase Buffer circuit (part of the A1 Timebase Buffer/Power Supply Control Assembly).

8-136. The Timebase Buffer on the A1 Assembly has four main output signals. The 10 MHz main signal goes to the A3 Counter and A5 Synthesizer Assemblies. Two rear panel outputs, 10 MHz and 1 MHz, are available for monitoring. When the instrument is in Standby, the 10 MHz and 1 MHz signals will still be available at the rear panel outputs, but not in the instrument.

8-137. The rear panel has an input for a 1, 2, 5, or 10 MHz external reference signal. A detection circuit on the A1 assembly will detect if an external reference source is being used for the timebase, and send a signal to the microprocessor, which will indicate through a display annunciator that an external source is being used. The instrument will automatically switch from the internal oscillator to the external reference. The display will also indicate when an ovenized oscillator (if present) is still cold.

8-138. The Timebase Buffer circuit also includes regulators for providing voltage supplies to both the standard and optional timebase oscillators, and a Standby voltage for the A4 microprocessor's internal RAM.

8-139. Power Supply Section (A8 and part of A1 Assemblies)

8-140. The power supply circuitry consists of the chassis-mounted power module and transformer, rectifying and series pass components on the A8 Motherboard/Power Supply Regulator Assembly, and current and voltage sense circuits on the Power Supply Control portion of the A1 Assembly. The A8 circuit produces regulated +15, +5, and -5.2 volt supplies for all instrument assemblies, as well as special purpose supplies for the HP-IB interface (+5V CMC), Microwave Module (+5V SW, +13V SW), and the oven oscillator and synthesizer boards (-24V).

8-141. Voltage and current sense lines from A8 go to the A1 circuitry, which in turn send voltage drive lines to the A8 circuitry to regulate the supplies. Unregulated +15 and +5 volts are also sent to the Timebase Buffer circuit for regulation, as described in paragraph 8-138.

8-142. HP-IB Interface Section (A11 Assembly)

8-143. The A11 Assembly controls all HP-IB interfacing between the HP 5350B/51B/52B and an external controller, allowing the counter to be remotely programmed to perform almost all functions normally available via the front panel keyboard. The interface partially decodes commands from the controller and sends them to the A4 microprocessor, and formats output data from the processor to send to the controller. The A11 Assembly contains a seven-position switch for manual selection of the HP 5350B/51B/52B HP-IB address; the address is also selectable via the front panel keyboard.

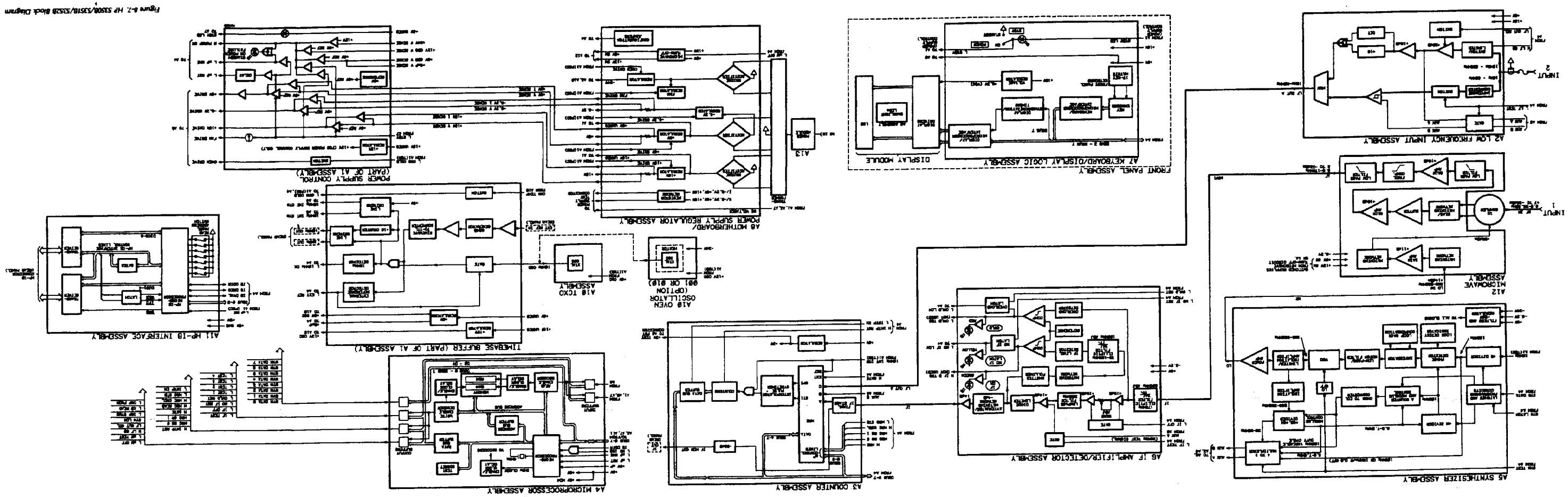


Figure 6-7. HP 5350B/5351B/5352B Block Diagram

8-144. DETAILED CIRCUIT DESCRIPTIONS

8-145. The following paragraphs cover the theory of operation of each of the assemblies (pc boards) in the instrument. A block diagram is provided for each assembly, and schematic diagrams are provided at the end of this manual (after the troubleshooting procedures). The descriptions are arranged in numerical order by assembly reference designation, with the exception of the A8/A1(PSC) assemblies that make up the power supply circuit, and the A10/A1(TBB) assemblies that form the timebase/timebase buffer circuits.

8-146. Power Supply Circuit (A8 and part of A1 assemblies)

8-147. The power supply for the 5350B/51B/52B consists of the Power Supply Regulator circuit on the A8 Assembly, and the Power Supply Control circuit on the A1 Assembly, together with several chassis-mounted components. The A8 motherboard contains the majority of the power supply components. The voltage regulators for the timebase oscillator and buffer circuits are located on the timebase buffer half of the A1 Assembly and are described in a separate theory of operation, beginning at paragraph 8-199.

8-148. A block diagram of the A8 Assembly is shown in *Figure 8-9*, and a block diagram of the Power Supply Control portion of the A1 Assembly is shown in *Figure 8-10*.

8-149. In the following circuit description, the chassis-mounted components will be discussed first. Then, each of the functional stages of the +5, +15, and -5.2 volt supplies will be described, first in general, and then specifically for each individual supply, as necessary. Finally, the +12V, -24V, and fan voltage will be described. The board assembly under discussion will be identified at the beginning of each functional description, and all reference designations in that description will be in reference to the named assembly, unless otherwise indicated.

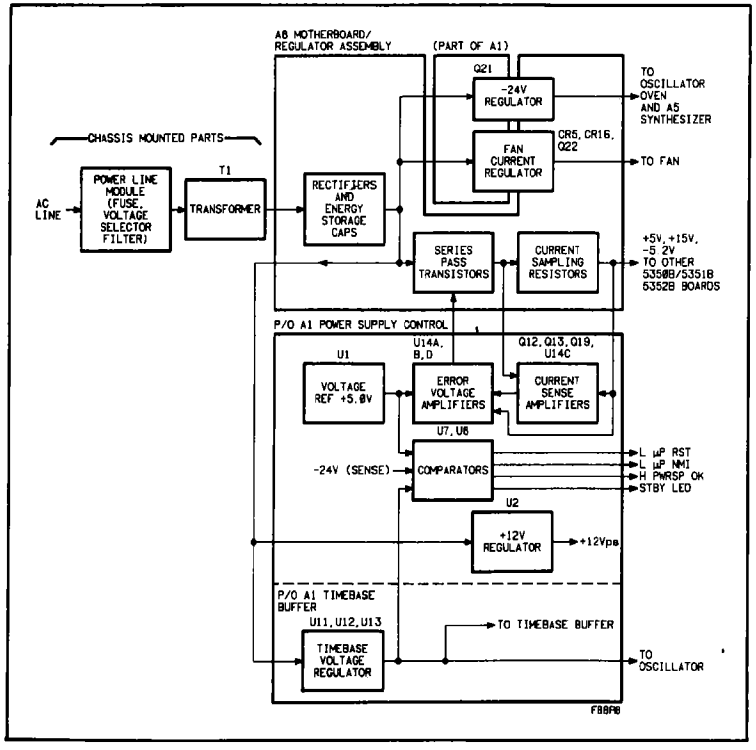


Figure 8-8. Power Supply Block Diagram

Figure 8-7
HP 5350B/5351B/5352B BLOCK DIAGRAM
(See Page 8-43)

8-150. CHASSIS-MOUNTED COMPONENTS. Chassis-mounted power supply components consist of the ac power module (A13), and the power transformer (T1). The ac power module in the instrument's rear panel contains a connector for the power cord, a fuse (in the hot line), a filter, and a four position line voltage selector card. The position of the voltage selector card determines the connections to the primary windings on the power transformer.

8-151. The power transformer converts the ac line voltage to several lower voltages and isolates the ac line from the instrument circuitry. Both the primary and secondary sides of the transformer have cable connectors (W7,W8) to allow easy disassembly and reassembly of the instrument.

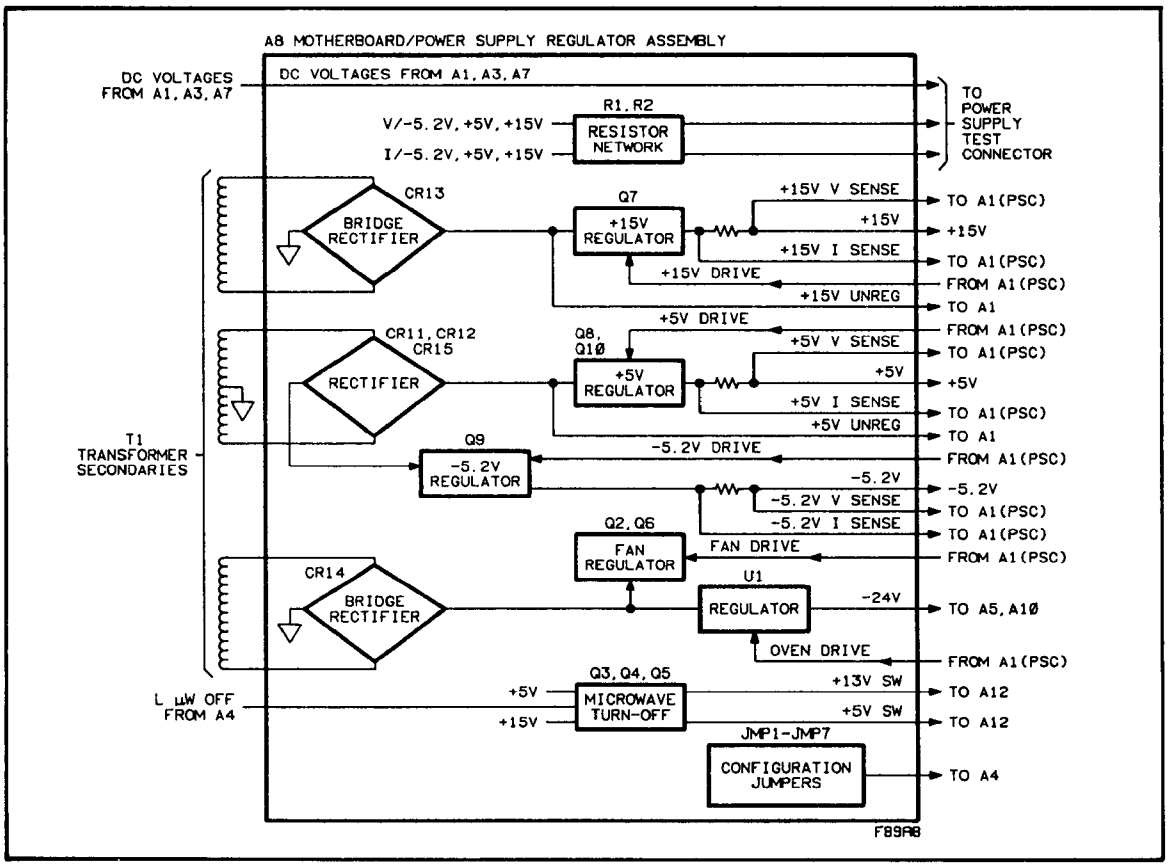


Figure 8-9. A8 Block Diagram

8-152. RECTIFIERS (A8). The lowest-voltage transformer secondary is center-tapped; CR15 is a full-wave center-tap rectifier for the unregulated +5V, and CR11 and CR12 form a full-wave center-tap rectifier for the unregulated -5.2V. The other two transformer secondaries are rectified by full-wave bridge rectifier CR13 for the unregulated +15V and +12V, and by CR14 for the unregulated -24V and fan voltage. The rectified unregulated voltages are present whenever ac power is connected to the instrument.

8-153. Fuse F2 is in series with the secondary which supplies the unregulated +15V because this secondary winding has enough series resistance to prevent a secondary short circuit from blowing the primary fuse.

8-154. ENERGY STORAGE CAPACITORS (A8). C3, C4, C18, and C19 store energy to supply the dc power to the regulators between peaks of the ac line half-cycles. R20A through E, and R14C slowly drain the charge out of the energy storage capacitors after the instrument is unplugged.

8-155. SERIES PASS TRANSISTORS (A8). Q7, Q9, and Q10 are series pass transistors for the +15V, -5.2V, and +5V regulators. Q8 supplies the base current for Q10 from the unregulated +15V. CR10 prevents large reverse currents through Q8 in case the unregulated +15V is off for any reason. The Power Supply Control part of the A1 board supplies the base current drive for Q7, Q8, and Q9. R14A,B,D, and R18 keep Q7, Q8, Q9, and Q10 turned off when there is no base drive, such as in standby mode or when the A1 board is not plugged into the instrument.

8-156. CURRENT SAMPLING RESISTORS (A8). The load currents from the +5V, +15V, and -5.2V supplies flow through R8, R10, and R11, causing small voltage drops which are monitored by the Power Supply Control part of the A1 board. The output voltages of these three supplies are sensed at the load side of the current sampling resistors. The voltage sense (V SENSE) voltages are referenced to ground, and the current sense (I SENSE) voltages are referenced to the V SENSE lines.

8-157. R9, R5, and R4 provide a minimum load current to keep the voltage regulators on if there is no other load. CR5, CR7, and CR6 help protect the loads in case a regulator fails to regulate the voltage, or in case a supply is shorted to some other supply. C8 slows the fall time of the +5V supply when the instrument is switched to Standby mode, giving the microprocessor time to store the instrument state into standby RAM before the supply drops below the level required for proper operation.

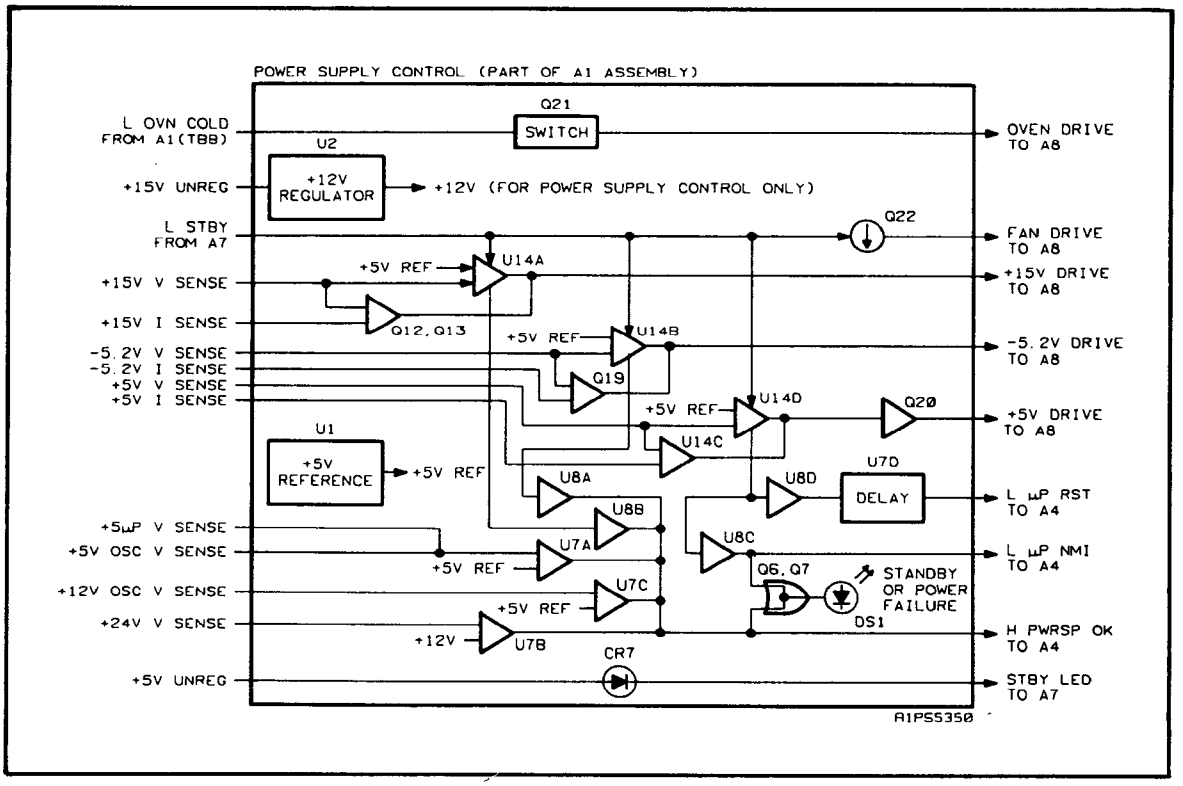


Figure 8-10. Power Supply Control Circuit Block Diagram

8-158. ERROR VOLTAGE AMPLIFIERS (A1). Operational amplifiers U14D, A, and B amplify the difference between the voltage sense lines of the +5V, +15V, and -5.2V supplies, and a stable voltage reference. Since the reference voltage is +5.0V, the +5V V SENSE is used directly, but the V SENSE lines for the +15V and -5.2V supplies are scaled.

8-159. The +15V V SENSE is scaled by R42, R43, and R44 down to +5V so that it can be compared to the +5.0V reference at the input of U14A. The -5.2V V SENSE is scaled by R41, R52, and R53, which sum the -5.2V V SENSE and the +5.0V reference to obtain 0V at U14B(5), where it is compared to the 0V from R45D. Schottky diode CR26 prevents U14B's input from being pulled negative enough to cause malfunction. CR27 reduces the current injected into the -5.2V supply through the -5.2V V SENSE line when in standby mode.

8-160. ERROR AMPLIFIER SUPPORT CIRCUITRY (A1). Support circuitry for the error amplifiers includes analog OR Gates, and level shifting and buffering circuits. The analog OR gates allow the power supply output voltages to be controlled by the error voltage amplifiers, the current sense amplifiers, or the L STBY control line (or several other things in the case of the +5V regulator). Level shifting circuitry is required for the +15V and -5.2V regulators because the error voltage amplifiers and the analog OR gates use a +12V supply (to be described later). The buffer circuits provide the proper drive current to the series pass transistors on the A8 Assembly.

8-161. Standby. The front panel ON/STBY switch electronically turns off the main regulators in Standby mode via the L STBY line. As mentioned above, when the L STBY line is asserted (low) it takes control of the voltage regulators through the analog OR gates and turns off their outputs. R29E pulls up the L STBY line to +12V when negated (instrument on). R38A and CR7 supply current from the +5V UNREG supply to the STBY LED on the instrument's front panel.

8-162. +5V Analog OR gate. In normal +5V regulator operation, CR12 is forward biased and error-voltage amplifier U14D is controlling the +5V output. If the regulator is current limited due to some fault condition in the load, CR22 will be forward biased. If the +5V UNREG voltage drops too low for proper regulation CR13, CR14, and CR15 will be forward biased. If the L STBY line is held low, CR6 will be forward biased. If some serious failure occurs in the regulator circuit, CR25 clamps the analog OR voltage. Only one of these conditions may control the regulator at any particular time. In any mode other than the normal (voltage regulated) mode, CR12 will be far reverse biased because the output of amplifier U14D will be saturated near the +12V supply. R45C biases the diodes in the analog OR gate.

8-163. +5V Buffer. The buffering stage in the +5V regulator consists of emitter-follower Q20, CR21, and CR23. The Q20 collector current is supplied from the +15V UNREG line through CR23. CR21 limits the reverse emitter-base voltage of Q20 when the base voltage is pulled down suddenly (such as when going into Standby mode). The output of the buffer stage is the +5V DRIVE line, which drives the +5V pass transistors on the A8 Assembly.

8-164. +15V Analog OR Gate. In normal +15V regulator operation, CR11 is forward biased and error-voltage amplifier U14A controls the +15V output. CR9 is forward biased when the L STBY line is held low. If the regulator is current limiting (load fault), the +15V current sense amplifier (Q12,Q13) will turn on and pull down the analog OR gate voltage. R29F supplies bias current for the analog OR gate. When the regulator is not in the normal (voltage regulated) mode CR11 will be far reverse biased because the output of U14A will be saturated near its +12V supply.

8-165. +15V Level Shifter And Buffer. Level shifting and buffering in the +15V regulator is performed by common-emitter Q10 and associated components CR10, CR4, R30A, and R31. CR10 and CR4 raise the analog OR gate voltage high enough above ground to work properly. R30A keeps Q10 cut off when the instrument is in Standby mode. R31 limits the current in Q10 if the +15V UNREG voltage drops too low to allow voltage regulation. The output of the level shifter and buffer is the +15V DRIVE line, which drives the +15V series pass transistor on the A8 Assembly.

8-166. -5.2V Analog OR Gate. In normal -5.2V regulator operation, CR29 is forward biased and error-voltage amplifier U14B controls the -5.2V output. CR8 will be forward biased when the L STBY line is held low. If the regulator is current limiting (load fault), the -5.2V current sense amplifier (Q19) will turn on and pull down the analog OR gate voltage. R29G provides bias current for the analog OR gate. When the regulator is not in the normal (voltage regulated) mode, CR29 will be far reverse biased because the output voltage of U14B will be saturated near its +12V supply.

8-167. -5.2V Level Shifter. The level shifter for the -5.2V regulator consists of Q15 and associated components CR28, CR18, and R30D. Q15 operates in the common-base mode. CR28 and CR18 raise the analog OR gate voltage high enough above ground to work properly. R30D keeps Q15 turned off when the instrument is in standby mode.

8-168. -5.2V Buffer. The buffer for the -5.2V regulator consists of emitter-follower Q16 and associated components R38D and R45A. R45A keeps Q16 turned off when the instrument is in Standby mode. R38D limits the current in Q16 if the -5.2V UNREG voltage drops too low to allow voltage regulation. The output of the buffer is the -5.2V DRIVE line, which drives the -5.2V series pass transistor on the A8 Assembly.

8-169. CURRENT SENSE AMPLIFIERS (A1). The current sense amplifiers monitor the voltage difference between the I SENSE and V SENSE inputs to the A1 Assembly, which are the two sides of the current sampling resistors on the A8 Assembly. When this voltage (load current) exceeds a certain value, the current sense amplifier takes control of the voltage regulator through the analog OR gate and reduces the output voltage. In the +15V and -5.2V regulators, the current limit is approximately constant, but the +5V regulator has foldback current limiting (i.e. the current limit decreases as the regulator output voltage decreases to reduce the power dissipation in the series pass transistor).

8-170. +5V Current Sense. In the +5V regulator, the current sense amplifier consists of operational amplifier U14C and resistors R47C, R47D, R46C, R46D, and R37C. These components form a differential amplifier with a voltage gain of about 5, and with its output voltage referenced to the analog OR gate voltage. As the load current increases, the output voltage of U14C decreases. When U14C's output voltage becomes one diode drop lower than the analog OR gate voltage, CR22 becomes forward biased, CR12 becomes reverse biased, and the current sense amplifier takes control of the voltage regulator. R37C generates an offset in the differential amplifier which tends to reverse bias CR22. Since this offset depends on the voltage across R37C, the current limit decreases as the +5V output voltage decreases (foldback current limiting). The short-circuit output current is approximately one-half of the maximum output current.

8-171. +15V Current Sense. In the +15V regulator, the current sense amplifier consists of Q12, Q13, CR3, R30B, and R30C. When the +15V load current becomes large enough to forward bias the Q12 base-emitter junction and CR3, Q12 supplies base current to Q13, Q13's collector current pulls down the analog OR gate voltage (CR11 becomes reverse biased), and the current sense amplifier takes control of the voltage regulator. R30B and R30C keep Q12 and Q13 turned off during normal (voltage regulated) operation. CR3's voltage drop allows the current sense amplifier to work when the +15V output is shorted to ground.

8-172. -5.2V Current Sense. Q19 is the current sense amplifier in the -5.2V regulator. When the -5.2V load current becomes large enough to forward bias the base-emitter junction of Q19, the Q19 collector current pulls down the analog OR gate voltage (CR29 becomes reverse biased) and the current sense amplifier takes control of the voltage regulator.

8-173. COMPARATORS (A1). The comparator section of the Power Supply Control circuit on A1 generates Reset and NMI (Non-Maskable Interrupt) signals to the instrument's microprocessor (the HP-IB microprocessor also uses the Reset signal) based on the condition of the +5V regulator, generates another logic signal to the microprocessor which indicates the condition of the other voltage regulators, and lights an LED on the A1 Assembly when the power supply is in Standby or when any of the voltage regulator outputs is not correct.

8-174. L μP NMI. Comparator U8C generates the L μP NMI signal by monitoring the voltage on CR12, a diode in the +5V analog OR gate. When the +5V regulator is regulating properly, CR12 will be forward biased and L μP NMI will be negated (high); otherwise CR12 will be reverse biased and L μP NMI will be asserted (low). The L μP NMI signal is used to give the microprocessor immediate warning that the +5V supply is going down (such as when going into Standby) so that state variables can be stored into standby RAM before the +5V drops below the operating limit for digital circuits.

8-175. L μP RST. The L μP RST signal is generated by U8D, U7D, R15, R13, C8, R29C, R14, and C24. U8D monitors the voltage on CR12 exactly like U8C does; therefore, the output of U8D is low when the L μP NMI signal from U8C is low. The voltage divider consisting of R29C and R14 provides an approximate +6V reference for comparator U7D. C8, R13, and R15 form a dual time constant circuit; R13 slowly charges C8 and R15 quickly discharges C8.

8-176. When the +5V supply is turned on, U8D holds C8 discharged until CR12 becomes forward biased (indicating proper voltage regulation). C8 then slowly charges to +12V through R13. U7D compares the voltage on C8 to the approximate +6V reference, so L μP RST (output of U7D) will be asserted (low) when the +5V supply is not regulated and for a fraction of a second after it becomes regulated. The L μP RST line is pulled-up on the A4 Microprocessor Assembly.

8-177. R15 and C8 provide a short delay between the assertion of L μP NMI and the assertion of L μP RST. This delay is long enough to allow the microprocessor to store variables in standby RAM, but short enough to ensure that the microprocessor is held in reset when the +5V supply is lower than the limit for digital circuits. R15 also limits the peak current when U8D discharges C8.

8-178. H PWRSP OK. The H PWRSP OK signal indicates to the A4 microprocessor that the voltage regulators (other than the +5V regulator) have the proper output voltage. The signal is derived from the wire-ORed outputs of comparators U8A, U8B, U7A, U7B, and U7C. U8B checks the +15V regulator by monitoring the voltage on CR11 in the analog OR gate; when the +15V output is properly regulated, CR11 is forward biased, otherwise CR11 is reverse biased. Similarly, U8A checks the -5.2V supply by monitoring the voltage on CR29. U7A compares the average of +5V μP V SENSE and +5V OSC V SENSE (standby +5V regulators on the timebase buffer half of A1) to 4.5V. R28B and R28C form a voltage divider which takes the average of the two V SENSE lines. R36B and R37A form a voltage divider which derives approximately 4.5V from the 5.0V reference. U7C compares the +12V OSC V SENSE (standby +12V regulator on the timebase buffer half of A1), divided by two by voltage divider R28D and R36A, to the +5.0V reference. U7B compares the -24V V SENSE (standby -24V regulator on A8), scaled and shifted by R54 and R29D, to the +5.0V reference. R35A, B, D, and R36C provide a small amount of positive feedback (hysteresis) for comparators U7A, C, and B to prevent oscillation with voltages exactly at the switching thresholds. R45B pulls-up the H PWRSP OK line to the +5V V SENSE.

8-179. Standby/Power Fail LED. The DS1 LED provides an indication that some regulator is not properly regulating its output voltage. The LED is on in Standby, when a regulator is current limited, when an unregulated voltage falls too low for adequate regulation, or when a regulator fails. Since the L μP NMI line, when asserted, indicates lack of regulation of the +5V, and the H PWRSP OK line, when negated, indicates lack of regulation of some other supply, Q6 and Q7 are ORed to provide the LED drive. R38B limits the current in DS1, although the current will vary with the +5V UNREG voltage. CR2 clamps the voltage on the anode of DS1 to ensure that the LED will not light when both digital lines are high. R37B ensures that Q6 will not turn on from leakage current when the A4 microprocessor board (with pull-up resistor) is not plugged in.

8-180. VOLTAGE REFERENCE (A1). U1 generates the +5.0V reference voltage used by the +5V, +15V, and -5.2V regulators and the comparator section. R36D isolates the Ref +5.0V line which goes to the Power Supply Test (PST) connector on A8 so that that line, if accidentally shorted to ground, will not affect the power supply.

8-181. +12V REGULATOR (A1). Voltage regulator U2 supplies +12V to the other integrated circuits in the power supply control section of A1. L7 prevents high frequency noise and interference on the +15V UNREG line (which supplies U2) from being injected into the Power Supply Control circuit's ground through bypass capacitor C14. R29B isolates the V/+12 PS line which goes to the Power Supply Test (PST) connector on the A8 motherboard so that the V/+12 PS line, if accidentally shorted to ground, will not affect the power supply.

8-182. Note that the +12V regulator described above is a different circuit than the +12V OSC regulator in the Timebase Buffer part of A1, which supplies the 10 MHz oscillator.

8-183. -24V REGULATOR (A8/A1). The -24V regulator primarily supplies the oven circuit of the optional timebase oscillator, but is also used by the A5 LO Synthesizer. The main part of the -24V regulator is on the A8 motherboard, but the circuit that switches between normal and warm-up modes for the oven oscillator is on the A1 Assembly.

8-184. MAIN -24V REGULATOR (A8). On A8, the -24V regulator consists of U1, CR2, CR3, CR4, and associated components. CR2 and CR3 help protect U1 from reverse currents in case of accidental grounding of the V_{in} or V_{out} terminals. CR4 prevents the -24V supply from becoming positive under any possible fault condition. The OVEN DRIVE line from A1 is either grounded (normal) or open (warm-up). During oven warm-up, the -24V supply is -28V typical (-30V maximum). During normal operation, R7 is in parallel with R19, causing the output of the regulator to drop to -24V. The oven draws a large amount of current during warm-up, after which the current drawn decreases suddenly to a relatively low level.

8-185. NORMAL/WARM-UP CONTROL (A1). In the Power Supply Control part of A1, Q21, CR24, R47B, and R46A switch the -24V regulator (on A8) between normal and warm-up modes. L OVN COLD is a 5V logic signal from the Timebase Buffer part of A1 which is low when the oven is cold and high when the oven is warm. Q21 is a common-base stage which is either turned off (cold) or saturated (warm); its output is the OVEN DRIVE line to the A8 motherboard. R47B limits the current in Q21. CR24 increases the noise immunity when L OVN COLD is low. R46A holds Q21 turned off when L OVN COLD is low.

8-186. When the TCXO standard timebase oscillator is used, the -24V will be in its normal (warm) mode because the TCXO board simulates the Oven Monitor output of the oven oscillator.

8-187. FAN CURRENT REGULATOR (A1/A8). The instrument is cooled by a dc fan, B1. The fan is driven by a constant-current regulator consisting of two parts: a circuit in the Power Supply Control part of A1 which generates a small constant current when the instrument is on (not in Standby), and a current mirror/amplifier on A8 which boosts the current by a factor of about 200.

8-188. CONSTANT CURRENT SOURCE (A1). In the Power Supply Control part of A1, the circuit consisting of Q22, CR5, CR16, R29A, R47A, and R37D generates a small constant current. Q22 is a common-base stage which is either in the linear range or turned off; its output is the FAN DRIVE line which goes to the A8 motherboard. R29A and R47A set the current in Q22. CR5 turns off the current through Q22 when the L STBY line is asserted (low); when the instrument is on CR5 is reverse biased. R37D holds Q22 cut off, and CR16 increases the noise margin when in Standby mode.

8-189. CURRENT MIRROR/AMPLIFIER (A8). On A8, a current mirror/amplifier composed of Q2, Q6, CR9, R12, R13, R17, and C10 boosts the current of the FAN DRIVE line (from A1) by a factor of about 200 to generate the fan current. The small constant current from A1 flows through CR9 and R12, causing a voltage drop which is applied across the base-emitter junction of Q2 and R17 in series (and filtered by C10). CR9 compensates for the temperature variations of Q2's base-emitter voltage. Q2, Q6, and R13 form a feedback circuit with high current capability and very high current gain. The current through R17 flows through Q6, F1, and the fan; the positive side of the fan motor is grounded. Since the voltage across R17 is approximately equal to the voltage across R12, the current through the fan is equal to the FAN DRIVE current from A1 times the ratio of R12 to R17. Fuse F1 protects the fan in case of a failure in the fan current regulator.

8-190. POWER SUPPLY TEST CONNECTOR (A8). Connector J7 on the A8 motherboard can be used as a central point for probing the power supply voltages. All of the signals in the connector (except ground) are protected with series resistors, or are otherwise current limited to prevent damage to the instrument should the pins be accidentally shorted together or shorted to ground. R1A through R1E and R2A through R2E protect the V SENSE and I SENSE lines; protection resistors for other signals are on the plug-in board assemblies which generate the signals.

8-191. In addition to the main power supply voltages (+5V, +15V, -5.2V, -24V), the test connector has pins for monitoring the +12V and +5.0V Reference (from the Power Supply Control part of A1), the +5V OSC and +12V OSC oscillator supplies (from the Timebase Buffer part of A1), the microprocessor standby +5V μP (also from the Timebase Buffer part of A1), the MRC's +3V (from the A3 Counter board), the fan voltage, and the load current in the main +5V, +15V, and -5.2V supplies. In addition, the instrument may be put into standby by grounding the L STBY pin available at the test connector.

8-192. MISCELLANEOUS CIRCUITS (A8). The following paragraphs describe additional circuits on the A8 motherboard which are not part of the power supply.

8-193. Microprocessor RAM Backup Diode. The standby RAM on the A4 microprocessor is supplied by the +5V μP voltage regulator on the Timebase Buffer part of A1 whenever the instrument is plugged in. CR1 (on A8) is a Schottky rectifier diode between the +5V μP and the main +5V, so that the main +5V can supply the microprocessor RAM in case of a failure in the Timebase Buffer, thus allowing the A4 Microprocessor Assembly to continue to operate in case of a Timebase Buffer +5V μP regulator failure.

8-194. Microwave Module Turn-Off. To reduce certain forms of electromagnetic interference at particular times, a microwave turn-off circuit on the motherboard allows the A4 microprocessor to turn off the Microwave Module circuitry. The microwave turn-off circuit operates by interrupting two of the power supply connections to the A12 Microwave Assembly. The circuit defaults to the "on" state if the A4 Microprocessor Assembly is not installed.

8-195. The microwave turn-off circuit is controlled by the L μW OFF line from the A4 microprocessor. Q4, Q5, R15, R16A and R16B gate the +5V to the IF preamplifier part of the A12 Assembly. Q1, Q3, CR8, and R16C, D, and E gate the +15V to the sampler driver part of the A12 Assembly. In normal operation, Q1 and CR8 drop the +15V supply to about +13.5V (typical) for proper operation of the sampler driver.

8-196. HP-IB Common Mode Choke Filter. To help prevent the digital signals during remote operation on an HP-IB system from causing interference in the counter, a Common Mode Choke (CMC) filter is used on the +5V and ground lines which supply the bus drivers and terminations on the A11 HP-IB Interface board. The CMC filter consists of L1, C1, and C2.

8-197. Configuration Jumpers. JMP1 through 7 and pull-up resistors R3A through R3I are factory set connectors which indicate to the A4 microprocessor the instrument configuration and options.

8-198. IF MON RTN Ground Jumpers. The IF MON signal to the rear panel has a separate return path (IF MON RTN) to A3's digital ground to isolate the IF MON signal from the motherboard ground plane (used by the analog signals for ground reference and return paths). Jumper wires W1 and W2, near the rear panel IF OUT connector (J4), provide the required ground connections. W2 ties the return path to the body of J4, and W1 ties the body of J4 to the motherboard ground plane.

8-199. Timebase Buffer (Part of A1 assembly)

8-200. The Timebase Buffer circuit on the A1 Assembly conditions an internal or external timebase reference signal so that it becomes a frequency standard for the instrument's synthesizer, a timebase standard for its MRC Counter, and a reference signal to which other instruments may be locked. The internal timebase reference source can be either a 10 MHz TCXO (A10 standard TCXO Assembly), or a 10 MHz ovenized crystal oscillator (A10 Option 001 or 010 Oven Oscillator). An external reference source must provide a sinewave or squarewave at 1, 2, 5, or 10 MHz, 0.7V p-p minimum into 1 kΩ shunted by 30 pF.

8-201. When an external reference is applied to the rear panel EXTERNAL IN connector, the signal appears on the EXT REF IN line at P1A(1,26). The external reference is preamplified by transistor Q17, and sent to one-shot U3. CR20 and CR30 provide input protection, CR19 temperature stabilizes the bias point of Q17, and CR31 prevents Q17 from saturating due to high level external reference inputs. U3 produces periodic 50 ns pulses, resulting in a comb of frequencies that are harmonics of the external reference frequency. Bandpass amplifiers Q3 and Q4, and their associated tank circuits consisting of L8, C20, C21, L1, C2, L2, and C3 filter out all frequency components except for the desired 10 MHz. CR17 insures unidirectional current flow at the output of U3.

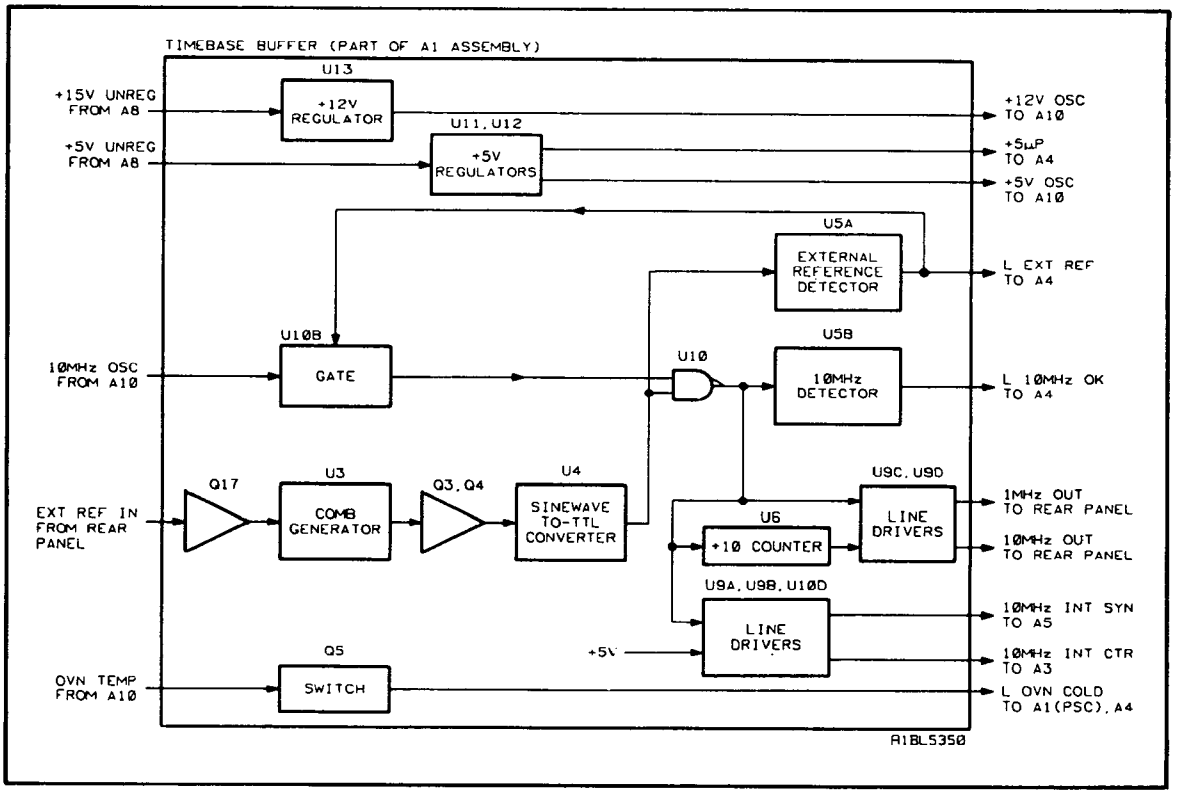


Figure 8-11. Timebase Buffer Block Diagram

8-202. NAND gate U4A acts as a sinewave-to-TTL converter. When an external timebase reference is used, TTL level, 50 ns pulses appear at U4A, pin 3. U4D ensures that the input to U10A, pin 1 is always high in the absence of an external timebase reference.

8-203. U5A is a retriggerable one-shot serving as a detector for external reference 10 MHz pulses. The values of R27 and C27 correspond to a triggered pulse width of 1.2 μs. Any periodic retrigger pulse with an interval less than 1.2 μs will keep the output of U5A (L EXT REF) low, indicating the presence of an external timebase reference.

8-204. An external timebase reference will always disable the internal reference in two ways. First, the L EXT REF line will render gate U10B nonconducting. Also, the L EXT REF line will shut down the dc power to the optional ovenized oscillator by means of transistor switches Q1 and Q8, or the standard TCXO by means of switches Q2 and Q9.

8-205. Gate U10A transmits either the internal or external pulse train. Two pulse trains cannot appear at the input of U10A simultaneously; the internal reference will appear at U10A(2), or the external reference will appear at U10A(1). U10A will always transmit whichever of the two pulse trains is present, since the nonpulsed input will always be high.

8-206. The 10 MHz detector U5B works in a similar manner to the external reference detector U5A. L 10MHz OK is low whenever a 10 MHz reference exists at the output of gate U10A.

8-207. The 10 MHz reference is distributed to the A5 Synthesizer Assembly, the MRC on the A3 Counter Assembly, and to the rear panel BNC connector A8J2 (10MHz OUT) via 50 ohm line drivers U9A, U9B, and U9C. R51 and C36 form a 100 MHz low-pass filter that minimizes transmission of frequency components in the synthesizer's tuning range. The line drivers to the synthesizer and the MRC, U9A and U9B, are disabled in Standby when the +5V supply at the inputs of U10D drops to 0V.

8-208. A 1 MHz output is derived from the 10 MHz output of U10A through decade divider U6 and line driver U9D, and provided at the rear panel via BNC connector A8J3 (1MHz OUT). R61 and C45 form a 50 MHz low-pass filter to reduce 10 MHz spikes on the 1 MHz output.

8-209. Operation is straightforward when only an internal timebase reference source is used. When there is no external reference, both the sinewave-to-TTL converter U4 and external reference detector U5A outputs are high. Consequently, the internal 10 MHz reference signal passes through gates U10B and U10A to the output line drivers.

8-210. OVEN TEMPERATURE MONITOR. The oven temperature monitor circuit consists of Q5, CR1, and associated components. This circuit translates the oven temperature monitor voltage from the optional ovenized oscillator to a TTL signal (L OVN COLD) indicating oven status to the A4 microprocessor.

8-211. The OVN TEMP input at P1A(44) is -1.5V when the oven is cold. This voltage is insufficient to break down 14V Zener diode CR1, thus Q5 is turned off and the L OVN COLD line is low. After the oven warms up, the OVN TEMP line changes to -20.5V, causing conduction through CR1. Q5 is turned on, and L OVN COLD is now high.

8-212. VOLTAGE REGULATORS. The +5V UNREG and +15V UNREG supplies appear whenever the instrument is connected to the power mains (these voltages are not controlled by the front panel power switch). U11, U12, and U13 voltage regulate these inputs to produce six supply voltages. Three of these regulated voltages are used locally by the Timebase Buffer circuit. The +5V from U12 is the supply voltage for all of the Timebase Buffer except the output line drivers U9 and counter U6. The +5V D1 and +5V D2 lines are the supply voltages for U9 and U6, respectively.

8-213. The remaining three regulated voltages are used off-board. The +12V OSC supply goes to the oscillator section of the optional ovenized timebase. The +5V OSC supply goes to the A10 TCXO, which is the standard timebase for the 5350B/51B/52B. The +5V μP supply provides standby power to the A4 microprocessor. As mentioned previously, the +12V OSC and +5V OSC supplies are turned off whenever an external reference timebase is present. A low on the L EXT REF line to Q1 and Q2 turns off series switches Q8 and Q9.

8-214. A2 Low Frequency Input Assembly

8-215. The A2 assembly consists of a 1MΩ impedance, 10 Hz to 80 MHz amplifier circuit, and a 50Ω impedance, 10 MHz to 525 MHz amplifier circuit, sharing a common input connector. The H LF 50 signal from the microprocessor, at P1(23), selects the high or low impedance mode of operation. For low impedance operation, the H LF 50 line goes high (>2V), and the diode bridge consisting of CR7-CR10 is forward-biased by dual operational amplifier U9. In this way, the 50Ω load (internal to U7) is connected to the input from A2W1. For high impedance operation, the H LF 50 line goes low, and the CR7-CR10 bridge is reverse-biased, disconnecting U7's 50Ω load from the input.

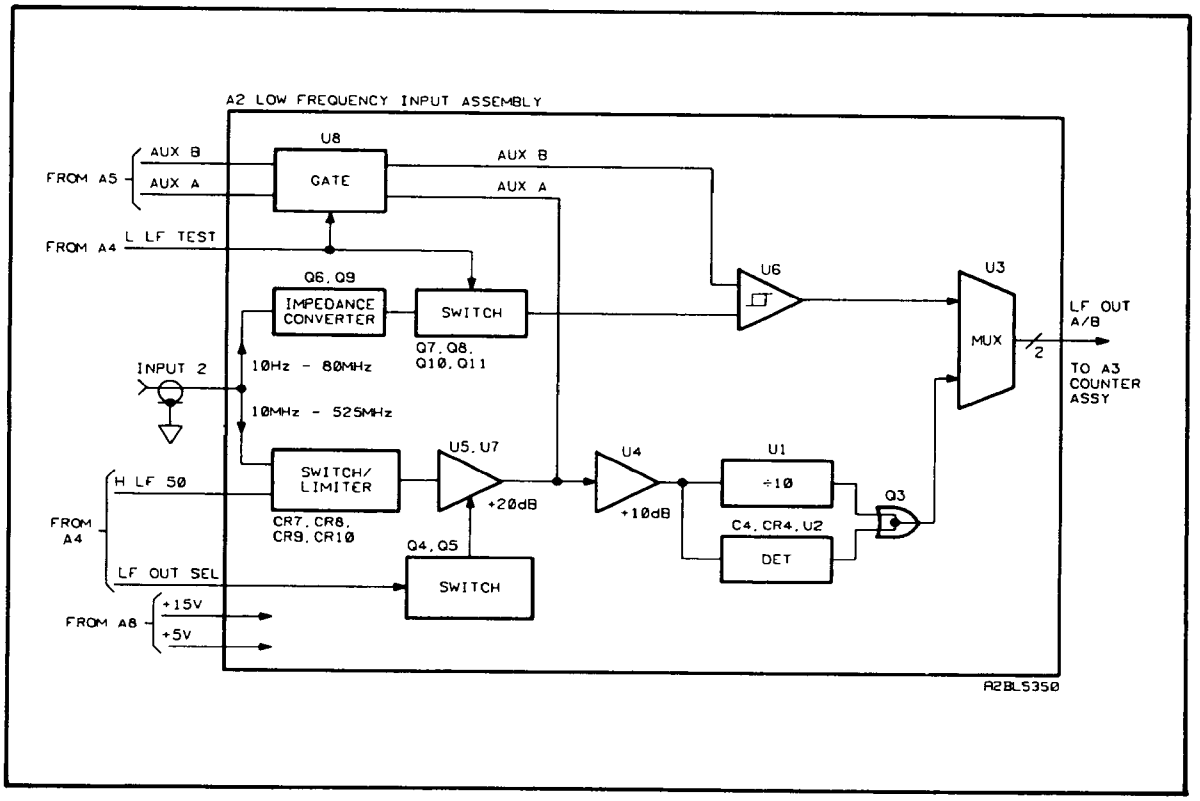


Figure 8-12. A2 Block Diagram

8-216. During high impedance operation, the input signal from A2W1 is ac coupled to the 1MΩ load, R54. C26, R53, and clamping diodes CR12 and CR14 provide protection from high voltage, low frequency inputs. High voltage, high frequency inputs are current limited by R56, and the fused input connector (J2) on the front panel provides additional protection from excessive currents. At high frequencies (>3.4 MHz), the input is limited to 8.2 volts peak by C27 and clamping diodes CR11 and CR13 located in the low impedance circuit. Voltages higher than 8.2 volts peak will blow the front panel fuse (J2F1).

8-217. A unity gain impedance converter consisting of Q6 and Q9 feeds a two stage amplifier and a Schmitt trigger consisting of U6B, U6A, and U6C, respectively. U6 is a triple differential line receiver with positive feedback around the last stage to form the Schmitt trigger. The output of the Schmitt trigger at U6C(15) goes to ECL quad NOR gate U3, which is connected as a multiplexer. A TTL high on the LF OUT SEL line at P1(9) is level shifted to ECL levels (referenced to a +5 volt level) by R15, R16, and R18, and is inverted by U3A. The output at U3A(2) in turn activates U3B so that the signal from U6C(15) is fed through U3B and U3D to the output level shifter, Q1 and Q2. The output level shifter provides the necessary drive levels for the MRC on the A3 Counter assembly.

8-218. The 50Ω channel is activated when the H LF 50 signal goes high, as previously described. When forward-biased, the CR7-CR10 diode bridge acts as a bridge limiter. The signal passes through the diodes virtually unattenuated at low levels, and is limited at high levels when the diodes become reverse-biased on alternate half cycles. The maximum peak output voltage is determined by the 50Ω input impedance of U7 and the dc current through the bridge (approximately 5 mA). This results in a maximum input voltage of 0.25 volts peak to U7.

8-219. The 10 MHz-525 MHz amplifier chain consists of three cascaded stages of approximately 10 dB gain each. The function of Q4 will be discussed later, but assume for now that Q4 is in saturation and that the +15 volt supply is applied to all stages. The final stage amplifier U4 drives a high frequency bridge limiter, a divide-by-10 IC, and a peak detector circuit.

8-220. The limiter consisting of CR1, CR2, CR3, and CR5 provides the the proper frequency response for the U1 input. This limiter is similar to the input limiter but inductor L1 is connected across it to provide more low frequency output. The divide-by-10 frequency divider U1 requires approximately 400 mV p-p at 600 MHz and 800 mV p-p at 10 MHz for proper operation. The output at U1(8) is fed to the U3 signal selector circuit, which in turn feeds level shifter Q1 and Q2 when the LF OUT SEL line at P1(9) is TTL low.

8-221. The peak detector circuit consisting of CR4, C4, and U2 is adjusted via R1 to trip when the signal level at the INPUT 2 connector (front panel BNC) rises to approximately 15 mV rms at 525 MHz. Resistor R5 provides a slight amount of positive feedback around operational amplifier U2B to produce some hysteresis. Whenever the signal falls below the preset threshold of the peak detector circuit, the output of U2A(7) turns on Q3, which serves as a wired-OR gate to pull the output of U1 high, cutting off the signal to U3. CR4 and C4 form the actual peak detector, while CR6 is used for temperature compensation for the reference inputs of U2. U2A is connected as a voltage follower to drive a guard trace around the high impedance inputs of U2B to minimize surface leakage affects.

8-222. A 35 MHz test signal from the A5 Synthesizer Assembly is used for self test and diagnostics. The L LF TEST line at P1(12) goes low to activate U8A and U8B, which allows the test signals from P1(25,50) to go to U6B(9) in the high impedance channel, and the input of U4 in the low impedance channel. In addition, the L LF TEST signal turns off Q7 and Q11. To prevent interaction with a signal present at the input connector, Q10 turns off and removes the +15V supply from the impedance converter Q6 and Q9, and Q8 turns on to shunt any input to ground. In the low impedance channel, the H LF 50 line is low, which keeps the input bridge limiter open, and turns off Q5 and Q4 to disconnect the +15V supply to the first two stages, U7 and U5. Note that the H LF 50 line is high only for 50Ω operation and is low for all other functions.

8-223. A3 Counter Assembly

8-224. The A3 Counter Assembly contains the final IF stage (Q1,Q2), the Multiple Register Counter (U7), an interpolator circuit (U2,U3,U5,C6), an 8-bit binary counter (U4), and an 8-bit latch (U6). A 3-terminal regulator (U1) provides a +3 volt supply, for on-board use only.

8-225. The operation of the A3 Assembly centers around the Multiple Register Counter, U7. The MRC 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.

8-226. The MRC has three frequency input channels (A,B, and C), a gate signal input (EXT), and a time base input (REF). Outputs include four data lines (D0-D3), and two interpolator lines (STI, SPI). The Channel A input counts the IF signal coming from the A6 IF Amplifier/Detector Assembly, Channel B counts the 35 MHz test signal from the A5 Synthesizer, and Channel C is used for INPUT 2 frequency measurements. The gating, channel selection, and all other MRC setups are controlled by the A4 Microprocessor Assembly.

8-227. The IF signal from the A6 Assembly is amplified by the final IF stage before entering Channel A of the MRC. The final IF stage consists of differential pair Q1 and Q2 driven single-ended, and has a frequency range of 35 MHz to 105 MHz. The collector of Q1 drives the Channel A input at U7(30), while the output from the collector of Q2 (IF MON OUT) is attenuated 20 dB by R39 and R40, and sent to the IF OUT connector, J4, on the rear panel.

8-228. The test signal from the A5 Synthesizer enters the A3 board as differential pair AUX B and AUX A. The AUX B line is ac coupled to the Channel B input at U7(28) for self test and diagnostic purposes, while the AUX A line is terminated by R29 and R33.

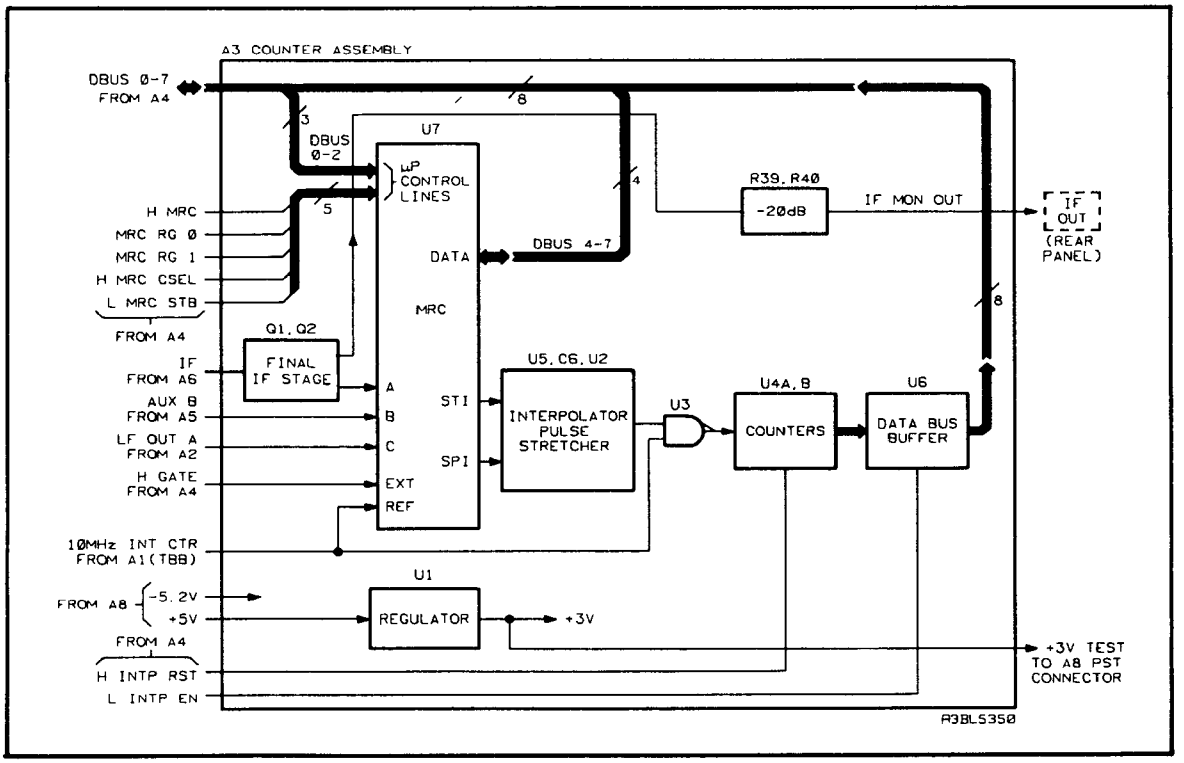


Figure 8-13. A3 Block Diagram

8-229. The low frequency input from the A2 Assembly enters as another differential pair, LF OUT A and LF OUT B, with the LF OUT A line being directly coupled to the Channel C input at U7(26). The ECL signal is referenced to a +2.65 volt level by the output level shifter on the A2 Assembly to provide the voltage level required by the MRC input. The LF OUT B line is terminated by R32.

8-230. The H GATE signal is controlled by the A4 microprocessor, and is level-shifted from TTL levels by CR2, R19, and R20, to the level required by the EXT input at U7(17).

8-231. The 10MHZ INT CTR signal from the Timebase Buffer circuit on the A1 Assembly drives the REF input at U7(21). The 10 MHz signal also branches to NAND gate U3 to be used as part of the interpolator circuit.

8-232. Regulator U1 provides a +3V supply (derived from the +5V line) to the MRC, the final IF stage, and the interpolator comparator reference. A test line (+3V TEST) goes to the PST connector, A8J7, on the A8 Motherboard/Power Supply Regulator Assembly. Voltage follower U8 sets the proper bias voltage for the MRC's V_{B1} supply at U7 (39).

8-233. INTERPOLATORS. When measuring a frequency, there is an inherent ±1 count uncertainty. For increased measurement resolution, an interpolator circuit is used to reduce the uncertainty introduced by the opening and closing of the counting gate. The gate signal during a measurement is normally synchronous with the main clock (timebase). If the gate does not open at the same time an IF signal event occurs, and close at the same time an event occurs (N number of events later), the time difference between the gating and the events may produce an error. This time difference is measured by the interpolator circuit, and the data is sent to the A4 microprocessor. The processor can then determine the actual gate time factor for calculating the input frequency, thus eliminating the ±1 count uncertainty. (See *Figure 8-14.*) By using interpolation, resolution of the actual gate time can be improved to about 1 ns.

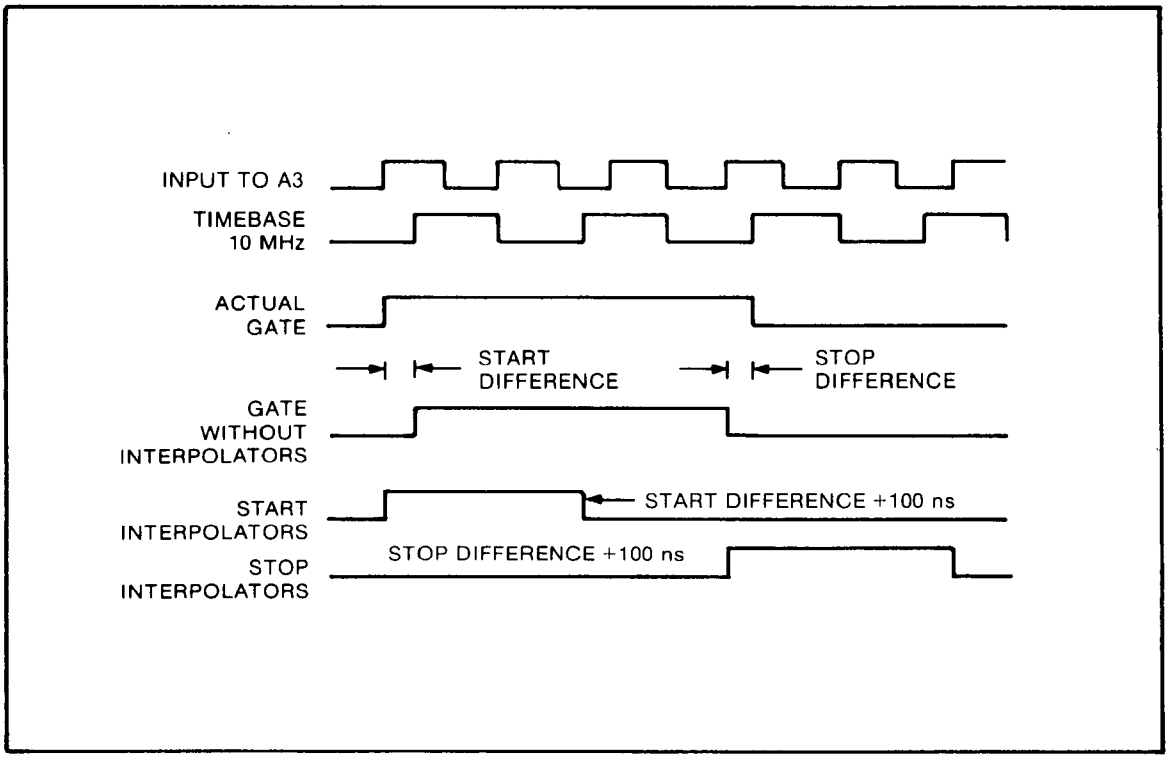


Figure 8-14. Interpolator Timing Diagram

8-234. The MRC detects the slight error factor, and provides start and stop interpolator pulses representing the time difference between the A3 input trigger events and the timebase. The interpolator circuit, consisting of transistor array U5, integration capacitor C6, comparator U2, and NAND gate U3, acts as a pulse-stretcher, expanding each pulse to a measurable time length. During each Start Interpolation and each Stop Interpolation, the MRC provides two calibration pulses of known value for interpolating the unknown value of the error pulse. Because the Start and Stop Interpolators operate serially, the interpolator outputs are wire-ORed at the collectors of U5B and U5C, and the interpolator circuit expands each set of start and stop pulses in turn. The following interpolator circuit description will discuss only the start pulse interpolation, as the stop pulse interpolation is identical.

8-235. The STI output from the MRC is normally high and pulses low, with a pulse width which varies from 1 to 2 clock periods (100 to 200 ns). The start pulse turns on U5C, causing a rapid discharge of C6 through R17. At the end of the pulse, C6 charges at about 1/200th the discharge rate, proportionally expanding the interpolator pulse by a factor of 200. PNP transistors U5D and U5E provide a constant charging current, set by R18. The C6 charge voltage is limited to a positive peak of about +3.6 volts by clamping diode CR1, and the negative voltage swing is limited to about +2.4 volts by the discharge current rate during the interpolator pulse.

8-236. The integrated waveshape at the C6 node is then squared by comparator U2, which is set for a trip point of approximately +3.1 volts. While the C6 voltage at U2(3) is below the reference value at U2(2), the comparator output enables NAND gate U3 to pass the clock signal (10MHZ INT CTR) to the 8-bit binary counter (U4A,B). The resulting burst of pulses is counted by U4, and the pulse count data is sent to the A4 microprocessor via 8-bit data latch U6. The processor enables the latch via the L INTP EN line, and resets the U4 counters via the H INTP RST line after the data is sent.

8-237. To convert the count in the interpolator counters to actual time (in nanoseconds), the MRC provides a short calibration pulse of 100 ns, and a long calibration pulse of 200 ns. By measuring the pulse count resulting from known time values, a mathematical proportion is established for interpolating the true time of the unknown error pulse. For example, if the short (100 ns) calibration pulse produced 200 counts, and the long (200 ns) calibration pulse produced 400 counts, a count of 300 (accumulated during the interpolator pulse integrator cycle) would indicate an error factor of 150 ns. (See *Figure 8-15.*) The U4 counter is allowed to overflow by a small amount to maximize the number of counts, and thus resolution. The overflow data is corrected by the microprocessor when it calculates the results of the interpolator measurements. (Note that in actual measurements, the interpolators will yield different counts, other than the 200 and 400 counts used in the above example.)

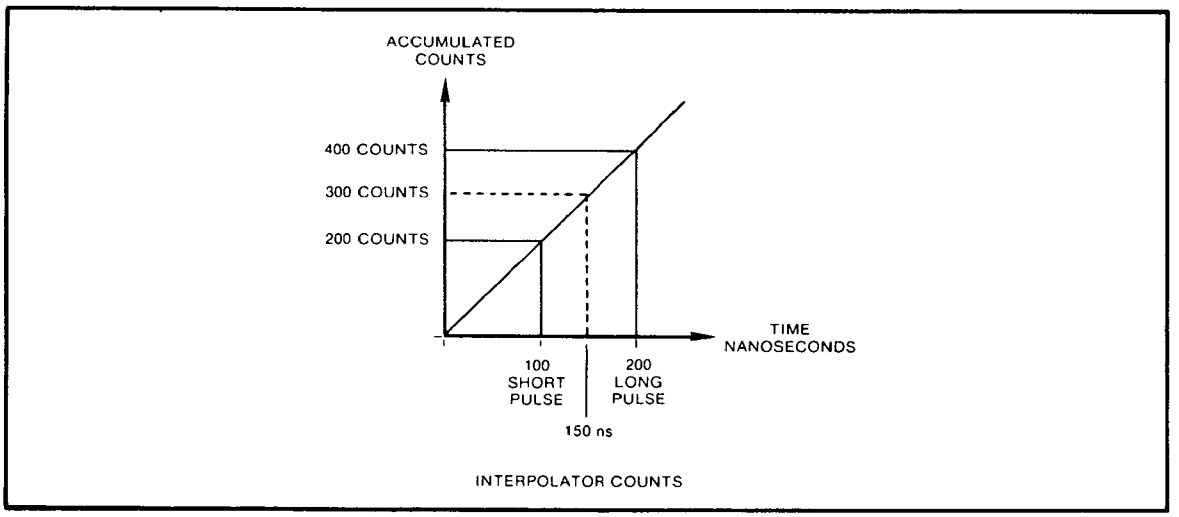


Figure 8-15. Short and Long Calibration Pulses Example

8-238. The final equation used by the A4 microprocessor for determining the actual measurement gate time is:

$$\text{GATE TIME} = (\text{Counts in T register}) \times 100 \text{ ns}$$

$$+ \frac{\text{Count X} - \text{Count S}}{\text{Count L} - \text{Count S}} \times 100 \text{ ns} \qquad \text{(for the Start Interpolator)}$$

$$- \frac{\text{Count X} - \text{Count S}}{\text{Count L} - \text{Count S}} \times 100 \text{ ns} \qquad \text{(for the Stop Interpolator)}$$

where:

Count X = effective counts from interpolation pulse
Count S = effective counts from short calibration pulse
Count L = effective counts from long calibration 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 8-bit counter at 255.

8-239. The general measurement program routine carried out by the microprocessor is to make a measurement, read the MRC registers, read the interpolator counter, perform the calculations, and display the results. Between measurements, the MRC registers and the interpolator counter are reset. For an INPUT 2 frequency measurement, the microprocessor uses the accumulated Events and Time data directly, calculating the measured frequency by dividing the contents of the Events register by the contents of the Time register. For an INPUT 1 measurement, the Events/Time data determines the IF frequency, which the microprocessor uses to calculate the frequency of the microwave input signal to the instrument.

8-240. A4 Microprocessor Assembly

8-241. The A4 Microprocessor (MPU) Assembly controls the overall operation of the instrument. This assembly receives instructions via the front panel keyboard or the HP-IB interface, and sends instructions and data to the front panel display, HP-IB interface, synthesizer, and counter circuitry, to control the measurement.

8-242. The A4 Assembly (see *Figure 8-16*) consists of the microprocessor (U2), two 16K byte ROM ICs (U14,U17), a 2K Byte RAM IC (U20), two input buffers (U16,U18), four output buffers (U1, U9,U11,U13), an address buffer (U12), a data buffer (U10), read/write enabling logic (U5,U7), and miscellaneous enabling and clock delay gates (U3,U4,U6). The main tasks the microprocessor executes are: read from ROM, read and write to RAM, write to output buffers, read from input buffers, transfer data over the two on-board bidirectional data buses, and execute Signature Analysis.

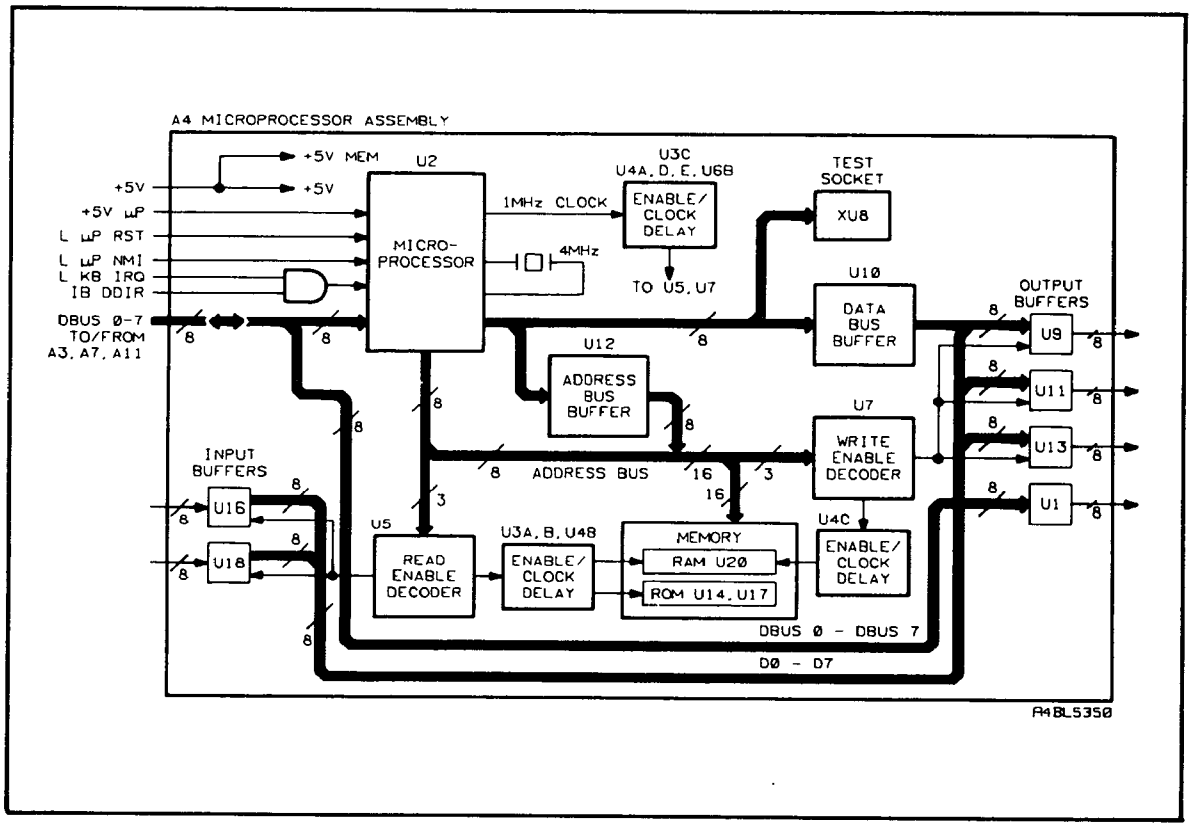


Figure 8-16. A4 Block Diagram

8-243. All control functions are performed by the LSI NMOS Motorola 6803 microprocessor. The processor contains an 8-bit CPU, 64 bytes of power-down RAM, 64 bytes of nonpower-down RAM, three 8-bit I/O ports, one 5-bit I/O port, clock generating circuitry, a programmable timer, and interrupt logic. The microprocessor performs all I/O transfers by reading and writing to memory (memory-mapped I/O), and uses seven 8-bit ports and one 5-bit port on the A4 Assembly for communication with other circuit assemblies. The memory map shown in *Figure 8-17* shows the memory locations for addressing the 8-bit static (latched) input and output ports. Three Static Output Ports (SOPRT1, SOPRT2, SOPRT3) are used for controlling other circuit assemblies, and two Static Input Ports (SIPRT1, SIPRT2) are used to sample circuit conditions in the instrument. An 8-bit Data Port (DPRT1) and a 5-bit Data Port (DPRT2) are used for bidirectional data transfer between other assemblies and the microprocessor.

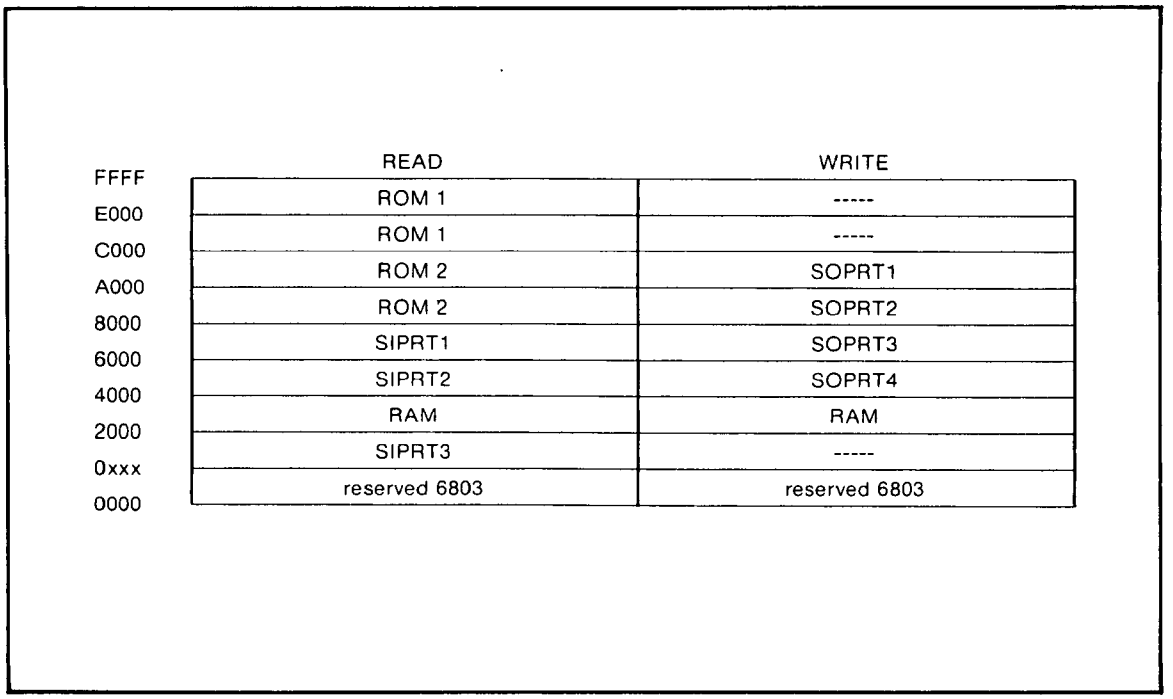


Figure 8-17. Memory Map

8-244. Microprocessor activity begins with the Reset sequence, after the +5V supply is first turned on. On the rise of the +5V supply, processor activity is held back by a logic low on the L μP RST line, U2(6). The L μP RST line, which comes from the Power Supply Control circuit on the A1 Assembly, goes logic high after a minimum delay of 100 ms, and then processor execution begins. The 100 ms delay enables the clock circuits in the 6803 to stabilize.

8-245. At power-up, the microprocessor is latched into its proper operating mode by the setup conditions at U2(8-10). The latching of the operating mode is explained in more detail in paragraph 8-260, but for now it is only necessary to know that once the operating mode is set, the processor reads from a preset address (0FFFE;0FFFF). The addressed memory location contains the starting address of the operating program.

8-246. In the following paragraphs, the basic tasks which the processor performs are described in detail, followed by a description of the various auxiliary circuits on the board.

8-247. ADDRESSING AND DATA TRANSFER. The 6803 uses an 8-bit multiplexed address/data port (A/D 0 to A/D 7). This port is demultiplexed by latch U12 to provide the lower 8 bits of the on-board address bus (A0-A7). The upper 8 bits of the address bus (A8-A15) come directly from U2(22-29). The required address lines are applied directly to ROM ICs U14 and U17, and RAM IC U20 (lines A8-A13 for ROM, lines A8-A10 for RAM). The lower 8 bits of the address are latched by U12 on the falling edge of the strobing pulse from U2(39), causing the address to be applied to the ROM and RAM ICs for the rest of the memory access cycle.

8-248. The multiplexed address/data lines are buffered by bidirectional transceiver U10 to provide the on-board 8-bit data bus (D0-D7). The level at the DIR input at U10(1) determines the direction of the data transfer. The U10 outputs are enabled by the rising edge of a delayed and inverted system clock signal ($\overline{\phi 2D}$), so that the U10 outputs are tri-stated during the address portion of the multiplexed bus cycle. U10 is also used for Signature Analysis testing of the A4 Assembly by removing U10 from its socket and installing it into Test Socket XU8. Refer to the troubleshooting procedures in this section of the manual for the Test Socket Signature Analysis procedure.

8-249. READ FROM ROM. ROM ICs U14 and U17 are NMOS LSI 16K byte devices, providing a total ROM space of 32K bytes. Each ROM has 2 enable lines, 14 address lines, and 8 tri-state data lines. Each is enabled when both the E (Enable) input at pin 20 and the OE (Output Enable) input at pin 22 are logic low. The $\overline{\phi 2D}$ enable signal goes high to turn the IC off during the address portion of the multiplexed data bus cycle, thus reducing overall power consumption. The OE line is the logical AND result (active low) of two of the read address decoder outputs from U5(7,9) or U5(10,11). Pull-up resistors R4 and R5 permit a faster rise time at the open-collector output of U3.

8-250. Two read address decoder lines are required because the ROM address space is divided into 8K byte sections for output port mapping. The three highest-order address lines at U2(22,23,24) are used to select 8K byte memory blocks. The R/$\overline{W}$ signal is inverted by U4A to make an active low signal on read ($\overline{R}$/W); this signal to U5(5) selects the U5 decoder. An inverted and delayed version of the system clock ($\overline{\phi 2D}$) goes to U5(4) to ensure that devices are not enabled during the address portion of the multiplexed bus cycle.

8-251. When the E and OE ROM enabling lines are active low, the data at the addressed location appears at the data lines. The data is held until one of the enable lines (typically the E input) goes high. The 6803 reads the data on the bus on the falling edge of the system clock. After the enable line goes high and the data lines are tri-stated, the ROMs go into their standby low power dissipation state.

8-252. RAM READ AND WRITE. The RAM IC, U20, is a 2K byte CMOS static RAM device. U20 has three enable lines, 11 address lines, and 8 bidirectional data lines. The CS (Chip Select) input at U20(18) is active low, and goes high to power-down the RAM during the address part of the multiplexed bus cycle, saving power. The OE (Output Enable) input is always high during a write, and will be discussed later. The WE (Write Enable) signal at U20(21) is active low during a write. The WE signal comes from NAND gate U6C, the inputs to which are the $\overline{R}$/W line (active high during a write), the system clock, $\phi 2$ (active high when data valid), and the write decoder select output (inverted by U4C) from U7(14). The U7 write decoder functions the same as the U5 read decoder, except it is enabled by the R/$\overline{W}$ line (active low during a write). Once enabled, data on the I/O lines at U20(9-11, 13-17) is stored into memory on the rising edge of the WE signal. This completes the write cycle to RAM.

8-253. The read from RAM cycle is identical to the read from ROM cycle, but with a different address sent to the U5 decoder, resulting in an enabling output from U5(14). The WE line is held high during the read operation, and the OE (Output Enable) input at U20(20) is active low. The OE input comes from NAND gate U6A, the inputs to which are the R/$\overline{W}$ line (active high during a read), a delayed version of the system clock (ϕ2D), and the enabling signal from U5(14), inverted by U4B.

8-254. READ FROM INPUT PORT. Status condition signals from other circuits are received at the SIPRT1 and SIPRT2 input ports, using 8-bit latches with tri-state outputs, U16 and U18, as input buffers. Reading from an input port is similar to reading from ROM, but only one enable signal is needed for each input buffer, at U16(1) and U18(1). The U5 read decoder output is selected based on address range. When the enable signal is low, data at the buffer inputs, U16(2-9) and U18(2-9), is transferred onto the data bus (D0-D7). The processor reads this data on the falling edge of the system clock ($\phi 2$), and the decoder disables the buffers before the next bus cycle begins.

8-255. WRITE TO OUTPUT PORT. Control signals to other circuits are transferred via the SOPRT1, SOPRT2, and SOPRT3 output ports, using 8-bit flip-flop ICs U9, U11, and U13, as output buffers. Writing to an output port is similar to writing to RAM. The inverted system clock, $\overline{\phi 2}$, at pin 1 of U9, U11, and U13, is used to latch the data on the processor bus (D0-D7) to the outputs of the buffers. Data transfer through each buffer is enabled only when the corresponding enable signal from write decoder U7 (pin 10, 11, or 12) is active low and the $\overline{\phi 2}$ line makes the low-to-high transition. The outputs of U9, U11, and U13 are totem pole outputs, and thus are always active.

8-256. DATA PORT READ AND WRITE. The microprocessor uses two of its ports as static data busses for data transfer to and from other assemblies. Data Port 1 (DPRT1) is an 8-bit bidirectional port which is used for all data transfers directly to and from the processor via the DBUS 0-DBUS 7 lines. Three lines of the 5-bit Data Port 2 (DPRT2) are used for handshaking with the HP-IB processor on the A11 HP-IB Interface Assembly. The three handshake lines (IB DVAL, IB DREC, IB DDIR), at U2(10,11,12) respectively, provide synchronization between the two asynchronous processors. The fourth DPRT2 line (L KB IRQ) is used to detect an interrupt caused by a front panel key being pressed. The fifth DPRT2 line is not used.

8-257. The pins of the DPRT1 and DPRT2 ports are individually programmable to be either inputs or outputs; at any one time, some pins may be inputs, and others may be outputs. A +5V pull-up via resistors R1, R2, and resistor network R3, makes the DPRT1 and DPRT2 lines high level when configured as inputs. When configured as outputs, the DPRT1 and DPRT2 lines are totem pole outputs. A read to, or write from, these ports is controlled entirely within the 6803 processor.

8-258. WRITE TO SYNTHESIZER ASSEMBLY. The A5 Synthesizer Assembly is programmed via a separate 8-bit latch, U1, in order to isolate the A5 Assembly from microprocessor noise. A write to the synthesizer is similar to writing to one of the SOPRT outputs, except the latching signal (SYN LCH) comes from U9(9) via the motherboard. The U1 output latch is always enabled by a ground connection at U1(1).

8-259. This completes the explanation of the basic operations of the microprocessor board. The following paragraphs describe auxiliary circuits and operations of the A4 Assembly, including: 6803 operating mode latching, clock delay and enabling gates U3, U4, and U6, power supply decoupling circuitry, crystal circuit, interrupts, standby RAM,and Signature Analysis.

8-260. LATCHING THE OPERATING MODE. The 6803 MPU is basically a 6801 single-chip microcomputer operating in mode 2. The 6803 operating mode is established on the rising edge of the L μP RST signal from the A1 Assembly. R12 and C24 produce a ramp input at U2(6). CR1 and CR2 are held low by the L μP RST line (logic low level here is 1.5 Vdc maximum), and the processor reads DPRT2 at U2(8,9,10) for the mode. The levels read by the processor are 010 (binary 2), i.e. mode 2. After the L μP RST line goes high, CR1 and CR2 have no effect and DPRT2 operates as a bidirectional data port.

8-261. ENABLING AND CLOCK DELAY GATES. The 6803 processor provides a single system clock output (ϕ2) at U2(40). A number of delayed and/or inverted clock signals are derived from this single clock by quad AND gate U3, hex inverter U4, and triple NAND gate U6. The ϕ2 system clock at U2(40) is a 1 MHz squarewave which is active high for data valid, and active low for address valid. Individual devices on the A4 board are enabled based on two things: the address decoders U5 and U7, and a precisely timed edge of the system clock. The decoding outputs of U5 and U7 have many propagation delays, and are used only for device selection, not device de-selection. The $\overline{R}$/W line is also used in some of the decoding; it is not used for device de-selection.

8-262. The ϕ2 signal is used to terminate the write to RAM, so that the cycle ends before the outputs of the processor go to their tri-state mode and write erroneous information to the RAM. The inverted clock, $\overline{\phi 2}$, is used to terminate the write to the output buffers, for the same reason.

8-263. The delayed clock signals are used for de-selection of devices. A delayed version of the noninverted clock, ϕ2D, is provided by a double inversion by U4E, U4D, and U3C. A +5V pull-up voltage via R8 at the open-collector output at U3C(8) permits a fast rise time. The ϕ2D signal is used to terminate the read from RAM so that the RAM holds its data for 10 ns after the 6803 reads.

8-264. The $\overline{\phi 2D}$ signal produced by three-input NAND gate U6B is used to enable the read and write decoders at U5(4) and U7(4). The L μP RST line is used to gate $\overline{\phi 2D}$ at U6B(3,4) so that no bus activity occurs when the L μP RST line is low.

8-265. CRYSTAL CLOCK. The 6803 has an internal clock generating circuit which requires only an external 4 MHz crystal (Y1) and the proper load capacitance (C1,C3). The 4 MHz crystal frequency is divided by 4 to give a system clock frequency of 1 MHz.

8-266. POWER SUPPLY DECOUPLING. The +5V supply from the A8 motherboard supplies V_{CC} for all the A4 circuitry except the memory devices. In order to keep power dissipation low, the memory devices (U14, U17, U20) are turned on and off at a 1 MHz rate (on when data valid). This generates system noise, so L2 and C23 provide extra filtering between the +5V MEM supply to the RAM and ROM devices and the +5V supply for the rest of the A4 Assembly.

8-267. INTERRUPTS. Two interrupt inputs to the processor are available in addition to the L μP RST input. The L μP NMI input at U2(4) is a non-maskable interrupt which is used in power-down situations to signal the CPU to save the contents of the internal standby RAM. This signal comes from the Power Supply Control circuit on the A1 Assembly.

8-268. The $\overline{\text{IRQ1}}$ input is an active low maskable interrupt enabled by either HP-IB communication, or the front panel keyboard when the operator presses a key. Both interrupts are logically ANDed together by U3D, and the output at U3(11) is applied to the single $\overline{\text{IRQ1}}$ input at U2(5). When the processor is interrupted, it scans the DPRT2 lines to determine whether the L KB IRQ line at U2(8), or the IB DDIR line at U2(12) has gone low, and executes the appropriate program based on which interrupt occurred.

8-269. STANDBY RAM. A separate +5V standby supply (+5V μP) is available at U2(21), supplied from the Timebase Buffer circuit on the A1 Assembly. This voltage is always present when the instrument is connected to ac power, and keeps the power-down RAM contents valid.

8-270. SIGNATURE ANALYSIS. There are three kinds of Signature Analysis (S.A.) available for testing the A4 Microprocessor Assembly: front panel keyboard S.A., test socket S.A., and hardwired S.A. Refer to the troubleshooting procedures in this section of the manual for all Signature Analysis procedures.

8-271. A5 Synthesizer Assembly

8-272. The A5 Synthesizer Assembly provides the 294.5 to 350.0 MHz local oscillator (LO) signal to the Microwave Module. The LO frequency is programmed by the A4 Microprocessor Assembly, and is referenced to the 10 MHz timebase signal. The synthesizer is based on a single phaselock loop (PLL), which gives the high frequency wideband tuneable oscillator (VCO) in the synthesizer the same frequency accuracy and drift characteristics as the crystal oscillator timebase. The following theory of operation will begin with a general discussion of the overall operation of the circuit (refer to *Figure 8-18*), followed by a detailed circuit description.

8-273. GENERAL. The 10 MHz signal from the timebase buffer on the A1 Assembly is divided by 100 to obtain a 100 kHz reference for the phaselock loop. A voltage controlled oscillator (VCO) frequency is divided by counters which are programmed by the microprocessor board. A phase detector compares the output of the programmable frequency dividers to the 100 kHz reference. The integrated and filtered phase detector signal controls the frequency of the VCO, forming a closed-loop negative feedback system. The feedback forces the output frequency of the programmable dividers to equal the 100 kHz reference. Thus, the VCO frequency is a programmable multiple of 100 kHz.

8-274. The VCO output signal is amplified to +14 dBm and sent to the microwave assembly via a coaxial cable. This LO output can be turned off under microprocessor control by removing the VCO bias current.

8-275. An auxiliary output signal (AUX A/B) is sent to the counter, IF, and low frequency boards for self test and diagnostics. The microprocessor selects one of four different signals to be at the auxiliary output. These signals are derived from the programmable dividers in the PLL, and are at least ten times lower in frequency than the main LO output. The auxiliary output is off during normal instrument operation.

8-276. To aid in troubleshooting, a red LED indicator at the top of the board lights when the synthesizer is not phaselocked. Also, some important low frequency (dc-audio) nodes in the circuit are available at a 14-pin connector (J1) at the top of the board, accessible through a rectangular hole in the top cover of the RF shielding for the A5 and A6 assemblies. Note that all three ECL ICs on the A5 board (U7, U8, U10) operate on the +5V supply (instead of the usual -5.2V), to allow easier interfacing of dc coupled control signals from CMOS and TTL devices operating on the +5V supply.

8-277. The operation of the A5 Synthesizer Assembly centers around synthesizer IC U3. U3 is an LSI PLL frequency synthesizer containing a programmable reference divider, digital-phase detector, divide-by-N and divide-by-A counters, and strobe, address, and data lines for programming. The U3 synthesizer IC is combined with an ECL prescaler, and discrete analog and RF circuitry to provide all the required synthesizer functions performed by the A5 Assembly.

8-278. DATA LATCH. The programmable frequency dividers of U3 are controlled via eight lines (SYN DATA 0 - SYN DATA 7) which come from a latched output port on the A4 Microprocessor Assembly. A TTL 8-bit latch (U4) passes the data when the Synthesizer Latch (SYN LCH) signal from the A4 microprocessor at U4(11) is high; when SYN LCH goes low, the U4 outputs are latched. Resistor network R19 pulls-up the "1" outputs of U4 to +5V (CMOS logic levels). The outputs of U4 provide data (D0-D3), addressing (A0-A2), and strobing (ST) signals as programming data to the inputs of U3.

8-279. The programming data is transferred to U3 as a series of 4-bit parallel inputs to D0-D3 at U3(2,1,20,19), respectively. Each set of 4 bits is directed to the proper circuits inside U3 by a 3-bit address at A0-A2 at U3(9,10,11), and latched into U3 when the ST input goes low. The U4 input latch is in the transparent (non-latched) state for the entire series of bytes used to program the synthesizer to a frequency.

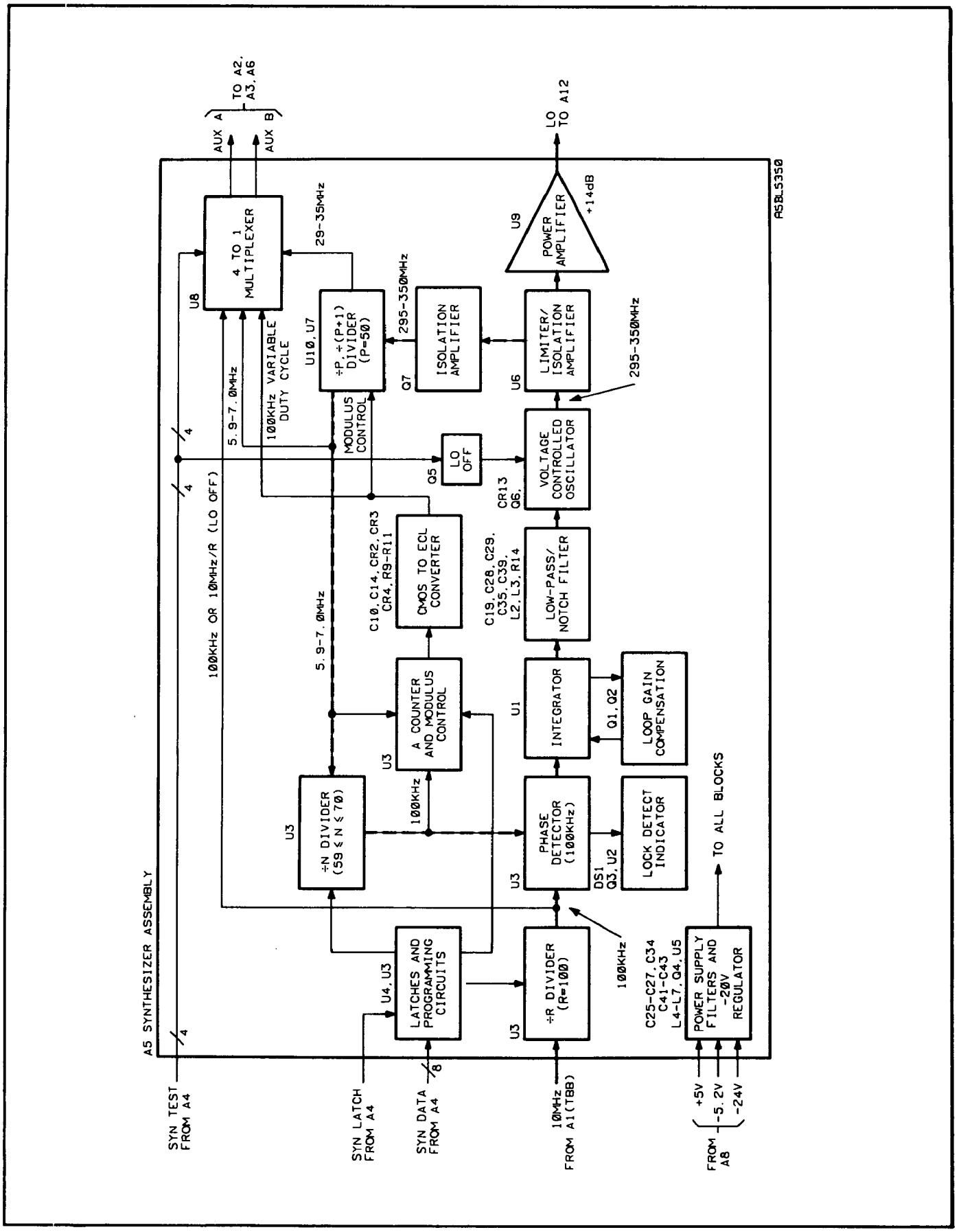


Figure 8-18. A5 Block Diagram

8-280. FREQUENCY DIVIDERS. U3, U7, and U10 form the programmable frequency dividers. In the main divider chain, the LO frequency is divided down to 100 kHz, using the dual-modulus divider technique. In the reference divider (within U3), the 10MHZ INT SYN reference frequency is divided down to 100 kHz.

8-281. Reference Divider (÷R). The 10MHZ INT SYN signal from the Timebase Buffer part of A1 is TTL amplitude (TTL line driver), but ac coupled. It is low-pass filtered on A1 to reduce harmonics above about 100 MHz. The 10MHZ INT SYN signal is ac coupled to the OSC IN input (CMOS) at U3(7). Diodes CR5 and CR7 protect U3 during power-up and power-down. The 10 MHz signal is turned off in Standby, even though the Timebase Buffer circuit remains powered.

8-282. The ÷R counter inside U3 divides the 10MHZ INT SYN signal by 100 to obtain the 100 kHz reference frequency for the phaselock loop. The value of R is programmed to 100 at instrument power-up and is not reprogrammed for each new synthesizer frequency.

8-283. Two-Modulus Counter. Two-modulus ECL counter U10 divides the LO frequency at its F_{in} input by 10 for the next period of its Q output if either (or both) of its E1 and E2 inputs are high. U10 divides the LO frequency by 11 for the next output period if E1 and E2 are both low. The state of U10's E1 and E2 inputs are important only just prior to the rising edge of the Q output. (See *Figure 8-19.*)

8-284. Bi-quinary (÷ 2 and ÷ 5) ECL counter U7 divides the output frequency of U10 by 5. The Q3 output of U7 drives the E2 input of U10 with a signal that is high for 4 cycles of U10's output and low for one cycle of U10's output. This forces U10 to divide its input frequency by 10 for 4 output cycles and allows U10 to divide its input frequency by 10 or 11 for one output cycle. Thus the combination of U10 and U7 form a divider which can divide the LO frequency by 50 or 51.

8-285. The ÷ 2 flip-flop in U7 does not divide the frequency, but instead provides an output which satisfies the input requirements of the F_{in} input at U3(3). The flip-flop is set by the Q2 output at U7(4) and clocked by the Q3 output at U7(3). The flip-flop's Q0 and $\overline{Q0}$ outputs at U7(15,14) have the same frequency as the Q3 and $\overline{Q3}$ outputs, but with a 40%/60% duty cycle and a phase allowing the maximum time for U3 to compute the modulus control for the next ÷50 or ÷51.

8-286. Low Frequency Programmable Divider (÷ N). The F_{in} input (CMOS) at U3(3), which is ac coupled from the $\overline{Q0}$ output at U7(14), is biased at about +2.4 V by R37 and R38. The F_{in} frequency is 5.9 to 7.0 MHz for LO frequencies in the 295 to 350 MHz range, being approximately the LO frequency divided by 50. The ÷ N counter inside U3 divides the F_{in} frequency down to 100 kHz (when phaselocked). N is an integer between 59 and 70 for LO frequencies in the 295 to 350 MHz range.

8-287. Modulus Control (A/MC). The F_{in} input also clocks the A counter inside U3, which generates the Modulus Control (MC) signal for the ECL divider. The MC output is a signal to U7 and U10 to divide by 50 (MC high) or 51 (MC low). The MC signal is low for A cycles of F_{in}, then high for N – A cycles of Fin (A is always programmed to a value less than 50 and N is at least 59, so N – A is always positive). Thus the total divide number $Nt = (A \bullet 51) + [(N - A) \bullet 50] = (N \bullet 50) + A$.

8-288. When phaselocked, the LO frequency will be Nt • 100 kHz, that is, $f_{LO} = [(N \bullet 50) + A] \bullet 100$ kHz = (N • 5 MHz) + (A • 100 kHz). The value of N acts as a coarse frequency control with 5 MHz steps, and the value of A acts as a fine frequency control with 100 kHz steps.

8-289. Switching back and forth between the two prescaling numbers (50 and 51) results in an average prescaling number which is a fractional value between 50 and 51. The switching between prescaling numbers is done at a 100 kHz rate. The total divide number, Nt, is always a whole number.

8-290. CMOS-to-ECL Converter. CR2, CR3, CR4, C10, C14, R9, R10, and R11 form a CMOS-to-ECL converter which changes the slow CMOS Modulus Control logic signal into a relatively fast ECL level signal. R9, R10, and R11 form a voltage divider which generates a +3.7V reference (ECL switching threshold, V_{bb}). CR2 and CR3 clamp the converter circuit output to one diode drop above or below this V_{bb} reference (approximately ECL logic levels).

8-291. C14 shifts the input switching thresholds of the converter circuit to levels near the beginning of U3's high-to-low and low-to-high transitions. Therefore, the converter circuit's input switching threshold is about +4.3V for high-to-low transitions and about +0.6V for low-to-high transitions.

8-292. PHASE DETECTOR. The phase detector inside U3 compares the 100 kHz signal from the reference divider, F_R, with the signal from the internal ÷N divider, F_V (100 kHz when phaselocked). The phase detector output (PD) is normally high impedance, but it pulses high or low at a 100 kHz rate. In the high impedance state the PD voltage will be about +2.4V, determined by the integrator circuit (discussed later) which follows the phase detector. The PD pulses are low if F_V leads F_R and high if F_V lags F_R, and the pulse width is proportional to the phase difference between F_V and F_R. The phaselock loop would normally drive the phase difference to zero, however, the loop is biased for a slight phase lead in order to maintain circuit stability.

8-293. If the phaselock loop is not phaselocked (F_V not 100 kHz), the phase detector (PD) output of U3 will be pulsing high if the LO frequency is too low (F_V < 100 kHz) or pulsing low if the LO frequency is too high (F_V > 100 kHz). The pulse width will be much greater than in the locked state, and the pulse width will be time varying. The average of the PD output will have an ac component and a dc component. The frequency of the ac component is the difference between F_V and F_R. The dc component will tend to drive the phaselock loop toward the locked state.

8-294. PHASELOCK INDICATOR. A red LED indicator at the top of the A5 board lights when the synthesizer is not phaselocked. The LED flashes at a rapid rate (it may appear to be just dimly lit) during the signal acquisition sweep in Auto mode. The lock indicator is derived from the phase detector.

8-295. The Lock Detect (LD) output at U3(13) is normally high, and pulses low whenever the phase detector (PD) pulses low or high. CR8, R8C, R16, and C13 form a dual time constant circuit. When the synthesizer is phaselocked, the LD pulses are narrow and allow C13 to charge to nearly a +5V level; when the synthesizer is not phaselocked, the LD pulses are wide and discharge the C13 voltage to a relatively low level (about 1V). Comparator U2 compares the voltage on C13 to about +3V from R9-R11. The U2 output and transistor Q3 drive the DS1 LED. DS1 lights when the synthesizer is not phaselocked. The Q3 collector also goes to the test connector as the L UNLOCKED signal.

8-296. INTEGRATOR. The integrator circuit following the phase detector, consisting of U1 and associated components, performs many functions: biasing the phase detector, generating a low impedance output in the voltage range of the VCO, providing large loop gain at low frequencies for phase noise reduction, setting the step response of the loop, and helping to filter out ripple from phase detector pulses.

8-297. R7, C8, and R6 convert the phase detector voltage pulses into current pulses, and remove the high frequency components which are beyond the frequency range of the integrator. Operational amplifier U1 and feedback components C1, R1, and C3 integrate the phase detector current pulses. C1 is the integrating capacitor, and R1 helps to keep the closed loop response stable.

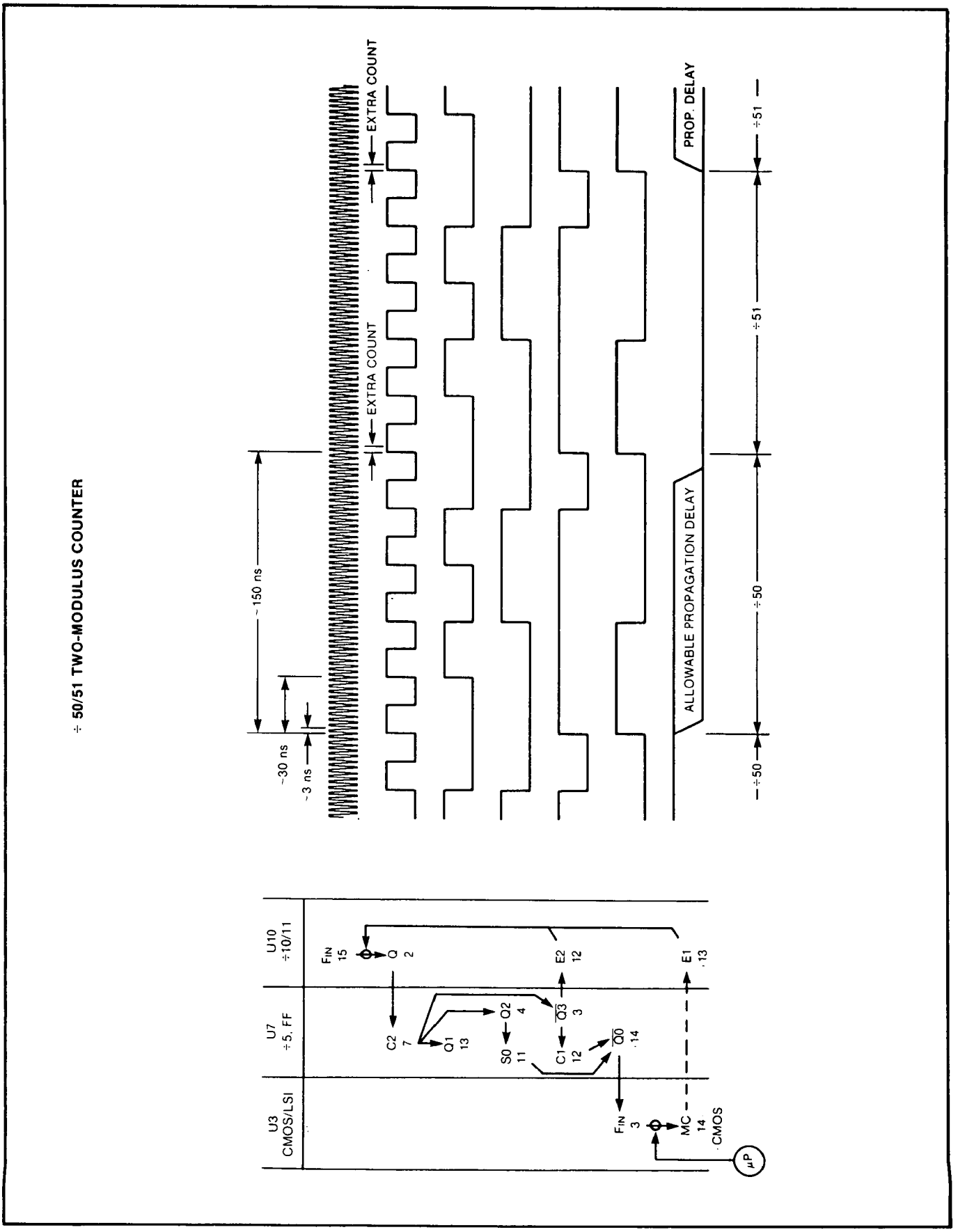


Figure 8-19. Two-Modulus Counter (÷50/÷51) Timing Diagram

8-298. The noninverting input at U1(3) is biased at about +2.35V dc by R8B, R4, and R8A. When the synthesizer is phaselocked, the inverting input is at the same voltage as the noninverting input. The voltage across R5 is the same as the voltage across R4 (about 0.3V dc). The current through R5 biases the phase detector so that, when phaselocked, the PD output of U3 will have narrow low pulses (20-100 ns).

8-299. When the synthesizer is not phaselocked, U1 will probably be saturated. Since U1 has no voltage gain in this condition, it cannot function as an integrator, and the inverting input will not be at the same voltage as the noninverting input.

8-300. LOOP GAIN COMPENSATION. The phaselock loop gain tends to vary with LO frequency because of changing VCO tuning sensitivity and changing divide number in the programmable frequency dividers. In the 300 to 370 MHz range the two effects mostly cancel, giving an almost constant loop gain. Below 300 MHz the loop gain increases, requiring compensation to keep the phaselock loop stable.

8-301. The loop gain increase below 300 MHz is compensated by detecting the integrator output voltage (VCO tuning voltage), and connecting resistance in parallel with R1. P-channel JFETs Q1 and Q2 are used to connect R3, or R3 and R2, in parallel with R1, as determined by the integrator output. When the U1 output voltage is more negative than about -4V, both Q1 and Q2 are off, and R1 determines the phaselock loop stability. When the U1 output is between about -3.5V and -1V, Q1 is on (Q2 remains off), and R3 is in parallel with R1. When the U1 output is more positive than about -0.5V, both Q1 and Q2 are on, so R3 and R2 are in parallel with R1.

8-302. CLAMP AND LOW PASS/NOTCH FILTER. CR1 prevents the integrator output of U1 from being more positive than +0.7V (U1 current limits at 15 to 20 mA). After passing through series resistor R14, the tuning voltage is limited to lower than about +0.2V by Schottky rectifier CR6 to prevent forward biasing the varactor diode (CR13) in the VCO.

8-303. Both ends of series resistor R14 are accessible at the test connector through R17A and B as the PLL OUT and PLL IN lines. C22 and C23 low-pass filter the signals to the test connector and help prevent interference pickup from the connector. The phaselock loop can be monitored or influenced through the PLL OUT and PLL IN connector pins.

8-304. R14, L2, L3, and C39 form a low-pass filter with a cut-off frequency of about 10 kHz. C28 and C29 in parallel with the series combination of L2 and L3 form a notch in the filter response at 100 kHz to block any remaining ripple caused by phase detector pulses. C19 (with R14) provides additional filtering above 100 kHz. C20 shunts to ground any RF signal which may have leaked back through the filter from the VCO. C35 helps maintain C39's low impedance in the 10-100 MHz range.

8-305. VOLTAGE CONTROLLED OSCILLATOR (VCO). The VCO is a grounded-collector varactor-tuned Hartley oscillator covering approximately 250 to 410 MHz. Only the 295 to 350 MHz range is used in the synthesizer. The VCO can be turned off by removing the bias current via software control.

8-306. The VCO tuned circuit (resonator) consists of varactor diode CR13, C45, L10, C51, and stray series inductance and shunt capacitance. The capacitance of CR13 varies from about 2 pF at 20V reverse bias to about 20 pF at 0V bias. The negative tuning voltage is applied to the anode of CR13 through RF choke L9; the dc side of L9 is bypassed by C38. C45 isolates the tuning voltage from the voltage on the emitter of the VCO transistor, Q6, and limits the tuning range at the low frequency end.

8-307. The resonator current flowing through the inductance of a short PC line between C44 and Q6 emitter produces an RF voltage which is ac coupled by C44 to the base of Q6. This RF voltage across the base-emitter junction of Q6 produces an RF collector-emitter current which sustains the oscillation in the resonator. The nonlinearity of Q6 limits the VCO amplitude by making the collector-emitter current more impulsive (instead of sinusoidal) as the base-emitter signal voltage increases.

8-308. The output of the VCO is the RF voltage drop of the resonator current flowing through the inductance of a short PC trace between C51 and the grounded cathode of CR13. C51 isolates the dc voltage on the emitter of Q6 from this grounded output inductance.

8-309. DC bias for the VCO circuit is provided by R28, R17D, and R20. R28 and R17D form a voltage divider which biases the base of Q6 at about -10V. L8 and C37 present a high reactive impedance to the base of Q6 at the oscillation frequency, while R27 prevents lower frequency oscillation by greatly reducing the Q of L8. The emitter current in Q6 is set by the voltage across R20.

8-310. Q5, CR11, R23, R22, and R21 allow the microprocessor or the service technician to turn off the VCO by removing Q6's emitter current. When the base of Q5 is pulled low, either by the L TEST 4 line from the A4 microprocessor (through CR12) or by the L LO OFF line from the test connector, the collector current from Q5 substitutes for the emitter current of Q6 in R20, reverse biasing CR11 and turning off the VCO.

8-311. RF AMPLIFIERS. The RF amplifiers amplify the 295-350 MHz signal from the VCO, limit the amplitude to give constant output level, split the signal into a main LO output and a PLL feedback path, and isolate the VCO from interference.

8-312. Limiter/Isolation Amplifier. U6 and associated components comprise a limiter/isolation amplifier which amplifies the signal from the VCO resonator, splits the signal into two isolated outputs (one for the main output and one for the PLL feedback), and limits the signal amplitude to give a constant RF level at both the main LO output and the frequency divider input.

8-313. U6 is a monolithic differential pair of transistors (and 3 resistors). The emitter bias current in U6 is set by a resistor inside U6 in series with R30A. Since U6 is driven into hard limiting, its gain will depend on its input amplitude. The output signal at each collector is about a 20 mA p-p near-squarewave of current. The small inductance of jumper W2 in series with the output to the main LO power amplifier improves the bandwidth.

8-314. Isolation Amplifier. The amplifier composed of common-base transistor Q7 and associated components isolates the digital dividers in the PLL feedback loop from the VCO and other RF amplifiers. The isolation amplifier passes the signal in the forward direction but blocks interference in the reverse direction. Q7 also transforms the near-squarewave of current from one output of limiter/isolation amplifier U6 into a near-sinewave of voltage at the clock (F_{in}) input of digital divider U10. The signal at the collector of Q7 is ac coupled to the clock (F_{in}) input of divider U10 and to R36. R36 is the main load on the isolation amplifier and also biases the F_{in} input at U10(15) from the V_{bb} output at U10(14). The fundamental frequency voltage amplitude at U10(15) is typically about 1.0 V p-p.

8-315. Power Amplifier. The RF power amplifier consisting of U9 and associated components amplifies the signal from one output of limiter/isolation amplifier U6 to +14.5 dBm typical at the main LO output, which drives the A12 Microwave Assembly. U9 is a common-emitter feedback amplifier with +14 dB gain.

8-316. AUX A/B MULTIPLEXER. The synthesizer generates an auxiliary output used for automatic synthesizer and instrument diagnostics and self test. The AUX multiplexer circuit allows the microprocessor to select one of four signals from various points in the PLL frequency dividers to send out via the AUX A and AUX B balanced output. This output goes to the MRC on the A3 Counter Assembly, the third stage of the IF amplifier chain on the A6 Amplifier/Detector Assembly, and to the middle stages of both the 1MΩ and 50Ω low frequency input channels on the A2 Low Frequency Input Assembly. During normal instrument operation none of the four signals is selected, so the AUX output is inactive. The multiplexer circuit is controlled by four dedicated lines from the microprocessor board, which are separate from the lines used to program the synthesizer frequency. One of the multiplexer control lines (L TEST 4) is also used to turn off the VCO for certain diagnostics.

8-317. The AUX multiplexer circuit consists of U8, resistor network R32, and bypass capacitors C48 and C49. U8 is an ECL IC which has four 3-input OR gates whose outputs feed an internal 4-input AND/NAND gate. Each of the four 3-input OR gates has inputs from a signal line and an active low control line (unused inputs are grounded). During normal instrument operation all four control lines are high, and the AUX output is inactive. In the test/diagnostic mode, one of the control lines goes low to pass the selected signal to the U8 output. Pull-up resistor network R32 allows the TTL control lines to drive the ECL inputs of U8. Pull-down resistors for the U8 outputs are mounted on the receiving boards.

8-318. The four control lines select the following signals for the AUX output:

L TEST 1: LO÷10 (29.5–35.0 MHz specified, 25-41 MHz typical)

L TEST 2: LO÷50 (5.9–7.0 MHz specified, 5-8 MHz typical)

L TEST 3: MC, Modulus Control (100 kHz, programmable duty cycle)

*L TEST 4: 10MHz÷R (usually set to 100 kHz, but programmable: $3 \leq R \leq 4096$)

*L TEST 4 also turns off the VCO.

8-319. POWER SUPPLY. The +5V supplies for digital and analog circuitry are kept separate on the A5 Synthesizer Assembly (+5VD, +5VA). Although the two supplies come from the same voltage regulator on the A8 motherboard, they enter the A5 board at separate pins on the P1 connector and are provided with separate filtering components to prevent digital interference in the analog circuitry. The +15V supply is available at the P1 connector, but is not used.

8-320. The voltage regulator consisting of U5 and associated components regulates the -24V supply down to -20V to supply the VCO and integrator. The -20V regulator is turned off when the counter is in Standby mode.

8-321. U5 is a three-terminal adjustable voltage regulator that maintains a -1.25V difference between its output (V_{out}) and adjust (ADJ) terminals. Voltage divider R24 and R13D multiply this reference voltage so that U5's output terminal is at about -20V. CR9 and CR10 protect U5 from excessive reverse current surges in case either the -24V or -20V side is shorted to ground.

8-322. Q4, R13, and R18 turn off the -20V output of the voltage regulator in Standby mode (whenever the +5VA supply is not on). When the instrument is on, voltage divider R13 and R18 between +5VA and -24V holds the base of Q4 at about +2.3V; Q4 is therefore cut off and has no effect on the voltage regulator. When the instrument is in Standby, +5VA is off (0V), the -24V remains on, Q4 saturates and pulls up the adjust terminal of U5, and the output of U5 is reduced to about -1.35V, which is not enough to turn on the VCO or the U1 integrator. The -20V supply can be monitored on the test connector -20 OUT pin. R17C limits short circuit current and prevents interference pick-up.

8-323. A6 IF Amplifier/Detector Assembly

8-324. The A6 IF Amplifier/Detector Assembly amplifies the IF signal from the A12 Microwave Assembly, and converts it into an amplitude-limited waveshape for the A3 Counter Assembly.

8-325. The A6 Assembly provides approximately 48 dB gain over a bandwidth of 0.1 to 175 MHz. The A6 Assembly also provides two detector flags to the A4 microprocessor: one detector flag is sent to the microprocessor whenever the IF signal has dropped below the minimum sensitivity level or is not in the proper frequency range, and another flag is sent whenever the counter input exceeds the overload level. During N determination, the microprocessor sweeps the A5 LO frequency and checks the state of the IF detector flag for both the main sweep and the offset sweep. As part of the counter's power-up test sequence, a 35 MHz test signal is routed through the IF circuit while the signal from the Microwave Assembly is turned off.

8-326. The IF gain is provided by two hybrid amplifier stages each providing 12 dB gain (U3, U4), and two stages of differential amplifiers, each providing 14 dB gain (Q10, Q11, Q9, Q8). The output of the last stage is attenuated 4 dB by impedance matching resistor R35.

8-327. Resistors R22 and R29 determine the current, and therefore the gain, of U3 and U4, respectively. Sensitivity adjustment potentiometer R25 (SENS ADJ) compensates for slight variations of sampler, IF preamplifier, and IF amplifier gains to permit the level detection circuits on the A6 board to trigger at the required sensitivity level.

8-328. There are several networks cascaded with the main signal path. The first is the 175 MHz elliptic filter consisting of L1, L2, L3, L4, L5, C3, and C7. The 175 MHz is equal to one half of the highest LO frequency of 350 MHz, and is the highest useful IF frequency for calculating the input frequency. A 200 MHz low-pass filter consisting of L16, L24, C34, C40, and C43 reduces the LO frequency to a level which will not interfere with automatic amplitude discrimination or sensitivity.

8-329. Limiting diodes CR8 and CR9 help automatic amplitude discrimination and IF level detection under large signal input conditions. The attenuator and matching network consisting of R50, R47, L30, L28, and C60 levels the frequency response and lowers the gain to increase circuit stability.

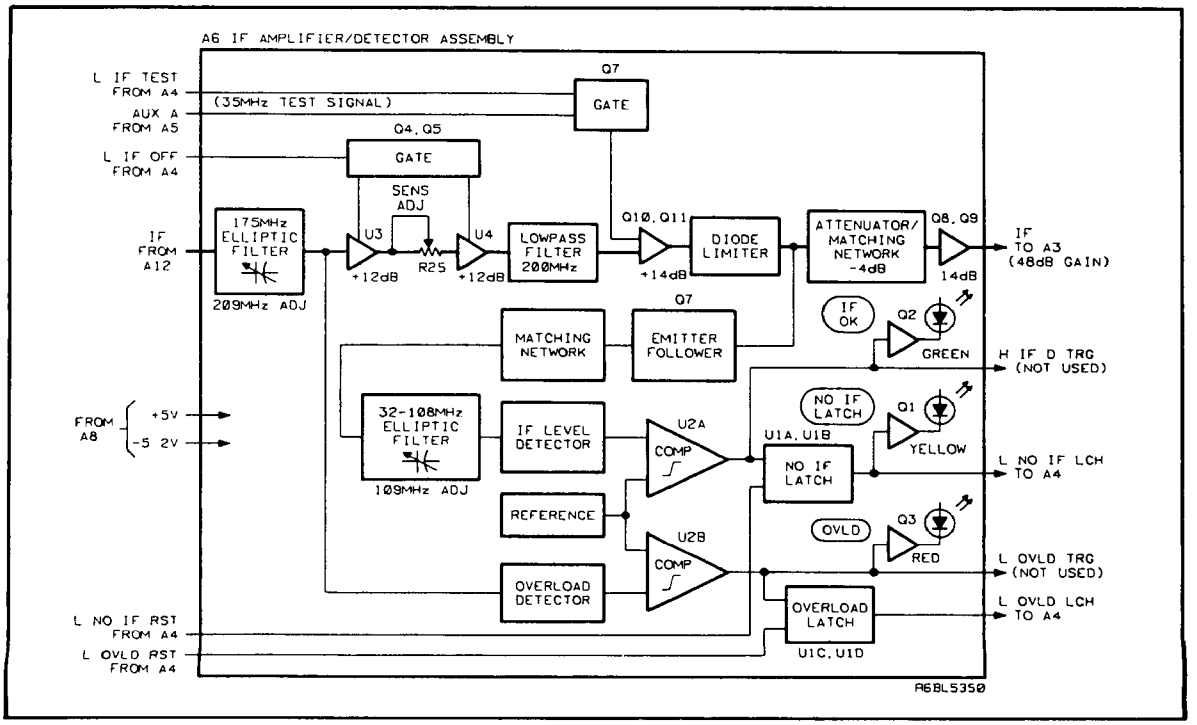


Figure 8-20. A6 Block Diagram

8-330. OVERLOAD DETECTION. An overload condition is sensed at the output of the 175 MHz elliptic filter through C8, full-wave detected by CR3 and CR4, and compared with temperature compensating reference diodes CR1 and CR2 at the input of comparator U2B. If an overload condition occurs, the output at U2B(7) triggers the overload latch composed of U1B and U1C, and turns on the DS1 red LED (OVLD). The latch output (L OVLD LCH) is checked by the A4 microprocessor at the end of the count. The latch is then reset via the L OVLD RST line.

8-331. TEST SIGNAL. The AUX A/B test signal is a 35 MHz signal from the A5 Synthesizer Assembly derived by dividing the 350 MHz LO frequency by 10. The AUX signal enters in a balanced mode (AUX A, AUX B) at P1(8,33) and P1(9,34), respectively, but only the AUX A signal is used by the A6 Assembly. During a test routine, the first two gain stages are turned off to prevent an input to the counter from producing an IF signal from the Microwave Module which would interfere with the 35 MHz test signal. In normal operation, IF input gate transistor Q4 is held saturated, which keeps Q5 saturated and U3 and U4 on. For test routines, the L IF OFF line goes low, turning off Q4, Q5, U3, and U4.

8-332. The AUX A test signal is enabled by the L IF TEST line going low to turn on Q6, which is normally turned off by +5V at the base, via R30. Diode CR7 puts the gate switching voltage at the center of the TTL range, and resistor R24 provides isolation. Q6 provides the proper input impedance and gain to the input test signal, and makes it appear as a normal IF signal to the rest of the IF circuits. The test signal is injected to the input of the first differential amplifier stage (Q10, Q11) from the collector of Q6.

8-333. IF LEVEL DETECTION. The signal for the IF level detector circuit is ac coupled to the base of emitter-follower Q7. Q7 provides high input impedance and a low source impedance for the 32–107 MHz elliptic bandpass filter. R28 and C28 provide frequency impedance compensation. The output of the filter is loaded by R21, full-wave detected by diodes CR5 and CR6, and compared with reference diodes CR1 and CR2 at the input of comparator U2A. The output of the comparator drives the latch (NO IF LATCH) composed of U1A and U1D. When the IF input is greater than the required sensitivity level, the output at U2A(1) turns on the DS3 green LED (IF OK), and the latch output (L NO IF LCH) is high.

8-334. If the IF input drops below the required sensitivity level, the U2A output turns off DS3, and triggers the latch. The latch output turns on the DS2 yellow LED (L NO IF LCH), and is sent to the A4 microprocessor. The microprocessor checks the L NO IF LCH line at the beginning and end of each measurement, and resets the latch via the L NO IF RST line.

8-335. A7 Keyboard/Display Logic Assembly

8-336. The A7 Keyboard/Display Logic Assembly consists of two major sections: the keyboard circuit, and the display logic circuit. The keyboard circuit includes the keyboard matrix (S2-S18), a key encoder (U4), and microprocessor interface circuitry (U2, U3, U5). The display logic circuit includes a synchronization and timing circuit (U1), a microprocessor interface circuit (U6, U7), a dc supply circuit (U8), and an LCD drive divider network (R10-R15). The front panel POWER switch circuit, and a dc supply filter circuit make up the remainder of the A7 Assembly. Ribbon cable W13 provides all connections between the A7 board and the A8 motherboard.

8-337. KEYBOARD CIRCUIT. The 5350B/51B/52B keyboard consists of 17 Bill West switches, S2-S18, for front panel data and function entry. The CMOS key encoder, U4, scans the lines to the keys and, when a key is pressed, makes available a code related to the key's X-Y position in the matrix. Key debouncing is performed internally. The debounce timing is controlled by capacitor C8 on the KBM input of the encoder, U4(7). Scan rate is controlled by C9 on the OSC input, U4(6). U4 contains internal pull-up resistors on columns 1 through 5 of about 1MΩ each, and additional pull-up is provided by external resistor pack R5.

8-338. Once the keypress has passed the debounce time, the DA (Data Available) output at U4(13) goes high. The DA signal is latched by flip-flop U5 to produce an interrupt signal for the A4 microprocessor. The output of U5 is buffered by NAND gate U2C, which sends the inverted interrupt signal (L KB IRQ) to the A4 Microprocessor Assembly. The DA signal also goes to the A4 microprocessor through buffer U2D as the L KB DAVL signal. The microprocessor uses the L KB DAVL signal to detect a key being held down for repeating. The U2C and D buffers block noise on the DA line which may cause spurious keyboard interrupts. The 5-line output of the U4 key encoder goes to tri-state inverting octal buffer U3, and then to the microprocessor via data bus lines DBUS 3 – DBUS 7. The active low L KB READ signal from the microprocessor enables the data transfer onto the bus, and resets the U5 flip-flop.

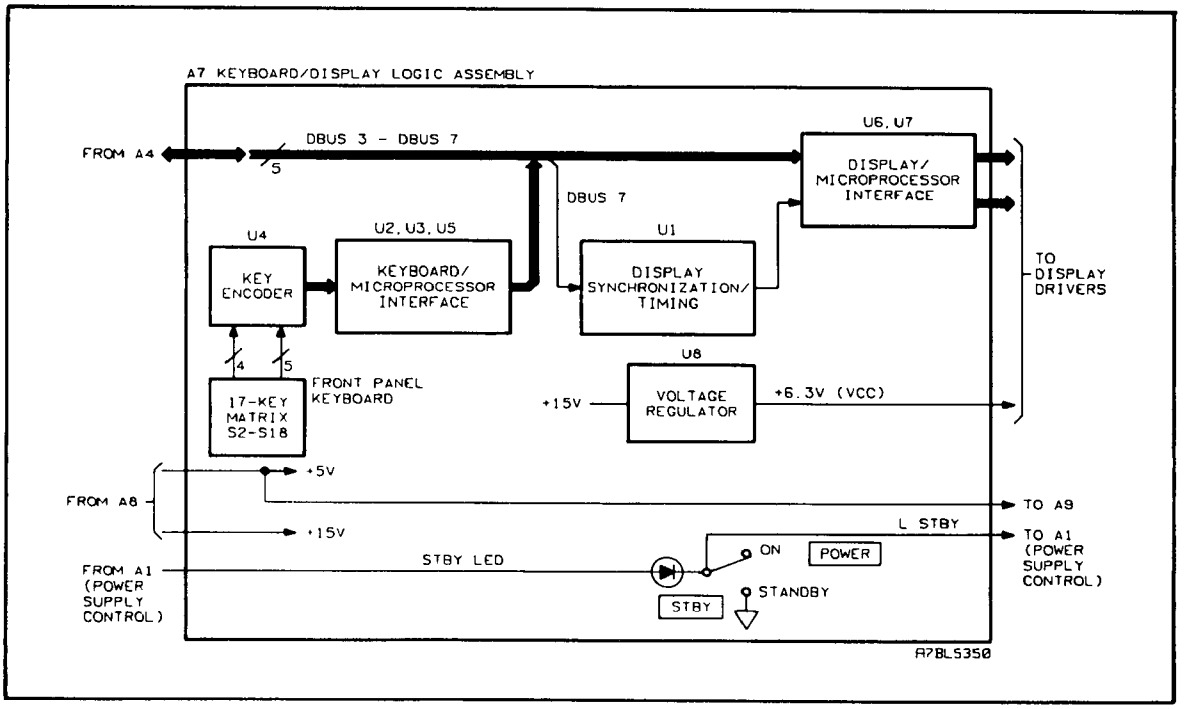


Figure 8-21. A7 Block Diagram

8-339. DISPLAY LOGIC CIRCUIT. The display logic circuit provides power, buffering and one clock signal to the CMOS display drivers. The +6.3V supply for the display (V_{CC}) is derived from +15V using variable voltage regulator U8. A multi-level dc supply is required for generating the drive waveforms on the LCD. These LCD drive waveform levels V1, V2, V3 are generated from +15V using a temperature compensated resistor/thermistor network consisting of resistors R10 through R14, and thermistor R15. Drive levels are set at approximately +4.8V (V3), +3.2V (V2), and +1.6V(V1) at 25°C. The 3-2-1 ratio of these voltages is maintained over temperature to provide an average dc voltage on the LCD of 0V.

8-340. All logic inputs from the microprocessor to the display (via the DBUS 3-7 lines) are buffered and inverted by NAND gates U6 and U7. The high voltage, open-collector NAND gate outputs are pulled-up through R6 to V_{CC}. A total of seven lines are buffered: six from the A4 microprocessor and one generated on A7. The logic levels are not standard TTL: H = V_{CC} - (0.25)V_{CC}, L = (0.25)V_{CC}.

8-341. Two driver boards, located in the display assembly, are used to control the LCD, one for each set of 12 characters. Two 16-pin cables (W3,W4) connect the A7 board to the display drivers via DIP connectors J1 and J2. Data is entered serially into each board via the INA line for characters and ISA for instructions. To speed display rewriting, each board is provided with an independent INA: INAR (right) and INAL (left). The control and ISA lines are shared.

8-342. An external capacitor on driver input OS1, at J1(5) and J2(5), determines the scan rate. This input cannot be shared so each driver board has its own capacitor (C14, C21). For correct sequencing of the power-up states within the display drivers, the INB lines at J1(13) and J2(13) are tied to V_{CC} via R6F and R16, respectively.

8-343. In addition to the data bus lines, there are two control lines from the A4 microprocessor to the display logic circuit. The L DSP PWON line enables the display drivers: As long as L DSP PWON is high, the display drivers do not care about the state of the other logic inputs. The L DSP SYNC line is used in conjunction with the ISA input to determine the type of data being sent to the LCD drivers.

8-344. Sychronization and timing are governed by two non-overlapping clocks, $\phi 1$ and $\phi 2$. $\phi 1$ is generated in software and comes to A7 via DBUS 7, through inverting buffer U6C, to the display drivers. $\phi 2$ is generated by dual monostable IC U1, on the A7 board. The first one-shot is triggered by the rising edge of DBUS 7. The resultant positive-going pulse at U1(13) is fed into the inverting input of the second one-shot at U1(9). On the falling edge of this pulse the second one-shot triggers, causing a negative-going pulse on its inverting output, U1(12). This pulse is then inverted by open-collector buffer U6B. Thus, the display drivers receive a positive-going pulse on their $\phi 2$ inputs, as shown in *Figure 8-22.*

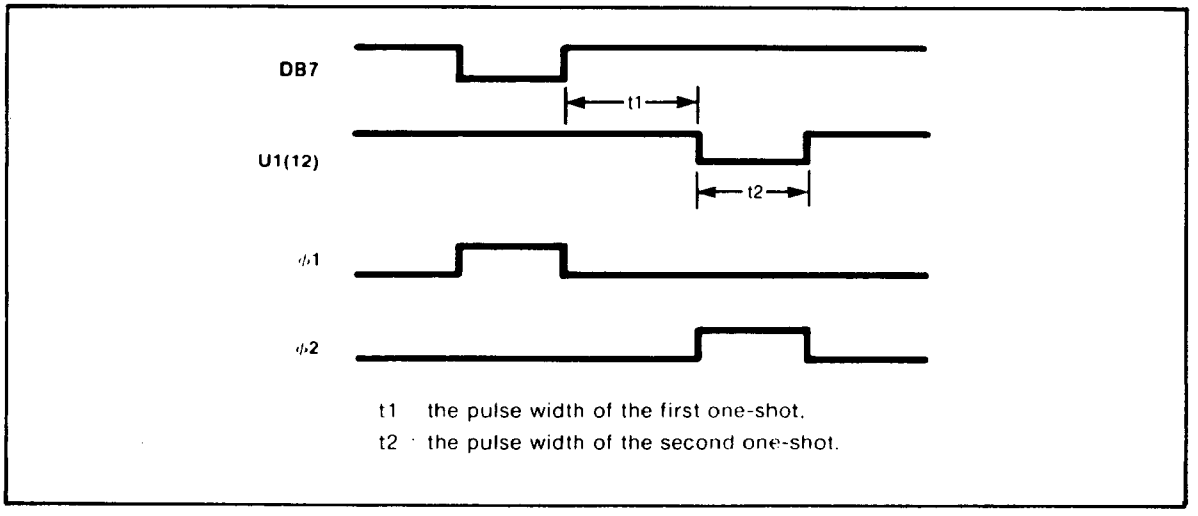


Figure 8-22. LCD Synchronization and Timing Diagram

8-345. POWER SWITCH AND DC FILTER. POWER Switch S1 is a low-power toggle switch When in Standby, S1 is closed, connecting L STBY and the cathode of DS1 to ground. This causes the STBY LED to light and most of the power supply to shut down. When set to ON, the POWER switch is open, allowing L STBY to remain high.

8-346. Both the +5V and +15V from the motherboard are filtered on the A7 board. The filtered +5V is used by keyboard-related circuits. Display-related circuits use both +5V and +15V. Two-wire cable W2 carries filtered +5V to power the backlight LEDs (in the A9 Backlight Assembly) for the display.

8-347. A10 Temperature Compensated Crystal Oscillator (TCXO)

8-348. The A10 TCXO Assembly supplies the internal 10 MHz reference signal to the Timebase Buffer circuit on the A1 assembly. The temperature compensated crystal oscillator, U1, generates a TTL-compatible 10 MHz signal. The U1 output frequency is adjustable through a hole in the rear panel of the instrument (TCXO ADJUST).

8-349. Inductor L1, and capacitors C1 and C2 filter, decouple, and bypass the +5V dc supply to U1. This +5V supply remains on when the instrument is in Standby mode, but is off whenever an external frequency standard is used.

8-350. Resistor R1 simulates the oven monitor signal (OVEN TEMP) of the optional oven oscillator assembly (Option 001 or 010). The OVEN TEMP line is connected via R1 to the -24V supply, and is sent to the oven temperature sensing circuit in the Timebase Buffer (Part of the A1 board) to prevent the instrument from indicating a cold oven when the TCXO assembly is used.

8-351. A11 HP-IB Interface Assembly

8-352. The HP-IB Assembly controls all HP-IB interfacing between the HP 5350B/51B/52B and an external controller. Commands from the controller are partially decoded and sent to the main microprocessor (A4U2), and output data from the main microprocessor is formatted and sent back to the controller.

8-353. Major components of the HP-IB board are the HP-IB processor (U5), two TTL logic IC's (U3,U4), and two transceiver IC's (U1,U2). The HP-IB processor U5 is internally programmed to control all HP-IB interface functions and overall operation of the HP-IB board. Quad NAND gate U3 and quad S-R latch U4 are used to speed the detection and response of the counter to particular HP-IB status and control lines. The 8-line bidirectional bus transceivers U1 and U2 drive the 8 data, 5 control, and 3 handshake lines used over the HP-IB. (See *Figure 8-23.*)

8-354. The 3870 microprocessor (U5) receives commands from the external controller, interprets them, and sends them to the A4 Assembly. It also receives measurement data from A4, formats it, and sends it out on HP-IB when addressed to talk. The bus protocol that performs these tasks is generated by software contained in the program ROM of the processor. The HP-IB processor has four 8-bit I/O ports, for a total of 32 I/O lines. The 16 lines of Port 1 and Port 5 and 1 line of Port 0 are used for data, control, and interface functions between the instrument and the external controller. The remaining 7 lines of Port 0 are used for data, control, and monitoring functions between the HP-IB Assembly and the rest of the instrument. All the lines of Port 4 are used for addressing and testing functions that can be set using address switch S1. The L μP RST signal from the power-up detection circuit on the A1 Assembly resets the HP-IB processor and the main (A4) microprocessor when the instrument POWER switch is set to ON.

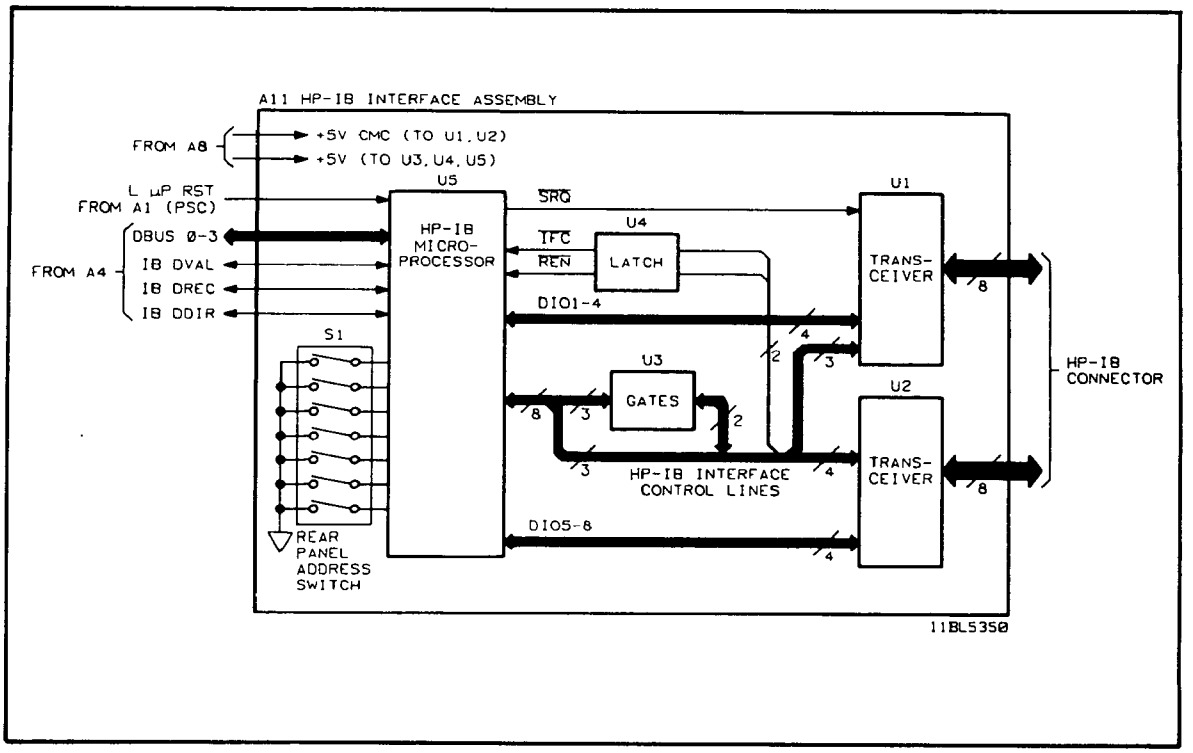


Figure 8-23. A11 Block Diagram

8-355. The open-collector bus transceivers U1 and U2 each drive 8 of the 16 lines used in HP-IB, with an internal driver/receiver pair of buffer amplifiers for each line. Direction of data flow is controlled by Send/Receive inputs on each IC, U1(1,8,11,14,17) and U2(1,8,11,14,17). The SRQ line is set to a permanent Send mode, and the $\overline{\text{ATN}}$ line is set to a permanent Receive mode due to their respective Send/Receive inputs being tied to +5V. The $\overline{\text{IFC}}$ and $\overline{\text{REN}}$ lines are set to permanent Receive mode due to their Send/Receive inputs being tied to ground. All other lines are switched by U5, or by the external controller via U3 and U4.

8-356. NAND gate U3A also pulls the $\overline{\text{NDAC}}$ line low to start the handshake for the information which is sent from the controller. The other two handshake lines, $\overline{\text{DAV}}$ and $\overline{\text{NRFD}}$, are driven directly by the HP-IB processor.

8-357. Quad latch IC U4 speeds the HP 5350B/51B/52B response by latching in the $\overline{\text{REMOTE ENABLE}}$ ($\overline{\text{REN}}$) and $\overline{\text{INTERFACE CLEAR}}$ ($\overline{\text{IFC}}$) signals. The HP-IB processor clears the latches within 1 ms after they have been set by sending a STROBE pulse from U5(7) to the active low inputs at U4B(6) and U4D(15). U3 and U4 together speed the response to the $\overline{\text{ATTENTION}}$ ($\overline{\text{ATN}}$) signal. When $\overline{\text{ATN}}$ goes low, the interface immediately releases control of the HP-IB data lines and goes into the acceptor handshake mode. When $\overline{\text{IFC}}$ goes low, control of the data and the handshake lines is relinquished.

8-358. The HP-IB Assembly is provided with two +5V power sources from the motherboard: +5V CMC (Common Mode Choke) via J2(13), and the standard +5V via J2(14). The +5V CMC circuit (on the A8 Assembly) contains additional filtering elements and is used to provide V_{CC} to the A11 transceivers U1 and U2 to prevent digital signal noise from the HP-IB getting back to the A8 Power Supply circuit. The standard +5V, filtered by L1 and C4, provides V_{CC} for all other IC's on the A11 Assembly.

8-359. Microwave Module (A12 Microwave Assembly/U1 Sampler)

8-360. The basic function of the microwave module in the HP 5350B/51B/52B counter is to down-convert microwave signals in the 500 MHz to 20.0 GHz [26.5 GHz, 40 GHz] region to the intermediate frequency (IF) region of the counter. The 30 to 175 MHz IF signal is amplified and detected by the A6 IF Amplifier/Detector Assembly, and then counted by the A3 Counter Assembly. (See *Figure 8-24.*)

8-361. To perform the down-conversion, the module receives a high power local oscillator (LO) signal from the A5 Synthesizer board, as well as dc power (+13V SW, +5V SW, -5.2V) from the power supply circuit. The microwave module can be divided into three sections: the sampler driver, sampler, and the IF preamplifier.

8-362. SAMPLER DRIVER (PART OF A12 ASSEMBLY). The sampler driver circuit on the A12 board is a medium power, class B power amplifier. The LO signal (295 to 350 MHz, +14 dBm) from the A5 Synthesizer board enters via connector J3 and is ac coupled to the impedance matching network consisting of L17, C28, C29, C21, and C22 to drive power transistor Q2. The inverted signal at the collector of Q2, amplified 10 dB, is ac coupled to the impedance matching network consisting of L15, C24, L14, and C19, and then goes to the sampler.

8-363. U1 SAMPLER. Hybrid sampler U1 is the heart of the down-conversion system. The medium power LO signal from the sampler driver section enters at pin 3 of the sampler. This signal drives a step-recovery diode (SRD) in the sampler which produces a very narrow voltage pulse. This pulse is used to control the sampling of the microwave signal entering the sampler RF connector J1. When a harmonic of the LO sampling frequency is close to the microwave input signal frequency, a signal within the IF frequency range is generated and sent to the IF preamplifier from the sampler.

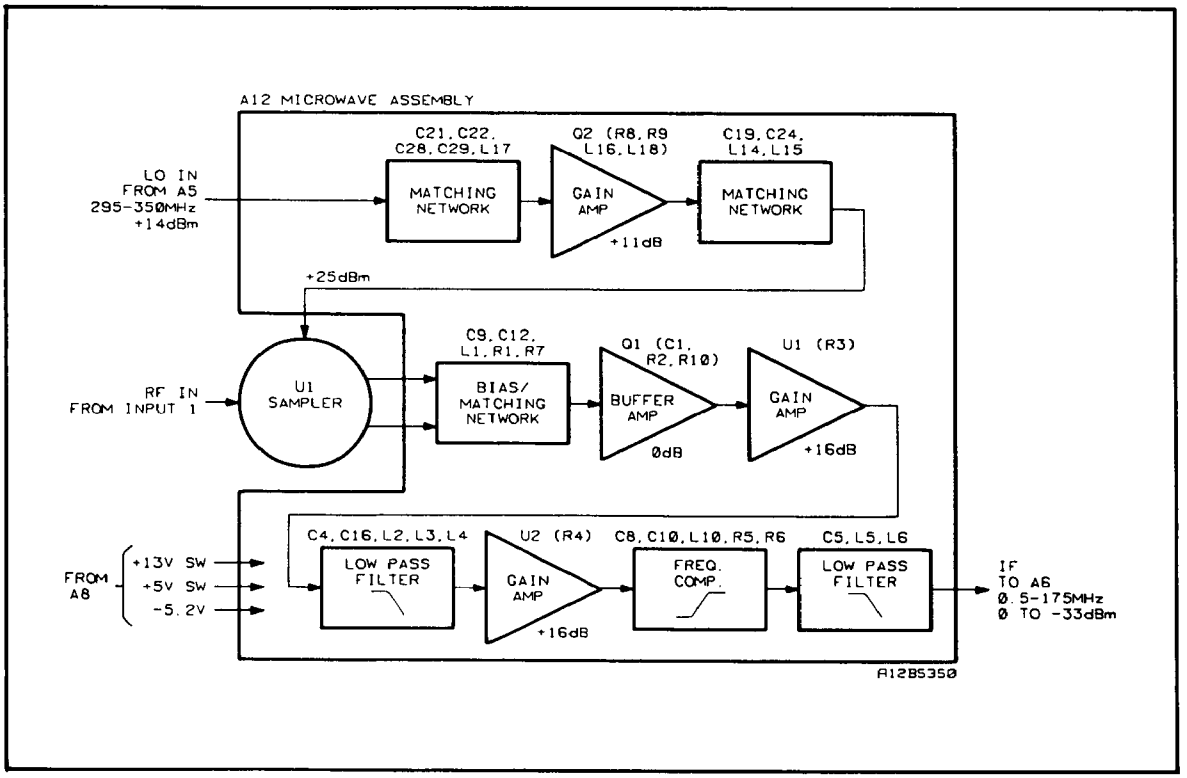


Figure 8-24. A12 Block Diagram

8-364. IF PREAMPLIFIER (PART OF A12 ASSEMBLY). The IF preamplifier on the A12 board performs several functions, including: boosting the IF signal to a level less susceptible to RF noise, providing a flat IF response from 1 MHz to 175 MHz to allow proper automatic amplitude discrimination, controlling dc bias current for U1's internal sampling diodes, converting the relatively high impedance of the sampler output to a 50Ω source impedance, and isolating the residual LO feedthrough signal and its harmonics from the IF signal. The IF preamplifier consists of seven stages: a bias/matching network, a buffer amplifier, two gain amplifiers, two low-pass filters, and a frequency compensation network.

8-365. DC bias current through the sampling diodes (within the sampler) is controlled by resistor R7. The IF signal generated in the sampler is ac coupled through capacitors C9 and C12 to the impedance matching network consisting of L1 and R1. Buffer amplifier Q1 translates the 1.5 kΩ sampler impedance to approximately 50Ω to match the input impedance of the following stages.

8-366. The IF signal is ac coupled to the first gain stage, U1. Amplifier U1 provides 16 dB of gain, set by bias resistor R3. The IF signal is connected via C3 to the first low-pass filter stage consisting of L2, C4, L3, C16, and L4. Besides generally reducing the LO signal and its harmonics from the IF signal, the low-pass filter prevents the second gain stage from getting saturated by the relatively high-level LO feedthrough signal.

8-367. Amplifier U2 provides another 16 dB of gain, set by bias resistor R4. The IF signal is coupled via C7 to the frequency compensation stage consisting of C8, C10, R5, R6, and L10. The frequency compensation network flattens the frequency response of the IF signal by adding frequency-selective loss to the frequency response. The second low-pass filter consists of L5, L6, and C5. The IF signal is ac coupled to output connector J1 via C11.

8-368. Two of the power supplies for the A12 Assembly are switched supplies, +13V SW and +5V SW. The two supplies are turned off by the A4 microprocessor, via a microwave turn-off circuit on the A8 motherboard, when INPUT 2 is selected or when the "SLEEP" mode has been turned on via the HP-IB.

8-369. MICROWAVE MODULE RF SHIELD. The microwave module is contained in a metal case for two reasons: a) To shield the IF circuitry from the effects of outside noise sources, and thereby improve instrument sensitivity, and b) to shield the rest of the instrument from the relatively high power LO signal which radiates off the sampler driver circuitry.

8-370. Oven Oscillator (Option 001 and 010)

8-371. The Option 001 Oven Oscillator is an extremely stable, compact, low-power source of 10 MHz. The crystal, along with the oscillator, circuit buffer amplifier, and oven control circuits are all mounted inside a thermally insulated housing. The Option 010 High Stability Oven Oscillator uses the same oven oscillator as the Option 001, but with a higher stability crystal. A block diagram of the oven oscillator is shown in *Figure 8-25.*

8-372. The oven oscillator is divided into three sections (circuit boards) connected by flexible cables: a main oscillator circuit, an automatic gain control circuit (including a voltage reference and an output impedance matching buffer), and an output buffer amplifier (including the oven controller circuitry).

8-373. The oscillator is a Colpitts-type crystal oscillator which uses the crystal as the series inductor. The crystal (Y1) is a "third overtone" crystal and is operated at 10 MHz. To keep the circuit from oscillating at the crystal's fundamental, or at a different overtone, the mode suppression network consisting of C5, L2, C6, and L3 appears capacitive only at frequencies between 9 MHz and 10.5 MHz. Above and below this frequency range, the network appears inductive. This does not allow the proper phase shift around the loop and thus suppresses oscillations at all frequencies other than 10 MHz.

8-374. Any reactance in series with the crystal will cause a change in frequency. Tuning capacitor C1 is available through the top of the oscillator outer housing. The change in reactance in C1 allows the oscillator's frequency to be varied over a 20 Hz (2×10^{-6}) range.

8-375. ELECTRONIC FREQUENCY CONTROL (EFC). To allow for a fine tuning control, a varactor (CR1) is added in parallel with the C1 tuning capacitor. The varactor's capacitance depends on the dc voltage applied to it (reverse bias). The EFC voltage range is +5V to -5V, giving a fine tuning range of about 1 Hz (1×10^{-7}). Since one side of the varactor is tied to a reference (6.4V), a full +5V applied to the EFC input will still keep CR1 reversed biased. C2 and C3 keep the EFC current from flowing into the crystal circuit. Note that the EFC input is not used in the HP 5350B/51B/52B, and is connected to ground to keep noise from modulating the EFC line and causing frequency changes.

8-376. AUTOMATIC GAIN CONTROL (AGC). The Automatic Gain Control circuit consists of emitter-follower Q3 and the peak detector circuit formed by C12, C13, CR4, and CR5. The input to the AGC circuit (and output amplifiers, discussed later) is taken across capacitor C10 and applied to Q3. The signal from Q3 goes to the peak detector which develops a dc voltage to control the crystal current. This negative control voltage forms the lower half of a voltage divider for the base of Q1 (with R6 and R7) which controls the bias current and gain of Q1, thus controlling the output signal level. The voltage across C10 is proportional to the current through the crystal. As the output of the oscillator changes, the output of the peak detector circuit changes. This change in the AGC voltage counteracts the change in bias current applied to the base of Q1 from the crystal and stops the impending output signal change.

8-377. By adjusting the AGC voltage with R6, the amplitude for the output (at the base of Q3) can be set. R5 sets the AGC limit when R6 is at its minimum resistance.

8-378. RF OUTPUT IMPEDANCE MATCHING AND OUTPUT BUFFER. The signal for the output amplifiers is taken from the same point as the AGC (across C10). The voltage is buffered by Q5, which is an impedance matching stage. Resistors R14 and R15 set the dc bias level; R14 is bypassed by C14. The signal is then applied to the output buffer stage of Q9. R40 provides a 50Ω source impedance when transformed by T1. The typical gain of Q9 is approximately 2.

8-379. VOLTAGE REFERENCES. Constant current diode CR2 feeds 1 mA to Zener diode CR3 providing 6.4V dc for the EFC varactor reference. R12 and C15 form a filter to attenuate noise from the Zener diode. R13 provides current limiting for Q5 if the 5.7V line is shorted.

8-380. OVEN HEATER AND CONTROLLER. The purpose of the oven is to shield the oscillator crystal and electronics from normal ambient temperature changes. The oven controller does this by maintaining a constant oven temperature which is higher than the highest expected ambient temperature. The oven circuit is made up of three main blocks: thermistor, amplifier (controller), and heaters.

8-381. In the following theory of operation, the term OVEN MASS will be used to describe the cast aluminum block in which the crystal and crystal electronics are located.

8-382. A thermistor (RT1) is secured with epoxy into a hole in the oven mass. U3 is the amplifier, and Q7 and Q8 are the heaters. It is the thermistor that senses the oven mass temperature. The thermistor is in one leg of a bridge circuit consisting of RT1, R18, R19, R20, and R21. When the mass temperature changes slightly, a voltage change occurs across the bridge. Amplifier U3 boosts this voltage change and then uses it to control the current through Q7 and Q8. The current flowing through Q7 and Q8 causes a power dissipation in the form of heat, and it is this heat that warms the oven mass. Therefore, when the mass temperature starts to change, the heaters are biased to adjust their power to cancel the impending temperature change.

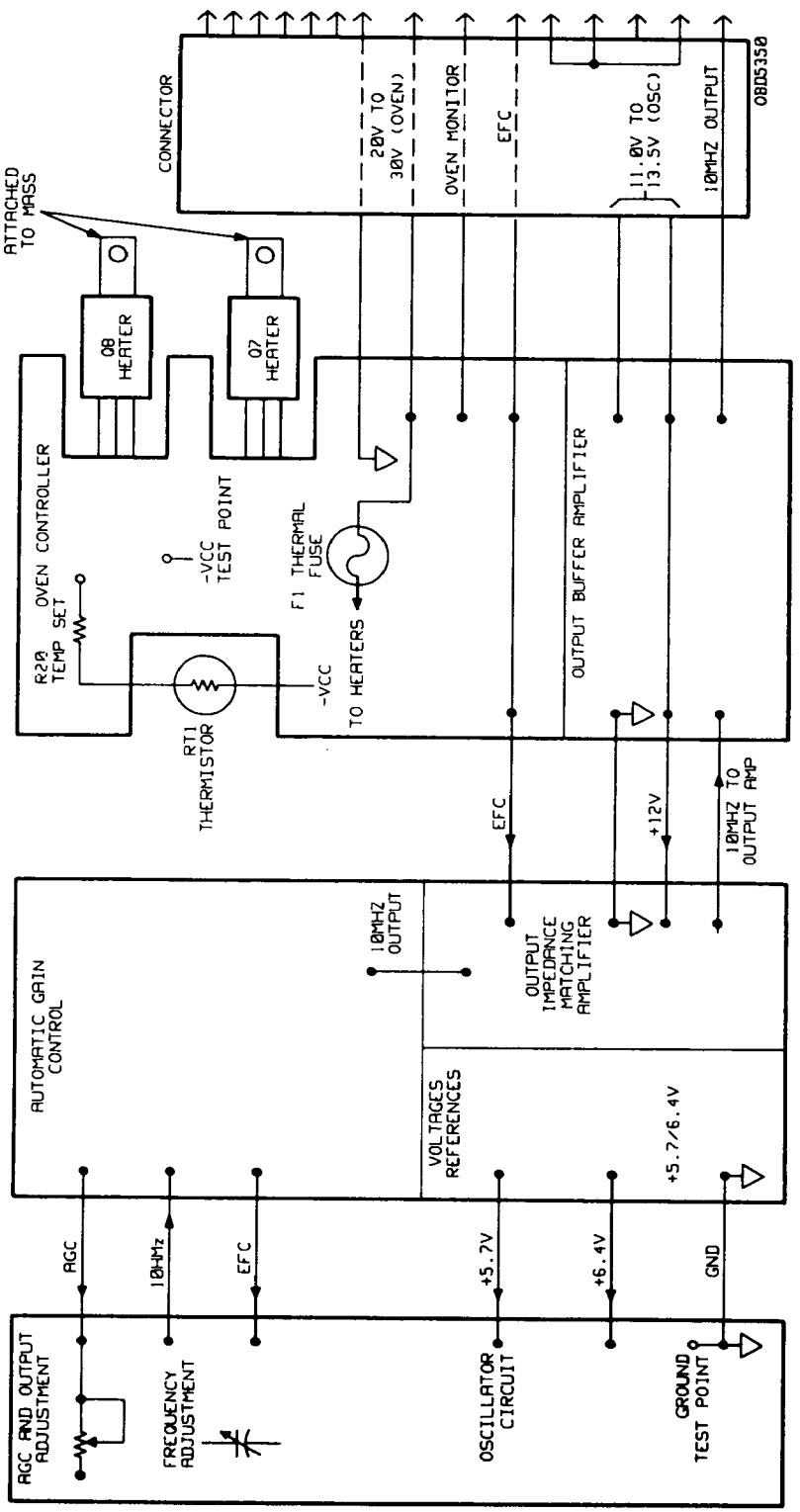


Figure 8-25. Oven Oscillator Block Diagram

8-383. WARM-UP: GENERAL OPERATION. If the oscillator has been off for several hours, the mass and thermistor will be at the ambient temperature. Assuming this is below the normal oven operating temperature (80 to 84°C), the resistance of the thermistor RT1 is higher than that of R18 + R20, and therefore the voltage at U3(3) is more positive than at U3(2). This causes the output of U3 to be approximately (V_{CC} - 1.5V), supplying base current to Q8 through Q6. A separate circuit limits the collector current of Q8 and is described later.

8-384. As the oven mass warms up, the thermistor's resistance begins to drop, causing the voltage at both U3 inputs to drop (the other U3 input voltage drops because the voltage at the junction of R17, R18, and R19 drops due to the lower RT1 resistance). The voltage at U3(3) decreases at a faster rate than at U3(2) and eventually the U3 inputs are equal when RT1 = R20 + R18. At this time, the oven controller "cuts back" and begins to operate in a linear mode, adjusting the collector current in Q8 (and therefore the power dissipated in Q7 and Q8) to keep the oven precisely at its set temperature. Resistor R17 reduces the power dissipated in the thermistor which causes it to self-heat above the oven operating temperature.

8-385. R38 and R39 in parallel provide a means of sensing the heater current. During warm-up, the voltage across the parallel resistors is used in the current limit circuit (described later). During normal linear operation, the voltage across R38 and R39 is essentially the feedback point for the oven controller loop.

8-386. Transistor Q6 is necessary primarily for the condition when the oscillator has been stored at -55°C. Since U3 (at -55°C) cannot supply enough base current for Q8, Q6 provides the added current gain required.

8-387. PRECISION VOLTAGE REFERENCE. U2 is a 10.0V voltage reference. It provides a stable voltage source for the bridge and U1. A change in the bridge reference voltage changes the voltage across the thermistor and hence, the power it dissipates.

8-388. OVEN CONTROLLER TURN-ON CURRENT LIMITING. The turn-on current limiting circuit consists of U1B and associated components. From an initial turn-on condition, the thermistor senses the oven temperature to be low. To correct this situation, U3 attempts to drive heavy amounts of current through the Q7 and Q8 heaters. If allowed to continue this way, excessive current will flow. When V_{CC} is applied to the oven, U1B forces the voltage across R38 and R39 to equal the voltage at U1B(2) by sinking the base current from Q6. By sensing V_{CC}, the circuit transforms the heater transistor into what appears to be a fixed heater resistance of 47Ω typical.

8-389. HEATER TRANSISTOR BALANCE. Because heater transistors Q7 and Q8 are not equally spaced from the crystal, it is necessary to offset the power dissipation between the two transistors. Amplifier U1A references a voltage divider across V_{CC} (R25, R26) and a second divider (R27, R28) referenced to the midpoint between the heater transistors. This arrangement allows U1A to control the base current of Q7 to ensure the voltage at the midpoint between the heater transistors is a constant percentage of V_{CC} ($\approx 0.57 \bullet V_{CC} \pm 2\%$).

8-390. Option 006 Limiter

8-391. Refer to *Figure 8-26* for discussion of Microwave Limiter theory.

8-392. The Microwave Limiter uses a PIN diode (CR1) as a limiter. As high power (+20 dBm and greater) is applied, the PIN diode begins conducting. The I region of the diode stores charge. The stored charge does not allow the diode to turn off, shorting power to ground. Though the diode remains on during both the positive and negative half cycles of the input signal, the resistance across the junction is slightly greater in the normally reversed biased direction than in the forward biased direction. The inductor to ground is used to prevent a charge from building up on the C1 and C2 blocking capacitors.

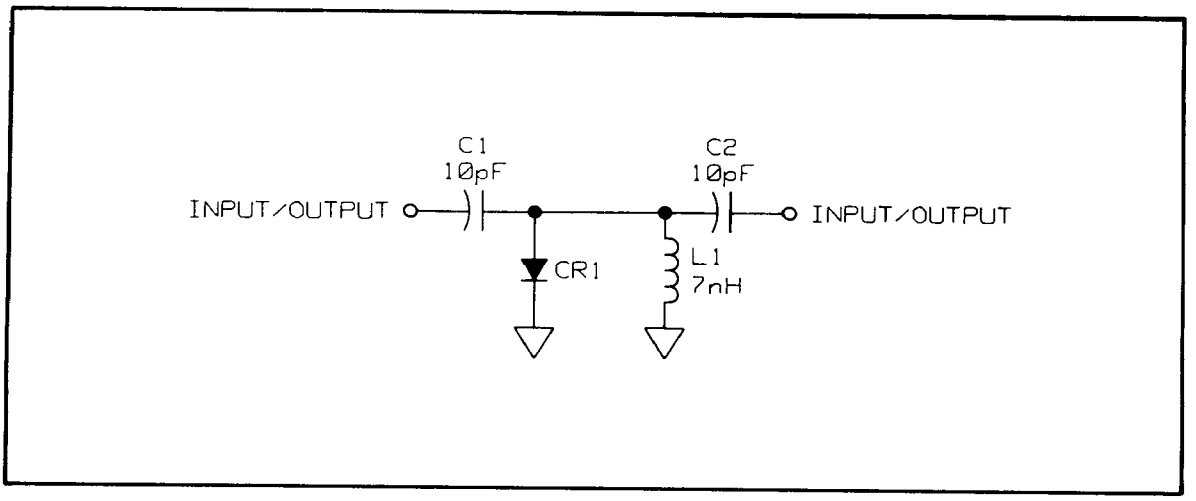


Figure 8-26. Limiter Schematic Diagram

8-393. DIAGNOSTICS

8-394. Introduction

8-395. The HP 5350B/51B/52B Microwave Counter is a microprocessor-based system with 37 built-in diagnostic tests. These diagnostics can be used as an aid in testing and troubleshooting the instrument by identifying faulty assemblies. All of the diagnostics are available via the front panel and, in most cases, over the HP-IB.

8-396. There are four types of diagnostics:

a. User-Callable Diagnostics: Individual tests which can be enabled via the front panel keyboard or over the HP-IB. (Refer to paragraph 8-399.)

b. Power-Up Self Test: A sequence of tests automatically executed when the instrument is powered-up. (Refer to paragraph 8-527.)

c. Self Check: A sequence of tests executed by pressing the SELF CHECK key on the front panel. These tests are a subset of the User-Callable Diagnostics. (Refer to paragraph 8-533.)

d. Hardwired Diagnostics: Tests executed at power-up only if jumpers in the circuitry have been set. (Refer to paragraph 8-541.)

8-397. The diagnostic routines are designed to isolate faults in the HP 5350B/51B/52B to the assembly level. In any given failure mode, the assembly that is found faulty by appropriate use of the diagnostics is the most probable cause of the failure. It is still possible that the fault lies elsewhere in the instrument, but using the diagnostics can quickly provide an appropriate starting point for component level troubleshooting.

8-398. The User-Callable and Hardwired diagnostics consist of tests which can be called individually, while the Power-Up and Self Check diagnostics execute a sequence of tests. Most of the diagnostics will display a message indicating whether the test passed or failed, and in remote operation the pass/fail result can be retrieved over the HP-IB. A few diagnostics may require an oscilloscope, spectrum analyzer or other equipment to obtain desired service information. The individual description for each diagnostic will list any required equipment. Refer to *Table 1-5*, Recommended Test Equipment, for test equipment specifications.

8-399. USER-CALLABLE DIAGNOSTICS

8-400. *Table 8-11* is a list of all the User-Callable Diagnostics by number, and includes the diagnostic name, the assembly (or assemblies) being tested, and the paragraph number where a description of the given diagnostic can be found. Each User-Callable Diagnostic can be executed as an individual test. The diagnostics numbered from 10 to 71 are identified in the following manner:

First Digit: Assembly number of board under test.

Second Digit: Test number

Example: DIAG 41 = A4 Microprocessor Assembly Test 1 (RAM test)

Table 8-11. User-Callable Diagnostics

Diag.	Name	Assembly Tested	Paragraph No.
1	Self Test	A1, A2, A3, A4 ,A5, A6	8-428
2	Display IF	Auxiliary Function	8-434
3	Display MRC E & T Register Contents	Auxiliary Function	8-437
4	Display LO Frequency	Auxiliary Function	8-439
5	Display N(integer) and Sideband	Auxiliary Function	8-441
6	Display N(fraction) and Sideband	Auxiliary Function	8-443
7	Display Interpolator Short Calibration	Auxiliary Function	8-445
8	Display Interpolator Long Calibration	Auxiliary Function	8-447
9	Display Interpolator Measurement	Auxiliary Function	8-449
10	Timebase Verification	A1 Timebase Buffer/Power Supply Control Assembly	8-451
11	Power Supply Verification	A1 Timebase Buffer/Power Supply Control Assembly A8 Motherboard/Power Supply Regulator Assembly	8-453
20	Low Frequency 50Ω Verification: 35 MHz	A2 Low Frequency Input Assembly	8-455
21	Low Frequency 1 MΩ Verification: 35 MHz	A2 Low Frequency Input Assembly	8-457

Table 8-11. User-Callable Diagnostics (Continued)

Diag.	Name	Assembly Tested	Paragraph No.
30	MRC CH A Verification: 10 MHz Timebase	A3 Counter Assembly	8-459
31	MRC CH B Verification: 35 MHz	A3 Counter Assembly	8-461
32	Interpolator Check	A3 Counter Assembly	8-463
40	ROM Version Number	A4 Microprocessor Assembly	8-465
41	RAM Test	A4 Microprocessor Assembly	8-467
42	ROM Test	A4 Microprocessor Assembly	8-469
43	Repeated Reset	A4 Microprocessor Assembly	8-471
44	Signature Analysis	A4 Microprocessor Assembly	8-475
50	LO Verification 29.5 MHz, 35.0 MHz	A5 Synthesizer Assembly	8-477
51	LO Verification, User-Entered Frequency	A5 Synthesizer Assembly	8-479
52	LO Sweep 275.0→375.0 MHz	A5 Synthesizer Assembly	8-486
53	LO Lower/Upper Frequency Bounds	A5 Synthesizer Assembly	8-488
60	IF Verification: 35MHz; Disable INPUT 1 & IF	A6 IF Amplifier/Detector Assembly	8-491
61	Overload Status	A6 IF Amplifier/Detector Assembly	8-493
62	Disable Hardware IF Detector Flag; Display Measurement	A6 IF Amplifier/Detector Assembly	8-495
63	Disable Hardware and Software IF Detector Flags; Display IF	A6 IF Amplifier/Detector Assembly	8-498
64	Disable Software IF Detector Flag; Display IF	A6 IF Amplifier/Detector Assembly	8-500
65	IF Verification: 35MHz; Disable INPUT 1	A6 IF Amplifier/Detector Assembly	8-502

Table 8-11. User-Callable Diagnostics (Continued)

Diag.	Name	Assembly Tested	Paragraph No.
70	Keyboard Test	A7 Keyboard/Display Logic Assembly	8-504
71	Display Test (flash on/off)	A7 Keyboard/Display Logic Assembly	8-509
80	HP-IB Verification	A11 HP-IB Interface Assembly	8-511
97	IF 175MHz Filter Adjust	Not Applicable	8-513
98	Keyboard Lockout	Not Applicable	8-517
99	Display Lockout	Not Applicable	8-522

8-401. There are 14 diagnostics which are exceptions in that the first digit is not the number of the assembly being tested. The first nine diagnostics (first digit = 0) form a special case, since there is no Assembly 0 in the HP 5350B/51B/52B. Diag 1 is a test routine similar to the Self Check function available from the front panel. Diag 2 through Diag 9 are auxiliary functions which can be used to display various components of the input frequency measurement. Diag 80 is actually an HP-IB verification of the A11 HP-IB Interface Assembly. Note that Diag 11, in addition to testing part of the A1 Assembly, also tests the power supply circuits on the A8 Motherboard/Power Supply Regulator Assembly.

8-402. Diag 97, 98, and 99 are also exceptions in that they are not tests, but are instead special HP 5350B/51B/52B operating conditions. Diag 97 is a special diagnostic that sets the counter to a particular state to allow the user to perform the 175 MHz Filter adjustment on the A6 IF Amplifier/Detector Assembly. (Refer to Section V, Adjustments.) This diagnostic can only be exited by setting the POWER switch to STBY momentarily, or by removing ac power from the counter. Diag 98 causes the instrument to ignore all subsequent keyboard entry, except for the special key sequence (7, 4, 0, RESET/LOCAL) which will return the keyboard to the normal operating condition. Diag 99 disables the front panel display, including the annunciators. The counter will perform normally in all other respects. The same special key sequence for exiting Diag 98 is used to exit Diag 99.

8-403. While diagnostics may be individually called from the front panel, they are best used in particular combinations and sequences to obtain the maximum amount of testing and troubleshooting information. Descriptions of the User-Callable Diagnostics begin at paragraph 8-421. Refer to the operating procedures in Section III , and to the troubleshooting procedures in this section for information on using the User-Callable Diagnostics.

8-404. Diagnostic Mode Entry

8-405. The diagnostic mode may be entered by pressing the front panel DIAGNOSTICS key once. After the key is pressed, the counter will carry out the current diagnostic routine. The current diagnostic will be that which was last entered by the user, or if the counter has just been turned on, the diagnostic will default to Diag 1.

8-406. The diagnostic mode may also be entered by using the parameter entry mode, which allows the user to change the diagnostic number. A new diagnostic number (from 1 to 99) may be entered using the following key sequence:

SET/ENTER,
DIAGNOSTICS,
digit(s) (Function/Data keys),
SET/ENTER

8-407. For example, to enter the diagnostic mode and set Diagnostic 32 (Interpolator Check, A3 Counter Assembly), press the following key sequence:

SET/ENTER
DIAGNOSTICS
3
2
SET/ENTER

8-408. The HP 5350B/51B/52B display contents will depend on the diagnostic in progress. Most of the diagnostic displays will show "DIAG XX" or "D XX" in the message portion on the right-hand side of the display (where XX represents a diagnostic number from 01 to 99). Most displays will also include the assembly number, preceded by the letter "A", just to the left of the diagnostic number. For example, the Diag 60 display would show "A6" just to the left of "D 60".

8-409. Once the diagnostic mode is entered, the diagnostic number may be changed by using the key sequence described above, or by pressing the INC (increment) or DEC (decrement) key to move through the list of diagnostics in numerical order (exceptions: Diag 97, 98, and 99 cannot be entered using the INC or DEC keys; once entered, Diag 70 cannot be exited using the INC or DEC keys). If the diagnostic mode is entered by pressing the DIAGNOSTICS key without using the SET/ENTER key sequence, the last test number entered will be the diagnostic executed. When the counter is first powered on, the diagnostic mode defaults to the following settings: DIAG 1, OFF.

8-410. Diagnostic Mode Exit and Special Conditions

8-411. For most diagnostics, the diagnostic mode can be exited by pressing the DIAGNOSTICS key a second time, or by pressing the RESET/LOCAL key. There are some exceptions, however, in which the DIAGNOSTICS key cannot be used to exit the mode because the key is used for other functions during the test. In these cases, pressing the RESET/LOCAL key will exit the mode. Note that if the RESET/LOCAL key is pressed to clear an "OUT OF RANGE 3 ERROR" (resulting from the entry of an invalid HP-IB address or Manual Center Frequency value), the error will be cleared and the diagnostic mode will be exited at the same time.

8-412. There are also a few diagnostics which have special conditions attached to their use. Refer to *Table 8-12*, and to the diagnostic descriptions beginning at paragraph 8-421.

Table 8-12. Special Diagnostic Conditions

Diagnostic	Special Condition
DIAG 1 - Self Test	Not accessible via HP-IB.
DIAG 41 - RAM Test	Not accessible via HP-IB.
DIAG 42 - ROM Test	Not accessible via HP-IB.
DIAG 43 - Repeated Reset	Not accessible via HP-IB.
DIAG 44 - Signature Analysis	Not accessible via HP-IB.
DIAG 51 - LO Verification, User-Entered Frequency	a) DIAGNOSTICS key interpreted as "1"; Press RESET/LOCAL key to exit. b) Parameter entry possible after enabling. Defaults to current LO frequency when enabled.
DIAG 61 - Overload Status	RESET/LOCAL key exits, clears overload status flag; DIAGNOSTICS key exits, leaves overload status flag as is.
DIAG 70 - Keyboard Test	Pressing DIAGNOSTICS key displays message, but will not exit; RESET/LOCAL key must be pressed to exit. INC and DEC (arrow) keys can be used to enter, but not to exit.
DIAG 80 - HP-IB Verification	Not accessible via HP-IB.
DIAG 97 - IF 175 MHz Filter Adjust	a) Counter must be powered down to exit. b) Not available via HP-IB.
DIAG 98 - Keyboard Lockout	Once enabled, counter automatically returns to measurement mode. Special key sequence is required to exit, all other keyboard entry is ignored.
DIAG 99 - Display Lockout	Once enabled, counter automatically returns to measurement mode. Keyboard functions normally while display is disabled. Special key sequence is required to exit this mode.

8-413. Invalid Diagnostic Numbers

8-414. If the user attempts to enter an invalid diagnostic number, the counter will display the message: "NOT AVAILABLE DIAG XX", where XX represents the invalid number. The only exception is if 00 is entered as the diagnostic number, in which case the counter will automatically default to Diag 1. If the INC or DEC key is being used to move through the list of diagnostics, the counter will display the "NOT AVAILABLE" message until the next valid diagnostic in the sequence is reached.

8-415. Calling Diagnostics Over The HP-IB

8-416. Most of the User-Callable Diagnostics available from the front panel are also available over the HP-IB using the DIAG, DIAGPARM, and DIAG? commands. Diagnostics are enabled over the HP-IB using the DIAG command. For example, the command "DIAG,32,ON" will cause the counter to cycle through the Interpolator Check until the command "DIAG,OFF" is sent. Diagnostics results can be obtained over the HP-IB by using the DIAG? command. The DIAGPARM command is used only with DIAG 51 to allow the user to enter a frequency parameter for local oscillator verification. Refer to Section III, paragraph 3-225, Remote Programming via the HP-IB, for detailed information on enabling the diagnostic routines over HP-IB.

8-417. There are seven diagnostics not available over the HP-IB, because they may erase needed memory or reset hardware. The diagnostics not available are:

Diag 1: Self Test
Diag 41: RAM Test
Diag 42: ROM Test
Diag 43: Repeated Reset
Diag 44: Signature Analysis
Diag 80: HP-IB Verification
Diag 97: IF 175 MHz Filter Adjust

8-418. Auxiliary Functions

8-419. The HP 5350B/51B/52B diagnostics include a set of auxiliary functions (Diags 2 through 9) which enable the counter to display various parameters of the measured input frequency. When the counter is in the auxiliary function mode, it cycles through the normal measurement sequence, and will display one of the parameters needed to compute the input frequency. The auxiliary functions are:

DIAG 2 - Display IF

DIAG 3 - Display MRC E & T Register Contents

DIAG 4 - Display LO (Synthesizer) Frequency

DIAG 5 - Display Harmonic Number (integer) and Sideband

DIAG 6 - Display Harmonic Number (fraction) and Sideband

DIAG 7 - Display Interpolator Short Calibration

DIAG 8 - Display Interpolator Long Calibration

DIAG 9 - Display Interpolator Measurement

8-420. Refer to the descriptions of the User-Callable Diagnostics in the following paragraphs for detailed information on each auxiliary function.

8-421. DESCRIPTION OF USER-CALLABLE DIAGNOSTICS

8-422. The following paragraphs provide descriptions of each User-Callable Diagnostic available in the HP 5350B/51B/52B. For complete information on how to use the diagnostic routines, refer to the paragraphs listed below:

a. Instructions for accessing the diagnostics via the front panel:

Section III, paragraph 3-162, Operating Procedures.

Section VIII, paragraph 8-399, User-Callable Diagnostics.

b. Information for calling diagnostics over HP-IB:

Section III, paragraph 3-225, Remote Programming Via The HP-IB.

Section VIII, paragraph 8-415, Calling Diagnostics Over The HP-IB.

c. Troubleshooting procedures using diagnostics:

Section VIII, paragraph 8-549, Overall Troubleshooting

8-423. The following diagnostic descriptions include examples of the PASS/FAIL messages which will appear on the display for a given test. In these message examples, a letter (x or y) is used to represent an unknown digit. Unknown digits may appear in the display when an erroneous frequency is being measured or an unpredictable value is being displayed. For example, if a test which is supposed to measure (and display) 10 MHz should fail, the displayed frequency will be represented in this manual by: xx xxx xxx.

8-424. Overload Display

8-425. If an overload condition occurs while the counter is in the diagnostic mode, an OVLD warning will appear in the diagnostic display. For most diagnostics, the OVLD will appear in the right-hand message side of the display, overriding the assembly number or the word "DIAG" in the display. For example, an overload during Diag 41 (RAM Test) would cause the letters "OVLD" to appear in place of the normal "A4 D" in the display, as shown below:

PASS RAM OVLD 41

8-426. A few diagnostics display the OVLD warning toward the left of the display, or give no overload indication. The diagnostic displays shown in the following paragraphs will include an example of an OVLD display just beneath the standard display for the given diagnostic. For example, the set of display examples for Diag 41 is shown in this manual as follows:

PASS RAM DIAG 41
FAIL RAM DIAG 41
PASS RAM OVLD 41

8-427. A few diagnostics may display alternate formats for a given pass or fail message. Any alternate characters in a display will be shown in a manner similar to the overload example above. Note that the words "PASS" or "FAIL" will always appear in the same location in the display.

8-428. Diagnostic 1: Self Test

8-429. Self Test enables a particular sequence of diagnostics to test the measurement circuits of the counter. This diagnostic performs the same sequence of tests as the front panel Self Check function, but will stay in a loop, repeating the test sequence until the diagnostic mode is exited or another diagnostic is chosen. The tests are arranged so that each routine involves only one untested assembly. The diagnostic routines and the order in which they occur are shown in *Table 8-13.*

Table 8-13. Diag 1 Self Test Sequence

Diag Number	Test	Assembly
Diag 11	Power Supply Verification	A1/A8
Diag 10	Time Base Verification	A1
Diag 30	MRC CH A Verification: 10 MHz Timebase	A3
Diag 50	LO Verification: 29.5 MHz, 35.0 MHz	A5
Diag 31	MRC CH B Verification: 35 MHz	A3
Diag 60	IF Verification: 35 MHz, Disable INPUT 1 and IF	A6
Diag 32	Interpolator Check	A3
Diag 20	Low Frequency 50Ω Verification: 35 MHz	A2
Diag 21	Low Frequency 1MΩ Verification: 35 MHz	A2

NOTE

Diag 1 is not available over the HP-IB.

8-430. If the counter passes Diag 1, the messages are:

```
PASS  35  000  0**   A0  D  01
PASS  35  000  0**   OVLD  01
```

8-431. If a failure should occur, the counter will display the number of the failed test, and the assembly involved. For example, if the Diag 21 test failed during Diag 1, the display would be:

```
FAIL  xx  xxx  xxx   A2  D  01
```

8-432. The failure display formats for Diag 11, 10, or 32 are exceptions to the format shown above. The possible messages are:

```
FAIL      POWER      A1  D  01
FAIL      TIMEBASE   A1  D  01
FAIL      INTERPOL   A3  D  01
```

8-433. If the user exits diagnostic mode during Diag 1, the diagnostic number will remain 1, regardless of whether the diagnostic passed or failed. For example, if the counter failed Diag 31 during Diag 1 and the user exited the diagnostic mode, the test number stored will be 1. The next time the DIAGNOSTICS key is pressed (to reenter the diagnostic mode), the counter will return to Diag 1, which (in this example) would again fail at Diag 31.

8-434. Diagnostic 2: Display IF

8-435. The instrument remains in its normal measurement cycle. Every time the display is updated, the current IF is displayed, with the chosen resolution and sample rate affecting the display (also the Smooth function, if enabled). An IF will only be displayed for an INPUT 1 measurement; for INPUT 2, the low frequency input measurement will be displayed. The IF display will be in the format shown below (assuming an IF of 75 MHz, and a chosen resolution of 1 Hz):

```
I F      7 5  0 0 0  0 0 0  .x x  D  0 2
O V L D  7 5  0 0 0  0 0 0  .x x  D  0 2
```

8-436. The display will always show 1 digit greater than the chosen resolution (2 digits greater for 1 Hz resolution). This may be useful in investigating accuracy past the specified resolution. As an example, if the resolution is chosen to be 1 kHz (gate time = 1 ms), the IF would be displayed as follows:

```
I F      7 5  0 0 0  x * *      D  0 2
```

- where digit "x" is random since the guaranteed resolution is only 1 kHz.

8-437. Diagnostic 3: Display MRC E and T Register Contents

8-438. The counter remains in its normal measurement cycle. Every time the display is updated, the contents of the MRC E (Events) and T (Time) registers, including overflow, are displayed. The chosen resolution will affect the contents of the T register (gate time), but the selected sample rate will not affect register contents. Math functions, if enabled, also have no effect. The fraction calculated from interpolator data is included in the display. The messages are:

```
E  x x x x x x x x  T  y y y y y y y .y y
E  x x x x x x x x  T  y y y y   O V L D
```

- where x and y are digits measured in the E and T registers, and digits yy to the right of the decimal point are a result of the interpolator data calculations. Note that due to lack of room on the display, this diagnostic is the only one not showing its diagnostic number in the display.

8-439. Diagnostic 4: Display LO Frequency

8-440. The instrument remains in its normal measurement cycle. Each time the display is updated, the current value of the LO frequency will be displayed. If the instrument is in Auto mode, it will only display the value of the LO when a measurement is in progress, not when the LO is sweeping or when the acquisition algorithm is in progress. When in Manual mode, the LO is calculated, set, and not changed, so the display will be stable. In INPUT 2 (50Ω or 1MΩ), the last LO value from either of the INPUT 1 modes (Auto or Manual) will appear. The messages are as follows (assuming an LO frequency of 345.8 MHz for this example):

```
L O  3 4 5.8  M H Z      D I A G  0 4
L O  3 4 5.8  M H Z      O V L D  0 4
```

8-441. Diagnostic 5: Display N (integer) Harmonic Number and Sideband

8-442. The counter remains in its normal measurement cycle. Each time the display is updated, the current harmonic value is displayed, along with the sideband location of the input frequency (USB = upper sideband, LSB = lower sideband) with respect to N•LO. If the counter is in Auto or Manual mode, the display will only change when a new harmonic number has been determined. If the counter is set to INPUT 2, the harmonic number will be "0", and USB (upper sideband) will be displayed. The messages are:

```
HARM  xx   USB  DIAG 05
HARM   x   LSB  DIAG 05
HARM  xx   USB  OVLD 05
HARM   x   LSB  OVLD 05
```

8-443. Diagnostic 6: Display N (fraction) Harmonic Number and Sideband

8-444. The counter remains in its normal measurement cycle. Each time the display is updated, it will display the current fractional value of the harmonic number to 0.01 accuracy. This diagnostic can be used to see if FM is affecting the measurement. The sideband notation is the same as Diag 5. When the instrument is set to Manual mode, the fractional value of the harmonic number will be the same as the integer value, as it is determined by formula to be an integer. The messages are:

```
HARM  xx.xx  USB  DIAG 06
HARM   x.xx  LSB  DIAG 06
HARM  xx.xx  USB  OVLD 06
HARM   x.xx  LSB  OVLD 06
```

8-445. Diagnostic 7: Display Interpolator Short Calibration

8-446. The instrument is in the normal measurement cycle. Interpolator Start (xxx) and Stop (yyy) counts are displayed for the short MRC calibration pulses (100 ns). The Start and Stop values should be within ±20 counts of each other, with a typical calibration count falling in the approximate range of 100-130. The Short calibration values should always be less than the values displayed by Diag 8 (Interpolator Long Calibration). The messages are:

```
SH CAL  xxx yyy  DIAG 07
SH CAL  xxx yyy  OVLD 07
```

8-447. Diagnostic 8: Display Interpolator Long Calibration

8-448. The instrument is in the normal measurement cycle. Interpolator Start (xxx) and Stop (yyy) counts are displayed for the long MRC calibration pulses (200 ns). The Start and Stop values should be within ±20 counts of each other, with a typical calibration count falling in the approximate range of 290-310. The long calibration values should always be greater than the values displayed by Diag 7 (Interpolator Short Calibration). The messages are:

```
LONG CAL  xxx yyy  DIAG 08
LONG CAL  xxx yyy  OVLD 08
```

8-449. Diagnostic 9: Display Interpolator Measurement

8-450. The counter remains in its normal measurement cycle. Interpolator Start (xxx) and Stop (yyy) counts are displayed for the current measurement. The Start value should fall within the range of the Start values displayed by Diag 7 (Short Calibration) and Diag 8 (Long Calibration) functions described above. Similarly, The Stop value should fall within the range of the Stop values displayed by Diag 7 and Diag 8. The messages are:

```
MEAS    xxx  yyy  DIAG  09
MEAS    xxx  yyy  OVLD  09
```

8-451. Diagnostic 10: Timebase Verification

8-452. This test confirms the presence of either an external or internal timebase reference frequency. A signal (L 10MHZ OK) from the Timebase Buffer circuit (on the A1 Timebase Buffer/Power Supply Control Assembly) is sampled by the A4 microprocessor to determine if the timebase is operational. The display messages are:

```
PASS    TIMEBASE  A1  D  10
FAIL    TIMEBASE  A1  D  10
PASS    TIMEBASE  OVLD  10
```

8-453. Diagnostic 11: Power Supply Verification

8-454. The Power Supply circuit (on the A1 Timebase Buffer/Power Supply Control Assembly) sends a signal (H PWRSP OK) to the A4 microprocessor to indicate that most of the power supplies are functioning. All supply voltages in the instrument (except +5V, and the +3V on the A3 Assembly) are checked only for their presence or absence, but are not checked for specified voltage levels. The messages are:

```
PASS    POWER    A1  D  11
FAIL    POWER    A1  D  11
PASS    POWER    OVLD  11
```

8-455. Diagnostic 20: Low Frequency 50Ω Verification: 35 MHz

8-456. A 35 MHz test signal (AUX A/B) is provided by the A5 Synthesizer Assembly, derived by dividing the LO frequency (350 MHz) by 10. The A4 microprocessor switches this signal to the 50Ω input (INPUT 2) and the MRC counts the signal, verifying the frequency to ±100 Hz. This measurement is taken using a 100 ms gate time (with no interpolation). The messages are:

```
PASS    35  000  0**  A2  D  20
FAIL    xx  xxx  xxx  A2  D  20
PASS    35  000  0**  OVLD  20
```

8-457. Diagnostic 21: Low Frequency 1MΩ Verification: 35 MHz

8-458. A 35 MHz test signal (AUX A/B) is provided by the A5 Synthesizer Assembly, derived by dividing the LO frequency (350 MHz) by 10. The A4 microprocessor switches this signal to the 1MΩ input (INPUT 2) and the MRC counts the signal, verifying the frequency to ±100 Hz. This measurement is taken using a 100 ms gate time (with no interpolation). The messages are:

```
PASS    35  000  0**  A2  D  21
FAIL    xx  xxx  xxx  A2  D  21
PASS    35  000  0**  OVLD  21
```

8-459. Diagnostic 30: MRC Channel A Verification, 10 MHz Timebase

8-460. The microprocessor programs the MRC to count its own 10 MHz timebase in both registers. The result is checked to ±100 Hz accuracy using a 100 ms gate time (with no interpolation). The messages are:

```
PASS   10  000  0**  A3  D  30
FAIL   xx  xxx  xxx  A3  D  30
PASS   10  000  0**  OVLD  30
```

8-461. Diagnostic 31: MRC Channel B Verification, 35 MHz

8-462. The 35 MHz test signal (AUX A/B) available from the A5 Synthesizer Assembly is used to test input B of the MRC. The result is checked to ±100 Hz using a 100 ms gate time (with no interpolation). The messages are:

```
PASS   35  000  0**  A3  D  31
FAIL   xx  xxx  xxx  A3  D  31
PASS   35  000  0**  OVLD  31
```

8-463. Diagnostic 32: Interpolator Check

8-464. This routine tests the interpolator circuitry by first comparing the Start and Stop measurements for the Short calibration. The difference must be less than 20 counts to pass the test. If the Short calibration values pass, the Long calibration will then be tested. The messages are:

```
PASS   INTERPOL  A3  D  32
FAIL   INTERPOL  A3  D  32
PASS   INTERPOL  OVLD  32
```

8-465. Diagnostic 40: ROM Version Number

8-466. This test displays the ROM software version number currently in use in the instrument. The messages are:

```
ROM VERSION  xxxx  A4  D  40
ROM VERSION  xxxx  OVLD  40
```

8-467. Diagnostic 41: RAM Test

8-468. A test algorithm is performed on the external RAM (A4U20). The standby RAM inside the microprocessor is assumed to be functional, and is in use when performing the test. This test erases whatever is stored in the external RAM; critical values required to restore instrument operation after the test are saved in standby RAM. The messages are:

```
PASS   RAM   A4  D  41
FAIL   RAM   A4  D  41
PASS   RAM   OVLD  41
```

8-469. Diagnostic 42: ROM Test

8-470. A checksum routine is performed on the ROMs (A4U14,U17). If the ROM which contains the execution code for this diagnostic is faulty, it is possible that the test may never be completed, causing an unpredictable display instead of a FAIL message. This depends entirely on the degree of the ROM failure. If the test passes or if the message display is not affected by a ROM failure, the possible messages are:

PASS	ROM		A4 D 42
FAIL	ROM	U14	A4 D 42
FAIL	ROM	U17	A4 D 42
FAIL	ROM	BOTH	A4 D 42
PASS	ROM		OVLD 42

8-471. Diagnostic 43: Repeated Reset

8-472. This diagnostic performs a test sequence similar to the Power-Up Self Test. The sequence of tests for Diag 43 is as follows:

1. Display all segments lit, all annunciators lit.
2. Diag 42 - ROM Test.
3. Diag 1 - Self Test.
    a. Diag 11 - Power Supply Verification
    b. Diag 10 - Timebase Verification
    c. Diag 30 - MRC Channel A Verification: 10 MHz Timebase
    d. Diag 50 - LO Verification: 29.5 MHz, 35.0 MHz
    e. Diag 31 - MRC Channel B Verification: 35 MHz
    f. Diag 60 - IF Verification: 35 MHz; Disable INPUT 1 and IF
    g. Diag 32 - Interpolator Check
    h. Diag 20 - Low Frequency 50Ω Verification: 35 MHz
    i. Diag 21 - Low Frequency 1MΩ Verification: 35 MHz
4. Restore front panel annunciators based on instrument status.
5. HP-IB verification and address display
6. Check for external reference, overload, oven; update annunciators.
7. Test for HOLD mode; If so, display message.
8. Test for lockouts in effect; if so, display message.
9. Set current Diagnostic number to 43.

8-473. The Diag 43 routine continuously cycles through the above tests until the diagnostic is exited by the operator. When exited, Diag 43, like the Power-Up Self Test, will restore the status of the instrument that existed before the diagnostic was called. If the tests are passed, the display will alternate between showing all segments lit, and showing the HP-IB address in the format shown below:

```
                              x x  H P -I B
O V L D                       x x  H P -I B
```

- where xx is a number from 0 to 31.

8-474. If a Diag 43 failure occurs, the messages displayed will depend on which diagnostics are failing. Refer to the descriptions of the individual diagnostics for examples of the possible failure messages which may occur during Diag 43.

8-475. Diagnostic 44: Signature Analysis

8-476. This routine exercises the static output ports and data ports on the A4 Assembly by continuously cycling a digital signal through the ports for examination by signature analysis. There is no pass/fail or overload indication for this diagnostic because the display lines are being exercised during the routine; the display will show faint, random patterns while Diag 44 is in progress. Refer to the A4 Assembly troubleshooting procedures for the signatures which can be expected when Diag 44 is enabled. Refer to *Table 1-5*, Recommended Test Equipment, for the Signature Analyzer specifications required for this diagnostic.

NOTE

Diagnostics 41, 42, 43, and 44 are not available over the HP-IB.

NOTE

In order to perform the Diag 44 routine, the cable to the A11 HP-IB Interface Assembly (A11J2W1) must be disconnected from the A8J6 motherboard socket.

8-477. Diagnostic 50: LO Synthesizer Verification — 29.5 MHz, 35.0 MHz

8-478. Diag 50 sets the A5 LO frequency to 295 MHz, and sends the AUX B (LO ÷ 10 = 29.5 MHz) signal to input B of the MRC to be counted. This test uses the same measurement procedure as Diags 20, 21, 30, 31, and 60. If the 295 MHz test passes, the test is repeated at 350 MHz. If the test fails at either frequency, the "FAIL" message will display the measured AUX B frequency. If the test passes both frequencies, the second AUX B measurement (LO ÷ 10 = 35.0 MHz) will be displayed. The messages are:

```
P A S S   3 5   0 0 0    0 * *   A 5   D   5 0
F A I L   x x   x x x    x x x   A 5   D   5 0
P A S S   3 5   0 0 0    0 * *   O V L D   5 0
```

8-479. Diagnostic 51: LO Synthesizer Verification — User-Entered Frequency

8-480. This diagnostic performs identically to Diag 50, but the user is allowed to enter (via the front panel keys, or over the HP-IB) any frequency in the LO range. The LO will be set to the frequency entered, and the user may then examine the result by connecting a spectrum analyzer, frequency counter, or power meter to the output cable from the A5 Synthesizer Assembly (W2).

8-481. A new LO frequency may be entered at any time during the test. When entering a value via the front panel keyboard, a four digit number (without the decimal point) must be entered, using the SET/ENTER key. For example, if the desired LO frequency is 310.5 MHz, enter 3, 1, 0, 5, SET/ENTER. The decimal point will be displayed after the SET/ENTER key has been pressed. To exit Diag 51, press the RESET/LOCAL key, or use the DEC or INC key (arrow keys). The DIAGNOSTICS key cannot be used to exit Diag 51 (the key is interpreted as a "1").

8-482. On entry to this routine, the LO will automatically be set to the last value used during the measurement cycle. When leaving this routine, the LO will remain at the last test value, until Auto or Manual mode is entered, at which time a new LO will be derived and set.

8-483. Indication of success or failure is shown on the display with an asterisk (*). The asterisk will NOT appear if the frequency is set and measured to be within the allowable margin defined by the upper and lower bounds of the synthesizer range (refer to Diagnostic 53, paragraph 8-488.) If the frequency is out of the synthesizer range, the asterisk will appear on the display beside the requested frequency value. For example, if the LO is set to 295.9 MHz (within the allowable range), the messages would be:

```
ENTER LO 295.9      A5 D 51
ENTER LO 295.9      OVLD 51
```

8-484. If the user enters 495.5 MHz (which is out of range), the message will be:

```
ENTER LO 495.5 *    A5 D 51
```

8-485. The asterisk will also appear if the instrument fails to measure the requested LO frequency. This result may indicate that the synthesizer output is missing or incorrect. For example, if the synthesizer failed to provide a requested frequency of 340.0 MHz, the asterisk would be displayed even though 340.0 MHz is within the allowable range. The LO frequency can be confirmed by monitoring the W2 output cable, as described previously.

8-486. Diagnostic 52: LO Synthesizer Sweep

8-487. This routine sweeps the synthesizer from 275.0 MHz up to 375.0 MHz, in 100 kHz steps. Diag 52 will not show a pass or fail message on the display, but will instead give a message indicating that a test is in progress. The complete sweep requires about four seconds. The results of this test may be seen by connecting a spectrum analyzer to the W2 output cable of the A5 Synthesizer Assembly. The messages are:

```
275-375 LO SWEEP A5 D 52
275-375 LO SWEEP OVLD 52
```

8-488. Diagnostic 53: LO Synthesizer Lower, Upper Frequency Bounds

8-489. This test determines the upper and lower bounds of the LO frequency. The A4 microprocessor attempts to program the synthesizer well below its known lower bound range. The measured frequency is a very good approximation to the lower bound. A similar procedure determines the upper bound. These upper and lower values are displayed for visual verification by the operator (the A4 microprocessor does not make a pass/fail decision). The messages are:

```
LO xxxx HI xxxx   A5 D 53
LO xxxx HI xxxx   OVLD 53
```

- where xxxx represents some Local Oscillator frequency in the format xxx.x MHz (the decimal point is implied). For example, if "LO 2505 HI 3985" is displayed, the lower bound is 250.5 MHz, and the upper bound is 398.5 MHz.

8-490. The lower bound of the LO frequency should be less than 275 MHz (a typical value would be 245 MHz). The upper bound should be greater than 375 MHz (a typical value would be 405 MHz).

8-491. Diagnostic 60: IF Verification: 35 MHz; Disable INPUT 1 and IF

8-492. The 35 MHz test signal (AUX A/B) provided by the A5 Synthesizer Assembly is switched to the A6 IF Amplifier/Detector Assembly which in turn sends the signal to Channel A of the MRC to be counted. The signal will be counted to ±100 Hz accuracy using a 100 ms gate time (with no interpolation). To ensure proper diagnostic results, the microprocessor disables the INPUT 1 circuit by turning off dc power to the A12 Microwave Assembly, and disables the normal IF path by turning off the first two gain stages of the A6 Assembly. The messages are:

```
PASS  35 000 0** A6 D 60
FAIL  xx xxx xxx A6 D 60
PASS  35 000 0** OVLD 60
```

8-493. Diagnostic 61: Overload Detector

8-494. This test will indicate whether the overload detector has triggered and been detected by the A4 microprocessor during the time since the last reset of the overload flag. (The red LED at the top of the A6 IF Amplifier/Detector Assembly indicates the circuit overload status.) There are two possible ways that the overload flag can be reset: pressing the RESET/LOCAL key to exit this diagnostic, or switching the instrument power off (STBY). If this test is exited using the DIAGNOSTICS key, the flag will NOT be reset. The messages are:

```
NO OVLD OCCURRED A6 D 61
   OVLD OCCURRED A6 D 61
```

8-495. Diagnostic 62: Disable Hardware IF Detector Flag; Display Measurement

8-496. This test will disable the IF wide band detector, and assumes that the IF is always "good" (i.e. within the band, and of required amplitude). After disabling the flag, the instrument returns to the normal measurement cycle, ignoring any results of IF in-band (narrow and wide band) tests. The frequency will be displayed as for a regular measurement, as shown:

```
xx xxx xxx xxx DIAG 62
xx xxx xxx xxx OVLD 62
```

8-497. If the user calls any other diagnostic (except for Diag 63), or leaves the diagnostic mode (by pressing RESET/LOCAL or toggling the DIAGNOSTICS key), the IF flag will once again be enabled, and measurements will proceed normally.

8-498. Diagnostic 63: Disable Hardware and Software IF Detector Flags; Display IF

8-499. This test is identical to Diag 62, except that the instrument will display the IF, using the same format as Diag 02 (Display IF). The messages are:

```
I F      x x  x x x  x x x  .x x  D  6 3
O V L D  x x  x x x  x x x  .x x  D  6 3
```

8-500. Diagnostic 64: Disable Software IF Detector Flag; Display IF

8-501. This diagnostic is similar to Diag 62, but instead of disabling the IF wide band detector, the software flag set by the IF detection results is ignored; the IF is assumed to be always within the required band. The instrument returns to the normal measurement cycle and the current IF measurement is displayed as follows:

```
I F      x x  x x x  x x x  .x x  D  6 4
O V L D  x x  x x x  x x x  .x x  D  6 4
```

8-502. Diagnostic 65: IF Verification: 35 MHz; Disable INPUT 1

8-503. This diagnostic is similar to Diag 60. The AUX A/B 35 MHz test signal from the A5 Synthesizer Assembly is switched by the A4 microprocessor to the A6 IF Amplifier/Detector Assembly, which in turn sends the signal to Channel A of the MRC to be counted. The signal is counted to ±100 Hz accuracy using a 100 ms gate time (with no interpolation). To perform this test, the microprocessor disables the INPUT 1 circuit by turning off dc power to the A12 Microwave Assembly, in the same way as Diag 60; however, the normal IF path is NOT disabled. The messages are:

```
P A S S  3 5  0 0 0  0 * *  A 6  D  6 5
F A I L  x x  x x x  x x x  A 6  D  6 5
P A S S  3 5  0 0 0  0 * *  O V L D  6 5
```

8-504. Diagnostic 70: Keyboard Test

8-505. This diagnostic allows the front panel keyboard to be tested. Any key, when pressed, will cause the name of the key function to be displayed. The displayed key names will be:

OFFSET	RESOL	HP-IB	50 OHM
SCALE	SELF CK	HI RES	1 MOHM
SMOOTH	DIAG	FM RATE	AUTO
SET	SAMP RT	TRIGGER	MANUAL
RESET			

8-506. Before a key is pressed, the messages are:

```
K E Y  T E S T          A 7  D  7 0
K E Y  T E S T          O V L D  7 0
```

8-507. When a key is pressed, the display changes to show the function name of the pressed key. For example, if the user presses the MANUAL key, the message will be:

```
KEY MANUAL      A7 D 70
```

8-508. To exit this routine, the user must press the RESET/LOCAL key. The word RESET will appear on the display for approximately 1 second, and then the instrument will return to the normal measurement mode. Pressing the DIAGNOSTICS key will NOT exit this test, as the diagnostic will interpret it as a key to be tested, and will only display the test message associated with that key. (Note that the INC and DEC functions are also not usable, as pressing the arrow keys is interpreted as a test of the SCALE and SMOOTH function keys.)

8-509. Diagnostic 71: Display Test

8-510. This diagnostic will cause the display to alternate between fully lit (all segments and annunciators) and fully blank (no segments and no annunciators lit). A visual verification is required. Note that an overload indication will NOT be shown in this display.

8-511. Diagnostic 80: HP-IB Verification

8-512. This routine causes the A11 HP-IB Interface Assembly to execute its start-up tests, resetting the HP-IB processor and initializing its memory. The messages are:

```
PASS    HP-IB    A11 D 80
FAIL    HP-IB    A11 D 80
PASS    HP-IB     OVLD 80
```

NOTE

Diag 80 is not available over the HP-IB.

8-513. Diagnostic 97: IF 175 MHz Filter Adjust

8-514. This routine is not a test, but a special operating condition required for adjusting the 175 MHz Elliptic Filter on the A6 IF Amplifier/Detector Assembly (refer to Section V, Adjustments). The message is:

```
ADJUST IF 175 FILTER D97
```

8-515. This routine can only be entered using the standard diagnostic keyboard entry sequence (SET/ENTER, DIAGNOSTICS, 9, 7, SET/ENTER). The INC key will increment to a maximum number of 96, and cannot be used to enter Diag 97.

8-516. If a key is pressed at any time after the Diag 97 condition is enabled, the key is ignored and the message remains. The only way to exit Diag 97 is to power down the counter (POWER switch to STBY). When the counter is powered up again, normal counting resumes and the diagnostic number defaults to 1.

NOTE

Diag 97 is not available over the HP-IB.

8-517. Diagnostic 98: Keyboard Lockout

8-518. This routine is not a test, but a special operating condition which causes the instrument to ignore all front panel keyboard entry, except for a special key sequence which will exit the mode. The display will continue to function normally. When the user enters this mode, a lockout message will be displayed for approximately 1 second, and the counter will then return to its normal measurement display. The message is:

K E Y B O A R D L O C K O U T

- Note that an overload condition will NOT be indicated in the display.

8-519. This routine can only be entered using the standard diagnostic keyboard entry sequence (SET/ENTER, DIAGNOSTICS, 9, 8, SET/ENTER). The INC key will increment to a maximum number of 96, and cannot be used to enter Diag 98.

8-520. If a key is pressed at any time after the lockout is enabled, the lockout message will appear briefly to indicate that the key has been ignored. The counter will then return to counting. If the instrument is powered-up from Standby with Diag 98 active, the lockout message will reappear for approximately 2 seconds, and the counter will then return to counting. When the Keyboard Lockout is enabled and counting resumes, the diagnostic number defaults to 1.

8-521. The only way to exit Diag 98 is to remove and then reconnect ac power, or to enter the following special key sequence: 7, 4, 0, RESET/LOCAL. Pressing this key sequence will restore normal front panel control of the counter.

8-522. Diagnostic 99: Display Lockout

8-523. This routine is not a test, but a special operating condition which locks all messages from the display. All the annunciators are blank and the display shows the following constant message:

D I S P L A Y L O C K O U T

- Note that an overload condition will NOT be indicated in the display.

8-524. This routine can only be entered using the standard diagnostic keyboard entry sequence (SET/ENTER, DIAGNOSTICS, 9, 9, SET/ENTER). The INC key will increment to a maximum number of 96, and cannot be used to enter Diag 99.

8-525. If the instrument is powered-up from Standby with Diag 99 active, the counter will go into normal measurement mode, and the display will show only the constant lockout message. When the Display Lockout is enabled and counting resumes, the diagnostic number defaults to 1.

8-526. The only way to exit Diag 99 is to remove and then reconnect ac power, or to enter the same key sequence used for exiting Diag 98: 7, 4, 0, RESET/LOCAL. Pressing this key sequence will cause the counter to return to normal message display.

8-527. Power-Up Self Test

8-528. When the HP 5350B/51B/52B is powered-up, an automatic internal check (an expanded version of Diag 43 - Repeated Reset) is made of several major components, including the microprocessor and related circuitry. During this cycle, all front panel display segments and annunciators will light for about 3 seconds, after which the current HP-IB address will be displayed. On successful completion of all tests, the normal measurement display will appear.

8-529. During the power-up cycle, the HP 5350B/51B/52B performs the following test sequence:

1. Display all segments lit, all annunciators lit.
2. Diag 41 - RAM Test.
3. Initialize input/output ports.
4. Initialize RAM.
5. Diag 42 - ROM Test.
6. Diag 01 - Self Test:
    a. Diag 11 - Power Supply Verification
    b. Diag 10 - Timebase Verification
    c. Diag 30 - MRC Channel A Verification: 10 MHz Timebase
    d. Diag 50 - LO Verification: 29.5 MHz, 35.0 MHz
    e. Diag 31 - MRC Channel B Verification: 35 MHz
    f. Diag 60 - IF Verification: 35 MHz; Disable INPUT 1 and IF
    g. Diag 32 - Interpolator Check
    h. Diag 20 - Low Frequency 50Ω Verification: 35 MHz
    i. Diag 21 - Low Frequency 1MΩ Verification: 35 MHz
7. Diag 80 - HP-IB Verification, and display address (if powered-up from STBY, recall address; if in full power-up, read rear panel switches).
8. Restore annunciators based on instrument measurement status, if powered-up from STBY. If in full power-up, set instrument status and annunciators to default to conditions programmed in standby RAM.
9. Check for external reference, overload, oven: update annunciators.
10. Test for HOLD mode: if so, display "HOLDING---" message.
11. Test for lockouts in effect: if so, display lockout message.
12. Set current diagnostic number to 1.
13. Begin measurement.

8-530. The failure messages for the Power-Up test will depend on which diagnostics are failing (similar to Diag 43). Refer to the descriptions of the individual diagnostics for examples of the possible failure messages resulting from a Power-Up test failure.

8-531. If any test during the Power-Up sequence fails, the failure message will remain until the user presses the RESET/LOCAL key. At that point the next test is executed (if possible). By pressing the RESET/LOCAL key, most failures can be bypassed to allow the counter to proceed with the

Power-Up test sequence. When the last test is completed, the counter will proceed to the normal operation mode, if possible. Refer to troubleshooting procedures in this section if a failure message appears during the Power-Up sequence.

3-532. In addition to failure messages, the counter may display "HP-IB NOT INSTALLED" if the ribbon cable from the A11 HP-IB Interface board to the A8 motherboard is not properly connected.

8-533. Self Check

8-534. When the SELF CHECK key is pressed, a particular sequence of diagnostics (a subset of the User-Callable Diagnostics) is executed to test the measurement circuitry of the HP 5350B/51B/52B. This diagnostic performs the same sequence of tests as Diag 1 (Self Test), but will only perform the test sequence once, and will show a different set of display messages.

8-535. The Self Check diagnostic routines are arranged so that each routine involves only one untested assembly. The Self Check routines and the order in which they occur are shown in *Table 8-14*.

Table 8-14. Self Check Sequence

Diag Number	Test	Assembly
Diag 11	Power Supply Verification	A1/A8
Diag 10	Timebase Verification	A1
Diag 30	MRC Channel A Verification: 10 MHz Timebase	A3
Diag 50	LO Verification: 29.5 MHz, 35.0 MHz	A5
Diag 31	MRC Channel B Verification: 35 MHz	A3
Diag 60	IF Verification: 35 MHz; Disable INPUT 1 and IF	A6
Diag 32	Interpolator Check	A3
Diag 20	Low Frequency 50Ω Verification: 35 MHz	A2
Diag 21	Low Frequency 1MΩ Verification: 35 MHz	A2

8-536. If the counter passes Self Check, it will display a "pass" message for approximately 3 seconds, and then return to its previous measurement mode. The pass messages are:

```
PASS   35  000  0xx      SELF
PASS   35  000  0**  OVLD  SC
```

8-537. If a failure should occur, the counter will display one of two message formats. If Diag 11, 10, or 32 fails, the messages are:

```
FAIL     POWER      A1  SELF
FAIL     TIMEBASE   A1  SELF
FAIL     INTERPOL   A3  SELF
```

8-538. If any of the other Self Check tests fail, the message format is:

F A I L x x x x x x x x A y S E L F

- where x's are random numbers, and y is the number of the assembly involved in the failure.

8-539. If Self Check passes, the counter automatically returns to its previous measurement mode. If a Self Check failure occurs, the fail message will remain on the display, and the counter will wait for the RESET/LOCAL key to be pressed. Pressing the RESET/LOCAL key causes the counter to proceed to the next test in the sequence, which will be performed, if possible. In this way, the user can scroll through all of the diagnostics in the Self Check sequence, even though one or more of the tests may be failing.

8-540. When performing the Self Check over the HP-IB using the "TEST?" command, only the first failure result will be returned over the bus, after which the counter exits the Self Check routine.

8-541. Hardwired Diagnostics

8-542. Hardwired diagnostics are a set of three tests which allow the user to troubleshoot the HP 5350B/51B/52B if a complete power-up failure should occur. A complete power-up failure will produce one of the following:

a. A blank display.

b. A hieroglyphic or erroneous message is displayed.

c. Display shows a missing segment or digit.

d. A "FAIL" message is displayed.

8-543. In addition, the instrument may be disabled and not respond to the front panel keyboard, even though Diag 98 (Keyboard Lockout) is not enabled. If a complete power-up failure occurs, the hardwired diagnostics can be used to directly test the display or keyboard or to set up a signature analysis routine, without having to rely on the software start-up routines which the microprocessor normally uses to initiate instrument operation.

8-544. On power-up, the microprocessor checks the status of two test pins on the A4 assembly, (TP1, TP2). The two pins may be in one of four possible states, as shown in *Table 8-15.*

Table 8-15. Hardwired Test Status

Test Pin Status		Instrument Status
TP1	TP2	
1	1	Normal instrument operation
1	0	Signature Analysis
0	1	Keyboard Test (Diag 70)
0	0	Display Test (Diag 71)

1 = No connection.
0 = Test pin jumpered to ground.

8-545. Refer to the troubleshooting procedures in this section for information on using the hardwired diagnostics.

8-546. TROUBLESHOOTING

8-547. The following paragraphs contain troubleshooting procedures for the HP 5350B/51B/52B. The procedures begin with overall troubleshooting procedures to isolate the problem to a specific board assembly, followed by procedures for each of the field-repairable assemblies in the HP 5350B/51B/52B. The troubleshooting procedures are listed in *Table 8-16*.

Table 8-16. Troubleshooting Procedures

Troubleshooting Procedure	Paragraph Number
Overall Troubleshooting - Diagnostics - Inference Chart - Assembly Troubleshooting Techniques	8-549
Power Supply Troubleshooting (A8/Part of A1)	8-565
Timebase Buffer Troubleshooting (Part of A1)	8-602
A2 Low Frequency Input Assembly Troubleshooting	8-609
A3 Counter Assembly Troubleshooting	8-628
A4 Microprocessor Assembly Troubleshooting	8-640
A5 Synthesizer Assembly Troubleshooting	8-664
A6 IF Amplifier/Detector Assembly Troubleshooting	8-680
A7 Keyboard/Display Logic Assembly Troubleshooting	8-697
A11 HP-IB Interface Assembly Troubleshooting	8-708
Microwave Module Troubleshooting (A12/U1 Sampler)	8-716
Option 001 Oven Oscillator Troubleshooting	8-729

8-548. Whenever repairs or adjustments are made, the instrument should be checked for proper performance. Refer to the adjustments in Section V, and to the Operation Verification procedures and Performance Tests in Section IV.

WARNING

TROUBLESHOOTING PROCEDURES REQUIRE INTERNAL ACCESS TO THE INSTRUMENT WITH THE PROTECTIVE COVERS REMOVED. THESE PROCEDURES MUST BE PERFORMED ONLY BY SERVICE-TRAINED PERSONNEL WHO ARE AWARE OF THE HAZARDS INVOLVED.

CAUTION

Electronic components and assemblies can be permanently degraded or damaged by electrostatic discharge. Use the following precautions:

ENSURE that static sensitive devices or assemblies are serviced at static safe work stations providing proper grounding for service personnel.

ENSURE that static sensitive devices or assemblies are stored in static shielding containers.

DO NOT wear clothing subject to static charge buildup, such as wool or synthetic materials.

DO NOT handle components or assemblies in carpeted areas.

DO NOT remove a replacement assembly from its static shielding container until you are ready to install it.

AVOID touching component leads. (Handle by the package only.)

8-549. OVERALL TROUBLESHOOTING

8-550. Diagnostics

8-551. Before removing the top cover of the instrument, the front panel diagnostic routines should be used to identify the faulty assembly. Once a particular assembly has been identified, exercising all of the diagnostic tests relating to it may help determine the specific portion of circuitry that is at fault.

8-552. The diagnostics in the HP 5350B/51B/52B have been designed using the kernel technique (i.e. the diagnostic test relies on not more than one untested assembly to perform the test). Therefore, it is important to know the status of all the assemblies involved in a particular test in order to confirm a diagnosis. The arrangement of the Self Check tests, and the Inference Chart shown in *Figure 8-27*, facilitate this.

8-553. There are four types of diagnostics, as follows:

1. User-Callable Diagnostics: These are individual tests which can be initiated from the front panel or via the HP-IB. (Refer to paragraph 8-399.)

2. Power-Up Self Test: A sequence of tests automatically executed on power-up. These tests include a subset of the User-Callable Diagnostics. (Refer to paragraph 8-527.)

3. Self Check: A sequence of tests executed by pressing the SELF CHECK key. The Self Check tests are a subset of the User-Callable Diagnostics. (Refer to paragraph 8-533.)

4. Hardwired: These tests will be executed on power-up and continuously thereafter if appropriate jumpers are set on the A4 Microprocessor Assembly. (Refer to paragraph 8-541.)

8-554. There are 37 available diagnostics, with identifying numbers ranging from 0 to 99. For the diagnostics numbered from 10 to 71, the first digit of the diagnostic number identifies the assembly being tested. The second digit identifies the specific test of the group of tests available for the particular assembly. Note that not all numbers between 0 and 99 are used; the counter will display a "NOT AVAILABLE" message if an invalid diagnostic number is entered.

8-555. Diagnostics 2 through 9 are a special subset referred to as Auxiliary Functions. Auxiliary functions display internal calculation data rather than a PASS/FAIL indication or status.

8-556. The Power-up Self Test, Self Check, and Diag 1 diagnostic routines are designed to execute individual tests in a sequence that verifies assemblies in a critical order. For example, the tests first verify that the timebase is functional before attempting to verify that the low frequency circuitry can count the timebase signal.

8-557. Inference Chart

8-558. Once a particular assembly has been identified as failing a diagnostic test or self test routine, the operator should refer to the Inference Chart, *Figure 8-27*, to determine further checks to perform. The "flow" of the Inference Chart is from left to right. In order to verify a particular assembly, all assemblies in the direct path to the left of the suspect assembly should be verified. For example, if executing a Self Check resulted in displaying an A6 Assembly failure (Diag 60, 61, 62, 63, 64, or 65 failure), the next step would be to verify the A4, A1, A3, and A5 assemblies, using the associated diagnostics.

8-559. It is important to understand that the diagnostic routines are not without certain limitations, nor are they foolproof. In some cases, it is not feasible to test 100% of a given circuit. These cases are pointed out in the appropriate troubleshooting procedure. It is also possible that the circuitry employed to test the board may cause a diagnostic test failure, even though the counter continues to make correct measurements. The possibility of test circuit failure has been minimized, but it is feasible for this type of failure to occur. The only assembly which is not tested in some form by the diagnostics is the Microwave Module (A12 Microwave Assembly/U1 Sampler).

8-560. Assembly Troubleshooting Techniques

8-561. In most cases, signal measurements can be made with a high impedance oscilloscope probe. It is important to minimize capacitance loading effects by using the appropriate probe. (Refer to *Table 1-5*, Recommended Test Equipment.) In addition, it is crucial that minimal ground lead lengths be used. Following these precautions will aid in achieving oscilloscope displays which match the waveform photographs shown in this manual.

8-562. In many cases, dc bias voltages are noted in the troubleshooting procedures, or on the schematics. These voltages will vary due to typical variations from component to component. However, it is helpful to verify that an active component is appropriately biased to determine if it is faulty. Generally look for relatively large deviations from these dc values to indicate a potential fault.

8-563. The troubleshooting procedures for each assembly (with the exception of the A8/A1 Power Supply and the Option 001 Oven Oscillator troubleshooting procedures) are arranged in the following order:

1. A list of diagnostic tests that pertain directly to the assembly.
2. Points to consider when troubleshooting the assembly.
3. Possible symptoms which may appear if the assembly is faulty.
4. Power supply voltages to verify on the assembly.
5. Inputs to the assembly to be verified.
6. Outputs from the assembly to be verified.
7. A general approach to verifying the circuitry on the assembly.

8-564. In the following troubleshooting procedures, reference is often made to physical locations of components (for example, the right leg of a resistor, the bottom leg of an inductor, etc.). All physical locations discussed in procedures and in tables are referenced looking toward the component side of the board, with the board oriented in its normal plugged-in position in the instrument. It is assumed that the board in question, where applicable, is mounted on an extender board(s), HP P/N 5060-0175. (Refer to paragraph 8-67.)

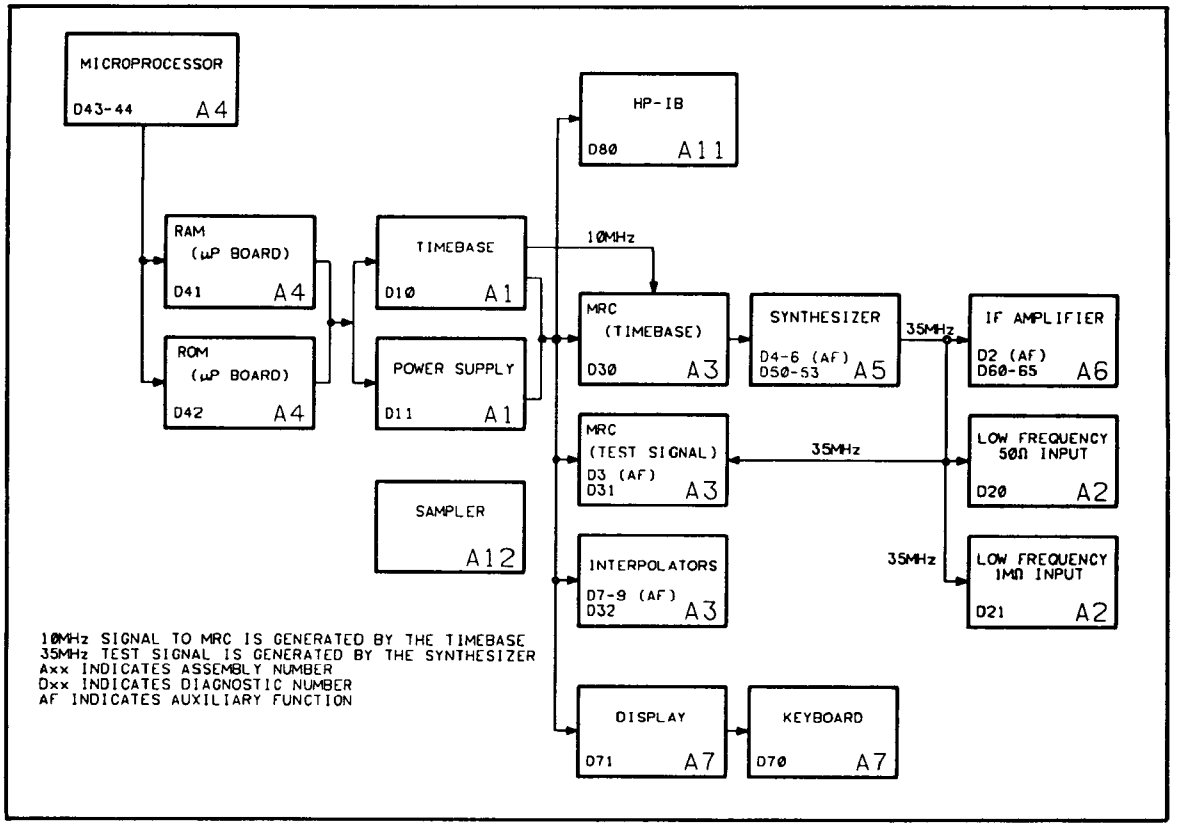


Figure 8-27. Diagnostic Inference Chart

8-565. POWER SUPPLY TROUBLESHOOTING (A8/PART OF A1)

WARNING

IF THE W13 RIBBON CABLE FROM THE A7 KEYBOARD/ DISPLAY LOGIC ASSEMBLY TO THE A8 MOTHERBOARD/ POWER SUPPLY REGULATOR ASSEMBLY IS DISCONNECTED, THE POWER SUPPLY CIRCUITS WILL ALWAYS BE ON WHEN THE INSTRUMENT IS CONNECTED TO AC POWER.

8-566. Fuse replacement

8-567. There are four fuses in the HP 5350B/51B/52B counter. The line fuse is located on the rear panel in the power line module. To replace this fuse, remove the ac power cord from the rear panel. Slide the clear plastic cover over the ac power cord male connector, exposing the fuse. Pull on the tab labeled "fuse pull" to pry the blown fuse out of the holder. Remove the blown fuse and push the fuse pull tab to its original position. Insert the replacement fuse in the holder and slide the plastic cover over the fuse.

8-568. Two fuses are located on the A8 Motherboard Assembly. A8F1 protects the fan. An open A8F1 can be detected by failure of the fan to operate during normal operation. A8F2 protects the +15V secondary. An open A8F2 can be detected by checking the +15V test point at the Power Supply Test Connector (A8J7). Replacement of these fuses requires desoldering the blown fuse and soldering in the replacement.

8-569. The remaining fuse protects the low frequency port, INPUT 2. This fuse is located in the front panel BNC connector for INPUT 2. Refer to paragraph 3-136 for replacement instructions.

8-570. Part numbers for replacement fuses can be found in *Table 6-3*, Standard Instrument Replaceable Parts.

8-571. Failure Symptoms

8-572. The two most probable power supply failure symptoms are: the ac line fuse (F1) in the rear panel power module is blown, or the counter powers on with a particular power supply output at an incorrect level.

8-573. When verifying power supply voltages in the 5350B/51B/52B, it is recommended that as many measurements as possible be made at the Power Supply Test Connector (A8J7) located on the motherboard. The test pin circuitry is designed so that accidental shorting at these pins will not damage the power supply circuit. In addition, provisions have been made to measure the current being supplied by the circuitry. The difference between voltages measured at the "V/X" test point and the corresponding "I/X" test point divided by the the current sense resistor value found on the A8 schematic will give the current supplied. See *Table 8-18*, Power Supply Test Connector Voltages for specific information.

8-574. BLOWN REAR PANEL LINE FUSE. First verify the proper orientation of the line voltage selector card in the power line module on the rear panel. Once this has been checked, plug the counter into a variable transformer and slowly increase the voltage, monitoring the current. Use the variable transformer to supply enough current to locate a short circuit, but not blow the main fuse. Typically this current should be about one-third that of the fuse rating.

8-575. The transformer secondaries are connected to the instrument at A8J8 and A8J9 via cable W8. Disconnecting these connectors one at a time may help isolate which secondary is shorted. The transformer may be shorted or open internally (if it is open, the fuse will probably not be blown, but the instrument will not power on).

8-576. Incorrect voltages at the test connector may be caused by a transformer unable to supply sufficient current for the load. Apply power with a variable transformer to the instrument with the W8 cable connectors at both A8J8 and A8J9 disconnected, and verify that the current is nearly zero amperes. Check the output of the transformer secondary with an oscilloscope.

8-577. The unregulated voltages in the counter and their ranges are shown in *Table 8-17*.

Table 8-17. Unregulated Voltages

Test point (on A8)	Signal Name	Allowable Range (normal line voltage applied)
C19(+)	+5V UNREG	+6 to +10 V
C18(-)	-5.2V UNREG	-6 to -10 V
C3(+)	+15V UNREG	+16 to +25 V
C4(-)	-24V UNREG	-27 to -45 V

8-578. Problems with these unregulated voltages could be caused by shorted diodes in the rectifiers or shorted capacitors C3, C19, C18, and C4. Also, the A1 Assembly uses these unregulated voltages. It may be helpful to remove the A1 Assembly to help isolate the source of the problem.

8-579. POWER SUPPLY OUT OF RANGE. The following procedures assume that the instrument is in a state where it can be connected to an ac power line and power on without blowing the rear panel fuse. Use the normal line voltage (not a variable transformer) for the following troubleshooting.

8-580. The pass or fail indication of Diagnostic 11 is a quick check of the status of the power supplies without having to remove the cover of the instrument. In addition, once the cover has been removed, the red LED at the top of the A1 assembly indicates the status of the power supply. The LED should be on when the counter is in the Standby (STBY) mode. When the counter is switched to ON, the LED should be off. If the LED stays on during normal operation, or is off in Standby mode, there is a fault in the power supply. The status circuit will detect problems in most cases, however, the Power Supply Test Connector voltages should be verified for a thorough check.

8-581. If the LED does not function as described above or Diagnostic 11 fails, probe the test connector to determine which supply is faulty. The current sense/voltage sense measurements (e.g. I/+5 and V/+5, etc.) are useful to determine if the +5V, -5.2V, or +15V supplies are being current limited. Refer to *Table 8-18.*

8-582. Check the +5V reference at TP5 on A1 (+4.94V to +5.06V). Also check the the +12V at TP6 on A1 (+11.2V to +12.8V). If either of these references is not correct, check the appropriate regulator IC (A1U1, A1U2). Both of these voltages must be operative for the A1 power supply control circuit to function properly.

8-583. If the +5V, -5.2V, or +15V supply is faulty, check the regulator circuitry on the A1 assembly as outlined below.

8-584. +5V REGULATOR. Note that this supply is different from the +5V μP Standby RAM supply and timebase supplies located on the timebase buffer portion of the A1 assembly. The +5V μP Standby RAM supply is connected to the +5V supply via CR1 on the A8 motherboard. The +5V supply will serve as a backup only if the +5V μP regulator fails (open).

8-585. Determine if another assembly is faulty causing the +5V supply to be pulled down. *Table 8-19* lists the assemblies which use the +5V supply.

8-586. Verify the unregulated +5V at the positive terminal of A8C19 (+6V to +10V). The voltage should never drop below +5.2V which would forward bias CR13, CR14, and CR15. Locate the analog OR gate node for the +5V regulator (anode of CR12). For normal operation, CR12 should be forward biased and U14D should control the node. The voltage at pin 13 of U14D should be close to that of TP5, causing pin 14 of U14D to be low enough to forward bias CR12.

8-587. Since the +5V regulator circuit is a "foldback" type regulator (refer to the theory of operation), it is difficult to determine if the supply is current limited by measuring the voltage across the current sense resistor on the A8 Motherboard. The best method to determine if the supply is current limited is to determine which circuit is controlling the analog OR gate node (on the A1 Assembly). In normal operation, CR12 will be forward biased. If, however, the supply is current limited, CR22 should be forward biased by the voltage at U1, pin 8. Note that the voltage at the analog OR gate node (CR12 anode) should never exceed 8.66V due to CR25.

Table 8-18. Power Supply Test Connector Voltages

Signal Name	Voltage Range	Comments
V/+5UP *	+4.70 to +5.25 V	Located on timebase buffer portion of A1 assembly
V/-24 *	-22.6 to -25.9 V	Standard timebase TCXO, or warm Option 001 or 010
	-23.0 to -30.0 V	Cold Option 001 or 010
V/+12PS *	+11.2 to +12.8 V	
REF/+5 *	+4.94 to +5.06 V	
V/+15	+14.75 to +15.25 V	
I/+15	The difference in voltage between this test pin and V/+15 [(I/+15)-(V/+15)] should be +0.15 to +0.50 volts.	
V/+5OS *	+4.60 to +5.25 V	Internal timebase reference
	0 to +0.5 V	External timebase reference (Located on timebase buffer portion of A1 assembly)
V/+12OS *	+11.25 to +12.60 V	Internal timebase reference
	0 to +.5 V	External timebase reference (Located on timebase buffer portion of A1 assembly)
V/+3	+2.97 to +3.03 V	Adjustment on A3 assembly
V/-FAN	-16.5 to -20.0 V	30 seconds after power on
I/+5	The difference in voltage between this test pin and V/+5 [(I/+5)-(V/+5)] should be +0.05 to +0.18 volts.	
V/+5	+4.93 to +5.07 V	
I/-5.2	The difference in voltage between this test pin and V/-5.2 [(I/-5.2)-(V/-5.2)] should be -0.15 to -0.27 volts.	
V/-5.2	-5.11 to -5.29 V	

* denotes that this supply is active in standby mode.

8-588. The remaining portion of the +5V regulator circuitry is devoted to controlling the microprocessor Reset (L μP RST) and Non-Maskable Interrupt (L μP NMI), and turning the LED on if there is a failure with the +5V regulator. Check that U8C, pin 14 is high (about +5V), when U11D is controlling the analog OR gate node (CR12 is forward biased). Pin 14 should go low when the counter is switched to Standby, interrupting the processor to store state variables before power completely goes away.

8-589. U8D monitors the voltage across CR12 exactly as U8C does. Verify similar operation of these two comparators by monitoring their outputs when switching from STBY to ON, and vice versa. The logic high for U8D, pin 13 should be +12V, and logic high for U8D, pin 14 should be +5V. When measuring at pin 13, use a 10MΩ probe such as the HP 10014A, since the pull-up impedance is 2.15MΩ. During normal operation, R29C, R14, and C24 should set a reference of approximately 6V at pin 11 of U7.

8-590. If the instrument fails to power on properly or fails to save constants when switched to Standby, and the A4 Microprocessor Assembly has been verified, the problem may be due to the reset circuitry for the microprocessor. *Figure 8-28* shows the relationship between the L μP NMI signal and the L μP RST signal at power on and power off. Verify that these signals have the appropriate timing relationship. The setup notes in the figure are for use with an HP 1744A Storage Oscilloscope. If the correct timing is not observed, the problem probably is caused by A1U7D and A1U8D, or A1U8C.

8-591. Verify A1Q20, A8Q1, and A8Q10 by checking base-emitter and collector-emitter voltages. The collector-emitter voltage of the series pass transistor A8Q10 should never exceed 10V. A1CR6 should be forward biased when the counter is in Standby.

8-592. +15V REGULATOR. Determine if another assembly is causing the +15V supply to be pulled down. Refer to *Table 8-19* to determine which assemblies use the +15V supply.

8-593. Check the +15V UNREG voltage at the positive terminal of A8C3 (+16V to +25V). Next, check that A1CR11 is forward biased and U14A is controlling the analog OR gate node of the +15V regulator. The voltage at U14A, pin 2 should be close to that of U14A, pin 3, causing the output at U14A, pin 1 to be low enough to forward bias A1CR11.

8-594. If difference between the I/+15 and V/+15 lines is greater than 0.85V (as verified at the Power Supply Test Connector on A8), the supply is current limited causing A1Q12 and Q13 to pull the analog OR gate node to ground, thereby controlling the node. In this case, CR11 should be forward biased. Check A1Q10 and A8Q7 for proper junction voltages. The collector-emitter junction should never exceed 25V. A1CR9 should be forward biased when the counter is in Standby.

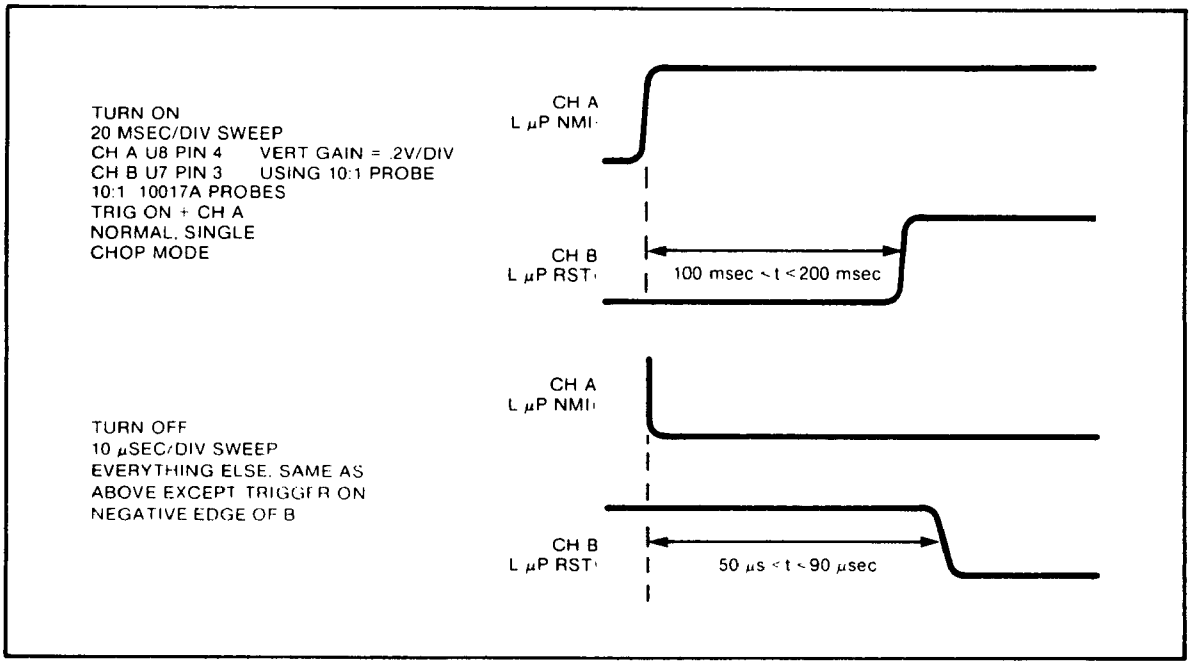


Figure 8-28. L μP NMI and L μP RST Timing Diagram

8-595. -5.2V REGULATOR. Determine if a fault on another assembly is loading the supply. Refer to *Table 8-19* to determine which assemblies use the -5.2V supply.

8-596. Verify the -5.2V UNREG voltage at the negative terminal of A8C18 (-6V to -10V). On the A1 Assembly, check that CR29 is forward biased and controlling the analog OR gate node. Pins 5 and 6 should be close to ground potential, thereby keeping pin 7 of U14B low enough to keep CR29 forward biased.

8-597. If the difference between the I/-5.2 and V/-5.2 lines is greater than -0.6V (as verified at the Power Supply Test Connector on A8), then the -5.2V supply is current limited and A1Q19 should be on, controlling the analog OR gate node. Check the junction voltages at A1Q15, A1Q16, and A8Q9. The A8Q9 collector-emitter voltage should not exceed 10V. A1CR8 should be forward biased only when the counter is in Standby.

8-598. The remainder of the A1 circuitry consists primarily of the U7 comparators for the other supplies (U7A, U7B, U7C). Check the inputs of these comparators and verify that the comparators do not pull the H PWRSP OK line low.

8-599. If power is not available at the Microwave Module, verify the microwave module turn off circuit (A8Q1, A8Q3, A8Q4, and A8Q5). These transistors turn off two of the dc supplies (+5V SW, +13V SW) to the A12 Microwave Assembly during certain measurements. The supplies should be off when the counter is set for INPUT 2 measurements, and on when the counter is set to INPUT 1. The "SLEEP" HP-IB command will also turn off these supplies.

8-600. The fan circuitry is divided between the A8 and A1 assemblies (A1Q22, A8Q2, and A8Q6). Check the junction voltages of these transistors to locate a faulty transistor.

8-601. A8U1 provides -24V regulation. It is recommended that the bottom cover be removed to probe this regulator when troubleshooting the -24V supply.

Table 8-19. Assemblies And Corresponding Power Supplies

Assembly	Power Supply								
	+5V	+5V SW	+5V μP	+15V	+13V SW	-5.2V	-24V	+5V OSC	+12V OSC
A1*	X		X	X		X		X	X
A2	X			X		**			
A3	X					X			
A4	X		X						
A5	X			**		X	X		
A6	X			**		X			
A7/A9	X			X					
A8***	X	X	X	X	X	X	X	X	X
A10							X	X	X
A11	X								
A12		X			X	X			

*The voltage lines to the A1 Power Supply Control circuit are for voltage sense purposes only. The A1 circuit draws no current from the voltage sense lines during normal operation.

**The indicated power supply is routed to the listed assembly, but is not used on that assembly.

***All power supply lines run via the A8 Motherboard connectors.

8-602. TIMEBASE BUFFER TROUBLESHOOTING (PART OF A1)

8-603. Board level diagnostics which could indicate faults in this circuitry are as follows:

- Diagnostic 10.
- Diagnostic 11. (Refer to Power Supply Troubleshooting, paragraph 8-565.)
- Diagnostic failures on the A2 through A7 assemblies. (See the Inference Chart, *Figure 8-27.*)
- Self Check or Diagnostic 1 failure.

8-604. Some important points to keep in mind when troubleshooting the Timebase Buffer are:

- Most of the circuitry involves detecting and conditioning the external reference signal. Verify that the counter works with the internal timebase before attempting to troubleshoot this circuit.
- The microprocessor power supply (+5V μP) is on this board. If this supply is faulty, the counter may not power up at all.
- The 10 MHz timebase is essential for the A3 and the A5 assemblies to function properly.

8-605. The following is a list of likely symptoms if the Timebase Buffer circuitry is faulty:

- No reference signal at rear panel (10 MHz out, 1 MHz out).
- Failure on Diagnostic 10, but counter functions properly otherwise.
- Option 001 or 010 always indicates "cold" or "warm". (This symptom could also be in the timebase oscillator itself.)
- Counter fails to recognize an external reference.
- Counter always displays 00 000 000 000. (The 10 MHz reference signal is not present. This may also be a fault in the timebase oscillator.)

8-606. Before attempting to troubleshoot any portion of this circuit, verify the power supply voltages listed in *Table 8-20.*

8-607. Verify that the internal 10 MHz signal is correct by tracing the signal flow from U10B, pin 5, through U10A, and out to the line drivers (U9A,B, and C). This should be done without an external reference connected to the rear panel.

8-608. Connect an external reference (1, 2, 5, or 10 MHz source) to the rear panel EXT REF IN connector, A8J1. If the counter will not recognize an external reference, trace the signal path from the EXT REF IN point at C44 to the output of U4D at pin 11. (See the photographs in *Figure 8-43.*) Verify that TP3 is logic 0 (0V) when an external reference is connected. Also check that TP2 is logic 0 (assuming that 10 MHz was verified at U10A, pin 3).

Table 8-20. Timebase Buffer Voltage Verification

Signal Name	Test Point	Voltage Range	Condition or comment
+12V OSC	collector of Q9 (top leg)	+11.25 to +12.6 V	Critical for Option 001 or 010
+5V OSC	collector of Q8 (right leg)	+4.60 to +5.25 V	Critical for standard timebase
+5V μP	output leg of L5 (top leg)	+4.70 to +5.25 V	
+5V	output leg of L4 (top leg)	+4.65 to +5.25 V	
+5V D1	output leg of L6 (top leg)	+4.65 to +5.25 V	
+5V D2	output leg of L3 (top leg)	+4.70 to +5.25 V	
+15V UNREG	upper leg of U13	+16 to +25 V dc with up to 0.75 V p-p ripple.	Full wave rectified, unregulated
+5V UNREG	input side of L9 (bottom leg)	+6 to +10 V dc with up to 0.6 V p-p ripple.	Full wave rectified, unregulated

8-609. A2 LOW FREQUENCY INPUT ASSEMBLY TROUBLESHOOTING

8-610. Diagnostics that may fail if the A2 Assembly is faulty:

- Diagnostic 20 if the 50Ω channel is faulty
- Diagnostic 21 if the 1MΩ channel is faulty
- Self Check and Diagnostics 20 and 21 during a Diag 1 routine.

8-611. The following is a list of points to consider when troubleshooting the A2 Assembly:

- The 50Ω and 1MΩ channels share the INPUT 2 connector. Therefore, if both channels do not operate properly, the fault could be a bad input fuse (J2F1), cable assembly A2W1, or a bad power supply.
- Diagnostics 20 and 21 depend on the AUX A/B (35 MHz) test signal being good and the A3 Counter Assembly working properly.
- If both diagnostic 20 and 21 pass, but a channel does not work properly, note that the test signal enters the 1MΩ channel after Q9, and enters the 50Ω channel after U5. Faults in the signal path before these points may be undetected by the diagnostics.
- The 50Ω channel contains a ÷10 counter (U1). The microprocessor firmware multiplies the A3 count by 10 to correct for the division. Since the disabling circuit for the 1MΩ channel is at the U3 multiplexer, a fault in U3 could cause the 1MΩ signal to be sent to the A3 Counter Assembly even though the microprocessor has selected the 50Ω channel, resulting in the displayed count being multiplied by 10.

8-612. Possible symptoms if the A2 Assembly is faulty are:

- The counter counts on INPUT 1, but not on INPUT 2.
- The counter fails to count in both the 50Ω and 1MΩ channels: the input fuse J2F1 is bad, there are connector problems, or power supply problems. In addition, check that the A3 assembly is counting properly (diagnostics 30 and 31). See the Inference Chart, *Figure 8-27.*
- The counter fails to count properly on either the 50Ω or the 1MΩ channel: a component or components are faulty in the appropriate amplifier/signal conditioning chain.

8-613. Check the following power supplies at the listed node before attempting further troubleshooting:

Supply Name	Test Point	Acceptable Range
+15V	CR11 cathode	+14.75 to +15.25V
+5V	U8, pin 1	+4.93 to +5.07V

8-614. Check the following inputs to the A2 Assembly:

1. Set the counter to Diagnostic 20. Check U8, pin 6 and pin 4 for the 35 MHz test signal. Note that this signal pulses on and off as the microprocessor loops through the diagnostic routine.
2. Set the counter to Diagnostic 21. Check U8, pin 6 and pin 4 for the 35 MHz test signal. Note that this signal pulses on and off as the microprocessor loops through the diagnostic routine.
3. Check that the L LF TEST signal (bottom leg of R33) is TTL low during Diagnostic 20 and 21, and that it is TTL high during normal operation.
4. Verify that the front panel input fuse J2F1 is good, i.e. that the signal reaches R54 and CR13. (These two components are not the first in the signal path after the fuse, but they do provide the best connection point for the oscilloscope probe.)
5. Probe the bottom leg of R15 and verify that the LF OUT SEL line is TTL high when the 1MΩ key is pressed, and TTL low when the 50Ω key is pressed.

NOTE

Once the counter is set to 50Ω, further pressing of the 50Ω key should pulse the LF OUT SEL line high momentarily.

6. Verify that the H LF 50 line (U9, pin 3) is TTL low for 1MΩ operation, and during Diagnostics 20, 21; the H LF 50 line should be TTL high for 50Ω operation.

8-615. Check the following outputs of the A2 Assembly:

1. Set the counter to the 50Ω channel, and connect a 50 MHz signal at -10 dBm to INPUT 2. Compare LF OUT A (collector of Q2) with photograph A in *Figure 8-45*. Note the dc level and check that the frequency is a factor of 10 less than the input frequency. (The MRC IC on the A3 Assembly requires a dc level of +2.65V).
2. Verify that the LF OUT A signal does not vary with input signal level as long as the input stays above the sensitivity of the 50Ω channel (25 mV rms). When the signal goes below the sensitivity, LF OUT A should be about 2V dc (i.e. the ac portion of the signal is not present).
3. Switch the counter to the 1MΩ mode and repeat steps 1 and 2. Compare the signal with photograph B in *Figure 8-45*. Note that the signal is not divided by 10 in this case. For signals with levels below the sensitivity, the output may be about 2 or 3 volts dc, but the ac portion of the signal should disappear.
4. Repeat steps 1, 2, and 3 for LF OUT B (collector of Q1). This signal should be similar to LF OUT A, but inverted.

8-616. If the above inputs and outputs are verified and the counter does not count in INPUT 2, refer to the troubleshooting procedure for the A3 Counter Assembly.

8-617. If the counter passes Diagnostic 20 and 21, but fails to count properly in normal operation, check the circuitry before the point where the test signal enters the circuit. For the 50Ω channel, connect a 50 MHz, 100 mV p-p signal to INPUT 2 of the counter and select the 50Ω channel. Connect an oscilloscope probe to the junction of CR7 and CR8. Observe that the signal goes away when switching the counter to 1MΩ. Set the counter to the 50Ω channel again and connect the scope probe to the output of U7 (lower leg of R36). Compare this waveform with photograph C in *Figure 8-45*. Note that the level of this signal is about 300 mV p-p. U7 should have a gain of 2.6 to 3.4.

8-618. Reduce the level of the signal source so the output of U7 is 100 mV. Move the probe to the output of U5 (lower leg of R27). Compare with photograph D in *Figure 8-45*. Note that U5 should also have a gain of about 3 (2.6 to 3.4).

8-619. To check the 1MΩ channel before the point where the test signal enters the circuit, press the 1MΩ key and connect the oscilloscope probe to the source of Q9 (lower leg of R48). Compare this signal with photograph E in *Figure 8-45*. Note that Q8 must be turned off by Q7 during normal operation and turned on by Q7 during diagnostic tests.

8-620. For failures on the 50Ω channel, check the output levels of U7 and U5 as described in paragraphs 8-617 and 8-618. Set the signal level at the output of U5 to 100 mV p-p and compare the output of U4, pin 2 (lower leg of R24) to photograph F in *Figure 8-45*. The U4 output should be about 300 mV p-p; U4 should have a gain of about 3 (2.6 to 3.4).

8-621. Next, check U1, pin 8 for proper output as shown in photograph G in *Figure 8-45*. Vary the input level and note that this signal is independent of input level as long as the input is above the sensitivity of INPUT 2. When the signal level becomes too low, the output of U1 should be approximately +5V.

8-622. Verify the proper operation and adjustment of the peak detector circuit by monitoring the voltage at TP1. Select the 50Ω channel of the counter and connect a 400 MHz, 17 mV signal to INPUT 2. Vary the signal level above and below 17 mV and note that the detector switches between about +4V for signals greater than 17 mV and about +2V for signals less than 17 mV.

8-623. Verify that U3C and U3D pass the output of U1 to Q1 and Q2 when the counter is in the 50Ω channel.

8-624. For failures on the 1MΩ channel, adjust a 50 MHz input signal level for a 100 mV p-p level at pin 10 of U6. Compare the output of U6, pin 7 with photograph H in *Figure 8-45*. The output should be about 400 mV p-p for a gain of about 4.

8-625. Repeat this procedure for U6A by setting the input (pin 5) to 100 mV and comparing the output (pin 2) to photograph I in *Figure 8-45*. The gain should be between 4 and 6.

8-626. Next, check the output of the Schmitt trigger, U6C, at pin 15. Observe the waveform shown in photograph J in *Figure 8-45*.

8-627. Verify that the signal is passed through U3B and U3D to Q1 and Q2 when the counter is in the 1MΩ channel.

8-628. A3 COUNTER ASSEMBLY TROUBLESHOOTING

8-629. Diagnostics that may fail if the A3 Assembly is faulty:

- Diagnostics 20 and 21
- Diagnostics 30 and 31
- Diagnostic 43
- Diagnostic 50
- Diagnostics 60 and 65
- Self Check and any of the above diagnostics during a Diag 1 test.

8-630. The following Diagnostics may provide additional information on the status of the A3 Assembly:

- Diagnostic 7: the short calibration counts are displayed for "start" and "stop". U7 (MRC) outputs two 100 ns pulses and the display shows the results after expansion by the interpolation circuitry. Typically this data should be about 120 counts each. The difference between the start and stop counts should be less than 20.

- Diagnostic 8: similar to Diagnostic 7 except 200 ns pulses are expanded and counted. Typically these are about 300 counts. It is important that the difference between long and short calibration counts are always greater than 128 and less than 256 counts. Typically this difference is 180.

- Diagnostic 9: displays the counts derived from the start and stop interpolators due to the input signal and will vary according to the phase between the input signal and the internal reference signal. The value is always between the short and long calibration counts.

NOTE

An input signal must be provided to the counter (INPUT 1 or INPUT 2) for the above diagnostics to display results other than 00.

- Diagnostic 30: The internal 10 MHz timebase reference signal is counted by U7 (MRC). If this diagnostic passes, but Diagnostic 31 fails, the A5 Synthesizer may be faulty.

- Diagnostic 31: Similar to Diagnostic 30 except that the AUX B (35 MHz) signal is counted by U7 (MRC). If this diagnostic passes, but Diagnostic 30 fails, the 10 MHz reference signal may be faulty.

- Diagnostic 32: This diagnostic fails if the difference between the two short or the two long calibration counts is greater than 20.

8-631. Points to consider when troubleshooting the A3 Counter Assembly:

- Most of the other assemblies in the counter rely on the A3 Counter Assembly to be operating properly in order for them to pass diagnostic tests. Therefore, if most of the assemblies are failing diagnostic tests, and the A4 Microprocessor Assembly, power supplies, and A5 Synthesizer are good, then the A3 circuitry may be at fault.

- A final IF amplifier stage is located on this assembly (Q1 and Q2). If the counter fails to operate properly in INPUT 1 and the A12 and A6 assemblies are found to be operating properly, this circuit could be at fault. A quick check can be made by verifying the rear panel IF OUT signal, and the signal at pin 30 of U7.

- The A5 Synthesizer Assembly must be operative in order for Diagnostic 31 to pass, but not for Diagnostic 30. Diagnostic 30 exercises the A3 Assembly with the 10 MHz reference signal, not the LO frequency.

- U7, the MRC integrated circuit, requires a 3V supply. This voltage is regulated from the +5V supply by the regulator circuit on the A3 Assembly (A3U1).

8-632. The following is a list of possible symptoms which may occur if the A3 Assembly is faulty:

- Diagnostics that count a test signal fail.

- Counter does not count or counts improperly in one or both inputs.

- The IF OUT signal does not appear at the rear panel BNC. The A12, A6, and A5 assemblies should be verified first.

8-633. Check the following power supplies at the listed node before attempting further troubleshooting:

Supply Name	Test Point	Acceptable Range
V/+5	R5 (right leg)	+4.93 to +5.07 V
V/+3	TP1	+2.97 to +3.03 V (adjustable at R4)
V/-5.2	R37 (right leg)	-5.11 to -5.29 V

8-634. Check the following inputs to the A3 Counter Assembly:

1. Input a 50 MHz signal at -20 dBm into INPUT 2 and select the 1MΩ channel. Set the counter to minimum resolution (1 MHz) and the fastest sample rate. Verify that there is activity on data bus lines 0 through 7 (DBUS 0-DBUS 7).

2. Verify that there is activity on the following control lines. The counter should be in a normal operating mode as in step 1.

   - H MRC READ, pin 40 of U7
   - MRC RG 0, pin 1 of U7
   - MRC RG 1, pin 2 of U7
   - H MRC CSEL, pin 3 of U7
   - L MRC STB, pin 8 of U7

3. Input a 1 GHz signal at -20 dBm to INPUT 1 of the counter. Set the counter to the Manual mode with a 1 GHz center frequency. Verify that an IF signal of 70 MHz is at the base of Q2 (left leg of L4), as shown in photograph A in *Figure 8-47*. The level of this signal should not vary with the input level as long as the input level is above -35 dBm.

4. Set the counter to Diagnostic 31. Verify that the 35 MHz test signal is seen at the right leg of R30. The signal will be pulsing on and off as the microprocessor goes through the diagnostic loop.

5. Input a 10 MHz signal at -20 dBm to INPUT 2 and select the 1MΩ channel. Verify that the 10 MHz signal appears at the left leg of R31, as shown in photograph B in *Figure 8-47*. This signal level should not vary with input signal level as long as the input level is greater than the INPUT 2 sensitivity specification of 25 mV rms.

6. With the 10 MHz signal still connected, verify that H GATE (right leg of R20) is pulsing synchronously with the GATE annunciator on the LCD display.

7. Verify that the 10 MHz reference signal is present at the left leg of R11.

8. Verify that both the L INTP EN (U6, pin 1) and H INTP RST (U4A, pin 2) lines have activity on them.

8-635. If any of the above signals are not present, refer to the appropriate troubleshooting procedure indicated by the signal line information given on the A3 schematic diagram (*Figure 8-48*).

8-636. If the counter operates properly for signals in INPUT 2, but not INPUT 1, and the IF OUT signal has been verified at the base of Q2, compare the signals at the rear panel IF OUT connector and the IF signal at pin 30 of U7 with photographs C and D in *Figure 8-47*.

8-637. Interpolator Troubleshooting

8-638. Set the counter for minimum resolution (1 MHz) and the fastest sample rate. Input a 10 MHz, -20 dBm signal to INPUT 2. Set the counter to Diagnostic 7 and select the 1MΩ channel. Connect an oscilloscope probe to pin 3 of U2 and another to pin 2 of U4. Use the signal from pin 2 of U4 to externally trigger the oscilloscope. Using the normal trigger mode of the oscilloscope, compare the signal at pin 3 of U2 with photograph E in *Figure 8-47*. Note that the magnitude of the measurement pulse is between that of the short calibration pulses and the long calibration pulses. If these signals are not present, or deviate from the waveform in photograph E, and U7 has been verified, replace the transistor array IC, U5, in the pulse stretcher circuit.

8-639. Using the same setup as the last procedure, check for negative going pulses at pin 8 of U3. These pulses should be counted by U4, so next check for activity at the outputs of the U4 counter and then at the output of the latch, U6.

8-640. A4 MICROPROCESSOR ASSEMBLY TROUBLESHOOTING

8-641. Diagnostics that may indicate an A4 Assembly failure:

- Diagnostic 41: RAM test
- Diagnostic 42: ROM test
- Diagnostic 43: Repeated Reset sequence
- Diagnostic 44: Signature Analysis

8-642. Points to consider when troubleshooting the A4 Assembly:

- Diagnostic 40 (Firmware revision code) should be used to confirm that the correct firmware is installed in the counter (the code for the B model counters should be 2631 or higher).
- Signature analysis is the primary technique for troubleshooting this assembly.
- The microprocessor itself (A4U2) must be functioning correctly for the instrument to begin its power-up cycle. A possible cause for failure to power on properly could be the L μP RST (Reset) and L μP NMI (Non-Maskable Interrupt) signals generated in the Power Supply Control circuit on the A1 Assembly. Refer to the A8/A1 Power Supply Troubleshooting procedures for a description of these signals.

8-643. Possible symptoms of a faulty A4 Microprocessor Assembly:

- Instrument fails to initiate its power-up sequence properly.
- LCD display is blank or displays nonsense characters.
- Instrument fails to retain previous measurement configuration when switched to STBY and back to ON.
- Instrument fails to make measurements at both inputs, even though the power supplies and A3 Counter Assembly have been verified.

8-644. Verify the following power supplies:

Supply Name	Test Point	Acceptable Range
+5V	C28(+)	+4.8 to +5.2 V
+Vcc	-Vcc test pin	+4.8 to +5.2 V
+5V μP	Pin 21 of U2 (measured when counter is in Standby mode)	+4.8 to +5.2 V
+5V MEM	C23(+)	+4.8 to +5.2 V

8-645. If the instrument fails to power on properly, verify the following signals:

1. The L μP RST signal at A4U2, pin 6 (Test Point RST) should be TTL high (less than 200 ms after power is switched on).
2. The L μP NMI signal at A4U2, pin 4 should be TTL high.
3. The $\overline{\text{IRQ1}}$ signal at A4U2, pin 5 (Test Point IRQ) should be a dc level (i.e. no activity). It may be either TTL high or low, but should be at a constant level. When checking this signal, disconnect the controller if one is being used, and do not press any front panel keys (either of these will cause activity at this node).
4. The clock signal at A4U2, pin 40 (Test Point CLK) should be a 2 MHz squarewave at TTL levels.

8-646. If the above signals are incorrect, trace back through the circuitry to determine the cause. These signals must be correct before attempting signature analysis troubleshooting.

8-647. Signature Analysis

8-648. The HP5350B/51B/52B has two modes of signature analysis incorporated into the A4 Assembly. The first mode is focused on determining whether or not the microprocessor is faulty, but also includes U14 and U17 (ROM), U12, and U10 (in the XU8 test socket). To enter this mode, U10 is removed from its normal operating mode socket and placed in the empty test socket labeled "XU8".

8-649. The second mode exercises the remaining nodes of the circuitry on the A4 Assembly to isolate supporting components of the processor. This mode can be entered by grounding TP1 on the A4 Assembly on power-up or by calling Diagnostic 44 from the front panel. While somewhat more convenient, the front panel Diagnostic 44 sequence may not be feasible if the faulty component is in the A4-A7 interface. Grounding TP1 alleviates this problem.

8-650. The routine for the first signature analysis mode has four different setups to adequately test the microprocessor kernel: Mode 1 (Setups 1, 2, 3, and 4). The routine for the second mode consists solely of Mode 2. The following paragraphs describe each signature analysis setup and procedure.

8-651. Note that the expected signatures for the 5350B and 5351B are shown in *Figures 8-29A, 8-30A, 8-31A, 8-32A,* and *8-33A*, while the expected signatures for the 5352B are shown in *Figures 8-29B, 8-30B, 8-31B, 8-32B,* and *8-33B*.

8-652. ROM Version Number (Diagnostic 40)

8-653. The following signature analysis procedures are for instruments with ROM firmware Version 2650. Before performing the signature analysis procedures, determine the ROM firmware version in your instrument by performing Diagnostic 40:

a. Press SET/ENTER, DIAGNOSTICS, 4, 0, SET/ENTER.

b. Observe the ROM version number displayed by the counter and perform the appropriate procedure:

If the ROM Firmware Version is:	Perform the Procedures
2650	In this section
Below 2650	Refer to Backdating in Section VII.

8-654. Mode 1, Setup 1

8-655. To perform signature analysis for Mode 1, Setup 1, proceed as follows:

CAUTION

Before performing the following steps, be sure that you are wearing a properly grounded anti-static strap.

1. Remove power from the rear panel of the instrument.
2. Remove the A4 Microprocessor Assembly.
3. Remove U10 from its socket and place it in the test socket, XU8.
4. Place the A4 Assembly on extender boards (HP P/N 5060-0175).
5. Attach the test pod leads of the signature analyzer as follows:

   START/ST/SP (green): J1, pin 7 (Test Point "A15")
   STOP/QUAL (red): J1, pin 1 (Test Point "Vcc")
   CLOCK (yellow): A4U2, pin 39 or A4U12, pin 11
   GND (black): J1, pin 2 (Test Point " ⏚ ")

6. The signature analyzer should be configured as follows:

   FUNCTION: Signature QUAL
   THRESHOLD: TTL
   POLARITY —
   CLOCK: falling edge
   START: rising edge
   STOP: rising edge
   QUAL: high level

7. Power on the counter and verify the signatures shown in *Figure 8-29A* for the 5350B/5351B, or *Figure 8-29B* for the 5352B.

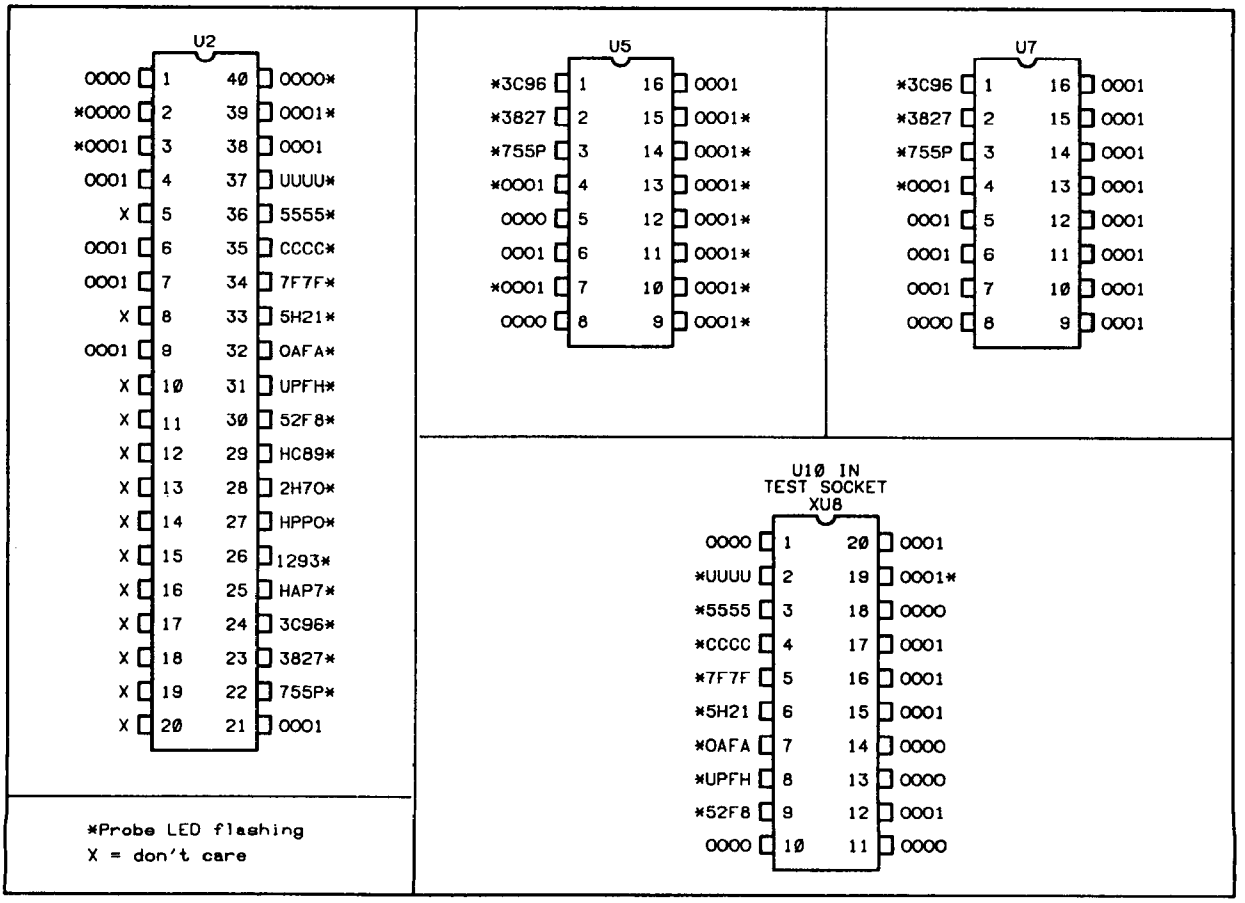


Figure 8-29A. 5350B/5351B A4 Signatures for Mode 1, Setup 1

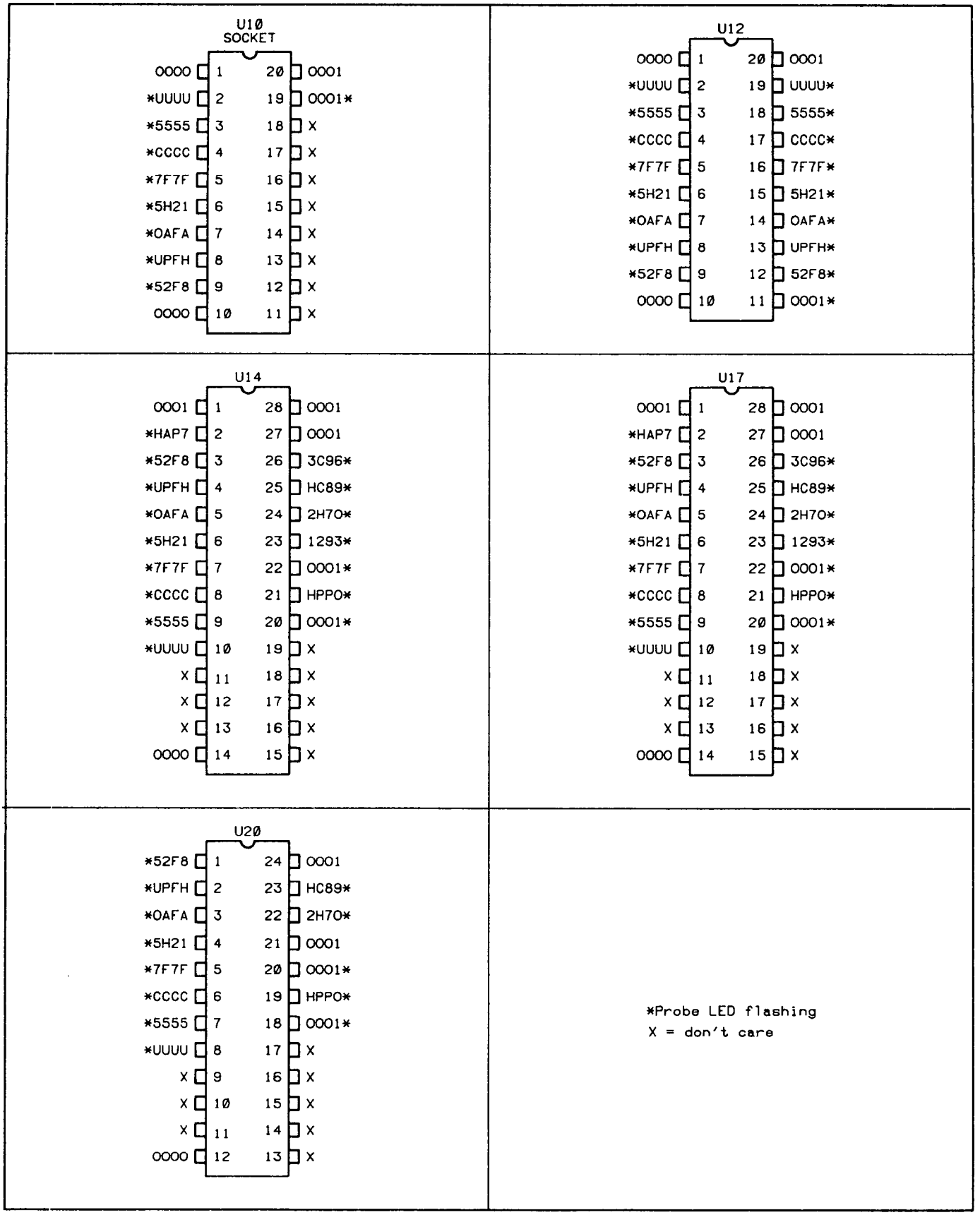


Figure 8-29A. 5350B/5351B A4 Signatures for Mode 1, Setup 1 (Continued)

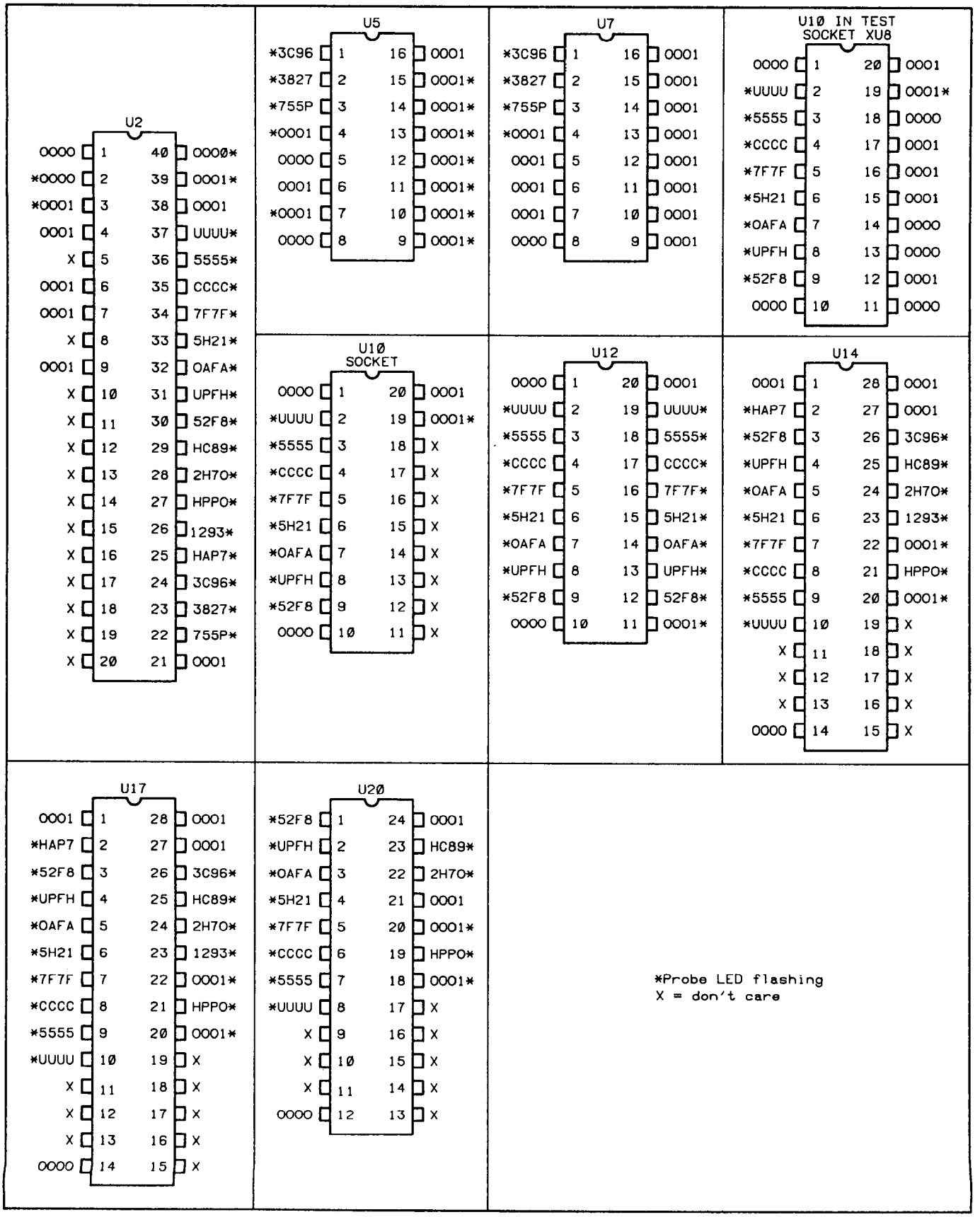


Figure 8-29B. 5352B A4 Signatures for Mode 1, Setup 1

8-656. Mode 1, Setup 2

8-657. To perform signature analysis for Mode 1, Setup 2, proceed as follows:

1. Attach the test pod leads of the signature analyzer as follows:

   START/ST/SP (green): J1, pin 7 (Test Point "A15")
   STOP/QUAL (red): J1, pin 1 (Test Point "Vcc")
   CLOCK (yellow): J1, pin 8 (Test Point "CLK")
   GND (black): J1, pin 2 (Test Point " ⏚ ")

2. The signature analyzer should be configured as follows:

   FUNCTION: Signature QUAL
   THRESHOLD: TTL
   POLARITY —
   CLOCK: falling edge
   START: rising edge
   STOP: rising edge
   QUAL: high level

3. Power on the counter and verify the signatures shown in *Figure 8-30A* for the 5350B/5351B, or *Figure 8-30B* for the 5352B.

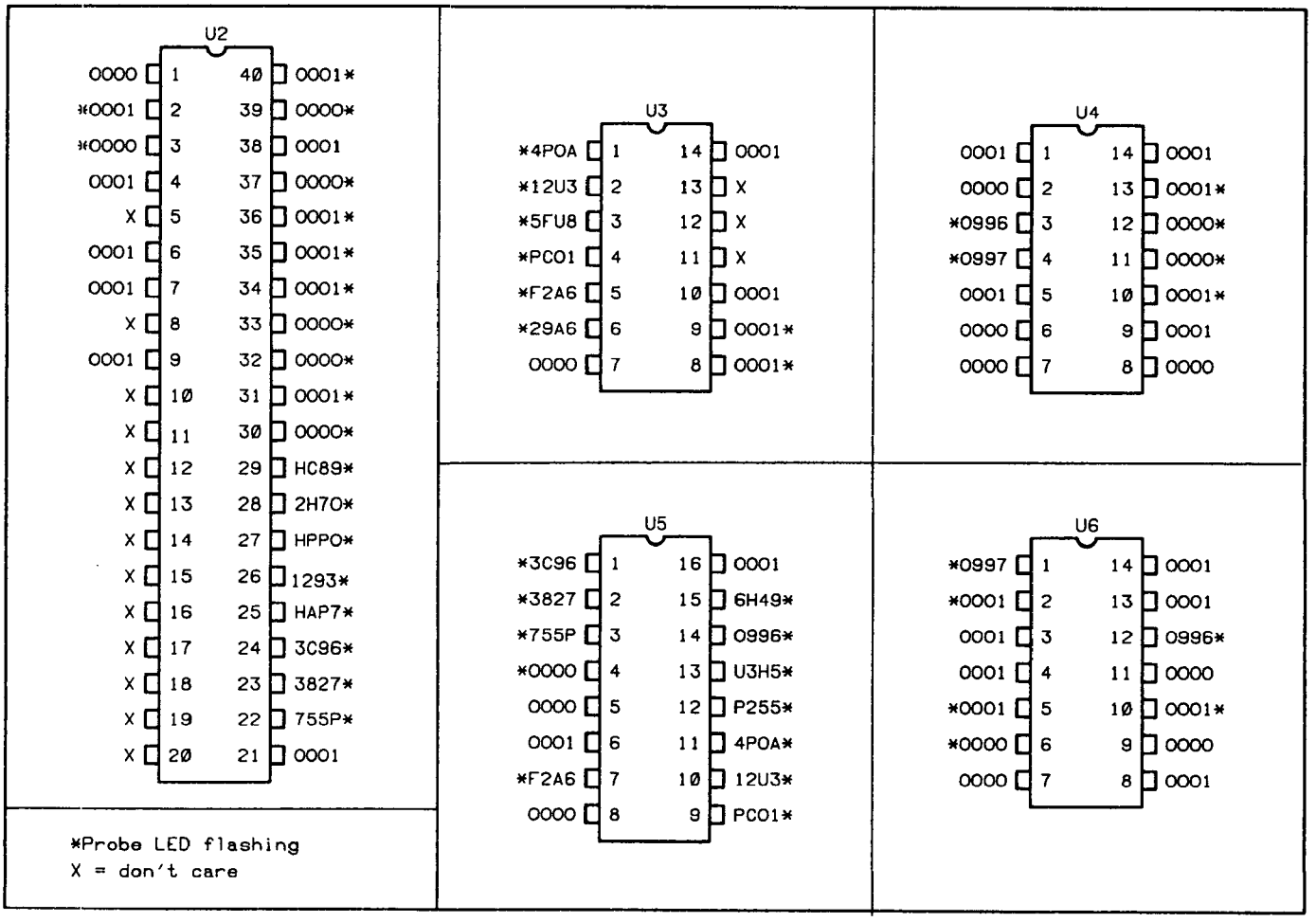


Figure 8-30A. 5350B/5351B A4 Signatures for Mode 1, Setup 2

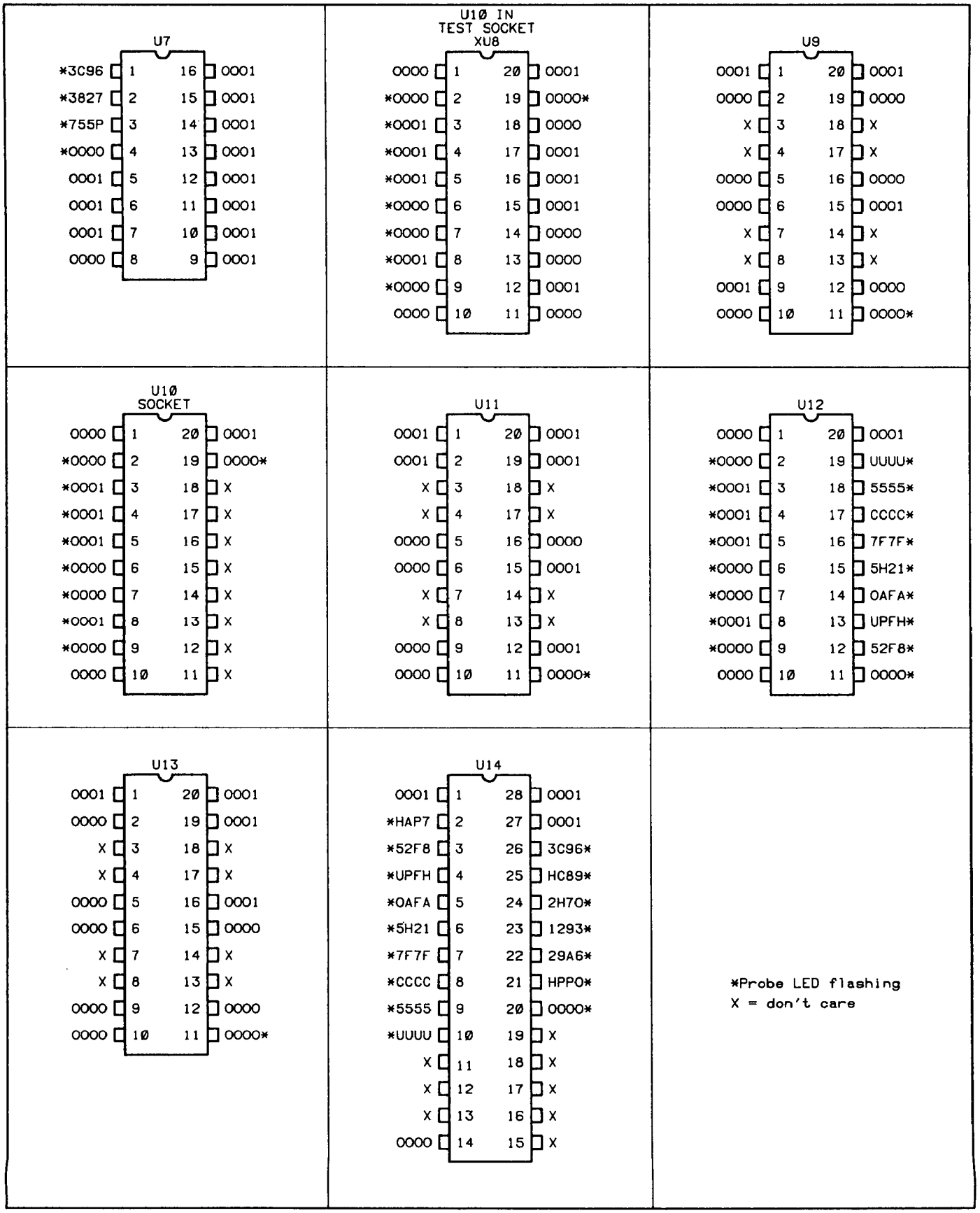


Figure 8-30A. 5350B/5351B A4 Signatures for Mode 1, Setup 2 (Continued)

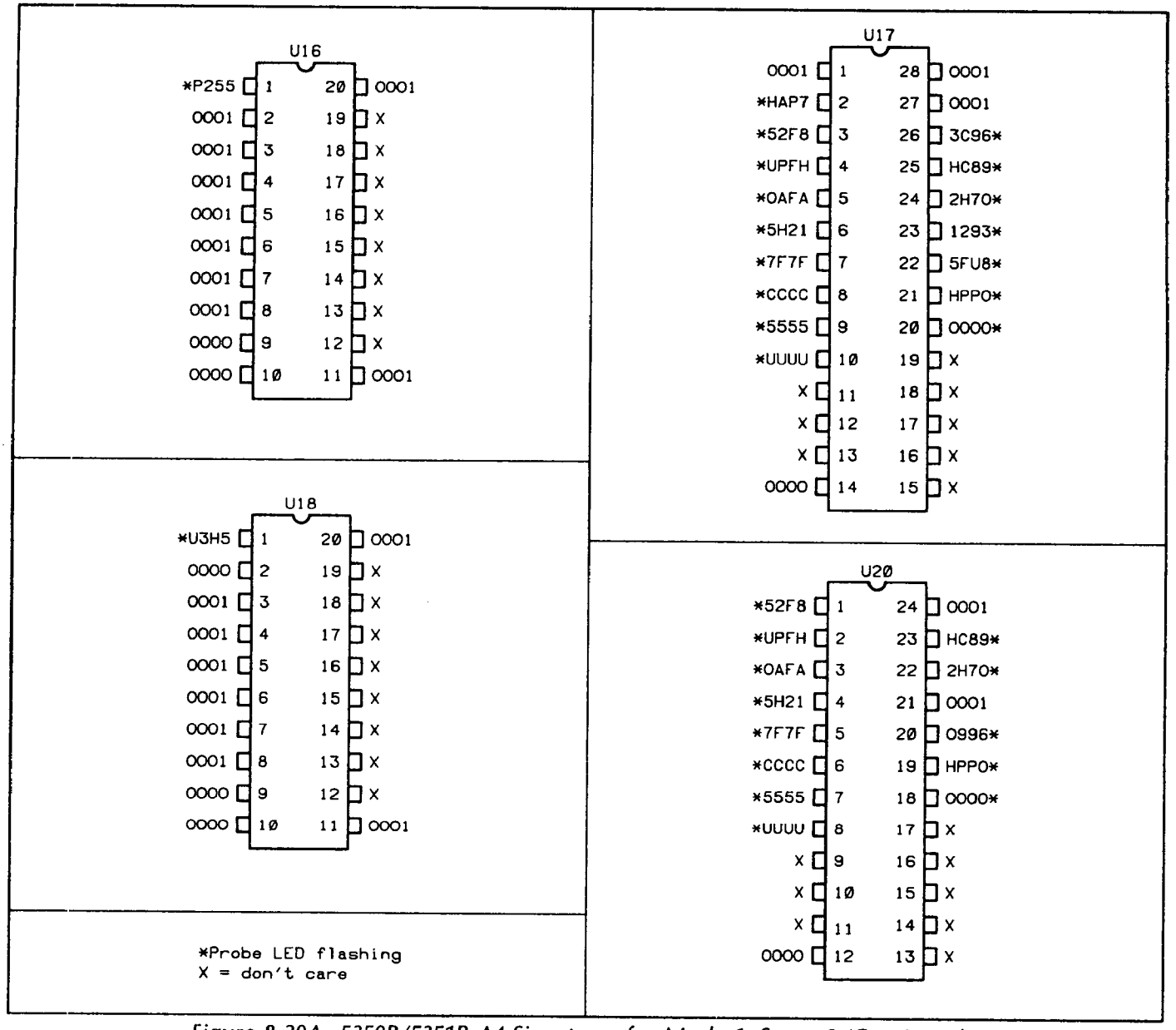


Figure 8-30A. 5350B/5351B A4 Signatures for Mode 1, Setup 2 (Continued)

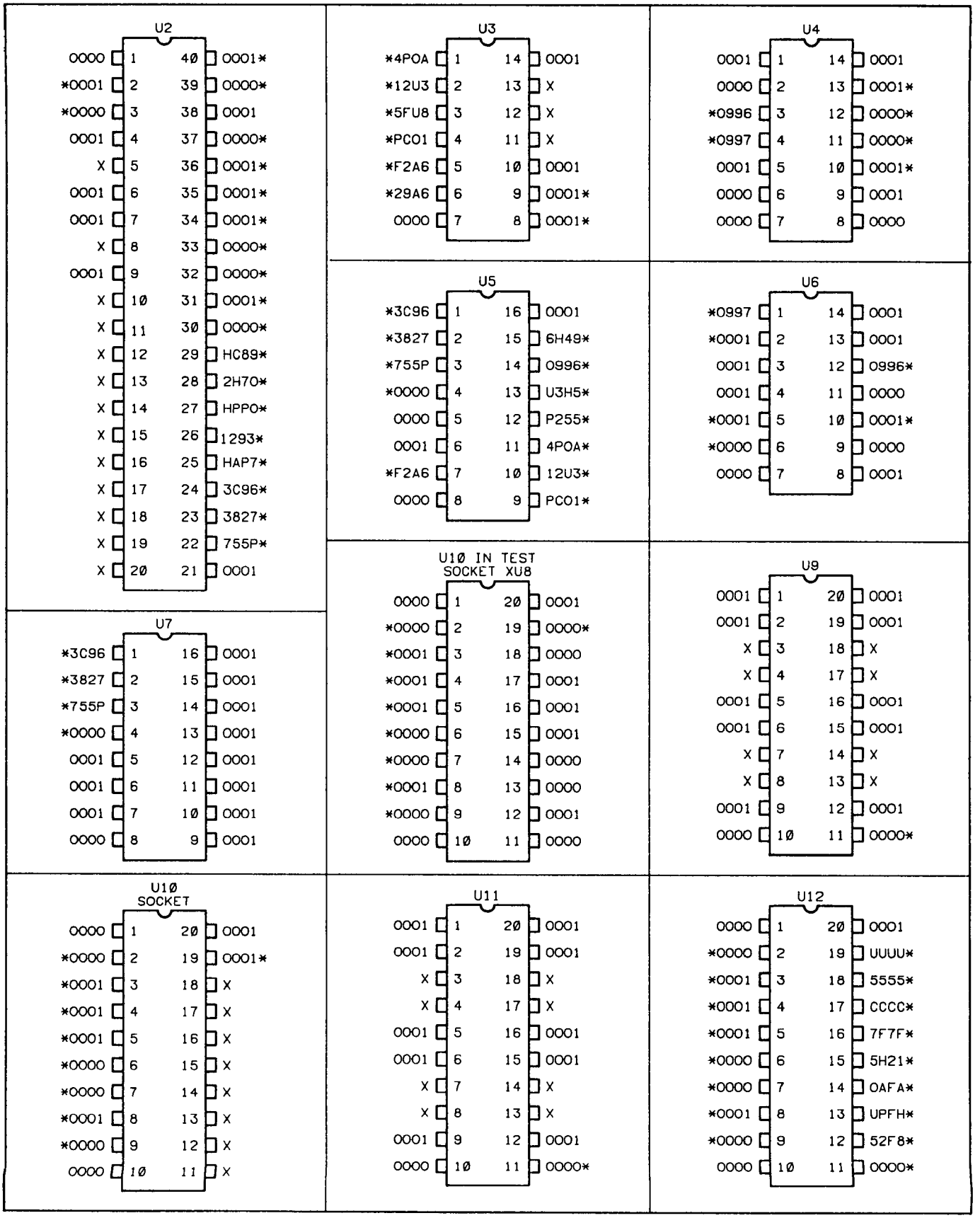


Figure 8-30B. 5352B A4 Signatures for Mode 1, Setup 2

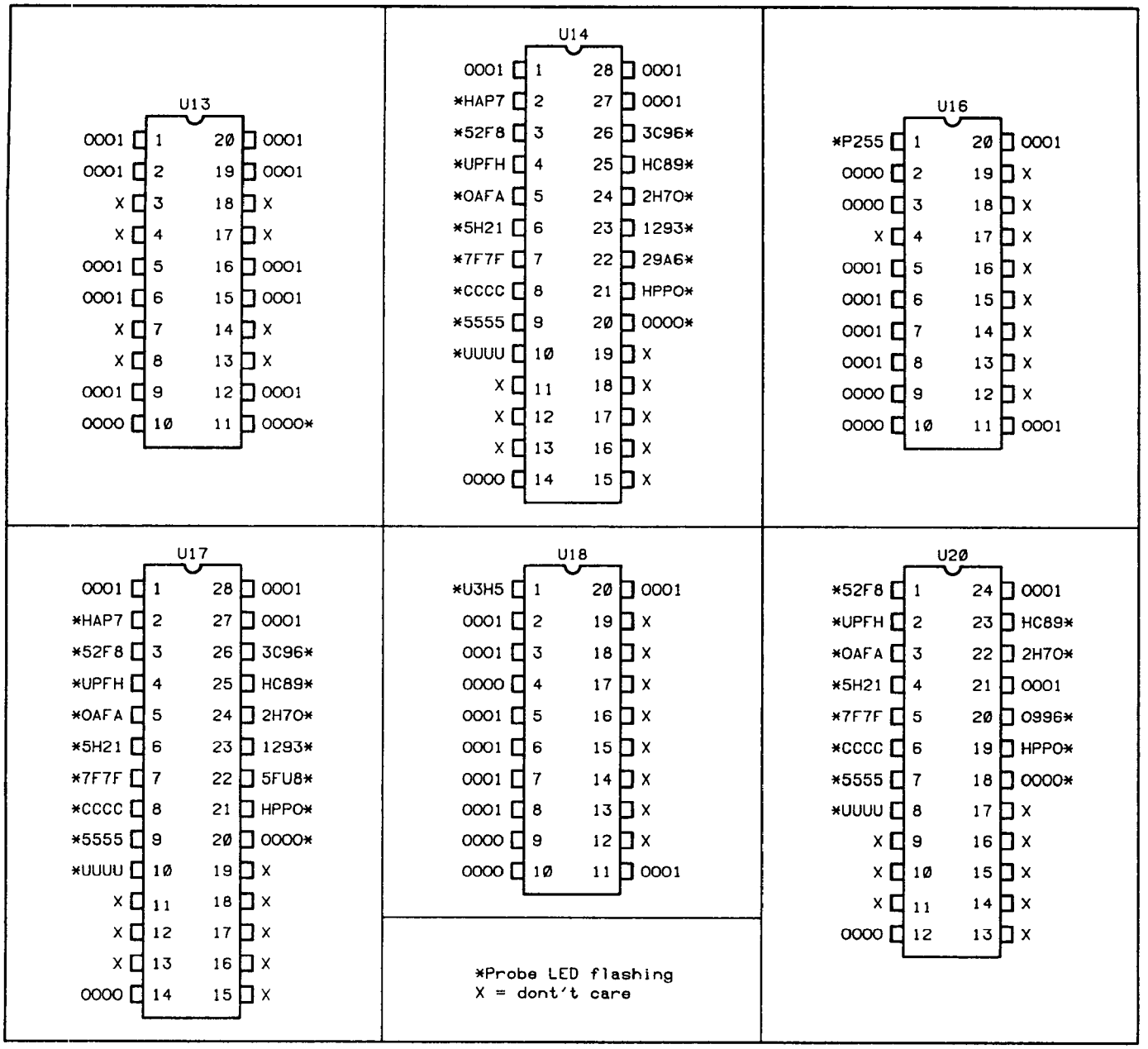


Figure 8-30B. 5352B A4 Signatures for Mode 1, Setup 2 (Continued)

8-658. Mode 1, Setup 3

8-659. To perform signature analysis for Mode 1, Setup 3, proceed as follows:

1. Attach the test pod leads of the signature analyzer as follows:

   START/ST/SP (green): J1, pin 7 (Test Point "A15")
   STOP/QUAL (red): A4U14, pin 22
   CLOCK (yellow): J1, pin 8 (Test Point "CLK")
   GND (black): J1, pin 2 (Test Point " ▽ ")

2. The signature analyzer should be configured as follows:

   FUNCTION: Signature QUAL
   THRESHOLD: TTL
   POLARITY —
   CLOCK: falling edge
   START: rising edge
   STOP: rising edge
   QUAL: low level

3. Power on the counter and verify the signatures shown in *Figure 8-31A* for the 5350B/5351B, or *Figure 8-31B* for the 5352B.

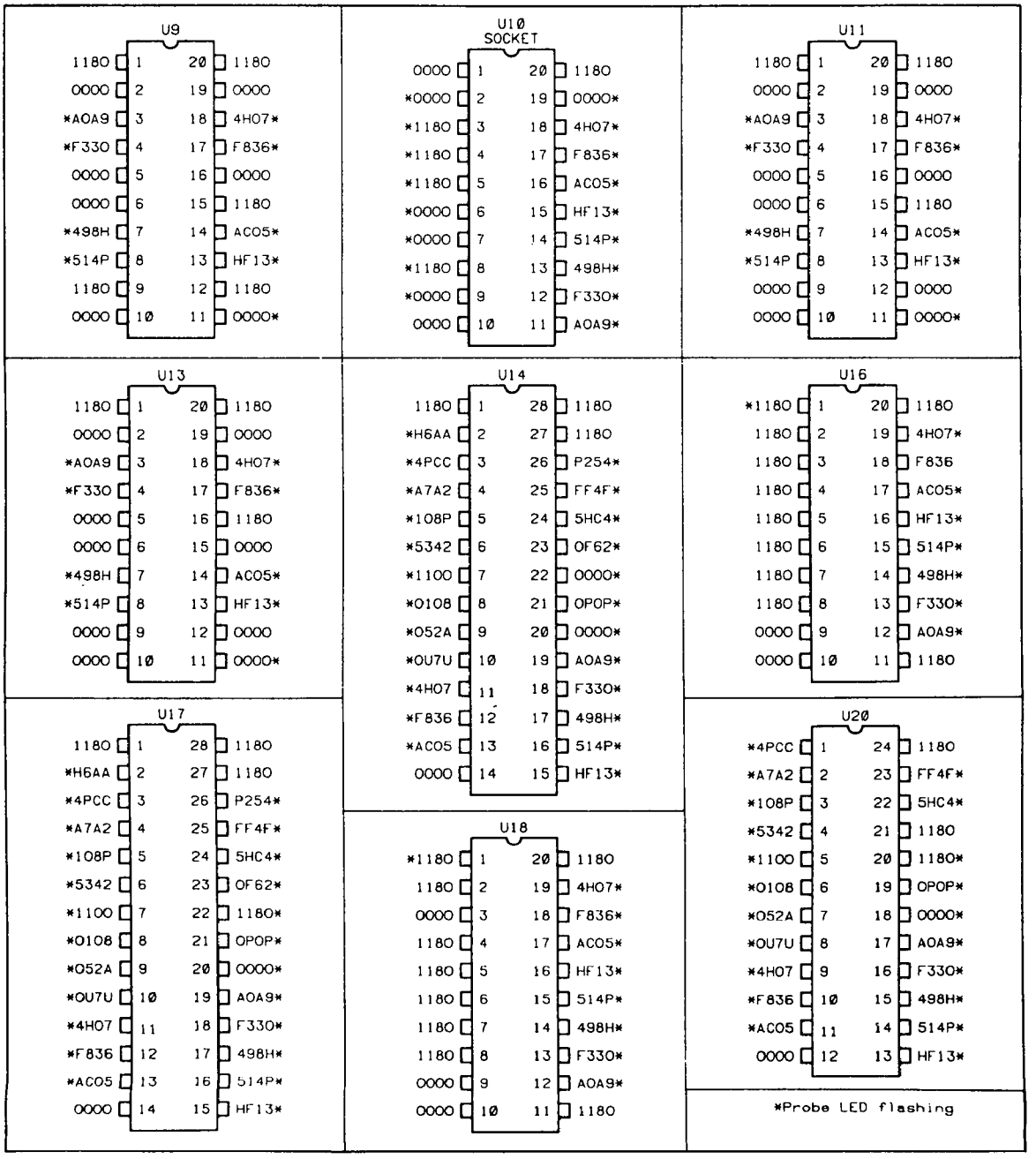


Figure 8-31A. 5350B/5351B A4 Signatures for Mode 1, Setup 3

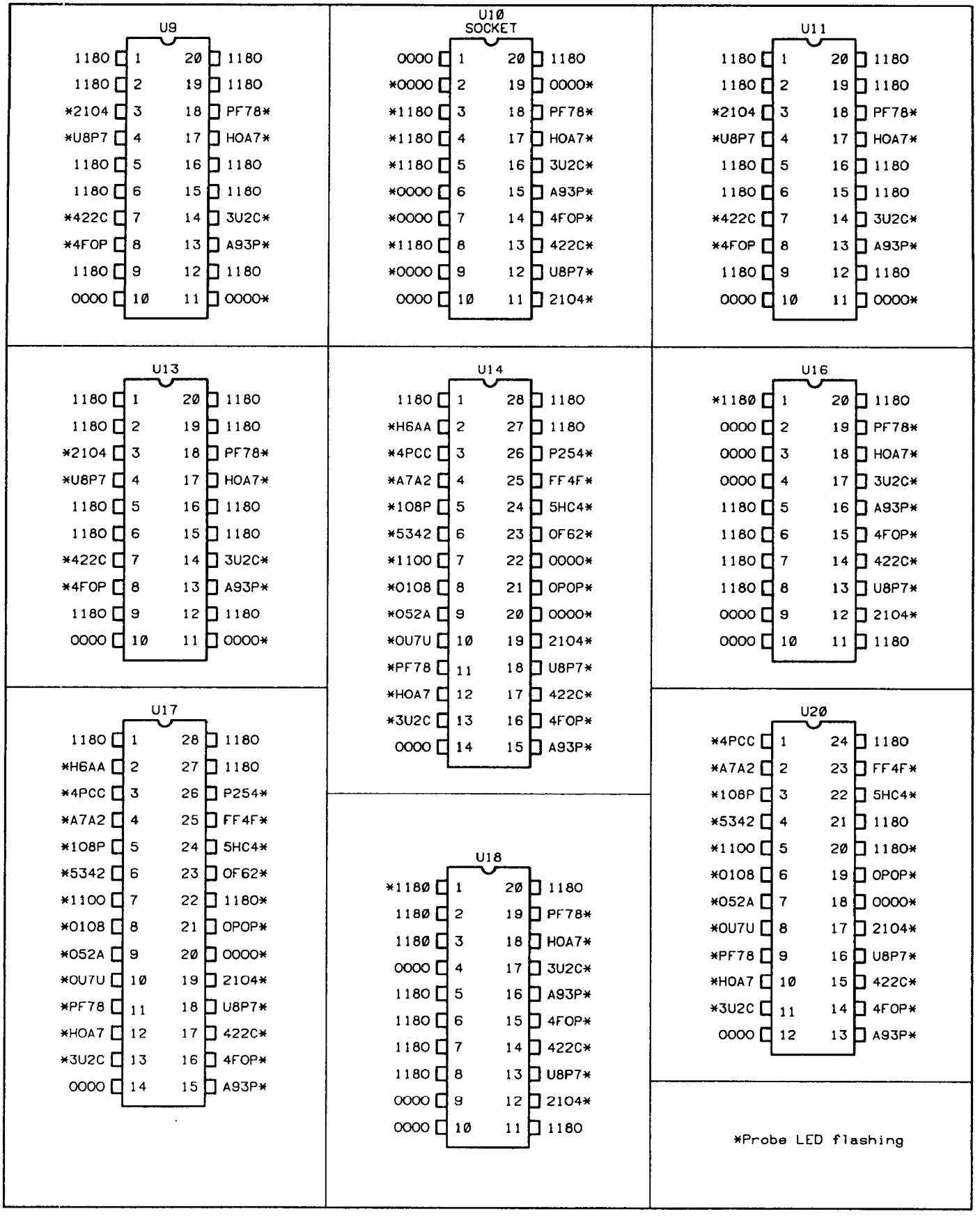


Figure 8-31B. 5352B A4 Signatures for Mode 1, Setup 3

8-660. Mode 1, Setup 4

8-661. To perform signature analysis for Mode 1, Setup 4, proceed as follows:

1. Attach the test pod leads of the signature analyzer as follows:

   START/ST/SP (green): J1, pin 7 (Test Point "A15")
   STOP/QUAL (red): A4U17, pin 22
   CLOCK (yellow): J1, pin 8 (Test Point "CLK")
   GND (black): J1, pin 2 (Test Point " ▽ ")

2. The signature analyzer should be configured as follows:

   FUNCTION: Signature QUAL
   THRESHOLD: TTL
   POLARITY —
   CLOCK: falling edge
   START: rising edge
   STOP: rising edge
   QUAL: low level

3. Power on the counter and verify the signatures shown in *Figure 8-32A* for the 5350B/5351B, or *Figure 8-32B* for the 5352B.

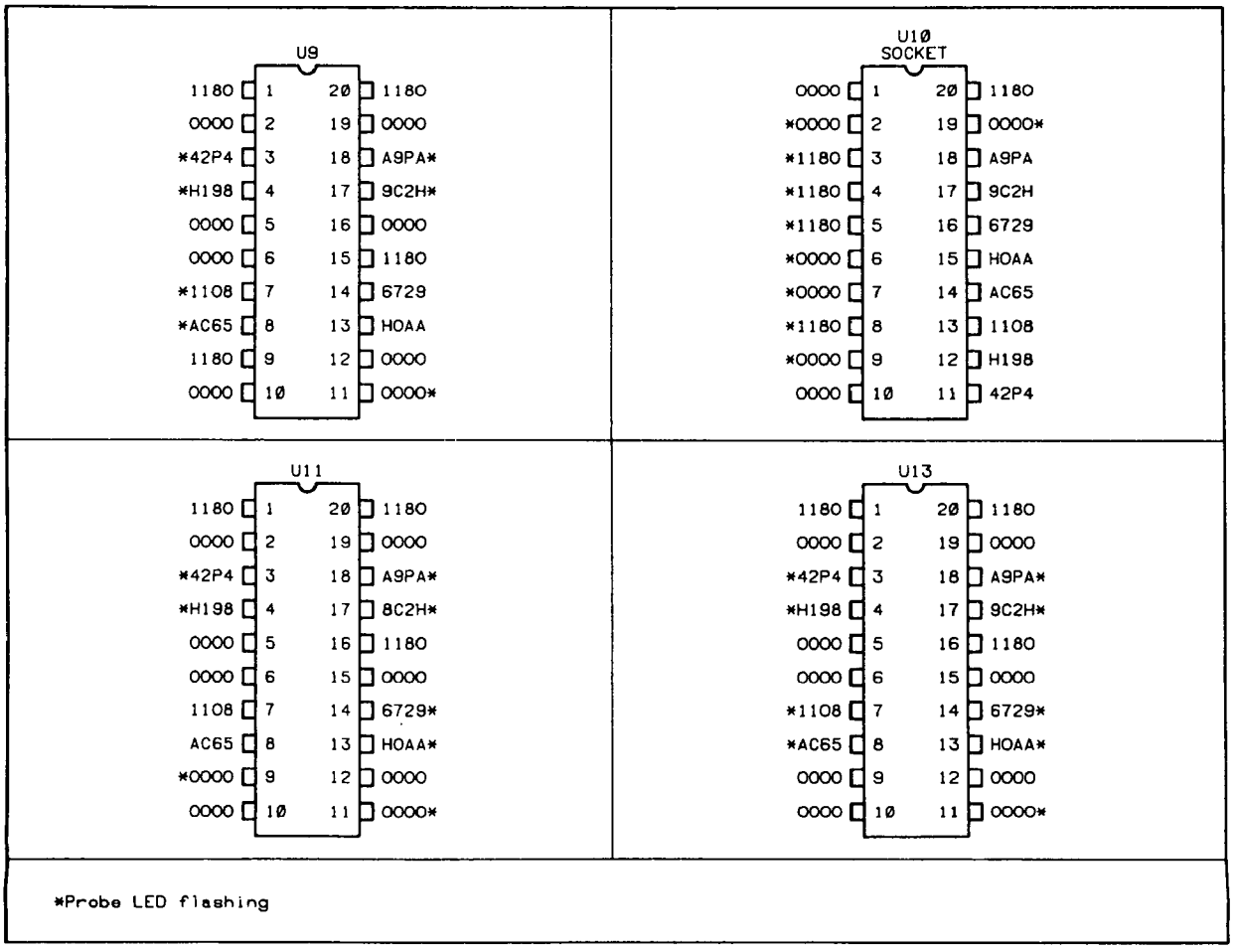


Figure 8-32A. 5350B/5351B A4 Signatures for Mode 1, Setup 4

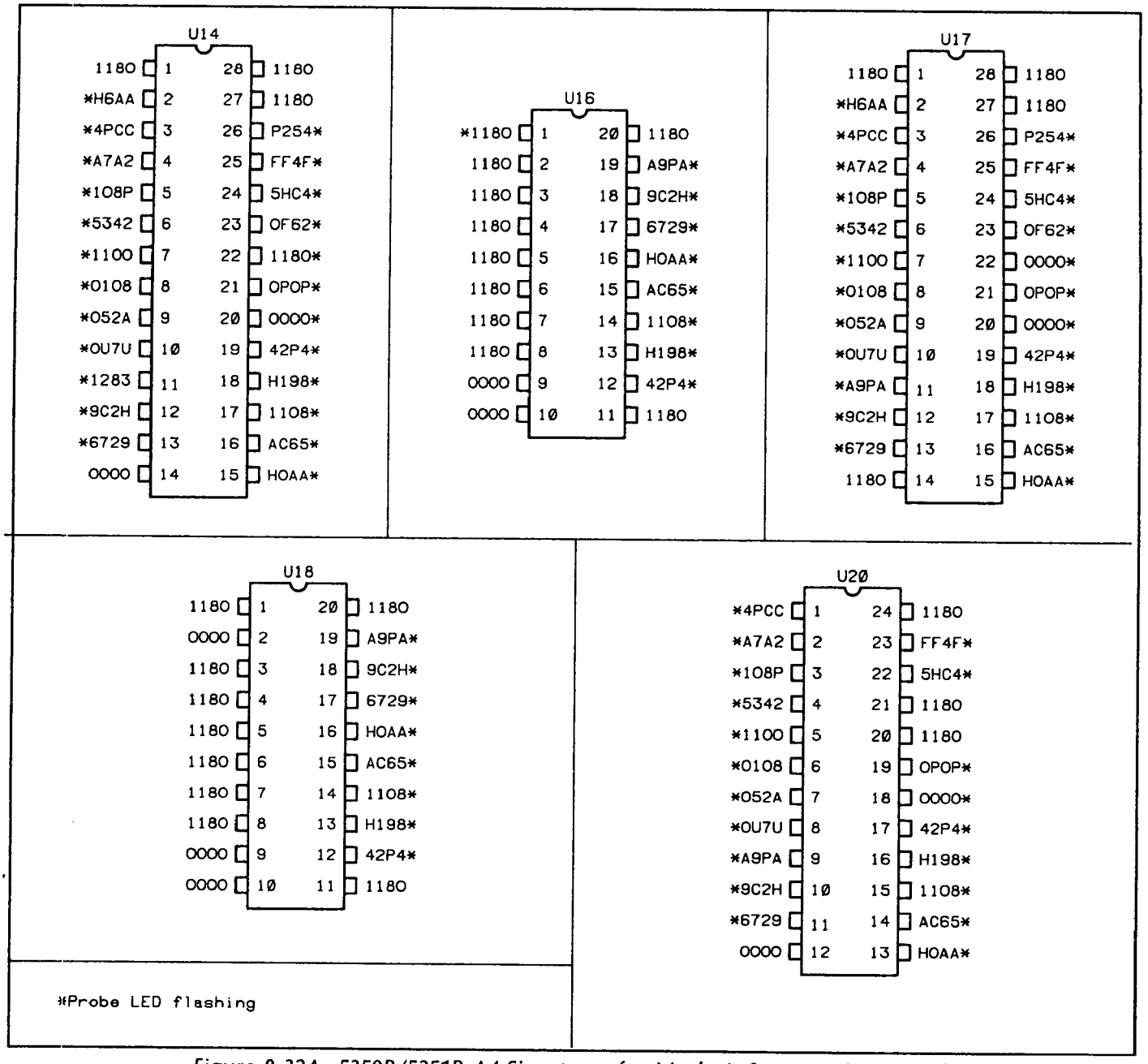


Figure 8-32A. 5350B/5351B A4 Signatures for Mode 1, Setup 4 (Continued)

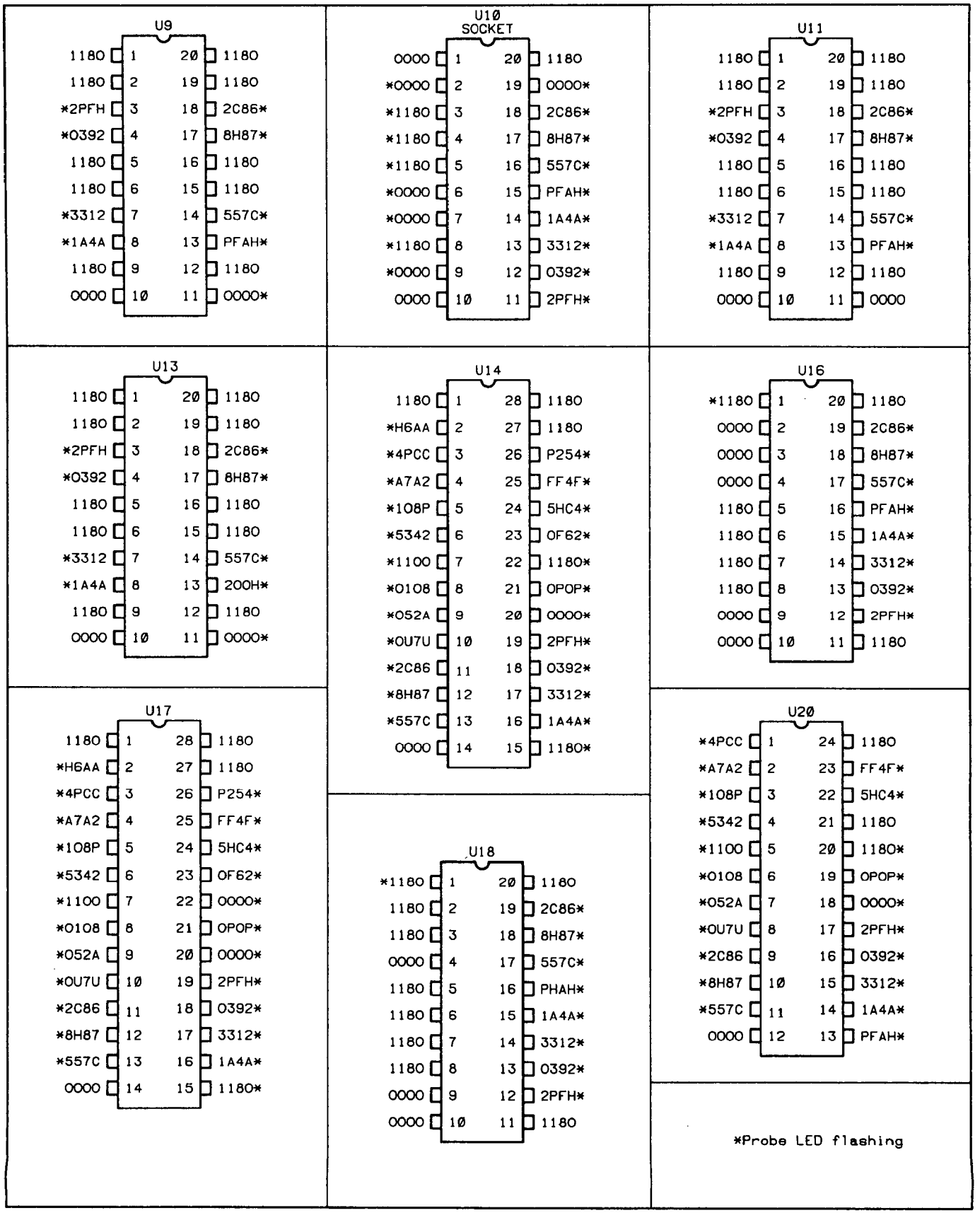


Figure 8-32B. 5352B A4 Signatures for Mode 1, Setup 4

8-662. Mode 2

8-663. If the mode 1 signature analysis routines fail to isolate the faulty component, verify the signatures in mode 2, as follows:

CAUTION

Before performing the following steps, be sure that you are wearing a properly grounded antistatic strap.

1. Remove ac power from the rear panel of the counter and move U10 to its normal operating socket (XU10).

2. Replace the A4 Assembly on the extender boards.

3. Attach the test pod leads of the signature analyzer as follows:

   START/ST/SP (green): J1, pin 5 (Test Point "TP2")
   STOP/QUAL (red): J1, pin 1 (Test Point "Vcc")
   CLOCK (yellow): J1, pin 8 (Test Point "CLK")
   GND (black): J1, pin 2 (Test Point " ▽ ")

4. The signature analyzer should be configured as follows:

   FUNCTION: Signature QUAL
   THRESHOLD: TTL
   POLARITY —
   CLOCK: falling edge
   START: falling edge
   STOP: rising edge
   QUAL: high level

5. Disconnect the A11 HP-IB Interface Assembly cable (A11J2W1) from motherboard connector A8J6.

6. The routine may be initiated in one of two ways:

   a. Front Panel: Power on the counter, press RESET/LOCAL, then enter Diagnostic 44 by pressing SET/ENTER, DIAGNOSTICS, 4, 4, SET/ENTER.

   b. Hardwired Diagnostic: With the counter powered off or set to Standby, connect a jumper between TP1 at the top of the A4 Assembly and ground. When the counter is powered on, it will be in the signature analysis routine. To exit this routine, switch the counter to Standby and remove the jumper between TP1 and ground.

7. Verify the signatures shown in *Figure 8-33A* for the 5350B/5351B or *Figure 8-33B* for the 5352B.

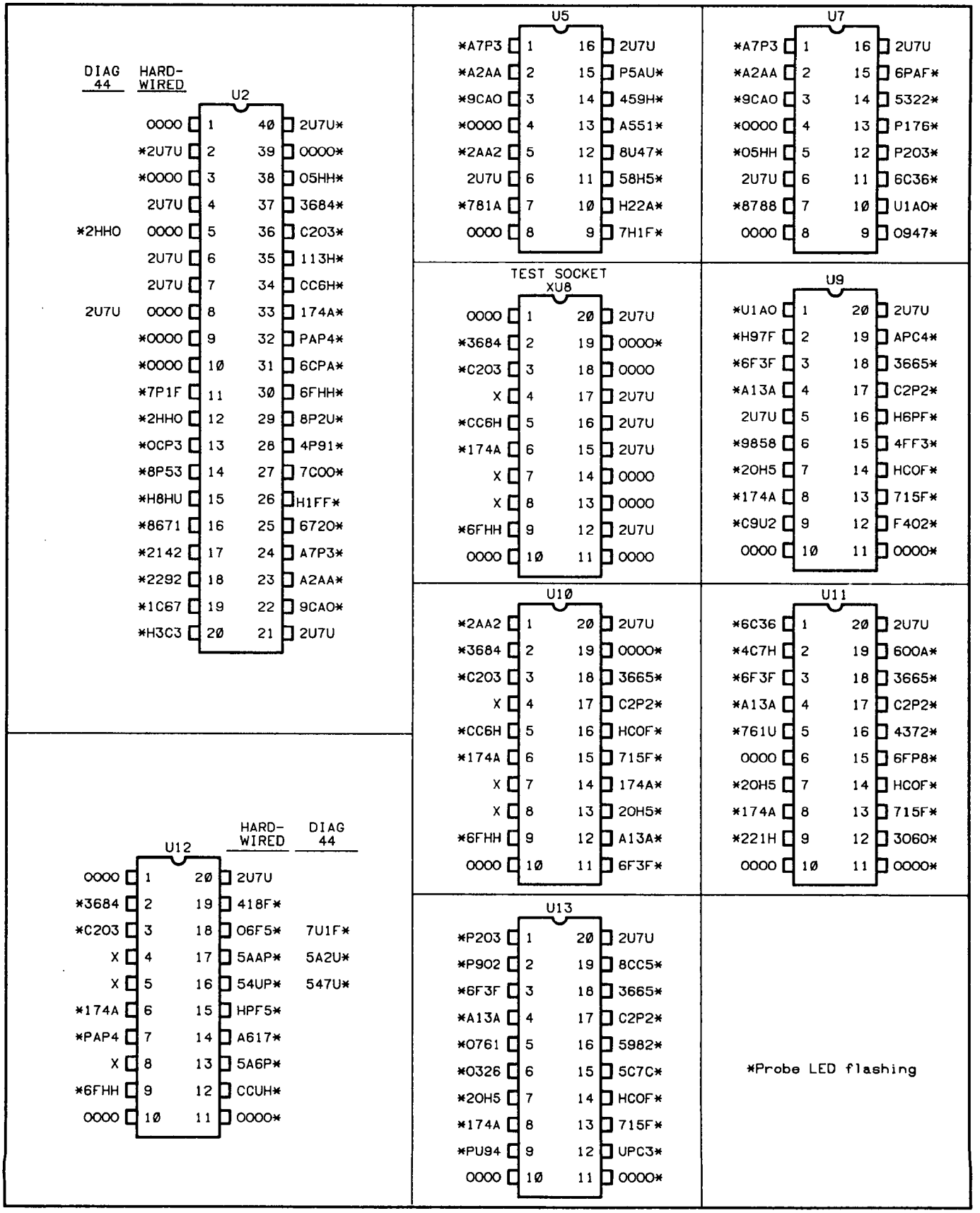


Figure 8-33A. 5350B/5351B A4 Signatures for Mode 2

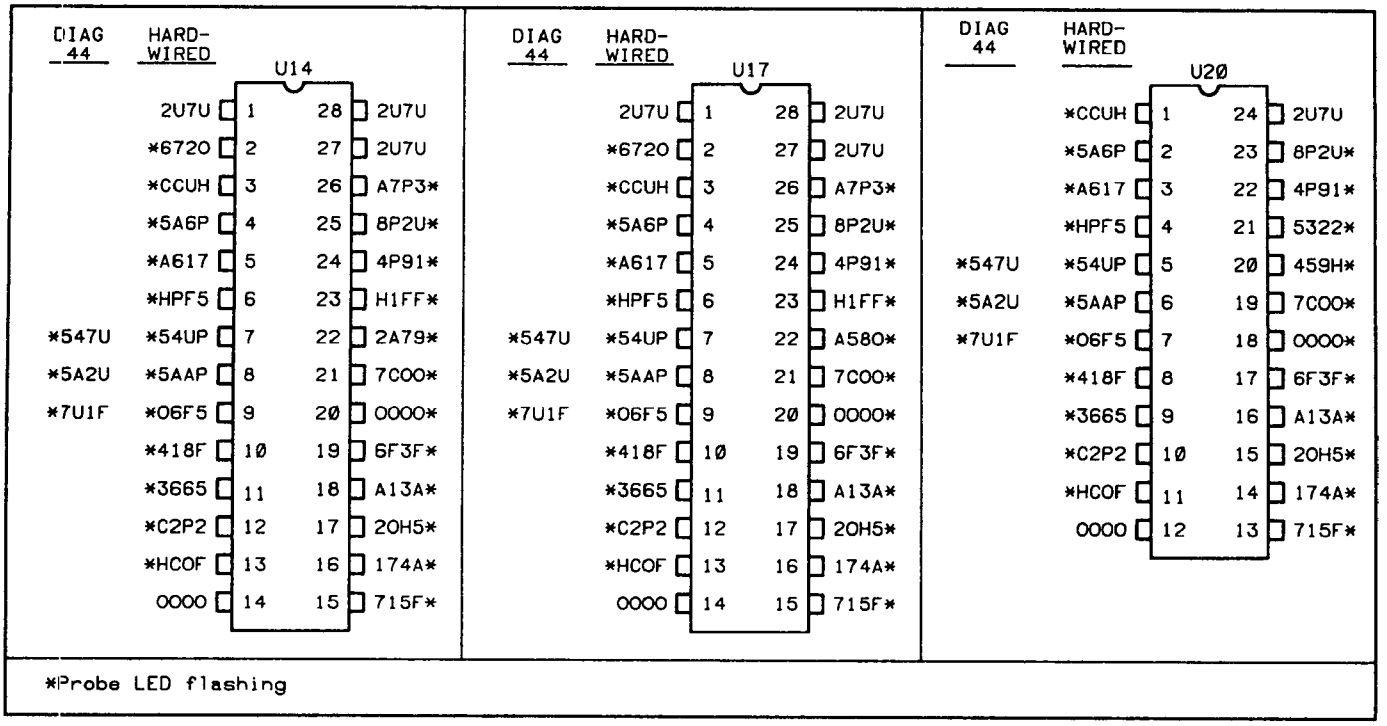


Figure 8-33A. 5350B/5351B A4 Signatures for Mode 2 (Continued)

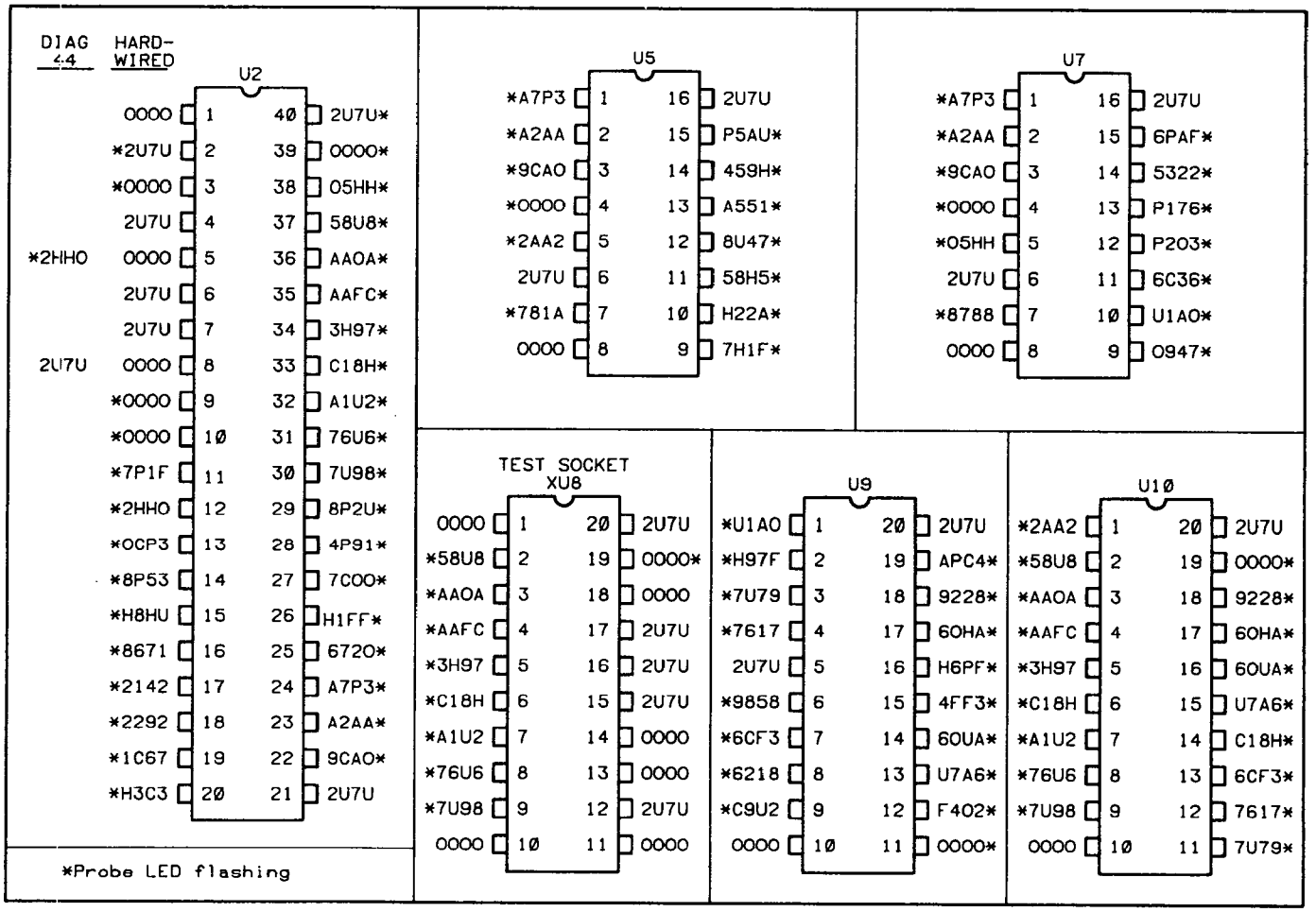


Figure 8-33B. 5352B A4 Signatures for Mode 2

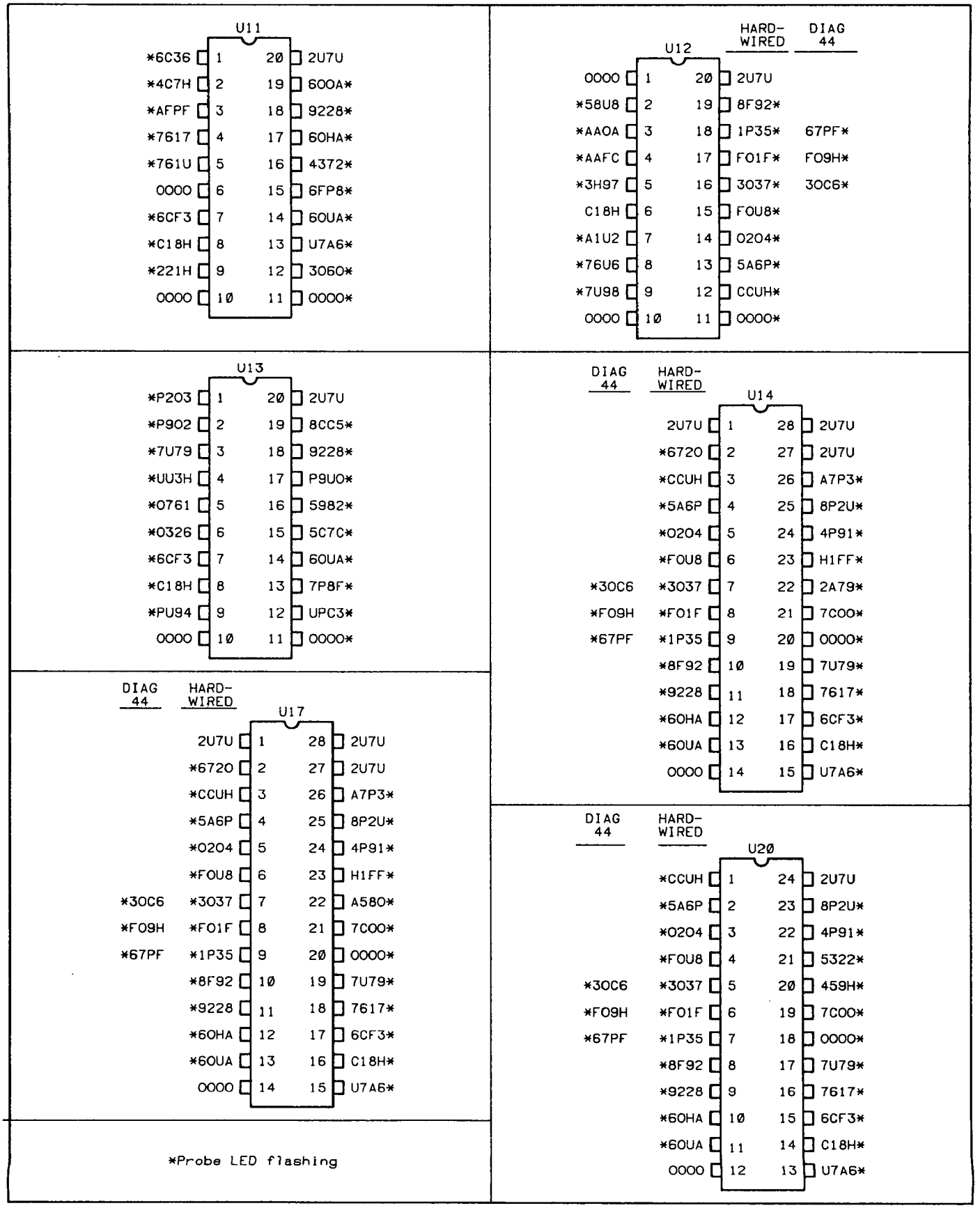


Figure 8-33B. 5352B A4 Signatures for Mode 2 (Continued)

8-664. A5 SYNTHESIZER ASSEMBLY TROUBLESHOOTING

8-665. Diagnostics that may fail or give further information if the A5 Synthesizer Assembly is faulty:

- Diagnostics 50 and 51 (see paragraph 8-479 for an explanation of the PASS/FAIL indication of Diagnostic 51)
- Diagnostics 52 and 53 will not display PASS or FAIL information, but may give further insight to the failure.
- Diagnostics 2, 4, 5, and 6 will give measurement parameter information (LO frequency, harmonic number, and IF)

8-666. Some points to consider when troubleshooting the A5 Assembly are:

- If the counter fails to operate properly for inputs to INPUT 1, it is important to use the above diagnostics to determine what data the counter is using to determine the input frequency. Verify that the A5 Assembly has detected an IF by using Diagnostic 2. Next, verify what LO frequency and what harmonic of the LO has been used. Use these values in the fundamental tuning equation:

  $$f = N \bullet LO \pm IF$$

  If Diagnostics 5 and 6 indicate the input frequency is on the lower sideband (LSB), the IF must be subtracted from N•LO. If the upper sideband is indicated (USB), the IF must be added to N•LO.

- Note the fractional portion of the harmonic number displayed by Diagnostic 6. If this fractional portion deviates more than .30 from an integer value (e.g. 3.30 to 3.70), the counter will not display a measurement. For fractional portions less than .30 from an integer value, the nearest integer value is used in the tuning equation. A large fractional portion of the harmonic number indicates that the counting circuitry is counting a signal with a relatively wide variation in frequency. This may be due to the input signal at the front panel (e.g. frequency modulation) or faults internal to the counter (e.g. the LO frequency is fluctuating).

- The red LED at the top of the A5 Assembly when lit, indicates that the synthesizer circuitry is NOT phaselocked.

- Diagnostic 51 allows the synthesizer to be set to a particular frequency from the front panel. However, to actually use a particular LO frequency to make measurements at INPUT 1, the Manual mode can be used. The center frequency (and also the input frequency) to be used for a desired LO can be calculated from the following equation:

  $$CF = (LO_{des} \bullet 2) + 70\ MHz$$

  where:

  CF = Manual mode center frequency
  LO_{des} = desired LO frequency
  70 MHz is the IF generated by this configuration

- The output of the synthesizer should be +15 dBm ±3 dB. Use sufficient attenuation when making spectrum analyzer measurements.

- While the spectrum analyzer should be used when making measurements above the oscilloscope bandwidth (275 MHz), the oscilloscope may be used to indicate the presence of a relatively high frequency signal, but not the amplitude.

- A test connector at the top of the A5 board allows access to important dc/low-frequency nodes without requiring removal of the RF shielding cover. The pin arrangement, as viewed from the top (pins 1-7 are toward the front of the instrument), is shown below:

GND	GND	PLL IN	PWR ADJ	GND	L LO OFF	GND
(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
GND	PLL OUT	L UNLOCKED	GND	-20 OUT	GND	GND

- A handy way to verify the A5 Synthesizer frequency is to connect the A5 output to the front panel INPUT 2 connector via a 6, 10, or 20 dB attenuator. First select INPUT 2, 50Ω. Next enter Diagnostic 51 (LO Synthesizer Verification: User-Entered Frequency), and set the LO to various frequencies to be measured at INPUT 2. Pressing the RESET/LOCAL key will display the frequency measurement at INPUT 2. Pressing the DIAGNOSTICS key allows a different LO frequency to be entered. Intermediate frequencies in the synthesizer circuit may also be measured using a standard 10:1 oscilloscope probe connected to INPUT 2.

- A5U10 can oscillate if it does not have a signal at its clock input, pin 15 (driven by the VCO circuit). Typically the oscillating frequency will be about 440 MHz producing a 44 MHz signal at U10's output, pin 2. If a diagnostic which normally counts the 35 MHz test signal fails and shows a frequency of about 44 MHz, the VCO and related circuitry is a likely fault.

8-667. Possible symptoms that may be seen if the A5 Synthesizer Assembly is faulty are listed below:

- Counter fails to acquire signals at INPUT 1 in either the Auto or Manual mode, but makes measurements at INPUT 2.

- Diagnostics which rely on counting the 35 MHz test signal fail and the A3 Assembly has been verified (i.e. INPUT 2 counts correctly).

- The red "NOT PHASELOCKED" LED at the top of the A5 Assembly is always on.

- Using a stable source such as a synthesized signal generator with its timebase locked to the counter, INPUT 1 measurements fluctuate on higher resolution digits, but INPUT 2 measurements are correct and stable. In this case, the LO frequency may not be stable.

8-668. Making the following measurements before removing the RF shielding cover may give further insight to the cause of the failure:

1. Check the following supplies at the Power Supply Test Connector on the motherboard (A8J7):

Supply Name	Test Pin on A8J7	Allowable Range
V/+5	14	+4.93 to +5.07 V
V/-5.2	16	-5.11 to -5.29 V
V/-24	2	-22.6 to -25.9 V

NOTE

If the counter is equipped with an Option 001 or 010 Oven Oscillator which has not yet warmed to its operating temperature, the V/-24 Test Connector voltage may be up to -30V (maximum).

2. The A5 Assembly actually uses a -20V supply which is regulated from the -24V supply. This supply can be verified at pin 5 of the test connector on the A5 Assembly (A5J1). The allowable range at this pin is -18.7V to -21.5V when the counter is on. When the counter is in Standby the voltage at this pin should be about -1.35V.

3. Verify that L LO OFF (pin 13 of the A5J1 test connector) is approximately +4.75V. If this signal is near ground, it will turn off the VCO.

4. Using Diagnostic 53, verify that the lower frequency limit of the synthesizer is less than 275 MHz and the upper limit is greater than 375 MHz.

5. Verify the output level of the synthesizer as follows:

   a. Connect the BNC end of the SMB male to BNC adapter cable (HP P/N 05350-60120) to a spectrum analyzer. Set the spectrum analyzer as follows:

      Input Attenuation: 20 dB
      Reference Level: 20 dBm
      Freq. span/div: 20 MHz
      Resolution BW: 300 kHz
      Center frequency: 325 MHz
      Sweep source: internal

   b. Disconnect the output of the A5 Assembly from the A12 Assembly at A12J2. Connect the SMB male end of the adapter cable to A5W2.

   c. Enter Diagnostic 52 (LO sweep) and note that the output sweep is flat from 275 to 375 MHz at a level of +15 dBm ±3 dB. See photograph A in *Figure 8-50.*

6. Without a signal connected at INPUT 1, and with the counter in the Auto mode, measure the waveform at pin 2 (PLL OUT) of the A5J1 test connector with an oscilloscope. Compare with photograph B in *Figure 8-50.* This is the signal that drives the VCO. The output frequency of the VCO varies inversely with voltage (i.e. the most negative voltage corresponds to the highest frequency). The LED at the top of the A5 Assembly will be dimly lit during this test.

7. With an oscilloscope connected to pin 2 of the test connector (A5J1), set the counter to Diagnostic 52. A relatively slow time varying voltage should be seen ranging from approximately -1V to -12V. This is the VCO drive signal during the LO sweep.

8-669. The power supplies and their allowable ranges on the A5 Synthesizer Assembly are listed below:

Supply Name	Test Point	Allowable Range
+5VD	C41(+)	+4.93 to +5.07 V
+5VA	C42(+)	+4.91 to +5.06 V
-5.2V	C34(-)	-5.10 to -5.29 V
-24V	C27(-)	-22.4 to -25.8 V (after oscillator warmup)
-20V	pin 5 of A5J1 or C26 (-)	-18.7 to -21.5 V (-1.35 V when in Standby)

8-670. Verify the following inputs to the A5 Assembly:

1. Verify the 10 MHz reference signal at pin 1 of A5P1 (pin 2 is a convenient ground). Compare to photograph C in *Figure 8-50*. Note that measuring this signal at U3, pin 7 may cause the dc bias to be shifted slightly. At A5P1, the signal is ac coupled.

2. Set the counter to Diagnostic 52 (LO sweep) and verify that there is activity on the SYN DATA lines, U4, pins 2 through 7 and pin 9. These signals should be at TTL levels. The SYN LATCH signal at U4, pin 11 should have activity during this diagnostic. Pin 8 should always be low, as this address line is only used during the initialization process at power-up.

3. Enter Diagnostic 50 and verify that U8, pin 11 toggles between 0V and 4V during this diagnostic.

8-671. Enter Diagnostic 50 and verify the pulsed 29.5 MHz and 35 MHz signal at pins 2 and 3 of U8. These signals should have a dc offset of about +3.7V with a peak-to-peak amplitude of about 0.8V.

8-672. If the actual synthesizer output has not been verified as outlined in paragraph 8-659, step 5, do so at this time.

8-673. The tests described above should help isolate the specific symptoms to one or more of the following:

- The synthesizer output level is below +12 dBm.
- The synthesizer output is "stuck" at one end of the frequency range.
- The red LED at the top of the A5 Assembly is always on.
- The synthesizer is phaselocked (red LED off), but a frequency other than what is programmed is seen at the synthesizer output.
- The synthesizer output is not stable or is noisy.

8-674. The following paragraphs provide suggestions for how to troubleshoot each of the symptoms listed above.

8-675. If the the synthesizer output level is below +12 dBm, proceed as follows:

1. The suspect circuitry is U6, U9, or the VCO. The schematic shows important bias voltages for these components. Verify these to determine if a component is shorted or open. An output signal at some amplitude will probably be seen even if U9 or U6 is faulty, however, it will not be at the typical +15 dBm level.

2. An easy way to check if the VCO is operating at all is to enter diagnostic 50 and check that the diagnostic passes and displays a frequency of 35 MHz. If a frequency of approximately 44 MHz is displayed, it is probable that U10 is not being clocked (pin 15) or, in other words, not receiving a signal from the VCO. U10 can oscillate at about 440 MHz (the output will be about 44 MHz) if no signal is present at the input to U10. Also check that the amplifier circuitry is operating properly (U6 and Q7).

8-676. If the synthesizer is "stuck" at one end of the frequency range, proceed as follows:

1. This symptom can be verified by monitoring the output on a spectrum analyzer while in Diagnostic 53. The output should be alternating between the high end frequency and the low end frequency for normal operation. Monitoring the PLL OUT (A5J1, pin 2) with an oscilloscope will reveal the same symptom as this is the VCO drive voltage. It is likely that the drive voltage will also fail to alternate between levels.

2. Set the counter to Diagnostic 51 with an entered frequency of 300.1 MHz. As a starting point to troubleshooting the phaselock loop, verify that U3 is generally functional. Begin by verifying that the 10 MHz reference signal is present at U3, pin 7 (A5P1, pin 1). Pin 8 of U3 should then have a 100 kHz signal which is the 10 MHz signal divided by 100.

3. Use an oscilloscope to verify activity at U3, pin 3. The frequency at this node should be between 5 and 8 MHz typically. However, at this point it is not important to measure to an exact frequency, but rather that a signal exists at all and is stable. If the signal is absent at U3, pin 3, trace back through U7 to U10 to locate the faulty component. Refer to photograph H in *Figure 8-50* (channel A trace).

4. Next check for activity at U3, pin 15. This should be a 100 kHz signal. If activity has been verified at U3, pin 3 as described above and the signal at U3, pin 15 is not 100 kHz, U3 may be faulty or may not be programmed correctly.

5. If checking the above nodes fails to isolate the problem, the phaselock loop may be "broken" by desoldering one leg of A5R14. The VCO can then be manually tuned by connecting a power supply to PLL IN (A5J1, pin 10). The tuning voltage ranges from +0.5V to -19V. Monitor the LO output with a spectrum analyzer to verify that the VCO frequency can be varied.

6. If the VCO frequency cannot be tuned manually, troubleshoot the notch filter circuitry consisting of C19, CR6, C20, C28, L2, L3, C29, C39, C35, C38, and L9. This can be done by removing power to the A5 Assembly and using an ohmmeter to look for open components or shorted components. With the A5 Assembly installed and the counter set to ON, verify the dc bias measurements around the VCO circuitry.

7. If the VCO can be tuned manually, the problem probably exists in U10, U7, U3, or the integrator circuitry (U1 and associated components). The measurements described in the following paragraphs to check these components require that the counter be set to Diagnostic 51 with an LO frequency of 300.0 MHz.

8. First, verify the signal at U10, pin 2 as shown in photograph J in *Figure 8-50*, using an oscilloscope. Display this trace on channel A of the oscilloscope.

9. Display the signal at U7, pin 11 on channel B of the oscilloscope. Compare to photograph D in *Figure 8-50*. Now display the signal at U7, pin 3 on channel B. Compare to photograph E in *Figure 8-50*. These are the signal relationships represented in *Figure 8-19* of the theory of operation for the A5 Assembly. Note that it is not possible to probe U7, pin 13 as shown in *Figure 8-19*, as this output is not used in the circuit and does not have a pull-down resistor to facilitate oscilloscope probing.

10. Display the signal at U7, pin 4 on channel A of the oscilloscope and the signal at U7, pin 14 on channel B. Compare to photograph F in *Figure 8-50* and note how the signal at pin 14 lags the signal at pin 4. Repeat this procedure, comparing the signals at U7, pin 3 (channel A) and U7, pin 14. Compare with photograph G in *Figure 8-50*. These measurements should isolate failures of U7 or U10.

11. To check U3, display the signal at U3, pin 3 on channel A of the oscilloscope and the signal at U3, pin 14 on channel B. Set the LO to 300.1 MHz using Diagnostic 51. Compare to photograph H in *Figure 8-50*. If the LO frequency is a multiple of 5 MHz, the signal at U3, pin 14 will be a constant dc level (Modulus Control).

12. The only remaining circuitry which has not been verified at this point is the integrating circuitry (U1 and associated components). First check the dc bias voltages noted on the schematic. Note that with the phaselock loop broken at R14, the output of the integrator will be held to approximately +0.7V or -18.5V.

8-677. If the red LED at the top of the A5 Assembly is always on, proceed as follows:

1. The red LED being on continuously denotes that the synthesizer is never becoming phase locked. Monitor the output of the synthesizer with a spectrum analyzer with the counter in Diagnostic 52 (LO sweep). If the output is completely absent, refer to paragraph 8-675; if the output is "stuck" at a particular frequency, refer to paragraph 8-676. Finally, if the output is oscillating, refer to the following troubleshooting suggestions.

2. Diagnostic 52 may give an indication as to what frequencies or set of conditions cause the phaselock loop to oscillate. For example, if the VCO is unable to function above or below a particular frequency, the feedback nature of the circuit will cause oscillations as it attempts to drive the VCO to a particular frequency, but is unable to do so.

3. Transistors Q1 and Q2 are used to keep the PLL loop gain approximately constant at lower synthesizer frequencies. If the synthesizer oscillates at lower LO frequencies, these transistors may be a possible cause.

4. A faulty U1 could also cause the phaselock loop to oscillate. Verify the dc bias voltages around U1 as noted in the schematic.

5. Typically if Q1, Q2, or U1 are causing the oscillations, the PLL OUT signal which drives the VCO will be oscillating sinusoidally or in a smooth, continuous fashion. Alternately, if the oscillations are the result of a problem in the VCO, U6, Q7, U7, or U10 causing an intermittent feedback, the PLL OUT signal will have a much more rough or jagged appearance.

8-678. If the synthesizer is phaselocked (LED off), but a frequency other than what is programmed appears at the LO output, proceed as follows:

1. A quick way to verify the condition is to connect the synthesizer output to INPUT 2 (50Ω) via a 6, 10, or 20 dB attenuator. Next, set the LO to a particular frequency using Diagnostic 51. Press the RESET/LOCAL key, and the LO frequency should be displayed on the counter.

2. Set the counter to Diagnostic 52 (LO sweep) and verify that there is activity on the SYN DATA lines, U4, pins 2 through 7 and pin 9. These signals should be at TTL levels. The SYN LCH signal, U4, pin 11, should have activity during this diagnostic. Pin 8 should always be low, as this address line is only used during the initialization process at power-up. These checks will verify that data from the microprocessor is reaching the synthesizer. If one or more of these lines is inactive during the LO sweep, refer to the A4 troubleshooting procedures. Also check U4 by verifying that pins 12 and 14 through 19 have activity on them and pin 13 is low. Check that U3 is operating by verifying a signal at U3, pin 5 (use a 10 MΩ probe).

3. For a specific starting point to troubleshoot, monitor U3, pin 14 while setting various LO frequencies using Diagnostic 51. Choose LO frequencies which are not multiples of 5 MHz to ensure that this line toggles. LO frequencies which are multiples of 5 MHz will cause the U7-U10 combination of counters to divide by 50 always. Thus U3, pin 14 will be in a static state. See photograph K in *Figure 8-50*.

4. After verifying the signal at U3, pin 14, check the CMOS-to-ECL converter circuit, CR2, CR3, CR4, CR10, C14, and R9-R11. Verify that the cathode of CR3 (anode of CR2) is approximately +3.7V. Compare the input and output of this circuit with photograph I in *Figure 8-50*.

5. If U3, pin 14 has activity as verified above, U10, U7, and U3 can be checked as described in the next three steps. (The counter should be set to Diagnostic 51 with an LO of 300.0 MHz for the following measurements.)

6. Display the signal at U10, pin 2 on channel A of the oscilloscope. Next, display the signal at U7, pin 11 on channel B of the oscilloscope. Compare to photograph D in *Figure 8-50*. Now display the signal at U7, pin 3 on channel B. Compare to photograph E in *Figure 8-50*. These are the signal relationships represented in *Figure 8-19* of the theory of operation for the A5 Assembly. Note that it is not possible to probe U7, pin 13 as shown in *Figure 8-19*, as this output is not used in the circuit and does not have a pull-down resistor to facilitate oscilloscope probing.

7. Display the signal at U7, pin 4 on channel A of the oscilloscope and the signal at U7, pin 14 on channel B. Compare to photograph F in *Figure 8-50* and note how the signal at pin 14 lags the signal at pin 4. Repeat this procedure, comparing the signals at U7, pin 3 (channel A) and U7, pin 14. Compare with photograph G in *Figure 8-50*. These measurements should isolate failures with U7 or U10.

8. To check U3, display the signal at U3, pin 3 on channel A of the oscilloscope and the signal at U3, pin 14 on channel B. Set the LO to 300.1 MHz using Diagnostic 51. Compare to photograph H in *Figure 8-50*. If the LO frequency is a multiple of 5 MHz, the signal at U3, pin 14 will be a constant dc level (Modulus Control).

8-679. If the synthesizer output is not stable or is noisy, proceed as follows:

1. This type of problem could appear as spurs or sidebands clustered around the LO frequency which are not harmonically related to the LO frequency.

2. Spurs which are less than 100 kHz from the LO frequency typically indicate that the phaselock loop is oscillating. Spurs which are greater than 100 kHz from the LO frequency typically indicate that either the VCO bias is incorrect, or one of the RF amplifiers (U6, Q7, or U9) is oscillating. If the spurs are exactly 100 kHz from the LO, the interference is probably caused by other parts of the A5 circuitry. A starting point for troubleshooting this problem would be to verify the components of the notch filter circuitry. In addition, the low pulses at U3, pin 5 should typically be between 20 and 100 nanoseconds wide. Pulses greater than 100 ns may cause interference and may indicate a faulty U3. Be sure to use a 10 MΩ probe when measuring waveforms at U3, pin 5.

8-680. A6 IF AMPLIFIER/DETECTOR ASSEMBLY TROUBLESHOOTING

8-681. Diagnostics that may fail if the A6 Assembly is faulty are:

- Diagnostics 60 and 65
- Diagnostics 2, 62, 63, and 64 will only display measurement information rather than explicit PASS or FAIL indication.
- Diagnostic 61 will display whether or not an overload condition was detected by the A6 Assembly.

8-682. In addition to using the above diagnostics to determine failures on the A6 Assembly, it may be helpful to use Diagnostics 4, 5, and 6. These diagnostics can give insights to the acquisition of the microwave signal by displaying the determined harmonic number, the present local oscillator frequency, and whether the unknown was determined to be on the upper or lower sideband of the local oscillator frequency.

8-683. Points to consider when troubleshooting the A6 Assembly are:

- If the counter fails to operate properly on INPUT 1, it is important to use the above diagnostics to determine what data the counter is using to compute the input frequency. Verify that the A6 Assembly has found an IF frequency by using Diagnostic 2. Next, verify what LO frequency and what harmonic of the LO has been used. Use these values in the fundamental tuning equation:

$$f = N \bullet LO + IF$$

- If Diagnostics 5 and 6 indicate the input frequency is on the lower sideband (LSB), then the IF must be subtracted from N•LO. If the upper sideband is indicated (USB), then the IF must be added to N•LO.
- Note the fractional portion of the harmonic number displayed by Diagnostic 6. If this fractional portion deviates more than .30 from an integer value (e.g. 3.30 to 3.70), the counter will be unable to acquire the signal. For a fractional portion less than .30 from an integer value, the nearest integer value is used in the tuning equation. A large fractional portion of the harmonic number indicates that the counting circuitry is counting a signal with a relatively wide variation in frequency. This may be due to the input signal at the front panel or faults internal to the counter.

- The IF bandwidth set by software flags is 43 MHz to 97 MHz. The hardware bandwidth is typically 30-35 MHz to 105-110 MHz.

- If the IF detector is not functioning properly, the counter may never acquire a microwave signal or always attempt to acquire the signal with an LO of 350 MHz.

- The effective width of the IF bandpass filter can be seen by putting the counter in the Manual mode and entering Diagnostic 64. This diagnostic disables both software and hardware flags and allows any IF frequency to be measured and displayed. By varying the input frequency, the minimum and maximum IF allowed by the hardware can be measured.

- Diagnostic 63 disables the software flags, enabling verification of the hardware detection circuitry. Diagnostic 2 can be used to verify the software flags at 43 MHz and 97 MHz.

- The 35 MHz test signal enters the IF amplifier circuit after the 200 MHz low pass filter. Failures in the circuit before this point may go undetected by Diagnostics 60 and 65.

- The green LED at the top of the A6 Assembly indicates that a signal between 35 and 105 MHz and greater than -35 dBm has been detected by the A6 Assembly. The yellow LED indicates that a signal meeting the above requirements has not been detected on the A6 Assembly. The latch (U1A and U1B) will be reset at the end of each measurement so that the lack of a signal in the IF bandpass during a measurement for even a moment will be indicated by the yellow LED. Use of Diagnostic 97 for the A6 adjustment procedure allows a faster reset of the latch (U1A and U1B) to facilitate the adjustment. The red LED at the top of the assembly indicates that a signal in excess of the maximum operating level has been detected by the circuitry on the A6 Assembly.

8-684. Possible symptoms that may be seen if the A6 Assembly is faulty are:

- Counter fails to count, or counts improperly, a signal with an amplitude greater than the INPUT 1 sensitivity specification.

- INPUT 1 has poor sensitivity. First, verify the LO and IF signals as described above.

- Counter fails to indicate an overload condition or indicates an overload condition for signals in the counter operating range.

8-685. Before removing the cover of the RF shielding compartment for the A5 and A6 boards, verify that the A12 Microwave Assembly is sending an IF signal to the A6 board, using the following procedure:

1. Set the counter to the Manual mode with a 1 GHz center frequency. Input a 1 GHz signal at -10 dBm to INPUT 1.

2. The green LED at the top of the A6 Assembly should be on. If it is not, check the IF output of the A12 Microwave Assembly, as follows:

   a. Remove ac power from the rear panel of the instrument.

   b. Disconnect A6W1 from A12J1 and connect the SMB (female) to BNC (male) adapter cable (HP P/N 05350-60121) to A12J1. Connect the BNC end of the cable to an oscilloscope. (An alternate method would be to use an HP 10017A probe to measure at the center conductor of the A6W1 cable.)

c. Reconnect ac power to the instrument and set the counter to Manual mode with a 770 MHz center frequency. Input a 770 MHz, -10 dBm signal to INPUT 1.

d. Compare the waveform with photograph A in *Figure 8-52*.

3. If the IF waveform is not present, verify the LO signal out of the A5 Assembly, as follows:

a. Remove ac power from the rear panel of the instrument.

b. Remove the cover of the RF shielding can and connect the SMB (male) to BNC (male) adapter cable to A5J2. Connect the BNC end of the adapter cable to a spectrum analyzer.

c. Reconnect ac power to the instrument.

d. Set the spectrum analyzer for 20 dB attenuation. A 1 GHz Manual center frequency will result in a 310 MHz LO. This signal should be +15 dBm ± 3 dB.

4. If the LO signal is present, but the IF signal differs from that shown in photograph A in *Figure 8-52*, refer to the A12 Microwave Assembly troubleshooting procedures.

5. If the LO signal is not present, or is below +12 dBm, refer to the A5 Synthesizer Assembly troubleshooting procedures.

8-686. Disconnect the adapter cables and reconnect the A6W1 cable to A12J1, and the W2 cable to A12J2.

8-687. Verify the following power supplies:

Supply Name	Test Point	Acceptable Range
+5D	L21A (top right leg)	+4.8 to +5.1 V
+5L	L21B (bottom right leg)	+4.8 to +5.1 V
V/-5.2	L17 (top leg)	-5.0 to -5.3 V

8-688. Verify the following inputs to the A6 Assembly:

1. Verify that the AUX A 35 MHz signal (upper leg of R24) pulses on and off when the counter is executing Diagnostics 60 and 65. The test signal should not be present during normal operation. This signal should have an amplitude of about 1.8V p-p.

2. The L IF TEST signal (lower leg of R24) should be switching between logic 1 and logic 0 during Diagnostics 60 and 65. It should be at a logic 1 (+5V) during normal operation.

3. The L IF OFF signal (bottom leg of R26) should be switching between TTL levels during Diagnostics 60 and 65, but TTL high during normal operation.

4. The A6W1 cable can be verified by setting the counter to Manual mode with a 770 MHz center frequency, applying a 770 MHz, -10 dBm signal to INPUT 1, and probing the upper leg of L1. Compare with photograph A in *Figure 8-52*.

5. Verify the L NO IF RST (TP1) and L OVLD RST (lower leg of R3) signals. These signals should pulse high between successive measurements as indicated by the gate annunciator. Set the resolution on the counter to 1 MHz for a faster measurement time and therefore easier viewing on an oscilloscope.

8-689. Verify the following outputs of the A6 Assembly:

1. Set the counter to the Manual mode with a 1 GHz center frequency. Input a 1 GHZ signal at -20 dBm to the front panel INPUT 1 connector and compare the signal at the collector of Q8 with photograph B in *Figure 8-52.*

2. Verify that for signals above the sensitivity of the counter, the green LED is on. For signals below the sensitivity, the yellow LED should be on. (The sensitivity specifications depend on the option configuration of the instrument. Refer to *Table 1-1.*)

3. Set the input to +10.5 dBm and verify that the L OVLD TRG line (base of Q3) is low and the red LED is on. Reduce the input level to 0 dBm and verify that the red LED is off and the signal line is high.

8-690. If the above inputs and outputs are correct, refer to the A3 and A4 Assembly troubleshooting procedures. Refer to the appropriate A4, A5, or A12 troubleshooting information if any of the input signals are incorrect.

8-691. It is recommended that when troubleshooting the A6 Assembly that the counter be placed in the Manual mode. This will bypass the automatic acquisition routine found in the Auto mode, thereby eliminating a periodic sweep of the IF signal as the counter attempts to search for the signal.

8-692. To troubleshoot the main IF signal path, proceed as follows:

1. Verify a dc bias voltage of about +3V ±0.3V at the outputs of U3 (bottom leg of R22) and U4 (bottom leg of R29). Make these measurements with no signal applied to INPUT 1.

2. Connect a scope probe to the lower leg of L5. With the counter in Manual mode and a center frequency of 1 GHz, apply a 1 GHz signal to the counter at a level to produce a 100 mV p-p, 70 MHz IF signal at L5. Compare the output of U3 with photograph C in in *Figure 8-52.* It is recommended that the circuit be loaded equally at the input and output of the amplifier. Therefore, set the input to 100 mV p-p with channel A of the oscilloscope and measure the U3 output with channel B of the oscilloscope, with channel A still attached.

3. Verify the IF bandpass sensitivity adjustment (SENS ADJ), R25. Refer to Section V, Adjustments.

4. Repeat the U3 procedure above with U4 by setting the input of U4 to 100mV p-p and comparing the output with photograph D in *Figure 8-52.*

8-693. Detector Troubleshooting

8-694. During Diagnostics 60 and 65, the green LED (IF OK) should flash synchronously with the pulsing of the 35 MHz test signal. The yellow LED (NO IF LATCH) will remain lit continuously, although somewhat dimmer than the green. The state of these LEDs can help in troubleshooting the detector portion of the IF amplifier.

8-695. Compare the waveform at the emitter of Q7 (upper leg of R28) with photograph F in *Figure 8-52*. Next, verify the operation of the detector circuit by probing at TP2 (R12). Input a 770 MHz signal to INPUT 1 with the counter in the Manual mode (center frequency of 770 MHz). Vary the level of the input signal at INPUT 1 above and below -35 dBm. At input levels -35 dBm and above, the voltage at TP2 should be about 750-900 mV. Below -35 dBm, the TP2 voltage should be about 1.0V to 1.2V. The comparator output (U2A, pin 1) should swing between TTL levels as TP2 swings between the above voltage levels. The trigger voltage at U2, pin 3 should be about 0.9V.

8-696. To check the overload peak detector, set the input to 1 GHz at +5 dBm. The voltage at U2, pin 5 should be about 1V to 1.3V. Increase the input level to +10 dBm. The voltage at U2, pin 5 should now be about 700 to 900 mV. The trigger voltage at U2, pin 6 should be about 0.9V.

8-697. A7 KEYBOARD/DISPLAY LOGIC ASSEMBLY TROUBLESHOOTING

8-698. Diagnostics that may aid troubleshooting the A7 Assembly are:

- Diagnostic 70: Keyboard Test
- Diagnostic 71: Display Test
- Hardwired Diagnostic: Keyboard Test (A4TP1 grounded and A4TP2 open)
- Hardwired Diagnostic: Display Test (A4TP1 and A4TP2 both grounded)

8-699. Points to consider when troubleshooting the A7 Assembly:

- To obtain access to the A7 Assembly, the front panel must be removed. It is suggested that Diagnostics 70 and 71 be used initially to determine if the A7 Assembly is faulty. The hardwired diagnostics can be used to set the instrument in a continuous diagnostic state for easier troubleshooting. The A11 HP-IB Interface Assembly cable should be disconnected from its motherboard connector (A8J6) to use these diagnostics.
- The display drivers, A9 Backlight Assembly, and the display itself are offered as a single replacement assembly only. This assembly is delicate and can be damaged by electrostatic discharge.
- Test points for the A7 Assembly consist of a row of ten open solder pads located on the A7 Assembly near A8W1. The topmost pad is TP1 and the pad closest to the A8 Motherboard Assembly is TP10.
- Ribbon cable A7W1 must be properly seated in its motherboard connector (A8J10) for the A7 Assembly to work. Verify the cable connection before disassembling the front panel.

8-700. Possible symptoms if the A7 Assembly is faulty are:

- The unit will not go from Standby to power-up or vice versa.
- The unit appears to be on whenever the line cord is connected. (Fan is running and display may or may not be functional).
- The unit fails to recognize entries from the front panel, but operates properly via the HP-IB.
- The liquid crystal display is missing segments during a display test or does not operate at all.

8-701. To make the measurements in the following procedures, it is not necessary to completely disassemble the front panel. After performing the disassembly procedures in paragraph 8-59, remove the front panel from the frame, leaving the W13 cable connected to the motherboard. The front panel keys and display will still be operative. Test points as well as individual IC pins on the A7 board are accessible from the circuit side of the board. It should not be necessary to remove the A7 board from the front sub-panel unless a component or the LCD assembly must be replaced. If it is necessary to remove the LCD assembly, use care when disconnecting and connecting the LCD ribbon cable connectors.

WARNING

IF THE W13 RIBBON CABLE FROM THE A7 KEYBOARD/DISPLAY LOGIC ASSEMBLY TO THE A8 MOTHERBOARD/POWER SUPPLY REGULATOR ASSEMBLY IS DISCONNECTED, THE POWER SUPPLY CIRCUITS WILL ALWAYS BE ON WHEN THE INSTRUMENT IS CONNECTED TO AC POWER.

8-702. Verify the following voltages:

Signal Name	Test Point	Voltage Range
+5V	TP1	+4.8 to +5.2 V
+15V	TP4	+14.75 to +15.25 V
V_{CC}	TP10	+5.90 to +6.70 V

8-703. If the counter fails to recognize keyboard entries, proceed as follows:

1. Remove ac power from the rear panel of the instrument, and disconnect the A11 ribbon cable (A11J2W1) from the motherboard.

2. With a test clip, connect A4TP1 to a ground test point. These test points are located at the top of the A4 Microprocessor Assembly. Reapply power to the rear panel of the instrument and turn it on. The counter will now be in the Keyboard Test (same as Diagnostic 70) until it is switched to Standby and the test clip is removed.

3. Probe TP7 on the A7 board and verify that the signal goes TTL high when a key is pressed and goes low when the key is released. This signal should remain high as long as the key is held down. An inverted version of this same signal should be present at U2, pin 11.

4. Probe TP8 and verify that this signal pulses TTL high for each key closure, but goes low (i.e. does not stay high if the key is held down).

5. Probe U5, pin 13. Verify that the signal is normally TTL high. Check that the signal pulses low when a key is pressed. This is a reset signal (L KB READ) from the microprocessor which allows the processor to read a key and reset the key interrupt. If this signal is not present as described, verify the connections between A4 and the A8 Motherboard Assembly as well as the connection of cable W13.

8-704. If the above procedures do not isolate the key failure, verify that U4, pin 12 pulses high when pressing a key in row 1 (refer to the A7 schematic diagram in *Figure 8-54*). Do the same for keys in rows 2, 3, and 4 at pins 11, 9, and 8, respectively. *Table 8-21* identifies the code that should be present for each key at the output pins of U4. Note that the RESET/LOCAL key sets all output lines to the low state. The appropriate code should remain on the data lines until another key is pressed. U3 is a tri-state buffer to the bidirectional data bus shared with the LCD data. Since the data at the outputs of U3 depends on whether LCD data or key data is present on the lines, a fault in U3 is best determined by first eliminating U4 as a possible cause.

Table 8-21. Front Panel Keys and Corresponding A7U4 Output Codes.

Key	A7U4 pin # 15	16	17	18	19
RESET/LOCAL	0	0	0	0	0
OFFSET	0	0	0	0	1
SMOOTH	0	0	0	1	0
SCALE	0	0	0	1	1
SET/ENTER	0	0	1	0	0
SAMPLE RATE	0	1	0	0	0
RESOLUTION	0	1	0	0	1
DIAGNOSTICS	0	1	0	1	0
HP-IB ADDRESS	0	1	0	1	1
TRIGGER	0	1	1	0	0
SELF CHECK	0	1	1	0	1
FM RATE/TRACK	0	1	1	1	0
HIGH RESOL	0	1	1	1	1
MANUAL	1	0	0	0	0
50Ω	1	0	0	0	1
AUTO	1	0	0	1	0
1MΩ	1	0	0	1	1

Note: "1" = TTL high, "0" = TTL low

8-705. If the Liquid Crystal Display is not operating properly, proceed as follows:

1. Verify the signals described below before attempting to replace the LCD assembly. For backlighting failures, verify that +5V is present at the A9 Backlight Assembly by measuring at A9J1 (connector with a red and black wire leading to it). If +5V is verified, the LCD assembly must be replaced.

2. Verify V1, V2, and V3 (see *Table 8-22*). These voltages are valid at room temperature. It is not critical that these voltages be exact. This circuit is designed to maintain an approximate 1:2:3 ratio between V1, V2, and V3 over the operating temperature of the instrument.

Table 8-22. LCD Supply Voltages at Room Temperature.

Signal Name	Approximate voltage
V1	+1.6 V
V2	+3.2 V
V3	+4.8 V
TP9	+4.8 V

3. Remove ac power from the rear panel of the instrument. With test clips, connect A4TP1 and A4TP2 to a ground test point. These test points are located at the top of the A4 Microprocessor Assembly. Reapply power to the rear panel of the instrument and turn it on. The counter will now be in the Display Test (same as Diagnostic 71) until it is switched to Standby and the test clips are removed.

8-706. Verify that a series of negative going pulses is present at U1, pin 2. These pulses should occur in a 10 to 20 ms burst approximately once per second. The pulse width should be approximately 3 microseconds. This signal should also be at U1, pin 12. The U1 one-shots provide a delayed clock signal ($\phi 2$) with respect to the $\phi 1$ clock signal at U6, pins 9 and 10. This delay is approximately 3 microseconds long and can be verified by displaying the signal at U6, pins 4 and 5 simultaneously with that at U6, pins 9 and 10 on an oscilloscope, using the chop mode.

8-707. U6 and U7 can be verified by checking that the inverse of the input signal is seen at the output of each buffer. The logic swings on the outputs of U6 and U7 should be 0 (ground) to V_{cc} (+6.3V).

8-708. A11 HP-IB INTERFACE ASSEMBLY TROUBLESHOOTING

8-709. Diagnostic 80 can be used to determine if the HP-IB processor is able to respond to the main processor. This diagnostic cannot determine functionality of the entire HP-IB interface circuit.

8-710. If Diagnostic 80 fails and the counter passes all other diagnostics, verify that the ribbon cable, A11J2W1, is properly seated in its motherboard connector, A8J6.

8-711. Verify the following voltages on the A11 Assembly:

Signal name	Test Point	Range
+5V	+5 (TP1)	+4.8 to +5.2 V
+5V CMC	U2, pin 24	+4.8 to +5.2 V

8-712. A signature analysis mode is available for the A11 Assembly. This technique is helpful to determine failed components on the A11 Assembly. For problems involving a particular controller, it is recommended that an HP 59401A Bus Analyzer and a logic analyzer be used to determine the cause of the problem. As an initial test, verify that the interface responds properly to the HP-IB test program found in Section IV (available on tape, HP P/N 59300-10002, Revision H or later) for the HP-85. Also verify that the controller interface is functioning properly.

8-713. To perform signature analysis for the A11 Assembly, proceed as follows:

1. Remove ac power from the rear panel of the counter.

2. Set all of the switches on the DIP switch, A11S1, to 1 (OPEN or upward).

3. Connect a signature analyzer such as the HP 5005B to the A11 Assembly as follows:

Timing Pod	Test Point
START/ST/SP (green lead)	ST (TP2)
STOP/QUAL (red lead)	SP (TP3)
CLOCK (yellow lead)	CK (TP4)
(black lead)	(TP5)

4. Set the CLOCK to a negative slope, the START to a positive slope, and the STOP to a negative slope on the front panel of the 5005B.

5. Connect a test lead between PAT (TP1) of the A11 Assembly and ground. Reconnect ac power to the rear panel and switch the counter on. Due to the test switch configuration on the A11 Assembly, the counter will fail several diagnostics at power-up. Leave the counter in the first failing diagnostic (Diag 30) to perform the signature analysis.

6. Remove the test lead from the PAT test point. The microprocessor checks this line at power-up and then goes to the signature analysis mode. The PAT point must be grounded on power up to achieve START and STOP signals, but a valid signature can only be taken at this point with the grounding clip removed. All other signatures on the A11 board should remain identical regardless of the status of PAT (TP1).

7. Verify the signatures shown in *Figure 8-34*. First verify the characteristic signatures, V_{cc} and ground. It is recommended that signatures on the HP-IB processor, U5, be checked first as this is where the signal activity is generated. The clock frequency for U5 should be 3.6 MHz typically, and can be checked by measuring the frequency at U5, pin 7 and multiplying by 367.

8-714. The signature analysis routine does not verify the $\overline{\text{REN}}$ line and the I/O lines between the A11 microprocessor and the main microprocessor on the A4 Assembly. Install the A11 Assembly into the instrument and reset the A11S1 DIP switch to its original setting. Enter the following program into an HP-85 and connect the HP-IB interface to the counter. Note for line 10, the appropriate address for the counter should be entered if different than 714.

```
10 REMOTE 714
20 LOCAL 7
30 GO TO 10
40 END
```

8-715. Run this program and verify activity at A11U5, pin 27. If there is no activity at this point, trace back through U4D, U4A, and U2 to locate the fault. Also verify activity on U5, pins 3,4,5,6,16,17, and 18. If there is no activity on these lines, a problem may exist in the interface between the A4 Microprocessor Assembly and the A11 HP-IB Interface Assembly.

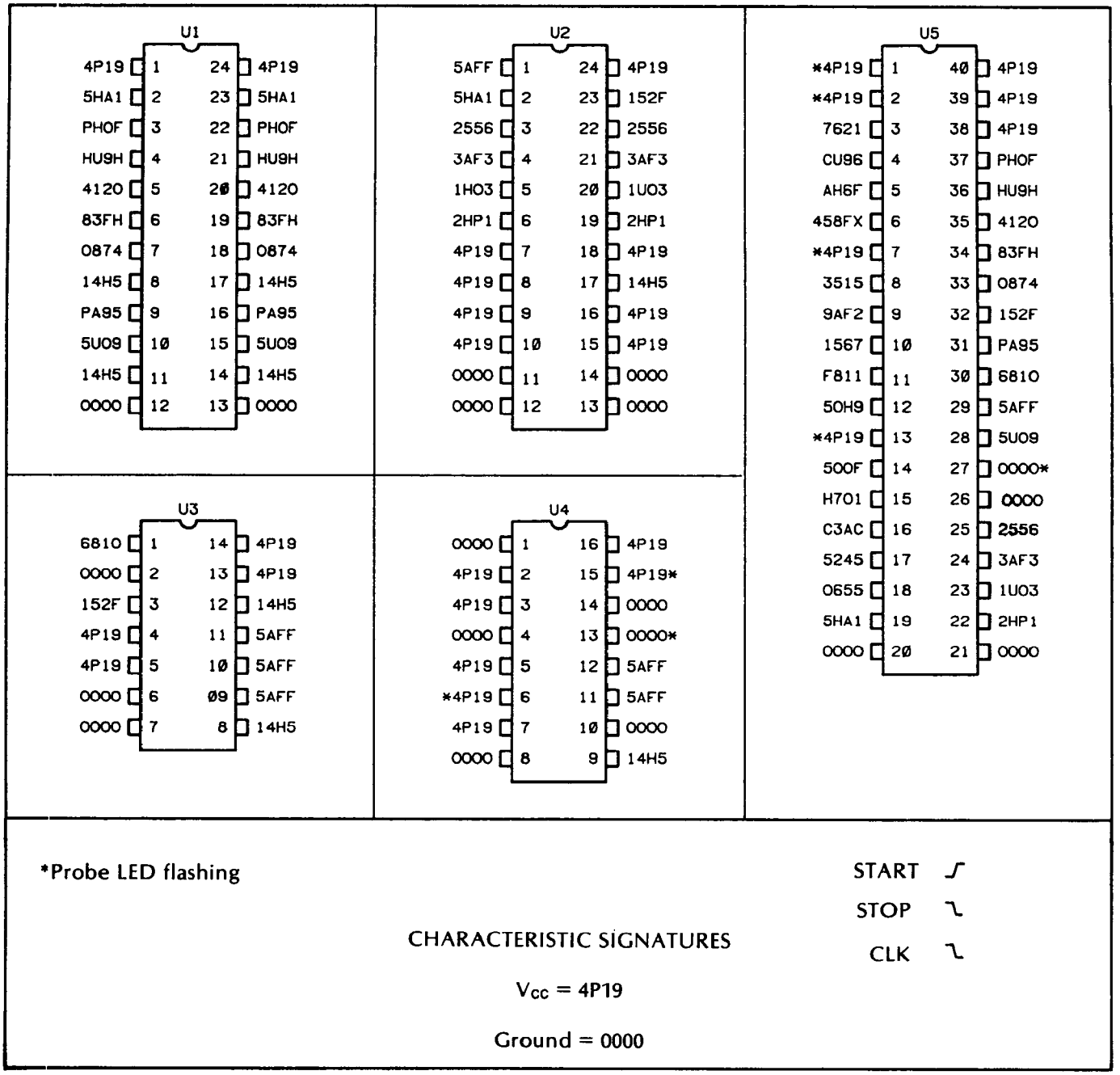


Figure 8-34. 5350B/5351B/5352B A11 Signatures

8-716. MICROWAVE MODULE TROUBLESHOOTING (A12/U1 SAMPLER)

8-717. There are no diagnostics available which directly test the A12 Microwave Assembly or the U1 Sampler.

8-718. Points to consider when troubleshooting the Microwave Module are:

- The GaAs sampler (U1) is located in the Microwave Module. This component is extremely sensitive to static electricity and care should be taken to observe proper ESD procedures when working with this component. It is strongly recommended that the circuitry around the sampler be verified before attempting to handle or replace it.
- Do not attempt to perform dc tests on the pins of the sampler. The abrupt application of current to the GaAs circuitry caused by using a standard voltmeter may damage an otherwise good component.
- The LO INPUT to the Module should be +14 dBm at the A12J1 input. Use proper attenuation on test equipment when measuring this signal. The LO INPUT must be at a proper level in order to generate an IF OUTPUT signal.
- If there is any IF OUTPUT at all from the A12 Assembly, the U1 sampler is probably good.
- The circuitry on this board should be tested using an active probe such as the HP 1120A. A standard 1MΩ oscilloscope probe does not have the required 400 MHz bandwidth, resulting in inaccurate signal level measurements.

8-719. Verify that all diagnostics return a "PASS" indication before attempting to troubleshoot the Microwave Module.

8-720. Remove the cover of the Module and verify the following power supply voltages:

Supply Name	Test Point	Acceptable Range
V/-5.2	feedthrough pin with blue wire attached	-5.11 to -5.29 V
V/+5	feedthrough pin with yellow wire attached	+4.93 to +5.07 V
V/+13	feedthrough pin with red wire attached	+12.7 to +14.3 V

8-721. Verify the output of the A5 Synthesizer Assembly as follows:

1. Connect the SMB to BNC adapter cable to the A12 end of W2. Connect the BNC end of the adapter cable to a spectrum analyzer.
2. Set the spectrum analyzer for 30 dB input attenuation with a 20 dBm reference level.
3. Set the counter to Diagnostic 51 and set the LO frequency to 325.0 MHz. Center the output on the spectrum analyzer display with a frequency span of 10 MHz per division.
4. Set the counter to Diagnostic 52 and verify that the signal sweeps across the entire display (275 MHz to 375 MHz) and is level at +14 dBm ±1 dBm (nominal). If this is not verified, refer to the A5 Assembly troubleshooting procedures. After verifying the LO signal, reconnect W2 (the cable supplied with the counter) to the LO INPUT at A12J2.

8-722. Verify the IF OUTPUT signal as follows:

1. Disconnect the IF OUTPUT A6W1 cable and connect the SMB to BNC adapter cable to the IF OUTPUT of the A12 Assembly.

2. Connect the BNC end of the adapter cable to the spectrum analyzer and set the spectrum analyzer for 0 dB input attenuation and a -10 dBm reference level. Set the frequency span to 20 MHz per division.

3. Apply a 770 MHz signal at -20 dBm to INPUT 1 of the counter. Set the counter to Manual mode with a center frequency of 770 MHz.

4. Center the IF signal on the spectrum analyzer display. Vary the input frequency from 700 MHz to 875 MHz, verifying that the IF signal stays flat ±3 dB across the range of 10 MHz to 175 MHz at a level between -21 and -26 dBm.

8-723. If the IF signal is verified, the A12 Assembly is in proper working order. Refer to the A6 Assembly troubleshooting procedures, and begin troubleshooting the A6 circuitry at a point prior to where the AUX A diagnostic test signal enters the main signal path.

8-724. If the IF signal is present, but not the correct amplitude or not flat across the sweep, then the U1 Sampler is not at fault. In this case, the suspect circuitry is Q1, U1, and U2. If the IF signal is not present, first check the LO matching and amplifier network.

8-725. To check the LO amplifier network, proceed as follows:

1. Check the bias voltage at the R8-R9 node. This voltage should be about 0.5V with no LO signal applied. The collector of Q2 should be at about +13V.

2. Set the counter to Diagnostic 52. Using the HP 1120A active probe with a 100:1 divider tip, compare the signal at the collector of Q2 with photograph A in *Figure 8-57* (for the 5350B/5351B), or *Figure 8-59* (for the 5352B). Check that the LO level does not drop below +20 dBm. (Remember that because the 100:1 divider tip was used, the spectrum analyzer measurement should have 40 dB added to it.) The heat sink on Q2 may have to be temporarily removed to make this measurement.

8-726. To check the IF preamplifier network, proceed as follows:

1. Verify that the base of Q1 is about -0.018V dc and the emitter is about -0.84V. The collector should be about +4.4V.

2. The input bias voltage to U1 and U2 should be about -0.84V, and the output bias voltage should be about +3.18V.

3. The dc voltages described above are typical and may vary due to the typical variations of each component. Generally however, a deviation of more than 0.1V from these values is an indication that a problem exists.

8-727. Set the counter to Manual mode with a 1 GHz Manual Center Frequency, and apply a 1 GHz, 0 dBm signal to INPUT 1. Using the 1120A active probe with the standard tip, compare the outputs of Q1, U1, and U2 with photographs B, C, and D in *Figure 8-57* (for the 5350B/5351B), or *Figure 8-59* (for the 5352B). Check for proper gain at each amplifier stage. Note that the noise seen in these measurements is due to the removal of the RF cover of the Microwave Module. During normal operation with the cover in place, this noise would not be present.

8-728. If the LO amplifier network is good, but there is no IF output from the U1 Sampler, then the sampler should be replaced. Refer to the disassembly procedures, paragraph 8-50.

8-729. OPTION 001 OVEN OSCILLATOR TROUBLESHOOTING

8-730. Inspection

8-731. The oscillator should be inspected for indications of mechanical and electrical defects. Electronic components that show signs of overheating, leakage, frayed insulation, and other signs of deterioration should be checked and a thorough investigation of the associated circuitry should be made to verify proper operation. Mechanical parts should be inspected for excessive wear, looseness, misalignment, corrosion, and other signs of deterioration.

8-732. Special Parts Replacement Considerations

8-733. Several mechanical parts and components must be replaced as a pair or require other special consideration. They are:

a. Oven mass assembly and thermistor: If the thermistor (RT1) is found to be defective, the thermistor and oven mass assembly must be replaced as one item, HP Part Number 10811-60106. Do not attempt to replace the thermistor alone.

b. Crystal and Temperature Set Resistor: The replacement crystal for Y1 will be accompanied by the required temperature set resistor (R20) for the oven. This resistor must be installed with the new crystal. The crystal and R20 can be ordered using HP Part Number 10811-60108. If only the temperature set resistor (R20) is found to be defective, it must be replaced with the same value and tolerance. If the resistor (R20) is unreadable, the value required can be determined by finding the oven temperature value marked on the crystal (Y1). The required resistor can then be determined from *Table 8-23*. When Y1 is replaced, the nut which secures it to the oven mass should be tightened to a torque of 0.6 newton-meters (5 in.-lbs). This will insure maximum heat transfer without overstressing the crystal package.

c. Oven heater transistors Q7 and Q8: Holding screws for Q7 and Q8 must also be torqued to a specific force of 0.6 newton-meters (5 in.-lbs.). There are several available Pozidriv torquing screwdrivers.

NOTE

When reinstalling or replacing one or both heater transistors (Q7 and Q8), replace both transistor insulators, HP Part Number 0340-0864. This is done to ensure the temperature stability of the oven crystal due to a balanced heat transfer to the oven mass from the heater transistors.

Table 8-23. Temperature Set Resistor List

OVEN TEMP °C	RESISTOR VALUE	PART NUMBER
80.0	1.33K	0698-7239
84.0	0	8159-0005

8-734. Special Test Connector

8-735. The following paragraphs describe a special connector fabricated for use in troubleshooting, alignment, and testing of the oven oscillator. The connector provides the following:

a. Two separate input leads for the power to the oscillator circuits and the oven heater/controller circuits.

b. 10 MHz output through a female BNC.

c. Oven monitor output for connection to a voltmeter.

d. EFC input connection to ground.

8-736. The following parts are required to construct the special test connector:

a. 15-pin pc board connector (HP Part Number 1251-0494).

b. 6 banana plugs (HP Part Number 1251-0124).

c. BNC female connector with ground lug and nut.

BNC connector	1250-0083
Ground lug	0360-0024
Lock washer	2190-0016
Nut	2950-0001

d. Approximately 6 feet of 24-gauge wire.

e. Labels for banana plugs.

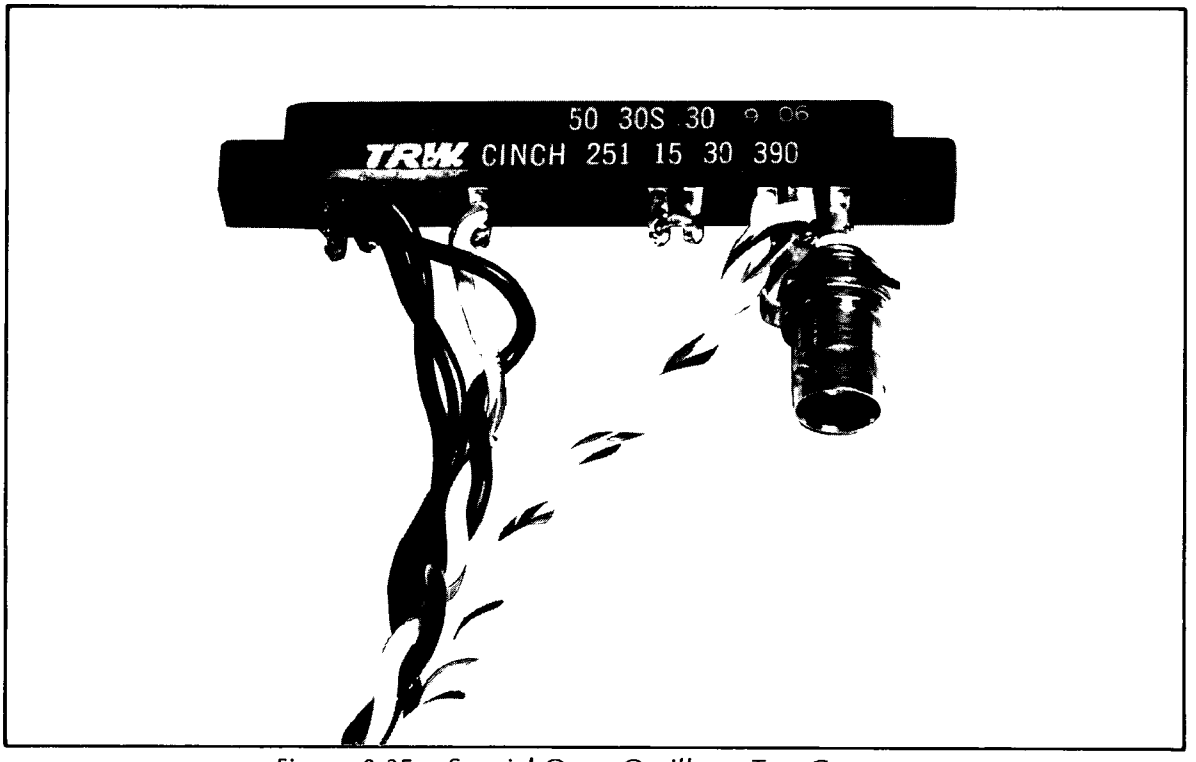


Figure 8-35. Special Oven Oscillator Test Connector

8-737. To construct the special test connector, proceed as follows:

a. Solder the center pin of the BNC connector to pin 1 of the printed circuit connector; this is the 10 MHz output signal.

b. Bend the BNC ground lug to align with pin 2 of the printed circuit connector.

c. Solder one end of a 2-foot length of wire and the BNC ground lug to pin 2 of the printed circuit connector. This is the oscillator or circuit common.

d. Solder one end of a 2-foot length of wire to pin 3 of the printed circuit connector. This is the oscillator (+) supply.

e. Connect a jumper wire between pins 5 and 6. This terminates the EFC input.

f. Solder one end of a 2-foot length of wire to pin 11. This is the oven monitor output.

g. Solder one end of a 2-foot length of wire to pin 14 of the printed circuit connector. This is the oven (+) supply.

h. Solder one end of two 2-foot lengths of wire to pin 15 of the printed circuit connector. This is the oven common.

i. Twist together one of the two wires connected to pin 15 and the wire connected to pin 14. These are the oven controller power supply inputs.

j. Twist together the remaining wire connected to pin 15 and the wire connected to pin 11. This is the oven monitor output.

k. Twist together the two wires connected to pins 2 and 3. These are the oscillator supply inputs.

l. Connect one banana plug to the free end of each wire.

m. Label each banana plug as follows:

Wire connected to:	Label as:
pin 2	oscillator supply (–)
pin 3	oscillator supply (+)
pin 11	oven monitor (+)
pin 14	oven supply (+)
pin 15 (two wires)	oven supply (–)
	oven monitor (–)

n. Inspect the connector for poor solder joints, and bent or damaged pins. Check the labeling of the plugs to be sure the polarity markings are correct. If the voltages are connected the wrong way, damage to the oven oscillator may occur.

8-738. Types of Failures

8-739. Failures in the oscillator unit can be divided into two sections:

1. Failure of the oscillator's circuits.
2. Failure in the oven controller circuits.

8-740. Failures in the oscillator circuits can be divided into thefollowing problems:

1. No output.
2. Output amplitude is too low or high.
3. Output is off frequency (high or low)

8-741. Poor frequency stability can be difficult to troubleshoot and many times the oscillator is not at fault. Environmental conditions can affect stability and should be ruled out first.

8-742. Failures in the oven circuitry can be divided into the following problems:

1. No oven current (heat)
2. Excessive oven current (>600 mA).
3. Oven does not cut back after warm-up (this will open the thermal fuse if allowed to continue).

8-743. Since the main oscillator and oven control power supply inputs are separate from each other, the defective circuit can be operated without applying power to the complete oscillator.

8-744. Determine which section is defective (oven or oscillator circuit), then proceed as described in the following troubleshooting section. The two circuits can be investigated separately.

8-745. Disassembly for Troubleshooting

8-746. To disassemble the oscillator unit, proceed as follows:

1. Remove the three screws securing the bottom cover to the outer housing, and remove bottom cover.
2. Remove the two screws securing the pc edge connector to the outer housing.
3. Remove the foam sheet to expose the oven controller circuit board.

WARNING

THE OSCILLATOR'S INTERNAL OVEN MASS TEMPERATURE MAY BE AS HIGH AS 85°C (185°F). TO AVOID SERIOUS BURNS, DO NOT REMOVE OSCILLATOR CIRCUITS AND/OR OVEN MASS ASSEMBLY FROM THE OUTER CAN UNTIL THE OSCILLATOR HAS SUFFICIENTLY COOLED (APPROXIMATELY ONE HOUR WITH BOTTOM COVER AND FOAM INSULATOR REMOVED). THE OUTER HOUSING TEMPERATURE IS NOT A RELIABLE INDICATION OF THE INTERNAL TEMPERATURE.

CAUTION

With the cover and foam insulator removed, the thermal fuse cannot protect the oven circuit from thermal runaway. Caution should be used at all times.

NOTE

If troubleshooting the oven controller, stop here and go to paragraph 8-748, Oven Controller Troubleshooting. Go to step 4 only if the trouble is in the oscillator circuit.

4. Using a long, small diameter tool, remove the complete oscillator assembly by inserting the tool into the tuning capacitor access hole (labeled FREQ ADJ) and gently pushing on the capacitor until the circuit can be grasped and removed easily.

5. Using a Pozidriv screwdriver, remove the two screws securing the heater transistors to the oven mass. Remove the washers and transistor insulators.

NOTE

When reassembling the oven mass, the heater transistor screws must be tightened to a torque of 0.6 newton-meters (5 in.-lbs.) (See paragraph 8-733(c)).

6. Tilt the oven oscillator assembly back and remove the foam insulator between the oven controller assembly and the oven mass. Be careful not to break the two black thermistor wires attached to the oven controller assembly.

7. Remove the eight screws (four each side) securing the covers to the oven mass assembly.

8. Use two of the screws from each cover (removed in Step 7) to secure the boards to the oven mass for troubleshooting.

8-747. Go to paragraph 8-758, Oscillator Troubleshooting. When reassembling the unit, reverse the above procedure.

8-748. Oven Controller Troubleshooting

8-749. GENERAL. The oven controller section consists of three major circuits and a 10V voltage reference for increased stability of sensitive circuits. *Figure 8-36* shows the major circuits and active components involved in their operation.

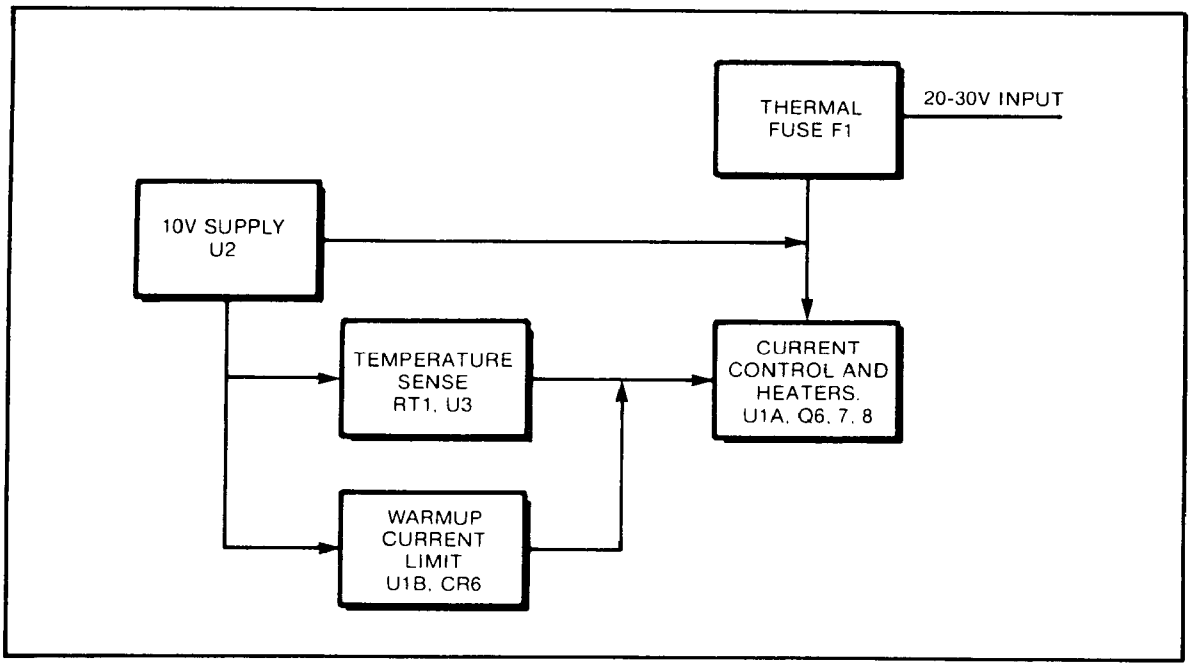


Figure 8-36. Oven Controller Block Diagram

8-750. The temperature sense circuit monitors the temperature of the oven mass and reduces the power drawn by the oven heater transistors when the oven mass has reached operating temperature. After power cutback, this circuit monitors the oven mass temperature and controls the power in the heaters to maintain the constant temperature. The thermistor (RT1) has a negative temperature coefficient. At room temperature the thermistor resistance is approximately 100kΩ, while at operating temperature (≈82°C) the resistance is approximately 9kΩ. Shorting the thermistor to oven common makes the oven mass appear too hot to the temperature sense circuit. This in turn causes the temperature sense circuit to shut off power to the oven heaters. This technique is used in the troubleshooting procedure.

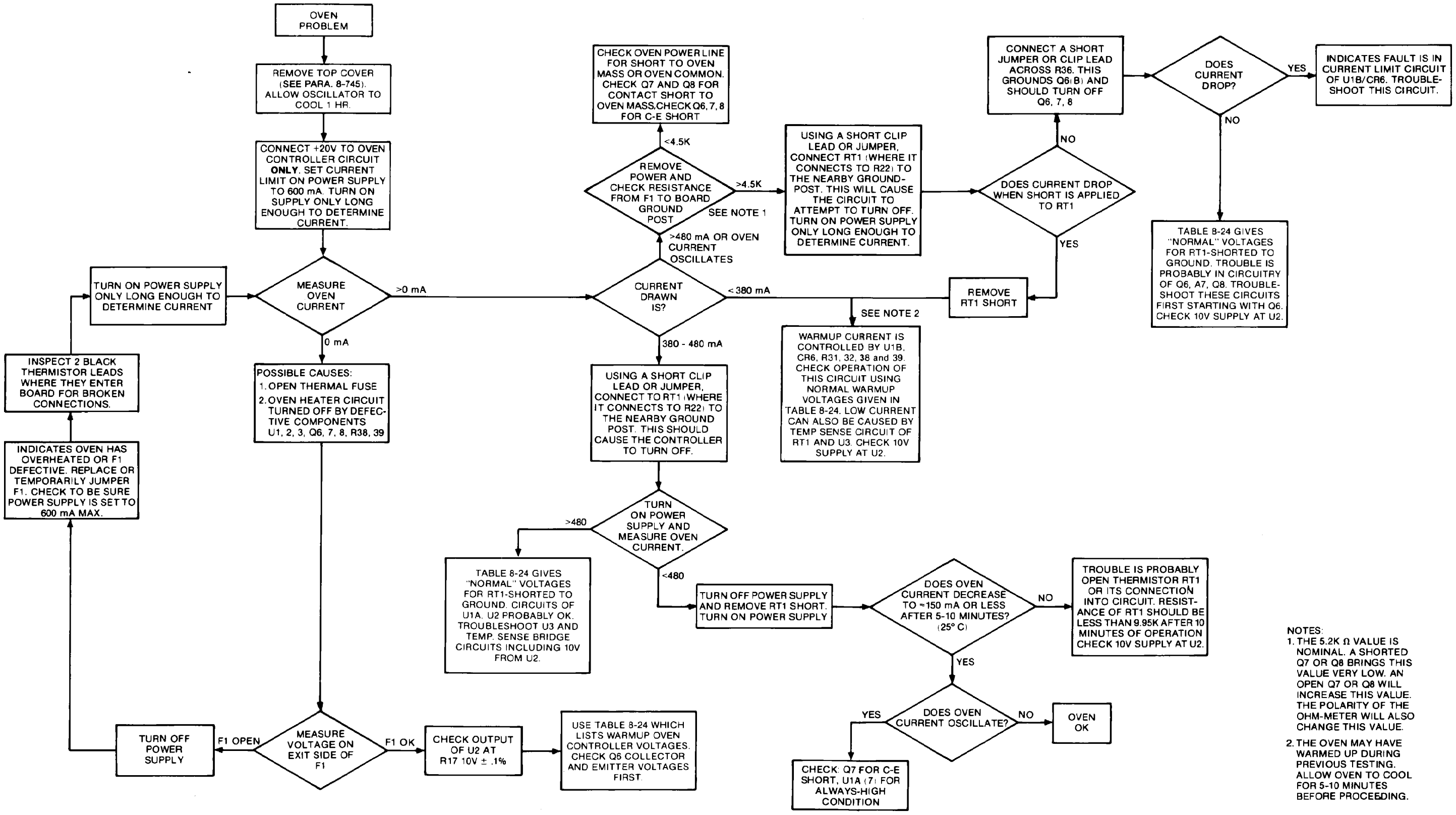
8-751. The warm-up current limit circuit controls the maximum current the oven may draw during warm-up (380 to 490 mA with 20V dc oven input). This circuit is only active during the warm-up phase of the oven circuit operation.

8-752. NORMAL OPERATION. When the oven is tested under normal conditions (≈25°C ambient temperature) it will initially draw 380 to 490 mA. After 5 to 10 minutes the oven current will start to drop. Over the next 10 to 15 minutes the oven current will fall to the 60 to 150 mA range where it will stabilize. The oven circuit should not oscillate.

WARNING

DO NOT OPERATE THE OVEN CIRCUITS WHEN THE OVEN MASS IS OUTSIDE OF THE OSCILLATOR INSULATED HOUSING. DOING SO WILL OVERHEAT THE OSCILLATOR CIRCUITS INSIDE THE OVEN MASS AND CAUSE PERMANENT DAMAGE. ALL OVEN TEST POINTS ARE AVAILABLE WITH THE OVEN MASS AND OVEN CONTROLLER CIRCUIT INSIDE THE HOUSING.

WHEN THE OSCILLATOR COVER AND INSULATOR ARE REMOVED, THE THERMAL FUSE WILL NOT PROTECT THE CIRCUIT FROM OVERHEATING. APPLY OVEN POWER ONLY WHEN ACTUALLY MAKING MEASUREMENTS FOR TROUBLE-SHOOTING OR AS DIRECTED IN THE TROUBLESHOOTING TREE, FIGURE 8-37.



NOTES:
1. THE 5.2K Ω VALUE IS NOMINAL. A SHORTED Q7 OR Q8 BRINGS THIS VALUE VERY LOW. AN OPEN Q7 OR Q8 WILL INCREASE THIS VALUE. THE POLARITY OF THE OHM-METER WILL ALSO CHANGE THIS VALUE.
2. THE OVEN MAY HAVE WARMED UP DURING PREVIOUS TESTING. ALLOW OVEN TO COOL FOR 5-10 MINUTES BEFORE PROCEEDING.

Figure 8-37. Oven Controller Troubleshooting Tree

8-753. TROUBLESHOOTING TREE. *Figure 8-37* is a troubleshooting tree for the oven circuits. The troubleshooting procedure separates the different functional circuits by monitoring the oven supply current during different operating conditions. For example, if the warm-up current is excessive, this indicates a problem in the warm-up current limit circuit, or the current control and heater circuit. If shorting the thermistor reduces the current being drawn from the power supply, this indicates the current control circuit is operating and the problem is most likely in the warm-up current limit circuit.

8-754. As with most troubleshooting trees, this is intended to be a guide to the trouble area. It is not a substitute for technical skill in isolating the faulty components.

8-755. *Table 8-24*, Oven Circuit Voltages (at the end of these procedures), gives normal circuit voltages during warm-up, operation, and when thermistor RT1 is shorted to ground. Use this table during troubleshooting.

8-756. TROUBLESHOOTING CAUTIONS. When oven current is excessive, turn on the power supply only long enough to make the necessary measurements. Do not leave power on if the oven is drawing excessive current. With the housing cover and foam insulator removed, the thermal fuse, F1, cannot protect the circuits in the oven mass from overheating and damage.

8-757. When power is applied to the oven controller circuit, it will go into its full warm-up mode. In this mode, the maximum heating power is applied to the oven mass. The oven mass is a metal casting surrounding the oscillator circuits and crystal. The OVEN MONITOR output will be approximately 1.5V below the oven power supply voltage. In about 10 minutes, the oven will have heated to the proper temperature. The oven controller will begin to regulate at this temperature and the OVEN MONITOR will drop to approximately 3.5V. It is normal for the oven temperature to drop momentarily to a low value when the temperature first reaches maximum. This lasts less than a second and is a typical circuit action.

8-758. Oscillator Troubleshooting

8-759. The oscillator circuits are relatively simple and straightforward. The following paragraphs will briefly describe the major circuit areas, a troubleshooting outline, and some helpful suggestions to make the troubleshooting process easier. The oscillator consists of four sections, as follows:

1. Oscillator Q1, Q2, and associated circuitry.
2. AGC Q3, CR4, CR5, and R6.
3. Output circuit Q5 and Q9.
4. 5.7V power supply CR2, CR3, and Q4.

8-760. The oscillator is the signal source. Its output level is controlled by the AGC. The 5.7V power supply provides an extra-stable clean voltage source for the oscillator circuits. The output circuits provide a high level signal capable of driving a 50Ω to 1kΩ load.

8-761. NORMAL OPERATION. The output of the oscillator circuit at Q2 collector is a 10 MHz undistorted sine wave with an amplitude of approximately 2.8V p-p. The AGC voltage (measured at CR5-C13 junction) is approximately –1.5V. The 10 MHz signal passes through Q5 to Q9 base at about the same level. The voltage gain of amplifier Q5 (base to collector) is approximately 2 with a 50Ω load on the output. The output of transformer T1 is approximately 1.5V p-p. All 10 MHz signals found in the oscillator will be undistorted sine waves unless otherwise noted in *Table 8-25*, Oscillator Section Normal Voltages.

Figure 8-37
OVEN CONTROLLER TROUBLESHOOTING TREE
(See Page 8-167)

8-762. TROUBLESHOOTING. When troubleshooting the oscillator section, remove the oven mass from the housing and the covers from the oven mass as described in paragraph 8-745. Connect 12V to the oscillator section; use the special connector described in paragraph 8-734, Special Test Connector. Set the power supply current limit to 60 mA. DO NOT apply power to the oven circuits!

8-763. Initial troubleshooting and probing should be done on the backside of the boards (trace side) while they are secured to the oven mass (see paragraph 8-746, step 8). This way the circuits are more easily handled. When the fault is isolated to a few components, the unit may then be disassembled for final troubleshooting and repair.

8-764. Points to consider when troubleshooting the oscillator circuit:

- Most points in the oscillator circuit cannot be measured with a dc voltmeter. The reactance of the voltmeter probe and leads will load the circuit and give false readings. Instead, use an oscilloscope with a high input impedance probe for these measurements. *Table 8-25,* Oscillator Section Normal Voltages, indicates when a dc voltmeter can be used.

- Before reinstalling the oven mass into the housing, adjust the output amplitude as instructed in paragraph 8-770, Output Amplitude Adjustment.

8-765. Symptoms of failures in the oscillator sections will generally fall into one of the following categories:

1. No output.

2. Output Amplitude is low or high.

3. Excessive drift of output frequency.

8-766. Troubleshooting of these faults is discussed in the following paragraphs.

8-767. NO OUTPUT. This is usually easy to repair by simple signal tracing. Localized fault finding (to actual defective component) can be somewhat more difficult if the problem is in the main oscillator circuit (Q1, Q2, and AGC). If the fault appears to be in the oscillator section and does not yield to normal troubleshooting techniques, measure the AGC voltage at the junction of CR5-C13 (See Note 7 in *Table 8-25,* Oscillator Section Normal Voltages). If this voltage appears normal, the problem may be a defective quartz crystal (Y1). To verify this possibility, obtain a 10 μH (HP Part No. 9100-2265) and a 12 μH inductor (HP Part No. 9100-2242). (Use the HP numbered parts as these have been tested in the circuit.) On the oscillator board, remove the red and blue wires connecting the crystal to the board. Place the 12 μH inductor in place of these wires. With 12V applied to the circuit, adjust the FREQ ADJ (C1) and the amplitude control (R6) for a good sine wave signal.

NOTE

At some settings of C1 and/or R6, intermittent oscillations may appear. Some minor adjustment of C1 and/or R6 should clear this. If this fails, replace the 12 μH inductor with the 10 μH inductor and repeat the C1/R6 adjustment.

8-768. If replacing the crystal with an inductor produces oscillation, this is a very good indication of a defective crystal. When replacing crystal Y1, read paragraph 8-733(b), Special Parts Replacement Considerations. If the circuit will still not oscillate, the problem is most likely one of the oscillator circuit elements.

8-769. OUTPUT AMPLITUDE HIGH OR LOW. Many times this can be cured by the adjustment of R6 as described in paragraph 8-770. If the correct amplitude cannot be obtained with this adjustment, monitor the signal at Q2 collector with an oscilloscope and set R6 to obtain an amplitude of 2.8V p-p. Then check Q5 and Q9 stages. If the R6 adjustment is not effective, investigate the operation of the AGC circuitry (Q3, CR4, CR5, C5, C6, R5, R6, R7, or Q1).

8-770. Output Amplitude Adjustment. The output amplitude is adjusted by the setting of the variable resistor R6 which is in the feedback of the AGC circuitry. R6 is not accessible from the outside of the oscillator.

8-771. The following procedure should be used to adjust the output amplitude only if the output level falls outside the specified level, or repairs have been made to the main oscillator or AGC circuitry.

1. Remove oscillator from instrument.

2. Remove the three screws holding the bottom cover on the oscillator. Remove the bottom cover and allow the oscillator to cool (if previously operated).

3. Remove the two screws securing the P.C. edge connector to the outer can. Remove the top foam insulator to expose the oscillator circuits.

WARNING

THE OSCILLATOR'S INTERNAL OVEN MASS TEMPERATURE MAY BE AS HIGH AS 85°C (185°F). TO AVOID SERIOUS BURNS, DO NOT REMOVE OSCILLATOR CIRCUITS AND/OR OVEN MASS ASSEMBLY FROM THE OUTER HOUSING UNTIL THE OSCILLATOR HAS SUFFICIENTLY COOLED (APPROXIMATELY 1 HOUR WITH BOTTOM COVER AND FOAM INSULATOR REMOVED). THE OUTER HOUSING TEMPERATURE IS NOT A RELIABLE INDICATION OF THE INTERNAL TEMPERATURE.

4. Once the oscillator is cool enough to handle, remove the oscillator assembly by pushing on the tuning capacitor (FREQ ADJ) with a long, small diameter tool until the oscillator assembly can be removed easily.

CAUTION

Under no circumstances should the oven circuit be operated with the oven mass removed from the outer housing. To do so will cause damage to components inside the oven mass.

5. Set up the equipment shown in *Figure 8-38.*

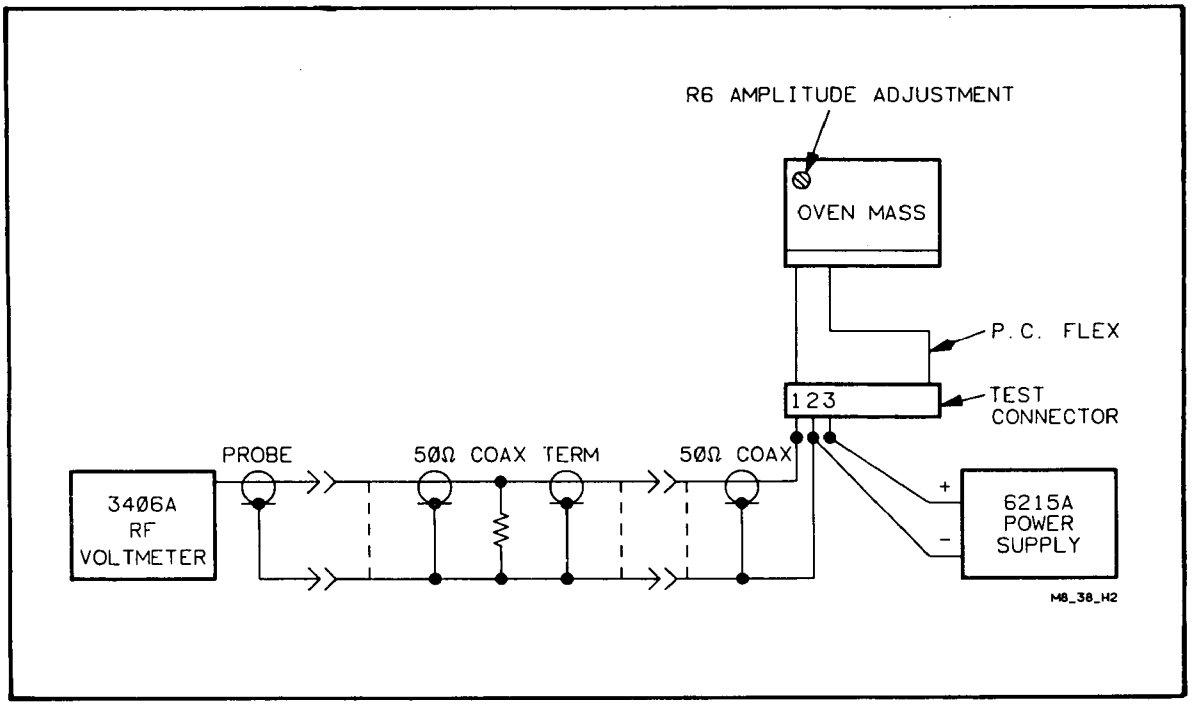


Figure 8-38. Oven Oscillator Output Amplitude Adjustment Setup

6. Preset power supply to 12V dc. Turn off the power supply before proceeding to the next step.

7. Connect the power supply to pins 2 (-) and 3 (+) of the 15 pin test connector. (See instructions in paragraph 8-734, Special Test Connector, to fabricate the test connector.)

   a. Insert the oscillator edge connector into the 15-pin test connector.

   b. Connect pin 1 and 2 of the 15-pin test connector to an oscilloscope using a 50Ω coaxial cable. Set the oscilloscope to 50Ω input. Do not apply power to the oven circuits.

8. Turn on the power supply and adjust R6 AGC control for 1.56V p-p ±0.14V p-p.

9. Turn off the power supply and reassemble the oscillator if the problem is corrected.

8-772. EXCESSIVE DRIFT OF OUTPUT FREQUENCY. When the quartz crystal oscillator has not been operated for a long period of time, or if it has been subjected to severe thermal or mechanical shock, the oscillator may take some time to stabilize. In most cases, the crystal will drift and then stabilize at or below the specified rate within a few days after being turned on. In isolated cases, depending on the amount of time the oscillator has been off and the environmental conditions it has experienced, the oscillator may take up to 1 week to reach the specified aging rate. This should be taken into consideration if the drift rate of the unit is out of specifications. If the unit has had sufficient time to stabilize but is still out of specification, the most likely cause of excessive drift is a defective crystal (Y1). If Y1 is to be replaced, read paragraph 8-733(b). Other possible causes are an unstable C3 and/or C8.

Table 8-24. Oven Circuit Voltages *

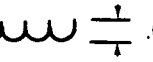
VOLTAGE POINT	OVEN AT OPERATING TEMP.	OVEN COLD (JUST AFTER TURN-ON)	RT1 GROUNDED
Q6B	1.6	2.	.25
Q6C	11.4	11.4	11.4
Q6E	1.	1.3	0
Q7B	12.5	12.7	11.9
Q7C	20.	20.	20.
Q7E	11.4	11.4	11.4
Q8B	1.	1.3	0
Q8C	11.4	11.4	11.4
Q8E	.07	.23	0
U1 Pin 1	8.9	1.8	8.9
U1 Pin 2	.07	.23	0
U1 Pin 3	.2	.23	.2
U1 Pin 5	4.	4.1	3.8
U1 Pin 6	4.	4.1	3.8
U1 Pin 7	3.3	4.8	1.5
U2 Pin 2	10.	10.	10.
U3 Pin 6	3.5	19.0	.5

*Voltage readings taken with oven supply voltage of 20V dc and insulating foam and cover removed. Voltages are approximate and will vary slightly from unit-to-unit.

Table 8-25. Oscillator Section Normal Voltages

VOLTAGE POINT	NORMAL VOLTAGES		REMARKS
	AC (p-p)	DC	
C3/R3	1 to 4	—	Note 8
CR5/C13	—	-1.5	Notes 4 and 7
CR3(C)	0	6.3	Note 4
Q1(B)	1	.75	Note 8
Q1(C)	0	5.5	Note 4
Q1(E)	.9	.03	Note 8
Q2(B)	0	2.7	Note 4
Q2(C)	2.7	5.6	Note 8
Q2(E)	.06	2	Notes 4 and 5
Q3(B)	2.7	5.6	Note 8
Q3(C)	0	11.8	Note 4
Q3(E)	2.4	4.9	Notes 4 and 6
Q4(B)	0	6.3	Note 4
Q4(C)	0	10.3	Note 4
Q4(E)	0	5.6	Note 4
Q5(B)	2.7	3.1	Note 8
Q5(C)	0	11.8	Notes 8 and 9
Q5(E)	2.8	2.6	Note 8
Q9(B)	2.8	2.8	Note 8, 9
Q9(C)	5.1	11.8	Note 8, 9
Q9(E)	2.5	1.9	Note 8

NOTES:

1. All voltages taken with 12V oscillator supply.
2. Voltages are approximate and will vary slightly from unit-to-unit.
3. All ac voltages are sine waves except Q2(E) and Q3(E).
4. This dc voltage may be measured with a standard dc voltmeter. All other voltages should be measured with an oscilloscope and high impedance probe to minimize circuit loading.
5. Waveform is  .06V.
6. Waveform is slightly flattened on the bottom.
7. This is the AGC voltage. Value shown is nominal with oscillator operating. If the oscillator is not oscillating, the AGC voltage will be ~+2.5V.
8. Measure both ac and dc voltages with an oscilloscope and a high impedance probe to minimize circuit loading.
9. AC voltage at Q9(C) measured with 50-ohm load on the output.

8-773. SCHEMATIC DIAGRAMS

8-774. The following pages contain rear panel and top internal views of the instrument, followed by the schematic diagrams for each of the circuit board assemblies in the HP 5350B/51B/52B. Each schematic diagram includes a component locator for each field repairable assembly. Where applicable, test and troubleshooting waveform photographs are placed adjacent to the schematic. The schematic diagrams are arranged in reference designation order, with the exception of the A8 Motherboard/Power Supply Regulator Assembly, which is placed first in the sequence.

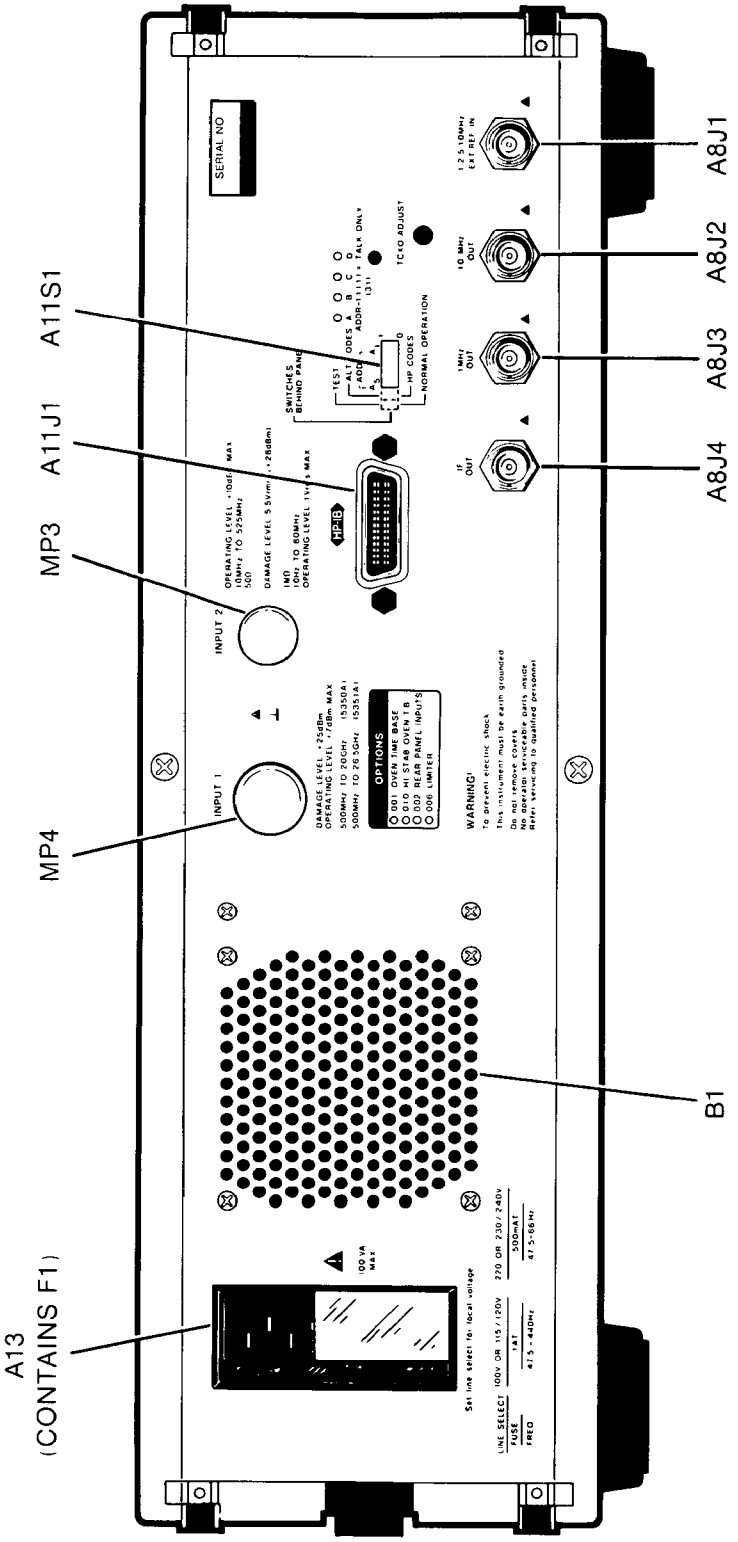


Figure 8-39. Rear Panel View

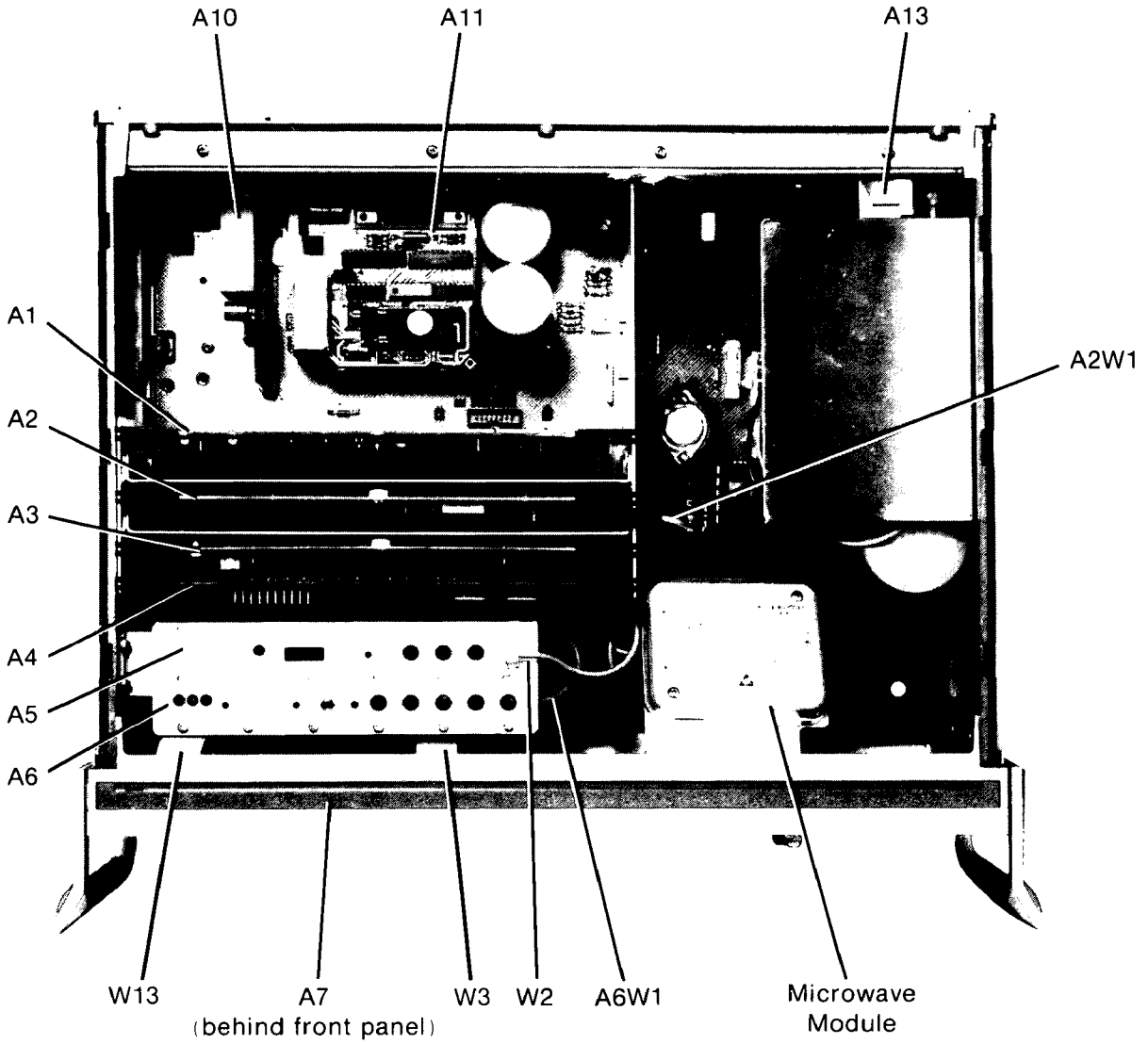
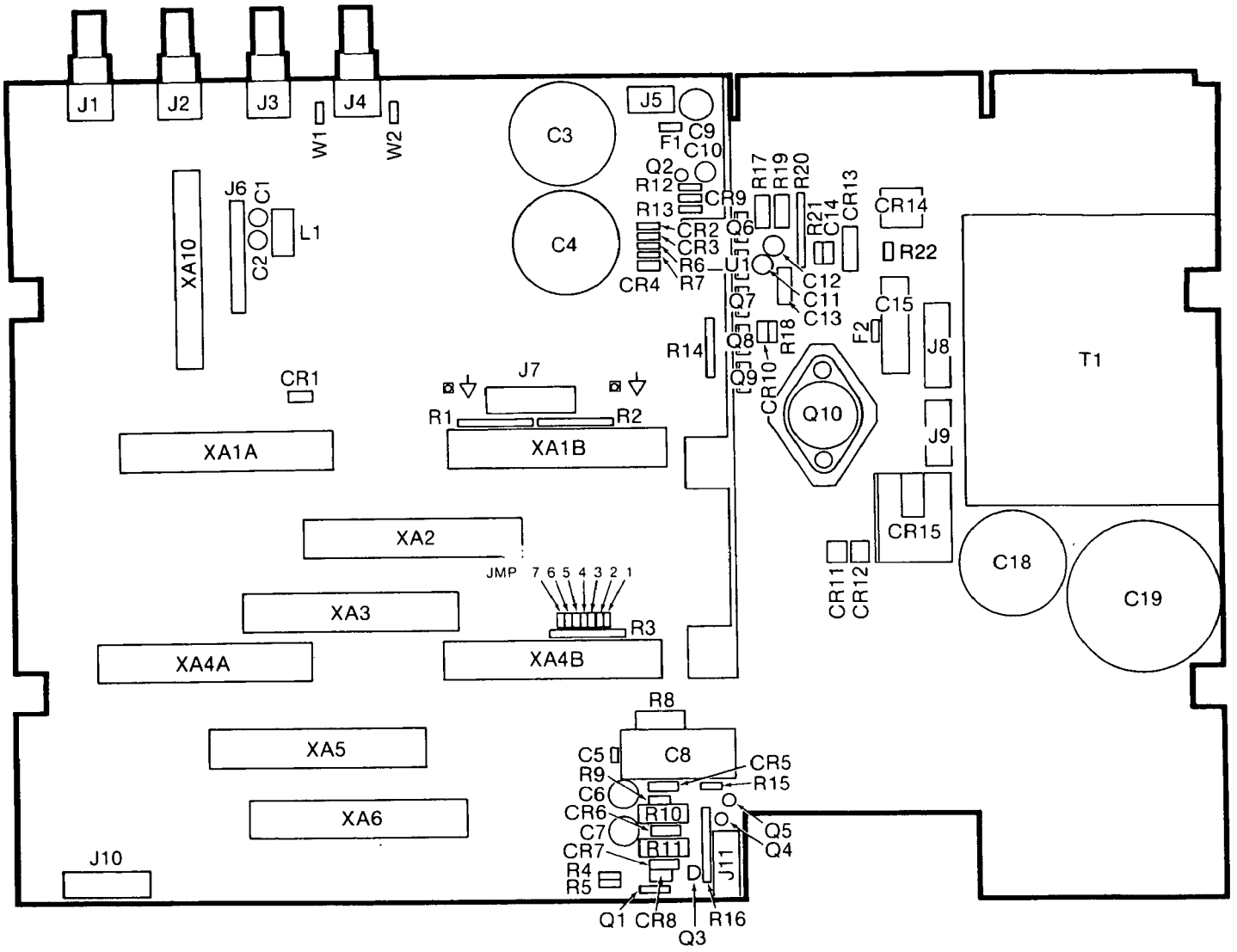


Figure 8-40. Top Internal View



NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.
2. UNLESS OTHERWISE INDICATED:
   RESISTANCE IN OHMS;
   CAPACITANCE IN MICROFARADS;
   INDUCTANCE IN MICROHENRIES.

REFERENCE DESIGNATIONS

A8 ASSEMBLY
C1-C15, C18, C19 CR1-CR15 F1, F2 J1-J11 JMP1-JMP7 L1 Q1-Q10 R1-R22 TP1, TP2 U1 W1, W2

A8 ACTIVE COMPONENTS

REFERENCE DESIGNATIONS	HP PART NUMBER	MFG. PART NUMBER
CR1	1901-1080	1N5817
CR2, CR3, CR9	1901-0050	1N4150
CR4, CR8, CR10	1901-0731	1N4004G
CR5, CR6	1902-0939	1N5908
CR7	1902-0632	1N5354B
CR11, CR12	1901-0673	A15A
CR13	1906-0096	MDA202
CR14	1906-0079	VJ148X
CR15	1906-0286	MBR2035CT
Q1	1853-0347	MJE700
Q2	1854-0365	2N4410
Q3, Q5	1854-0215	2N3904
Q6, Q7	1853-0478	2N6490
Q8, Q9	1854-0884	2N6488
Q10	1854-0697	2N5886
U1	1826-0527	LM337T

A8J7

POWER SUPPLY TEST CONNECTOR CIRCUIT SIDE OF MOTHERBOARD

V/+5V OSC	9	1	V/+5μP
V/+12V OSC	10	2	V/-24V
V/+3V	11	3	V/+12PS
V/-FAN	12	4	REF/+5V
I/+5V	13	5	GROUND
V/+5V	14	6	L STBY
V/-5.2V	15	7	V/+15V
V/-5.2V	16	8	I/+15V

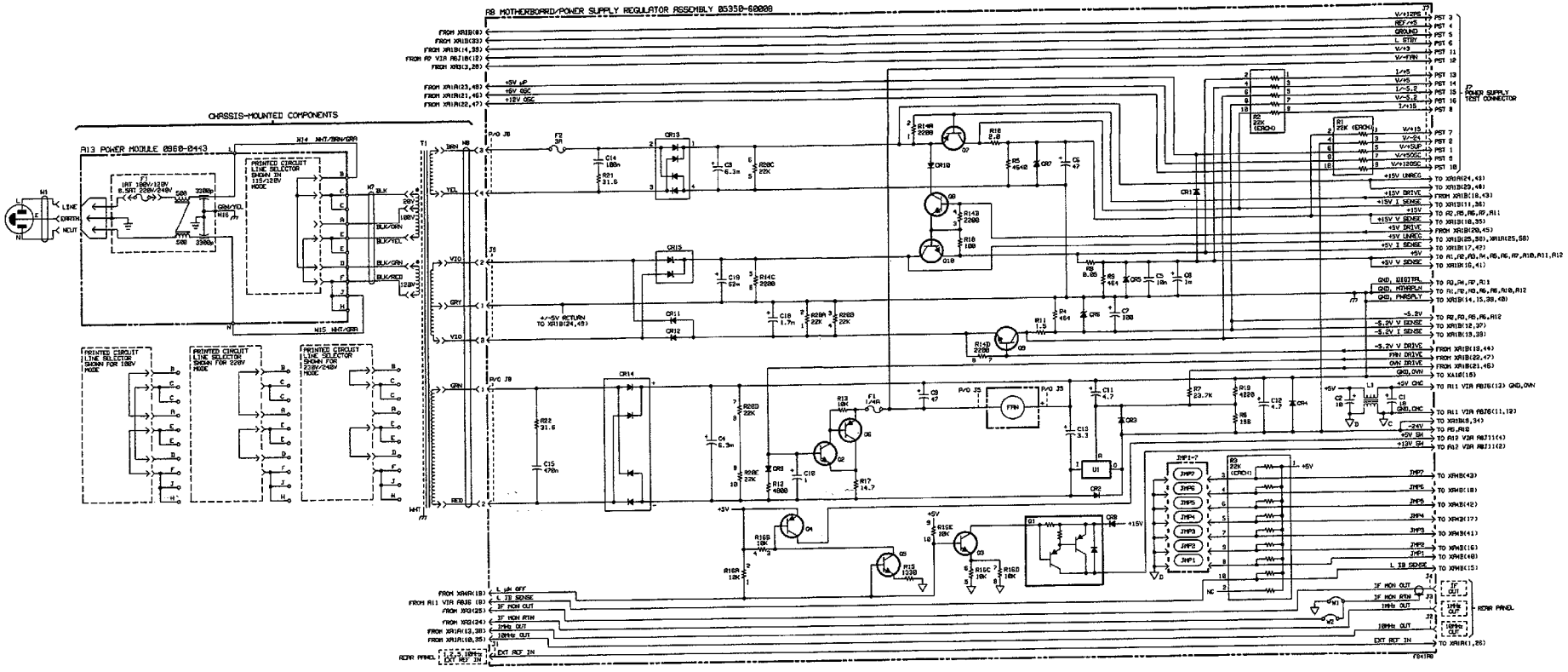
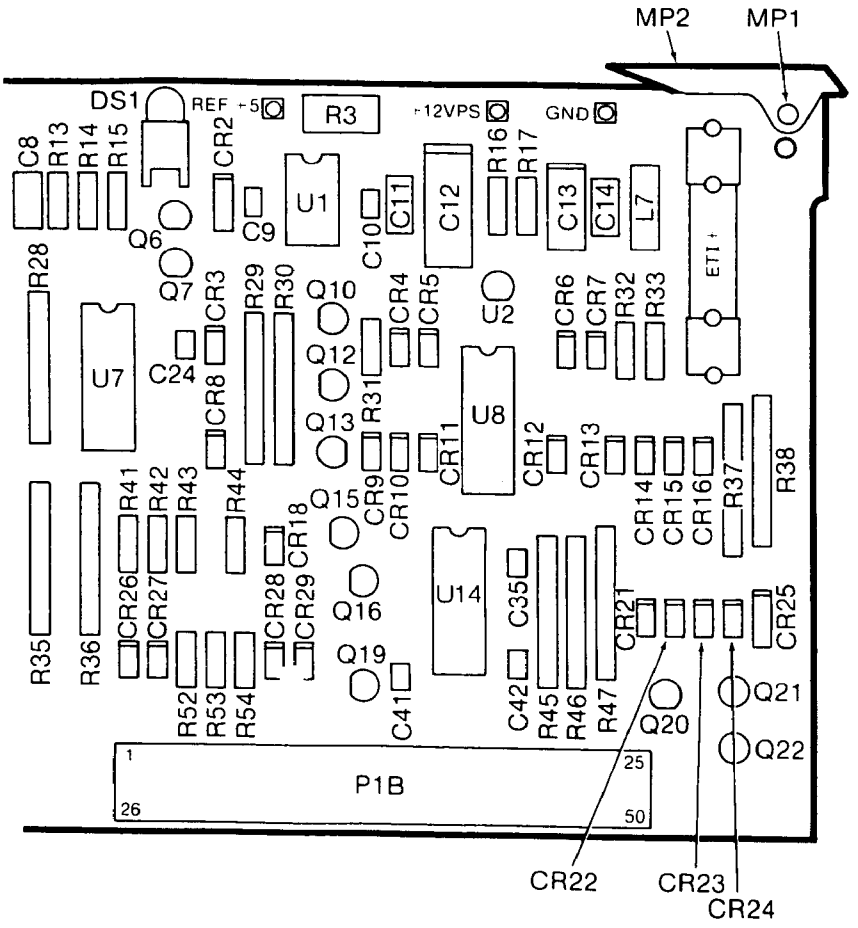
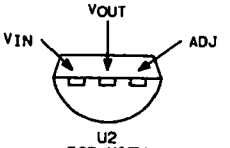


Figure 8-41. A8 Motherboard/Power Supply Regulator Assembly

Figure 8-41
A8 MOTHERBOARD/POWER SUPPLY REGULATOR ASSEMBLY
(See Page 8-177)





U2
TOP VIEW

NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.
2. UNLESS OTHERWISE INDICATED:
   RESISTANCE IN OHMS;
   CAPACITANCE IN MICROFARADS;
   INDUCTANCE IN MICROHENRIES.
3. THE ETI FUSEHOLDER IS RESERVED FOA AN OPTIONAL (SPECIAL ORDER) 5000 HOUR ELAPSED TIME INDICATOR.
4. R28A IS USED FOR FACTORY TEST PURPOSES ONLY.

REFERENCE DESIGNATIONS

A1 ASSEMBLY
C1-C24, C26-C33, C35-C45
CR1-CR31
DS1
L1-L8
P1A, P1B
Q1-Q10, Q12, Q13, Q15-Q17, Q19-Q22
R1, R2, R4-R24, R26-R57, R59-R61
TP1-TP7
U1-U14

A1 ACTIVE COMPONENTS
POWER SUPPLY CONTROL CIRCUIT

REFERENCE DESIGNATIONS	HP PART NUMBER	MFG. PART NUMBER
CR2	1902-0057	SAME
CR3, CR26	1901-0841	HSCH-1001
CR4-CR16, CR18, CR21-CR24, CR27-CR29,	1901-0050	1N4150
CR25	1902-0050	SAME
DS1	1990-1022	HLMP-5030
Q6, Q7, Q12, Q15	1853-0036	2N3906
Q10, Q13, Q16, Q18, Q20	1854-0215	2N3904
Q21, Q22	1853-0281	2N2907A
U1	1826-0718	SAME
U2	1826-0772	SAME
U7, U8	1826-0138	LM339
U14	1826-0161	MLM324P

XR1B
CONNECTOR PINOUT
CIRCUIT SIDE OF MOTHERBOARD
(POWER SUPPLY CONTROL)

	26	1	GND MTHERPLN
	27	2	L OVN COLD
	28	3	H PWRSP OK
	29	4	STBY LED
	30	5	LSTBY
	31	6	L µP RESET
	32	7	L µP NMI
REF +5.0V	33	8	V/+12
	34	9	-24V V SENSE
	35	10	+15V V SENSE
	36	11	+15V I SENSE
	37	12	-5.2V V SENSE
	38	13	-5.2V I SENSE
	39	14	GND, PWRSPLY
	40	15	GND, PWRSPLY
	41	16	+5V V SENSE
	42	17	+5V I SENSE
	43	18	+15V DRIVE
	44	19	-5.2V DRIVE
	45	20	+5V DRIVE
	46	21	OVN DRIVE
	47	22	FAN DRIVE
	48	23	+15 UNREG
	49	24	+-5V RETURN (0V)
	50	25	+5V UNREG

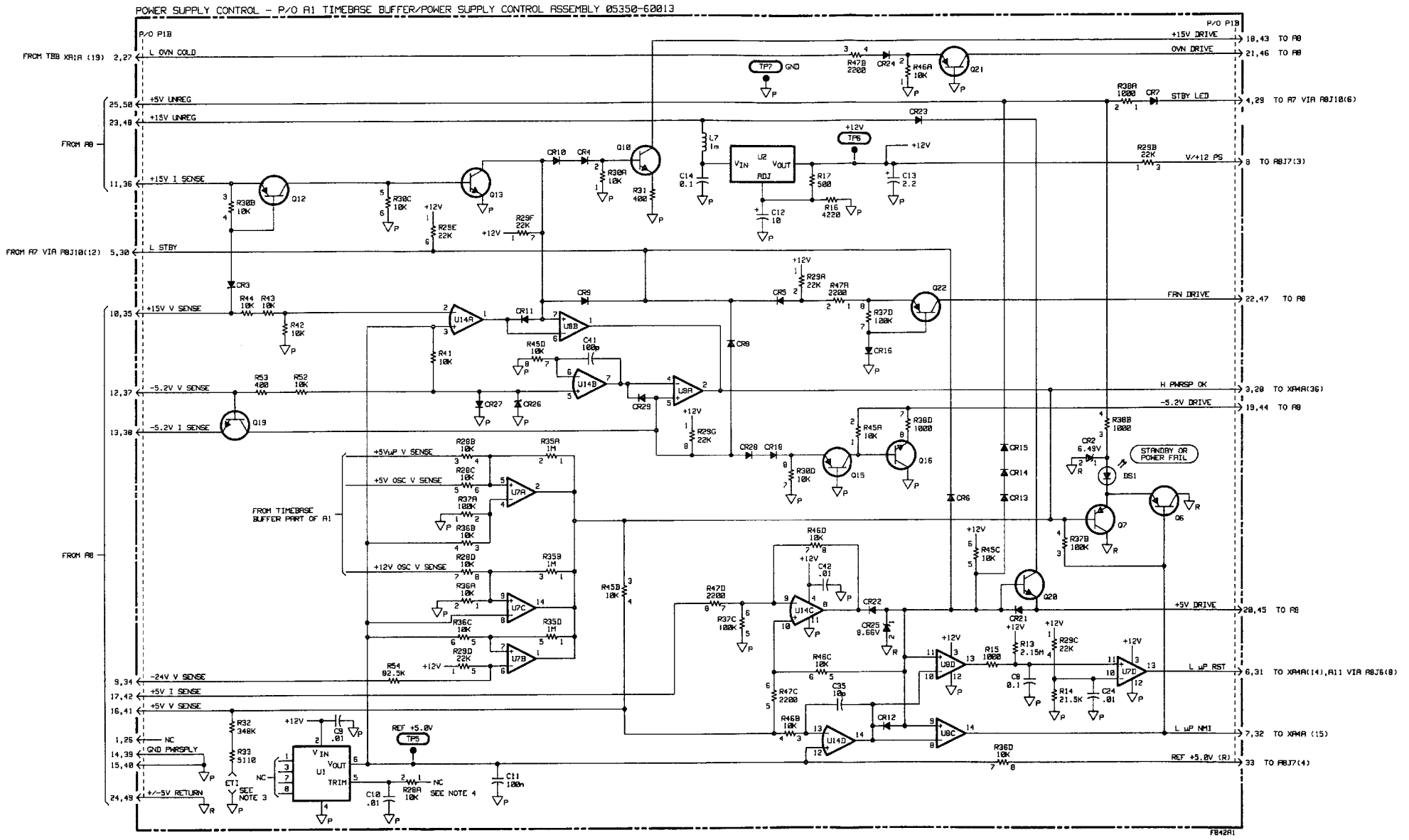
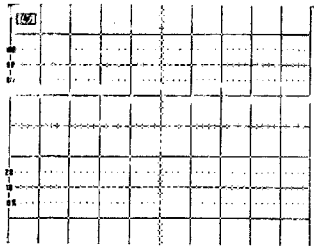


Figure 8-42. Power Supply Control (Part of A1 Timebase Buffer/Power Supply Control Assembly)

A

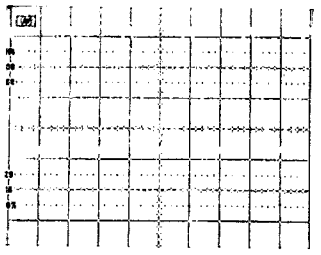


Collector of Q17

Vertical = .02 V/div
Horizontal = .05 μs/div
DC coupled, HP 10017A probe

10 MHz, -5 dBm input to EXT REF IN on rear panel.

B

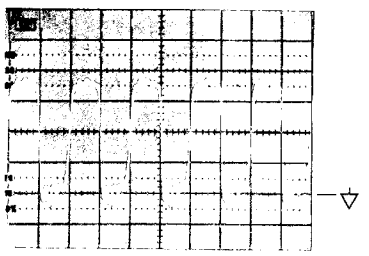


Collector of Q17

Vertical = .02 V/div
Horizontal = .5 μs/div
DC coupled, HP 10017A probe

1MHz, -5 dBm input to EXT REF IN on rear panel.

C

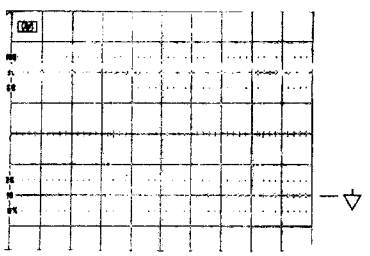


U3, pin 4

Vertical = .05 V/div
Horizontal = .05 μs/div
DC coupled, HP 10017A probe

10 MHz, -5 dBm input to EXT REF IN on rear panel.

D

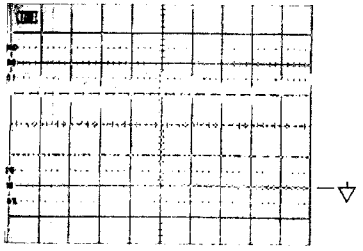


U3, pin 4

Vertical = .05 V/div
Horizontal = .2 μs/div
DC coupled, HP 10017A probe

1MHz, -5 dBm input to EXT REF IN on rear panel.

E

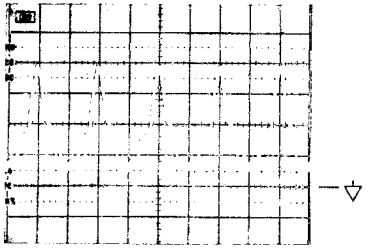


Emitter of Q4

Vertical = .02 V/div
Horizontal = .05μs/div
DC coupled, HP 10017A probe

10 MHz, -5 dBm input to EXT REF IN on rear panel.

F

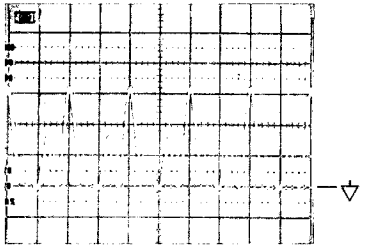


Emitter of Q4

Vertical = .02 V/div
Horizontal = .2 μs/div
DC coupled, HP 10017A probe

1MHz, -5 dBm input to EXT REF IN on rear panel.

G

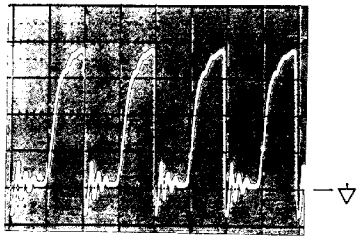


TP1

Vertical = .05 V/div
Horizontal = .05 μs/div
DC coupled, HP 10017A probe

10 MHz, -5 dBm input to EXT REF IN on rear panel.

H



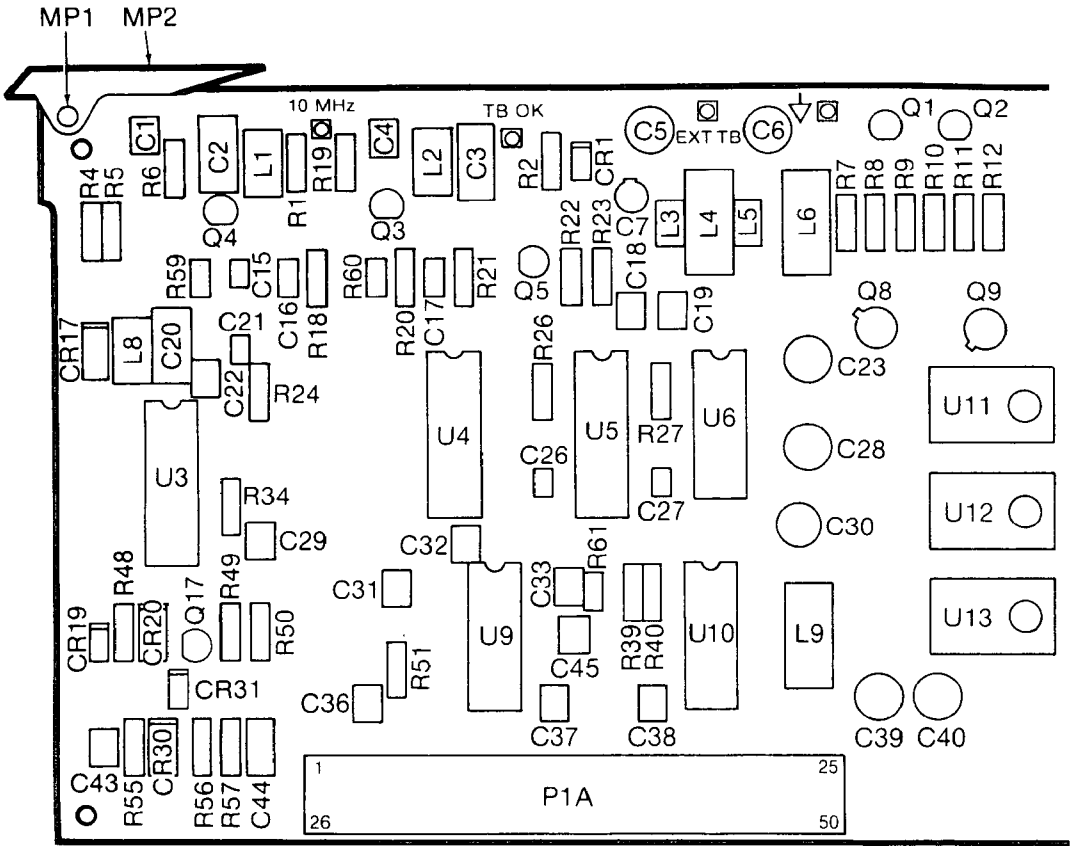
U4D, pin 11

Vertical = .1 V/div
Horizontal = .05 μs/div
DC coupled, HP 10017A probe

10 MHz, -5 dBm input to EXT REF IN on rear panel.

Figure 8-43. Timebase Buffer Waveforms

Figure 8-42
POWER SUPPLY CONTROL (PART OF A1 TIMEBASE BUFFER/POWER SUPPLY CONTROL ASSEMBLY)
(See Page 8-179)



NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.
2. UNLESS OTHERWISE INDICATED:
   RESISTANCE IN OHMS;
   CAPACITANCE IN MICROFARADS;
   INDUCTANCE IN MICROHENRIES.

REFERENCE DESIGNATIONS

A1 ASSEMBLY
C1-C24, C26-C33, C35-C45 CR1-CR31 DS1 L1-L9 P1A, P1B Q1-Q10, Q12, Q13, Q15-Q17, Q19-Q22 R1, R2, R4-R24 R26-R57, R59-R61 TP1-TP7 U1-U14

A1 ACTIVE COMPONENTS
TIMEBASE BUFFER CIRCUIT

REFERENCE DESIGNATIONS	HP PART NUMBER	MFG. PART NUMBER
CR1	1902-0040	SAME
CR17, CR20, CR30	1901-0047	SAME
CR19	1901-0050	1N4150
CR31	1901-0539	SAME
Q1, Q2	1854-0215	2N3904
Q3, Q4	1854-0092	SAME
Q5	1853-0036	2N3906
Q8, Q9	1853-0281	2N2907A
Q17	1853-0352	SAME
U3	1820-1437	SN74LS221N
U4, U10	1820-1425	SN74LS132N
U5	1820-1423	SN74LS123N
U6	1820-1442	SN74LS290N
U9	1820-1074	SN74126N
U11, U12	1826-0904	SAME
U13	1826-0147	MC7812CP

XA1A
CONNECTOR PINOUT
CIRCUIT SIDE OF MOTHERBOARD
(TIMEBASE BUFFER)

	26	1	EXT REF IN
	27	2	GND, MTHRPLN
	28	3	GND, MTHRPLN
	29	4	10MHz INT SYM
	30	5	GND, MTHRPLN
	31	6	GND, MTHRPLN
	32	7	10MHz INT CTR
	33	8	GND, MTHRPLN
	34	9	GND, MTHRPLN
	35	10	10MHz OUT
	36	11	GND, MTHRPLN
	37	12	GND, MTHRPLN
	38	13	1MHz OUT
	39	14	GND, MTHRPLN
L 10MHz OK	40	15	L EXT REF
	41	16	GND, MTHRPLN
	42	17	10MHz OSC
	43	18	GND, MTHRPLN
OVN TEMP	44	19	L OVN COLD
	45	20	+5V
	46	21	+5V OSC
	47	22	+12V OSC
	48	23	+5VμP
	49	24	+15V UNREG
	50	25	+5V UNREG

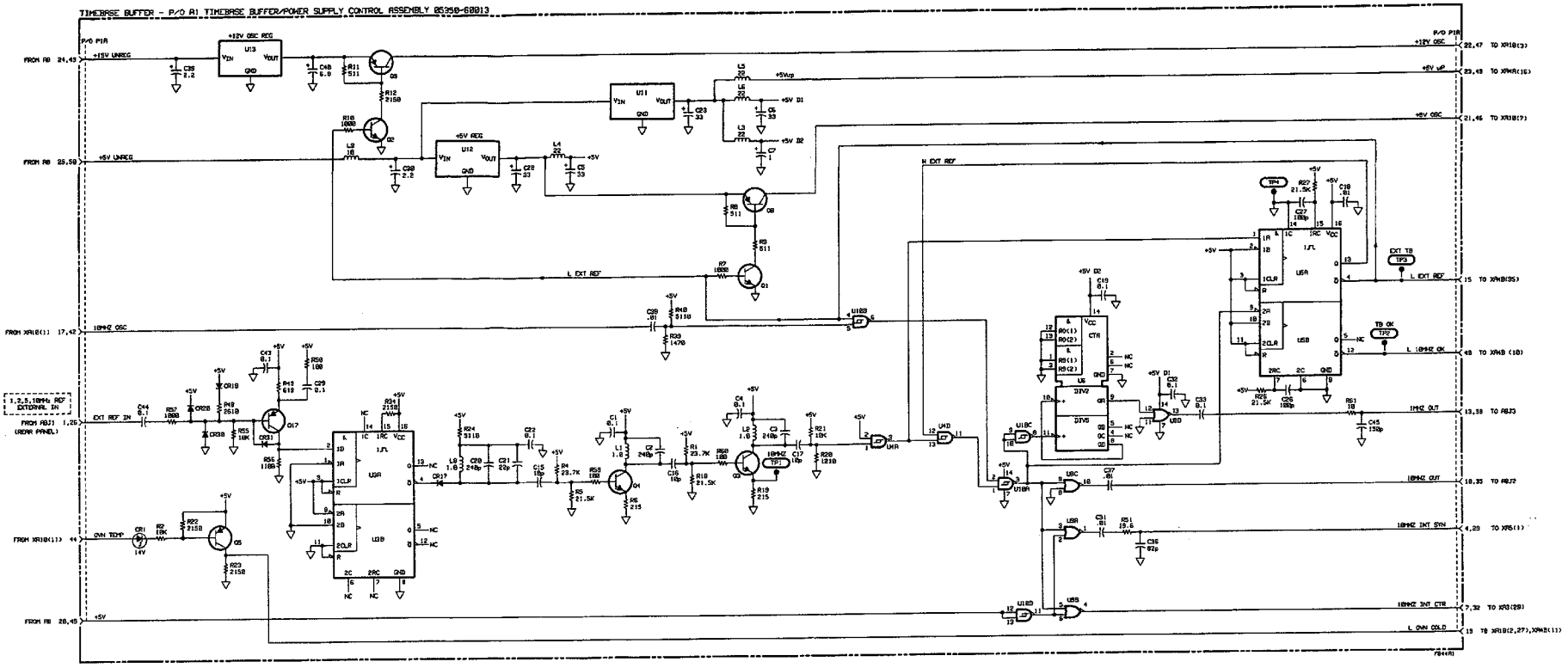
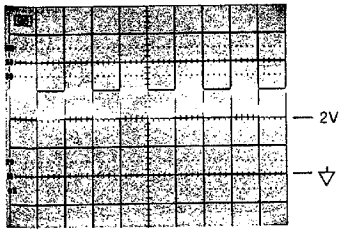


Figure 8-44. Timebase Buffer (Part of A1 Timebase Buffer/Power Supply Control Assembly)

A

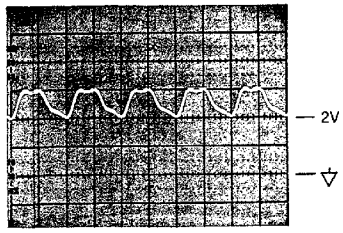


LF OUT A

Counter in 50Ω mode; 50 MHz, -10 dBm input to INPUT 2.

Vertical = .1 V/div
Horizontal = .1 μs/div
DC coupled, HP 10017A probe

B

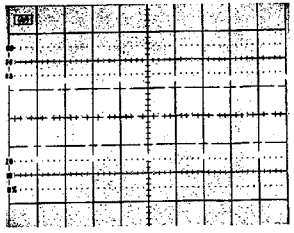


LF OUT A

Counter in 1MΩ mode; 50 MHz, -10 dBm input to INPUT 2.

Vertical = .1 V/div
Horizontal = .01 μs/div
DC coupled, HP 10017A probe

C

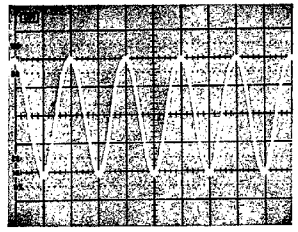


U7, pin 2

Counter in 50Ω mode; 50 MHz, 100 mV p-p input to INPUT 2.

Vertical = .01 V/div
Horizontal = .01 μs/div
AC coupled, HP 10017A probe

D

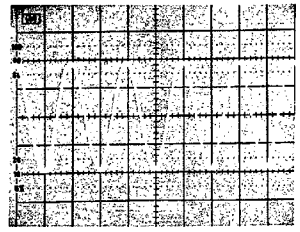


U5, pin 2

Counter in 50Ω mode; 50 MHz, 100 mV p-p input to INPUT 2.

Vertical = .01 V/div
Horizontal = .01 μs/div
AC coupled, HP 10017A probe

E

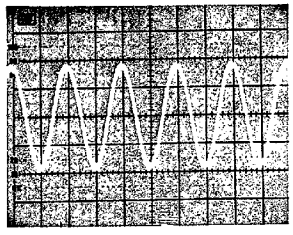


Source of Q9

Counter in 50Ω mode; 50 MHz, -10 dBm input to INPUT 2.

Vertical = .01 V/div
Horizontal = .01 μs/div
AC coupled, HP 10017A probe

F

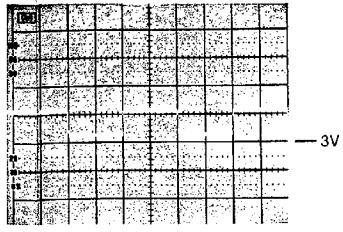


U4, pin 2

Counter in 50Ω mode; 50 MHz, 100 mV p-p input to INPUT 2.

Vertical = .01 V/div
Horizontal = .01 μs/div
AC coupled, HP 10017A probe

G

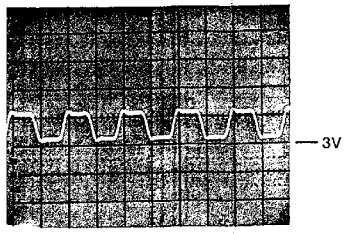


U1, pin 8

Counter in 50Ω mode; 50 MHz, -10 dBm input to INPUT 2.

Vertical = .1 V/div
Horizontal = .05 μs/div
DC coupled, HP 10017A probe

H

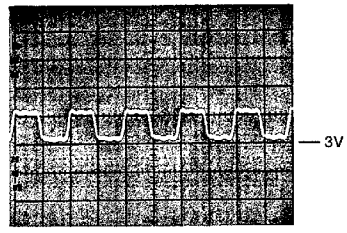


U6, pin 7

Counter in 1MΩ mode; 50 MHz, 100 mV p-p level at U6, pin 10.

Vertical = .1 V/div
Horizontal = .01 μs/div
DC coupled, HP 10017A probe

I

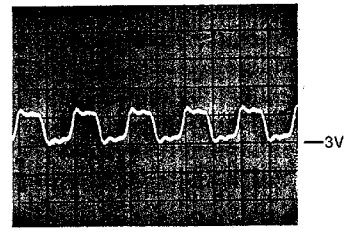


U6, pin 2

Counter in 1MΩ mode; 50 MHz, 100 mV p-p level at U6, pin 5.

Vertical = .1 V/div
Horizontal = .01 μs/div
DC coupled, HP 10017A probe

J



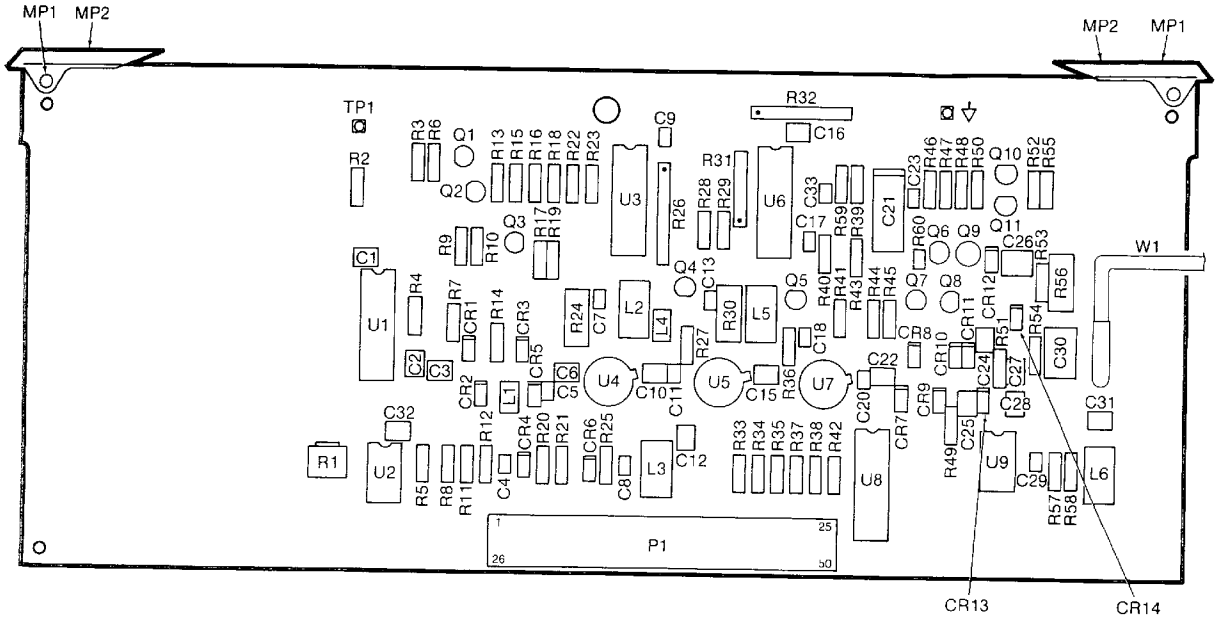
U6, pin 15

Counter in 1MΩ mode; 50 MHz, -20 dBm input to INPUT 2.

Vertical = .1 V/div
Horizontal = .01 μs/div
DC coupled, HP 10017A probe

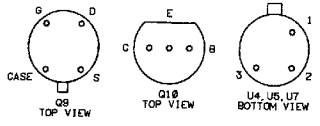
Figure 8-45. A2 Waveforms

Figure 8-44
TIMEBASE BUFFER (PART OF A1 TIMEBASE BUFFER/POWER SUPPLY CONTROL ASSEMBLY)
(See Page 8-181)



NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.
2. UNLESS OTHERWISE INDICATED:
   RESISTANCE IN OHMS;
   CAPACITANCE IN MICROFARADS;
   INDUCTANCE IN MICROHENRIES.



REFERENCE DESIGNATIONS

A2 ASSEMBLY
C1-C13, C15-C18 C20-C33 CR1-CR14 L1-L6 P1 Q1-Q11 R1-R60 TP1, TP2 U1-U8 W1

A2 ACTIVE COMPONENTS

REFERENCE DESIGNATIONS	MP PART NUMBER	MFG. PART NUMBER
CR1-CR10 CR11, CR13 CR12, CR14	1901-0539 1901-0050 1901-0376	SAME 1N4150 1N3595
Q1, Q2 Q3, Q4, Q10 Q5, Q7, Q8 Q11	1854-0082 1853-0036 1854-0215	SAME 2N3906 2N3904
Q6 Q9	1853-0354 1855-0327	SAME 2N4416
U1 U2 U3, U6 U4, U5 U6 U7 U8	1820-1780 1826-0138 1820-2823 1813-0215 1820-3075 1813-0214 1826-0346	11C90DC CA1458G MC10H102P MWA220 MC10H116L MWA210 LM358N

XA2
CONNECTOR PINOUT
CIRCUIT SIDE OF MOTHERBOARD

GND, MTHRPLN	26	1	GND, MTHRPLN
GND, MTHRPLN	27	2	LF OUT B
GND, MTHRPLN	28	3	LF OUT A
GND, MTHRPLN	29	4	GND, MTHRPLN
NC	30	5	NC
NC	31	6	NC
NC	32	7	NC
GND, MTHRPLN	33	8	GND, MTHRPLN
NC	34	9	LF OUT SEL
NC	35	10	NC
NC	36	11	NC
NC	37	12	L LF TEST
GND, MTHRPLN	38	13	NC
NC	39	14	NC
+5V	40	15	+5V
NC	41	16	NC
NC	42	17	NC
NC	43	18	NC
NC	44	19	NC
NC	45	20	NC
+5V	46	21	+15V
GND, MTHRPLN	47	22	GND, MTHRPLN
NC	48	23	H LF 50
-5.2V	49	24	-5.2V
AUX A	50	25	AUX B

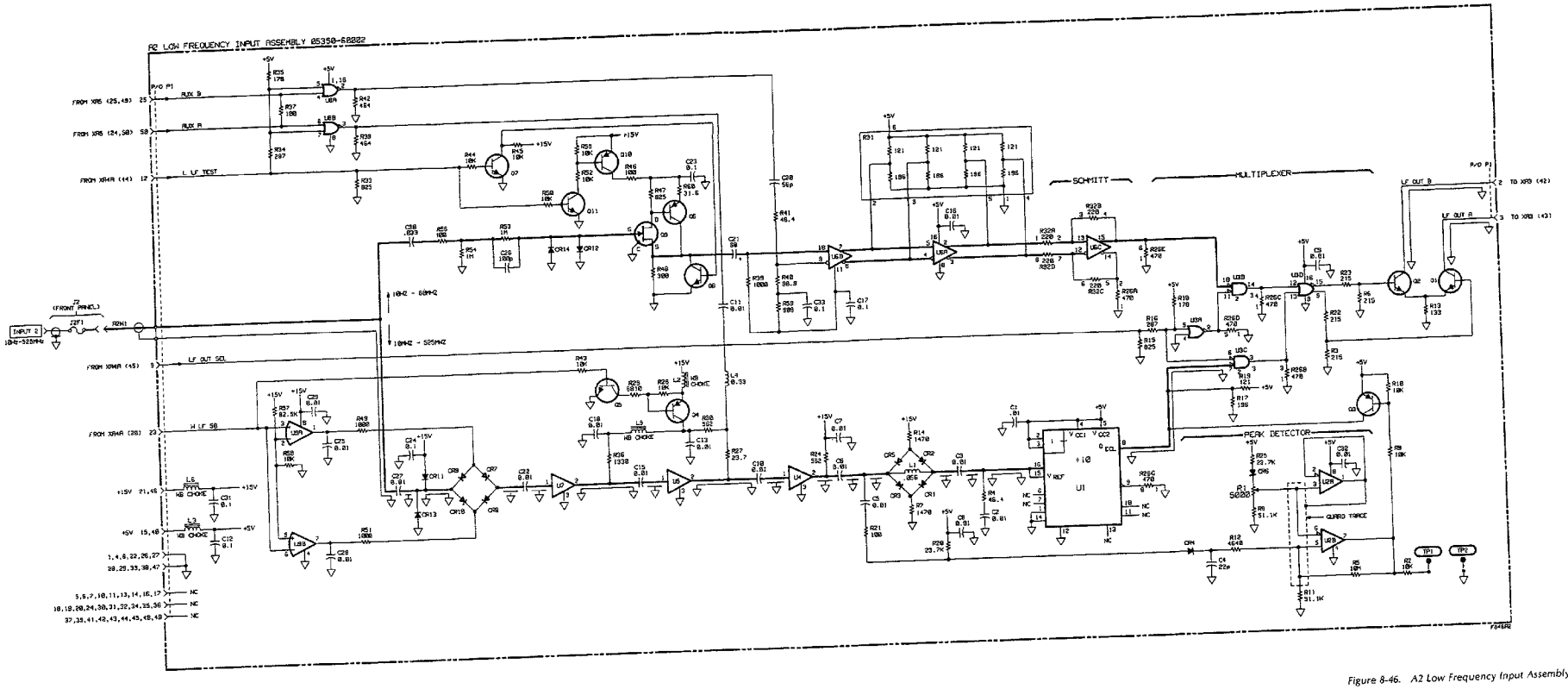
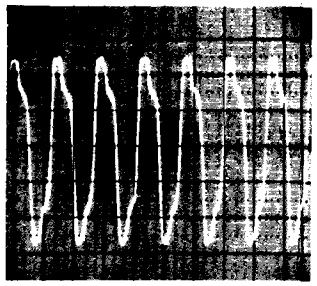


Figure 8-46. A2 Low Frequency Input Assembly

A



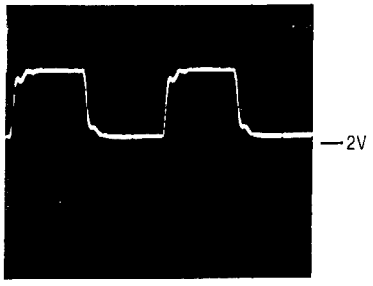
70 MHz IF, base of Q2

Counter in INPUT 1, Manual mode; Manual CF = 1 GHz.

1 GHz, -20 dBm input to INPUT 1.

Vertical = .02 V/div
Horizontal = .01 μs/div
AC coupled, HP 10017A probe

B

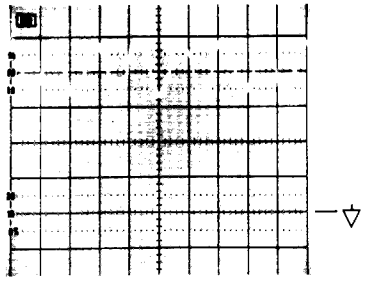


U7, pin 26

Counter in 1MΩ mode; 10 MHz, -20 dBm input to INPUT 2.

Vertical = .05 V/div
Horizontal = .02 μs/div
DC coupled, HP 10017A probe

C



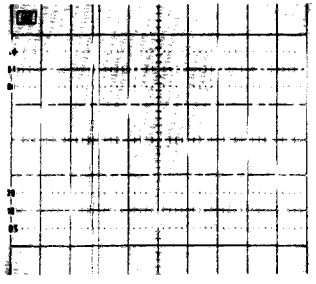
70 MHz IF at U7, pin 30

Counter in INPUT 1, Manual mode; Manual CF = 1 GHz

1 GHz, -20 dBm input to INPUT 1.

Vertical = .05 V/div
Horizontal = .01 μs/div
DC coupled, HP 10017A probe

D



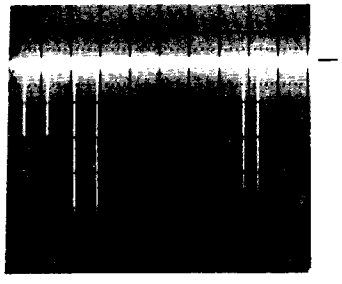
70 MHz IF at rear panel BNC connector IF OUT.

Counter in INPUT 1, Manual mode, Manual CF = 1 GHz.

1 GHz, -20 dBm input to INPUT 1.

Vertical = .02 V/div
Horizontal = .01 μs/div
Direct BNC cable connection to oscilloscope.
AC coupled

E



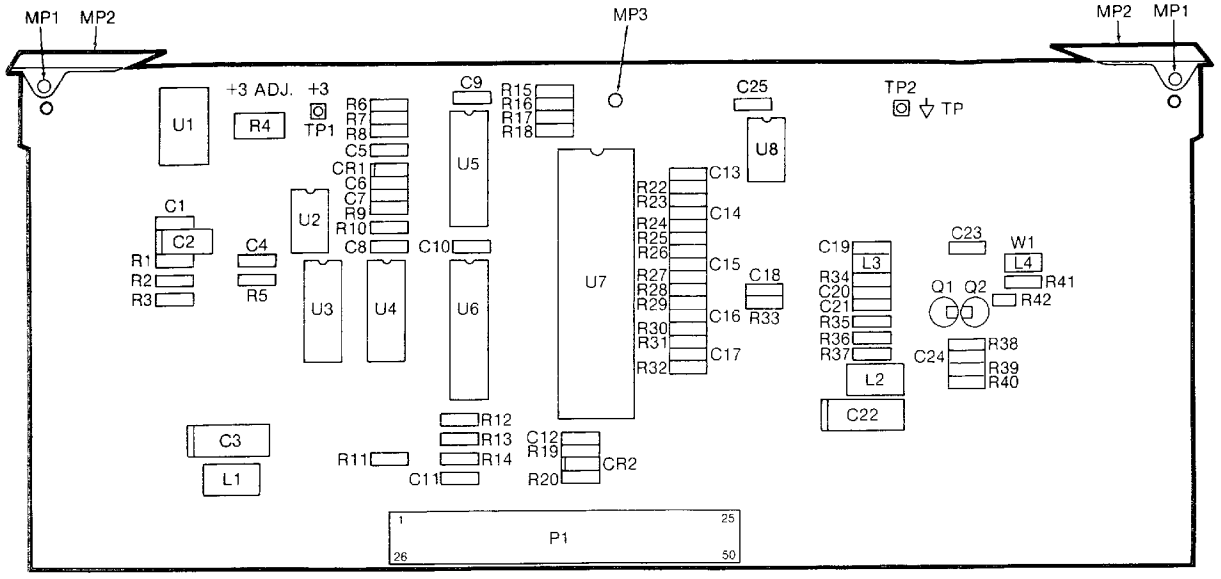
U2, pin 3

Counter in 1MΩ mode; Diag 7 on, Fastest sample rate, minumum resolution

Vertical = .02 V/div
Horizontal = 2 ms/div
AC coupled, external trigger off U4, pin 2
HP 10017A probe

Figure 8-47. A3 Waveforms

Figure 8-46
A2 LOW FREQUENCY INPUT ASSEMBLY
(See Page 8-183)



NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.
2. UNLESS OTHERWISE INDICATED:
   RESISTANCE IN OHMS;
   CAPACITANCE IN MICROFARADS;
   INDUCTANCE IN MICROHENRIES.

REFERENCE DESIGNATIONS

A3 ASSEMBLY
C1-C25 CR1, CR2 L1-L3 P1 Q1, Q2 R1-R20, R22-R42 TP1, TP2 U1-U8

A3 ACTIVE COMPONENTS

REFERENCE DESIGNATIONS	HP PART NUMBER	MFG. PART NUMBER
CR1, CR2	1901-0050	1N4150
Q1, Q2	1854-0501	BFR90
U1	1826-0393	SAME
U2	1826-0065	LM311N
U3	1820-1425	SN74LS132N
U4	1820-2086	SN74LS393N
U5	1858-0054	SAME
U6	1820-2724	SN74ALS573BN
U7	1820-2312	IDA9-2802
U8	1826-0346	LM358N

XA3
CONNECTOR PINOUT
CIRCUIT SIDE OF MOTHERBOARD

+5V	26	1	+5V
GND, DIGITAL	27	2	GND, DIGITAL
+3V TEST	28	3	+3V TEST
10 MHz INT CTR	29	4	NC
GND, MTHRPLN	30	5	GND, DIGITAL
DBUS 1	31	6	DBUS 0
DBUS 3	32	7	DBUS 2
DBUS 5	33	8	DBUS 4
DBUS 7	34	9	DBUS 6
GND, DIGITAL	35	10	GND, DIGITAL
L INTP EN	36	11	H INTP RST
L MRC STB	37	12	MRC RG0
H MRC CSEL	38	13	MRC RG1
H MRC READ	39	14	NOT USED
GND, DIGITAL	40	15	H GATE
GND, DIGITAL	41	16	GND, DIGITAL
LF OUT B	42	17	GND, DIGITAL
LF OUT A	43	18	GND, DIGITAL
GND, DIGITAL	44	19	GND, DIGITAL
NC	45	20	NC
AUX B	46	21	AUX B
AUX A	47	22	AUX A
-5.2V	48	23	-5.2V
IF	49	24	IF MON RTN
IF RTN	50	25	IF MON OUT

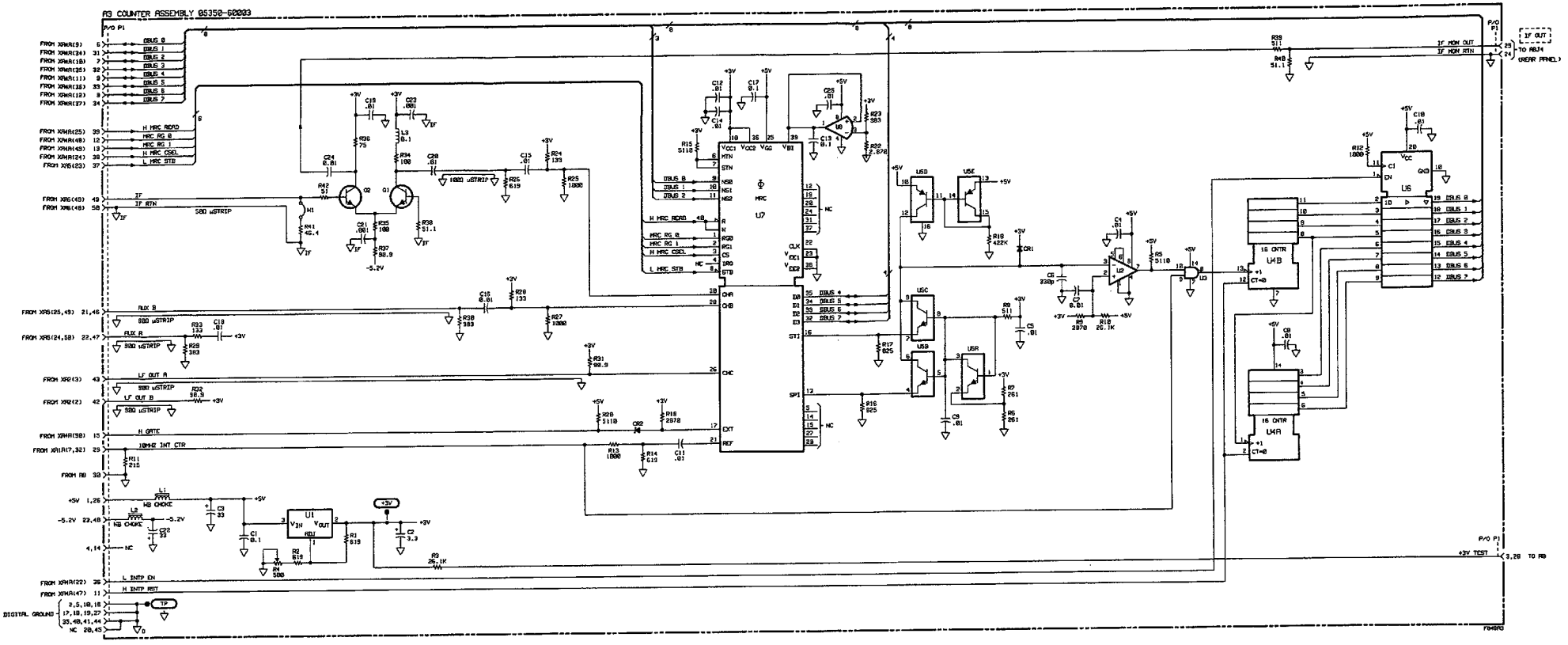


Figure 8-48. A3 Counter Assembly

Figure 8-48
A3 COUNTER ASSEMBLY
(See Page 8-185)

NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.
2. UNLESS OTHERWISE INDICATED:
   RESISTANCE IN OHMS;
   CAPACITANCE IN MICROFARADS;
   INDUCTANCE IN MICROHENRIES.

REFERENCE DESIGNATIONS

A4 ASSEMBLY
C1-C14, C16-C19, C22-C24, C26-C28
CR1, CR2, CR5
J1
L1, L2
P1A, P1B
R1-R12
U1-U7, U9-U14, U16-U18, U20
XU8, XU10, XU14, XU17
Y1

A4 ACTIVE COMPONENTS (5350B/5351B)

REFERENCE DESIGNATIONS	HP PART NUMBER	MFG. PART NUMBER
CR1, CR2, CR5	1901-0050	1N4150
U1, U12, U16, U18	1820-2724	SN74ALS573BN
U2	1820-3159	MC68B03L
U3	1820-1246	SN74LS08N
U4	1820-2634	SN74ALS04BN
U5, U7	1820-3100	SN74ALS138N
U6	1820-2775	SN74ALS10N
U9, U11, U13	1820-1858	SN74LS377N
U10	1820-3121	SN74ALS245AN
U14	05350-80016	2712BA
U17	05350-80017	2712BA
U20	1818-1790	HM6116LP-2

XA4A
CONNECTOR PINOUT
CIRCUIT SIDE OF MOTHERBOARD

SYN DATA 1	26	1	SYN DATA 0
SYN DATA 3	27	2	SYN DATA 2
SYN DATA 5	28	3	SYN DATA 4
SYN DATA 7	29	4	SYN DATA 6
GND, DIGITAL	30	5	GND, DIGITAL
IB DDIR	31	6	SYN LCH
IB DVAL	32	7	IB DREC
L KB IRQ	33	8	NOT USED
DBUS 1	34	9	DBUS 0
DBUS 3	35	10	DBUS 2
DBUS 5	36	11	DBUS 4
DBUS 7	37	12	DBUS 6
GND, DIGITAL	38	13	GND, DIGITAL
NC	39	14	L µP RST
NOT USED	40	15	L µP NMI
NC	41	16	+5V µP
L DSP SYNC	42	17	SYN LCH
L DSP PWRON	43	18	L KB READ
L LF TEST	44	19	L µW OFF
LF OUT SEL	45	20	H LF 50
GND, DIGITAL	46	21	GND, DIGITAL
H INTP RST	47	22	L INTP EN
MRC RG0	48	23	L MRC STB
MRC RG1	49	24	H MRC CSEL
H GATE	50	25	H MRC READ

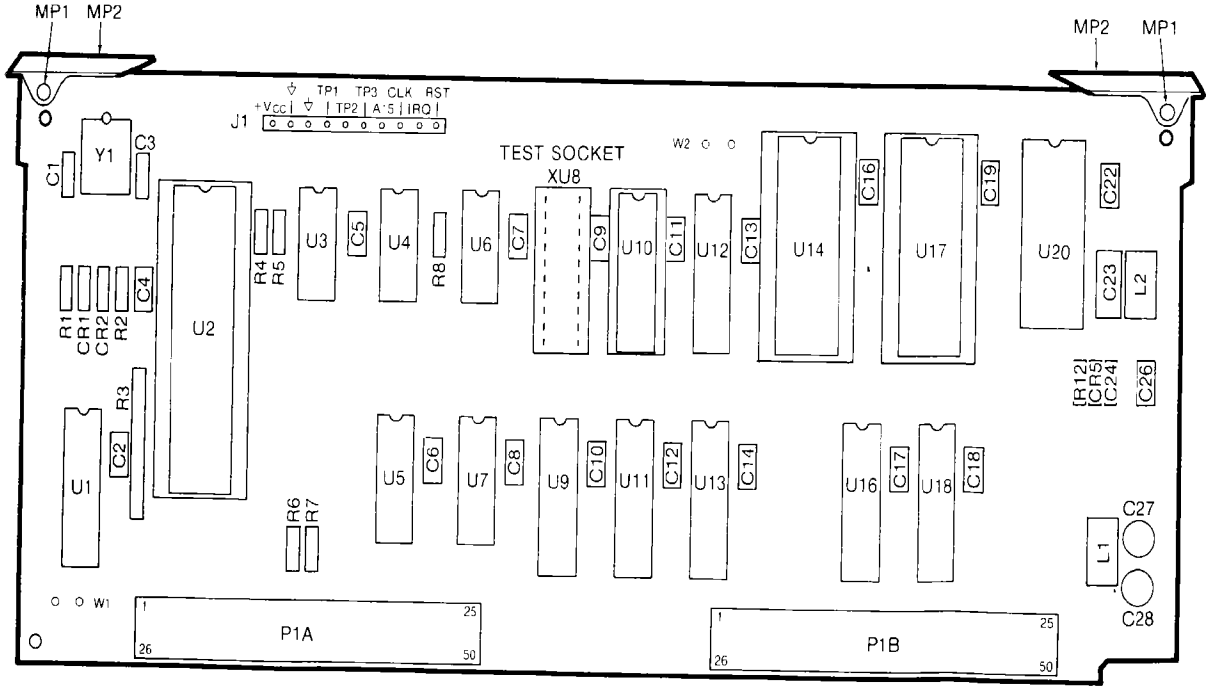
XA4B
CONNECTOR PINOUT
CIRCUIT SIDE OF MOTHERBOARD

L TEST 1	26	1	L TEST 4
L TEST 3	27	2	L TEST 2
L OVLD RST	28	3	L NO IF RST
L IF OFF	29	4	L IF TEST
GND, DIGITAL	30	5	GND, DIGITAL
NC	31	6	NC
NC	32	7	NC
NC	33	8	NC
NC	34	9	NC
L EXT REF	35	10	L 10MHz OK
H PWRSP OK	36	11	L OVN COLD
NOT USED	37	12	L KB DAVL
L NO IF LCH	38	13	L OVLD LCH
GND, DIGITAL	39	14	GND, DIGITAL
L JMP 1	40	15	L IB SENSE
L JMP 3	41	16	L JMP 2
L JMP 5	42	17	L JMP 4
L JMP 7	43	18	L JMP 6
NC	44	19	NC
NC	45	20	NC
NC	46	21	NC
NC	47	22	NC
GND, DIGITAL	48	23	GND, DIGITAL
+5V	48	24	GND, DIGITAL
+5V	50	25	+5V

TO/FROM RG1

NOTE

This A4 schematic diagram and accompanying information apply only to the 05350-60014 assembly installed in the 5350B and 5351B. Refer to *Figure 8-49B* for the 5352B A4 schematic diagram and component information.



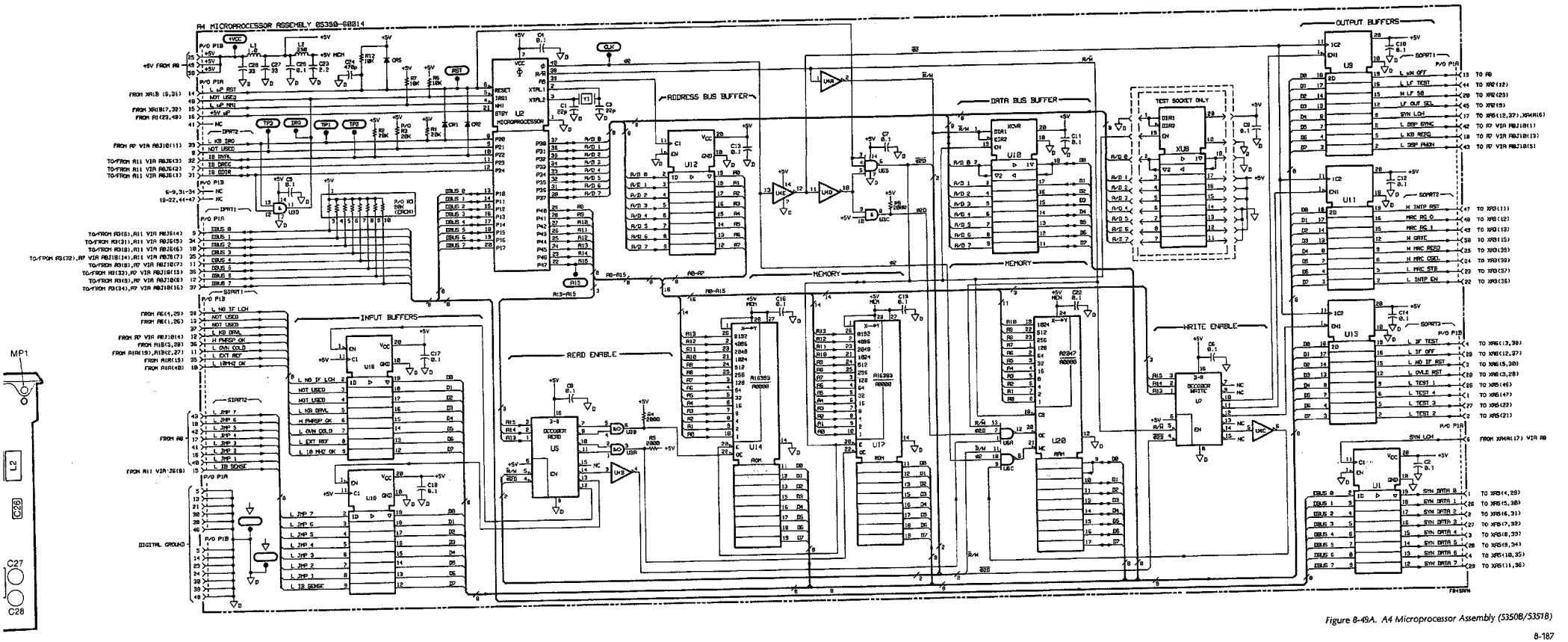


Figure 8-49A. A4 Microprocessor Assembly (5350B/5351B)

Figure 8-49A
A4 MICROPROCESSOR ASSEMBLY (5350B/5351B)
(See Page 8-187)

NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.
2. UNLESS OTHERWISE INDICATED:
   RESISTANCE IN OHMS;
   CAPACITANCE IN MICROFARADS;
   INDUCTANCE IN MICROHENRIES.

REFERENCE DESIGNATIONS

A4 ASSEMBLY
C1-C14, C16-C19, C22-C24, C26-C28 CR1, CR2, CR5 J1 L1, L2 P1A, P1B R1-R12 U1-U7, U9-U14, U16-U18, U20 XU8, XU10, XU14, XU17 Y1

A4 ACTIVE COMPONENTS(5352B)

REFERENCE DESIGNATIONS	HP PART NUMBER	MFG PART NUMBER
CR1, CR2, CR5	1901-0050	1N4150
U1, U12, U16, U18	1820-2724	SN74ALS573BN
U2	1820-3159	MC68B03L
U3	1820-1246	SN74LS09N
U4	1820-2634	SN74ALS04BN
U5, U7	1820-3100	SN74ALS138N
U6	1820-2775	SN74ALS10N
U8, U11, U13	1820-1858	SN74LS377N
U10	1820-3121	SN74ALS245AN
U14	05352-80018	27128A
U17	05352-80019	27128A
U20	1818-1790	HM6116LP-2

XA4A
CONNECTOR PINOUT

CIRCUIT	SIDE OF MOTHERBOARD		CIRCUIT
SYN DATA 1	26	1	SYN DATA 0
SYN DATA 3	27	2	SYN DATA 2
SYN DATA 5	28	3	SYN DATA 4
SYN DATA 7	29	4	SYN DATA 6
GND, DIGITAL	30	5	GND, DIGITAL
IB DDIR	31	6	SYN LCH
IB DVAL	32	7	IB DREC
L KB IRQ	33	8	NOT USED
DBUS 1	34	9	DBUS 0
DBUS 3	35	10	DBUS 2
DBUS 5	36	11	DBUS 4
DBUS 7	37	12	DBUS 6
GND, DIGITAL	38	13	GND, DIGITAL
NC	39	14	L µP RST
NOT USED	40	15	L µP NMI
NC	41	16	+5V µP
L DSP SYNC	42	17	SYN LCH
L DSP PWRON	43	18	L KB READ
L LF TEST	44	19	L µW OFF
LF OUT SEL	45	20	H LF 50
GND, DIGITAL	46	21	GND, DIGITAL
H INTP RST	47	22	L INTP EN
MRC RG0	48	23	L MRC STB
MRC RG1	49	24	H MRC CSEL
H GATE	50	25	H MRC READ

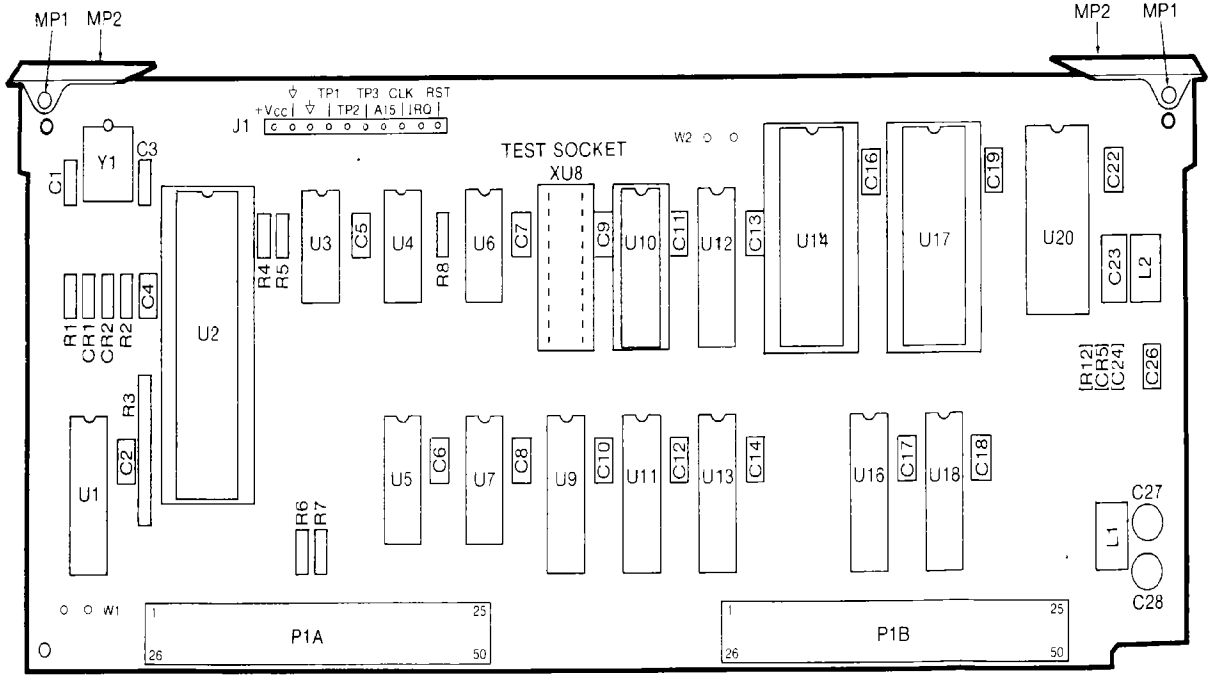
XA4B
CONNECTOR PINOUT

CIRCUIT	SIDE OF MOTHERBOARD		CIRCUIT
L TEST 1	26	1	L TEST 4
L TEST 3	27	2	L TEST 2
L OVLD RST	28	3	L NO IF RST
L IF OFF	29	4	L IF TEST
GND, DIGITAL	30	5	GND, DIGITAL
NC	31	6	NC
NC	32	7	NC
NC	33	8	NC
NC	34	9	NC
L EXT REF	35	10	L 10MHz OK
H PWRSP OK	36	11	L OVN COLD
NOT USED	37	12	L KB OAVL
L NO IF LCH	38	13	L OVLD LCH
GND, DIGITAL	39	14	GND, DIGITAL
L JMP 1	40	15	L IB SENSE
L JMP 3	41	16	L JMP 2
L JMP 5	42	17	L JMP 4
L JMP 7	43	18	L JMP 6
NC	44	19	NC
NC	45	20	NC
NC	46	21	NC
NC	47	22	NC
GND, DIGITAL	48	23	GND, DIGITAL
+5V	49	24	GND, DIGITAL
+5V	50	25	+5V

TO/FROM I

NOTE

This A4 schematic diagram and accompanying information apply only to the 05352-60014 assembly installed in the 5352B. Refer to *Figure 8-49A* for the 5350B and 5351B A4 schematic diagram and component information.



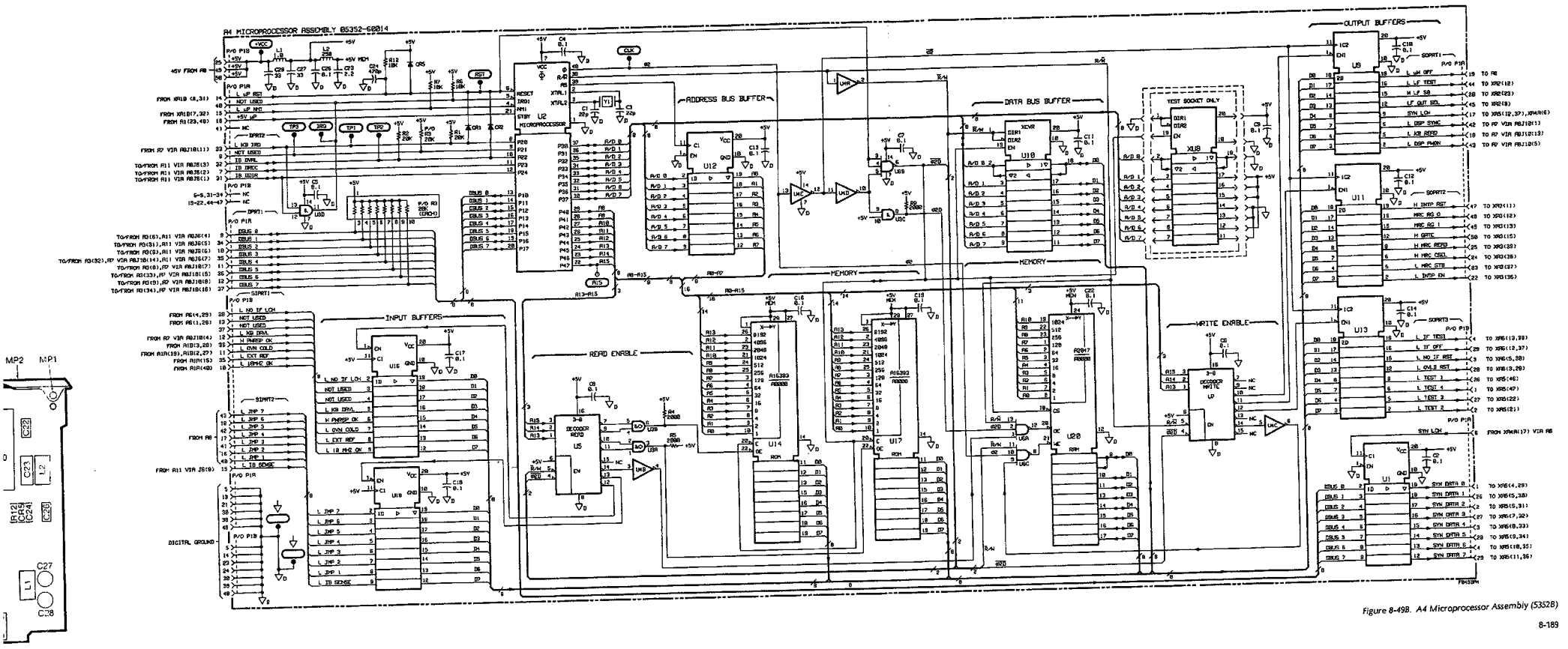


Figure 8-49B. A4 Microprocessor Assembly (53528)

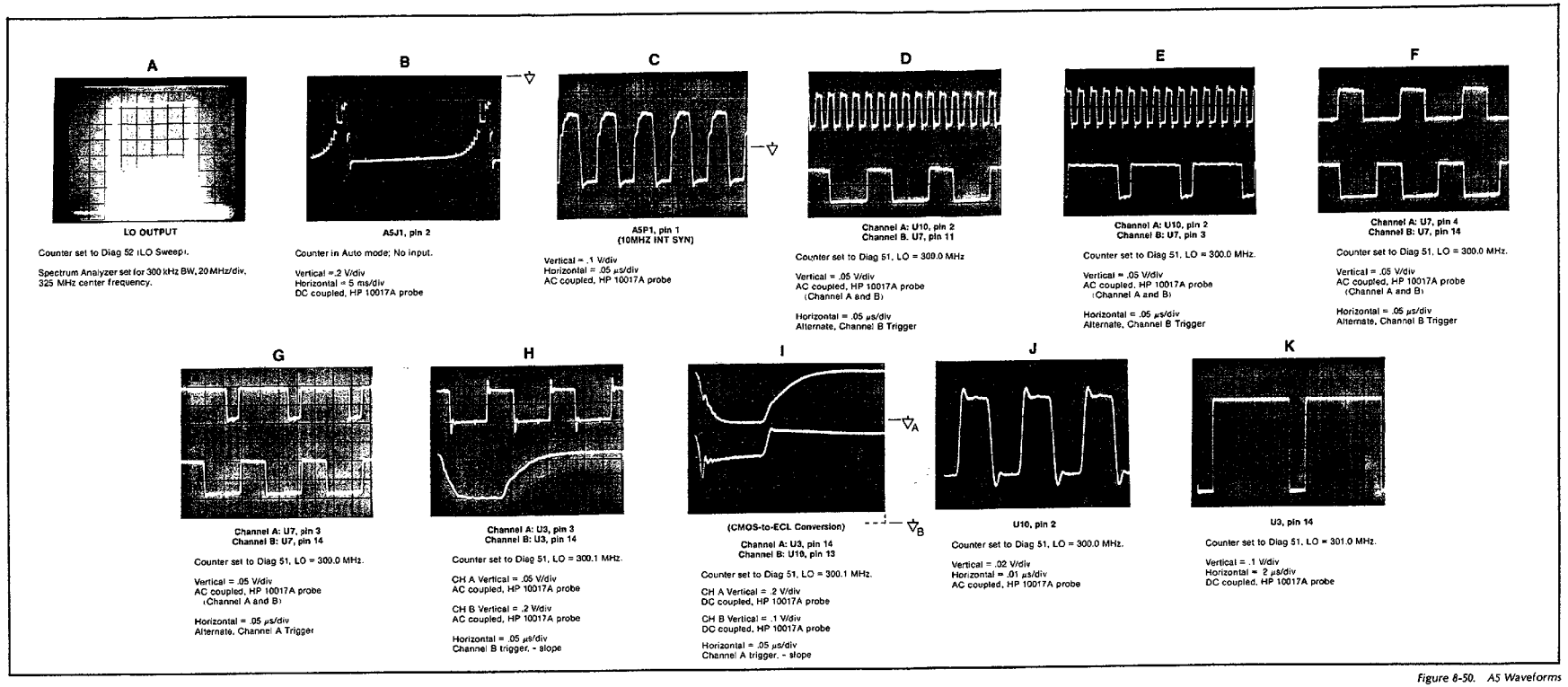
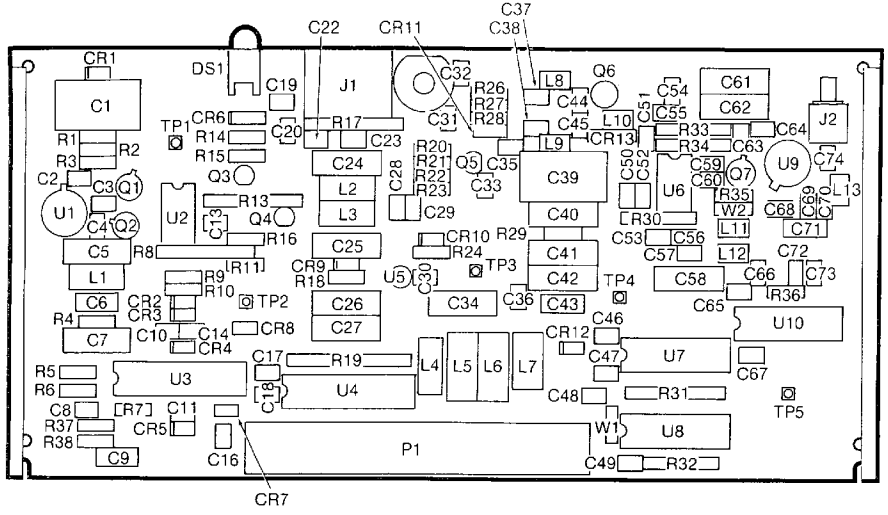


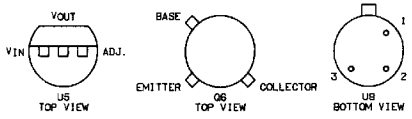
Figure 8-50. A5 Waveforms

Figure 8-49B
A4 MICROPROCESSOR ASSEMBLY (5352B)
(See Page 8-189)



NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.
2. UNLESS OTHERWISE INDICATED:
   RESISTANCE IN OHMS;
   CAPACITANCE IN MICROFARADS;
   INDUCTANCE IN MICROHENRIES.
3. PC TRACE INDUCTANCE.
4. TOLERANCE FOR ALL DC VOLTAGES ON SCHEMATIC IS ±0.1 VOLT UNLESS OTHERWISE NOTED.



REFERENCE DESIGNATIONS

A5 ASSEMBLY
C1-C11, C13, C14, C16-C20, C22-C74
CR1-CR13
DS1
J1, J2
L1-L13
P1
Q1-Q7
R1-R11, R13-R24, R26-R38
TP1-TP5
U1-U10
W1, W2

A5 ACTIVE COMPONENTS

REFERENCE DESIGNATIONS	HP PART NUMBER	MFG. PART NUMBER
CR1-CR5, CR7-CR12	1901-0050	1N4150
CR6	1901-0734	1N5818
CR13	0122-0161	BB4050
DS1	1990-1022	HLMP-5030
Q1, Q2	1855-0540	2N5115(SEL)
Q3	1854-0215	2N3904
Q4, Q5	1853-0036	2N3906
Q6	1854-0591	BFR90
Q7	1854-0345	2N5179
U1	1826-0685	LF351H
U2	1826-0412	LM383N
U3	1820-3405	MC14514BP
U4	1820-2724	SN74ALS573BN
U5	1826-1088	LM337LZ
U6	1826-0372	A251-0100
U7	1820-1383	MC10138L
U8	1820-3340	MC10H121P
U9	1813-0213	MWA130
U10	1820-1888	MC12013L

XA5
CONNECTOR PINOUT
CIRCUIT SIDE OF MOTHERBOARD

GND, MTHRPLN	26	1	10MHz INT SYN
10MHz INT SYN	27	2	GND, MTHRPLN
	28	3	GND, MTHRPLN
	29	4	SYN DATA 0
	30	5	SYN DATA 1
	31	6	SYN DATA 2
	32	7	SYN DATA 3
	33	8	SYN DATA 4
	34	9	SYN DATA 5
	35	10	SYN DATA 6
	36	11	SYN DATA 7
	37	12	SYN LCH
	38	13	GND, MTHRPLN
	39	14	-24V
	40	15	-5.2V
	41	16	+15V (NOT USED)
	42	17	GND, MTHRPLN
	43	18	+5V
	44	19	+5V
	45	20	GND, MTHRPLN
L TEST 1	46	21	L TEST 2
L TEST 4	47	22	L TEST 3
	48	23	GND, MTHRPLN
AUX B	49	24	AUX A
AUX A	50	24	AUX B

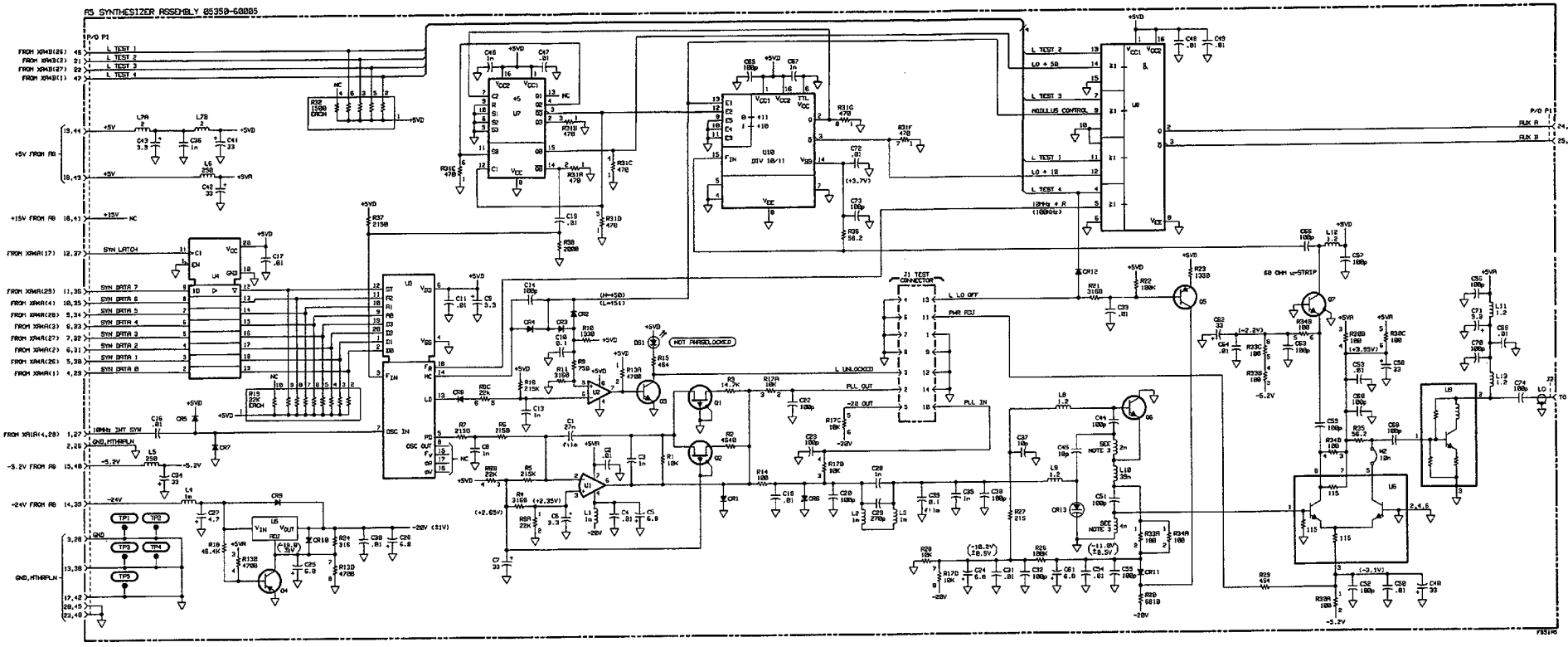
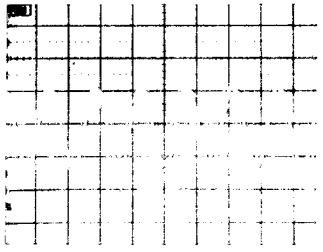


Figure 8-51. A5 Synthesizer Assembly

A



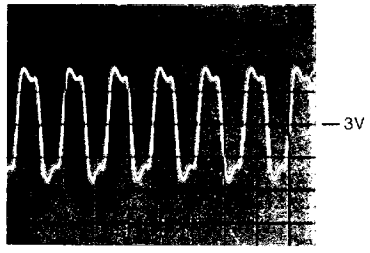
IF OUTPUT
(A12J1)

Counter in INPUT 1, Manual mode;
Manual CF = 770 MHz.

770 MHz, -10 dBm input to INPUT 1.

Vertical = .01 V/div
Horizontal = .01 μs/div
AC coupled, HP 10017A probe

B



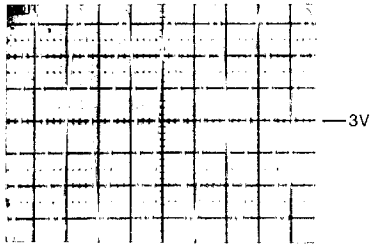
Collector of Q8
(lower leg of L27)

Counter in INPUT 1, Manual mode;
Manual CF = 1 GHz.

1 GHz, -20 dBm input to INPUT 1.

Vertical = .05 V/div
Horizontal = .01 μs/div
DC coupled, HP 10017A probe

C



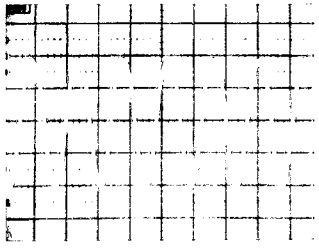
U3 Output
(lower leg of R22)

Counter in INPUT 1, Manual mode; Manual CF = 1 GHz.

1 GHz, -10 dBm input to INPUT 1.

Vertical = .02 V/div
Horizontal = .01 μs/div
DC coupled, HP 10017A probe

D



U4 Output
(lower leg of R29)

Counter in INPUT 1, Manual mode, Manual CF = 1 GHz.

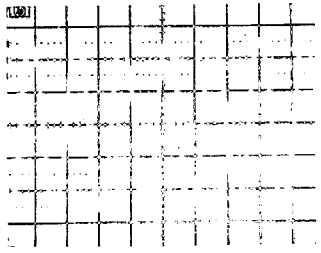
100 mV input to U4.

Vertical = .02 V/div
Horizontal = .01 μs/div
DC coupled, HP 10017A probe

Figure 8-52. A6 Waveforms

Figure 8-51
A5 SYNTHESIZER ASSEMBLY
(See Page 8-191)

E



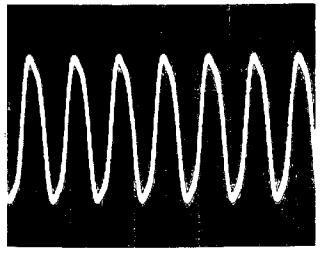
Collector of Q11
(top pin)

Counter in INPUT 1, Manual mode; Manual CF = 1 GHz.

1 GHz, -10 dBm input to INPUT 1.

Vertical = .02 V/div
Horizontal = .01 µs/div
AC coupled, HP 10017A probe

F



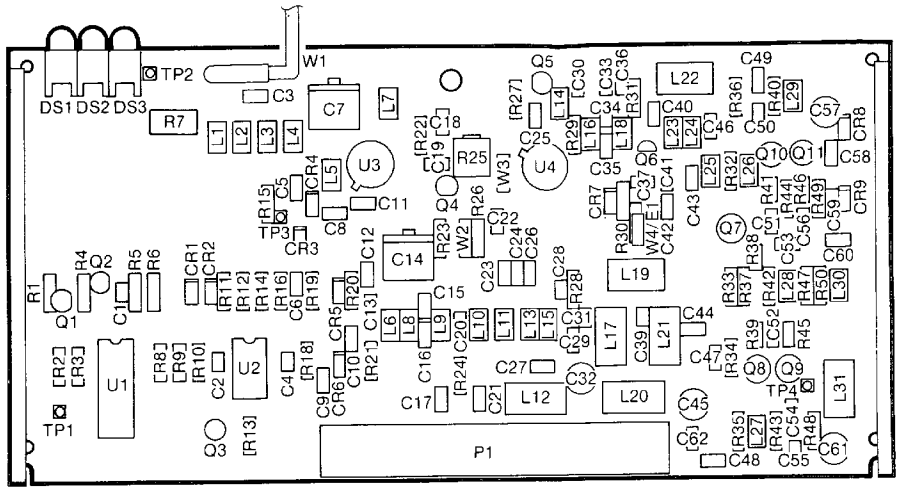
Emitter of Q7
(upper leg of R28)

Counter in INPUT 1, Manual mode; Manual CF = 1 GHz.

1 GHz, -30 dBm input to INPUT 1.

Vertical = .02 V/div
Horizontal = .01 µs/div
AC coupled, HP 10017A probe

Figure 8-52. A6 Waveforms (Continued)



NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.
2. UNLESS OTHERWISE INDICATED:
   RESISTANCE IN OHMS;
   CAPACITANCE IN MICROFARADS;
   INDUCTANCE IN MICROHENRIES.

REFERENCE DESIGNATIONS

A6 ASSEMBLY
C1-C62 CR1-CR9 DS1-DS3 E1 L1-L31 P1 Q1-Q11 R1-R16, R18-R50 TP1-TP4 U1-U4 W1-W4

A6 ACTIVE COMPONENTS

REFERENCE DESIGNATIONS	HP PART NUMBER	MFG. PART NUMBER
CR1-CR6, CR8, CR9	1901-0535	SAME
CR7	1902-3050	SAME
DS1	1990-1022	HLMP-5030
DS2	1990-1024	SAME
DS3	1990-0966	HLMP-5050
Q1, Q3, Q5	1853-0036	2N3906
Q2, Q4	1854-0215	2N3904
Q6	1853-0352	SAME
Q7	1854-0345	2N5179
Q8-Q11	1854-0581	BFR90
U1	1820-1197	SN74LS00N
U2	1826-0412	LM393N
U3, U4	1813-0211	MWA110

XA6
CONNECTOR PINOUT
CIRCUIT SIDE OF MOTHERBOARD

	26	1	L OVLD LCH
	27	2	L OVLD TRG
	28	3	L OVLD RST
	29	4	L NO IF LCH
	30	5	L NO IF RST
	31	6	H IF D TRG
	32	7	GND, MTHRPLN
	33	8	AUX A
	34	9	AUX B
	35	10	GND MTHRPLN
NC	36	11	NC
	37	12	L IF OFF
	38	13	L IF TEST
NC	39	14	NC
NC	40	15	NC
NC	41	16	NC
	42	17	-5.2V
	43	18	+15V
	44	19	+5V
	45	20	GND, MTHRPLN
NC	46	21	NC
	47	22	GND, MTHRPLN
IF RTN	48	23	GND, MTHRPLN
IF	49	24	GND, MTHRPLN
	50	25	GND, MTHRPLN

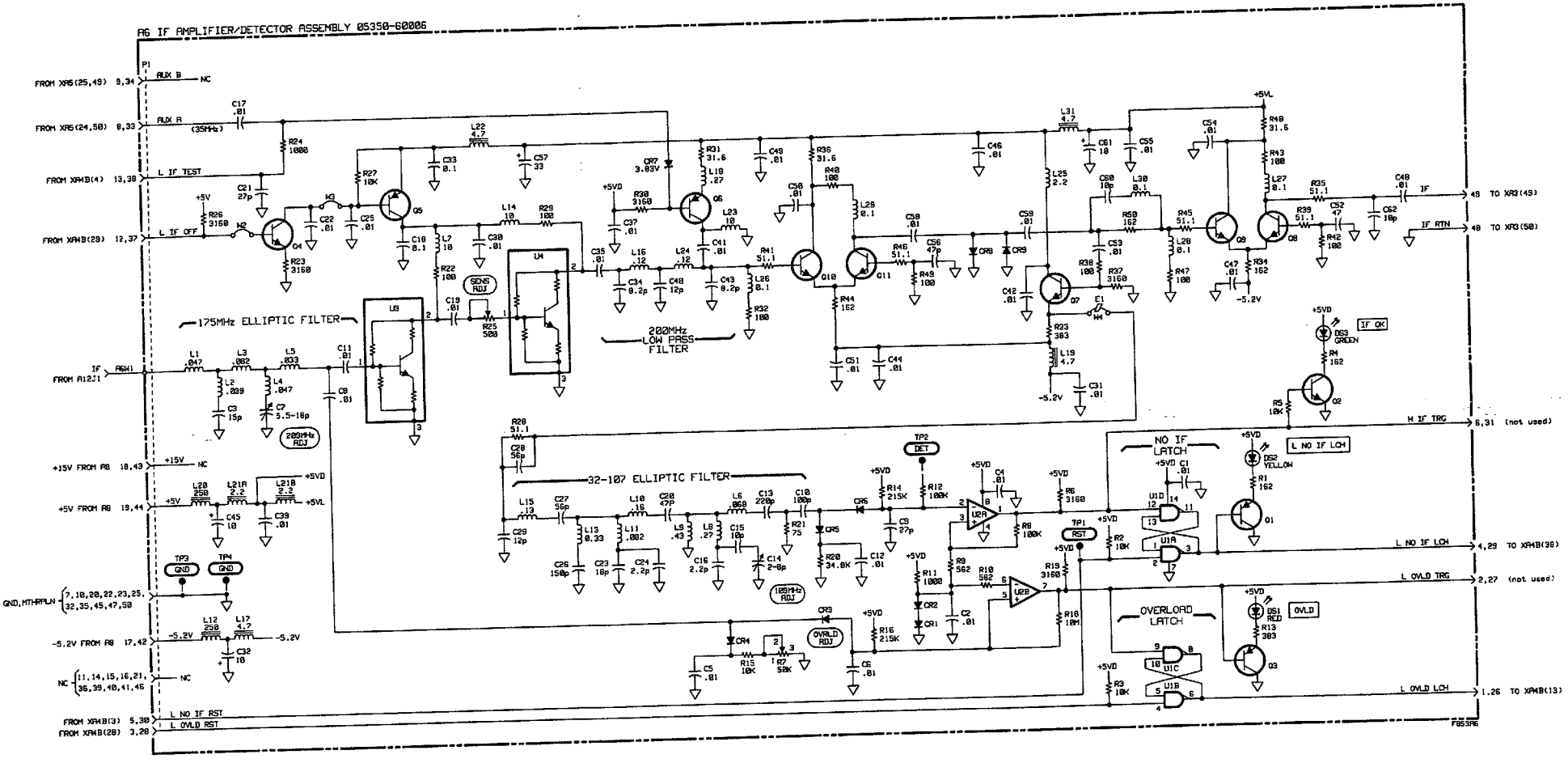
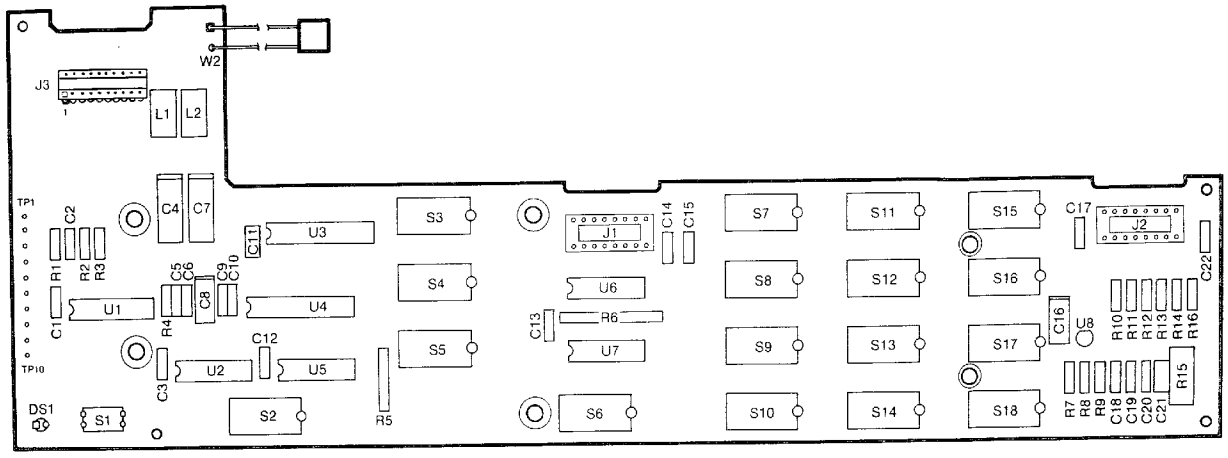


Figure 8-53. A6 IF Amplifier/Detector Assembly

Figure 8-53
A6 IF AMPLIFIER/DETECTOR ASSEMBLY
(See Page 8-193)



NOTES

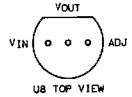
1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.
2. UNLESS OTHERWISE INDICATED:
   RESISTANCE IN OHMS;
   CAPACITANCE IN MICROFARADS;
   INDUCTANCE IN MICROHENRIES.

REFERENCE DESIGNATIONS

A7 ASSEMBLY
C1-C6, C7-C22 DS1 J1-J3 L1, L2 R1-R16 S1-S18 U1-U8 W2

A7 ACTIVE COMPONENTS

REFERENCE DESIGNATIONS	HP PART NUMBER	MFG. PART NUMBER
DS1	1990-0486	HLMP-1301
U1	1820-1437	SN74LS221N
U2	1820-3278	SN74ALS03AN
U3	1820-3638	SN74ALS486AN
U4	1820-2309	MM74C923N
U5	1820-2486	SN74ALS74AN
U6, U7	1820-1417	SN74LS26N
U8	1826-0772	SAME



U8 TOP VIEW

A6J10
CONNECTOR PINOUT
CIRCUIT SIDE OF MOTHERBOARD

GND, DIGITAL	9	1	L DSP SYNC
NC	10	2	+5V
L KB IRQ	11	3	+15V
L STBY	12	4	L KB DAVL
L KB READ	13	5	L DSP PWON
DBUS 3	14	6	STBY LED
DBUS 5	15	7	DBUS 4
DBUS 7	16	8	DBUS 6

A6J3
CONNECTOR PINOUT
CIRCUIT SIDE OF A7 BOARD

L DSP SYNC	16	1	GND, DIGITAL
+5V	15	2	NC
+15V	14	3	L KB IRQ
L KB DAVL	13	4	L STBY
L DSP PWON	12	5	L KB READ
STBY LED	11	6	DBUS 3
DBUS 4	10	7	DBUS 5
DBUS 6	9	8	DBUS 7

A7 TEST POINTS
CIRCUIT SIDE OF A7 BOARD

TP1 o +5V
TP2 o GND
TP3 o GND
TP4 o +15V
TP5 o NC
TP6 o NC
TP7 o DA
TP8 o IRQ
TP9 o V3
TP10 o VCC

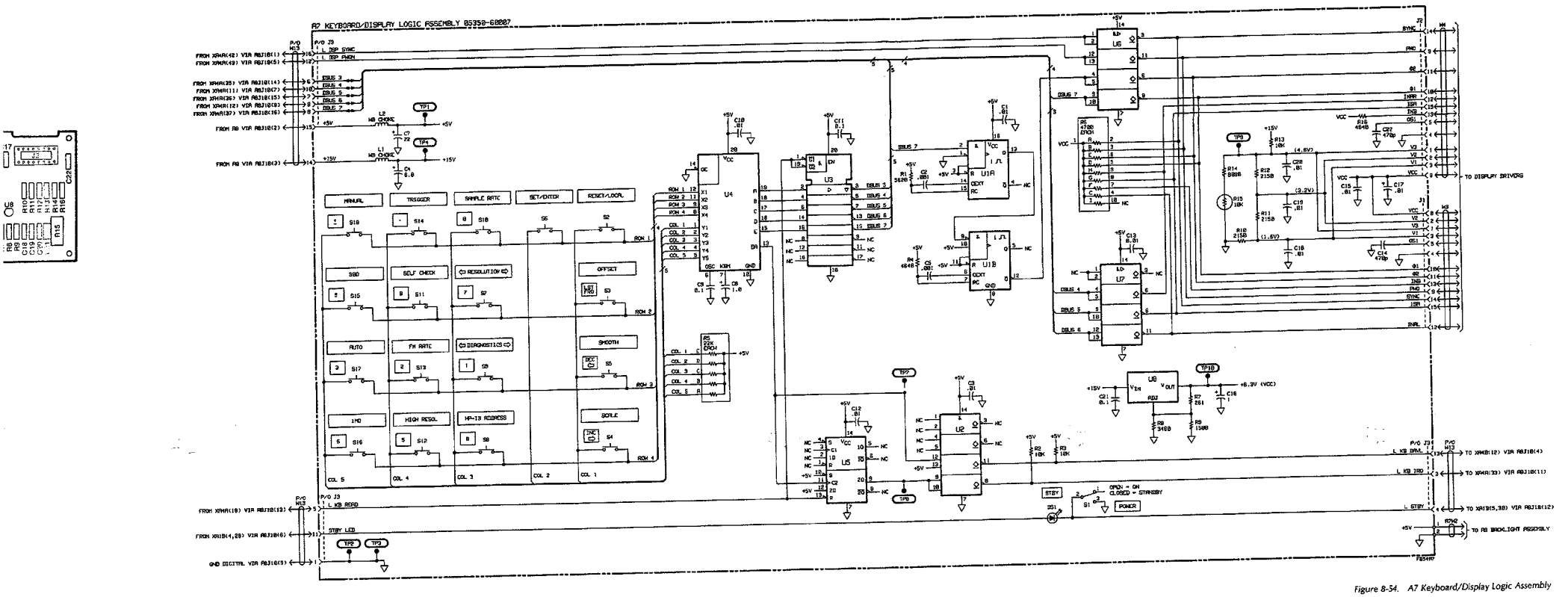


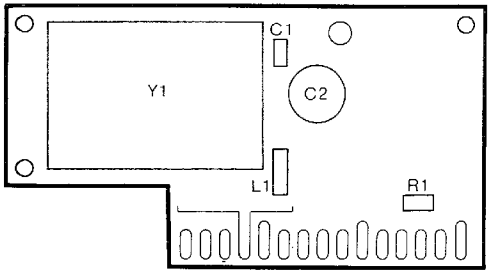
Figure 8-54. A7 Keyboard/Display Logic Assembly

Figure 8-54
A7 KEYBOARD/DISPLAY LOGIC ASSEMBLY
(See Page 8-195)

NOTE

The A9 Backlight Assembly is not a field-repairable assembly. The A9 schematic diagram is shown here for electrical reference only.

FR



NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.
2. UNLESS OTHERWISE INDICATED:
   RESISTANCE IN OHMS;
   CAPACITANCE IN MICROFARADS;
   INDUCTANCE IN MICROHENRIES.

REFERENCE DESIGNATIONS

A10 ASSEMBLY
C1, C2 L1 R1 Y1

A10 ACTIVE COMPONENTS

REFERENCE DESIGNATIONS	HP PART NUMBER	MFG. PART NUMBER
Y1	0960-0394	SAME

XA10
CONNECTOR PINOUT
CIRCUIT SIDE OF MOTHERBOARD

1	10MHz
2	GND, MTHRPLN
3	+12V OSC
4	GND, MTHRPLN
5	GND, MTHRPLN
6	GND, MTHRPLN
7	+5V OSC
8	NC
9	NC
10	NC
11	OVEN TEMP
12	NC
13	NC
14	GND, OVN
15	-24V

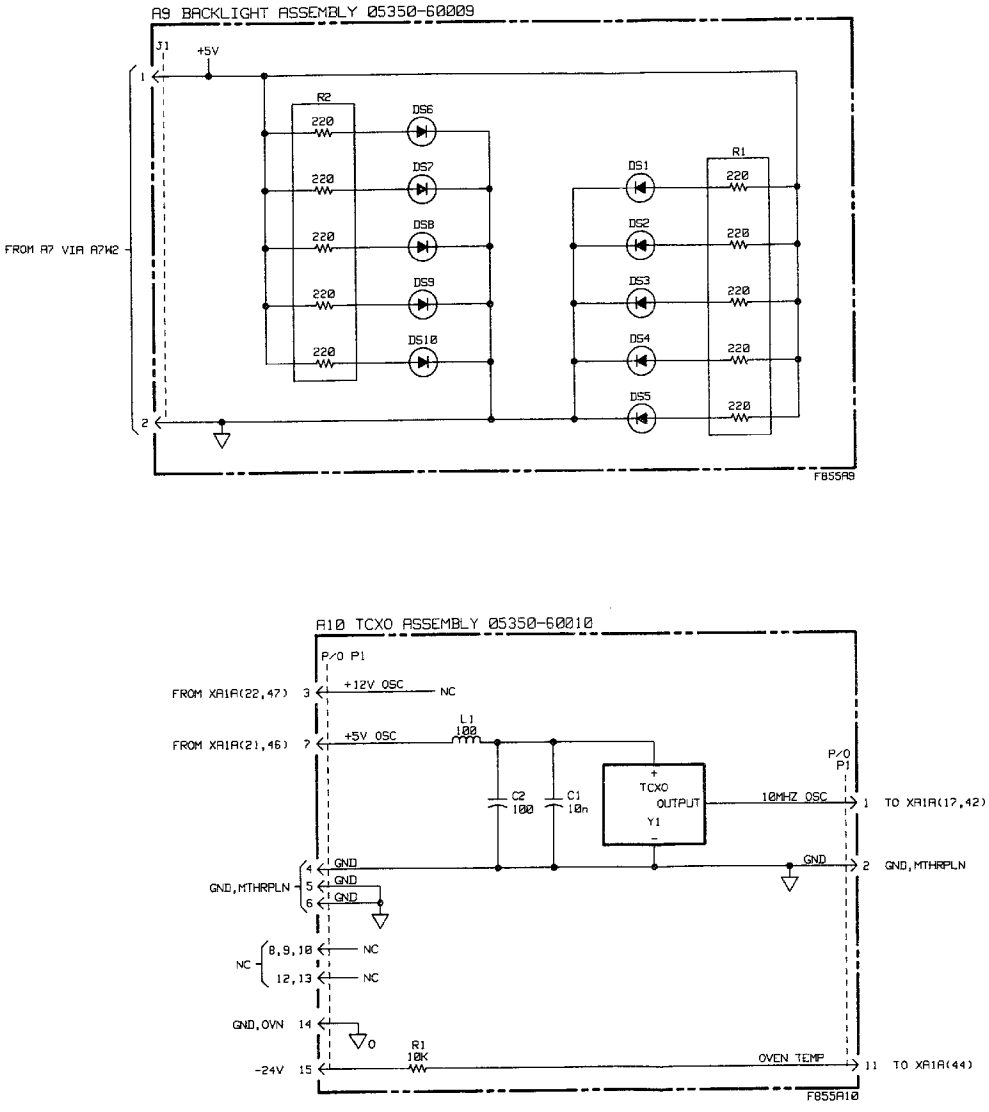
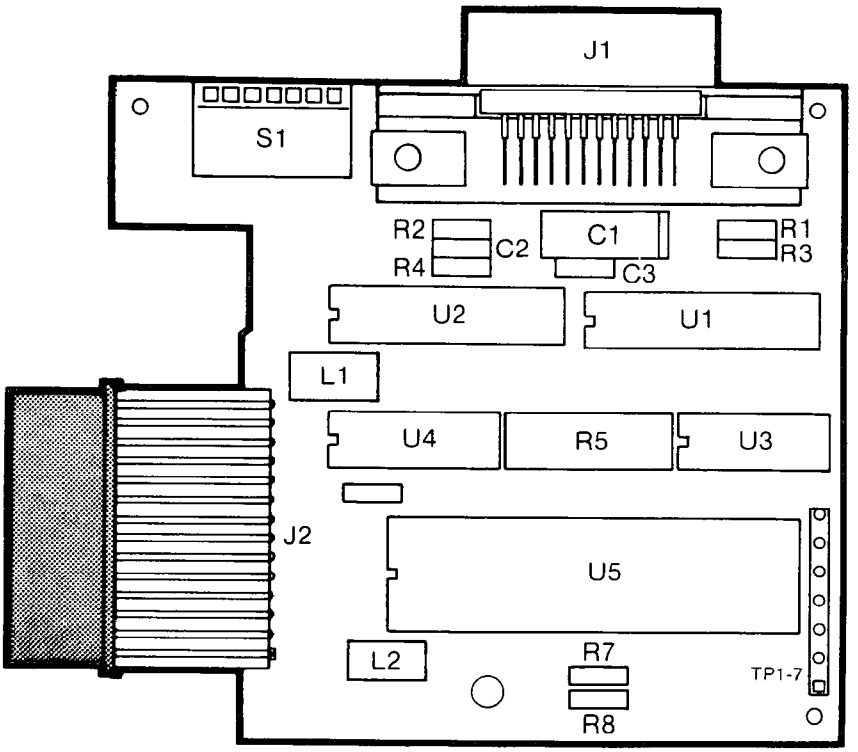


Figure 8-55. A9 Backlight Assembly
A10 Temperature Compensated Crystal Oscillator Assembly

Figure 8-55
A9 BACKLIGHT ASSEMBLY
A10 TEMPERATURE COMPENSATED CRYSTAL OSCILLATOR ASSEMBLY
(See Page 8-197)



NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.
2. UNLESS OTHERWISE INDICATED:
   RESISTANCE IN OHMS;
   CAPACITANCE IN MICROFARADS;
   INDUCTANCE IN MICROHENRIES.

REFERENCE DESIGNATIONS

A11 ASSEMBLY
C1-C4 J1, J2 L1, L2 R1-R5, R7, R8 S1 TP1 U1-U5

A11 ACTIVE COMPONENTS

REFERENCE DESIGNATIONS	HP PART NUMBER	MFG. PART NUMBER
U1, U2	1820-2461	MC3447P3
U3	1820-1198	SN74LS03N
U4	1820-1440	SN74LS279N
U5	1820-3870	SAME

A8J6
CONNECTOR PINOUT
CIRCUIT SIDE OF MOTHERBOARD

- 14 +5V
- 13 +5V CMC
- 12 GND, CMC
- 11 GND, CMC
- 10 GND, DIGITAL
- 9 L µP RST
- 8 L IB SENSE
- 7 DBUS 3
- 6 DBUS 2
- 5 DBUS 1
- 4 DBUS 0
- 3 IB DVAL
- 2 IB DREC
- 1 IB DDIR

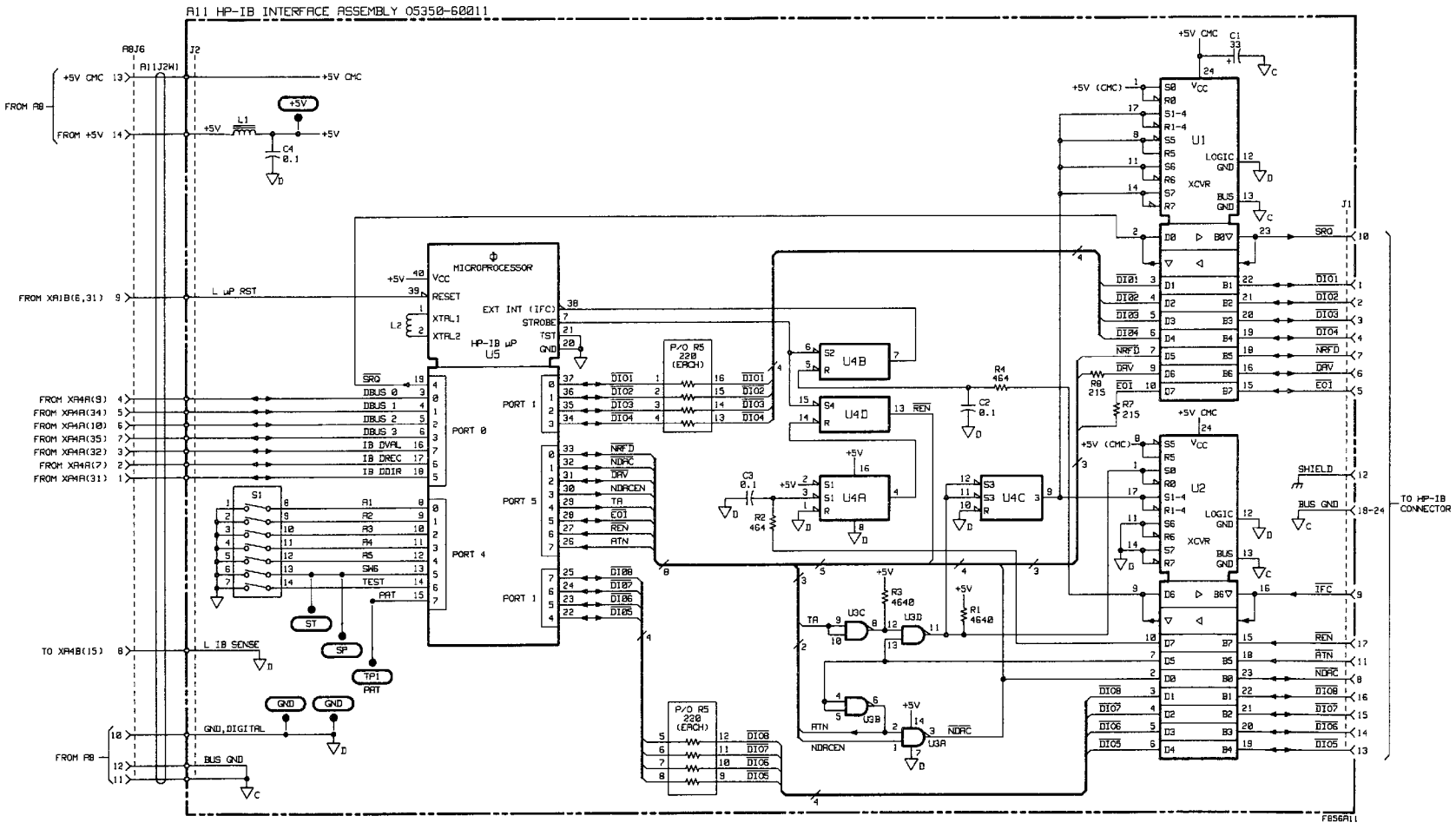
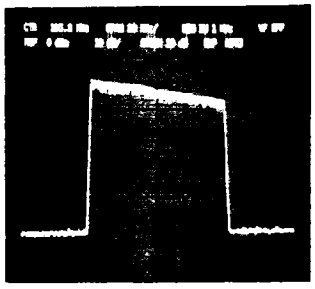


Figure 8-56. A11 HP-IB Interface Assembly

A



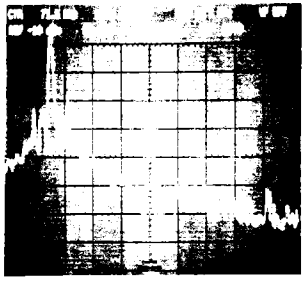
Collector of Q2
(Leg of C20)

Counter set to Diag 52.

HP 1120A active probe with 100:1 tip.

Center: 325.2 MHz
Span: 20 MHz/div
Bandwidth: 1 MHz
Reference: 0 dBm
Attenuation: 10 dB

B



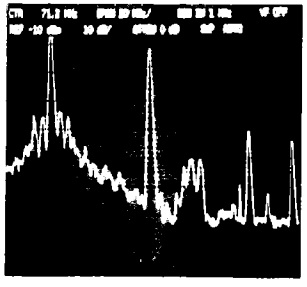
Emitter of Q1
(Leg of R2)

Counter in INPUT 1, Manual mode; Manual CF = 1 GHz.

1 GHz, 0 dBm input to INPUT 1.

Center: 71.2 MHz
Span: 20 MHz/div
Bandwidth: 1 MHz
Reference: -10 dBm
Attenuation: 0 dB

C



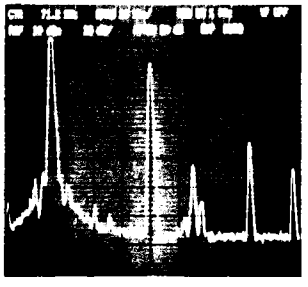
Ouput of U1
(Leg of R3)

Counter in INPUT 1, Manual mode; Manual CF = 1 GHz.

1 GHz, 0 dBm input to INPUT 1.

Center: 71.2 MHz
Span: 20 MHz/div
Bandwidth: 1 MHz
Reference: -10 dBm
Attenuation: 0 dB

D



Output of U2
(Leg of R4)

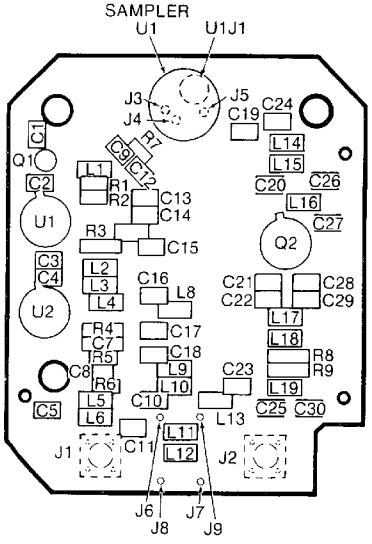
Counter in INPUT 1, Manual mode; Manual CF = 1 GHz.

1 GHz, 0 dBm input to INPUT 1.

Center: 71.2 MHz
Span: 20 MHz/div
Bandwidth: 1 MHz
Reference: 10 dBm
Attenuation: 20 dB

Figure 8-57. 5350B/5351B A12 Waveforms

Figure 8-56
A11 HP-IB INTERFACE ASSEMBLY
(See Page 8-199)



NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.
2. UNLESS OTHERWISE INDICATED:
   RESISTANCE IN OHMS;
   CAPACITANCE IN MICROFARADS;
   INDUCTANCE IN MICROHENRIES.
3. SAMPLER U1 IS NOT PART OF THE A12 ASSEMBLY. REFER TO REPLACEABLE PARTS LIST IN SECTION VI FOR SAMPLER PART NUMBER.

REFERENCE DESIGNATIONS

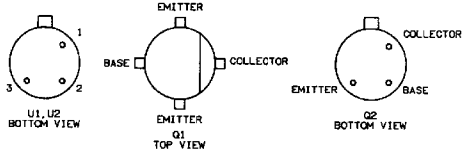
A12 ASSEMBLY
C1-C5, C7-C30 J1-J9 L1-L6, L8-L19 Q1-Q2 R1-R10 U1, U2

A12 ACTIVE COMPONENTS (5352A)

REFERENCE DESIGNATIONS	HP PART NUMBER	MFG. PART NUMBER
Q1	1854-1003	SAME
Q2	1854-0990	SAME
U1, U2	1813-0211	MWA110

A8J11
CIRCUIT SIDE OF MOTHERBOARD

NOT CONNECTED TO MICROWAVE MODULE			TO MICROWAVE MODULE VIA W5
GND, MTHRPLN	6	1	NC
+15V	7	2	+13V SW
-5.2V	8	3	GND, MTHRPLN
-5.2V	9	4	+5V SW
+5V	10	5	-5.2V



NOTE

This A12 schematic diagram and accompanying information apply only to the 05350-60012 assembly installed in the 5350B and 5351B. Refer to *Figure 8-60* for the 5352B A12 schematic diagram and component information.

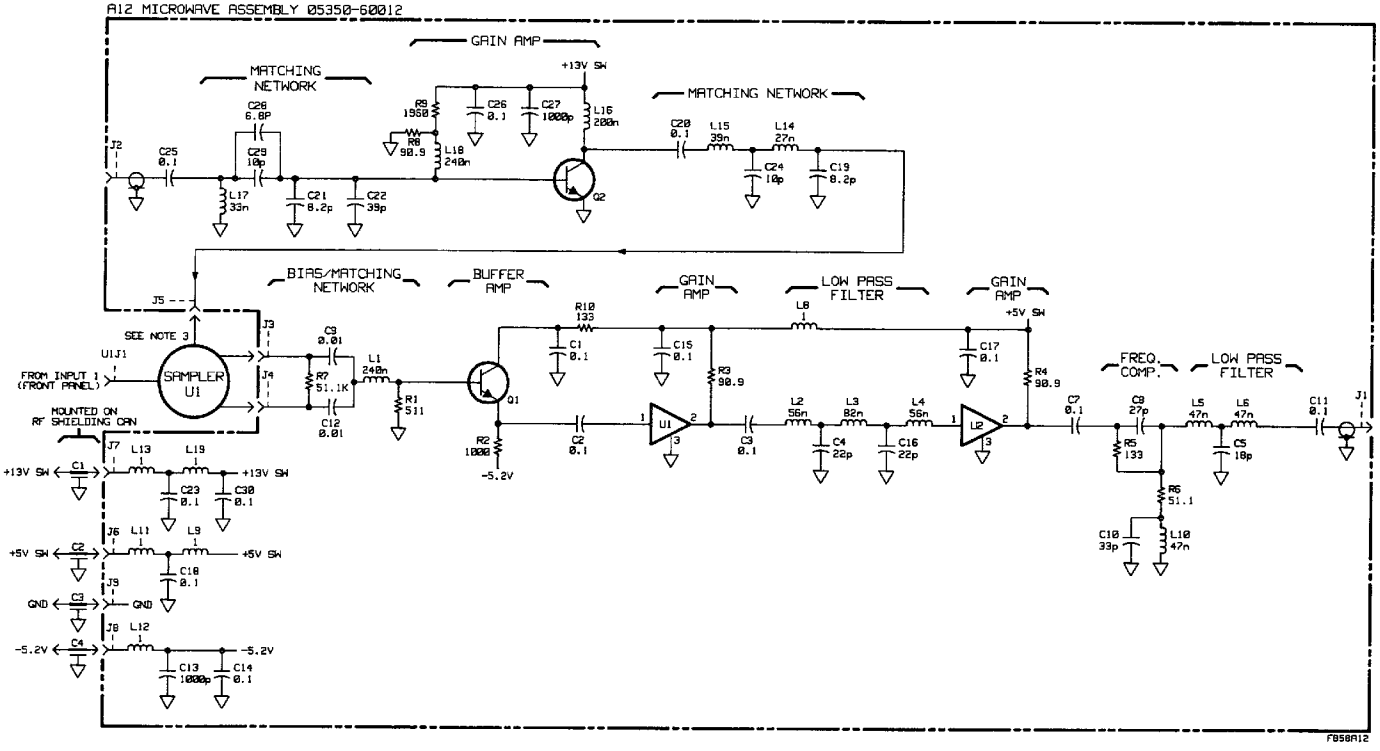
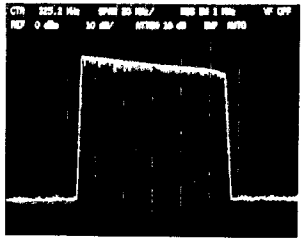


Figure 8-58. 5350B/5351B Microwave Module (A12 Microwave Assembly/U1 Sampler)

Figure 8-58
5350B/5351B MICROWAVE MODULE (A12 MICROWAVE ASSEMBLY/U1 SAMPLER)
(See Page 8-201)

A



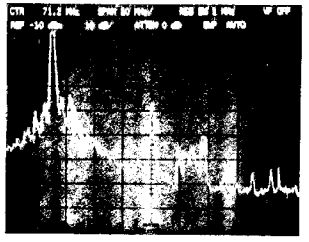
Collector of Q2
(Leg of C20)

Counter set to Diag 52.

HP1120A active probe with 100:1 tip.

Center: 325.2 MHz
Span: 20 MHz/div.
Bandwidth: 1 MHz
Reference: 0 dBm
Attenuation: 10 dB

B



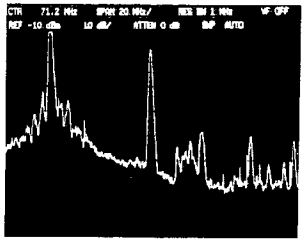
Emitter of Q1
(Leg of R2)

Counter in INPUT 1, Manual Mode; Manual CF = 1 GHz.

1 GHz, 0 dBm input to INPUT 1.

Center: 71.2 MHz
Span: 20 MHz/div.
Bandwidth: 1 MHz
Reference: -10 dBm
Attenuation: 0 dB

C



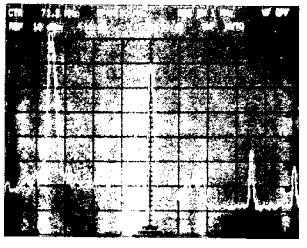
Ouput of U1
(Leg of R3)

Counter in INPUT 1, Manual mode; Manual CF = 1 GHz.

1 GHz, 0 dBm input to INPUT 1.

Center: 71.2 MHz
Span: 20 MHz/div.
Bandwidth: 1 MHz
Reference: -10 dBm
Attenuation: 0 dB

D



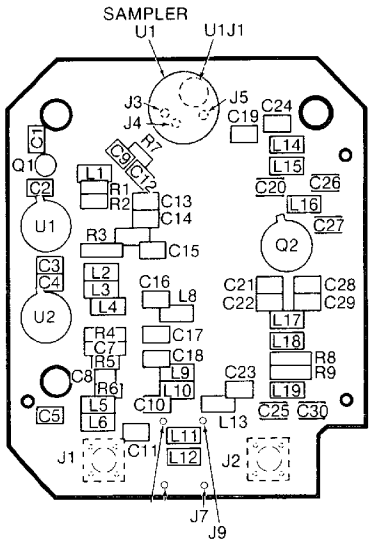
Output of U2
(Leg of R4)

Counter in INPUT 1, Manual Mode; Manual CF = 1 GHz.

1 GHz, 0 dBm input to INPUT 1.

Center: 71.2 MHz
Span: 20 MHz/div.
Bandwidth: 1 MHz
Reference: 10 dBm
Attenuation: 20 dB

Figure 8-59. 5352B A12 Waveforms



NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.
2. UNLESS OTHERWISE INDICATED:
   RESISTANCE IN OHMS;
   CAPACITANCE IN MICROFARADS;
   INDUCTANCE IN MICROHENRIES.
3. SAMPLER U1 IS NOT PART OF THE A12 ASSEMBLY. REFER TO REPLACEABLE PARTS LIST IN SECTION VI FOR SAMPLER PART NUMBER.

REFERENCE DESIGNATIONS

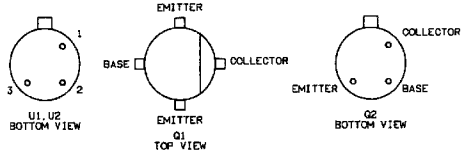
A12 ASSEMBLY
C1-C5, C7-C30 J1-J8 L1-L5, L8-L19 Q1-Q2 R1-R10 U1, U2

A12 ACTIVE COMPONENTS (5352A)

REFERENCE DESIGNATIONS	HP PART NUMBER	MFG. PART NUMBER
Q1	1854-1003	SAME
Q2	1854-0888	SAME
U1, U2	1813-0211	MWA110

A8J11
CIRCUIT SIDE OF MOTHERBOARD

NOT CONNECTED TO MICROWAVE MODULE			TO MICROWAVE MODULE VIA W5
GND, MTHRPLN	6	1	NC
+15V	7	2	+13V SW
-5.2V	8	3	GND, MTHRPLN
-5.2V	9	4	+5V SW
+5V	10	5	-5.2V



NOTE

This A12 schematic diagram and accompanying information apply only to the 05352-60012 assembly installed in the 5352B. Refer to *Figure 8-58* for the 5350B and 5351B A12 schematic diagram and component information.

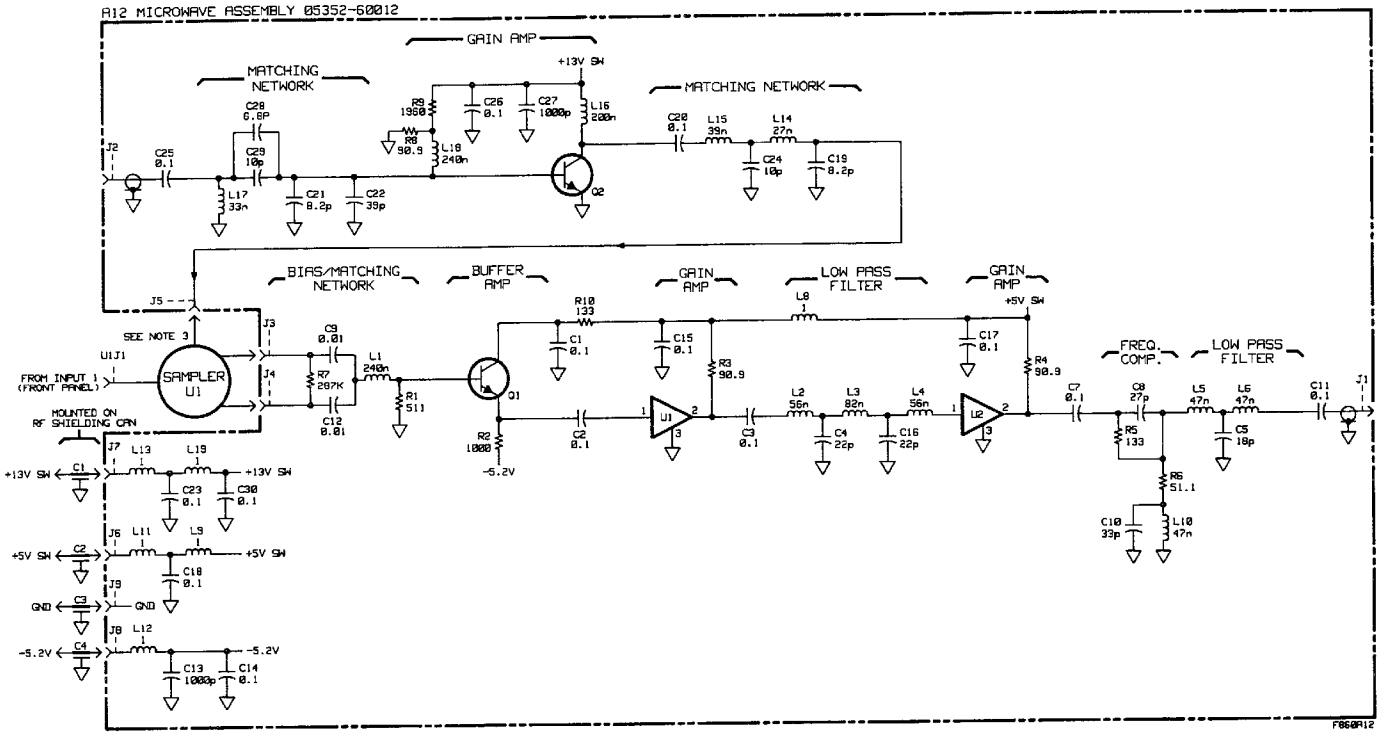
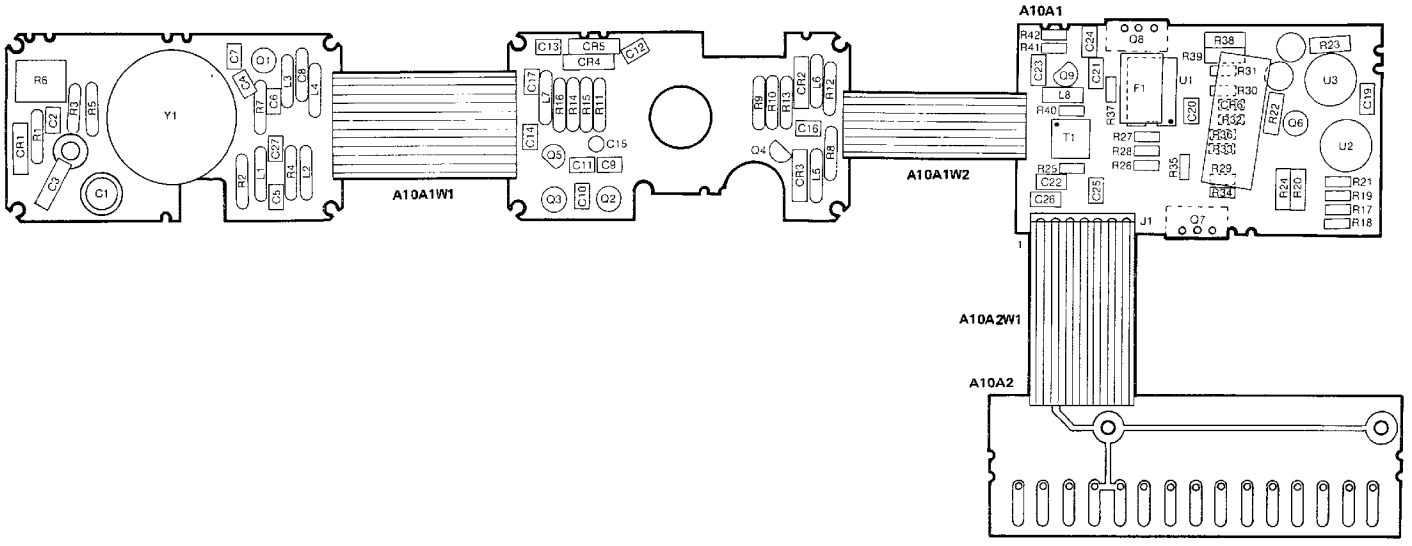
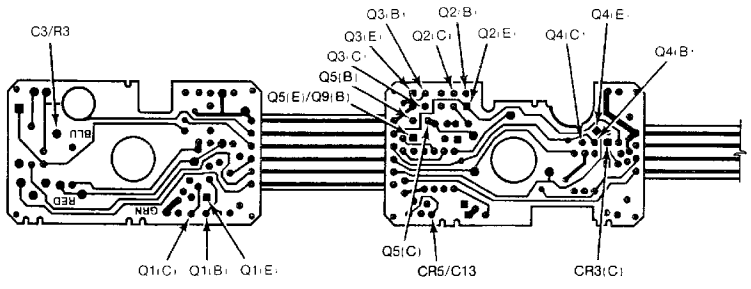


Figure 8-60. 5352B Microwave Module (A12 Microwave Assembly/U1 Sampler)

Figure 8-60
5352B MICROWAVE MODULE (A12 MICROWAVE ASSEMBLY/U1 SAMPLER)
(See Page 8-203)





NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DISCRIPTION.
2. UNLESS OTHERWISE INDICATED:
   RESISTANCE IN OHMS;
   CAPACITANCE IN MICROFARADS;
   INDUCTANCE IN MICROHENRIES.
3. ASTERISK(*) INDICATES SELECTED COMPONENT. AVERAGE VALUES SHOWN.
4. THE VOLTAGE AT Q6 (COLLECTOR) SHOULD BE .57X OVEN SUPPLY VOLTAGE + OR - 10% SEE NOTE 10.
5. SEE PARAGRAPH 8-733(B) BEFORE REPLACING THE CRYSTAL, Y1. WHEN REINSTALLING THE CRYSTAL INTO THE OVEN MASS, TIGHTEN MOUNTING NUT TO A TORQUE OF 5 IN-LBS (0.6 NEWTON-METRES).
6. THERMISTOR ROOM TEMPERATURE RESISTANCE IS APPROXIMATELY 100K. THERMISTOR IS PART OF OVEN MASS (MP 1) AND CANNOT BE REPLACED SEPARATELY. RESISTANCE BETWEEN THERMISTOR AND OVEN MASS SHOULD BE GREATER THAN 100 MOHMS.
7. THIS AREA OF THE CIRCUIT BOARD IS HIGH IMPEDANCE. THE AREA MUST REMAIN CLEAN.
8. THE VOLTAGE GAIN FROM Q9(BASE) TO Q8 (COLLECTOR) IS APPROXIMATELY 2 WITH A 50 OHM LOAD ON THE OUTPUT.
9. R20 IS SELECTED TO MATCH CRYSTAL Y1. IF Y1 IS REPLACED, THE SUPPLIED R20 MUST BE USED. SEE PARAGRAPH 8-733(B).
10. ALL VOLTAGES MEASURED WITH 12V TO THE OSCILLATOR CIRCUITS AND -24V TO THE OVEN CIRCUITS.
11. WHEN REINSTALLING Q7 AND Q8 INTO THE OVEN MASS TIGHTEN THE MOUNTING SCREWS TO 5 IN-LBS (0.6 NEWTON METRES). IF Q7 AND/OR Q8 IS TO BE REPLACED, SEE PARAGRAPH 8-733(C).

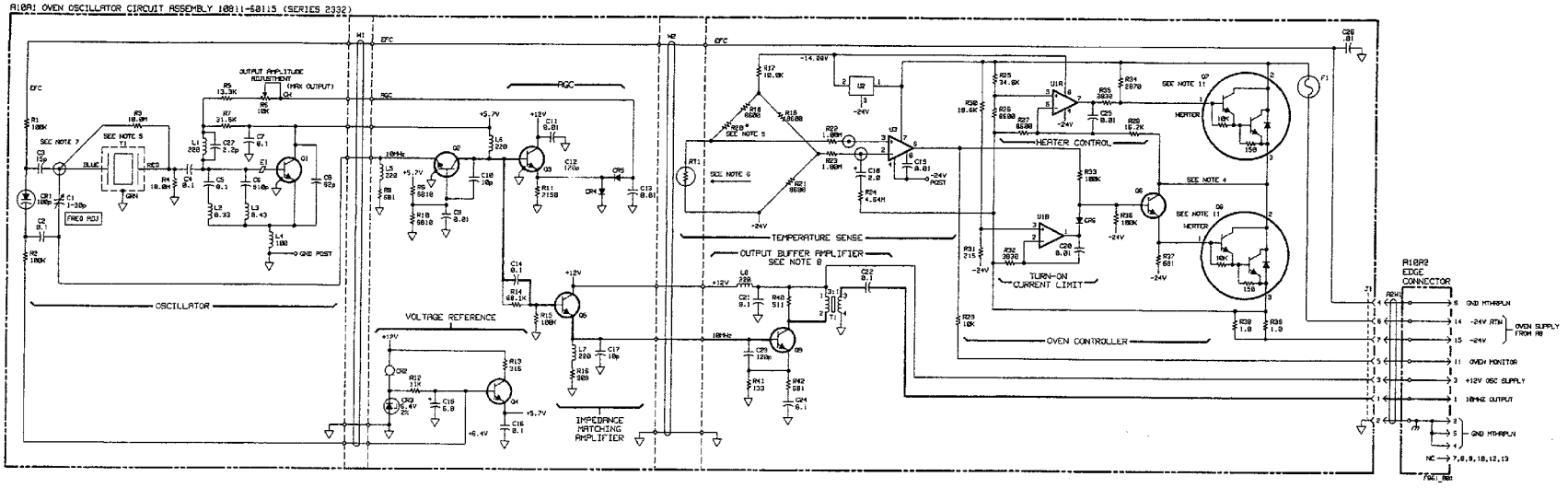


Figure 8-61. Option 001 Oven Oscillator Timebase

Figure 8-61
OPTION 001 OVEN OSCILLATOR TIMEBASE
(See Page 8-205)

MANUAL PART NUMBER 05350-90021

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