

HP 5347A/5348A  
Microwave Counter/  
Power Meter

Service Manual

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# HP 5347A/48A

## Microwave Counter/Power Meter

SERIAL NUMBER PREFIX: 3009

This manual applies to the following instruments:

HP 5347A, Serial Number Prefix 3009

HP 5348A, Serial Number Prefix 3009

If your HP 5347A/48A does not have

the above serial prefix number, refer to the

"Manual Changes" sheet for this manual.

For additional information about serial numbers, refer to

INSTRUMENT AND MANUAL IDENTIFICATION in

Section 1 of the Operating and Programming Manual.

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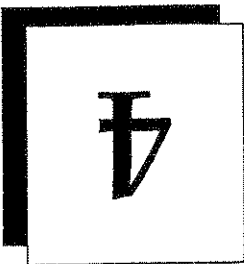
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# PERFORMANCE TESTS



## 4-1. INTRODUCTION

This section contains procedures for testing the electrical performance of the HP 5347A/48A Microwave Counter/Power Meter, using the specifications listed in Appendix A, as performance standards.

## 4-2. OPERATIONAL VERIFICATION

The Operational Verification, beginning at Section 4-8, is an abbreviated series of checks that may be performed to give a high degree of confidence that the instrument is operating properly without performing the complete Performance Test. An operational verification should be useful for incoming inspection, routine maintenance, and after instrument repair.

## 4-3. PERFORMANCE TEST

The complete Performance Test procedures begin at Section 4-16. All tests can be performed without access to the inside of the instrument.

## 4-4. HP-IB VERIFICATION (FOR OPTION 011)

An HP-IB Verification program, described in Section 4-25, exercises the instrument through the majority of its command set via the HP-IB Interface. The program is written for an HP 9000 series 200 or 300 Desktop Computer 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 is working properly. The HP-IB program is available on floppy discs, HP Part Number 05348-13502 (5-1/4 inch LIF disc) and HP Part Number 05348-13501 (3-1/2 inch LIF disc). These discs are included in the HP 5347A/48A Service Accessories Kit (see Table 8-2).

## 4-5. EQUIPMENT REQUIRED

The equipment required for all test procedures in this section is listed in Table 4-1. Any equipment that satisfies the required characteristics given in the table may be substituted for the recommended models. (Appendix B, RECOMMENDED TEST EQUIPMENT, in the Service Manual is a complete list of the recommended test equipment for the performance tests, adjustments, and troubleshooting procedures.)

#### 4-6. CALIBRATION CYCLE

The HP 5347A/48A requires periodic verification of operation. Depending on the use and environmental conditions, the HP 5347A/48A should be checked using the operational 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.

#### 4-7. TEST RECORD

Results of the operational verification should be recorded on a copy of the Operational Verification Record, *Table 4-2*, located at the end of the operational procedures. Results of the Performance Tests should be recorded on a copy of the Performance Test Record, located at the end of the performance test procedures. Results of the HP-IB verification test should be recorded on a copy of the HP-IB Verification Test Record, *Table 4-3*, located at the end of the HP-IB verification test procedures.

Table 4-1. Equipment Required

Recommended Model	Required Characteristics	Instrument
HP 8350B mainframe/HP 83595A plug-in	.01-20 GHz [26.5 GHz] Frequency Modulation capability 14 MHz p-p	Sweep Oscillator
HP 8495D	dc to 26.5 GHz 0 - 70 dB in 10-dB steps	Attenuator
HP 3325B with Option 001 (10 MHz Oven Output)	10 Hz to 10 MHz -20 dbm to +5 dbm	Synthesizer
HP 8673B or HP 8340B	2 GHz to 26.5 GHz 1 Hz Accuracy +4 dbm output	Synthesizer
HP 8660C/ HP 86603A/HP 86632B or HP 8642A	10 MHz - 2.6 GHz 5% AM, 200 kHz FM p-p, -40 dbm to +10 dbm	Synthesized Signal Generator
HP 437B	50 MHz to 40 GHz	Power Meter
HP 8485A	50 MHz to 26.5 GHz, -30 to +10 dbm	Power Sensor
HP 11667B	dc to 26.5 GHz	Power Splitter
HP 432A	Range: 1 mW Transfer accuracy: 0.2% (input to output)	Power Meter
HP 478A-H75 or HP 478A-H76	SWR: 1.05 at 50 MHz Accuracy: $\pm 0.5\%$ at 50 MHz	Thermistor Mount
HP 8493C	dc to 26.5 GHz, 10dB	Fixed Attenuator
HP 10100C	50 $\Omega$	Feedthrough
HP 8565A	RF inputs from 1 MHz	Spectrum Analyzer
HP 3466A	4 1/2 digit AC/DC	Digital Voltmeter (Multimeter)
HP 8340B	10 MHz to 26.5 GHz	Synthesized Sweeper
HP 909D	dc to 26.5 GHz	50 $\Omega$ Termination
HP 8780A	1 GHz with Frequency Modulation, 20 MHz p-p, 1 KHz modulating frequency	Vector Signal Generator
HP 11683A	Calibration functions: 3, 10, 30, 100, and 300 $\mu$ W; 1, 3, 10, 30, and 100 mW	Range Calibrator
HP 11730A	3.0 metres (10 ft.)	Sensor Cable

## 4-8. OPERATIONAL VERIFICATION PROCEDURES

The checks included here are not as thorough and exhaustive as the performance tests. This group of checks is intended only to serve as a method for giving the operator a high degree of confidence that the instrument is performing properly. No attempt is made to check the specifications of the instrument.

### 4-9. Preliminary Procedure

The following operational verification and performance test procedures require measurement of the actual input sensitivity of the HP 5347A/48A. Before measuring actual sensitivity, perform the following:

1. To perform valid verification and testing of the specifications, allow the instrument to warm up for 30 minutes.
2. Be sure to calibrate the power meter according to the frequency calibration data provided on the power sensor to be used in the test.
3. Decrease the input level to the HP 5347A/48A until it stops counting, then slowly increase the input level until the HP 5347A/48A measures the input properly (as defined by the particular procedure being performed).

### 4-10. Power-Up Self Test

1. Turn on the HP 5347A/48A and verify the Power-Up Self Test routine, as follows:

- a. Immediately after switching the power on, the HP 5347A/48A 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.

- b. The next portion checks a number of internal circuits. If any of the internal tests fail, the results of the first test that failed will be displayed after the display test. Pressing the Reset/Local key will display the next test, if any, that failed. When all tests that failed have been displayed, the HP-IB address is displayed 5 seconds. If the Option 011 HP-IB Interface is not installed in the HP 5347A/48A, then the "HP-IB NOT INSTALLED" message will be displayed. If the tests pass, the HP-IB address or "HP-IB NOT INSTALLED" message is displayed immediately after the Display Test.
- c. After the HP-IB address is displayed, the HP 5347A/48A should go into the measurement mode last selected if the instrument had been previously left in the Standby mode.

- d. If a FAIL message is displayed during the Power-Up Self Test, refer to troubleshooting procedures in Section 8, Service, for information about specific diagnostic failures.

2. Mark Pass or Fail on the Operational Verification Record card (Table 4-2), line 1.

#### 4-11. Frequency Counter Checks

##### 4-12. INPUT 2, GATING AND COUNTING CHECK

Description: A 10 MHz input is connected to INPUT 2 to check that the HP 5347A/48A gates and counts with INPUT 2 impedance set at both 1 M $\Omega$  and 50  $\Omega$ .

1. Set up an HP 3325B Synthesizer to output an 1 Vp-p, 10 MHz, sine-wave signal.

2. Connect the 10 MHz signal to INPUT 2 connector of the HP 5347A/48A.

3. Press POWER key to turn ON the HP 5347A/48A.

4. Press Input 2 50  $\Omega$ /1M $\Omega$  key to set the HP 5347A/48A to the INPUT 2, 50  $\Omega$  impedance mode. (This key toggles INPUT 2's impedance between 50  $\Omega$  and 1 M $\Omega$  as indicated by the front panel 50  $\Omega$  and 1 M $\Omega$  annunciators). Observe that the (V) annunciator above the 50 $\Omega$  label on the front panel indicates that the INPUT 2 impedance is set to 50  $\Omega$ .

5. Verify the HP 5347A/48A displays 10 MHz.

6. Mark Pass or Fail on the Operational Verification Record card, line 2 (a).

7. Now, press Input 2 50  $\Omega$ /1M $\Omega$  key to set INPUT 2 impedance to 1 M $\Omega$ .

8. Verify the HP 5347A/48A displays 10 MHz.

9. Mark Pass or Fail on the Operational Verification Record card, line 2 (b).

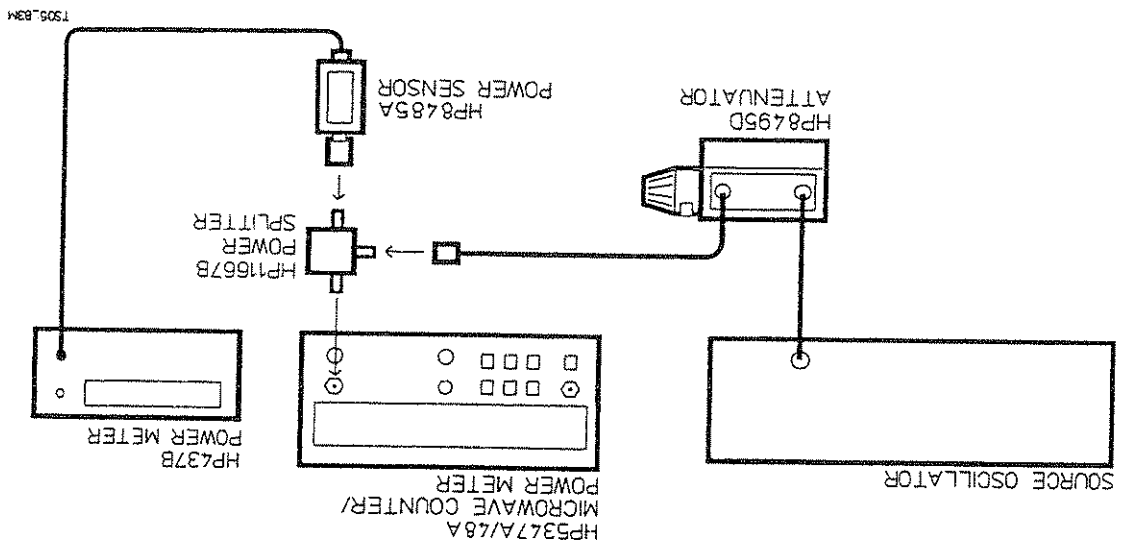
##### 4-13. INPUT 2, 10 Hz-525 MHz INPUT SENSITIVITY CHECK

Specification: 50 $\Omega$ : 10 MHz to 525 MHz, 25 mV rms  
 1M $\Omega$ : 10 Hz to 80 MHz, 25 mV rms

Description: This check is in two parts to check both the high frequency measuring capability of the 50  $\Omega$  input impedance and the low frequency measuring capability of the 1 M $\Omega$  input impedance of INPUT 2. In Part 1, the HP 5347A/48A is set to the 10 MHz-525 MHz range, 50 $\Omega$  impedance, and a 25 mV rms (-19.3 dBm) signal is applied to INPUT 2. The source is set to selected frequencies and the HP 5347A/48A is checked for proper counting. Next, the HP 5347A/48A's 1M $\Omega$  impedance for the lower frequency range is checked. Since the same test setup in Figure 4-1 with the addition of a 50 $\Omega$  feedthrough is used to perform the 80 MHz check, the 80 MHz check is performed before the 10 Hz-50 MHz check. A 25 mV rms (-19.3 dBm) 80 MHz signal is applied to INPUT 2 through a 50 $\Omega$  feedthrough, and the HP 5347A/48A is checked for proper counting. In Part II, the test setup is changed to Figure 4-2 to test the 10 Hz-50 MHz range.

2. Press Input 2 50  $\Omega$ /1M  $\Omega$  key to set the HP 5347A/48A to the 10 MHz-525 MHz range, 50 $\Omega$  impedance. Observe that the  $\nabla$  annunciator indicates that INPUT 2 impedance is set to 50  $\Omega$ .
3. Set source to 50 MHz, and for an output level of 25 mV rms (-19.3 dbm) as measured on the HP 437B Power Meter. Measure actual sensitivity and verify that the HP 5347A/48A 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 source.)
4. Mark Pass or Fail on the Operational Verification Record card, lines 3 through 6.

Figure 4-1. INPUT 2, 50 MHz-525 MHz Verification Test Setup



1. Connect the equipment as shown in Figure 4-1.

Part I: INPUT 2, 50 MHz-525 MHz (50 $\Omega$ ) Check

**NOTE**

The 1 M $\Omega$  impedance of INPUT 2 is checked with an 80 MHz input signal before it is checked with signals from 10 Hz through 50 MHz. This is done for convenience since to perform the 80 MHz check you need to use the test setup in Figure 4-1 with the addition of the 50 $\Omega$  feedthrough between the power splitter and INPUT 2 connector.

1. Using the test setup in Figure 4-1, insert a 50 $\Omega$  feedthrough (HP 10100C) between the HP 1667B power splitter and INPUT 2 of the HP 5347A/48A.
2. Press Input 2 50  $\Omega$ /1M  $\Omega$  key to select the 1M $\Omega$  impedance, 10 Hz-80 MHz input. Observe that the 1M  $\Omega$  annunciator ( $\nabla$ ) lights.
3. Set the source to 80 MHz, and for a level of 25 mV rms (-19.3 dBm) as measured on the HP 437B Power Meter.
4. Verify that the HP 5347A/48A counts properly at 80 MHz at 25 mV rms, and mark Pass of Fail on the Operational Verification Record card, line 7.

Description: The HP 5347A/48A is set to the 500 MHz-20 GHz [26.5 GHz for HP 5348A] range and the appropriate input signal is applied to INPUT 1. The source generator is set to selected frequencies and levels appropriate for the HP 5347A/48A, and the actual sensitivity of the HP 5347A/48A is measured up to 20 GHz [26.5 GHz for HP 5348A].

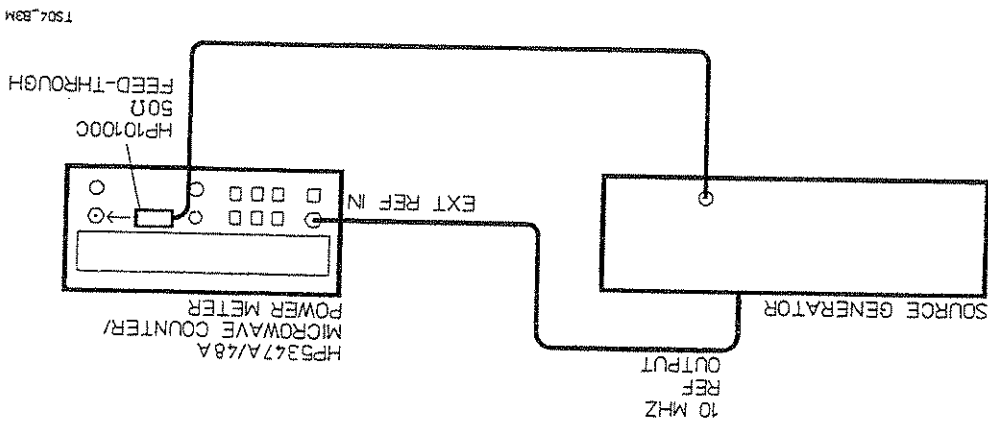
Specifications:

HP 5347A/48A =	Standard Instrument
-32 dBm, 500 MHz - 12.4 GHz	
-27 dBm, 12.4 GHz - 20 GHz	
-16 dBm, 20 GHz - 26.5 GHz	
HP 5348A only =	
-29 dBm	Option 006
-23 dBm	
-15 dBm	

4-14. INPUT 1, 500 MHz-20 GHz [26.5 GHz for HP 5348A] INPUT SENSITIVITY CHECK

1. The HP 5347A/48A settings are the same as in the 80 MHz test (INPUT 2, 1M $\Omega$ ).
2. Set the source for an output of 25 mV rms (-19.3 dBm) at 10 Hz.
3. Verify that the HP 5347A/48A counts properly at 10 Hz, 50 kHz, 1 MHz, 10 MHz, and 50 MHz. Mark Pass or Fail on the Operational Verification Record card, lines 8 through 12.

Figure 4-2. INPUT 2, 10 MHz-50 MHz Verification Test Setup

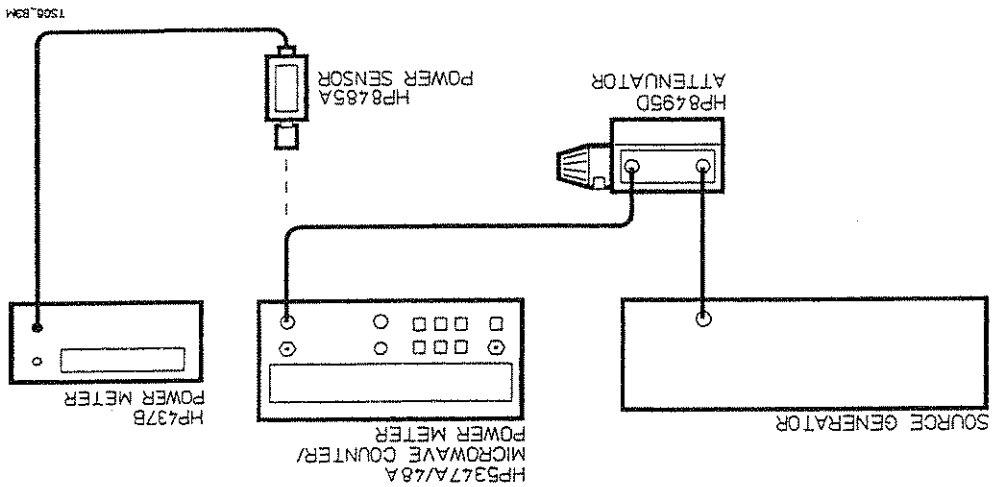


1. Connect the equipment as shown in Figure 4-2.
- Part II: INPUT 2, 10 Hz-50 MHz (1M $\Omega$ ) Check



2. Press Input 1 50Ω key to set the HP 5347A/48A to INPUT 1.
3. Set the source to 500 MHz, and set the output for -32 dbm as measured on the HP 437B. If Option 006 is installed, set the input to -29 dbm.
4. Measure the actual sensitivity at 500 MHz, 1 GHz, 5 GHz, and 12.4 GHz. (Verify the signal level with the HP 437B Power Meter at each of these frequencies.) Mark Pass or Fail on the Operational Verification Record card, lines 13 through 16.
5. Set the source to 18 GHz, and the output for -27 dbm as measured on the HP 437B. If Option 006 is installed, set the input to -23 dbm.
6. Measure the actual sensitivity at 18 GHz and 20 GHz. (Verify the signal level with the HP 437B Power Meter at each of these frequencies.) Mark Pass or Fail on the Operational Verification Record card, lines 17 and 18.
7. For the HP 5348A only, set the source for -16 dbm at 22 GHz. Measure the dbm at 22 GHz. Measure the actual sensitivity at 22 GHz and 26.5 GHz. Mark Pass or Fail on the Operational Verification Record card, lines 19 and 20. If Option 006 is installed, set the input to -15 dbm.

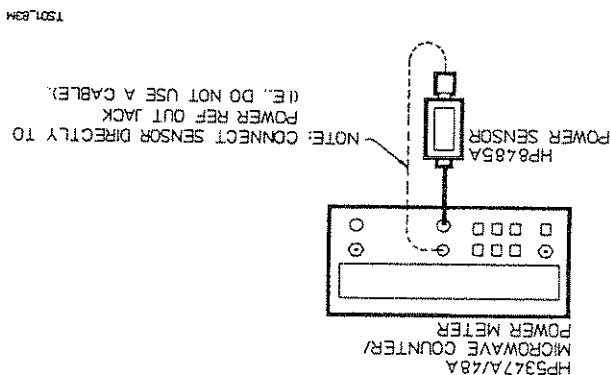
Figure 4-3. INPUT 1, 500 MHz-26.5 GHz Verification Test Setup



1. Connect the equipment as shown in Figure 4-3.

3. Turn on the HP 5347A/48A
4. Press Input dbm/Watt key.
5. Press the Zero key, and observe the "ZERONING" message in the display during the process, which takes from 10 to 20 seconds. When completed, the HP 5347A/48A will show random readings, reflecting residual noise in the Power Meter circuits.

Figure 4-4. Power Meter Mode Verification Test Setup



2. Connect the equipment as shown in Figure 4-4.
1. With the HP 5347A/48A OFF, set the SENSOR TYPE switches of the rear panel DIP switch to select the 8485A sensor.

Procedure

- Power Sensor ..... HP 8485A
- Power Sensor Cable ..... HP 11730A

Equipment

Description: Checks the HP 5347A/48A ability to zero, and to calibrate on the 1 mW, 50 MHz Power Reference Oscillator signal.

4-15. Power Meter Checks

6. Press Input dbm/Watt key again, and verify that the reading is  $0.00 \pm 0.06 \mu\text{W}$ . Mark Pass or Fail on the Operational Verification Record card, line 21.
7. Press Calibrate/Store key, and observe the "CALIBRATING" message in the display during the process, which takes about 5 seconds.
8. Correct operation is signaled by the fact that after "CALIBRATING" message disappears, the display will show random readings, and no error message appears. (Note: the Power Reference Oscillator is ON only during the actual calibration process. The Performance Tests [Section 4-24] contain a test procedure to check the Power Reference Oscillator output level.)
9. Verify random readings. Mark Pass or Fail on the Operational Verification Record card, line 22.

Table 4-2. Operational Verification Record

Hewlett-Packard Model 5347A/48A  
 Microwave Frequency Counter/Power Meter

Repair/Work Order No. \_\_\_\_\_

Temperature: \_\_\_\_\_

Relative Humidity: \_\_\_\_\_

Test Performed By: \_\_\_\_\_

Date: \_\_\_\_\_

Notes: \_\_\_\_\_

Serial Number: \_\_\_\_\_

Post Calibration Test:

Pre Calibration Test:

PARA. NO.	TEST	TEST RESULTS
4-10.	Power-Up Self Test	1.
4-12.	INPUT 2, Gating and Counting Check (50Ω/1MΩ):	2 (a). 2 (b).
4-13.	INPUT 2, 10 Hz-525 MHz Input Sensitivity Check(50 Ω/1MΩ):	3. 4. 5. 6. 7. 8. 9. 10. 11. 12.
4-14.	INPUT 1, 500 MHz - 20 GHz [26.5 GHz] Input Sensitivity Test:	13. 14. 15. 16. 17. 18. 19. 20.
4-15.	POWER METER CHECKS	21. 22.

Part I 500 MHz  
 1 GHz  
 5 GHz  
 12.4 GHz  
 Part II 18 GHz  
 20 GHz  
 22 GHz (HP 5348A only)  
 26.5 GHz

Part I 50 Ω:  
 50 MHz  
 100 MHz  
 250 MHz  
 525 MHz  
 1 M Ω:  
 80 MHz  
 Part II 1 M Ω:  
 10 Hz  
 50 KHz  
 1 MHz  
 10 MHz  
 50 MHz

random readings  
 0.00 ± 0.06 μW

## 4-16. PERFORMANCE TEST PROCEDURES

### 4-17. Frequency Counter Tests

#### 4-18. INPUT 2, 10 Hz-525 MHz INPUT SENSITIVITY TEST

Specification: 50 $\Omega$ : 10 MHz to 525 MHz, 25 mV rms

1M $\Omega$ : 10 Hz to 80 MHz, 25 mV rms

Description: This test is in two parts to check both the high frequency measuring capability of the 50  $\Omega$  input impedance and the low frequency measuring capability of the 1 M  $\Omega$  input impedance of INPUT 2. In Part I, the HP 5347A/48A is set to the 10 MHz-525 MHz range, 50 $\Omega$  impedance, and a 25 mV rms (-19.3 dBm) signal is applied to INPUT 2. The source oscillator is set to selected frequencies and the HP 5347A/48A is checked for proper counting. Next, the HP 5347A/48A 1M $\Omega$  impedance for the lower frequency range is checked. Since the same test setup in Figure 4-5 with the addition of a 50 $\Omega$  feedthrough is used to perform the 80 MHz check, the 80 MHz check is performed before the 10Hz-50MHz check. A 25 mV rms (-19.3 dBm) 80 MHz signal is applied to INPUT 2 through a 50 $\Omega$  feedthrough, and the HP 5347A/48A is checked for proper counting. In Part II, the test setup is changed to Figure 4-6 to test the 10 Hz-50 MHz range.

#### Part I: INPUT 2, 50 MHz-525 MHz (50 $\Omega$ ) Test

1. Connect the equipment as shown in Figure 4-5.

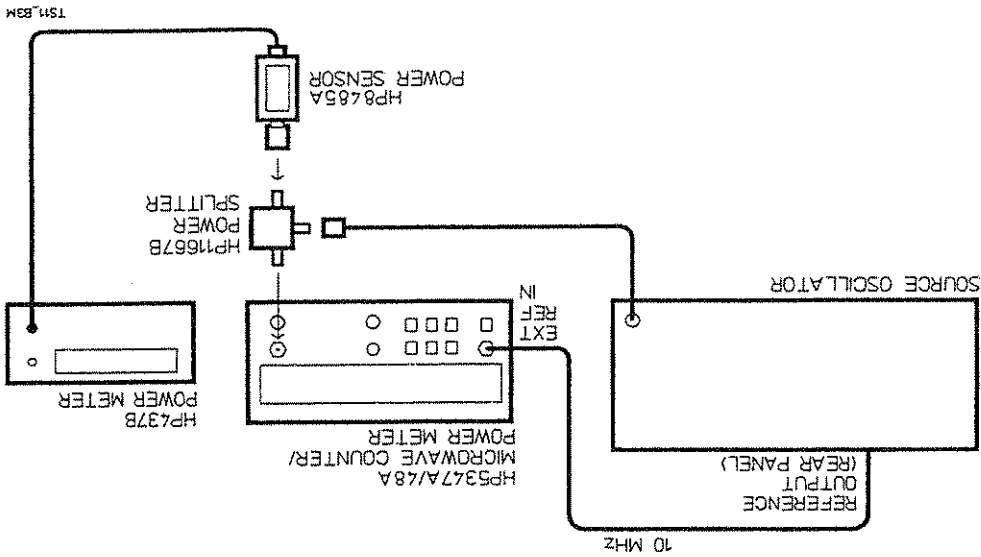
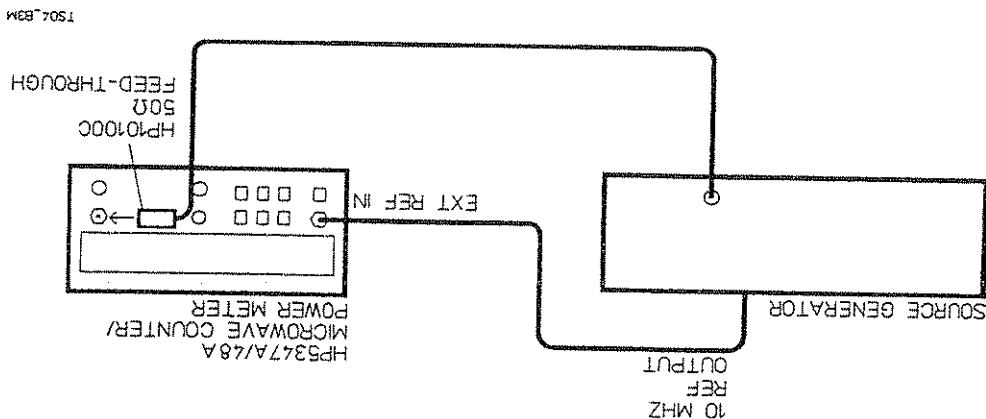


Figure 4-5. INPUT 2, 50 MHz-525 MHz Test Setup

- The HP 5347A/48A settings are the same as in the 80 MHz test (INPUT 2, 1 M $\Omega$ ).

Figure 4-6. INPUT 2, 10 Hz-10 MHz Test Setup



- Connect the equipment as shown in Figure 4-6.

Part II: INPUT 2, 10 Hz-10 MHz (1 M $\Omega$ ) Test

- Using the test setup in Figure 4-5, connect the HP 1167B to INPUT 2 of the HP 5347A/48A via a 50 $\Omega$  feedthrough (HP 10100C).
  - Press Input 2 50 $\Omega$ /1M  $\Omega$  key to select the 1 M $\Omega$  impedance of INPUT 2.
  - Set the source to 80 MHz, and for an output level of 25 mV rms (-19.3 dBm) as measured on the HP 437B Power Meter.
  - Verify that the HP 5347A/48A counts 80 MHz,  $\pm$  1 Hz, at 25 mV rms (-19.3 dBm). Enter the results on the Performance Test Record.
- INPUT 2, 80 MHz (1 M $\Omega$ ) Test (Part of Part I)
- Press Input 2 50  $\Omega$ /1M  $\Omega$  key to set the HP 5347A/48A to the 10MHz-525 MHz range, 50 $\Omega$  impedance. Observe that 50 $\Omega$  annunciator lights.
  - Set the source to 50 MHz, and for an output level of 25 mV rms (-19.3 dBm) as measured on the HP 437B Power Meter. Verify that the HP 5347A/48A counts 50 MHz, 100 MHz, 200 MHz, 400 MHz, and 525 MHz,  $\pm$  1 Hz. Record the actual sensitivity at each frequency on the Performance Test Record, located at the end of the performance test procedures.

Description: In Part I, the HP 5347A/48A is set to the 500 MHz - 20 GHz [26.5 GHz for HP 5348A] range and the appropriate input signal is applied to INPVT 1. The source generator is set to selected frequencies up to 1 GHz, and the actual sensitivity of the HP 5347A/48A is measured. In Part II, the test setup is changed to Figure 4-8 to measure sensitivity in the 2.5 GHz-20 GHz [26.5 GHz for HP 5348A] range. The source generator is set to the appropriate test level, and the actual sensitivity is measured at selected frequencies up to 20 GHz [26.5 GHz for HP 5348A].

HP 5347A/48A =	-32 dbm, 500 MHz - 12.4 GHz	-29 dbm
HP 5348A only =	-27 dbm, 12.4 GHz - 20 GHz	-23 dbm
	-16 dbm, 20 GHz - 26.5 GHz	-15 dbm

Standard Instrument  
Option 006

The following test is in two parts, Figure 4-7 is the test setup for Part I (500 MHz to 1 GHz), and Figure 4-8 is the test setup for Part II (2.5 GHz to 20 GHz [26.5 GHz for HP 5348A]).

4-19. INPVT 1, 500 MHz-20 GHz [26.5 GHz for HP 5348A] INPVT SENSITIVITY TEST

A2 Low Frequency Input Assembly  
A3 Counter Assembly

- If the HP 5347A/48A fails any of the above sensitivity tests, refer to Section 5 (Adjustments) and verify the INPVT 2 sensitivity adjustment (Peak Detector Adjustment, A2R1). If this adjustment is correct, and the HP 5347A/48A continues to fail the sensitivity tests, refer to Section 8, for troubleshooting procedures for the following assemblies, in the order shown:
4. Verify that the HP 5348A counts properly at 10 Hz, 1 kHz, 500 kHz, 1 MHz, and 10 MHz, ±1 Hz. Record the actual sensitivity on the Performance Test Record.
  3. Set the source for an output of 25 mV rms (-19.3 dbm) at 10 Hz.

4. Connect the source to the HP 5347A/48A with the attenuator in line.
5. Measure the actual sensitivity at 500 MHz and 1 GHz. (The HP 5347A/48A should measure these frequencies to  $\pm 4$  Hz). Verify the signal levels with HP 437B Power Meter at each frequency. Enter the result on the Performance Test Record.

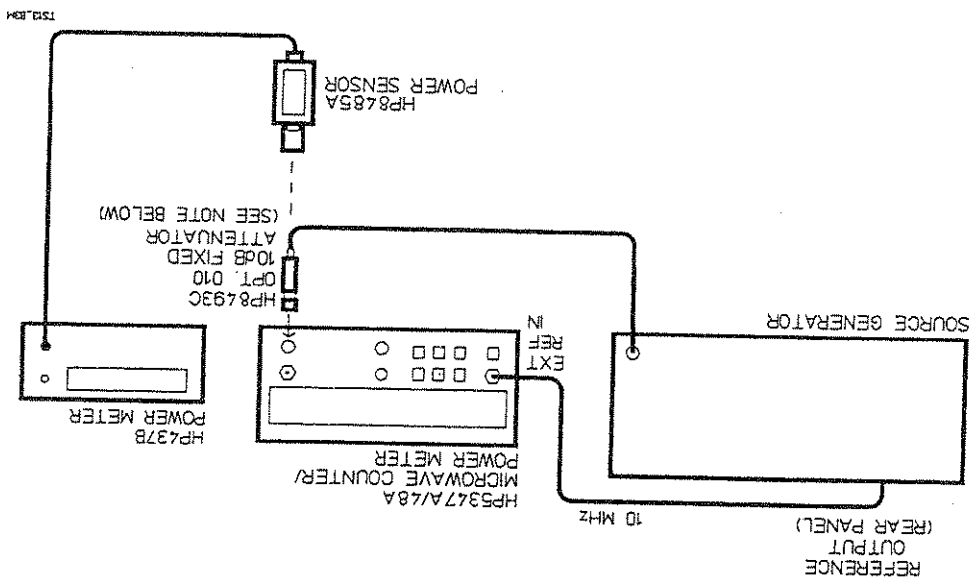
(If Option 006 is installed, the attenuator is not needed.)

The HP 8485A Power Sensor measures down to -30 dBm; therefore, it is not possible to set the signal level at -32 dBm. By using the 10 dB Fixed Attenuator and setting the level at -22 dBm, an output of -32 dBm can be attained at the input of the Counter.

**NOTE**

2. Press Input 1 50  $\Omega$  key to set the HP 5347A/48A to INPUT 1.
3. Set the source to 500 MHz, and for an output of -22 dBm as measured on the HP 437B, without the attenuator in line. If Option 006 is installed, set the output to -29 dBm.

Figure 4-7. INPUT 1, 500 MHz-1 GHz Test Setup



1. Connect the equipment as shown in Figure 4-7.

Part I: INPUT 1, 500 MHz - 1 GHz Test



4. Connect the source to the HP 5347A/48A with attenuator in line. If Option 006 is installed, do not use the attenuator.
5. Measure actual sensitivity at 2.5, 5, 10, and 12.4 GHz, by first verifying the signal level with the 437B/8485A, and then verifying that each of the frequencies is counted to  $\pm 4$  Hz.
6. Set the source to 18 GHz at a level of -17 dBm, as measured on the HP 437B, with the 10 dB attenuator in place. (Since the -27 dBm signal desired is within the power sensor

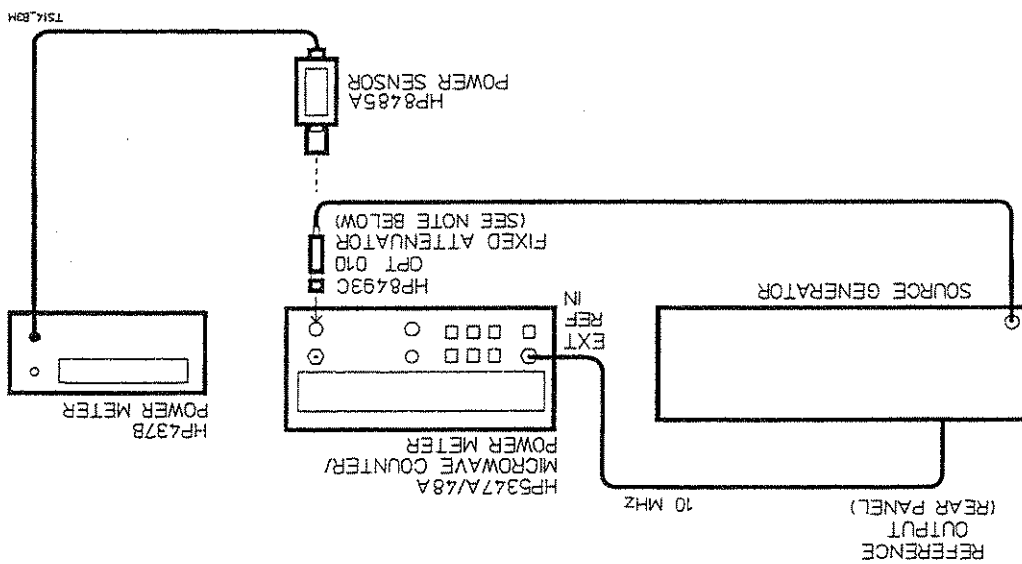
(If Option 006 is installed, the attenuator is not needed.)

The HP 8485A Power Sensor measures down to -30 dBm; therefore, it is not possible to set the signal level at -32 dBm. By using the 10 dB Fixed Attenuator and setting the level at -22 dBm, an output of -32 dBm can be attained at the input of the Counter.

**NOTE**

2. The HP 5347A/48A settings are the same as in Part I (INPUT 1).
3. Set the source to 2.5 GHz at a level of -22 dBm, as measured on the HP 437B, without the attenuator in line. If Option 006 is installed, set the output to -29 dBm.

Figure 4-8. INPUT 1, 2.5 GHz-20 GHz [26.5 GHz] Test Setup



1. Connect the equipment as shown in Figure 4-8.

Part II: INPUT 1, 2.5 GHz - 20 GHz [26.5 GHz] Test

4-20. AUTOMATIC AMPLITUDE DISCRIMINATION TEST

**Specification:** The HP 5347A/48A 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 for HP 5348A].

**Description:** Two microwave source generators are used to provide two signals to the HP 5347A/48A. The relative level of the two signals is adjusted to the specification, and the HP 5347A/48A must count the higher amplitude signal.

- A5 Synthesizer Assembly
- A3 Counter Assembly
- A6 IF Amplifier/Detector Assembly
- Microwave Module (A12 Microwave Assembly, U1 Sampler)

If the HP 5347A/48A fails any of the above sensitivity tests, refer to Section 5 (Adjustments) and verify the A6 IF Amplifier/Detector Assembly adjustments. If these adjustments are correct, and the HP 5347A/48A continues to fail the above tests, refer to Section 8 (Service) for troubleshooting procedures for the following assemblies:

9. Enter the results on the Performance Test Record.

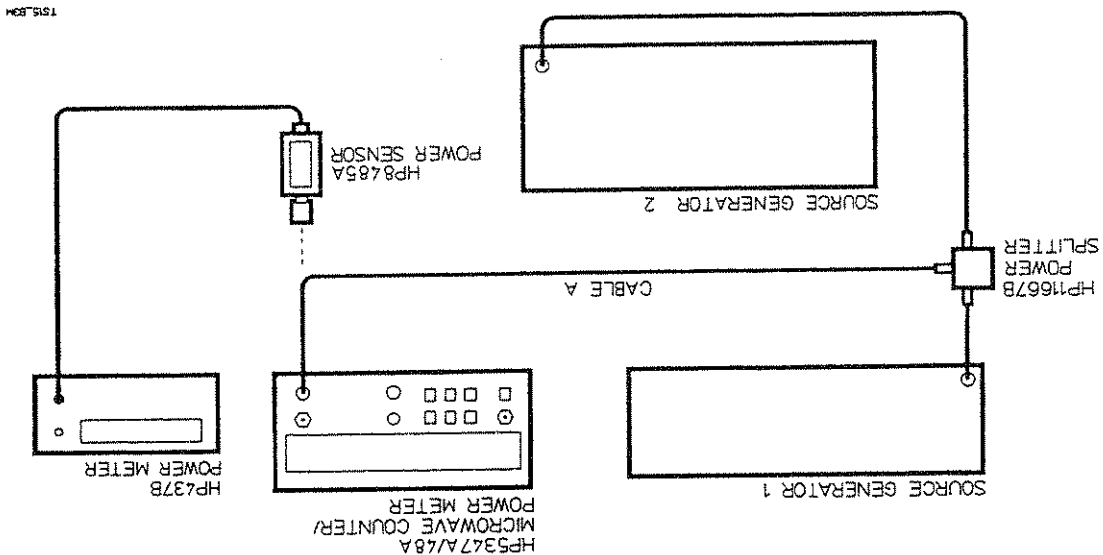
8. For the HP 5348A only, repeat the above procedure for 20-26.5 GHz at the appropriate input level (-6 dbm) with the 10 dB attenuator in place. (Since the -16 dbm signal desired is within the power sensor range, the 10 dB attenuator can be removed, if desired. In this case, adjust the source for -16 dbm signal level.) Measure actual sensitivity at 22 GHz, 24 GHz, and 26.5 GHz,  $\pm 4$  Hz. If Option 006 is installed, do not use the attenuator, and set the output level to -15 dbm.
7. Measure actual sensitivity at 18, 19, and 20 GHz, by first verifying the signal level with the HP 437B, and then verifying that each of the frequencies is counted to  $\pm 4$  Hz. For the HP 5348A only, repeat the above procedure for 20-26.5 GHz at the appropriate input level (-6 dbm) with the 10 dB attenuator in place. (Since the -16 dbm signal desired is within the power sensor range, the 10 dB attenuator can be removed, if desired. In this case, adjust the source for -16 dbm signal level.) If Option 006 is installed, do not use the attenuator, and set the output level to -23 dbm.

2. Set source 1 for an 18 GHz output at a level to deliver -5 dbm to the HP 5347A/48A. To set this level, disconnect source 2 from the HP 11667B and terminate that port of the HP 11667B with a 909D 50 $\Omega$  termination. Connect the HP 8485A Power Sensor to the HP 5347A/48A end of cable A and adjust source 1 output for a -5 dbm reading.
3. Set source 2 for a 500 MHz output at a level to deliver -25 dbm to the HP 5347A/48A. To set this level, disconnect source 1 from the HP 11667B input (reconnect source 2 to the HP 11667B) and terminate source 1 port of the HP 11667B with the 909D 50 $\Omega$  termination. Connect the HP 8485A to the HP 5347A/48A end of cable A and adjust source 2 for a -25 dbm reading.
4. Connect both sources to the HP 11667B inputs. Connect cable A to INPUT 1 of the HP 5347A/48A. Verify that the HP 5347A/48A counts 18 GHz. Increase the level of source 2 until the HP 5347A/48A counts incorrectly; measure that level (using the procedure described above) and enter the result on the Performance Test Record.

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

**NOTE**

Figure 4-9. Automatic Amplitude Discrimination Test Setup



1. Connect the Equipment as shown in Figure 4-9.

## 4-21. FM TOLERANCE TEST

Specification: 20 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 HP 5347A/48A can acquire and count. The HP 5347A/48A averages out the deviations and displays a carrier frequency. In addition, the HP 5347A/48A offers a choice of two FM rate modes. This test will verify that the HP 5347A/48A performs properly in these modes.

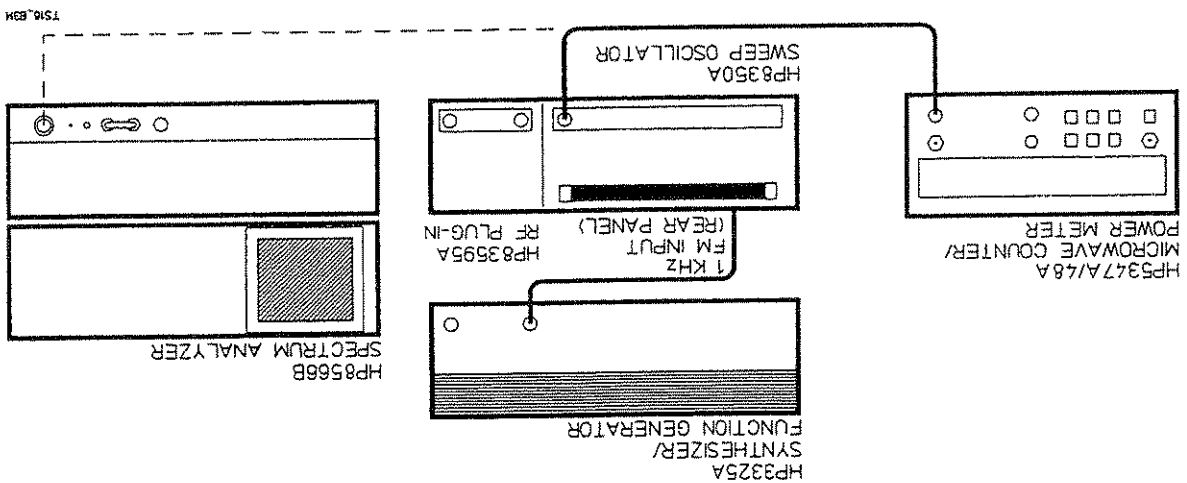
A6 IF Amplifier/Detector Assembly  
Microwave Module (A12 Microwave Assembly, U1 Sampler)

If the HP 5347A/48A fails the above Automatic Amplitude Discrimination tests, refer to Section 8 (Service) for troubleshooting procedures for the following assemblies:

5. Set source 1 for a 2.5 GHz output at a level to deliver -5 dbm to the HP 5347A/48A using the technique described above. Set source 2 for a 2.0 GHz output at a level to deliver -11 dbm to the HP 5347A/48A using the same technique. Connect both sources to the HP 11667B, and cable A to the HP 5347A/48A. Verify that the HP 5347A/48A counts 2.5 GHz. Increase source 2 level until the HP 5347A/48A counts incorrectly; measure that level and enter the result on the Performance Test Record.

1. Verify that the HP 5347A/48A is set for 1 Hz resolution (In this setting, FM Rate is NORMAL). The "2" switch of the rear panel RES switch on the HP 5347A/48A should be set to the 1 Hz (down) position.
2. Set the source to 1 GHz and the HP 83595A to -5 dbm.
3. Set the HP 3325B to 1 KHz.
4. Using the Spectrum Analyzer to verify the width of the FM deviation at the output of the source, set the amplitude of the HP 3325A output to achieve a peak-to-peak width of 14 MHz. For a full explanation of the FM Tolerance, refer to Section 8 in the Service manual.

Figure 4-10. FM Tolerance Test Setup



1. Connect the equipment as shown in Figure 4-10.

**NOTE**

The test source shown in Figure 4-10 is commonly available equipment, but is specified to  $\pm 7$  MHz FM deviation, or 14 MHz p-p at a 1 kHz modulating frequency. It may produce a test signal in excess of this, but its performance is not specified beyond 14 MHz p-p. For larger deviations with test equipment specifications, the HP 8780A Vector Signal Generator may be substituted.

Verify that the HP 5347A/48A acquires and counts the modulated input (1 GHz) correctly, as follows.

6. The following steps are used to display the harmonic number, which indicates that the HP 5347A/48A has set its internal Local Oscillator (LO) to correctly measure the input frequency. Since the HP 5347A/48A measures the Average Frequency over the gate time, a FM input will cause a displayed value that will vary. However, the harmonic number will not vary more than 0.3 from its integer value if the HP 5347A/48A is working properly. The Diagnostics mode is used to display this number. Two methods exist to enter this mode:
- Rear panel DIP switch
  - HP-IB

For instruments not equipped with the HP-IB or where the use of the HP-IB is not desired, proceed to step 7.

For instruments equipped with the HP-IB, proceed to step 8.

7. To set the HP 5347A/48A to Diagnostic 6 by using the rear panel DIP switch, perform the following:

- a. Turn off the HP 5347A/48A.
- b. Set rear panel MODE switch to the Diagnostics mode ("up" position).
- c. Turn on the HP 5347A/48A.
- d. Press Input 2 50  $\Omega$ /1M  $\Omega$  or Input 1 50  $\Omega$  key (depending on whether you need to increment or decrement to get to Diagnostic 6).
- e. Press Calibrate/Store key to initiate the Diagnostic 6 test.

The HP 5347A/48A 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.)

8. To set the HP 5347A/48A to Diagnostic 6 via the HP-IB, perform the following:
    - a. Set the HP 5347A/48A HP-IB address to a known value.
    - b. Connect a suitable controller (e.g., HP 9836, HP 200/300 Series controller) to the HP 5347A/48A rear panel HP-IB connector.
    - c. Send the command `OUTPUT 7XX; "DIAGENT"` — where XX is the address selected in step a, above.
    - d. Now, send the command `OUTPUT 7XX; "DIAG 6"`.
  9. Set the HP 5347A/48A for 10 KHz resolution (In this setting, FM Rate is TRACK):
    - a. Turn off the HP 5347A/48A.
    - b. Set rear panel RES switch to the 10 KHZ position.
    - c. Turn on the HP 5347A/48A.

or

Use the HP-IB as described in step 8, and send `OUTPUT 7XX; "RESOL 4"` command — where XX is the selected address.
  10. Set the HP 3325B to output 300 KHz, and verify the test signal on the Spectrum Analyzer.
  11. Set the HP 5347A/48A to DIAG 6 as described previously.
  12. Verify the harmonic numbers as described at the end of step 7. The harmonic numbers should not deviate more than 0.3 from its integer value. Mark Pass or Fail on the Performance Test Record card.
  13. Press **Reset/Local** key on the HP 5347A/48A. This completes the test.
- If the HP 5347A/48A fails the FM Tolerance test, refer to Section 5 (Adjustments), and verify the A6 IF Amplifier/Detector Assembly adjustments. If the adjustments are correct and the HP 5347A/48A continues to fail, refer to Section 8 (Service) for troubleshooting procedures for the following assemblies:
- A6 IF Amplifier/Detector Assembly  
 Microwave Module (A12 Microwave Assembly, U1 Sampler)

**NOTE**

To perform valid testing of the specifications, the instrument must be warmed up for 30 minutes.

**4-23. POWER METER ACCURACY TEST**

Specifications:

Electrical Characteristics	Performance Limits	Conditions
Accuracy: Instrumentation, includes sensor linearity.	$\pm 0.5\%$ or $\pm 0.02$ dB	Within same calibration range

Description: After the Power Meter is initially calibrated on the 1 mW range, the readout is monitored as the range calibrator is switched to provide reference inputs corresponding to each of the Power Meter operating ranges.

Equipment

- Range Calibrator ..... HP 11683A
- Power Sensor Cable ..... HP 11730A



Procedure

1. Connect the equipment as shown in Figure 4-11.

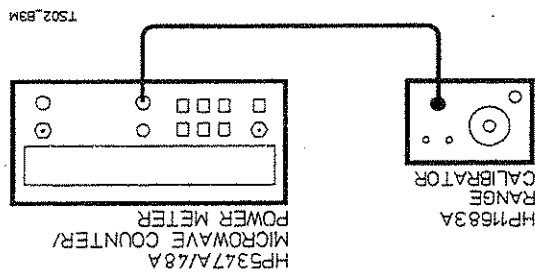


Figure 4-11. Power Meter Accuracy Test Setup

2. Turn on the HP 5347A/48A
3. Press Reset/Local key.

  - a. Press Input 2 key.
  - b. Press Calibrate/Store/Frequency key.

4. Set the Range Calibrator switches as follows:  
 FUNCTION .....STANDBY  
 POLARITY .....NORMAL  
 RANGE .....1 mW  
 LINE .....ON
5. Press the Input dBm/Watt key twice. This will set the HP 5347A/48A to read power in the Watt units.
6. Press the Zero key, and wait for the readout to appear. Verify that the reading is  $0.00 \pm 0.06 \mu\text{W}$ .
7. Set the Range Calibrate FUNCTION switch to CALIBRATE.
8. Press Calibrate/Store key. Verify that the HP 5347A/48A display reads  $1.000 \pm 0.006 \text{ mW}$ .

10. Enter the results on the Performance Test Record.
11. Press the Input dBm/Watt key again to the dBm position and verify that the display changes to the dBm mode, and that the indication is within  $20.00 \pm 00.04$  dBm with the Range Calibrator in the 100 mW/20 dBm position.
12. Enter the results on the Performance Test Record.
13. Set the Range Calibrator RANGE switch to -10 dBm.
14. Verify that the Power Meter displays  $-10.00 \pm 0.04$  dBm.

\_\_\_\_\_ -9.98 dBm  
\_\_\_\_\_ -10.02 dBm

\_\_\_\_\_ 19.98 dBm  
\_\_\_\_\_ 20.02 dBm

Enter the results on the Performance Test Record.

RANGE CALIBRATOR		RESULTS	
RANGE	MIN	ACTUAL	MAX
3 $\mu$ W	3.10 $\mu$ W	3.23 $\mu$ W	
10 $\mu$ W	9.90 $\mu$ W	10.10 $\mu$ W	
30 $\mu$ W	31.4 $\mu$ W	31.8 $\mu$ W	
100 $\mu$ W	99.5 $\mu$ W	100.5 $\mu$ W	
300 $\mu$ W	0.314 mW	0.318 mW	
1 mW	0.995 mW	1.005 mW	
3 mW	3.14 mW	3.18 mW	
10 mW	9.95 mW	10.05 mW	
30 mW	31.4 mW	31.8 mW	
100 mW	99.5 mW	100.5 mW	

9. Set the Range Calibrator RANGE switch to the positions shown in the following table. For each setting, verify that the HP 5347A/48A autoranges properly, and that the display is within the limits shown.

The Range Calibrator output level is adjustable in 5 dB increments. Thus, the 3  $\mu$ W, 30  $\mu$ W, 300  $\mu$ W, 3 mW, and 30 mW legends on the RANGE switch are approximations. The true values for these settings are 3.16, 31.6, 316, and 316  $\mu$ W, 3.16 mW and 31.6 mW.

4-24. POWER METER REFERENCE LEVEL TEST

Specification:

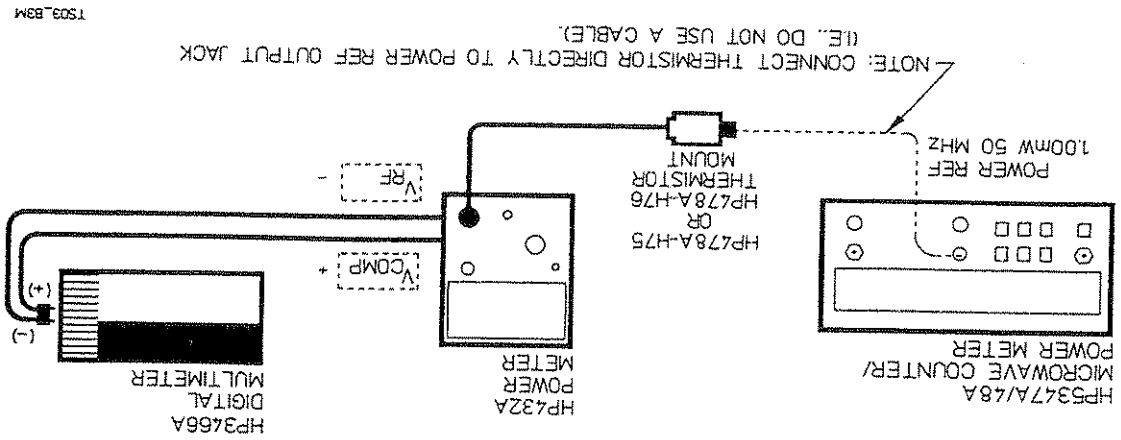
Electrical Characteristics	Performance Limits	Conditions
Power reference	1.0 mW	Internal 50 MHz oscillator factory set to $\pm 0.7\%$ traceable to the National Institute of Standards and Technology.
Power reference Accuracy	$\pm 1.2\%$ $\pm 0.9\%$	Worst case root-sum square (RSS) for one year.

Description: The power reference oscillator output is factory adjusted to 1 mW  $\pm 0.7\%$ . To achieve this accuracy, Hewlett-Packard employs a special measurement system accurate to 0.5% (traceable to the National Institute of Standards and Technology) and allows for a transfer error of  $\pm 0.2\%$  in making the adjustment. If an equivalent measurement is employed for verification, the power reference oscillator output can be verified to 1 mW  $\pm 1.9\%$  ( $\pm 1.2\%$  accuracy plus  $\pm 0.5\%$  verification system error plus  $\pm 0.2\%$  transfer error = 1.9% maximum error). The power reference oscillator output can be set to  $\pm 0.7\%$  using the same equipment and following the adjustment procedure. To ensure maximum accuracy in verifying the power reference oscillator output, the following procedure provides step by step instructions for using specified Hewlett-Packard test instruments of known capability. If equivalent test instruments are used, signal acquisition criteria may vary and reference should be made to the manufacturer's guidelines for operating the instruments.

Equipment

- Test Power Meter ..... HP 432A
- Thermistor Mount ..... HP 478A-H75 or HP 478A-H76
- Digital Voltmeter (DVM) ..... HP 3466A
- Power Sensor Cable ..... HP 8120-1082

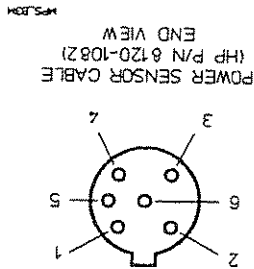
Figure 4-12. Power Meter Reference Level Test Setup



4. Connect the test power meter to the HP 5347A/48A Power Ref. as shown in Figure 4-12.

R

3. Round off the DVM indication to two decimal places and record this value as the internal bridge resistance (R) of the test power meter (approximately 200 ohms).



2. Set up the DVM to measure resistance and connect the DVM between the Vref connector on the rear panel of the HP 432A (test power meter), and pin 1 on the thermistor mount end of the test power meter interconnect cable (HP P/N 8120-1082). See the figure below to locate pin 1:

1. Make sure the HP 432A is OFF for the following setup tests.

Procedure

5. Set the HP 432A and HP 5347A/48A POWER to ON state. Then wait thirty minutes for the test power meter thermistor mount to stabilize before proceeding to the next step.
  6. Set the test power meter Range switch to Coarse Zero and adjust the front panel Coarse Zero control to obtain a zero meter indication.
  7. Fine Zero the test power meter on the most sensitive range, than set the test power meter Range switch to 1 mW. On the HP 432, press FINE ZERO toggle switch down to actuate the Fine Zero function.
- NOTE**
- 
- Ensure that the DVM input leads are isolated from chassis ground when performing the next step.*
- 
8. Set up the DVM to measure microvolts and connect the positive and negative input leads, respectively, to the Vcomp and Vrt connectors on the rear panel of the test power meter. Note that Vcomp and Vrt connectors are BNC female. BNC cables and BNC-to-banana jack adapters for DVM connection will make hookup easy.
  9. Observe the indication on the DVM. If less than 400 microvolts, proceed to the next step. If 400 microvolts or greater, press and hold the test power meter Fine Zero switch and adjust the Coarse Zero control so that the DVM indicates 200 microvolts or less. Then release the Fine Zero switch and proceed to the next step.
  10. Round off the DVM indication to the nearest microvolt and record this value as  $V_0$
- $V_0$
- 
11. Turn on the 1 mV, 50 MHz Power Reference Oscillator; there are two methods that can be used to turn on the Power Reference Oscillator (The reference oscillator is normally ON when the Calibrate/Store key is pressed, and is turned OFF when the calibration cycle is completed.):
    - Diagnostic 73 via DIP switch
    - HP-IB
- For instruments not equipped with the HP-IB or where the use of the HP-IB is not desired, proceed to step 12.
- For instruments equipped with the HP-IB, proceed to step 13.
12. To set the HP 5347A/48A to Diagnostic 73 by using the rear panel DIP switch, perform the following:
    - a. Turn off the HP 5347A/48A.

Note: See step 19 for an example of how P<sub>rf</sub> is calculated, using the above formula.  
 Calibration Factor = value for thermistor mount at 50 MHz  
 (traceable to the National Institute of Standards and Technology).

P<sub>rf</sub> = Power Reference Oscillator output level  
 V<sub>comp</sub> = previously recorded value  
 V<sub>1</sub> = previously recorded value  
 V<sub>0</sub> = previously recorded value  
 R = previously recorded value

Where:

$$P_{rf} = \frac{4R (\text{Calibration Factor})}{2V_{comp} (V_1 - V_0) + V_0^2 - V_1^2}$$

16. Calculate the Power Reference Oscillator output level (P<sub>rf</sub>) from the following formula:

$$V_{comp}$$

15. Disconnect the DVM negative input lead from the V<sub>rf</sub> connector on the test power meter. Reconnect it to the test power meter chassis ground. Record the new indication observed on the DVM as V<sub>comp</sub>.

$$V_1$$

14. Record the indications observed on the DVM as V<sub>1</sub>.

- a. Connect a controller to the HP 5347A/48A.
- b. Check the address setting of HP 5347A/48A rear panel HP-IB switch.
- c. Send the OUTPUT 7XX;"LG;OC1" command. This will cause the HP 5347A/48A to enter the Power Meter mode (dbm readings), and turn on the Power Reference Oscillator.

13. To turn on the 1 mV, 50 MHz Power Reference Oscillator via the HP-IB, perform the following:
- a. Press Calibrate/Store key to initiate Diagnostic 73. The Power Reference Oscillator should now be ON. Proceed to step 14.
  - b. Set rear panel MODE switch to Diagnostics mode ("up" position).
  - c. Turn on the HP 5347A/48A.
  - d. Press Input 2 50 Ω/1M Ω or Input 1 50 Ω key (depending on whether you need to increment or decrement to get to Diagnostic 73).
  - e. Press Calibrate/Store key to initiate Diagnostic 73. The Power Reference Oscillator should now be ON. Proceed to step 14.

$$P_{rf} = \frac{2(5.1583)(.078 - 0)^2 + (.000170)^2 - (.078)^2}{4(200)(99.68\%)} = \frac{.80469 - .00608}{.79744} = \frac{.79744}{.79744} = 1.00147 \text{ mW}$$

Note:  $V_0$  is eventually dropped out of the equation in the following steps because its value is very small (basically zero).

$$P_{rf} = \frac{2V_{comp}(V_1 - V_0) + V_0^2 - V_1^2}{4R(\text{Calibration Factor})}$$

$$R = 200\Omega$$

$$V_0 = 170 \mu V \text{ or } 170 \times 10^{-6} V$$

$$V_1 = 78,107 \mu V \text{ or } 78,107 \times 10^{-6} \text{ or } .078 V$$

$$V_{comp} = 5.1583 V$$

$$\text{Cal Factor} = 99.68\%$$

17. Verify that the P<sub>rf</sub> is within the following limits:
18. Enter the results on the Performance Test Record.
19. The following is an example showing how calculations of the Power Reference Output level are performed:

Min	0.988 mW
Actual	1.012 mW
Max	1.012 mW

17. Verify that the P<sub>rf</sub> is within the following limits:





HP 5347A/48A PERFORMANCE TEST RECORD (Page 1 of 2)

HEWLETT-PACKARD MODEL 5347A/48A  
Microwave Frequency Counter/Power Meter

Serial Number: \_\_\_\_\_  
 Test Performed By: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Notes: \_\_\_\_\_

Temperature: \_\_\_\_\_  
 Relative Humidity: \_\_\_\_\_

Repair/Work Order No. \_\_\_\_\_

Pre Calibration Test:   
 Post Calibration Test:

PARA. NO.	TEST	CORRECT DISPLAY	RESULTS		
			MINIMUM	ACTUAL	MAXIMUM
4-18.	INPUT 2, 10 MHz-525 MHz Input Sensitivity (50Ω) (Part I): Input conditions: 25 mV rms (-19.3 dBm) 50 MHz 100 MHz 200 MHz 400 MHz 525 MHz 80 MHz INPUT 2, 10 Hz-80 MHz Input Sensitivity (1MΩ) (Part II): Input conditions: 10 Hz 25 mV rms (-19.3 dBm) 1 kHz 500 kHz 1 MHz 10 MHz	50 000 000 100 000 000 200 000 000 400 000 000 525 000 000 80 000 000 10 1000 500 000 1 000 000 10 000 000	49 999 999 99 999 999 199 999 999 399 999 999 524 999 999 79 999 999 9 999 499 999 999 999 9 999 999	50 000 001 100 000 001 200 000 001 400 000 001 525 000 001 80 000 001 11 1001 501 001 1 000 001 10 000 001	
4-19.	INPUT 1, 500 MHz Input Sensitivity (Part I): Input conditions -32 dbm 500 MHz 1 GHz INPUT 1, 2.5 GHz-20 GHz [26.5 GHz for HP 5348A] (Part II) 2.5 GHz 5 GHz 10 GHz 12.4 GHz 18 GHz 19 GHz 20 GHz Input conditions: (HP 5348A only): -16 dbm 22 GHz 26.5 GHz	500 000 000 1 000 000 000 2 500 000 000 5 000 000 000 10 000 000 000 12 400 000 000 18 000 000 000 19 000 000 000 20 000 000 000 22 000 000 000 26 500 000 000	499 999 996 999 999 996 2 499 999 996 4 999 999 996 9 999 999 996 12 399 999 996 17 999 999 996 18 999 999 996 19 999 999 996 21 999 999 996 26 499 999 996	500 000 004 1 000 000 004 2 500 000 004 5 000 000 004 10 000 000 004 12 400 000 004 18 000 000 004 19 000 000 004 20 000 000 004 22 000 000 004 26 500 500 004	

PARA. NO.	TEST	CORRECT DISPLAY	RESULTS	
			PASS	FAIL
4-20.	Automatic Amplitude Discrimination Test: Input conditions: 18 GHz, -5 dBm 2.5 GHz, -5 dBm 17.5 GHz separation 500 MHz separation	20 dBm 6 dBm	_____	_____
4-21.	FM Rate Tolerance: Normal Rate (1 kHz) Track Rate (300 kHz)	1000 300 000	_____	_____
4-23.	Power Meter Accuracy Test Watt Mode 3 μW 10 μW 30 μW 100 μW 300 μW 1 mW 3 mW 10 mW 30 mW 100 mW dBm Mode 20 dBm -10 dBm	3 μW 10 μW 30 μW 100 μW 300 μW 1 mW 3 mW 10 mW 30 mW 100 mW 19.98 dBm -9.98 dBm	MINIMUM ACTUAL MAXIMUM	_____
4-24.	Power Meter Referent Test (Pt)	1 mW	0.988 mW	1.012 mW

#### 4-25. HP-IB VERIFICATION (FOR OPTION 011)

The HP-IB Verification program listed in *Table 4-5* exercises the HP 5347A/48A through various operating modes via the HP 5347A/48A's HP-IB Interface. If the HP 5347A/48A the A11 HP-IB Interface Assembly is operating correctly. This program is not intended to be an automated test system for operational verification of the entire instrument, but rather an aid to verify that the HP-IB Interface is handshaking properly, sending valid data to the controller, and controlling the HP 5347A/48A properly. If the HP 5347A/48A does not respond as described, refer to A11 HP-IB Interface Assembly troubleshooting in Section 8 of the Service Manual.

To perform the verification, set up the HP 5347A/48A and signal source as in *Figure 4-13*. The program will function with any valid HP-IB address set for the HP 5347A/48A.

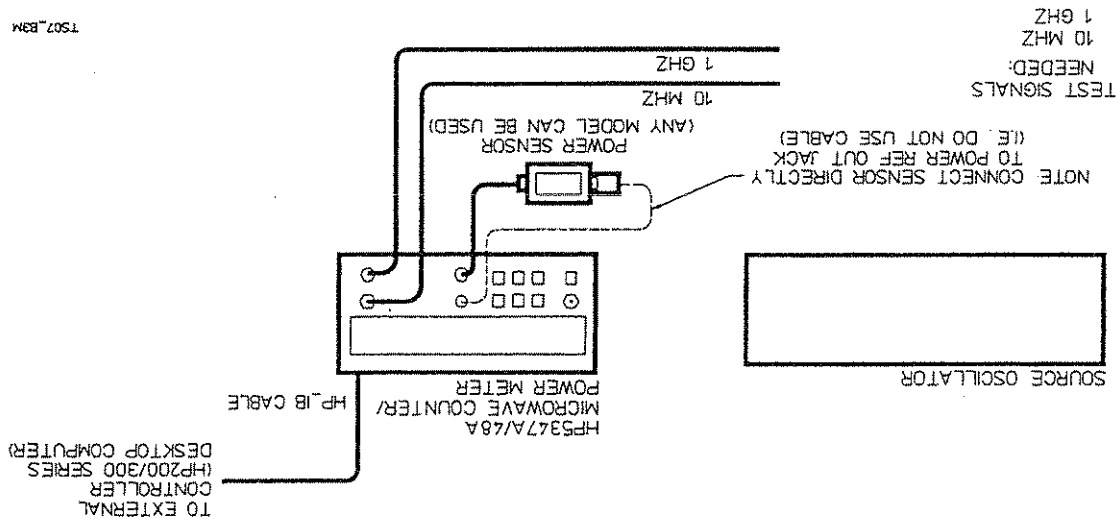


Figure 4-13. HP-IB Verification Test Setup

The program listed in *Table 4-5* may be loaded into the HP 9000 series 200 or 300 Desktop Computer from the HP-IB Verification disc (HP P/N 05348-13502 for 5-1/4 inch disc or HP P/N 05348-13501 for 3-1/2 inch disc). To run the program on the disc, insert the disc into the Desktop Computer, load the program via Load "HP5348A", and press RUN key. The program goes through 20 checkpoints, including a test to verify remote response at all legal addresses. 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 4-4* is a sample printout of the results of the HP-IB Verification program. The printed listing of results should be attached to the HP-IB Verification Record, *Table 4-3*.

Various checkpoints throughout the program ask the operator to verify that the HP 5347A/48A 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 4-3. HP-IB Verification Record

HEWLETT-PACKARD MODEL 5347A/48A Microwave Frequency Counter/Power Meter		Tested by _____	Date _____	Serial Number: _____	4-25. HP-IB Verification	PASS _____ FAIL _____
--	--	-----------------	------------	----------------------	--------------------------	--------------------------

Table 4-4. Example HP-IB Verification Program Listing

```

5347A/5348A HP-IB CHECKPOINT SUMMARY
** 11 'AUTO' and 'MANUAL'
** 12 'SRQMASK'
** 13 'DUMP'
** 14 'WATTS', 'DBM', 'MOD?'
** 15 'ZERO'
** 16 'CALIBRATE'
** 17 'REF OSC ON/OFF', 'OSC?'
** 18 'AUTO', 'MANUAL', 'RNG?'
** 19 'TRIGGER', 'PTRG?'
** 20 'CHECK ALL ADDRESSES'

1 'REMOTE', 'LOCAL'
2 Self Check ('TEST')
3 'DISPLAY'
4 'INIT', 'RESET', and 'CLEAR'
5 'REF', and 'REF?'
6 'ERR?'
7 'SET', and 'SET?'
8 'LOWZ', and 'HIGHZ'
9 'SAMPLE', and 'TRIGGER'
10 'RESOL 0', & 'RESOL 4'

'D?' is also checked during HP-IB address search at program startup.
*****
CHECKPOINT RESULTS
*****
Instrument: HP, 5348A at address 703
11 NOT PERFORMED
12 NOT PERFORMED
13 NOT PERFORMED
14 NOT PERFORMED
15 PASS
16 PASS
17 PASS
18 NOT PERFORMED
19 NOT PERFORMED
20 NOT PERFORMED
1 PASS
2 PASS
3 PASS
4 PASS
5 PASS
6 NOT PERFORMED
7 PASS
8 NOT PERFORMED
9 NOT PERFORMED
10 NOT PERFORMED

```

Table 4-5. HP-IB Verification Program

10	HP5347A/5348A MICROWAVE FREQUENCY COUNTER/POWER METER
20	THIS PROGRAM IS DESIGNED TO WORK ON A SERIES 200 COMPUTER, OR VECTRA
30	EQUIPPED WITH BASIC 4.0
40	1
50	THIS VERSION ALSO ALLOWS USERS TO CHANGE THE HP-IB ADDRESS OF THE PRINTER
60	1
70	HP-IB OPERATIONAL VERIFICATION PROGRAM
80	1 JD
90	DATE: 890512
100	REVISION A
110	THIS program exercises the 5347A/48A through the majority of its command
120	code set via HP-IB. The program consists of 20 checkpoints, and
130	provides the user with the ability to execute and repeat these tests
140	in any order. Also provided are options to print the checkpoint
150	summary and results. The program relies on subroutines in addition
160	to arrays and simple variables.
170	1
180	OPTION BASE 1
190	DIM Ascii_data[24], Horiz_line[80], Inst_id[8]
200	DIM setup[76], Title[80], Id_data[8]
210	DIM Fail_address(30), Pass_address(30), Test_results(20)[13]
220	INTEGER Test_number
230	Initialize:
240	ON ERROR GOTO Error_exit
250	OFF TIMEOUT
260	PRINTER IS CRT
270	CONTROL KBD,1;0
280	CONTROL KBD,2;2
290	OUTPUT KBD;CHR\$(255)&"K";
300	GRAPHICS OFF
310	ALPHA ON
320	CONTROL 1,12;1 : Key labels off
330	RESET 7
340	Test_number=0
350	checkpoint=0
360	Ascii_data=""
370	Inst_id=""
380	Horiz_line\$="*****"
390	Initialize test results array to "NOT PERFORMED"
400	FOR I=1 TO 20
410	Test_results(I)="NOT PERFORMED"
420	NEXT I
430	PRINT ""
440	Title\$="HP 5347A/5348A HP-IB OPERATIONAL VERIFICATION PROGRAM"
450	GOSUB sub_title
460	PRINT Horiz_line\$
470	PRINT "The HP-IB address of the printer is assumed to be 701. Would"
480	PRINT "You like to change that?"
490	PRINT
500	PRINT "CAUTION! Do not set printer address the same as the counter address."
510	GOSUB Clear_keys
520	ON KEY 1 LABEL "YES" GOTO change_add
530	ON KEY 6 LABEL " " GOTO change_add
540	ON KEY 4 LABEL " NO" GOTO same_add
550	ON KEY 9 LABEL " " GOTO same_add
560	GOSUB wait_for_key

Table 4-5. HP-IB Verification Program (Continued)

```

570 same_add:1 ASSUME PRINTER ADDRESS TO BE 701
580 ptr_add=701
590 GOTO start_program
600 change_add:
    ; CHANGE THE ADDRESS OF THE PRINTER FROM 701
610 CONTROL 1,12;1
620 INPUT "PLEASE ENTER THE CORRECT ADDRESS OF THE PRINTER.",ptr_add
630 IF (ptr_add(700) OR ptr_add(731) OR ptr_add(721)) THEN GOTO bad_add
640 start_program:1
650 OUTPUT KBD;CHR$(255)&"K";
660 title$="HP 5347A/5348A HP-IB OPERATIONAL VERIFICATION PROGRAM"
670 GOSUB sub_title
680 PRINT horiz_line$
690 PRINT
700 GOSUB Menu
710 GOSUB Ready_start
720 IF VAL(SYSTEM$("PRINTER IS"))=ptr_add THEN GOTO Already_printed 1 ***** 701
730 PRINT
740 PRINT "Would you like a hardcopy of the checkpoint summary?"
750 PRINT
760 PRINT "YES - press K1 to receive a hardcopy, or"
770 PRINT "NO - press K4 to continue."
780 GOSUB clear_keys
790 ON KEY 1 LABEL "YES" GOTO printer_setup
800 ON KEY 6 LABEL " " GOTO printer_setup
810 ON KEY 4 LABEL "NO" GOTO Already_printed
820 ON KEY 9 LABEL " " GOTO Already_printed
830 GOSUB wait_for_key
840 printer_setup:1 Yes, printout
850 GOSUB keys_off
860 OUTPUT KBD;CHR$(255)&"K";
870 PRINTER IS ptr_add
880 ON ERROR GOTO bad_add
890 ON TIMEOUT ptr_add DIV 100,1 GOTO print_broke
900 OUTPUT ptr_add USING "#,K"; " "
    ;Test for a response
910 OFF TIMEOUT
920 OFF ERROR
930 GOSUB Menu
940 GOTO Already_printed
950 bad_add:1
960 DISP ptr_add;" IS INVALID. TRY AGAIN."
970 BEEP 600,.3
980 WAIT 2
990 OFF ERROR
1000 OFF TIMEOUT
1010 GOTO change_add
1020 print_broke:1
1030 CONTROL 1,12;1
    ;Key labels off
1040 DISP (ptr_add);" NOT RESPONDING. CHECK PRINTER IS ON, & ADDRESS & HOOKUP IS CORRECT."
1050 BEEP 600,.3
1060 WAIT 3
1070 GOTO initialize
1080 PRINTER IS CRT
1090 Already_printed:1
1100 GOSUB keys_off
1110 PRINTER IS CRT
1120 OUTPUT KBD;CHR$(255)&"K";

```

```

1130 TITLE$="MAKE THE CONNECTIONS"
1140 GOSUB sub_title
1150 PRINT Horiz_line$
1160 PRINT
1170 PRINT "Connect the HP-IB Interface to the rear panel of the counter and turn on the
1180 PRINT "power."
1190 PRINT
1200 PRINT "Sources capable of supplying signals to both counter inputs will be needed:"
1210 PRINT "Input 1: 500 Mhz to either 20 GHz (5347A) or 26 GHz (5348A)."
```

```

1220 PRINT "Input 2, 50 ohms: 10 Mhz to 500 Mhz."
1230 PRINT "Input 2, 1 Mohm: 10 Hz to 80 Mhz."
1240 PRINT "No source needed for power meter. Internal reference will be used."
1250 PRINT
1260 PRINT "Consult the operation and programming manual for additional information."
1270 GOSUB Ready_start
1280 I
1290 GOSUB Begin_search
1300 GOTO First_check
1310 *****
1320 START OF CHECKPOINT TESTS
1330 *****
1340 I
1350 CHK1: I
1360 Test_number=1
1370 Title$="REMOTE AND LOCAL."
1380 GOSUB Print_title
1390 PRINT "checkpoint 1 tests the REMOTE and LOCAL commands."
1400 PRINT
1410 PRINT "Each command will be programmed and the operator will be prompted as to"
1420 PRINT "what conditions should be verified."
1430 PRINT
1440 GOSUB Ready_start
1450 I
1460 LOCAL Address
1470 REMOTE Address
1480 OUTPUT Address;"INIT"
1490 PRINT
1500 Title$="REMOTE"
1510 GOSUB sub_title
1520 PRINT
1530 PRINT "Verify that the RMT and LSN annunciators are on."
1540 PRINT
1550 GOSUB Ready_start
1560 PRINT
1570 Title$="LOCAL"
1580 GOSUB sub_title
1590 PRINT
1600 PRINT "Verify that the RMT annunciator is no longer on, and the ":Inst_id$
1610 PRINT "responds to front panel entries."
1620 LOCAL 7
1630 PRINT
1640 GOSUB Ready_start
1650 REMOTE Address
1660 GOTO Record_results
1670 I End of CHK1
1680 I

```

Table 4-5. HP-IB Verification Program (Continued)



```

1690 Chk2:1
1700 Test_number=2
1710 Title$="SELF CHECK ('TEST?'"
1720 Gosub Print_title
1730 Print "Checkpoint 2 tests the 'TEST?', HP-IB command."
1740 Print
1750 Print "The results of the SELF CHECK will be sent over the bus and displayed on the
1760 Print "controller CRT."
1770 Print
1780 Gosub Ready_start
1790 Remote Address
1800 Output Address;"INIT"
1810 Output Address;"TEST?"
1820 Enter Address;Ascii_data$
1830 Print "The results of SELF CHECK are: ";Trim$(Ascii_data$)
1840 Print
1850 If Ascii_data$(1,4)="PASS" THEN Goto Pass_test1
1860 Print "The ";Inst_id$;" failed the SELF CHECK. It is recommended that the fault on"
1870 Print "the ";Trim$(Ascii_data$(18,19));" or associated assemblies be corrected"
1880 Print "before continuing with the HP-IB verification."
1890 Print
1900 Pass_test1:1
1910 Goto Record_results
1920 I End of Chk2
1930 I
1940 Chk3:1
1950 Test_number=3
1960 Title$="DISPLAY'"
1970 Gosub Print_title
1980 Print "Checkpoint 3 tests the 'DISPLAY' command."
1990 Print
2000 Gosub Ready_start
2010 Output Address;"INIT"
2020 Output Address;"DISPLAY,HP-IB VERIFICATION'"
2030 Print "Verify that the ";Inst_id$;" display shows 'HP-IB VERIFICATION'."
2040 Print
2050 Gosub Ready_start
2060 Output Address;"DISPLAY,'"
2070 Goto Record_results
2080 I End of Chk3
2090 I
2100 Chk4:1
2110 Test_number=4
2120 Title$="INIT', 'RESET' and 'CLEAR'"
2130 Gosub Print_title
2140 Print "Checkpoint 4 tests the 'INIT', 'RESET' and 'CLEAR' commands."
2150 Print
2160 Gosub Ready_start
2170 Output Address;"INIT"
2180 Init = Plug-in power-up state, except HP-IB and mode
2190 I RESET = same as pressing RESET key
2200 I CLEAR = similar to RESET but doesn't affect all the functions RESET does
2210 Output Address;"INIT"
2220 Title$="INIT'"
2230 Gosub Sub_title
2240 Print

```

Table 4-5. HP-IB Verification Program (Continued)

Table 4-5. HP-IB Verification Program (Continued)

2250	PRINT "Verify that the RMT and LSN annunciators are on and that the"
2260	PRINT "display shows a value appropriate for input 1."
2270	PRINT
2280	GOSUB Ready_start
2290	!set up SAMPLE HOLD to test RESET..RESET will exit this mode.
2300	OUTPUT Address;"SAMPLE HOLD"
2310	Title\$="RESET"
2320	GOSUB sub_title
2330	PRINT
2340	PRINT "Verify that the ";Inst_id\$;" is in SAMPLE HOLD...display reads 'HOLDING- -'"
2350	PRINT
2360	PRINT "The 'RESET' command is supposed to clear the HOLDING condition."
2370	PRINT
2380	PRINT "After pressing ENTER, verify that the ";Inst_id\$;" is no longer"
2390	PRINT "in the HOLDING state."
2400	PRINT
2410	PRINT "When ENTER is pressed, the 'RESET' command will be sent."
2420	GOSUB Ready_start
2430	OUTPUT Address;"RESET"
2440	PRINT
2450	GOSUB Ready_start
2460	! set up SAMPLE HOLD to test CLEAR..CLEAR will not exit this state.
2470	OUTPUT Address;"SAMPLE HOLD"
2480	Title\$="CLEAR"
2490	PRINT
2500	GOSUB sub_title
2510	PRINT
2520	PRINT "Verify that the ";Inst_id\$;" is in SAMPLE HOLD...display reads 'HOLDING- -'"
2530	PRINT
2540	PRINT "The 'CLEAR' command will NOT cause the ";Inst_id\$;" to exit the HOLDING state."
2550	PRINT "After pressing ENTER, verify that the ";Inst_id\$;" is still 'HOLDING'."
2560	PRINT
2570	PRINT "When ENTER is pressed, the 'CLEAR' command will be sent."
2580	GOSUB Ready_start
2590	OUTPUT Address;"CLR"
2600	PRINT
2610	GOTO Record_results
2620	! End of CHK4
2630	!
2640	CHK5:1
2650	Test_number=5
2660	Title\$="REF2"
2670	GOSUB print_title
2680	PRINT "Checkpoint 5 tests the 'REF2' command."
2690	PRINT
2700	GOSUB Ready_start
2710	OUTPUT Address;"INIT"
2720	Title\$="REF2"
2730	GOSUB sub_title
2740	PRINT
2750	PRINT "Disconnect the external reference (on front panel) if one is connected."
2760	PRINT
2770	GOSUB Ready_start
2780	OUTPUT Address;"INIT"
2790	WAIT 1
2800	OUTPUT Address;"REF2"

Table 4-5. HP-IB Verification Program (Continued)

```

2810 ENTER Address:Ascii_data$ ; Enter the status of the reference
2820 PRINT
2830 PRINT "Verify that the EXT REF annunciator is off."
2840 PRINT
2850 GOSUB Ready_start
2860 PRINT
2870 PRINT "The ";Inst_id$; " has returned its timbase reference status as ";
2880 PRINT TRIM$(Ascii_data$);"ERRAL."
2890 PRINT
2900 IF Ascii_data$="INT" THEN GOTO Okay1
2910 PRINT "RETURNED HP-IB DATA INCORRECT";CHR$(7)
2920 PRINT
2930 Okay1:
2940 GOSUB Ready_start
2950 Title$="REF?"
2960 GOSUB sub_title
2970 PRINT
2980 PRINT "Connect an external 10 Mhz timbase to the External Reference Input on the front
panel."
2990 PRINT
3000 GOSUB Ready_start
3010 OUTPUT Address;"REF?"
3020 ENTER Address;Ascii_data$
3030 PRINT
3040 PRINT "Verify that the EXT REF annunciator is on. The ";Inst_id$; " has returned"
3050 PRINT " a reference status of ";TRIM$(Ascii_data$);"ERRAL."
3060 PRINT
3070 IF TRIM$(Ascii_data$)="EXT" THEN GOTO Okay2
3080 PRINT "RETURNED HP-IB DATA INCORRECT"
3090 Okay2:
3100 GOSUB Ready_start
3110 OUTPUT KBD;CHR$(255)&"K";
3120 PRINT
3130 GOTO Record_results
3140 I End of Chk5
3150 I
3160 Chk6:
3170 Test_number=6
3180 Title$="ERR?"
3190 GOSUB print_title
3200 OUTPUT Address;"INIT"
3210 PRINT "Checkpoint 6 tests the 'ERR?' command."
3220 PRINT
3230 PRINT "An error state will be programmed and the type of error will read back to the"
3240 PRINT "controller."
3250 GOSUB Ready_start
3260 OUTPUT Address;"MANUAL,PR99" ; Out of range, error guaranteed
3270 OUTPUT Address;"ERR?"
3280 ENTER Address;Ascii_data$
3290 PRINT
3300 PRINT "Verify that the ";Inst_id$; " displays 3 ERROR."
3310 PRINT
3320 IF Ascii_data$[18,18]="3" THEN GOTO Okay3
3330 PRINT "RETURNED HP-IB DATA INCORRECT."
3340 PRINT
3350 Okay3:

```

Table 4-5. HP-IB Verification Program (Continued)

```

3360 PRINT "Press ENTER to RESET the ";inst_id$;".
3370 GOSUB Ready_start
3380 OUTPUT Address;"RESET"
3390 GOTO Record_results
3400 ! End of chk6
3410 !
3420 CHK7:1
3430 Test_number=7
3440 Title$="SET" and 'SET7'
3450 GOSUB Print_title
3460 PRINT "Checkpoint 7 tests the 'SET' and 'SET7' commands."
3470 PRINT
3480 PRINT "A configuration will be programmed and then saved using the 'SET7' command."
3490 PRINT "The counter will then be set to the initial power-on condition and then"
3500 PRINT "re-programmed using the 'SET' command."
3510 PRINT
3520 GOSUB Ready_start
3530 REMOTE Address
3540 OUTPUT Address;"INIT"
3550 OUTPUT Address;"LOWZ"
3560 ! Test setup
3570 PRINT "The front panel set-up to be stored has the INPUT 2 and 50 OHM annunciators on."
3580 PRINT "Verify these annunciators."
3590 PRINT
3600 PRINT "When the ENTER key is pressed, the";inst_id$; "front panel setup will be stored."
3610 PRINT "Then the ";inst_id$; "will be INITIALIZED to power up conditions."
3620 GOSUB Ready_start
3630 OUTPUT Address;"SET7"
3640 ENTER Address;setup$
3650 OUTPUT Address;"INIT"
3660 PRINT "This configuration is now stored and the ";inst_id$; "is initialized."
3670 OUTPUT KBD;CHR$(255)&"K";
3680 PRINT "Verify that the INPUT 2 and 50 ohm annunciators are off."
3690 PRINT
3700 PRINT "After the ENTER key is pressed, the setup will be recalled."
3710 PRINT
3720 GOSUB Ready_start
3730 OUTPUT Address;"SET";"SET";"SET";"SET";
3740 PRINT "Verify that the INPUT 2 and 50 ohm annunciators are on again."
3750 PRINT
3760 GOSUB Ready_start
3770 GOTO Record_results
3780 ! End of chk7
3790 !
3800 CHK8:1
3810 Test_number=8
3820 Title$="LOWZ" and 'HIGHZ'
3830 GOSUB Print_title
3840 PRINT "Checkpoint 8 tests the 'LOWZ' and 'HIGHZ' commands."
3850 PRINT
3860 PRINT "Connect a signal to INPUT 2 of the ";inst_id$; " of appropriate frequency and
level."
3870 PRINT "10 mhz is a good choice."
3880 PRINT
3890 GOSUB Ready_start
3900 REMOTE Address

```

```

3910 OUTPUT Address;"INIT"
3920 OUTPUT Address;"LOWZ"
3930 ENTER Address;Meas_data
3940 OUTPUT KBD;CHR$(255)&"K";
3950 TITLE$="LOWZ"
3960 GOSUB sub_title
3970 PRINT
3980 PRINT "Verify that the 50 ohm, INPUT 2, RMT, and TLK annunciators are on"
3990 PRINT "The display should read the input to the accuracy of the source setting."
4000 PRINT
4010 PRINT "Measured frequency is ";Meas_data
4020 PRINT
4030 GOSUB Ready_start
4040 OUTPUT Address;"HIGHZ"
4050 ENTER Address;Meas_data
4060 OUTPUT KBD;CHR$(255)&"K";
4070 TITLE$="HIGHZ"
4080 GOSUB sub_title
4090 PRINT
4100 PRINT "Verify that the 1 Mohm, INPUT 2, RMT, and TLK annunciators are on."
4110 PRINT "The display should read the input to the accuracy of the source setting."
4120 PRINT
4130 PRINT "Measured frequency is ";Meas_data
4140 PRINT
4150 GOTO Record_results
4160 I End of CHK8
4170 I
4180 CHK9:I
4190 Test_number=9
4200 TITLE$="SAMPLE and TRIGGER"
4210 GOSUB Print_title
4220 PRINT "Checkpoint 9 tests the 'SAMPLE' and 'TRIGGER' commands."
4230 PRINT
4240 PRINT "Connect a signal to INPUT 2 of the ";Inst_id$;" of appropriate frequency and
level."
4250 PRINT
4260 GOSUB Ready_start
4270 OUTPUT Address;"INIT"
4280 OUTPUT Address;"SAMPLE,HOLD,HIGHZ"
4290 PRINT "Verify that the RMT, LSN, and INPUT 2 and 1Mohm annunciators are on. The
display"
4300 PRINT "should read: HOLDING--"
4310 PRINT
4320 INPUT "Press ENTER to trigger the counter and take a measurement.",Dummy$
4330 OUTPUT Address;"TRIGGER"
4340 ENTER Address;Meas_data
4350 OUTPUT KBD;CHR$(255)&"K";
4360 PRINT "The display should read the input to the accuracy of the source setting."
4370 PRINT
4380 PRINT "Measured frequency is ";Meas_data
4390 PRINT
4400 GOTO Record_results
4410 I End of CHK9
4420 I
4430 CHK10:I
4440 Test_number=10

```

Table 4-5. HP-1B Verification Program (Continued)

Table 4-5. HP-IB Verification Program (Continued)

```

4450 Title$="RESOL 0' and RESOL 4'"
4460 GOSUB PRINT_TITLE
4470 PRINT "Checkpoint 10 tests the RESOL 0' and RESOL 4' commands."
4480 PRINT
4490 PRINT "Connect a signal to Input 2 of the ";Inst_id$;" of appropriate frequency and
level."
4500 PRINT
4510 GOSUB Ready_start
4520 OUTPUT Address;"INIT"
4530 OUTPUT Address;"HIGHZ;RESOL 0" 1 Hz resolution
4540 Title$="RESOL 0'"
4550 GOSUB sub_title
4560 PRINT
4570 PRINT "Verify that the current reading is to 1Hz resolution."
4580 PRINT "Verify that the RMT, LSN, INPUT 2, and 1 Mohm annunciators are on."
4590 GOSUB Ready_start
4600 OUTPUT KBD;CHR$(255)E"K";
4610 OUTPUT Address;"RESOL 4"
4620 Title$="RESOL 4'"
4630 GOSUB sub_title
4640 PRINT
4650 PRINT "Verify that the RMT, LSN, INPUT 2, and 1 Mohm annunciators are on."
4660 PRINT "The display should read: XX XX* ***, where XX XX represents the 4 most
4670 PRINT "significant digits."
4680 PRINT
4690 GOTO Record_results
4700 ; End of CHK10
4710 ;
4720 CHK11:1
4730 Test_number=11
4740 Title$="AUTO' and MANUAL'"
4750 GOSUB PRINT_TITLE
4760 PRINT "Checkpoint 11 tests the AUTO' and MANUAL' commands."
4770 PRINT
4780 PRINT "Apply a signal to Input 1 of the ";Inst_id$;" of appropriate frequency and
level."
4790 PRINT
4800 GOSUB Ready_start
4810 REMOTE Address
4820 OUTPUT Address;"INIT"
4830 OUTPUT Address;"SAMPLE,HOLD;TRIGGER" 1 Auto mode, single measurement
4840 ENTER Address;Meas_data
4850 OUTPUT KBD;CHR$(255)E"K";
4860 Title$="AUTO'"
4870 GOSUB sub_title
4880 PRINT
4890 PRINT "Verify that the INPUT 1, RMT, and TLK annunciators are on"
4900 PRINT "and the ";Inst_id$;" is displaying ";Meas_data;" Hz."
4910 PRINT
4920 PRINT "If the ";Inst_id$;" display does not match the above reading, then an
4930 PRINT "error occurred in the HP-IB transfer."
4940 PRINT
4950 GOSUB Ready_start
4960 OUTPUT KBD;CHR$(255)E"K";
4970 Title$="MANUAL'"
4980 GOSUB sub_title

```

```

4990 PRINT
5000 PRINT "This will trigger the ";inst_id$;".
5010 GOSUB Ready_start
5020 OUTPUT Address;"MANUAL LAST"
5030 OUTPUT Address;"SAMPLE HOLD;TRIGGER"
5040 ENTER Address;meas_data
5050 OUTPUT KBD;CHR$(255)&"K";
5060 Title$="MANUAL"
5070 GOSUB sub_title
5080 PRINT
5090 PRINT "Verify that the INPUT 1, RMT, TRK annunciators are on"
5100 PRINT "and the ";inst_id$; " is displaying ";meas_data;" Hz."
5110 PRINT
5120 PRINT "If the ";inst_id$; " display does not match the above reading, then an"
5130 PRINT "error occurred in the HP-IB transfer."
5140 PRINT
5150 GOTO Record_results
5160 PRINT
5170 ! End of CHK11
5180 !
5190 CHK12:1
5200 Test_number=12
5210 Title$="SRQMASK"
5220 GOSUB Print_title
5230 OUTPUT Address;"INIT"
5240 THIS LINE HAS BEEN DELETED
5250 REMOTE Address
5260 PRINT "Checkpoint 12 tests the 'SRQMASK' command."
5270 PRINT
5280 GOSUB Ready_start
5290 OUTPUT KBD;CHR$(255)&"K";
5300 Title$="OVERLOAD bit"
5310 GOSUB sub_title
5320 PRINT
5330 PRINT "This section tests the overload bit of the ";inst_id$;".
5340 PRINT
5350 OUTPUT Address;"SRQMASK,8"
5360 PRINT "Apply a signal of appropriate frequency at a level of 0 dBm to Input 1."
5370 PRINT "The 0 dBm level is crucial in this test."
5380 GOSUB Ready_start
5390 PRINT " "
5400 PRINT " "
5410 PRINT " "
5420 PRINT "NOW CHANGE THE SIGNAL LEVEL TO +10dBm"
5430 PRINT "This will cause the overload condition."
5440 PRINT " "
5450 PRINT " "
5460 ! IF THE SIGNAL LEVEL HAS ALWAYS BEEN 10dBm, THERE WILL NOT BE A 0 TO 1
5470 ! TRANSITION AT THE INTERRUPT BIT
5480 GOSUB Ready_start
5490 ON INTR 7 GOTO Over_intr
5500 ENABLE INTR 7;2
5510 WAIT 3
5520 OFF INTR 7
5530 Fail_overload:1
5540 PRINT Inst_id$;" FAILED the OVERLOAD bit test."

```

Table 4-5. HP-IB Verification Program (Continued)

Table 4-5. HP-IB Verification Program (Continued)

```

5550 GOTO Fail_intr
5560 Over_intr:1
5570 OFF INTR 7
5580 STATUS 7,1:B
5590 S=SPOLL(Address)
5600 PRINT "THE SPOLL IS ";S
5610 IF BIT(S,3) THEN GOTO Pass_overload
5620 GOTO Fail_overload
5630 Pass_overload:1
5640 PRINT Inst_id$;" PASSED the OVERLOAD bit test."
5650 Fail_intr:1
5660 PRINT
5670 PRINT "Set the signal source output level to -5 dbm."
5680 PRINT
5690 BEEP 250,.15
5700 WAIT 1
5710 BEEP 250,.15
5720 GOSUB Ready_start
5730 OUTPUT KBD;CHR$(255)F"K";
5740 Title$="MEASUREMENT COMPLETE bit"
5750 GOSUB sub_title
5760 PRINT
5770 PRINT "This section tests the MEASUREMENT COMPLETE bit of the status byte of"
5780 PRINT "the ";Inst_id$;"."
5790 PRINT
5800 OUTPUT Address;"INIT"
5810 OUTPUT Address;"SAMPLE,HOLD;SRQMASK,2"
5820 GOSUB Ready_start
5830 ON INTR 7 GOTO Meas_intr
5840 ENABLE INTR 7;2
5850 OUTPUT Address;"TRIGGER"
5860 WAIT 2
5870 OFF INTR 7
5880 Fail_measure:1
5890 PRINT Inst_id$;" FAILED the MEASUREMENT COMPLETE bit test."
5900 GOTO Meas_done
5910 Meas_intr:1
5920 OFF INTR 7
5930 STATUS 7,1:B
5940 S=SPOLL(Address)
5950 PRINT "THE SPOLL IS ";S
5960 IF BIT(S,1) THEN GOTO Pass_measure
5970 GOTO Fail_measure
5980 Pass_measure:1
5990 PRINT Inst_id$;" PASSED the MEASUREMENT COMPLETE bit test."
6000 Meas_done:1
6010 PRINT
6020 GOSUB Ready_start
6030 OUTPUT KBD;CHR$(255)F"K";
6040 Title$="LOCAL bit"
6050 GOSUB sub_title
6060 PRINT
6070 PRINT "This section tests the LOCAL bit of the status bytes of the ";Inst_id$;"."
6080 PRINT
6090 OUTPUT Address;"SRQMASK,16"
6100 GOSUB Ready_start

```



```

6110 ON INTR 7 GOTO srq_intr
6120 ENABLE INTR 7;2
6130 LOCAL Address: SHOULD SET LCL BIT
6140 WAIT 1
6150 OFF INTR 7
6160 Fail_local:1
6170 PRINT Inst_id$;" FAILED the LOCAL bit test.."
6180 GOTO done_srq
6190 srq_intr:1
6200 OFF INTR 7
6210 STATUS 7,1:B
6220 S=SPOLL(Address)
6230 PRINT "THE SPOLL IS " ;S
6240 IF BIT(S,4) THEN GOTO Pass_local
6250 GOTO Fail_local
6260 Pass_local:1
6270 PRINT Inst_id$;" PASSED the LOCAL bit test.."
6280 done_srq:1
6290 PRINT
6300 GOSUB Ready_start
6310 OUTPUT KBD;CHR$(255)&"K";
6320 Title$="ERROR bit"
6330 GOSUB sub_title
6340 PRINT
6350 PRINT "This section tests the ERROR bit of the ";Inst_id$;". "
6360 PRINT
6370 OUTPUT Address;"SRQMSK,4"
6380 GOSUB Ready_start
6390 ON INTR 7 GOTO Error_intr
6400 ENABLE INTR 7;2
6410 OUTPUT Address;"MANUAL,9E+99" ; Error condition
6420 WAIT 1
6430 OFF INTR 7
6440 Fail_error:1
6450 PRINT Inst_id$;" FAILED the ERROR bit test.."
6460 GOTO done_error
6470 Error_intr:1
6480 OFF INTR 7
6490 STATUS 7,1:B
6500 S=SPOLL(Address)
6510 PRINT "THE SPOLL IS " ;S
6520 IF BIT(S,2) THEN GOTO Pass_error
6530 GOTO Fail_error
6540 Pass_error:1
6550 PRINT Inst_id$;" PASSED the ERROR bit test.."
6560 done_error:1
6570 OUTPUT Address;"RESET"
6580 PRINT
6590 GOSUB Ready_start
6600 OUTPUT KBD;CHR$(255)&"K";
6610 Title$="OUTPUT DATA READY bit"
6620 GOSUB sub_title
6630 PRINT
6640 PRINT "This section tests the OUTPUT DATA READY bit of the "
6650 PRINT Inst_id$;". "
6660 PRINT

```

Table 4-5. HP-IB Verification Program (Continued)

Table 4-5. HP-1B Verification Program (Continued)

```

6670 OUTPUT Address;"SRQMASK,1"
6680 GOSUB Ready_start
6690 ON INTR 7 GOTO Ready_intr
6700 ENABLE INTR 7;2
6710 OUTPUT Address;"ID?"
6720 WAIT 1
6730 OFF INTR 7
6740 Fail_ready:1
6750 PRINT Inst_id$;" FAILED the OUTPUT DATA READY bit test."
6760 GOTO Done_ready
6770 Ready_intr:1
6780 PRINT
6790 OFF INTR 7
6800 STATUS 7,1;B
6810 S=SPOLL(Address)
6820 PRINT "THE SPOLL IS ":S
6830 ENTER Address;setup$
6840 IF BIT(S,0) THEN GOTO Pass_ready
6850 GOTO Fail_ready
6860 Pass_ready:1
6870 PRINT Inst_id$;" PASSED the OUTPUT DATA READY bit test."
6880 Done_ready:1
6890 PRINT
6900 OUTPUT Address;"SRQMASK,4"
6910 GOTO Record_results
6920 ! End of CHK12
6930 !
6940 CHK13:1
6950 Test_number=13
6960 Title$="DUMP,"
6970 GOSUB Print_title
6980 REMOTE Address
6990 OUTPUT Address;"INIT"
7000 PRINT "Checkpoint 13 tests the 'DUMP' command."
7010 PRINT
7020 Hookup:1
7030 PRINT "Connect a signal to input 1 of the ":Inst_id$;" of appropriate frequency and
7040 PRINT
7050 PRINT "Press ENTER to begin DUMPING data from the ":Inst_id$;" to the controller."
7060 PRINT "Ten measurements will be taken and displayed."
7070 PRINT
7080 GOSUB Ready_start
7090 REMOTE Address
7100 ENTER Address;Meas_data
7110 IF Meas_data=1.E+38 THEN GOTO Hookup
7120 OUTPUT Address;"MANUAL LAST"
7130 OUTPUT Address;"RESOL 4;DUMP ON"
7140 PRINT "MEAS# DATA "
7150 FOR I=1 TO 10
7160 ENTER Address;Ascii_data
7170 PRINT I,Ascii_data,"*10 KHZ"
7180 NEXT I
7190 PRINT
7200 OUTPUT Address;"DUMP,OFF"
7210 GOTO Record_results

```

Table 4-5. HP-IB Verification Program (Continued)

```

7220 ! End of CHK13
7230 !
7240 CHK14:1
7250 Test_number=14
7260 Title$="POWER METER TESTS"
7270 GOSUB Print_title
7280 PRINT "Checkpoint 14 checks 'WATTS', and 'DBM' modes, and 'MOD?' query"
7290 PRINT
7300 PRINT "connect power sensor to the ',inst_id$'," and the power Ref Jack."
7310 PRINT
7320 GOSUB Ready_start
7330 OUTPUT Address;"INIT"
7340 WAIT .2
7350 OUTPUT Address;"LN;OCI"
7360 S=SPOLL(Address)
7370 IF BIT(S,1) THEN
7380 ENTER Address;Meas_data
7390 ELSE
7400 GOTO 7360
7410 END IF
7420 OUTPUT Address;"MOD?"
7430 ENTER Address;Power_data
7440 OUTPUT KBD;CHR$(255)&"K";
7450 Title$="WATTS' or linear mode"
7460 GOSUB sub_title
7470 PRINT
7480 PRINT "Verify that the POWER annunciator is on and that the reading is followed by"
7490 PRINT "a linear suffix...watts, milliwatts, etc."
7500 PRINT
7510 PRINT Meas_data;"watts"
7520 PRINT
7530 PRINT "MODE query: a response of '0' for linear mode is correct reply."
7540 PRINT
7550 PRINT "MODE query reply is ";Power_data;
7560 GOSUB Ready_start
7570 OUTPUT Address;"CLR"
7580 OUTPUT Address;"LG"
7590 WAIT .2
7600 OUTPUT Address;"OCI"
7610 S=SPOLL(Address)
7620 IF BIT(S,1) THEN
7630 ENTER Address;Meas_data
7640 ELSE
7650 GOTO 7610
7660 END IF
7670 OUTPUT Address;"MOD?"
7680 ENTER Address;Power_data
7690 OUTPUT KBD;CHR$(255)&"K";
7700 Title$="dbm' or log mode"
7710 GOSUB sub_title
7720 PRINT
7730 PRINT "Verify that the POWER annunciator is on and that the reading is"
7740 PRINT "followed by 'dbm'."
7750 PRINT
7760 PRINT Meas_data;"dbm"
7770 PRINT

```

```

7780 PRINT "MODE query: a response of '1' for log mode is correct reply."
7790 PRINT
7800 PRINT "MODE query reply is ";power_data
7810 PRINT
7820 GOTO Record_results
7830 ! End of CHK14
7840 !
7850 CHK15:1
7860 Test_number=15
7870 Title$="ZERO."
7880 GOSUB Print_title
7890 PRINT "Checkpoint 15 tests Power Meter 'ZERO' command"
7900 PRINT
7910 PRINT "Connect a power sensor to the ";Inst_id$;" and to Power Ref Jack."
7920 PRINT
7930 GOSUB Ready_start
7940 OUTPUT Address;"INIT"
7950 OUTPUT Address;"LG"
7960 OUTPUT Address;"CS"
7970 !This makes sure the status byte is clear.
7980 OUTPUT KBD;CHR$(255)&"K";
7990 GOSUB sub_title
8000 PRINT
8010 PRINT "The 'zeroing' process may take up to 20 seconds. The program will continuously"
8020 PRINT "read the status byte. This will be visible on the controller screen."
8030 PRINT
8040 PRINT "When 'zeroing' is complete, the status byte will turn to 40."
8050 PRINT
8060 PRINT "When ENTER is pressed, 'ZEROING' will begin."
8070 PRINT
8080 PRINT "observe ";Inst_id$;" displays 'ZEROING' message."
8090 GOSUB Ready_start
8100 OUTPUT Address;"ZE"
8110 S=SPOLL(Address)
8120 PRINT "status byte is ";S
8130 IF BIT(S,3) THEN
8140 ! 41=zero complete.
8150 ELSE
8160 GOTO 8110
8170 END IF
8180 PRINT
8190 PRINT " 'ZEROING' is complete...the display should show randomly varying readings."
8200 PRINT
8210 GOTO Record_results
8220 ! End of CHK15
8230 !
8240 CHK16:1
8250 Test_number=16
8260 Title$="CALIBRATE"
8270 GOSUB Print_title
8280 PRINT "Checkpoint 16 tests the power meter 'CALIBRATE' command."
8290 PRINT
8300 PRINT "Connect a sensor to the ";Inst_id$;" and to the Power Ref Jack."
8310 PRINT
8320 GOSUB Ready_start
8330 REMOTE Address

```

Table 4-5. HP-IB Verification Program (Continued)

```

8340 OUTPUT Address;"INIT"
8350 OUTPUT Address;"highz;store"
      !This forces power meter cal factor to 100%
8360 OUTPUT Address;"LG"
8370 OUTPUT Address;"CS"
8380 OUTPUT Address;"OC1"
8390 OUTPUT KBD;CHR$(255)*"K";
      GOSUB sub_title
8400 PRINT
8410 PRINT
8420 PRINT "The 'calibrate' process may take up to 10 seconds. The program will continuously"
8430 PRINT "read the status byte. This will be visible on the display."
8440 PRINT
8450 PRINT "When 'calibrating' is complete, the status byte will turn to 40."
8460 PRINT
8470 PRINT "Observe the ";inst_id$;" display shows 'CALIBRATING'."
8480 PRINT
8490 GOSUB Ready_start
8500 OUTPUT Address;"CL"
8510 S=SPOLL(Address)
8520 PRINT "status byte is ";s
8530 IF BIT(S,3) THEN
8540   ! 41= cal complete
8550 ELSE
8560   GOTO 8510
8570 END IF
8580 PRINT
8590 OUTPUT Address;"OC1"
8600 PRINT "Observe a display of '0 dbm' +/- 0.2 dbm."
8610 PRINT
8620 PRINT "NOTE: cal factor is normally 95%, which is incorrect for 50 Mhz ref osc."
8630 PRINT "This checkpoint contains a step to set cal factor to 100% so that ref osc is"
8640 PRINT "read properly"
8650 PRINT
8660 GOSUB Ready_start
8670 OUTPUT Address;"OC0"
8680 PRINT
8690 GOTO Record_results
8700 ! End of Chk16
8710 !
8720 CHK17:
      Test_number=17
8730 TITLE$="REF OSC ON/OFF CONTROL"
8740 GOSUB Print_title
8750 PRINT "Checkpoint 17 tests the remote control of the Ref Osc on/off circuits."
8760 PRINT
8770 PRINT
8780 PRINT "Connect a sensor to the ";inst_id$;" and to the Power Ref output jack."
8790 GOSUB Ready_start
8800 OUTPUT Address;"INIT"
8810 OUTPUT Address;"HIGHZ;STORE"
      !This forces power meter cal factor to 100%
8820 OUTPUT Address;"LG"
8830 OUTPUT Address;"OC1"
8840 OUTPUT KBD;CHR$(255)*"K";
8850 PRINT
8860 PRINT "Observe a power reading on the ";inst_id$;" . Depending on the ZERO and CAL
      status,"
8870 PRINT "and cal factor setting, it should read at or near 0 dbm."
8880 PRINT

```

Table 4-5. HP-IB Verification Program (Continued)

```

8890 gosub Ready_start
8900 OUTPUT Address;"0C0"
8910 PRINT "Observe the power reading displays random numbers, indicating the power ref osc
      is off."
8920 PRINT
8930 GOTO Record_results
8940 END of Chk17
8950 I
8960 Chk18:1
8970 Test_number=18
8980 Title$="AUTO RANGE, MANUAL RANGE, and RNG?"
8990 gosub Print_title
9000 PRINT "Checkpoint 18 tests the commands 'AUTO RANGE', 'MANUAL RANGE', and query 'RNG?'
9010 PRINT
9020 PRINT "Connect a power sensor to the ";Inst_id$; and to the Power Ref Jack."
9030 PRINT
9040 gosub Ready_start
9050 OUTPUT Address;"INT"
9060 OUTPUT Address;"IG"
9070 OUTPUT Address;"OC1"
9080 OUTPUT Address;"RNG?"
9090 ENTER Address;Power_data
9100 PRINT "The query command RNG? will cause the power meter to reply with a number
      between"
9110 PRINT "11 and 15 if it is in AUTO RANGE."
9120 PRINT
9130 PRINT "RNG? query response is ";Power_data;
9140 gosub Ready_start
9150 OUTPUT KBD;CHR$(255)&"K";
9160 OUTPUT Address;"RM3"
9170 OUTPUT Address;"RNG?"
9180 ENTER Address;Power_data
9190 PRINT "The power meter has been commanded to range 3."
9200 PRINT
9210 PRINT "The query command RNG? will cause a reply of 3, indicating MANUAL RANGE 3."
9220 PRINT "Observe below."
9230 PRINT "RNG? query response is ";Power_data;
9240 gosub Ready_start
9250 OUTPUT KBD;CHR$(255)&"K";
9260 OUTPUT Address;"RA"
9270 OUTPUT Address;"RNG?"
9280 ENTER Address;Power_data
9290 PRINT "The power meter has again been commanded to AUTO RANGE."
9300 PRINT
9310 PRINT "Observe the RNG? query response of a number between 11 and 15, indicating"
9320 PRINT "Power meter is now again in AUTO RANGE."
9330 PRINT
9340 PRINT "RNG? query response is ";Power_data;
9350 GOTO Record_results
9360 END of Chk18
9370 I
9380 Chk19:1
9390 Test_number=19
9400 Title$="Trigger modes and PTRG?"
9410 gosub Print_title
9420 PRINT "Checkpoint 19 tests the power meter trigger modes and the query command 'PTRG?'"

```

Table 4-5. HP-IB Verification Program (Continued)

```

9430 PRINT
9440 PRINT "Connect a power sensor to the ";Inst_id$;" to the Power Ref Jack."
9450 PRINT
9460 GOSUB Ready_start
9470 OUTPUT Address;"INIT"
9480 OUTPUT Address;"Ig;TR3"
9490 OUTPUT Address;"OC1"
9500 OUTPUT Address;"TRG?"
9510 ENTER Address;Power_data
9520 PRINT
9530 PRINT "FREE RUN TRIGGER"
9540 PRINT
9550 PRINT "Verify the power meter is taking continuous measurements."
9560 PRINT
9570 PRINT "Check below for PTRG? query response of 0, indicating free run."
9580 PRINT
9590 PRINT "PTRG? trigger mode query response is ";Power_data;
9600 GOSUB Ready_start
9610 OUTPUT KBD;CHR$(255)&"K";
9620 PRINT
9630 PRINT "'TRIGGER HOLD' and take one measurement"
9640 PRINT
9650 OUTPUT Address;"TR0"
9660 PRINT "Verify the power meter has stopped taking measurements."
9670 OUTPUT Address;"TRG?"
9680 ENTER Address;Power_data
9690 PRINT
9700 PRINT "Check below for PTRG? query response of 1, indicating trigger hold."
9710 PRINT
9720 PRINT "PTRG? trigger mode query response is ";Power_data;
9730 GOSUB Ready_start
9740 OUTPUT KBD;CHR$(255)&"K";
9750 PRINT "In the following step, the power meter will be commanded to take 1 measurement."
9760 PRINT
9770 INPUT "Press ENTER to trigger the power meter.";Dummy$
9780 OUTPUT Address;"TR1"
9790 S=SPOL(Address)
9800 IF BIT(S,2) THEN
9810 ENTER Address;Meas_data
9820 GOTO 9790
9830 ELSE
9840 END IF
9850 PRINT "Verify the power meter took one measurement."
9860 PRINT
9870 PRINT "Power measurement is ";Meas_data;" dbm."
9880 PRINT
9890 GOTO Record_results
9900 END OF CHK19
9910 I
9920 CHK20:I
9930 Test_number=20
9940 Title$="CHECK ALL ADDRESSES"
9950 GOSUB Print_title
9960 REMOTE Address
9970 OUTPUT Address;"INIT"
9980 PRINT "Checkpoint 20 tests all of the valid HP-IB addresses except 21, which is"

```

Table 4-5. HP-IB Verification Program (Continued)

Table 4-5. HP-IB Verification Program (Continued)

```

9990 PRINT "the address of the controller. If a printer is connected to the system,"
10000 PRINT "its address must be different than the ";inst_id$;
10010 PRINT
10020 PRINT
10030 PRINT
10040 PRINT "TEST OVERVIEW"
10050 PRINT
10060 PRINT "Each address to be tested is manually set on rear of instrument. Program will
10070 PRINT "test it when TEST softkey is pressed. Then, next address is set on instrument,"
10080 PRINT "the INCR softkey is pressed to increment program to next address, and test"
10090 PRINT "is done. A running tally of tests, passes, and fails is logged by program."
10100 PRINT
10110 GOSUB Ready_start
10120 Fail_counter=01 Reset fail counter
10130 Pass_counter=01 Reset pass counter
10140 FOR Address=700 TO 730
10150 IF Address=721 THEN GOTO Incr_address
Re_test:
10170 OUTPUT KBD;CHR$(255)&"K";
10180 LOCAL 7
10190 PRINT
10200 PRINT "On the ";inst_id$; ", set address to be tested at rear panel DIP switch."
10210 PRINT
10220 PRINT "Cycle power to cause instrument to recognize any changes made."
10230 PRINT
10240 PRINT "WAIT for instrument to finish power-up routine before testing."
10250 PRINT
10260 PRINT
10270 PRINT
10280 GOSUB Clear_keys
10290 ON KEY 1 LABEL "TEST" GOTO Test_address
10300 ON KEY 6 LABEL " " GOTO Test_address
10310 ON KEY 2 LABEL "INCR" GOTO Incr_address
10320 ON KEY 7 LABEL " " GOTO Incr_address
10330 ON KEY 4 LABEL "EXIT" GOTO Exit_test1
10340 ON KEY 9 LABEL " " GOTO Exit_test1
10350 PRINT "Press TEST to test current HP-IB address ";Address
10360 PRINT "Press INCR to skip to HP-IB address—";
10370 IF Address=720 THEN
10380 PRINT Address+2
10390 ELSE
10400 IF Address/30 THEN
10410 PRINT Address+1
10420 ELSE
10430 PRINT " none."
10440 END IF
10450 END IF
10460 PRINT "Press EXIT to terminate this checkpoint."
10470 GOSUB Wait_for_key
Test_address:1
10480 GOSUB Keys_off
10490 GOSUB Keys_off
10500 ON TIMEOUT 7,3 GOTO No_response
10510 REMOTE Address
10520 OUTPUT Address;"ID?"
10530 ENTER Address;id_data$
10540 IF id_data$=inst_id$ THEN GOTO Incr_pass

```



```

10550 No_response:1
10560 OFF TIMEOUT 7
10570 PRINT
10580 Fail_counter=Fail_counter+1 Increment fail counter
10590 Fail_address(Fail_counter)=Address! Store passed address
10600 PRINT
10610 PRINT Inst_id$;" does not respond at address ";Address
10620 BEEP 250,.15
10630 WAIT .1
10640 BEEP 250,.15
10650 PRINT
10660 GOSUB Ready_start
10670 GOTO Re_test
10680 Incr_pass:1
10690 OFF TIMEOUT 7
10700 Pass_counter=Pass_counter+1 Increment pass ctr
10710 Pass_address(Pass_counter)=Address! Store pass address
10720 PRINT
10730 PRINT Inst_id$;" responds at address ";Address
10740 PRINT
10750 GOSUB Ready_start
10760 GOTO Re_test
10770 Incr_address:1
10780 GOSUB Keys_off
10790 ABORT 7
10800 CLEAR Address
10810 NEXT Address
10820 Exit_test:1
10830 GOSUB Keys_off
10840 ABORT 7
10850 CLEAR Address
10860 IF Pass_counter=0 THEN GOTO No_pass_addr
10870 OUTPUT KBD;CHR$(255)&"K";
10880 PRINT "The ";Inst_id$;" responded at the following addresses:"
10890 FOR I=1 TO Pass_counter
10900 PRINT " ";Pass_address(I)
10910 NEXT I
10920 No_pass_addr:1
10930 IF Fail_counter=0 THEN GOTO No_address
10940 PRINT
10950 PRINT "The";Inst_id$;" failed to respond at the following addresses:"
10960 FOR I=1 TO Fail_counter
10970 PRINT " ";Fail_address(I)
10980 NEXT I
10990 GOTO Finish_address
11000 No_address:1
11010 IF Pass_counter THEN GOTO Finish_address
11020 PRINT
11030 PRINT "No addresses were tested."
11040 Finish_address:1
11050 PRINT
11060 GOSUB Ready_start
11070 OFF TIMEOUT 7
11080 GOSUB Begin_search
11090 GOTO Record_results
11100
!This is done to re-establish the current correct
!HP-IB address of the instrument.

```

Table 4-5. HP-IB Verification Program (Continued)

Table 4-5. HP-IB Verification Program (Continued)

```

1110 : End of CHK20
1120 :
1130 :
1140 Final_exit:
1150 PRINT "HP-IB VERIFICATION DONE"
1160 GOTO Exit_opver
1170 Error_exit:
1180 PRINT ERRMS
1190 Exit_opver:
11200 CONTROL 1,12;0
11210 RESET 7
11220 PRINTER IS CRT
11230 STOP
! End of program
*****
SUBROUTINES SECTION
*****
11260 : *****
11270 Begin_search: ! Search for 5347A/48A address
11280 OUTPUT KBD;CHR$(255)&"K";
11290 PRINT "Searching for HP counter at address ";
11300 ON TIMEOUT 7,.4 GOTO TRY_another
11310 FOR Address=700 TO 731
11320 IF Address=721 THEN GOTO TRY_another ! Skip controller
11330 IF Address=ptr_add THEN GOTO TRY_another ! COUNTER ADDRESS SHOULD NOT BE EQUAL THAT OF
THE PRINTER
11340 OUTPUT CRT;Address;CHR$(8);CHR$(8);CHR$(8);CHR$(8);
11350 REMOVE Address
11360 OUTPUT Address;"ID? "
11370 ENTER Address;Inst_id$
11380 IF Inst_id$="HP,5347A" THEN GOTO Found_one
11390 IF Inst_id$="HP,5348A" THEN GOTO Found_one
11400 TRY_another:
11410 ABORT 7
11420 CLEAR Address
11430 NEXT Address
11440 BEEP 550,.15
11450 WAIT .1
11460 BEEP 150,.15
11470 PRINT
11480 PRINT
11490 PRINT "No counter was found on the HP-IB. Check all connections and switch settings."
11500 PRINT
11510 PRINT "Make sure that the address of the printer is not the same as the counter."
11520 PRINT
11530 PRINT "Restart program."
11540 GOSUB Ready_start
11550 DISP Inst_id$
11560 GOTO Error_exit ! GOTO SKIP_PRINT ! TRY AGAIN
Found_one:
11570 PRINT
11580 PRINT
11590 PRINT
11600 PRINT Inst_id$; " found at address ";VAL$(Address);"."
11610 BEEP 800,.03
11620 WAIT 3
11630 OFF TIMEOUT 7
11640 RETURN
11650 Record_results:

```

```

11660 BEEP 800,.03
11670 INPUT "press ENTER to record the results. ",dummy$
11680 PRINT
11690 PRINT " Press the appropriate softkey to record the results of
CHECKPOINT";Test_number;". "
11700 GOSUB clear_keys
11710 ON KEY 1 LABEL "PASS" GOTO Pass_test
11720 ON KEY 6 LABEL " " GOTO Pass_test
11730 ON KEY 4 LABEL "FAIL" GOTO Fail_test
11740 ON KEY 9 LABEL " " GOTO Fail_test
11750 ! Keys 1 and 6 are both activated so user can hit shifted or unshifted key and get
action...a user-friendly touch.
11760 ! Same holds true for keys 4 and 9.
11770 GOSUB wait_for_key
11780 Pass_test: !
11790 GOSUB keys_off
11800 Test_results$(Test_number)="PASS"
11810 GOTO Next_checkpt
11820 Fail_test: !
11830 GOSUB keys_off
11840 Test_results$(Test_number)="FAIL"
11850 Next_checkpt: ! Determine next checkpoint to be executed
11860 IF Test_number=21 THEN RETURN
11870 OUTPUT KBD;CHR$(255)+CHR$(255);
11880 PRINT "Current checkpoint: ";Test_number
11890 PRINT
11900 PRINT "Press the appropriate softkey to select the desired checkpoint..."
11910 PRINT
11920 PRINT "NEXT"
11930 PRINT "GOTO# - Press K1 to select an arbitrary checkpoint, or"
11940 PRINT "REPEAT - Press K2 to repeat this checkpoint, or"
11950 PRINT "EXIT"
11960 GOSUB clear_keys
11970 ON KEY 0 LABEL "NEXT" GOTO Next_test
11980 ON KEY 5 LABEL " " GOTO Next_test
11990 ON KEY 1 LABEL "GOTO #" GOTO Test_entry
12000 ON KEY 6 LABEL " " GOTO Test_entry
12010 ON KEY 2 LABEL "REPEAT" GOTO Repeat_test
12020 ON KEY 7 LABEL " " GOTO Repeat_test
12030 ON KEY 4 LABEL "EXIT" GOTO Exit_test
12040 ON KEY 9 LABEL " " GOTO Exit_test
12050 ! Keys vertically adjacent to each other are active for label shown...
this is done so user can hit shifted or unshifted key.
12060 GOSUB wait_for_key
12070 First_check: ! Determines the first checkpoint to execute
12080 OUTPUT KBD;CHR$(255)+CHR$(255);
12090 PRINT "press the softkey to select the desired checkpoint."
12100 PRINT
12110 PRINT "FIRST - press K0 to perform the first checkpoint,"
12120 PRINT "GOTO# - press K2 to select an arbitrary checkpoint, or"
12130 PRINT "EXIT - press K4 to end the program."
12140 GOSUB clear_keys
12150 ON KEY 0 LABEL "FIRST" GOTO First_test
12160 ON KEY 5 LABEL " " GOTO First_test
12170 ON KEY 2 LABEL "GOTO #" GOTO Test_entry
12180 ON KEY 7 LABEL " " GOTO Test_entry

```

Table 4-5. HP-IB Verification Program (Continued)

Table 4-5. HP-IB Verification Program (Continued)

```

12190 ON KEY 4 LABEL "EXIT" GOTO Exit_test
12200 ON KEY 9 LABEL " " GOTO Exit_test
12210 ! Keys vertically adjacent to each other are active with label shown...
      this allows user to hit shifted or unshifted key.
12220 GOSUB wait_for_key
12230 Key_trap: !
12240 DISP "Wrong key pressed. Try again.";CHR$(7)
12250 RETURN
12260 wait_for_key: !
12270 CONTROL 1,12;0
12280 DISP
12290 Loop:GOTO Loop
12300 Keys_off: !
12310 CONTROL 1,12;1
12320 RETURN
12330 Ready_start: !
12340 BEEP 800,.03
12350 INPUT "press ENTER to continue.";dummy$
12360 RETURN
12370 Print_title: ! Display checkpoint title
12380 OUTPUT KBD;CHR$(255)&"K";
12390 PRINT
12400 PRINT TAB(34);"CHECKPOINT";Test_number
12410 GOSUB sub_title
12420 PRINT Horiz_lines
12430 BEEP 800,.03
12440 INPUT "press ENTER to start the test.";dummy$
12450 OUTPUT KBD;CHR$(255)&"K";
12460 RETURN
12470 sub_title: !
12480 PRINT
12490 PRINT
12500 PRINT
12510 ! The following line provides for centering the title.
12520 PRINT TAB(INT((80-(LEN(TRIM$(TITLE$)))/2));TITLE$
12530 ! TRIM$(TITLE$) strips leading and trailing blanks
12540 ! LEN is length of resulting string
12550 ! 80 is subtracted from this to get number of characters in the line of text.
12560 ! This result is divided by 2 to center title. INT truncates any fraction to a whole
      number.
12570 ! TAB then moves cursor over the calculated number of spaces before printing occurs.
12580 RETURN
12590 First_test: !
12600 GOSUB Keys_off
12610 checkpoint=1
12620 GOTO Branch_checkpoint
12630 Next_test: !
12640 GOSUB Keys_off
12650 checkpoint=Test_number+1
12660 GOTO Branch_checkpoint
12670 Exit_test: !
12680 checkpoint=0
12690 GOTO Branch_checkpoint
12700 Repeat_test: !
12710 GOSUB Keys_off
12720 checkpoint=Test_number

```

Table 4-5. HP-IB Verification Program (Continued)

```

12730 GOTO Branch-checkpt
12740 Test_entry:1
12750 GOSUB Keys_off
12760 OUTPUT KBD;CHR$(255)&"K";
12770 Title$="CHECKPOINT SUMMARY"
12780 GOSUB sub_title
12790 PRINT
12800 GOSUB Menu
12810 INPUT "Type the checkpoint number desired (1 to 20), and press ENTER. ",Test_number
12820 IF (Test_number) OR (Test_number20) THEN GOTO Integer_error
12830 Checkpoint=Test_number
12840 GOTO Branch-checkpt
12850 Integer_error:1
12860 DISP "Please enter an integer only, 1 through 20.";CHR$(7)
12870 GOTO Test_entry
12880 Branch-checkpt:1
12890 IF (checkpoint=0 OR checkpoint=21) THEN GOTO Print_results
12900 ON checkpoint GOTO chk1,chk2,chk3,chk4,chk5,chk6,chk7,chk8,chk9,chk10,chk11,chk12,chk13,
chk14,chk15,chk16,chk17,chk18,chk19,chk20
12910 Print_results:1
12920 PRINTER IS CRT
12930 OUTPUT KBD;CHR$(255)&"K";
12940 PRINT "Do you wish to have a hardcopy of the results?"
12950 PRINT
12960 PRINT "NOTE: Printer address assumed to be ";VAL$(ptr_add);"."
12970 GOSUB clear_keys
12980 ON KEY 1 LABEL " YES" GOTO print_it
12990 ON KEY 4 LABEL " NO" GOTO no_print
13000 ON KEY 9 LABEL " " GOTO no_print
13010 ON KEY 9 LABEL " " GOTO no_print
13020 GOSUB wait_for_key
13030 RETURN
13040 clear_keys:1
13050 CONTROL 1,12;0
13060 ON KEY 0 LABEL " " GOSUB key_trap
13070 ON KEY 1 LABEL " " GOSUB key_trap
13080 ON KEY 2 LABEL " " GOSUB key_trap
13090 ON KEY 3 LABEL " " GOSUB key_trap
13100 ON KEY 4 LABEL " " GOSUB key_trap
13110 ON KEY 5 LABEL " " GOSUB key_trap
13120 ON KEY 6 LABEL " " GOSUB key_trap
13130 ON KEY 7 LABEL " " GOSUB key_trap
13140 ON KEY 8 LABEL " " GOSUB key_trap
13150 ON KEY 9 LABEL " " GOSUB key_trap
13160 RETURN
13170 Menu:1
13180 CONTROL 1,12;1
13190 Title$="5347A/5348A HP-IB CHECKPOINT SUMMARY"
13200 GOSUB sub_title
13210 PRINT
13220 PRINT " 1,REMOTE',LOCAL',** 11,AUTO' and 'MANUAL,'"
13230 PRINT " 2 self check ('TESTS',)** 12,'SRQMASK',"
13240 PRINT " 3,DISPLAY',** 13,DUMP',"
13250 PRINT " 4,INIT',RESET' and 'CLEAR',** 14,WAIT',DBM',MOD?'"
13260 PRINT " 5,REF' and 'REF',** 15,ZERO',"
13270 PRINT " 6,ERRS',** 16,CALIBRATE,'"

```

Table 4-5. HP-IB Verification Program (Continued)

```

13280 PRINT " 7,SET' and 'SET7' ** 17,REF OSC ON/OFF,'OSCR'"
13290 PRINT " 8,LOWZ' and 'HIGHZ' ** 18,AUTO','MANUAL','RNG7'"
13300 PRINT " 9,SAMPLE' and 'TRIGGER' ** 19,TRIGGER','PTRG7'"
13310 PRINT " 10,RESOL 0' & 'RESOL 4' ** 20,CHECK ALL ADDRESSES'"
13320 PRINT
13330 PRINT " 'ID7' is also checked during HP-IB address search at program startup."
13340 PRINT
13350 PRINT
13360 PRINT "IT:1
13370 GOSUB Keys_off
13380 OUTPUT KBD;CHR$(255)&"K";
13390 PRINTER IS ptr_add
13400 ON ERROR GOTO ptr_stuck
13410 ON TIMEOUT ptr_add DIV 100,1 GOTO ptr_stuck
13420 OUTPUT ptr_add USING "#,K";" "
13430 OFF TIMEOUT 13440
13460 ptr_stuck:1
13470 CONTROL 1,12;1
13480 DISP (ptr_add);" NOT RESPONDING. CHECK PRINTER IS ON, & ADDRESS & HOOK-UP IS CORRECT."
13490 BEEP 600,.3
13500 WAIT 3
13510 OFF TIMEOUT
13520 OFF ERROR
13530 GOTO print_results
13540 No_print:1
13550 GOSUB Keys_off
13560 OUTPUT KBD;CHR$(255)&"K";
13570 Title$="CHECKPOINT RESULTS"
13580 GOSUB sub_title
13590 PRINT Horiz_lines
13600 PRINT
13610 PRINT "Counter: ";inst_id$;" at address";address
13620 PRINT
13630 FOR Test_number=1 TO 10
13640 PRINT "
";Test_number;TAB(8);Test_results$(Test_number);
13650 PRINT TAB(30);10+Test_number;TAB(34);Test_results$(10+Test_number)
13660 NEXT Test_number
13670 PRINT
13680 PRINTER IS CRT
13690 OUTPUT Address;"INIT"
13700 LOCAL 7
13710 GOTO Final_exit
13720 END

```

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.

**WARNING**

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

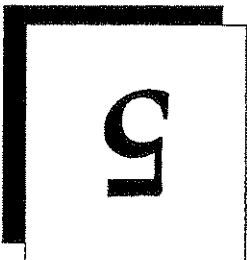
**5-2. SAFETY CONSIDERATIONS**

*Table 5-1* lists the recommended test equipment needed to perform the adjustment procedures. *Table 5-2* lists the adjustment procedures and the recommended order of performance, and identifies the adjustable components involved.

This section describes the adjustments required to maintain the HP 5347A/48A 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 5347A/48A line input voltage must be within +5% to -10% of normal.

**5-1. INTRODUCTION**

**ADJUSTMENTS**



The test equipment required for the adjustment procedures is listed in *Table 5-1, Equipment Required*. Substitute test equipment may be used if it meets or exceeds the required characteristics listed in the table. (Appendix B, RECOMMENDED TEST EQUIPMENT, in this manual is a complete list of the recommended test equipment for the performance tests, adjustments, and troubleshooting procedures.)

### 5-3. EQUIPMENT REQUIRED

*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.*

CAUTION



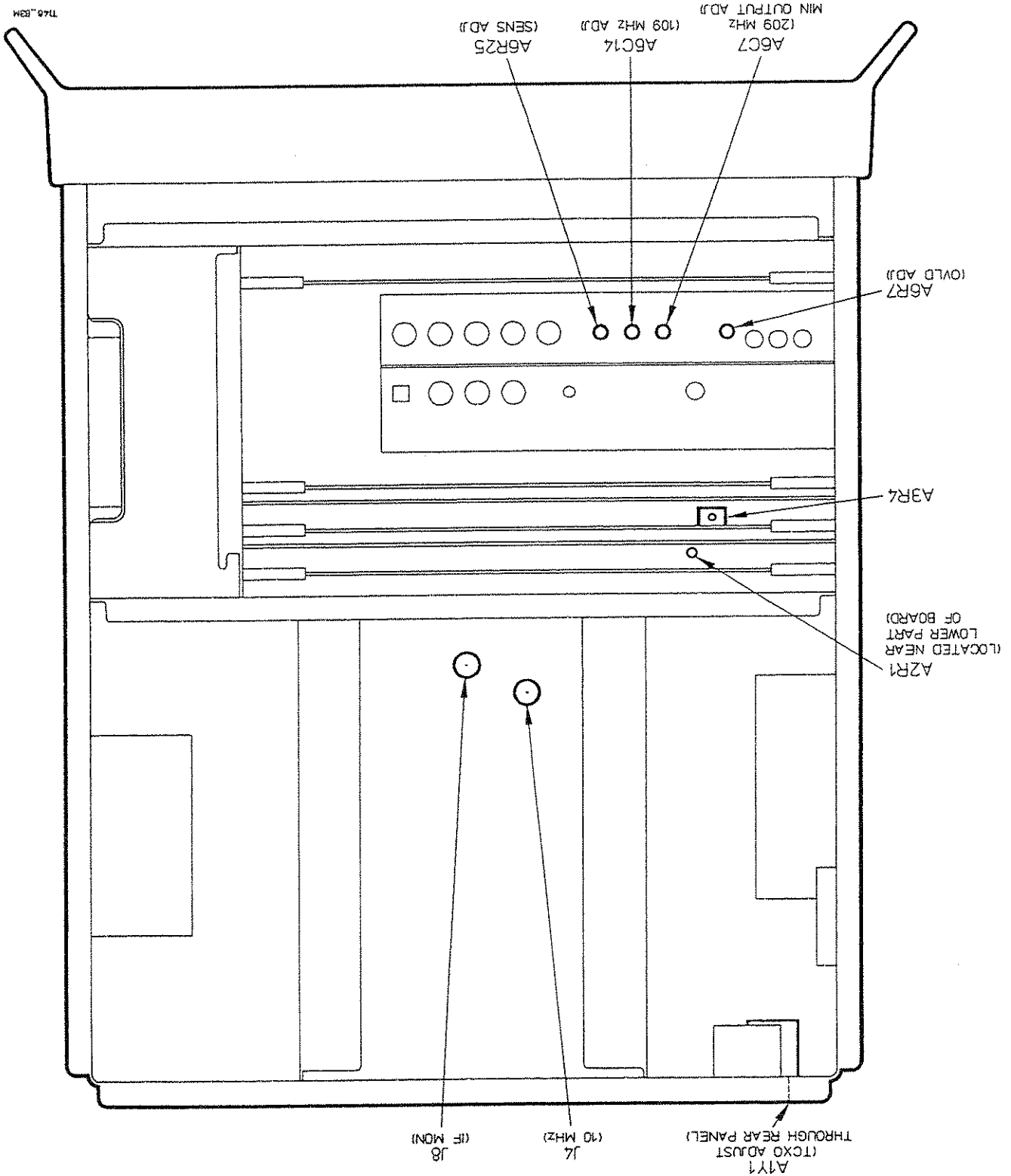
Table 5-1. Equipment Required

Instrument	Required Characteristics	Recommended Model
Oscilloscope	275 MHz bandwidth delayed sweep or 250 MHz Digital Oscilloscope	HP 1725A (or equivalent) HP 54111D
Oscilloscope Probe	High impedance (10:1), minimal capacitance (8-10 pF), compensate 10-16 pF scope input	HP 10017A or HP 10432A
Oscilloscope Probe for HP 54111D	High impedance (10:1), compensate 6-9 pF	HP 10431A
Digital Voltmeter	4 1/2-digit AC/DC	HP 3466A (or equivalent)
Synthesizer Sweeper	10 MHz to 26.5 GHz	HP 8340B
Frequency Counter	9-digit resolution	HP 5384A
Synthesized Signal Generator	10 MHz to 2.6 GHz, 5% Amplitude Modulation, 200 kHz FM p-p, -40 dBm to +10 dBm	HP 8660C/ HP 86603A/ HP 86632B or HP 8663A or HP 8642A
Fixed Attenuator	20 dB Attenuation	HP 8491A Opt. 20
Spectrum Analyzer	RF inputs from 1 MHz	HP 8590A (or equivalent)
Power Meter	50 MHz to 26.5 GHz	HP 436A or HP 437B or HP 8902A
Power Sensor	50 MHz to 26.5 GHz -30 to +10 dBm	HP 8485A
Range Calibrator	Calibration functions: 3, 10, 30, 100, and 300 $\mu$ W 1, 3, 10, 30, and 100 mW	HP 11683A
Sensor Cable	3.0 metres (10 ft.)	HP 11730A

#### 5-4. ADJUSTMENT LOCATIONS

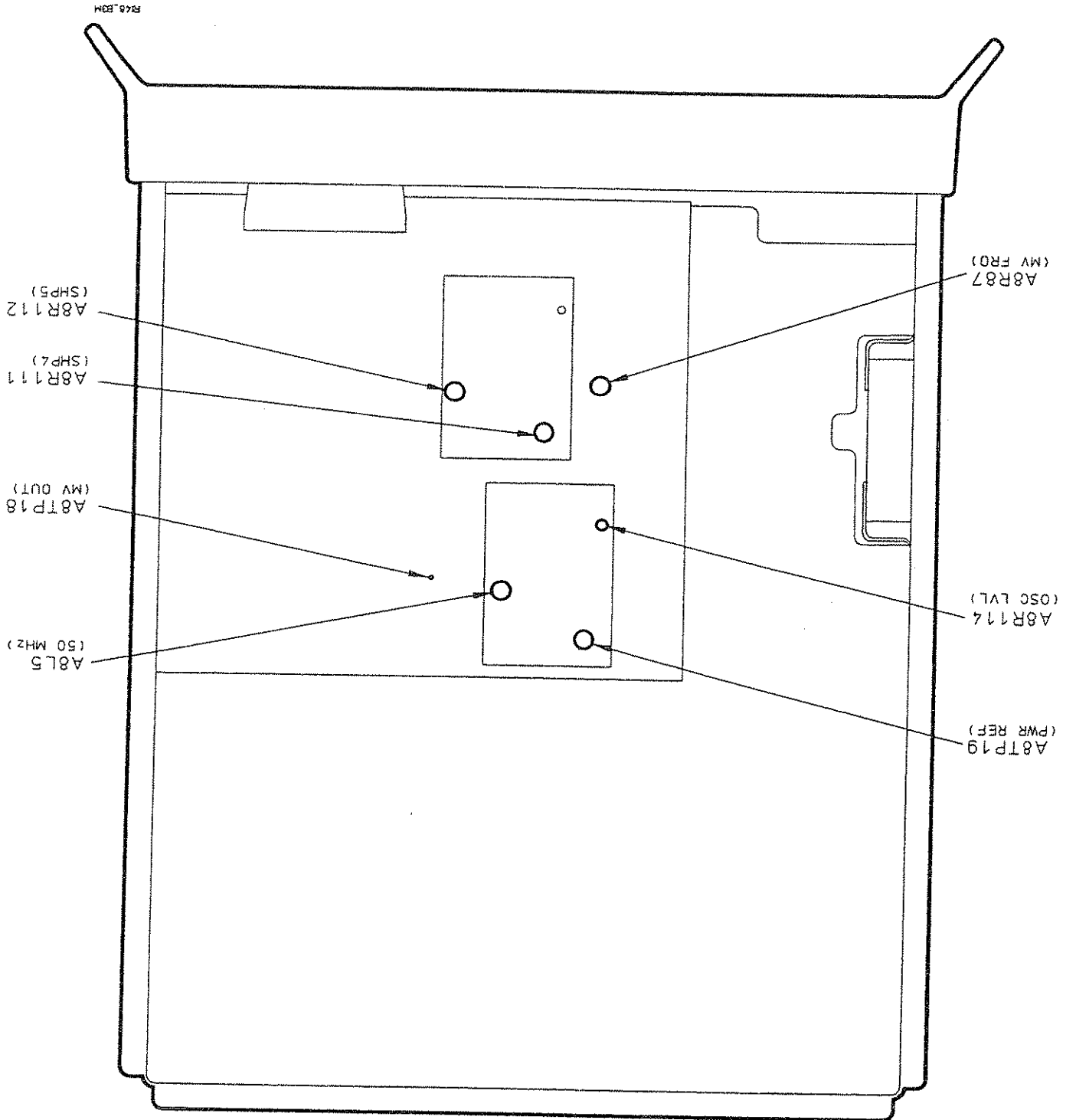
Adjustment locations are identified in *Figures 5-1 and 5-2*. Note that all adjustments must be made with the cover removed (refer to Section 5-5, Cover Removal). The TCXO adjustment is made through the rear panel hole labeled TCXO ADJUST.

Figure 5-1. HP 5347A/48A Adjustment Locations (Top View)



1740 .03M

Figure 5-2. HP 5347A/48A Adjustment Locations (Bottom View)



## 5-5. COVER REMOVAL

Perform the following procedure to remove the cover and optional battery pack (if present):

### WARNING

WHEN THE COVER IS REMOVED FROM THE  
HP 5347A/48A, LINE VOLTAGES ARE EXPOSED WHICH  
ARE DANGEROUS AND MAY CAUSE SERIOUS INJURY  
IF TOUCHED. DISCONNECT POWER.

1. Turn off HP 5347A/48A, remove all power connections, and be sure any cables or adapters are removed from front panel.
  2. If the Option 002 Battery Pack is present, temporarily remove the pack by performing the following:
    - a. Loosen two screws that hold rear panel's battery compartment door in place, and remove door. The screws are retained in the door. To remove the battery, tip front of instrument slightly. Battery will slide out.
    - b. Obtain the battery's protective cap or other protective device, and place it on the terminal end of the battery pack to protect the battery from short circuits. Retain the cap with rubber band or tape if necessary.
  3. Stand HP 5347A/48A on its front handles, and loosen recessed Pozidriv screw located in center of each rear foot. The screws are retained in the feet.
  4. Slide the cover off the chassis from the rear. You may have to gently tap, with your hands, the sides of the cover to enable the cover to slide off the chassis.
- All top and bottom adjustments should now be accessible as shown in Figures 5-1 and 5-2. Table 5-2 gives a summary of the adjustments, and indicates the order in which they should be performed.

Table 5-2. Summary of Adjustments

Order of Performance	Purpose	Reference Designation	Name
1	Sets +3V Supply for MRC (A3U7).	A3R4	MRC Power Supply Adjustment
2	Sets maximum sensitivity of low frequency input circuitry (INPUT 2)	A2R1	Peak Detector Adjustment
3	Sets sensitivity of the IF bandpass.	A6R25	IF Amplifier Adjustments
4	Sets frequency response of the 175 MHz elliptic filter.	A6C7	
5	Sets the width of the IF bandpass.	A6C14	
6	Sets overload indicator threshold.	A6R7	
7	Sets the 220 Hz for maximum Power Meter readout.	A8R87	220 Hz Frequency Adjustment
8	Sets Power Meter input amplifier for proper gain.	A8R111, A8R112	Range 4 and 5 Shaper Adjustment
9	Sets the Power Reference Oscillator frequency to 50 MHz.	A8L5	Reference Oscillator Frequency Adjustment
10	Sets the Power Reference Oscillator level to 1.0 mW.	A8R114	Reference Oscillator Level Adjustment
	Sets TCXO timebase to exact specified frequency.	A1Y1	TCXO Timebase Adjustments

May be performed at anytime.

## 5-6. FREQUENCY COUNTER ADJUSTMENT PROCEDURES

### 5-7. MRC Supply Adjustment

#### NOTE

Before making any A3 Counter Assembly adjustments, allow at least 15 minutes for the HP 5347A/48A to warmup.

Reference: Figure 8-40. A3 Counter Assembly Schematic Diagram

The only power supply in the HP 5347A/48A which requires adjustment is the +3 volt supply for the MRC (U7) on the A3 Counter Assembly. To perform this adjustment, proceed as follows:

1. Connect the negative terminal of a DVM (HP 3466A) to chassis ground of the HP 5347A/48A.

2. Connect the positive terminal of the DVM to the +3V test point located at the top of the A3 Assembly.

3. Adjust A3R4 for a DVM reading of 3.000 Vdc ( $\pm 20$  mV).

If the MRC supply cannot be adjusted to the required level, check the voltages at the Power Supply Test connector (A1X1) to confirm that the other power supplies voltages of the HP 5347A/48A are at their proper levels. (Test connector A1X1 is on A1 Motherboard). Refer to Section 8 (Service) for the specified voltage levels for all of the instrument power supply voltages.

### 5-8. Peak Detector Adjustment (INPUT 2, 50 $\Omega$ )

#### NOTE

Before making any A2 Low Frequency Input Assembly adjustments, allow at least 15 minutes for the HP 5347A/48A to warmup.

Reference: Figure 8-39. A2 Low Frequency Input Assembly Schematic Diagram

Potentiometer A2R1 adjusts the peak detector circuitry for the 50 $\Omega$  portion of INPUT 2. The peak detector determines the sensitivity of the input circuitry. To perform this adjustment, proceed as follows:

1. Connect the negative terminal of the HP 3466A DVM to chassis ground of the HP 5347A/48A.

5-9. IF Amplifier Adjustments

NOTE

Before making any A6 IF Amplifier/Detector Assembly adjustments, allow at least 15 minutes for the HP 5347A/48A to warm up. The warm-up period is recommended especially for the IF adjustment.

Reference: Figure 8-43. A6 IF Amplifier/Detector Assembly Schematic Diagram

The IF Amplifier adjustments consist of four 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 5-3.

2. Connect the positive terminal of the DVM to TP1 at the top of the A2 assembly.
3. Set a synthesizer (HP8660C/86603A/86632B) for an output of 17 mV (-24.0 dBm) at 400 MHz, and connect the synthesizer output to INPUT 2 of the HP 5347A/48A.
4. Connect the REFERENCE OUTPUT connector on the rear panel of the synthesizer to the front panel External Reference Input connector of the HP 5347A/48A.
5. Press Input 2 502/1MΩ key to set the HP 5347A/48A to INPUT 2's 50Ω impedance mode.
6. Adjust A2R1 clockwise until the HP 5347A/48A 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 HP 5347A/48A should be gating and displaying the 400 MHz signal.
7. To verify the adjustment, set the synthesizer output to -24.5 dBm at 400 MHz, and verify that the HP 5347A/48A displays all zeroes: 00 000 000 000. Slowly increase the synthesizer level to -23.5 dBm and verify that the HP 5347A/48A displays 400 MHz correctly.



1. Connect a suitable controller (e.g., HP 9836, HP 200/300 Series controller) to the HP 5347A/48A rear panel HP-IB connector.
2. Set up the HP 5347A/48A and test equipment as shown in Figure 5-4.

In the procedures following, the appropriate HP-IB command string will be shown, along with an explanation for use. BASIC is the language used.

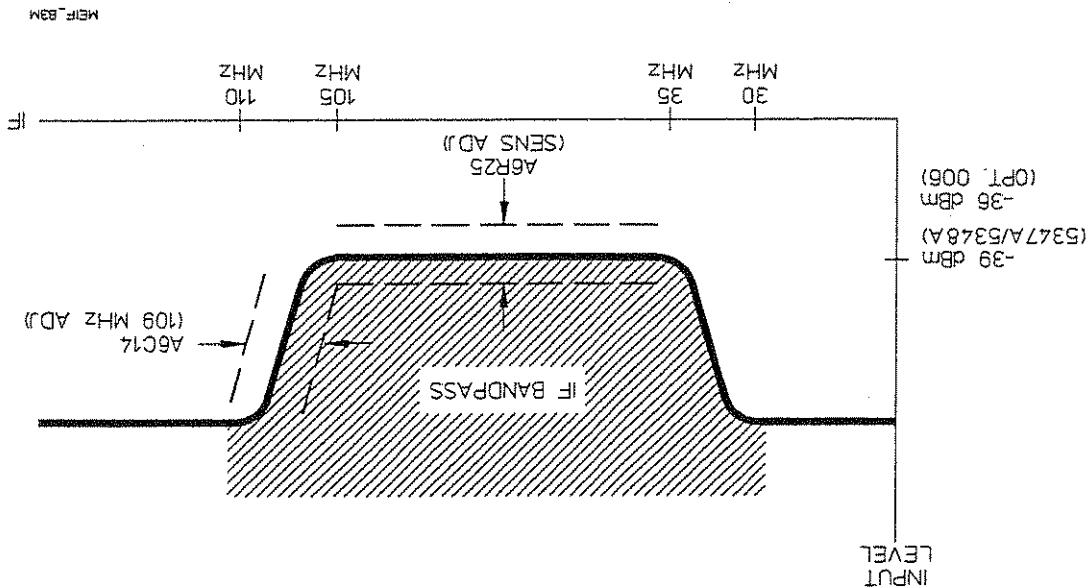
To set the Manual mode center frequency in the following IF adjustment procedures, a simple controller and interface is required. Of course, the HP 5347A/48A must have the HP-IB Interface Assembly (Option 011) installed. For instruments sold without the HP-IB Interface Assembly, the necessary hardware is available in the Service Accessories Kit (HP Part Number 05348-67001).

The HP 5347A/48A was designed for simple front panel operation; however, many advance functions are available via the HP-IB only.

**NOTE**

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

Figure 5-3. Effects of IF Bandpass Adjustments



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

If calibration data is available for the attenuator, the power level in step 3 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 synthesizer should be set for a -20.2 dBm reading on the power meter.

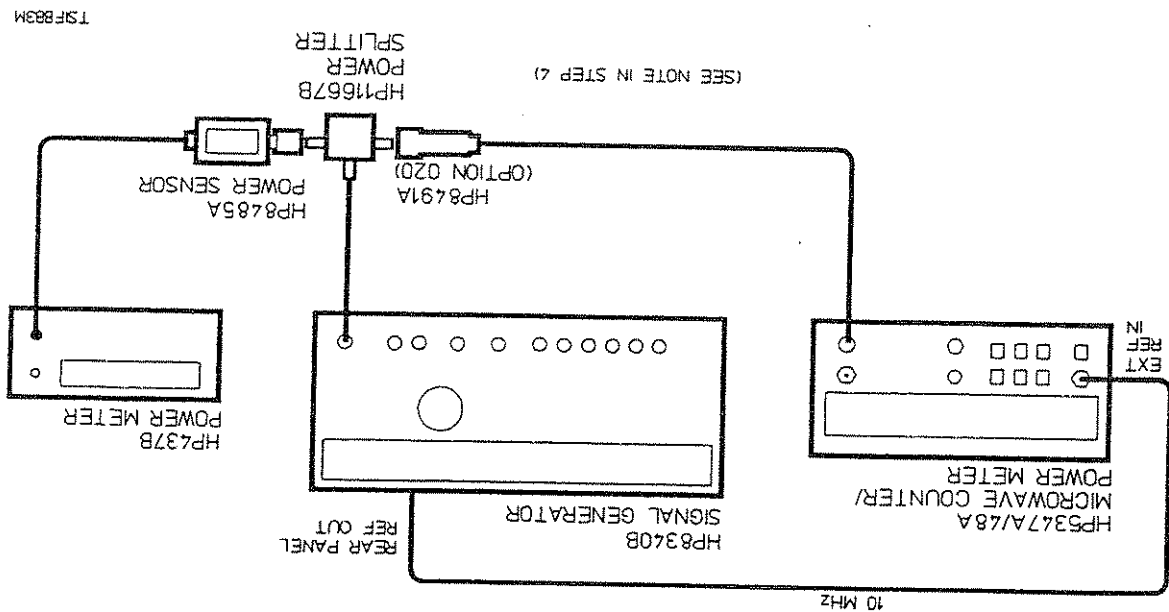
**NOTE**

The output level set in step 3 above will result in a -40 dBm input level to the HP 5347A/48A due to the HP 8491A (Option 20) Attenuator. The 12.37 GHz frequency to the HP 5347A/48A will result in an IF of 70 MHz in the HP 5347A/48A (using the second harmonic of the 300 MHz LO frequency).

**NOTE**

- Set the HP 8340B Synthesized Sweeper for a 12.37 GHz frequency, at an output level -20 dBm, as measured on the HP 437B Power Meter.

Figure 5-4. IF Bandpass Sensitivity Adjustment Setup



- Set the HP 5347A/48A to the MANUAL mode via the HP-IB with a 670 MHz center frequency by executing the OUTPUT 7XX; "MANUAL,670E+6" command (where XX is the selected address of the HP 5347A/48A). This will set the LO frequency to 300 MHz.

6. 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.

7. Adjust A6R25 clockwise until both the green and yellow LEDs are ON with equal brightness.

8. Press the Reset/Local key on the HP 5347A/48A.

a. Set the output level of the HP 8340B so that the HP 437B reads -19.5 dbm. The level at the HP 5347A/48A input is now -39.5 dbm. (If option 006 is installed, set the output level of the HP 8340B so that the HP 437B reads -16.5 dbm resulting in 36.5 dbm at the HP 5347A/48A input.) Verify that the yellow LED (NO IF LATCH) is ON and the green LED (IF OK) is OFF.

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

a. Set the output level of the HP 8340B to -38.5 dbm and verify that the yellow LED (NO IF LATCH) is ON and the green LED (IF OK) is OFF.

b. Set the output level of the HP 8340B so that the HP 437B reads -18.5 dbm. The level at the HP 5347A/48A input is now -38.5 dbm. (If option 006 is installed, set the output level of the HP 8340B so that the HP 437B reads -15.5 dbm resulting in -35.5 dbm at the HP 5347A/48A input.) Verify that the green low LED (IF DC) is ON and the yellow LED (NO LATCH) is OFF.

10. The following steps are used to display the 70 MHz IF frequency. The Diagnostics mode used to display this frequency value; thus, the user needs to enter the Diagnostics mode of the HP 5347A/48A. Two methods exist to enter this mode:

- Rear Panel DIP switch

- HP-IB

For instruments not equipped with the HP-IB or where the use of the HP-IB is not desired, proceed to step 11.

For instruments equipped with the HP-IB, proceed to step 12.

11. To set the HP 5347A/48A to Diagnostic 63 by using the rear panel DIP switch, perform the following:

a. Turn off the HP 5347A/48A.

b. Set rear panel MODE switch to the Diagnostics mode ("up" position).

c. Turn on the HP 5347A/48A.

- c. Send the command OUTPUT 7XX,"DIAGENT" (where XX is the address selected in step b, above). This will put the HP 5347A/48A into the Diagnostics mode.
- d. Now, send the command OUTPUT 7XX;"DIAG,63,ON". This will cause the HP 5347A/48A to run Diagnostic 63.

13. Verify that the correct IF frequency (70 MHz) is displayed.

The IF Bandpass Sensitivity Adjustment is now completed.

175 MHZ ELLIPTIC FILTER ADJUSTMENT. Capacitor A6C7 (209 MHZ MIN OUTPUT AD) 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:

1. Set up the HP 8590A Spectrum Analyzer as follows:

SPAN .....	20 MHZ
CENTER FREQ .....	209 MHZ
VIDEO BW .....	3 KHZ
RES BW .....	100 KHZ

2. Set the HP 8660C Synthesized Signal Generator to 0 dbm at 209 MHz, verifying the output with a HP 437B Power Meter.

3. Connect the output of the synthesizer to INPUT 1 of the HP 5347A/48A as shown in Figure 5-5.

4. Connect the IF MON connector (A1J8) on the A1 Motherboard Assembly to the RF INPUT 502 input of the HP 8590A Spectrum Analyzer as shown in Figure 5-5. (Note: A1J8 is a SMB connector. Thus, use the LO Test cable [HP P/N 05350-60121; SMB-to-BNC adapter cable] to make this connection. The LO Test cable is in the Service Accessory Kit.)

- a. Connect the controller to the HP 5347A/48A rear panel HP-IB connector.
- b. Check the address setting of the HP 5347A/48A rear panel HP-IB switch.
- c. Send the command OUTPUT 7XX;"DIAGENT" (where XX is the address selected in step b).
- d. Now, send the command OUTPUT 7XX;"DIAG,97,ON". This will cause the HP 5347A/48A to run Diagnostic 97. Proceed to step 6.

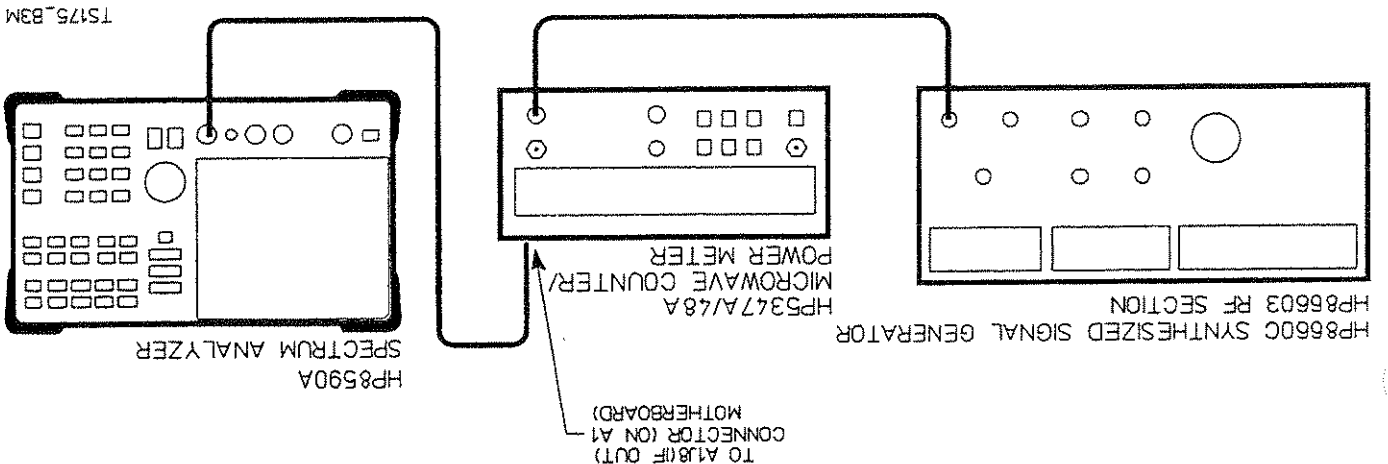
To use the HP-IB method, perform the following:

- a. Turn off the HP 5347A/48A.
- b. Set rear panel MODE switch to the Diagnostics mode ("up" position).
- c. Turn on the HP 5347A/48A.
- d. Press Input 2 502/IM2 or Input 1 502 key (depending on whether you need to increment or decrement to get to Diagnostic 97).
- e. Press Calibrate/Store key to initiate the Diagnostic 97 test. The HP 5347A/48A display should read: "ADJUST IF 175 FILTER D97". Proceed to step 6.

To use the rear panel DIP switch method, perform the following:

- 5. Set the HP 5347A/48A to Diagnostic 97 by performing one of the methods shown below:

Figure 5-5. 175 MHz Elliptic of IF Bandpass Adjustments



TS175\_B3M

6. While monitoring IF MON connector on the A1 Motherboard Assembly with the spectrum analyzer, 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.
  7. The A6C7 adjustment is now completed. Power down the HP 5347A/48A (POWER switch to Standby position) to exit Diagnostic 97.
- If the rear panel DIP switch method was used to execute Diagnostic 97, set the rear panel MODE switch to the Meas. (up) position.
8. Now, continue with the next adjustment procedure.

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

1. Leave the synthesizer connected to the HP 5347A/48A as in the previous adjustment procedure. The spectrum analyzer will not be needed, and can be disconnected.
2. Turn on the HP 5347A/48A.
3. Set the HP 5347A/48A to the Manual mode with a center frequency of 770 MHz by sending the OUTPUT 7XX;"MANUAL,770E+6" command (where XX is the selected address of the HP 5347A/48A).
4. Set the synthesizer for an output of +5 dbm at 809 MHz. This signal will generate an IF of 109 MHz in the HP 5347A/48A. The red overload (OVL) 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.
5. Set the HP 86632B for Frequency Modulation of 200 kHz deviation.
6. Adjust A6C14 (109 MHz ADJ) clockwise until both the green and yellow LEDs 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.
7. 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.

## OVERLOAD INDICATOR THRESHOLD ADJUSTMENT. To adjust A6R7 (OVLAD ADJ) to set the overload indication threshold, proceed as follows:

1. Leave the HP 5347A/48A in the Manual mode with a center frequency of 770 MHz, as in the previous procedure, to obtain an LO frequency of 350 MHz.
2. Set the synthesizer to +4.0 dBm at 2.03 GHz, verifying the output at the end of the cable with the HP 437B Power Meter and HP 8485A Power Sensor. The 2.03 GHz frequency to the HP 5347A/48A will result in an IF of 70 MHz in the HP 5347A/48A (using the sixth harmonic of the 350 MHz LO frequency). (If option 006 is installed, set synthesizer to +7.0 dBm.)
3. Connect the synthesizer output to INPUT 1 of the HP 5347A/48A. Adjust A6R7 (OVLAD ADJ) clockwise until the red LED (OVLAD) on the A6 Assembly turns ON.
4. Disconnect the synthesizer from the HP 5347A/48A and set the synthesizer level to +2.5 dBm, verifying the output at the end of the cable with the power meter. (If option 006 is installed, set synthesizer to +5.5 dBm.)
5. Reconnect the synthesizer output to INPUT 1 of the HP 5347A/48A and verify that the red LED (OVLAD) is OFF.

## 5-10. Internal TCXO Timebase Adjustment

Two procedures are given for the adjustment of the TCXO internal timebase. If the operation of the HP 5347A/48A will be solely at 25°C (78°F), then adjust the oscillator frequency as close as possible to 10 MHz, using the first procedure, immediately following this paragraph (i.e., TCXO TIMEBASE ADJUSTMENT). If the operation of the HP 5347A/48A will be over the full temperature range of 0° to 50°C, then the TCXO must be offset by the amount labeled on its cover, using the second procedure "TCXO TIMEBASE/OFFSET ADJUSTMENT". 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.

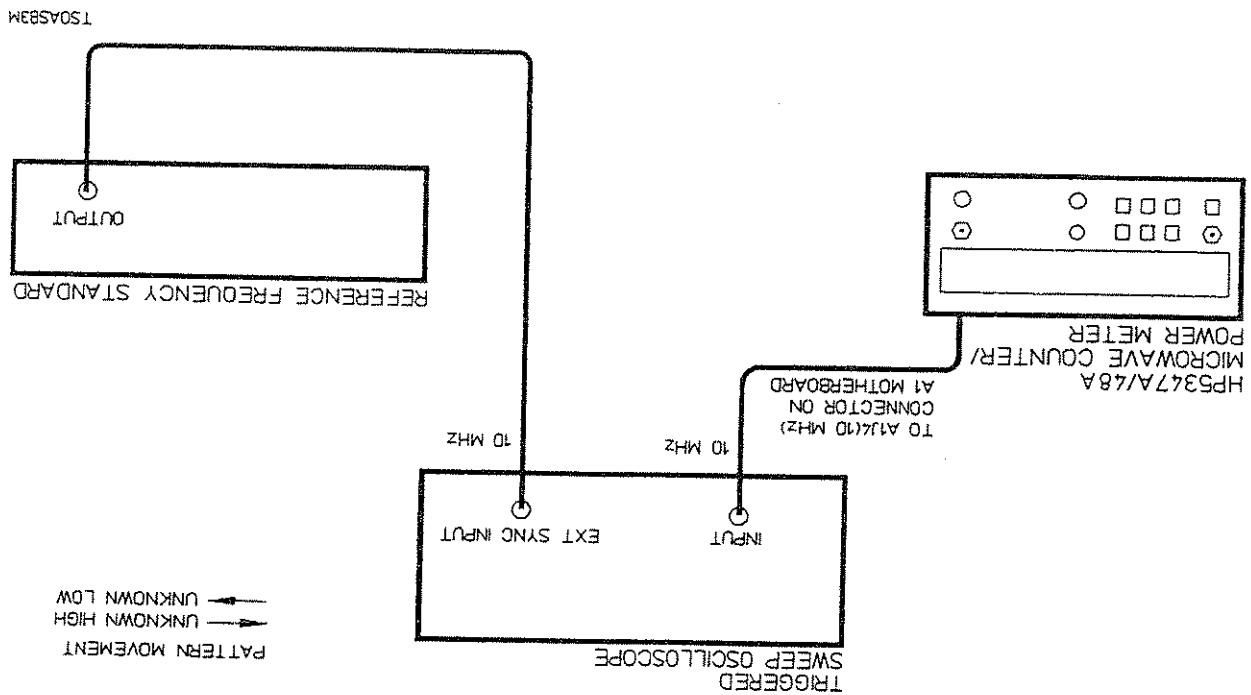
## TCXO TIMEBASE ADJUSTMENT

To adjust the TCXO Timebase for 25° C, proceed as follows:

1. Connect a house standard (10 MHz reference frequency) to the EXTERNAL SYNC INPUT of an oscilloscope and set the oscilloscope to EXTERNAL SYNC. Connect the HP 5347A/48A 10 MHz connector (A1J4) on the A1 Motherboard to the Channel A input of the oscilloscope as shown in *Figure 5-6*. (Note: A1J4 is a SMB connector. Thus, use the LO Test cable [HP P/N 05350-60120; SMB-to-BNC adapter cable] to help with connection to the Power Sensor. The LO Test cable is in the Service Accessory Kit.)

2. Insert a tuning wand through the TCXO ADJUST hole in the rear panel of the HP 5347A/48A and into the tuning screw of the TCXO (Y1) on the A1 Motherboard Assembly. Adjust the TCXO for a minimum sideways movement of the signal on the oscilloscope display.
  3. 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 5-3.
- This completes the adjustment of the TCXO for use at 25° C.

Figure 5-6. Oscillator Adjustment Setup





Range Calibrator .....HP 11683A  
 Frequency Counter .....HP 5384A  
 Power Cable .....HP 11730A

Equipment

Description: The 220 Hz signal is adjusted for maximum amplitude (or a 0.00  $\mu$ W readout on the HP 5347A/48A) and the frequency is checked.

Reference: Figure 8-46. A8 Power Meter Analog Assembly Schematic Diagram

5-12. 220 Hz Frequency Adjustment

5-11. POWER METER ADJUSTMENT PROCEDURES

This completes the adjustment of the TCXO with offset for use at 0° C to 50° C.

1. Connect a house standard (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).
2. Connect the HP 5347A/48A 10MHZ (A1J4) on the A1 Motherboard Assembly to the HP 5384A Channel A Input BNC connector.
3. Set the HP 5384A to FREQ A, 1 second GATE TIME.
4. Insert a tuning wand through the TCXO ADJUST hole in the rear panel of the HP 5347A/48A and into the tuning screw of the TCXO (A1Y1) on the A1 Motherboard Assembly. Adjust the TCXO frequency to 10 MHz  $\pm$  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.

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

TCXO TIMEBASE/OFFSET ADJUSTMENT

MOVEMENT	SWEEP SPEED			NOTES
	1 $\mu$ /cm	0.1 $\mu$ s/cm	0.01 $\mu$ s/cm	
1 cm/s 1 cm/10s 1 cm/100s	1 $\times$ 10 <sup>-6</sup> 1 $\times$ 10 <sup>-7</sup> 1 $\times$ 10 <sup>-8</sup>	1 $\times$ 10 <sup>-7</sup> 1 $\times$ 10 <sup>-8</sup> 1 $\times$ 10 <sup>-9</sup>	1 $\times$ 10 <sup>-8</sup> 1 $\times$ 10 <sup>-10</sup> 1 $\times$ 10 <sup>-10</sup>	Time scope trace movement with second hand of watch or clock

Table 5-3. Sweep Movement versus Calibration Accuracy

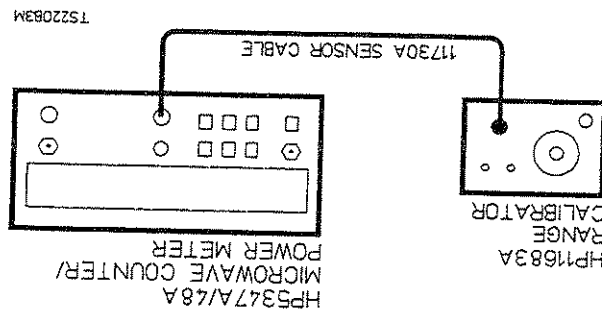
This completes the 220 Hz Frequency Adjustment.

10. Connect an HP 5384A counter to A8TP18 (MV OUT). Verify the that the frequency is from 220 Hz to 235 Hz.
9. Adjust A8R87 (MV FREQ) for maximum reading.
8. Press Calibrate/Store key.
7. Set the Range Calibrator function switch to CALIBRATE.
6. Press Zero key, and wait for the readout to appear in the HP 5347A/48A display. Verify that the reading is  $0.00 \pm 0.06 \mu\text{W}$ .
5. Press Input dbm/Watt key twice. This will set the HP 5347A/48A to read power in the Watt units.

FUNCTION ..... STANDBY  
 POLARITY ..... NORMAL  
 RANGE ..... 1 mW  
 LINE ..... ON

4. Set the Range Calibrator switches as follows:
  - a. Press Input 2 key.
  - b. Press Calibrate/Store Frequency key.
3. Press Reset/Local key.
2. Turn on HP 5347A/48A.

Figure 5-7. 220 Hz Frequency Adjustment Setup



1. Connect the Range Calibrator output to the power INPUT connector of the HP 5347A/48A as shown in Figure 5-7.

### 5-13. Range 4 and 5 Shaper Adjustment

Reference: Figure 8-46. A8 Power Meter Analog Assembly Schematic Diagram

Description: Ranges 4 and 5 Shaper circuits are adjusted for proper gain.

#### Equipment

- Range Calibrator ..... HP 11683A
- Power Cable ..... HP 11730A

#### Procedure

1. Connect Range Calibrator output to the power INPUT connector of the HP 5347A/48A as shown in Figure 5-8.

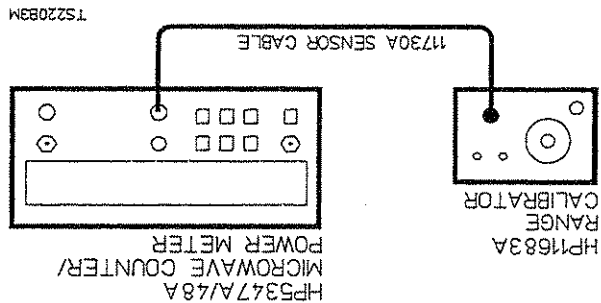


Figure 5-8. Ranges 4 and 5 Shaper Adjustment Setup

2. Turn on the HP 5347A/48A.
  - a. Press Input 2 key.
  - b. Press Calibrate/Store Frequency key.
4. Set the Range Calibrator controls as follows:
  - FUNCTION ..... STANDBY
  - POLARITY ..... NORMAL
  - RANGE ..... 1 mW
  - LINE ..... ON
5. Press Input dBm/Watt key twice. This will set the HP 5347A/48A to read power in the Watt units.
6. Press ZERO key and allow time (approximately 15 to 17 seconds) for the Power Meter zeroing process.
7. Set the Range Calibrator function switch to CALIBRATE.

1. Connect the equipment as shown in Figure 5-9 and set up the HP 5384A Counter to measure frequency.

Equipment

Frequency Counter ..... HP 5384A

**Description:** Variable inductor A8L5 is adjusted to set the Power Reference Oscillator output frequency to  $50.00 \pm 0.5$  MHz.

**Reference:** Figure 8-46. A8 Power Meter Analog Assembly Schematic Diagram

*Adjustment of the Power Reference Oscillator frequency may also affect the output level of the oscillator. Thus after the frequency is adjusted  $50.0 \pm 0.5$  MHz, the output level should be checked as described in Section 4. A procedure for adjusting the output to the specified level is provided in the next Section.*

**NOTE**

**5-14. Power Reference Oscillator Frequency Adjustment**

This completes the Range 4 and 5 Shaper Adjustments.

13. Steps 9 through 12 are interactive. Repeat until proper readings are obtained.
12. Adjust potentiometer A8R112 (SHP5) for a reading of  $100.0 \pm 0.1$  mW on the HP 5347A/48A display.
11. Set the Range Calibrator to 100 mW.
10. Adjust potentiometer A8R111 (SHP4) for a reading of  $10.00 \pm 0.01$  mW on the HP 5347A/48A display.
9. Set the Range Calibrator range to 10 mW.
8. Press Calibrate/Store key. This procedure causes the HP 5347A/48A to calibrate using the Range Calibrator 1 mW output.

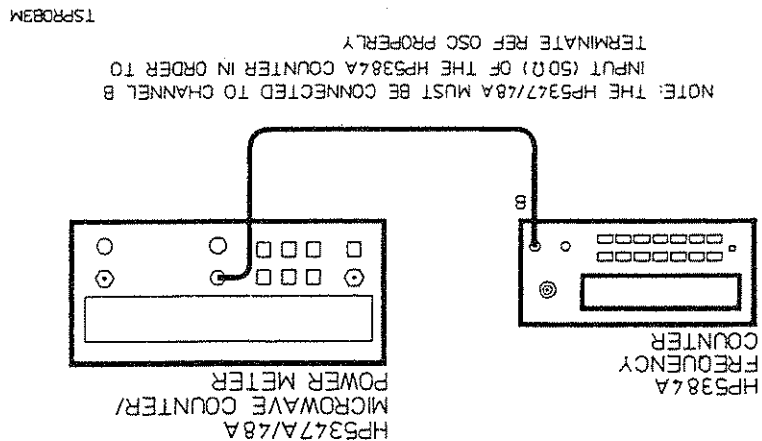
2. Turn on HP 5347A/48A.
3. Turn on the 1 mV, 50 MHz Power Reference Oscillator; there are two methods that can be used to turn on the Power Reference Oscillator (i.e., by not having to go into the Calibrate cycle):
  - Diagnostic 73 via DIP switch
  - HP-IB

For instruments not equipped with the HP-IB or where the use of the HP-IB is not desired, proceed to step 4.

For instruments equipped with the HP-IB, proceed to step 5.
4. To set the HP 5347A/48A to Diagnostic 73 by using the rear panel DIP switch, perform the following:
  - a. Turn off the HP 5347A/48A.
  - b. Set rear panel MODE switch to Diagnostics mode ("up" position).
  - c. Turn on the HP 5347A/48A.
  - d. Press Input 2 5021M $\Omega$  or Input 1 502 key (depending on whether you need to increment or decrement to get to Diagnostic 73).
  - e. Press Calibrate/Store key to initiate Diagnostic 73. The Power Reference Oscillator should now be ON. Proceed to step 6.

Procedure

Figure 5-9. Power Reference Oscillator Frequency Adjustment Setup



5. To turn on the 1 mV, 50 MHz Power Reference Oscillator via the HP-IB, perform the following:

- a. Connect a controller to the HP 5347A/48A.
- b. Check the address setting of HP 5347A/48A rear panel HP-IB switch.
- c. Send the OUTPUT 7XX;"LG;OCI" command. This will cause the HP 5347A/48A to enter the Power Meter mode (dbm readings), and turn on the Power Reference Oscillator.

6. Observe a reading of  $50.0 \pm 0.5$  in the display of the HP 5384A Counter, which indicates that the Power Reference Oscillator is ON. If the Power Reference Oscillator frequency is not within the limits, adjust the Power Reference Oscillator frequency as described in step 7.

7. From the bottom of the HP 5347A/48A (see Figure 5-2), adjust A8L5 (50 MHZ) to obtain a  $50.00 \pm 0.5$  MHz indication on the HP 5384A Counter. Note: The tuning slug of the coil (A8L5) has two places where the oscillator will output 50 MHz; however, the correct position for the tuning slug is when it is adjusted to the inward position. The other position is the outward position of the tuning slug that leaves the slug protruding through the hole in the protective metal shield, causing unwanted interaction between the coil and the shield.

This completes the Power Reference Oscillator Frequency Adjustment.

### 5-15. Power Reference Oscillator Level Adjustment

Reference: Figure 8-46. A8 Power Meter Analog Assembly Schematic Diagram

Description: The Power Reference Oscillator is factory adjusted to  $1.0 \text{ mW} \pm 0.7\%$  using a special measurement system accurate to 0.5% (traceable to the National Institute of Standards and Technology) and allowing for a 0.2% transfer error. To ensure maximum accuracy in readjusting the Power Reference Oscillator, the following procedure provide step-by-step instructions for using specified Hewlett-Packard instruments of known capability. If equivalent instruments are used, signal acquisition criteria may vary and reference should be made to the manufacturer's guidelines for operating the equipment.

### NOTE

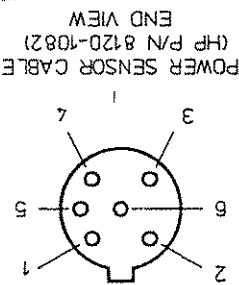
The HP 5347A/48A may be returned to the nearest HP office to have the Power Reference Oscillator checked and/or adjusted. Refer to Section A-28 (Packaging) in Appendix A of the Operating and Programming Manual.

**Equipment**

- Test Power Meter ..... HP 432A
- Thermistor Mount ..... HP 478A-H75
- Digital Voltmeter (DVM) ..... HP 3466A
- Power Sensor Cable ..... HP 8120-1082

**Procedure**

1. Make sure the HP 432A is OFF for the following setup tests.
2. Setup the DVM to measure resistance and connect the DVM between Vrf connector on the rear panel of the HP 432A (test power meter), and pin 1 on the thermistor mount to locate pin 1:  
end of the test power meter interconnect cable (HP P/N 8120-1082). See figure below to

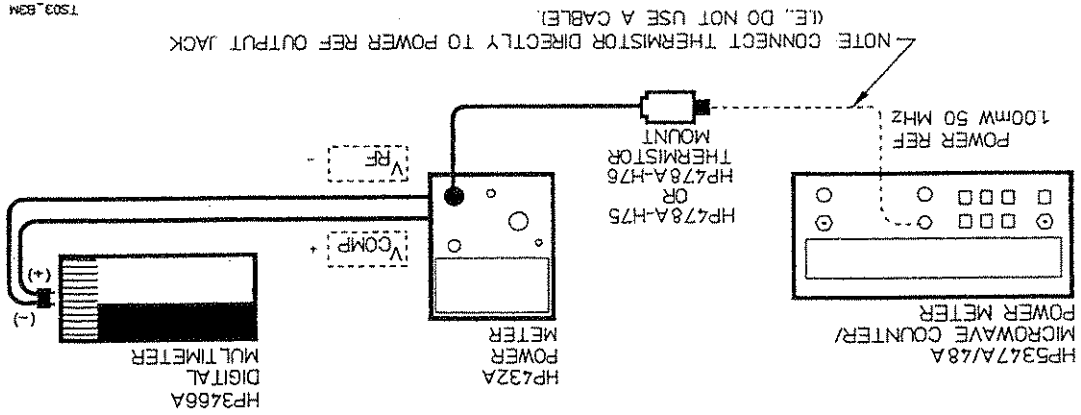


3. Round off the DVM indication to two decimal places and record this value as the internal bridge resistance ( $R$ ) of the HP 432A (approximately 200 ohms).

$R$

4. Connect the HP 432A Power Meter to the HP 5347A/48A Power Ref. as shown in

*Figure 5-10.*



*Figure 5-10. Power Meter Reference Level Test Setup*

5. Set the HP 432A and HP 5347A/48A POWER to ON state. Then wait thirty minutes for the test power meter thermistor mount to stabilize before proceeding to the next step.
6. Set the test power meter switch to Coarse Zero and adjust the front panel Coarse Zero control to obtain a zero meter indication.
7. Fine Zero the test power meter on the most sensitive range, then set the test power meter Range switch to 1 mW. On the HP 432A, press FINE ZERO toggle switch down to actuate the Fine Zero function.

**NOTE**

Ensure that the DVM input leads are isolated from chassis ground when performing the next step.

8. Set up the DVM to measure microvolts and connect the positive and negative input leads, respectively, to the  $V_{comp}$  and Vrf connectors on the rear panel of the HP 432A.
9. Observe the indication on the DVM. If less than 400 microvolts, proceed to the next step. If 400 microvolts or greater, press and hold the test power meter Fine Zero switch and adjust the Coarse Zero control so that the DVM indicates 200 microvolts or less. Then release the Fine Zero switch and proceed to the next step.
10. Round off the DVM indication to the nearest microvolt and record this value as  $V_0$ .

$V_0$

11. Disconnect the DVM negative input lead from the Vrf connector on the test power meter. Reconnect it to the test power meter chassis ground. Record the new indication observed on the DVM as  $V_{comp}$ .

$V_{comp}$

12. Turn on the 1 mV, 50 MHz Power Reference Oscillator; there are two methods that can be used to turn on the Power Reference Oscillator (i.e., by not having to go into the Calibrate cycle):

- Diagnostic 73 via DIP switch

- HP-IB

For instruments not equipped with the HP-IB or where the use of the HP-IB is not desired, proceed to step 13.

For instruments equipped with the HP-IB, proceed to step 14.



13. To set the HP 5347A/48A to Diagnostic 73 by using the rear panel DIP switch, perform the following:

a. Turn off the HP 5347A/48A.

b. Set rear panel MODE switch to Diagnostics mode ("up" position).

c. Turn on the HP 5347A/48A.

d. Press Input 2 502/1M52 or Input 1 502 key (depending on whether you need to increment or decrement to get to Diagnostic 73).

e. Press Calibrate/Store key to initiate Diagnostic 73. The Power Reference Oscillator should now be ON. Proceed to step 15.

14. To turn on the 1 mV, 50 MHz Power Reference Oscillator via the HP-IB, perform the following:

a. Connect a controller to the HP 5347A/48A.

b. Check the address setting of HP 5347A/48A rear panel HP-IB switch.

c. Send the OUTPUT 7XX;"LG;OC1" command. This will cause the HP 5347A/48A to enter the Power Meter mode (dbm readings), and turn on the Power Reference Oscillator.

The Power Reference Oscillator should now be ON.

15. Disconnect the DVM negative input lead from chassis ground and reconnect it to the Vrf connector on the test power meter rear panel. The DVM is now set up to measure  $V_1$  which represents the Power Reference Oscillator output level.

16. Calculate the value of  $V_1$  equal to 1 mW from the following equation:

$$V_1 - V_0 = V_{comp} - \sqrt{(V_{comp})^2 - (10^{-3})(4R)(Cal. Factor)}$$

Where:

$V_0$  = previously recorded value

$V_{comp}^{10^{-3}}$  = previously recorded value

$10^{-3}$  = 1 milliwatt

R = previously recorded value

Calibration Factor = value for thermistor mount at 50 MHz (traceable to the National Bureau of Standards).

17. Adjust A8R114 (OSC LVL) so that the DVM indicates the calculated value of  $V_1$ .

TYPICAL CALCULATIONS:

I. ACCURACY:

DVM Measurements:	$(V_{comp})$	$\pm 0.018\%$
	$(V_1 - V_0)$	$\pm 0.023\%$
	(R)	$\pm 0.03\%$
Math Assumptions:		$\pm 0.01$
Calibration Factor (NIST, formerly NBS):		$\pm 0.5\%$
Mismatch Uncertainty (Source & Mount SWR less than or equal to 1.05):		$\pm 0.1\%$
Less than or equal to		$\pm 0.7\%$

II. MATH ASSUMPTIONS:

Basic Formula for Power

$$Prf = \frac{4R (\text{Calibration Factor})}{2V_{comp} (V_1 - V_0) + V_2^0 - V_2^1}$$

Assume:  $V_0 - V_1 = (V_1 - V_0)^2$

$$-(V_1 - V_2)^2 = -V_2^1 + 2V_1 - V_2^0$$

Want:  $V_2^0 - V_2^1$

Therefore,  $error = (V_2^1 + 2V_1V_0 - V_2^0)$

$$= -2V_2^0 + 2V_1V_0 = 2V_1(V_1 - V_0)$$

if  $2V_1(V_1 - V_0)$  is much less than  $(>>) 2V_{comp} (V_1 - V_0)$  i.e.,  $V_0 << V_{comp}$ , error is negligible.

$V_{comp} \sim 4$  volts. If  $V_0 > 400 \mu V$ , error is  $< 0.01\%$ .

(typically  $V_0$  can be set to  $> 50 \mu V$ ).

III. DERIVATION OF FORMULA FOR  $V_1 - V_0$

$$Prf = \frac{4R \text{ (Calibration Factor)}}{2 V_{comp} (V_1 - V_0) + V_0^2 - V_1^2}$$

Desired Prf =  $1 \text{ mW} = 10^{-3}$

Therefore,  $10^{-3} = \frac{4R \text{ (Calibration Factor)}}{2 V_{comp} (V_1 - V_0) + V_0^2 - V_1^2}$

Let  $4R \text{ (Calibration Factor)} (10^{-3}) = K$

Substitute:  $-(V_1 - V_0)^2$  for  $(V_0^2 - V_1^2)$

(see Math Assumptions under Accuracy)

then  $0 = -(V_1 - V_0)^2 = -2V_{comp} (V_1 - V_0) + K$

or  $V_1 - V_0 = V_{comp} \sqrt{(V_{comp})^2 - K}$

18. Using the Prf formula above, verify that the Power Reference Oscillator output level is within the limits of 0.988 mW to 1.012 mW.

19. The following is a sample showing how calculations of  $V_1$  to obtain 1.000 mW is performed:

$Prf = 1.000 \text{ mW} = 1 \times 10^{-3} \text{ W}$

$R = 200\Omega$

$V_0 = 170 \mu\text{V}$  or  $170 \times 10^{-6} \text{ V}$

$V_{comp} = 5.1583 \text{ V}$

Cal Factor = 99.68%

$V_1 - V_0 = V_{comp} \sqrt{(V_{comp})^2 - (10^{-3}) (4R) \text{ (Cal. Factor)}}$

$V_1 - 170 \times 10^{-6} \text{ V} = 5.1583 \sqrt{(5.1583)^2 - 10^{-3} (4 \times 200) (99.68)}$

$= 5.1583 - \sqrt{26.6080 - 10^{-3} (800) (99.68)}$

$= 5.1583 - \sqrt{26.6080 - 797.44 \times 10^{-3}}$

$= 5.1583 - \sqrt{26.6080 - .79744}$

$= 5.1583 - \sqrt{25.8106}$

$= 5.1583 - 5.0804$

This completes the Power Reference Oscillator Level Adjustment.

$$V_1 = .00789 + .00017 = .07806V$$

$$V_1 - .000170 = .07789$$

$$V_1 - 170 \times 10^{-6}V = .07789$$

*Table 6-1* 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

## 6-4. ABBREVIATIONS AND REFERENCE DESIGNATIONS

The A9 Display/Driver Assembly consists of the Liquid Crystal Display, and the display driver and backlight circuits. The A9 Display/Driver Assembly is not a repairable assembly. If any portion of the assembly is defective, a new Display/Driver Assembly must be ordered (HP P/N 05350-60019). The W3 cable (HP P/N 05350-60122) is not included, and must be ordered separately.

## 6-3. SPECIAL REPLACEMENT FOR A9 DISPLAY/DRIVER ASSEMBLY

U1 Sampler	05350-60113	05350-60114
ASSEMBLY	NEW ASSEMBLY HP PART NO.	EXCHANGE ASSEMBLY HP PART NO.

The U1 Sampler component assembly 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. The part numbers for the U1 Sampler assemblies are listed below:

## 6-2. EXCHANGE ASSEMBLIES

This section contains information for ordering parts. *Table 6-1* lists abbreviations and reference designations used in the parts list and throughout the manual. *Table 6-2* lists all replaceable parts for the HP 5347A and HP 5348A in reference designation order. *Table 6-3* contains the names and addresses that correspond to the manufacturer's code numbers given in the parts list.

## 6-1. INTRODUCTION

# REPLACEABLE PARTS



To identify the part(s) you want, first refer to the Service information in the manual for the product. Use schematic diagrams and component locator diagrams, and parts list descriptions. When ordering from Hewlett-Packard, the important numbers to note from the Parts List are the HP Part Number and part-number check digit (in the "CD" column), and the quantity of the part you want.

### 6-7. Parts Identification

- Identifying the part and the quantity you want.
  - Determining the ordering method to be used and contacting Hewlett-Packard.
- Hewlett-Packard wants to keep your parts ordering process as simple and efficient as possible. Think of the process as having the following steps:

### 6-6. HOW TO ORDER A PART

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.

1. The Hewlett-Packard part number.
2. Part number check digit (CD).
3. The total quantity (Qty) in each individual assembly.
4. The description of the part.
5. A typical manufacturer of the part in a five-digit code.
6. The manufacturer's part number for the part.

The information given for each part consists of the following:

1. Electrical assemblies and their components in alphanumeric order by reference designation.
2. Chassis-mounted electrical parts in alphanumeric order by reference designation.
3. Chassis hardware and mechanical parts in alphanumeric order by reference designation.

Table 6-2 is a list of the replaceable parts and is organized as follows:

### 6-5. REPLACEABLE PARTS LIST

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.

Hewlett-Packard  
Support Materials Roseville  
P.O. Box 1145  
Roseville, CA 95661-1145

For mail correspondence, use the address below:

- For Parts Identification Assistance, call us at (916) 783-0804. Our Parts Identification hours are from Monday through Friday, 6 am to 5 pm (Pacific Time).
- If you need a part in a hurry, an extra-cost Hotline phone ordering service is available, 24 hours a day. Use the toll-free number above at the times indicated; at other times, use (415) 968-2347.
- For Parts Ordering, use our toll-free number, (800) 227-8164, Monday through Friday (except Holidays), 6 am to 5 pm (Pacific Time).

By telephone:

- Within the United States, we encourage you to order replacement parts or request parts information directly by telephone or mail from the HP Support Materials Organization, using the telephone numbers or address listed below. (You can also contact your local HP sales office. HP sales offices are listed at the back of this manual.)
  - Outside the United States, contact your local HP sales office. HP sales offices are listed at the back of this manual.
- Depending on where you are in the world, there are one or more ways in which you can get parts or parts information from Hewlett-Packard.

### 6-8. Contacting Hewlett-Packard

- Instrument Model Number (example "HP 5347A").
- Complete instrument Serial Number (example "1234A56789"). Information about where to find the serial number is in Section 1 of the Operating and Programming Manual.
- Description of the part and its use.
- Quantity of the part required.

If the part you want is *not* identified in the manual, you can call on Hewlett-Packard for help (see "Contacting Hewlett-Packard" below). Please have the following information at hand when you contact HP for help:

## 6-9. CABINET PARTS AND HARDWARE

To locate and identify miscellaneous cabinet and chassis parts and instrument hardware, refer to *Figures 6-1 through 6-3*. These figures provide various exploded views of the instrument, with the parts identified by reference designations. Two 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.





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

Reference	HP Part Number	C	D	Qty	Description	Mfr Code	Mfr Part Number
A1	05348-60001	2		1	MOTHERBOARD ASSEMBLY	28480	05348-60001
A1C1	0160-0576	5		21	CAP-FXD 0.1UF 50V	12344	C220C104M5R5CA
A1C2	0160-4040	6		4	CAP-FXD 1000PF 100 V	12344	C220C102J1G5CA
A1C3	0160-0576	5		4	CAP-FXD 0.1UF 50V	12344	C220C102J1G5CA
A1C4	0180-3831	3		14	CAP-FXD 10UF 35 V TA	12344	C220C103M1R5CA
A1C5	0160-5862	2		2	CAP-FXD 240PF 100V	12344	C220C104M5R5CA
A1C6	0180-4791	4		2	CAP-FXD 10PF 100V	12344	C410C100J1G5CA
A1C7	0180-2865	4		2	CAP-FXD 10PF 100V	12344	C410C100J1G5CA
A1C8	0160-3879	7		11	CAP-FXD 0.01UF 100V	12344	C410C100J1G5CA
A1C9	0160-0576	5		5	CAP-FXD 0.1UF 50V	12344	C220C103M1R5CA
A1C10	0160-3879	7		7	CAP-FXD 0.01UF 100V	12344	C220C103M1R5CA
A1C11	0160-3879	7		7	CAP-FXD 0.01UF 100V	12344	C220C103M1R5CA
A1C12	0160-3879	7		7	CAP-FXD 0.01UF 100V	12344	C220C103M1R5CA
A1C13	0160-4791	4		4	CAP-FXD 10PF 100V	12344	C410C100J1G5CA
A1C14	0160-5862	2		2	CAP-FXD 240PF 100V	12344	C410C100J1G5CA
A1C15	0180-4146	5		1	CAP-FXD 6800UF 50V AL-ELCTLT	56289	80D182P100KD28
A1C16	0180-4145	4		2	CAP-FXD 1800UF 100V AL ELCTLT	56289	80D182P100KD28
A1C17	0160-4966	5		5	CAP-FXD 0.1UF 50V	12344	C220C104M5R5CA
A1C18	0160-0576	5		5	CAP-FXD 0.1UF 50V	12344	C220C104M5R5CA
A1C19	0160-0576	5		5	CAP-FXD 0.1UF 50V	12344	C220C104M5R5CA
A1C20	0160-3879	7		7	CAP-FXD 0.01UF 100V	12344	C220C103M1R5CA
A1C21	0160-4497	7		1	CAP-FXD 82PF 200V	12344	C320C82J2G5CA
A1C22	0180-3831	3		2	CAP-FXD 100PF 100 V	12344	T398G106K035AS
A1C23	0160-4801	7		2	CAP-FXD 100PF 100 V	12344	T398G106K035AS
A1C24	0160-4801	7		2	CAP-FXD 100PF 100 V	12344	T398G106K035AS
A1C25	0160-0576	5		14	CAP-FXD 0.1UF 50V	12344	C220C1045MR5CA
A1C26	0180-3771	0		0	CAP-FXD 1UF 35V TA	12344	T398A105K035AS
A1C27	0180-3831	3		3	CAP-FXD 10UF 35V TA	12344	T398G106K035AS
A1C28	0160-0576	5		3	CAP-FXD 0.1UF 50V	12344	T398G106K035AS
A1C29	0180-3831	3		3	CAP-FXD 10UF 35V TA	12344	T398G106K035AS
A1C30	0180-3831	3		3	CAP-FXD 10UF 35V TA	12344	T398G106K035AS
A1C31	0160-0576	5		5	CAP-FXD 0.1UF 50V	12344	T398A105K035AS
A1C32	0180-3831	3		3	CAP-FXD 10UF 35V TA	12344	T398G106K035AS
A1C33	0180-3831	3		3	CAP-FXD 10UF 35V TA	12344	T398G106K035AS
A1C34	0180-3196	3		3	CAP-FXD 120UF 40V AL-ELCTLT	12344	T398G106K035AS
A1C35	0180-3831	3		3	CAP-FXD 10UF 35V TA	12344	T398G106K035AS
A1C36	0180-3771	0		0	CAP-FXD 1UF 35V TA	12344	T398A105K035AS
A1C37	0180-3771	0		0	CAP-FXD 1UF 35V TA	12344	T398A105K035AS
A1C38	0160-0576	5		5	CAP-FXD 0.1UF 50V	12344	T398A105K035AS
A1C39	0160-0576	5		5	CAP-FXD 0.1UF 50V	12344	T398A105K035AS
A1C40	0160-0576	5		5	CAP-FXD 0.1UF 50V	12344	T398A105K035AS
A1C41	0180-3771	0		0	CAP-FXD 1UF 35V TA	12344	T398A105K035AS
A1C42	0160-3879	7		7	CAP-FXD 0.01UF 100V	12344	T398A105K035AS
A1C43	0160-3879	7		7	CAP-FXD 0.01UF 100V	12344	T398A105K035AS
A1C44	0180-3771	0		0	CAP-FXD 1UF 35V TA	12344	T398A105K035AS
A1C45	0180-3831	3		3	CAP-FXD 10UF 35V TA	12344	T398G106K035AS
A1C46	0160-0576	5		5	CAP-FXD 0.1UF 50V	12344	T398G106K035AS
A1C47	0180-4145	4		4	CAP-FXD 1800UF 100V AL ELCTLT	12344	C220C1045MR5CA
A1C48	0180-3196	3		3	CAP-FXD 120UF 40V AL-ELCTLT	56289	80D182P100KD28
A1C49	0180-3831	3		3	CAP-FXD 10UF 35V TA	12344	T398G106K035AS
A1C50	0160-3879	7		7	CAP-FXD 0.01UF 100V	12344	T398G106K035AS
A1C51	0160-4040	6		6	CAP-FXD 1000PF 100 V	12344	C220C102J1G5CA
A1C52	0160-0576	5		5	CAP-FXD 0.1UF 50V	12344	C220C102J1G5CA
A1C53	0160-4040	6		6	CAP-FXD 1000PF 100 V	12344	C220C102J1G5CA
A1C54	0160-0576	5		5	CAP-FXD 0.1UF 50V	12344	C220C102J1G5CA
A1C55	0180-3771	0		0	CAP-FXD 1UF 35V TA	12344	C220C1045MR5CA
A1C56	0180-3771	0		0	CAP-FXD 1UF 35V TA	12344	T398A105K035AS
A1C57	0160-3879	7		7	CAP-FXD 0.01UF 100V	12344	C220C103M1R5CA
A1C58	0180-3196	3		4	CAP-FXD 120UF 40V AL-ELCTLT	56289	80D182P100KD28

Table 6-2 Replaceable Parts

Table 6-2 Replaceable Parts (Continued)

Reference	HP Part Number	C	D	Qty	Description	Mfr Code	Mfr Part Number
A1C59	0180-3196	3		4	CAP-FXD 120UF 40V AL-ELCTL	56289	67D1Z7F040DMAG
A1C60	0180-3771	0		0	CAP-FXD 1UF 35V TA	12344	T398A105K035AS
A1C61	0180-3831	3		3	CAP-FXD 10UF 35V TA	12344	T398G106K035AS
A1C62	0160-0576	5		3	CAP-FXD 0.1UF 50V	12344	C320C1045MR5CA
A1C63	0160-0576	5		5	CAP-FXD 0.1UF 50V	12344	C320C1045MR5CA
A1C64	0180-3276	0		0	CAP-FXD 2200UF 25 V AL-ELCTL	56289	674D22BH025HL5A
A1C65	0180-3276	0		0	CAP-FXD 2200UF 25 V AL-ELCTL	56289	674D22BH025HL5A
A1C66	0160-0576	5		5	CAP-FXD 0.1UF 50V	12344	C320C1045MR5CA
A1C67	0160-0576	5		5	CAP-FXD 0.1UF 50V	12344	C320C1045MR5CA
A1C68	0160-0576	5		5	CAP-FXD 0.1UF 50V	12344	C320C1045MR5CA
A1C69	0180-3771	0		0	CAP-FXD 1UF 35V TA	12344	T398A105K035AS
A1C70	0180-3771	0		0	CAP-FXD 1UF 35V TA	12344	T398A105K035AS
A1C71	0180-3831	3		3	CAP-FXD 10UF 35V TA	12344	T398G106K035AS
A1C72	0180-3771	0		0	CAP-FXD 1UF 35V TA	12344	T398A105K035AS
A1C73	0180-3771	0		0	CAP-FXD 1UF 35V TA	12344	T398A105K035AS
A1C74	0160-0576	5		5	CAP-FXD 0.1UF 50V	12344	C320C1045MR5CA
A1C75	0180-3771	0		0	CAP-FXD 1UF 35V TA	12344	T398A105K035AS
A1C76	0180-3771	0		0	CAP-FXD 1UF 35V TA	12344	T398A105K035AS
A1C77	0160-0576	5		5	CAP-FXD 0.1UF 50V	12344	C320C1045MR5CA
A1C78	0180-3831	3		3	CAP-FXD 10UF 35V TA	12344	T398G106K035AS
A1C79	0160-3879	7		7	CAP-FXD 0.01UF 100V	12344	C320C103M1R5CA
A1C80	0160-0576	5		5	CAP-FXD 0.1UF 50V	12344	C320C1045MR5CA
A1C81	0160-4040	6		6	CAP-FXD 1000PF 100 V	12344	C320C102J1G5CA
A1C100	0160-3879	7		7	CAP-FXD 0.01UF 100V	12344	C320C103M1R5CA
A1C101	0160-4547	8		1	CAP-FXD 150PF 200V	04222	SR202A151JAAHA
A1CR1	1884-0293	8		1	THYRISTOR-SCR	04713	MCR69-2
A1CR2	1901-0050	3		11	DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A1CR3	1901-0050	3		3	DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A1CR4	1901-0033	2		1	DIODE-GEN PWP 180V 200MA DO-35	9N171	1N645
A1CR5	1901-0050	3		3	DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A1CR6	1901-0638	3		1	DIODE-FW BRIDGE 100V 4A	71744	KBU4B
A1CR7	1901-0050	3		1	DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A1CR8	1901-0986	4		1	DIODE-PWR RECT 60V 10A TO-220AC	04713	MB41060
A1CR9	1901-0050	3		3	DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A1CR10	1901-0050	3		3	DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A1CR11	1901-0050	3		3	DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A1CR12	1901-0970	6		7	DIODE-SWITCHING 150V 1A 35NS DO-41	04713	MUR115
A1CR13	1901-0970	6		7	DIODE-SWITCHING 150V 1A 35NS DO-41	04713	MUR115
A1CR14	1901-0261	8		2	DIODE-CT-RECT 150V 16A	28480	1906-0261
A1CR15	1901-0261	8		2	DIODE-CT-RECT 150V 16A	28480	1906-0261
A1CR16	1901-0970	6		6	DIODE-SWITCHING 150V 1A 35NS DO-41	04713	MUR115
A1CR17	1901-0970	6		6	DIODE-SWITCHING 150V 1A 35NS DO-41	04713	MUR115
A1CR18	1901-0970	6		6	DIODE-SWITCHING 150V 1A 35NS DO-41	04713	MUR115
A1CR19	1901-0970	6		6	DIODE-SWITCHING 150V 1A 35NS DO-41	04713	MUR115
A1CR20	1901-0970	6		6	DIODE-SWITCHING 150V 1A 35NS DO-41	04713	MUR115
A1CR21	1901-0535	9		2	DIODE-SCHOTTKY SM SIG	12403	A2X356
A1CR22	1901-0535	9		2	DIODE-SCHOTTKY SM SIG	12403	A2X356
A1CR23	1901-0970	6		1	DIODE-SWITCHING 150V 1A 35NS DO-41	04713	MUR115
A1CR24	1901-0734	0		1	DIODE-PWR RECT 1N5818	04713	1N5818
A1CR100	1901-0050	3		3	DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A1CR101	1901-0050	3		3	DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A1CR200	1902-0970	8		1	DIODE-ZNR 33V 5% DO-ET PD=.4W TC=0.097%	50088	1N5278
A1CR201	1902-0963	2		2	DIODE-ZNR 16V 5% DO-35 PD=.4W TC=0.088%	50088	1N5248B
A1CR202	1901-1081	2		1	DIODE-PWR RECT 100V 3A	04713	MRF501
A1CR203	1902-0963	9		9	DIODE-SCHOTTKY SM SIG	50088	1N5248B
A1CR204	1901-0535	9		9	DIODE-SCHOTTKY SM SIG	12403	A2X356

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

Table 6-2 Replaceable Parts (Continued)

Reference	HP Part Number	C	D	Qty	Description	Mfr Code	Mfr Part Number
A1D51	1990-0485	5		1	LED-LAMP LUM-INT=2MCD IF=30MA-MAX BCR=5V	28480	1990-0485
A1F1	2110-0002	9		1	FUSE (INCH) 2A 250V NTD FE UL	75915	312 002
A1F2	2110-0713	9		1	FUSE-SUBMINIATURE 10A 125V NTD AX	75915	R251010T1
A1J1	1250-0257	1		3	CONNECTOR-RF SMB M PC 50-OHM	16179	5162-5021-09
A1J2	1252-0032	4		4	CONN-UTL P-&-SKT 2-CKT 2-CONT	27264	15-31-1026
A1J3	1252-0032	4		4	CONN-UTL P-&-SKT 2-CKT 2-CONT	27264	15-31-1026
A1J4	1250-0257	1		1	CONNECTOR-RF SMB M PC 50-OHM	16179	5162-5021-09
A1J5	1252-0032	4		4	CONN-UTL P-&-SKT 2-CKT 2-CONT	27264	15-31-1026
A1J6	1252-0008	0		0	CONNECTOR 8-PIN F FLAT FLEX CABLE	16873	68100-008
A1J7	1251-7684	4		4	CONN-POST TYPE 100-PIN-SPCG 14-CONT	28480	1251-7684
A1J8	1250-0257	1		1	CONNECTOR-RF SMB M PC 50-OHM	16179	5162-5021-09
A1J9	1251-4541	6		1	CONN-POST-TYPE .100-PIN-SPCG 14-CONT	28480	1251-4541
A1J10	1252-0293	9		1	CONN-POST-TYPE .100-PIN-SPCG 4-CONT	28480	1252-0293
A1J11	1252-0032	4		4	CONN-UTL P-&-SKT 2-CKT 2-CONT	27264	15-31-1026
A1J12	1252-0032	4		4	CONN-UTL P-&-SKT 2-CKT 2-CONT	27264	15-31-1026
A1J13	1251-8535	6		1	CONN-POST-TYPE .100-PIN-SPCG 10-CONT	27264	15-31-1026
A1K1	0490-1701	9		1	RELAY 1AB 12VDC-COIL 8A 380VAC	28480	0251-8535
A1K2	0490-1689	2		1	RELAY 1AB 5VDC-COIL 8A 380VAC	01852	STTE-L2-DC5V
A1L1	9100-0348	2		2	INDUCTOR RF-CH-MLD 1UH ±1%	91637	IM-4 1UH 1%
A1L2	9140-0928	8		1	INDUCTOR 100UH ±10% 172D-IN X.43LG-IN	91637	IMS-5 100UH ±10%
A1L3	9100-0348	2		2	INDUCTOR RF-CH-MLD 1UH ±1%	91637	IM-4 1UH 1%
A1L4	9100-0566	6		2	INDUCTOR RF-CH-MLD 4.7UH ±5%	91637	IM-2 4.7UH 5%
A1L5	9140-0531	9		1	INDUCTOR RF-CH-MLD 1UH ±5%	91637	IM-2 1UH 5%
A1L6	9100-3060	1		1	INDUCTOR 250UH ±15%	12406	H0260
A1L7	9100-0566	6		1	INDUCTOR RF-CH-MLD 4.7UH ±5%	91637	IM-2 4.7UH 5%
A1L8	9100-0541	7		1	INDUCTOR RF-CH-MLD 250UH ±10%	91637	IM-2 4.7UH 5%
A1L9	9100-4808	7		1	INDUCTOR 885UH -5% -5% 33W-MM X 23.3LG-MM	28480	9100-4808
A1L10	9140-0537	5		1	INDUCTOR RF-CH-MLD 2.2UH ±5%	91637	IM-2 2.2UH 5%
A1L11	9140-0566	0		2	INDUCTOR RF-CH-MLD 47UH ±5%	91637	IM-2 47UH 5%
A1L12	9140-0566	0		2	INDUCTOR RF-CH-MLD 47UH ±5%	91637	IM-2 47UH 5%
A1L51	0960-0553	4		1	AUDIO TRANSDUCER 3-12VDC; 75-95 DB SOUND	08261	QMB-06
A1Q1	1854-0215	1		9	TRANSISTOR NPN SI TO-92 PD=350MW	04713	2N3904
A1Q2	1854-0092	2		2	TRANSISTOR NPN SI PD=200MW FT=600MHZ	27014	FN3563-5
A1Q3	1854-0092	2		2	TRANSISTOR NPN SI PD=200MW FT=600MHZ	27014	FN3563-5
A1Q4	1853-0281	9		1	TRANSISTOR PNP SI TO-18 PD=400MW	27014	PN3563-5
A1Q5	1853-0036	2		6	TRANSISTOR PNP SI TO-92 PD=625MW	04713	2N2907A
A1Q6	1854-0215	1		1	TRANSISTOR NPN SI TO-92 PD=350MW	04713	2N3904
A1Q7	1854-0215	1		1	TRANSISTOR NPN SI TO-92 PD=350MW	04713	2N3904
A1Q8	1853-0036	2		9	TRANSISTOR PNP SI TO-92 PD=625MW	04713	2N3904
A1Q9	1853-0526	9		1	TRANSISTOR MOSFET P-CHAN E-MODE SI	04713	2N3906(SEL)
A1Q10	1853-0525	8		1	TRANSISTOR MOSFET N-CHAN E-MODE SI	17856	VN0300M
A1Q11	1853-0347	8		1	TRANSISTOR PNP SI DARL PD=40W FT=1MHZ	04713	MJ2700
A1Q12	1853-0618	0		1	TRANSISTOR MOSFET N-CHAN E-MODE TO-3 SI	04713	IRF140
A1Q13	1853-0036	2		2	TRANSISTOR PNP SI TO-92 PD=625MW	04713	2N3906(SEL)
A1Q14	1853-0036	2		2	TRANSISTOR PNP SI TO-92 PD=625MW	04713	2N3906(SEL)
A1Q15	1854-0215	1		1	TRANSISTOR NPN SI TO-92 PD=350MW	04713	2N3904
A1Q16	1854-0215	1		1	TRANSISTOR NPN SI TO-92 PD=350MW	04713	2N3904
A1Q17	1854-0215	1		1	TRANSISTOR NPN SI TO-92 PD=350MW	04713	2N3904
A1Q18	1853-0036	2		1	TRANSISTOR PNP SI TO-92 PD=625MW	04713	2N3904
A1Q19	1853-0036	2		1	TRANSISTOR PNP SI TO-92 PD=625MW	04713	2N3904
A1Q20	1854-0215	1		1	TRANSISTOR NPN SI TO-92 PD=350MW	04713	2N3904
A1Q200	1853-0036	2		2	TRANSISTOR PNP SI TO-92 PD=625MW	04713	2N3906(SEL)
A1Q201	1853-0670	4		4	TRANSISTOR MOSFET N-CHAN E-MODE TO-220	04713	IRF540
A1Q202	1853-0670	4		4	TRANSISTOR MOSFET N-CHAN E-MODE TO-220	04713	IRF540
A1Q203	1854-0215	1		1	TRANSISTOR NPN SI TO-92 PD=350MW	04713	2N3904

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

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

Reference Designation	HP Part Number	C	D	Qty	Description	Mfr Code	Mfr Part Number
A1R1	0757-0442	9	16	1	RESISTOR 10K ±0.1%, 125W TF TC=0±100	12498	CT4-1/8-T0-1002-F
A1R2	0698-6360	6	1	1	RESISTOR 10K ±0.1%, 125W TF TC=0±25	12498	CT4-1/8-T0-1002-F
A1R3	0811-1077	4	2	2	RESISTOR .033 ±5% 2W P1 TC=0±90	91637	LVR-2
A1R4	0757-0199	3	12	3	RESISTOR 21.5K ±1%, 125W TF TC=0±100	12498	CT4 1/8-T0-2152-F
A1R5	0698-3158	4	3	3	RESISTOR 23.7K ±1%, 125W TF TC=0±100	12498	CT4-1/8-T0-2372-F
A1R6	0757-0280	3	1	1	RESISTOR 1K ±1%, 125W TF TC=0±100	12498	CT4-1/8-T0-1001-F
A1R7	0698-3158	4	7	1	RESISTOR 23.7K ±1%, 125W TF TC=0±100	12498	CT4-1/8-T0-2372-F
A1R8	0811-3349	7	1	1	RESISTOR 1K ±0.025%, 0.5W P1 TC=0±10	01686	P342
A1R9	0698-3159	5	3	3	RESISTOR 261K ±1%, 125W TF TC=0±100	12498	CT4-1/8-T0-2612-F
A1R10	0698-8826	3	1	1	RESISTOR 825K ±1%, 125W TF TCX0±100	12498	CT4
A1R11	0757-0465	6	5	5	RESISTOR 100K ±1%, 125W TF TC=0±100	12498	CT4-1/8-T0-1003-F
A1R12	0757-0405	4	4	2	RESISTOR 162 ±1%, 125W TF TC=0±100	12498	CT4-1/8-T0-162R-F
A1R13	0698-3158	4	4	4	RESISTOR 23.7K ±1%, 125W TF TC=0±100	12498	CT4-1/8-T0-2372-F
A1R14	0757-0199	3	3	3	RESISTOR 21.5K ±1%, 125W TF TC=0±100	12498	CT4-1/8-T0-2152-F
A1R15	0757-0401	0	2	2	RESISTOR 100 ±1%, 125W TF TC=0±100	12498	CT4-1/8-T0-101-F
A1R16	0698-0084	9	9	9	RESISTOR 2.15K ±1%, 125W TF TC=0±100	26480	0698-0084
A1R17	0757-0442	3	5	5	RESISTOR 5.11K ±1%, 125W TF TC=0±100	12498	CT4 1/8-T0-5111-F
A1R18	0757-0438	3	3	3	RESISTOR 5.11K ±1%, 125W TF TC=0±100	12498	CT4 1/8-T0-5111-F
A1R19	0757-1094	9	1	1	RESISTOR 1.47K ±1%, 125W TF TC=0±100	12498	CT4-1/8-T0-1471-F
A1R20	0757-0278	9	1	1	RESISTOR 1.76K ±1%, 125W TF TC=0±100	12498	CT4-1/8-T0-1781-F
A1R21	0757-0288	1	2	2	RESISTOR 9.09K ±1%, 125W TF TC=0±100	19701	5033R-1/8-T0-9091-F
A1R22	0757-0405	2	4	2	RESISTOR 162 ±1%, 125W TF TC=0±100	12498	CT4-1/8-T0-162R-F
A1R23	0698-3429	2	2	2	RESISTOR 19.6 ±1%, 125W TF TC=0±100	2M627	CRB14 OR CRB25
A1R24	0757-0416	7	5	5	RESISTOR 511 ±1%, 125W TF TC=0±100	12498	CT4-1/8-T0-511R-F
A1R25	1810-0398	9	2	2	NETWORK-RES 10-SIP 22.0K OHM X 9	C1433	750-101
A1R26	0757-0839	8	1	1	RESISTOR 10K ±1% SW TF TC=0±100	K8479	H2
A1R27	0757-0464	5	2	2	RESISTOR 90.9K ±1%, 125W TF TC=0±100	12498	CT4-1/8-T0-9092-F
A1R28	0698-0084	9	6	1	RESISTOR 2.15K ±1%, 125W TF TC=0±100	26480	0698-3150
A1R29	0698-3150	6	6	6	RESISTOR 2.37K ±1%, 125W TF TC=0±100	26480	CT4-1/8-T0-2151-F
A1R30	0757-0199	3	3	3	RESISTOR 21.5K ±1%, 125W TF TC=0±100	12498	CT4-1/8-T0-2152-F
A1R31	0698-3446	3	1	1	RESISTOR 383 ±1%, 125W TF TC=0±100	28480	0698-3446
A1R32	0757-0442	9	9	9	RESISTOR 10K ±1%, 125W TF TC=0±100	12498	CT4-1/8-T0-1002-F
A1R33	1810-0347	8	8	2	NETWORK-RES 8-SIP 2.2K OHM X 4	32997	4308R-102-222
A1R34	1810-0347	8	8	8	NETWORK-RES 8-SIP 2.2K OHM X 4	32997	4308R-102-222
A1R35	0757-0199	3	3	3	RESISTOR 21.5K ±1%, 125W TF TC=0±100	12498	CT4-1/8-T0-2152-F
A1R36	0757-0199	3	3	3	RESISTOR 21.5K ±1%, 125W TF TC=0±100	12498	CT4-1/8-T0-2152-F
A1R37	0757-0442	9	9	9	RESISTOR 10K ±1%, 125W TF TC=0±100	12498	CT4-1/8-T0-1002-F
A1R38	0757-0416	7	7	7	RESISTOR 5.11K ±1%, 125W TF TC=0±100	12498	CT4-1/8-T0-511R-F
A1R39	0757-0438	3	3	3	RESISTOR 5.11K ±1%, 125W TF TC=0±100	12498	CT4-1/8-T0-511R-F
A1R40	0698-3429	2	2	2	RESISTOR 19.6 ±1%, 125W TF TC=0±100	2M627	CR014 OR CR825
A1R41	0757-0442	9	9	9	RESISTOR 10K ±1%, 125W TF TC=0±100	12498	CT4-1/8-T0-1002-F
A1R42	0757-0442	9	9	9	RESISTOR 10K ±1%, 125W TF TC=0±100	12498	CT4-1/8-T0-1002-F
A1R43	0757-0288	1	9	1	RESISTOR 9.09K ±1%, 125W TF TC=0±100	19701	5033R-1/8-T0-9091-F
A1R44	0757-0442	9	9	9	RESISTOR 10K ±1%, 125W TF TC=0±100	12498	CT4-1/8-T0-1002-F
A1R45	0757-0438	3	3	3	RESISTOR 5.11K ±1%, 125W TF TC=0±100	12498	CT4-1/8-T0-5111-F
A1R46	0757-0394	0	1	1	RESISTOR 51.1 ±1%, 125W TF TC=0±100	12498	CT4-1/8-T0-511R-F
A1R47	0698-8822	9	9	1	RESISTOR 6.81 ±1%, 125W TF TC=0±100	12498	CT4-1/8-T0-511R-F
A1R48	0757-0442	7	7	3	NETWORK-RES 10-SIP 22.0K OHM X 5	32997	431OR-102-223
A1R49	1810-0429	9	9	3	NETWORK-RES 10-SIP 22.0K OHM X 5	32997	431OR-102-223
A1R50	1810-0429	7	7	7	NETWORK-RES 10-SIP 22.0K OHM X 5	32997	431OR-102-223
A1R51	1810-0429	7	7	7	NETWORK-RES 10-SIP 22.0K OHM X 5	32997	431OR-102-223
A1R52	0698-0084	9	9	1	RESISTOR 2.15K ±1%, 125W TF TC=0±100	12498	CT4-1/8-T0-2151-F
A1R53	0757-0424	4	7	2	RESISTOR 1M ±1%, 125W TF TC=0±100	12498	CT4-1/8-T0-1101-F
A1R54	0698-8827	4	2	2	RESISTOR 1M ±1%, 125W TF TC=0±100	12498	CT4
A1R55	0757-0467	8	8	2	RESISTOR 121K ±1%, 125W TF TC=0±100	12498	CT4-1/8-T0-1213-F
A1R56	0757-0438	3	3	3	RESISTOR 5.11K ±1%, 125W TF TC=0±100	12498	CT4-1/8-T0-5111-F
A1R57	0757-0199	3	3	3	RESISTOR 21.5K ±1%, 125W TF TC=0±100	12498	CT4-1/8-T0-2152-F
A1R58	0757-0467	5	8	5	RESISTOR 121K ±1%, 125W TF TC=0±100	12498	CT4 1/8-T0-1213-F
A1R59	0698-3266	8	5	1	RESISTOR 237K ±1%, 125W TF TC=0±100	12498	CT4-1/8-T0-2373-F
A1R60	0698-0084	9	9	9	RESISTOR 2.15K ±1%, 125W TF TC=0±100	12498	CT4-1/8-T0-2151-F

Table 6-2 Replaceable Parts (Continued)

Table 6-2 Replaceable Parts (Continued)

Reference	Designation	HP Part Number	C	D	Qty	Description	Mfr Code	Mfr Part Number
A1R51	A1R51	0811-1077	4		1	RESISTOR .033 ±5% 2W P1 TC=±0.90	91637	LVR 2
A1R52	A1R52	0757-0417	8		1	RESISTOR 582 ±1% .125W TF TC=±0.100	12498	CT4 1/8-TO-062R-F
A1R53	A1R53	0811-3830	9		1	NETWORK RES 10-SIP 22.0K OHM X 9	C1433	750-101
A1R54	A1R54	0811-3830	1		1	RESISTOR 2S ±10% 5W PWT TC=±0.90	91637	CW 5
A1R55	A1R55	0757-0442	9		1	RESISTOR 10K ±1% .125W TF TC=±0.100	12498	CT4 1/8-TO-1002-F
A1R56	A1R56	0698-3153	9		1	RESISTOR 3.83K ±1% .125W TF TC=±0.100	12498	CT4 1/8-TO-3831-F
A1R57	A1R57	0757-0274	5		1	RESISTOR 1.21K ±1% .125W TF TC=±0.100	12498	CT4 1/8-TO-1211-F
A1R58	A1R58	0757-0428	1		1	RESISTOR 1.62K ±1% .125W TF TC=±0.100	12498	CT4 1/8-TO-1621-F
A1R59	A1R59	0698-8827	4		3	RESISTOR 1M ±1% .125W TF TC=±0.100	12498	CT4 1/8-TO-1621-F
A1R70	A1R70	0757-0199	3		3	RESISTOR 21.5K ±1% .125W TF TC=±0.100	12498	CT4 1/8-TO-2152-F
A1R71	A1R71	0757-0199	3		3	RESISTOR 21.5K ±1% .125W TF TC=±0.100	12498	CT4 1/8-TO-2152-F
A1R72	A1R72	0757-0442	9		1	RESISTOR 10K ±1% .125W TF TC=±0.100	12498	CT4 1/8-TO-1002-F
A1R73	A1R73	0811-1672	3		1	RESISTOR 3.3 5% 2W PWT TC=±0.400	11502	SPH
A1R74	A1R74	0757-0199	5		1	RESISTOR 21.5K ±1% .125W TF TC=±0.100	12498	CT4 1/8-TO-2152-F
A1R75	A1R75	0757-0444	1		1	RESISTOR 12.1K ±1% .125W TF TC=±0.100	12498	CT4 1/8-TO-1212-F
A1R76	A1R76	0757-0464	5		1	RESISTOR 90.9K ±1% .125W TF TC=±0.100	12498	CT4 1/8-TO-9092-F
A1R77	A1R77	0757-0416	7		1	RESISTOR 511 ±1% .125W TF TC=±0.100	12498	CT4 1/8-TO-511R-F
A1R78	A1R78	0757-0438	3		1	RESISTOR 5.11K ±1% .125W TF TC=±0.100	11498	CT4 1/8-TO-SLUR-F
A1R79	A1R79	0757-0442	3		1	RESISTOR 10K ±1% .125W TF TC=±0.100	12498	CT4 1/8-TO-1002-F
A1R80	A1R80	0698-3159	5		1	RESISTOR 26.1K ±1% .125W TF TC=±0.100	12498	CT4 1/8-TO-2612-F
A1R81	A1R81	0757-0442	9		1	RESISTOR 10K ±1% .125W TF TC=±0.100	12498	CT4 1/8-TO-1002-F
A1R82	A1R82	0698-0084	9		1	RESISTOR 2.15K ±1% .125W TF TC=±0.100	12498	CT4 1/8-TO-2151-F
A1R83	A1R83	0698-3159	5		1	RESISTOR 26.1K ±1% .125W TF TC=±0.100	12498	CT4 1/8-TO-2612-F
A1R84	A1R84	0698-0084	9		1	RESISTOR 2.15K ±1% .125W TF TC=±0.100	12498	CT4 1/8-TO-2151-F
A1R85	A1R85	0757-0416	7		1	RESISTOR 511 ±1% .125W TF TC=±0.100	12498	CT4 1/8-TO-511R-F
A1R86	A1R86	0698-3157	3		1	RESISTOR 19.6K ±1% .125W TF TC=±0.100	12498	CT4 1/8-TO-1962-F
A1R87	A1R87	0757-0442	9		1	RESISTOR 10K ±1% .125W TF TC=±0.100	12498	CT4 1/8-TO-1002-F
A1R88	A1R88	0698-0084	9		1	RESISTOR 2.15K ±1% .125W TF TC=±0.100	12498	CT4 1/8-TO-2151-F
A1R89	A1R89	0757-0465	6		1	RESISTOR 100K ±1% .125W TF TC=±0.100	12498	CT4 1/8-TO-1003-F
A1R90	A1R90	0698-3152	8		1	RESISTOR 3.48K ±1% .125W TF TC=±0.100	12498	CT4 1/8-TO-3481-F
A1R91	A1R91	0698-3444	1		2	RESISTOR 316 ±1% .125W TF TC=±0.100	12498	CT4 1/8-TO-316R-F
A1R92	A1R92	0757-0199	3		2	RESISTOR 21.5K ±1% .125W TF TC=±0.100	12498	CT4 1/8-TO-2152-F
A1R93	A1R93	1810-0206	8		2	NETWORK RES B-SIP 10.0K OHM X 7	C1433	750-81
A1R94	A1R94	0698-3444	1		1	RESISTOR 316 ±1% .125W TF TC=±0.100	12498	CT4 1/8-TO-316R-F
A1R95	A1R95	0757-0416	7		1	RESISTOR 511 ±1% .125W TF TC=±0.100	12498	CT4 1/8-TO-511R-F
A1R96	A1R96	0757-0279	0		2	RESISTOR 3.16K ±1% .125W TF TC=±0.100	12498	CT4 1/8-TO-3161-F
A1R97	A1R97	0757-0442	9		1	RESISTOR 10K ±1% .125W TF TC=±0.100	12498	CT4 1/8-TO-1002-F
A1R98	A1R98	0757-0317	7		1	RESISTOR 1.33K ±1% .125W TF TC=±0.100	12498	CT4 1/8-TO-1331-F
A1R99	A1R99	1810-0207	9		1	NETWORK RES B-SIP 22.0K OHM X 7	C1433	750-81
A1R100	A1R100	1810-0206	8		1	NETWORK RES B-SIP 10.0K OHM X 7	C1433	750-81
A1R101	A1R101	0757-0442	9		1	RESISTOR 10K ±1% .125W TF TC=±0.100	12498	CT4 1/8-TO-1002-F
A1R102	A1R102	0757-0279	0		1	RESISTOR 3.16K ±1% .125W TF TC=±0.100	12498	CT4 1/8-TO-3161-F
A1R103	A1R103	0698-4037	0		1	RESISTOR 46.4 ±1% .125W TF TC=±0.100	08439	MK2
A1R104	A1R104	0757-0439	4		1	RESISTOR 6.81K ±1% .125W TF TC=±0.100	12498	CT4 1/8-TO-6811-F
A1R105	A1R105	0698-3160	8		1	RESISTOR 31.6K ±1% .125W TF TC=±0.100	12498	CT4 1/8-TO-3162-F
A1R106	A1R106	0757-0401	0		1	RESISTOR 100 ±1% .125W TF TC=±0.100	12498	CT4 1/8-TO-101-F
A1R200	A1R200	0757-0465	6		1	RESISTOR 100K ±1% .125W TF TC=±0.100	12498	CT4 1/8-TO-1003-F
A1R201	A1R201	0757-0199	3		1	RESISTOR 100K ±1% .125W TF TC=±0.100	12498	CT4 1/8-TO-1003-F
A1R202	A1R202	0757-0199	3		1	RESISTOR 21.5K ±1% .125W TF TC=±0.100	12498	CT4 1/8-TO-2152-F
A1R203	A1R203	0757-0465	6		1	RESISTOR 100K ±1% .125W TF TC=±0.100	12498	CT4 1/8-TO-1003-F
A1R204	A1R204	0812-0019	4		1	RESISTOR .33 ±5% 3W PWT TC=±0.90	01686	T20-79
A1R205	A1R205	0757-0199	6		1	RESISTOR 100K ±1% .125W TF TC=±0.100	12498	CT4 1/8-TO-1003-F
A1S1	A1S1	3101-2215	2		1	SWITCH-DIP BKR 7-1A 0.05A 30VDC	00779	1-435802-B
A1T1	A1T1	9100-2616	1		1	TRANSFORMER-PULSE BIPOLAR WOUND; 18.0 MM	12406	E46
A1T2	A1T2	9100-4805	4		1	TRANSFORMER-SWITCHING; PRI IND; 135 MH	28480	9100-4805

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

Table 6-2 Replaceable Parts (Continued)

Reference Designation	HP Part Number	C	D	Qty	Description	Mfr Code	Mfr Part Number
A1T1-TP18	0360-0124	3		18	CONNECTOR-SGL CONT PIN .04-IN-BSC-SZ RND	28480	0360-0124
A1U1	1826-1485	0		1	IC V RGLTR-0V-V-SEN 40V 8-DIP-P PKG	04713	MC342SP1
A1U2	1826-1968	4		1	IC V RGLTR-ADJ-POS 4.975/5.025V 8-DIP-P	27014	LM2951ACN
A1U3	1826-0138	8		1	IC COMPARATOR GP QUAD 14-DIP-P PKG	27014	LM339N
A1U4	1820-1423	4		1	IC MV TTL LS MONOSTBL RETRIG DUAL	01295	SN74LS123N
A1U5	1820-1425	6		1	IC SCHMITT-TRIG TTL LS NAND QUAD 2-INP	01295	SN74LS132N
A1U6	1826-0276	5		1	IC V RGLTR-FXD-POS 4.8/5.2V TO-92 PKG	04713	MC78L05ACP
A1U7	1820-1074	1		1	IC DRVR TTL NOR QUAD 2-INP	01295	SN74128N
A1U8	1826-0551	9		1	IC V RGLTR-FXD-POS 4.9/5.1V TO-220 PKG	27014	LM340AT-5
A1U9	1826-0275	4		1	IC V RGLTR-FXD-POS 11.5/12.5V TO-92 PKG	04713	MC78LL2ACP
A1U10	1820-2922	0		1	IC GATE CMOS/74HC NAND QUAD 2-INP	04713	MC74HC00N
A1U11	1820-3373	7		2	IC MV CMOS/74HC MONOSTBL CLEAR DUAL	27014	MM74HC221AN
A1U12	1820-0412	1		1	IC COMPARATOR PRGN DUAL 8-DIP-P PKG	27014	LM339N
A1U13	1826-1338	2		2	IC MISC 8-DIP-P PKG	01295	TL7705A
A1U14	1826-1338	2		2	IC MISC 8-DIP-P PKG	01295	TL7705A
A1U15	1820-3373	7		7	IC MV CMOS/74HC MONOSTBL CLEAR DUAL	27014	MM74HC221AN
A1U16	1826-1066	3		1	IC V RGLTR V-REF FXD 2.5V 8-DIP-C PKG	34333	S83503V
A1U17	1826-0457	5		1	IC V RGLTR-DUAL TRKG 14.5/15.5V TO-100	27014	LM325H
A1U18	1826-0631	7		1	IC V RGLTR-ADJ-POS 1.2/33V TO-3 PKG	27014	LM350K
A1U19	1826-0393	7		2	IC V RGLTR-ADJ POS 1.2/37V TO-220 PKG	27014	LM317T
A1U20	1826-1338	2		2	IC MISC 8-DIP P PKG	01295	TL7705A
A1U21	1826-0393	7		7	IC V RGLTR-ADJ OS 1.2/37V TO-220 PKG	27014	LM317T
A1U22	1820-3638	7		1	IC BFR TTL ALS INV OCTL	01295	SN74ALS466AN
A1U23	1820-2309	3		1	IC ENCODR CMOS	27014	MM74C923N
A1U24	1820-2488	7		1	IC FF TTL ALS D-TYPE POS-EDGE-TRIG	01295	SN74ALS74AN
A1U25	1820-3562	6		1	IC BFR TTL ALS INV HEX	01295	SN74ALS1005N
A1U26	1820-1437	0		1	IC MV TTL LS MONOSTABL DUAL	01295	SN74LS221N
A1U27	1826-0180	0		1	IC TIMER TTL MONO/ASSTBL	18324	N555N
A1W1	8159-0005	0		2	RESISTOR-ZERO OHM 22-AWG LEAD DIA	11502	YZ0 1/4
A1W2	1251-6073	3		1	CONNECTOR POST-TYPE .100-PIN SPCG 2-C-CONT	28480	1251-6073
A1W3	8159-0005	0		0	RESISTOR-ZERO OHM 22-AWG LEAD DIA	11502	YZ0 1/4
A1X1	1251-8773	4		1	CONNECTOR-POST-TYPE .100-PIN SPCG 20-CONT	28480	1251-8773
A1X2	1251-7300	1		1	CONNECTOR POST-TYPE .100-PIN SPCG 50-CONT	28480	1251-7300
A1X3	1251-7300	1		1	CONNECTOR POST-TYPE .100-PIN SPCG 50-CONT	28480	1251-7300
A1X4A	1251-8911	2		2	CONNECTOR POST-TYPE .100-PIN SPCG 60-CONT	28480	1251-8911
A1X4B	1251-8911	2		2	CONNECTOR POST-TYPE .100-PIN SPCG 60-CONT	28480	1251-8911
A1X5	1251-7300	1		1	CONNECTOR-POST-TYPE .100-PIN SPCG 50-CONT	28480	1251-7300
A1X6	1251-7300	1		1	CONNECTOR-POST-TYPE .100-PIN SPCG 50-CONT	28480	1251-7300
A1X7A	1251-7300	1		1	CONNECTOR-POST-TYPE .100-PIN SPCG 50-CONT	28480	1251-7300
A1X7B	1251-7300	1		1	CONNECTOR-POST-TYPE .100-PIN SPCG 50-CONT	28480	1251-7300
A1X8	1252-1034	8		1	CONNECTOR-POST-TYPE .100-PIN SPCG 34-CONT	28480	1252-1034
A1Y1	0960-0612	6		1	CRYSTAL OSCILLATOR 10.0 MHZ 0-55-DEG C	82567	03-02236-001
	0515-0892	1		2	SCREW-MACH M3.5 X 0.6 12MM-LG PAN-HD	00000	ORDER BY DESCRIPTION
	0515-1232	5		4	SCREW-MACH M3.5 X 0.6 8MM-LG PAN-HD	00000	ORDER BY DESCRIPTION
	0535-0007	2		4	NUT-HEX DBL-CHAM M3.5 X 0.6 3MM-THK	00000	ORDER BY DESCRIPTION
	0340-0596	1		1	INSULATOR-XSTR THERM-CONDCT	52525	7403-03FR-04
	1205-0462	5		1	HEAT SINK SGL TO-220-CS	13103	6038B-TT
	05348-00005	0		1	HEAT SINK	28480	05348-00005
	1258-0141	8		2	JUMPER-REMOVABLE FOR 0.025-IN SQ PINS	00779	530153-2
	1400-0249	0		1	CABLE TIE .062-.625-DIA .091-WD NYLON	16366	08-465/GRAY
	0380-2009	2		2	STANDOFF-RND 4-MM-LG 3.74-MM-ID M3.5	05791	BR5115SPC-04-0-34
	0380-2010	2		2	STANDOFF-RND 3-MM-LG 3.74-MM-ID M3.5	05791	BR5115SPC-03-0-34
	0380-2032	8		1	STANDOFF-RVT-ON 25-MM-LG M3.5 X 0.6-THD	05791	BR5115SPC-25-0-034
	2110-0269	0		2	FUSEHOLDER CLIP-TYPE	91506	6008-32CN

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

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

Reference	HP Part Number	C	D	Qty	Description	Mfr Code	Mfr Part Number
A2	05350-60002	7		1	LOW FREQUENCY INPUT ASSY (SERIES 2713)	28480	05350-60002
A2C1	0160-3879	7		11	CAPACITOR-FXD .01UF +20% 100VDC CER	28480	0160-3879
A2C2	0160-3879	7		7	CAPACITOR-FXD .01UF +20% 100VDC CER	28480	0160-3879
A2C3	0160-3879	7		7	CAPACITOR-FXD .01UF +20% 100VDC CER	28480	0160-3879
A2C4	0160-4787	8		1	CAPACITOR-FXD 22PF +5% 100VDC CER 0-30	28480	0160-3879
A2C5	0160-4554	7		8	CAPACITOR-FXD .01UF +20% 50VDC CER	28480	0160-4787
A2C6	0160-3879	7		7	CAPACITOR-FXD .01UF +20% 100VDC CER	28480	0160-4554
A2C7	0160-4554	7		7	CAPACITOR-FXD .01UF +20% 50VDC CER	28480	0160-3879
A2C8	0160-4554	7		7	CAPACITOR-FXD .01UF +20% 50VDC CER	28480	0160-4554
A2C9	0160-4554	7		7	CAPACITOR-FXD .01UF +20% 50VDC CER	28480	0160-4554
A2C10	0160-3879	7		7	CAPACITOR-FXD .01UF +20% 100VDC CER	28480	0160-4554
A2C11	0160-4554	7		7	CAPACITOR-FXD .01UF +20% 50VDC CER	28480	0160-4554
A2C12	0160-0576	5		3	CAPACITOR-FXD .01UF +20% 50VDC CER	28480	0160-4554
A2C13	0160-4554	7		7	CAPACITOR-FXD .01UF +20% 50VDC CER	28480	0160-0576
A2C14	0160-4554	7		7	CAPACITOR-FXD .01UF +20% 50VDC CER	28480	0160-4554
A2C15	0160-3879	7		7	CAPACITOR-FXD .01UF +20% 100VDC CER	28480	0160-4554
A2C16	0160-3879	7		7	CAPACITOR-FXD .01UF +20% 100VDC CER	28480	0160-3879
A2C17	0160-4557	0		3	CAPACITOR-FXD .1UF +20% 50VDC CER	28480	0160-3879
A2C18	0160-4554	7		7	CAPACITOR-FXD .01UF +20% 50VDC CER	28480	0160-4554
A2C19	0160-4804	0		1	NOT ASSIGNED	28480	0160-4554
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 7A	28480	0180-2929
A2C22	0160-3879	7		7	CAPACITOR-FXD .01UF +20% 100VDC CER	28480	0160-3879
A2C23	0160-3879	7		7	CAPACITOR-FXD .01UF +20% 100VDC CER	28480	0160-3879
A2C24	0160-4557	0		0	CAPACITOR-FXD .1UF +20% 50VDC CER	28480	0160-3879
A2C25	0160-3879	7		7	CAPACITOR-FXD .01UF +20% 100VDC CER	28480	0160-3879
A2C26	0160-5649	3		1	CAPACITOR-FXD 100PF +5% 50VDC CER	28480	0160-5649
A2C27	0160-4704	9		1	CAPACITOR-FXD .01UF +10% 50VDC CER	28480	0160-4704
A2C28	0160-3879	7		7	CAPACITOR-FXD .01UF +20% 100VDC CER	28480	0160-4704
A2C29	0160-4554	7		7	CAPACITOR-FXD .01UF +20% 50VDC CER	28480	0160-3879
A2C30	0160-4204	4		1	CAPACITOR-FXD .033UF +10% 500VDC CER	28480	0160-4554
A2C31	0160-0576	5		5	CAPACITOR-FXD .1UF +20% 50VDC CER	28480	0160-0576
A2C32	0160-3879	7		7	CAPACITOR-FXD .01UF +20% 100VDC CER	28480	0160-3879
A2C33	0160-4557	0		0	CAPACITOR-FXD .1UF +20% 50VDC CER	28480	0160-3879
A2C34	0160-3879	7		7	CAPACITOR-FXD .01UF +20% 100VDC CER	28480	0160-3879
A2CR1	1901-0539	3		10	DIODE-SM SIG SCHOTTKY	28480	1901-0539
A2CR2	1901-0539	3		10	DIODE-SM SIG SCHOTTKY	28480	1901-0539
A2CR3	1901-0539	3		10	DIODE-SM SIG SCHOTTKY	28480	1901-0539
A2CR4	1901-0539	3		10	DIODE-SM SIG SCHOTTKY	28480	1901-0539
A2CR5	1901-0539	3		10	DIODE-SM SIG SCHOTTKY	28480	1901-0539
A2CR6	1901-0539	3		10	DIODE-SM SIG SCHOTTKY	28480	1901-0539
A2CR7	1901-0539	3		10	DIODE-SM SIG SCHOTTKY	28480	1901-0539
A2CR8	1901-0539	3		10	DIODE-SM SIG SCHOTTKY	28480	1901-0539
A2CR9	1901-0539	3		10	DIODE-SM SIG SCHOTTKY	28480	1901-0539
A2CR10	1901-0539	3		10	DIODE-SM SIG SCHOTTKY	28480	1901-0539
A2CR11	1901-0050	3		2	DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0539
A2CR12	1901-0376	6		2	DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0539
A2CR14	1901-0050	3		6	DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0539
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		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		6	CORE-FERRITE CHOKE-WIDEBAND;IMP;>680	28480	9100-1788
A2L6	9100-1788	6		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	4040-0748	3		2	EXTR-PC BD BLK POLYC .062-IN-BD-THKNS	28480	4040-0748
A2MP4	1206-0554	6		1	PLUG-HOLE BDR-HD FOR .187-D-HOLE NYL	28480	1206-0554
A2P1	1251-7996	9		1	CONN-POST TYPE .100-PIN SPCG 50-CONT	28480	1251-7996

Table 6-2. Replaceable Parts (Continued)



Table 6-2. Replaceable Parts (Continued)

Reference	HP Part Number	C	D	Qty	Description	Mfr Code	Mfr Part Number
A2Q1	1854-0092	2	2	2	TRANSISTOR NPN SI PD=200MW FT=600MHZ	26480	1854-0092
A2Q2	1854-0092	2	2	2	TRANSISTOR NPN SI PD=200MW FT=600MHZ	26480	1854-0092
A2Q3	1853-0036	2	2	3	TRANSISTOR PNP SI PD=310MW FT=250MHZ	27014	2N3906
A2Q4	1853-0036	2	2	2	TRANSISTOR PNP SI PD=310MW FT=250MHZ	27014	2N3906
A2Q5	1854-0215	1	1	4	TRANSISTOR NPN SI TO-92 PD=350MW	04713	2N3904
A2Q6	1853-0354	7	7	1	TRANSISTOR PNP SI TO-92 PD=350MW	26480	1853-0354
A2Q7	1854-0215	1	1	1	TRANSISTOR NPN SI TO-92 PD=350MW	04713	2N3904
A2Q8	1854-0215	1	1	1	TRANSISTOR NPN SI TO-92 PD=350MW	04713	2N3904
A2Q9	1855-0327	8	8	1	TRANSISTOR J-FET 2N4416 N-CHAN D-MODE	01296	2N4416
A2Q10	1853-0036	2	2	2	TRANSISTOR PNP SI PD=310MW FT=250MHZ	27014	2N3906
A2Q11	1854-0215	1	1	1	TRANSISTOR NPN SI TO-92 PD=350MW	04713	2N3904
A2R1	2100-2489	9	9	1	RESISTOR 1TRMR 5K 10% C SID-ADJ 1-TRN	73138	82PARSK
A2R2	0757-0442	9	9	11	RESISTOR 10K 1% .125W F TC=0+100	24546	CT4-1/8-TO-1002-F
A2R3	0698-3441	8	8	4	RESISTOR 215 1% .125W F TC=0+100	24546	CT4-1/8-TO-215R-F
A2R4	0698-4037	0	0	2	RESISTOR 46.4 1% .125W F TC=0+100	26480	0698-4037
A2R5	0699-0073	8	8	1	RESISTOR 10M 1% .125W F TC=0+150	26480	0699-0073
A2R6	0698-3441	8	8	8	RESISTOR 215 1% .125W F TC=0+100	24546	CT4-1/8-TO-215R-F
A2R7	0757-1094	9	9	2	RESISTOR 1.47K 1% .125W F TC=0+100	24546	CT4-1/8-TO-1471-F
A2R8	0757-0458	7	7	2	RESISTOR 51.1K 1% .125W F TC=0+100	24546	CT4-1/8-TO-5112-F
A2R9	0757-0442	9	9	9	RESISTOR 10K 1% .125W F TC=0+100	24546	CT4-1/8-TO-1002-F
A2R10	0757-0442	9	9	9	RESISTOR 10K 1% .125W F TC=0+100	24546	CT4-1/8-TO-1002-F
A2R11	0757-0458	7	7	7	RESISTOR 51.1K 1% .125W F TC=0+100	24546	CT4-1/8-TO-5112-F
A2R12	0698-3155	1	1	1	RESISTOR 4.64K 1% .125W F TC=0+100	24546	CT4-1/8-TO-4641-F
A2R13	0698-2437	2	2	1	RESISTOR 133 1% .125W F TC=0+100	24546	CT4-1/8-TO-133R-F
A2R14	0757-1094	9	9	9	RESISTOR 1.47K 1% .125W F TC=0+100	24546	CT4-1/8-TO-1471-F
A2R15	0757-0421	4	4	3	RESISTOR 825 1% .125W F TC=0+100	24546	CT4-1/8-TO-825R-F
A2R16	0698-3443	0	0	2	RESISTOR 287 1% .125W F TC=0+100	24546	CT4-1/8-TO-287R-F
A2R17	0698-3440	7	7	1	RESISTOR 196 1% .125W F TC=0+100	24546	CT4-1/8-TO-196R-F
A2R18	0698-3439	4	4	2	RESISTOR 178 1% .125W F TC=0+100	24546	CT4-1/8-TO-178R-F
A2R19	0757-0403	2	2	2	RESISTOR 121 1% .125W F TC=0+100	24546	CT4-1/8-TO-121R-F
A2R20	0698-3158	4	4	2	RESISTOR 23.7K 1% .125W F TC=0+100	24546	CT4-1/8-TO-2372-F
A2R21	0757-0401	0	0	3	RESISTOR 100 1% .125W F TC=0+100	24546	CT4-1/8-TO-101-F
A2R22	0698-3441	8	8	8	RESISTOR 215 1% .125W F TC=0+100	24546	CT4-1/8-TO-215R-F
A2R23	0698-3441	8	8	8	RESISTOR 215 1% .125W F TC=0+100	24546	CT4-1/8-TO-215R-F
A2R24	0757-0727	3	3	2	RESISTOR 562 1% .25W F TC=0+100	24546	NAS-1/4-TO-562R-F
A2R25	0698-3158	4	4	2	RESISTOR 23.7K 1% .125W F TC=0+100	24546	CT4-1/8-TO-2372-F
A2R26	1810-0203	5	5	1	NETWORK RES B-SIP 470.0 OHM X 7	11236	750-81-R470
A2R27	0698-3431	6	6	1	RESISTOR 23.7 1% .125W F TC=0+100	03888	PM355-1/8-TO-237R-F
A2R28	0757-0442	9	9	9	RESISTOR 10K 1% .125W F TC=0+100	24546	CT4-1/8-TO-1002-F
A2R29	0757-0439	4	4	1	RESISTOR 6.81K 1% .125W F TC=0+100	24546	CT4-1/8-TO-6811-F
A2R30	0757-0727	3	3	3	RESISTOR 562 1% .25W F TC=0+100	24546	NAS-1/4-TO-562R-F
A2R31	1810-0541	4	4	1	NETWORK RES B-SIP MULT-V ALUE	28480	1810-0541
A2R32	1810-0219	3	3	1	NETWORK RES B-SIP 220.0 OHM X 4	11236	750-83-R220
A2R33	0757-0421	4	4	4	RESISTOR 825 1% .125W F TC=0+100	24546	CT4-1/8-TO-825R-F
A2R34	0698-3443	0	0	4	RESISTOR 287 1% .125W F TC=0+100	24546	CT4-1/8-TO-287R-F
A2R35	0698-3439	4	4	4	RESISTOR 178 1% .125W F TC=0+100	24546	CT4-1/8-TO-178R-F
A2R36	0757-0317	7	7	1	RESISTOR 1.33K 1% .125W F TC=0+100	24546	CT4-1/8-TO-1331-F
A2R37	0757-0401	0	0	0	RESISTOR 100 1% .125W F TC=0+100	24546	CT4-1/8-TO-101-F
A2R38	0698-0082	7	7	2	RESISTOR 46.4 1% .125W F TC=0+100	24546	CT4-1/8-TO-4640-F
A2R39	0757-0280	3	3	3	RESISTOR 1K 1% .125W F TC=0+100	24546	CT4-1/8-TO-1001-F
A2R40	0757-0400	9	9	1	RESISTOR 90.9 1% .125W F TC=0+100	24546	CT4-1/8-TO-909R-F
A2R41	0698-4037	0	0	0	RESISTOR 46.4 1% .125W F TC=0+100	26480	0698-4037
A2R42	0698-0082	7	7	7	RESISTOR 46.4 1% .125W F TC=0+100	24546	CT4-1/8-TO-4640-F
A2R43	0757-0442	9	9	9	RESISTOR 10K 1% .125W F TC=0+100	24546	CT4-1/8-TO-1002-F
A2R44	0757-0442	9	9	9	RESISTOR 10K 1% .125W F TC=0+100	24546	CT4-1/8-TO-1002-F
A2R45	0757-0442	9	9	9	RESISTOR 10K 1% .125W F TC=0+100	24546	CT4-1/8-TO-1002-F

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

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Reference Designation	HP Part Number	D	C	Qty	Description	Mfr Code	Mfr Part Number
A2R46	0757-0401	0		1	RESISTOR 100 1% .125W F TC=0+100	24546	CT4-1/8-TO-101-F
A2R47	0757-0421	4		1	RESISTOR 825 1% .125W F TC=0+100	24546	CT4-1/8-TO-825R-F
A2R48	0757-1108	6		1	RESISTOR 300 1% .125W F TC=0+100	24546	CT4-1/8-TO-301-F
A2R49	0757-0280	3		1	RESISTOR 1K 1% .125W F TC=0+100	24546	CT4-1/8-TO-1001-F
A2R50	0757-0442	9		1	RESISTOR 10K 1% .125W F TC=0+100	24546	CT4-1/8-TO-1002-F
A2R51	0757-0280	3		1	RESISTOR 1K 1% .125W F TC=0+100	24546	CT4-1/8-TO-1001-F
A2R52	0757-0442	9		1	RESISTOR 10K 1% .125W F TC=0+100	24546	CT4-1/8-TO-1002-F
A2R53	0698-8827	4		2	RESISTOR 1M 1% .125W F TC=0+100	26480	CT4-1/8-TO-1002-F
A2R54	0698-8827	4		2	RESISTOR 1M 1% .125W F TC=0+100	26480	CT4-1/8-TO-1002-F
A2R55	0757-0442	9		2	RESISTOR 10K 1% .125W F TC=0+100	24546	CT4-1/8-TO-1002-F
A2R56	0757-0178	8		1	RESISTOR 100 1% .25W F TC=0+100	24546	NA5-1/4-TO-101-F
A2R57	0757-0463	4		1	RESISTOR 82.5K 1% .125W F TC=0+100	24546	CT4-1/8-TO-8252-F
A2R58	0757-0442	9		1	RESISTOR 10K 1% .125W F TC=0+100	24546	CT4-1/8-TO-1002-F
A2R59	0757-0422	5		1	RESISTOR 909 1% .125W F TC=0+100	24546	CT4-1/8-TO-909R-F
A2R60	0698-7200	5		1	RESISTOR 31.6 1% .05W F TC=0+100	24546	CT4-1/8-TO-31R6-F
A2TP1	1251-0600	0		2	CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A2TP2	1251-0600	0		2	CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A2U1	1820-3517	1		1	IC DRIVER ECL VAR MODUL	52648	SP8680BDG
A2U2	1826-0139	9		1	IC OP AMP GP DUAL 8-DIP-P PKG	31585	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		2	IC WIDEBAND AMPL TO-39 PKG	04713	MWA220
A2U6	1820-3075	6		1	IC RECEIVER ECL/10KH LINE RECEIVER TPL	04713	MC10H116L
A2U7	1813-0214	4		1	IC WIDEBAND AMPL TO-39 PKG	04713	MWA210
A2U8	1820-2823	0		1	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	CABLE ASSY-LOW FREQUENCY	28480	05350-60103

Table 6-2. Replaceable Parts (Continued)

Table 6-2. Replaceable Parts (Continued)

Reference Designation	HP Part Number	C	D	Qty	Description	Mfr Code	Mfr Part Number
A3	05350-60003		8	1	COUNTER ASSEMBLY (DATE CODE 92051)	28480	05350-60003
A3C1	0160-4557		0	2	CAPACITOR-FXD .1UF +20% 50VDC CER	28480	CAC04X7R104M050A
A3C2	0180-0210		6	1	CAPACITOR-FXD 3.3UF +20% 15VDC TA	56289	150D336X0015A2
A3C3	0180-4135		2	2	CAPACITOR-FXD 33UF +10% 10VDC TA	12340	T322D336K010A5
A3C4	0160-4554		7	17	CAPACITOR-FXD .01UF +20% 50VDC CER	28480	0160-4554
A3C5	0160-4554		7	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	7	CAPACITOR-FXD .01UF +20% 50VDC CER	28480	0160-4554
A3C8	0160-4554		7	7	CAPACITOR-FXD .01UF +20% 50VDC CER	28480	0160-4554
A3C9	0160-4554		7	7	CAPACITOR-FXD .01UF +20% 50VDC CER	28480	0160-4554
A3C10	0160-4554		7	7	CAPACITOR-FXD .01UF +20% 50VDC CER	28480	0160-4554
A3C11	0160-4554		7	7	CAPACITOR-FXD .01UF +20% 50VDC CER	28480	0160-4554
A3C12	0160-4554		7	7	CAPACITOR-FXD .01UF +20% 50VDC CER	28480	0160-4554
A3C13	0160-4557		0	0	CAPACITOR-FXD .1UF +20% 50VDC CER	28480	CAC04X7R104M050A
A3C14	0160-4554		7	7	CAPACITOR-FXD .01UF +20% 50VDC CER	28480	0160-4554
A3C15	0160-4554		7	7	CAPACITOR-FXD .01UF +20% 50VDC CER	28480	0160-4554
A3C16	0160-4554		7	7	CAPACITOR-FXD .01UF +20% 50VDC CER	28480	0160-4554
A3C17	0160-4554		7	7	CAPACITOR-FXD .01UF +20% 50VDC CER	28480	0160-4554
A3C18	0160-4554		7	7	CAPACITOR-FXD .01UF +20% 50VDC CER	28480	0160-4554
A3C19	0160-4554		7	7	CAPACITOR-FXD .01UF +20% 50VDC CER	28480	0160-4554
A3C20	0160-4554		7	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	7	CAPACITOR-FXD 33UF +10% 10VDC TA	56289	150D336X9010B2
A3C23	0160-4556		9	9	CAPACITOR-FXD 1000PF +20% 100VDC CER	16299	CAC02X7R102M100A
A3C24	0160-4554		7	7	CAPACITOR-FXD .01UF +20% 50VDC CER	28480	0160-4554
A3C25	0160-4554		7	7	CAPACITOR-FXD .01UF +20% 50VDC CER	28480	0160-4554
A3C26	1901-0050		3	2	DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A3C27	1901-0050		3	3	DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A3H1	2360-0286		0	1	SCREW MACH 6-32 .25IN-LG BDG HD SLT	00000	2360-0286
A3H2	9100-1788		6	2	CORE-FERRITE CHOKER-WIDEBAND;IMP>680	28480	9100-1788
A3L1	9100-1788		6	2	CORE-FERRITE CHOKER-WIDEBAND;IMP>680	28480	9100-1788
A3L2	9100-1788		6	6	INDUCTOR RF-CH-MILD 100NH 10%	28480	9100-2247
A3L3	9100-2247		4	1	INDUCTOR RF-CH-MILD 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	EXTRACTOR-PC BD BLK POLYC .062-IN-BD THKNS	28480	4040-0748
A3MP3	4040-0026		6	1	PLUG-HOLE BDR-HD FOR .187-D HOLE NYLON	02768	207-120241-03-0101
A3P1	1251-7986		9	1	CONN-POST TYPE .100-PIN SPG50-CONT	28480	1251-7986
A3Q1	1854-0591		6	2	TRANSISTOR NPN SI PD=180MW FT=4GHZ	25403	BFR90
A3Q2	1854-0591		6	6	TRANSISTOR NPN SI PD=180MW FT=4GHZ	25403	BFR90
A3R1	0757-0418		9	1	RESISTOR 619 1% .125 F TC=0+100	24546	C74-1/8-T0-619R-F
A3R2	0757-0418		5	2	RESISTOR 25.1K 1% .125W F TC=0+100	24546	C74-1/8-T0-619R-F
A3R3	0698-3159		9	5	RESISTOR 25.1K 1% .125W F TC=0+100	24546	C74-1/8-T0-619R-F
A3R4	0757-0418		9	9	RESISTOR 619 1% .125 F TC=0+100	24546	C74-1/8-T0-619R-F
A3R5	0757-0438		3	3	RESISTOR 5.11K 1% .125W F TC=0+100	24546	C74-1/8-T0-5111-F
A3R6	0698-3132		4	2	RESISTOR 261 1% .125W F TC=0+100	24546	C74-1/8-T0-2610-F
A3R7	0698-3132		4	2	RESISTOR 261 1% .125W F TC=0+100	24546	C74-1/8-T0-2610-F
A3R8	0757-0416		7	2	RESISTOR 511 1% .125W F TC=0+100	24546	C74-1/8-T0-5111-F
A3R9	0698-3151		7	3	RESISTOR 2.87K 1% .125W F TC=0+100	24546	C74-1/8-T0-2871-F
A3R10	0698-3159		5	5	RESISTOR 25.1K 1% .125W F TC=0+100	24546	C74-1/8-T0-2612-F
A3R11	0698-3441		8	1	RESISTOR 215 1% .125W F TC=0+100	24546	C74-1/8-T0-215R-F
A3R12	0757-0280		3	4	RESISTOR 1K 1% .125W F TC=0+100	24546	C74-1/8-T0-1001-F
A3R13	0757-0280		3	3	RESISTOR 1K 1% .125W F TC=0+100	24546	C74-1/8-T0-1001-F
A3R14	0757-0418		9	9	RESISTOR 619 1% .125 F TC=0+100	24546	C74-1/8-T0-619R-F
A3R15	0757-0438		3	3	RESISTOR 5.11K 1% .125W F TC=0+100	24546	C74-1/8-T0-5111-F
A3R16	0757-0421		4	2	RESISTOR 825 1% .125W F TC=0+100	24546	C74-1/8-T0-825R-F
A3R17	0698-3460		4	1	RESISTOR 422K 1% .125W F TC=0+100	28480	0698-3460
A3R18	0698-3460		1	1	RESISTOR 422K 1% .125W F TC=0+100	28480	0698-3460
A3R19	0698-3151		7	7	RESISTOR 2.87K 1% .125W F TC=0+100	24546	C74-1/8-T0-2871-F
A3R20	0757-0438		3	3	RESISTOR 5.11K 1% .125W F TC=0+100	24546	C74-1/8-T0-5111-F

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

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

Table 6-2. Replaceable Parts (Continued)

Reference Designation	HP Part Number	C	D	Qty	Description	Mfr Code	Mfr Part Number
A3R21	0698-3151	7			NOT ASSIGNED		
A3R22	0698-3446	3		2	RESISTOR 2.87K 1% .125W F TC=0+100	24546	CT4-1/8-T0-287-F
A3R23	0698-3439	3		3	RESISTOR 383 1% .125W F TC=0+100	24546	CT4-1/8-T0-383R-F
A3R24	0698-3439	3		3	RESISTOR 178 1% .125 F TC=0+100	24546	CT4-1/8-T0-178R-F
A3R25	0698-3439	3		3	RESISTOR 1K 1% .125W F TC=0+100	24546	CT4-1/8-T0-1001-F
A3R26	0757-0418	9		9	RESISTOR 619 1% .125 F TC=0+100	24546	CT4-1/8-T0-619R-F
A3R27	0757-0280	3		3	RESISTOR 1K 1% .125W F TC=0+100	24546	CT4-1/8-T0-1001-F
A3R28	0698-3439	3		3	RESISTOR 178 1% .125 F TC=0+100	24546	CT4-1/8-T0-178R-F
A3R29	0698-3446	3		3	RESISTOR 383 1% .125W F TC=0+100	24546	CT4-1/8-T0-383R-F
A3R30	0698-3439	3		3	RESISTOR 178 1% .125 F TC=0+100	24546	CT4-1/8-T0-178R-F
A3R31	0757-0399	1		1	RESISTOR 82.5 1% .125W F TC=0+100	24546	CT4-1/8-T0-82.5R-F
A3R32	0757-0400	9		2	RESISTOR 90.9 1% .125W F TC=0+100	24546	CT4-1/8-T0-90.9R-F
A3R33	0698-3437	2		1	RESISTOR 133 1% .125W F TC=0+100	24546	CT4-1/8-T0-90.9R-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		2	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		2	RESISTOR 90.9 1% .125W F TC=0+100	24546	CT4-1/8-T0-90.9R-F
A3R38	0757-0394	0		2	RESISTOR 51.1 1% .125W F TC=0+100	24546	CT4-1/8-T0-51.1R-F
A3R39	0757-0416	7		7	RESISTOR 511 1% .125W F TC=0+100	24546	CT4-1/8-T0-511R-F
A3R40	0757-0394	0		1	RESISTOR 51.1 1% .125W F TC=0+100	24546	CT4-1/8-T0-51.1R-F
A3R41	0698-4037	0		1	RESISTOR 46.4 1% .125W F TC=0+100	24546	CT4-1/8-T0-51.1R-F
A3R42	0698-1542	8		1	RESISTOR 51 1% .125W F TC=0+50	28480	0698-4037
A3TP1	1251-0600	0		2	CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ-SQ	28480	1251-0600
A3TP2	1251-0600	0		2	CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ-SQ	28480	1251-0600
A3U1	1826-0393	7		1	IC V-RGLTR-ADJ-POS 1.237V TO-220 PKG	28480	1826-0393
A3U2	1826-0065	0		1	IC COMPARTOR PRON 8-DIP-P PKG	28480	1826-0393
A3U3	1820-1425	6		1	IC SCHMITT-TRIG TTL LS NAND QUAD 2-INP	27014	LM311N
A3U4	1820-2096	9		1	IC CNTR TTL LS BIN DUAL 4-BIT	01295	SN74LS132N
A3U5	1858-0054	4		1	TRANSISTOR ARRAY 16-PIN PLSHC 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	1820-2312
A3U8	1826-0346	0		1	IC OP AMP GP DUAL 8-DIP-P PKG	27014	LM358N
A3W1	8159-0005	0		1	RESISTOR-ZERO OHMS 22AWG LEAD DIA	28480	8159-0005
A3XU1-							
A3XU6	1200-0654	7		1	NOT ASSIGNED	02414	DILB40P-308T
A3XU7	0361-0685	3		1	RIVET,NYLON 12501A	28480	0361-0687

Table 6-2. Replaceable Parts (Continued)

Reference	HP Part Number	C	D	Qty	Description	Mfr Code	Mfr Part Number
A4	05348-60004	5		1	MICROPROCESSOR ASSEMBLY	28480	05348-60004
A4C1	0180-3775		4	2	CAPACITOR-FXD 68UF 10V TA	12344	T398H666K010AS
A4C2	0180-3775		4	1	CAPACITOR-FXD 68UF 10V TA	12344	T398H666K010AS
A4C3	0180-4130		7	1	CAPACITOR-FXD 2.2UF 20V TA	12344	T322B225K020AS
A4C4	0160-4557		0	25	CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A3C5	0160-4557		0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A3C6	0160-4557		0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A3C7	0160-4557		0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A3C8	0160-4557		0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A3C9	0160-4557		0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A3C10	0160-4557		0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A3C11	0160-4557		0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A3C12	0160-4557		0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A3C13	0160-4557		0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A3C14	0160-4557		0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A3C15	0160-4557		0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A3C16	0160-4557		0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A3C17	0160-4557		0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A3C18	0160-4557		0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A3C19	0160-4557		0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A3C20	0160-4557		0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A3C21	0160-4557		0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A3C22	0160-4557		0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A3C23	0160-4557		0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A3C24	0160-4557		0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A3C25	0160-4557		0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A3C26	0160-4557		0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A3C27	0160-4557		0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A3C28	0160-4557		0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A3CR1	1901-0050	3	2	2	DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A3CR2	1901-0050	3			DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A3J1	1251-4775	8		1	CONNECTOR, POST TYPE .150-PIN SFCG 10-CONT	28480	1251-4775
A3H2					NOT ASSIGNED		
A3L1	9100-0990	4		1	INDUCTOR 1UH +-10% .175D-INX.43L6-IN	91637	IMS-5-01 1.0UH +-10%
A3L2	9100-0541	7		1	INDUCTOR RF-CH-MLD 250UH +-10%	91637	ICS-1041-1
A3MF1	1480-0116	8	2	2	PIN-GRV .062-IN-DIA .25-IN-LG STL	28480	1480-0116
A3MF2	1480-0116	8	2	2	PIN-GRV .062-IN-DIA .25-IN-LG STL	28480	1480-0116
A3MF3	4040-0748	3	2	2	EXTRACTOR-PC BD BLK POLYC .062-IN-BD THKNS	28480	4040-0748
A3MF4	4040-0748	3	2	2	EXTRACTOR-PC BD BLK POLYC .062-IN-BD THKNS	28480	4040-0748
A3MF5	4040-0748	3	3	3	EXTRACTOR-PC BD BLK POLYC .062-IN-BD THKNS	28480	4040-0748
A3R1	1810-0398	9	9	4	NETWORK-RESISTOR 10-SIP 22.0K OHM X 9	C1433	750-101
A3R2	1810-0398	9	9	4	NETWORK-RESISTOR 10-SIP 22.0K OHM X 9	C1433	750-101
A3R3	1810-0398	9	9	4	NETWORK-RESISTOR 10-SIP 22.0K OHM X 9	C1433	750-101
A3R4	1810-0398	9	9	4	NETWORK-RESISTOR 10-SIP 22.0K OHM X 9	C1433	750-101
A3R5	0757-0199	3		1	RESISTOR 21.5K +-1% .125W TF TC=0+-100	12498	C14-1/8-TO-2152-F
A4U1	1820-2724	0	7	0	IC LOH TTL ALS TRANSSPARENT OCTL	01295	SN74ALS573CN
A4U2	1820-2724	0	0	7	IC LOH TTL ALS TRANSSPARENT OCTL	01295	SN74ALS573CN
A4U3	1820-2724	0	0	0	IC LOH TTL ALS TRANSSPARENT OCTL	01295	SN74ALS573CN
A4U4	1820-2724	0	0	0	IC LOH TTL ALS TRANSSPARENT OCTL	01295	SN74ALS573CN
A4U5	1820-2724	0	0	0	IC LOH TTL ALS TRANSSPARENT OCTL	01295	SN74ALS573CN
A4U6	1820-2724	0	0	0	IC LOH TTL ALS TRANSSPARENT OCTL	01295	SN74ALS573CN
A4U7	1820-2724	0	0	0	IC LOH TTL ALS TRANSSPARENT OCTL	01295	SN74ALS573CN
A4U8	1820-3159	7	7	1	IC MPU W/2 MHZ CLK, B-TITS 64K ADDRESS	04713	MC68803L

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

Table 6-2. Replaceable Parts (Continued)

Reference Designation	HP Part Number	C	D	Qty	Description	Mfr Code	Mfr Part Number
A4U9	1820-1858	9		3	IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A4U10	1820-1858	9		9	IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A4U11	1820-1858	9		9	IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A4U12	1820-3121	3		3	IC TRANSCEIVER TTL ALS BUS OCTL	01295	SN74ALS245AN
A4U13	1820-3121	3		3	IC TRANSCEIVER TTL ALS BUS OCTL	01295	SN74ALS245AN
A4U14	05348-80002	5		1	EPROM	28480	05348-80002
A4U15	1818-3330	1		1	IC CMOS 65536 (64K) STAT RAM 120-NS 3-S	S4111	HM6264P-12
A4U16	1820-3100	8		1	IC DCDR TTL ALS BIN 3-TO-8 LINE 3-INP	01295	SN74ALS138N
A4U17	1820-2775	1		1	IC GATE TTL ALS HAND TPL 3-INP	01295	SN74ALS10AN
A4U18	1820-2634	1		1	IC INV TTL ALS HEX	01295	SN74ALS04BN
A4U19	1820-2635	2		1	IC GATE TTL ALS AND QUAD 2-INP	01295	SN74ALS04BN
A4U20	1820-2739	7		1	IC GATE TTL ALS NOR QUAD 2-INP	01295	SN74ALS08N
A4U21	1820-2656	7		1	IC GATE TTL ALS NAND QUAD 2-INP	01295	SN74ALS00AN
A4U22	1820-2689	6		1	IC GATE TTL F NAND DUAL 4-INP	18324	74F20N
A4U23	1820-2488	3		1	IC FF TTL ALS D-TYPE POS-EDGE-TRIG	01295	SN74ALS74AN
A4U24	1820-2772	8		1	IC FF TTL ALS JK NEG EDGE-TRIG	01295	SN74ALS112AN
A4U25	1813-0605	7		1	CLOCK-OSCILLATOR-XTAL 16.0 MHZ 0.10%	00815	HS-113-16MHA
A4W1	8159-0005	0		1	RESISTOR-ZERO OHMS 22AWG LEAD DIA	11502	YZ0 1/4
A4XU14	1200-0567	1		1	SOCKET-IC DIP 28-CONT DIP DIP-SLDR	01295	C8728-01

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

Table 6-2. Replaceable Parts (Continued)

Reference	HP Part Number	C	D	Qty	Description	Mfr Code	Mfr Part Number
A5	05350-60018			1	SYNTHESIZER ASSEMBLY (SERIES 3049)	28480	05350-60018
A5C1	0170-0066			9	CAP-FXD 0.027UF 200V POLY-EFL	19701	708D1HJ273P201AX
A5C2	0160-3879			7	CAP-FXD 0.01UF 100 V	09969	RP3121-105X4103M100V
A5C3	0160-4040			6	CAP-FXD 1000PF 100 V	09969	RP3121-105C0G102J100V
A5C4	0160-3879			7	CAP-FXD 0.01UF 100 V	09969	RP3121-105X4103M100V
A5C5	0180-4132			9	CAP-FXD 6.8UF ±10% 35V TA	12340	T322D685K035AS
A5C6	0180-0210			6	CAP-FXD 3.3UF 15V TA	56289	T322D335X0015A2
A5C7	0180-4135			2	CAP-FXD 33UF ±10% 10V TA	12340	T322D336K010AS
A5C8	0160-4040			6	CAP-FXD 1000PF 100 V	09969	RP3121-105C0G102J100V
A5C9	0180-0210			6	CAP-FXD 3.3UF 15V TA	56289	T322D335X0015A2
A5C10	0160-0576			5	CAP-FXD 0.1UF 50V	09969	RP3121-105X7R104M50V
A5C11	0160-3879			7	CAP-FXD 0.01UF 100 V	09969	RP3121-105X4103M100V
A5C12	0160-4040			6	CAP-FXD 1000PF 100 V	09969	RP3121-105C0G102J100V
A5C13	0160-4389			6	CAP-FXD 100PF 200V	09969	RP3121-105C0G101J200V
A5C14	0160-4389			6	CAP-FXD 100PF 200V	09969	RP3121-105C0G101J200V
A5C15	NOT ASSIGNED				NOT ASSIGNED		
A5C16	0160-3879			7	CAP-FXD 0.01UF 100 V	09969	RP3121-105X4103M100V
A5C17	0160-3879			7	CAP-FXD 0.01UF 100 V	09969	RP3121-105X4103M100V
A5C18	0160-3879			7	CAP-FXD 0.01UF 100 V	09969	RP3121-105X4103M100V
A5C19	0160-3879			7	CAP-FXD 0.01UF 100 V	09969	RP3121-105X4103M100V
A5C20	0160-4389			6	CAP-FXD 100PF 200V	09969	RP3121-105C0G101J200V
A5C21	NOT ASSIGNED				NOT ASSIGNED		
A5C22	NOT ASSIGNED				NOT ASSIGNED		
A5C23	NOT ASSIGNED				NOT ASSIGNED		
A5C24	0180-4132			9	CAP-FXD 6.8UF ±10% 35V TA	12340	T322D685K035AS
A5C25	0180-4132			9	CAP-FXD 6.8UF ±10% 35V TA	12340	T322D685K035AS
A5C26	0180-4132			9	CAP-FXD 6.8UF ±10% 35V TA	12340	T322D685K035AS
A5C27	0180-1731			8	CAP-FXD 4.7UF 50V TA	56289	150D475X9050B2
A5C28	0160-4040			6	CAP-FXD 1000PF 100 V	09969	RP3121-105C0G102J100V
A5C29	0160-4481			9	CAP-FXD 270PF 100V	09969	RP3121-105C0G27J100V
A5C30	0160-3879			7	CAP-FXD 0.01UF 100 V	09969	RP3121-105X4103M100V
A5C31	0160-3879			7	CAP-FXD 0.01UF 100 V	09969	RP3121-105X4103M100V
A5C32	NOT ASSIGNED				NOT ASSIGNED		
A5C33	0160-3879			7	CAP-FXD 0.01UF 100 V	09969	RP3121-105X4103M100V
A5C34	0180-4135			2	CAP-FXD 33UF ±10% 10V TA	12340	T322D336K010AS
A5C35	0160-4040			6	CAP-FXD 1000PF 100 V	09969	RP3121-105C0G102J100V
A5C36	0160-4040			6	CAP-FXD 1000PF 100 V	09969	RP3121-105C0G102J100V
A5C37	0160-3874			2	CAP-FXD 0F 200V	09969	RP3121-105C0G100D200V
A5C38	NOT ASSIGNED				NOT ASSIGNED		
A5C39	0170-0019			2	CAP-FXD 0.1UF 200V POLY-EFL	19701	708D1MR104P201AX
A5C40	0180-4135			2	CAP-FXD 33UF ±10% 10V TA	12340	T322D336K010AS
A5C41	0180-4135			2	CAP-FXD 33UF ±10% 10V TA	12340	T322D336K010AS
A5C42	0180-4135			2	CAP-FXD 33UF ±10% 10V TA	12340	T322D336K010AS
A5C43	0180-0210			6	CAP-FXD 3.3UF 15V TA	56289	150D335X0015A2
A5C44	0160-4527			4	CAP-FXD 56PF ±5% 200V CER COG	12340	C320C560J2G5CA
A5C45	0160-4492			2	CAP-FXD 18PF 200V	09969	RP3121-105C0G180J200V
A5C46	0160-4040			6	CAP-FXD 1000PF 100 V	09969	RP3121-105C0G102J100V
A5C47	0160-3879			7	CAP-FXD 0.01UF 100 V	09969	RP3121-105X4103M100V
A5C48	0160-3879			7	CAP-FXD 0.01UF 100 V	09969	RP3121-105X4103M100V
A5C49	0160-3879			7	CAP-FXD 0.01UF 100 V	09969	RP3121-105X4103M100V
A5C50	0160-3879			7	CAP-FXD 0.01UF 100 V	09969	RP3121-105X4103M100V
A5C51	NOT ASSIGNED				NOT ASSIGNED		
A5C52	NOT ASSIGNED				NOT ASSIGNED		
A5C53	0160-3879			7	CAP-FXD 0.01UF 100 V	09969	RP3121-105X4103M100V
A5C54	0160-3879			7	CAP-FXD 0.01UF 100 V	09969	RP3121-105X4103M100V
A5C55	0160-4389			6	CAP-FXD 100PF 200V	09969	RP3121-105C0G101J200V
A5C56	0160-4389			6	CAP-FXD 100PF 200V	09969	RP3121-105C0G101J200V
A5C57	0160-4389			6	CAP-FXD 100PF 200V	09969	RP3121-105C0G101J200V
A5C58	0180-4135			2	CAP-FXD 33UF ±10% 10V TA	12340	T322D336K010AS
A5C59	0160-4389			6	CAP-FXD 100PF 200V	09969	RP3121-105C0G101J200V
A5C60	0160-4389			6	CAP-FXD 100PF 200V	09969	RP3121-105C0G101J200V

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Reference Designation	HP Part Number	C	D	Qty	Description	Mfr Code	Mfr Part Number
ASQ61	0180-4132	9	2	1	CAP-FXD 6.8UF +10% 35V TA	12340	T322D68K035AS
ASQ62	0180-4135	6	2	1	CAP-FXD 33UF +10% 10V TA	12340	T322D33K010AS
ASQ63	0160-4389	6	7	1	CAP-FXD 100PF 200V	09969	RP3121-105C0G101J200V
ASQ64	0160-3879	6	7	1	CAP-FXD 0.01UF 100 V	09969	RF3121-105X4103M100V
ASQ65	0160-4389	6	6	1	CAP-FXD 100PF 200V	09969	RP3121-105C0G101J200V
ASQ66	0160-4389	6	6	1	CAP-FXD 100PF 200V	09969	RP3121-105C0G101J200V
ASQ67	0160-4040	6	6	1	CAP-FXD 1000PF 100 V	09969	RP3121-105C0G101J200V
ASQ68	0160-4389	6	6	1	CAP-FXD 100PF 200V	09969	RP3121-105C0G101J200V
ASQ69	0160-3879	7	7	1	CAP-FXD 0.01UF 100 V	09969	RF3121-105C0G101J200V
ASQ70	0160-4389	6	6	1	CAP-FXD 100PF 200V	09969	RF3121-105X4103M100V
ASQ71	0180-0210	6	6	1	CAP-FXD 3.3UF 15V TA	56289	150D335X0015A2
ASQ72	0160-3879	7	7	1	CAP-FXD 0.01UF 100 V	09969	RF3121-105C0G101J200V
ASQ73	0160-4389	6	6	1	CAP-FXD 100PF 200V	09969	RP3121-105C0G101J200V
ASQ74	0160-4389	6	6	1	CAP-FXD 100PF 200V	09969	RP3121-105C0G101J200V
ASCR1	1901-0050	3	3	11	DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
ASCR2	1901-0050	3	3	1	DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
ASCR3	1901-0050	3	3	1	DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
ASCR4	1901-0050	3	3	1	DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
ASCR5	1901-0050	3	3	1	DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
ASCR6	1901-0724	0	0	1	DIODE-PWR RECT 1N5818 30V 1A	04713	1N5858
ASCR7	1901-0050	3	3	1	DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
ASCR8	1901-0050	3	3	1	DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
ASCR9	1901-0050	3	3	1	DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
ASCR10	1901-0050	3	3	1	DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
ASCR11	1901-0050	3	3	1	DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
ASCR12	1901-0050	3	3	1	DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
ASCR13	0122-0161	4	4	1	DIODE-VVC 2.15PF 7% BVR=30V	9N171	1N4150
ASD31	1990-1022	8	8	1	LED-LAMP LUM-IN7=4MCD IF=25MA-MAX BVR=5V	28480	HLMF-5030
ASJ2	1250-1314	3	3	1	CONNECTOR-RF SM-SLD FEM PC 50-OHM	98291	52-054-0000-226
ASL1	9140-0906	2	2	4	INDUCTOR 1MH +10% .172D-INX.43LG-IN	04099	9250-105
ASL2	9140-0906	2	2	2	INDUCTOR 1MH +10% .172D-INX.43LG-IN	04099	9250-105
ASL3	9140-0906	2	2	2	INDUCTOR 1MH +10% .172D-INX.43LG-IN	04099	9250-105
ASL4	9140-0906	2	2	2	INDUCTOR 1MH +10% .172D-INX.43LG-IN	04099	9250-105
ASL5	9100-0541	7	7	2	INDUCTOR RF-CH-MLD 250UG +10%	04099	9250-105
ASL6	9100-0541	7	7	1	INDUCTOR RF-CH-MLD 250UG +10%	91637	ICS-1041-1
ASL7	9100-0654	3	3	1	CORE-FERRITE CHOKE-WIDEBAND:IMP>800	02114	VK200 21/48
ASL8	9100-2258	7	7	5	INDUCTOR RF-CH-MLD 1.2UH +10%	91637	IM-2 1.2UH 10%
ASL9	9100-2258	7	7	7	INDUCTOR RF-CH-MLD 1.2UH +10%	91637	IM-2 1.2UH 10%
ASL10	9135-0076	6	6	1	INDUCTOR RF-CH-MLD 39NH +6%	06566	010150-054J
ASL11	9100-2258	7	7	7	INDUCTOR RF-CH-MLD 1.2UH +10%	91637	IM-2 1.2UH 10%
ASL12	9100-2258	7	7	7	INDUCTOR RF-CH-MLD 1.2UH +10%	91637	IM-2 1.2UH 10%
ASL13	9100-2258	7	7	7	INDUCTOR RF-CH-MLD 1.2UH +10%	91637	IM-2 1.2UH 10%
ASMP1	5000-9043	6	6	1	PIN EXTRACTOR	28480	5000-9043
ASMP2	5040-6852	3	3	1	EXTRACTOR-ORN	28480	5040-6852
ASMP3	05350-00014	5	5	1	GROUND STRAP-RIG	28480	05350-00014
ASMP4	05350-00015	6	6	1	GROUND STRAP-LEFT	28480	05350-00015
ASMP5	1205-0316	8	8	1	HEAT SINK SGL TO-5/TO-39-CS	13103	2260C
ASMP6	1205-0554	6	6	2	HEAT SINK SGL DIP	30161	5802B
ASP1	1251-7986	9	9	1	CONN-POST TYPE .100-PIN SPCG 50-CONT	28480	1251-7986
ASQ1	NOT ASSIGNED						
ASQ2	NOT ASSIGNED						
ASQ3	1854-0215	1	2	1	TRANSISTOR NPN SI TO-92 PD=350MW	04713	2N3904
ASQ4	1853-0036	2	2	3	TRANSISTOR PNP SI TO-92 PD=625MW	04713	2N3906(SEL)
ASQ5	1853-0036	2	2	2	TRANSISTOR PNP SI TO-92 PD=625MW	04713	2N3906(SEL)
ASQ6	1854-0591	6	6	1	TRANSISTOR NPN SI PD=180MW FT=4 GHZ	03334	BFR90
ASQ7	1854-0345	8	8	1	TRANSISTOR NPN SI PD=200MW	02037	2N5179
ASQ8	NOT ASSIGNED						
ASQ9	NOT ASSIGNED						

Table 6-2. Replaceable Parts (Continued)



Table 6-2. Replaceable Parts (Continued)

Reference Designation	HP Part Number	C	D	Qty	Description	Mfr Code	Mfr Part Number
ASR1	0757-0442	9	1	3	RESISTOR 10K ±1%, 125W TF TC=0+100	12498	CT4-1/8-T0-1002-F
ASR2	0698-3155	1	1	1	RESISTOR 4.64K ±1%, 125W F TC=0+100	12482	CT4-1/8-T0-4641-F
ASR3	0698-3156	2	2	2	RESISTOR 14.7K ±1%, 125W F TC=0+100	12482	CT4-1/8-T0-1472-F
ASR4	0757-0279	0	0	3	RESISTOR 3.16K ±1%, 125W TF TC=0+100	12498	CT4-1/8-T0-3161-F
ASR5	0698-3454	3	3	2	RESISTOR 215K ±1%, 125W TF TC=0+100	12498	CT4-1/8-T0-2153-F
ASR6	0698-0084	9	9	2	RESISTOR 2.15K ±1%, 125W TF TC=0+100	12498	CT4-1/8-T0-2151-F
ASR7	0698-0084	9	9	2	RESISTOR 2.15K ±1%, 125W TF TC=0+100	12498	CT4-1/8-T0-2151-F
ASR8	1810-0478	6	6	1	NETWORK RES 8-SIP 22.0K OHM X 4	32997	4308R-102-223
ASR9	0757-0420	3	3	1	RESISTOR 750 ±1%, 125W TF TC=0+100	12498	CT4-1/8-T0-751-F
ASR10	0757-0317	7	7	2	RESISTOR 1.33K ±1%, 125W TF TC=0+100	12498	CT4-1/8-T0-1331-F
ASR11	0757-0279	0	0	0	RESISTOR 3.16K ±1%, 125W TF TC=0+100	12498	CT4-1/8-T0-3161-F
ASR12	1810-0488	8	8	1	NETWORK-RESIS 8-SIP 4.7K OHM X 4	32997	4308R-102-472
ASR13	NOT ASSIGNED						
ASR14	0757-0401	0	0	1	RESISTOR 100 ±1%, 125W TF TC=0+100	12498	CT4-1/8-T0-101-F
ASR15	0698-0082	7	7	1	RESISTOR 464 ±1%, 125W TF TC=0+100	12498	CT4-1/8-T0-4640-F
ASR16	0698-3454	3	3	1	RESISTOR 215K ±1%, 125W TF TC=0+100	12498	CT4-1/8-T0-2153-F
ASR17	1810-0406	0	0	1	NETWORK RES 8-SIP 10.0K OHM X 4	32997	4308R-102-103
ASR18	0698-3162	0	0	1	RESISTOR 46.4K ±1%, 125W TF TC=0+100	12498	CT4-1/8-T0-4642-F
ASR19	1810-0398	9	9	1	NETWORK RES 10-SIP 22.0K OHM X 9	C1433	750-101
ASR20	0698-3152	8	8	1	RESISTOR 3.48K ±1%, 125W TF TC=0+100	12498	CTR-1/8-T0-1002-F
ASR21	0757-0279	0	0	0	RESISTOR 3.16K ±1%, 125W TF TC=0+100	12498	CT4-1/8-T0-3161-F
ASR22	0757-0465	7	7	3	RESISTOR 100K ±1%, 125W TF TC=0+100	12498	CT4-1/8-T0-1002-F
ASR23	0757-0317	7	7	1	RESISTOR 1.33K ±1%, 125W TF TC=0+100	12498	CT4-1/8-T0-1331-F
ASR24	0698-3444	7	7	1	RESISTOR 316 ±1%, 125W TF TC=0+100	12498	CT4-1/8-T0-316R-F
ASR25	2100-3352	7	7	1	RESISTOR-TRMR 1K 10% TKD SIDE-ADJ 1-TRN	28480	2100-3352
ASR26	0757-0465	6	6	1	RESISTOR 100K ±1%, 125W TF TC=0+100	12498	CT4-1/8-T0-1002-F
ASR27	0698-3441	8	8	1	RESISTOR 215 ±1%, 125W TF TC=0+100	12498	CT4-1/8-T0-215R-F
ASR28	0757-0442	9	9	1	RESISTOR 10K ±1%, 125W TF TC=0+100	12498	CT4-1/8-T0-1002-F
ASR29	1810-0445	7	7	3	NETWORK RES 6-SIP 100.0 OHM X 3	32997	4308R-102-101
ASR30	1810-0445	7	7	7	NETWORK RES 6-SIP 100.0 OHM X 3	06252	750-63-R100
ASR31	1810-0203	5	5	1	NETWORK RES 8-SIP 470.0 OHM X 7	C1433	750-81
ASR32	1810-0708	5	5	1	NETWORK RES 6-SIP 1.5K OHM X 3	C1433	750-61
ASR33	1810-0445	7	7	7	NETWORK RES 6-SIP 100.0 OHM X 3	06252	750-63-R10001
ASR34	1810-0445	7	7	7	NETWORK RES 6-SIP 100.0 OHM X 3	32997	4308R-102-101
ASR35	0757-0395	1	1	2	RESISTOR 56.2 ±1%, 125W TF TC=0+100	12498	CT4-1/8-T0-56R2-F
ASR36	0757-0395	1	1	1	RESISTOR 56.2 ±1%, 125W TF TC=0+100	12498	CS4-1/8-T0-56R2-F
ASR37	0698-0084	9	9	1	RESISTOR 2.15K ±1%, 125W TF TC=0+100	12498	CT4-1/8-T0-2151-F
ASR38	0757-0283	6	6	1	RESISTOR 2K ±1%, 125W TF TC=0+100	12498	CT4-1/8-GO-2001-F
ASR39	NOT ASSIGNED						
ASR40	0757-0438	3	3	1	RESISTOR 5.11K 1%, 125W F TC=0+100	12482	CT4-1/8-T0-5111-F
ASR41	0757-0465	6	6	1	RESISTOR 100K ±1%, 125W TF TC=0+100	12498	CT4-1/8-T0-1003-F
ASTP1	1251-0600	0	0	5	CONNECTOR-SGL CONT PIN 1,14-MM-BSC-SZ SQ	12360	94-155-1010-01-03-00
ASTP2	1251-0600	0	0	0	CONNECTOR-SGL CONT PIN 1,14-MM-BSC-SZ SQ	12360	94-155-1010-01-03-00
ASTP3	1251-0600	0	0	0	CONNECTOR-SGL CONT PIN 1,14-MM-BSC-SZ SQ	12360	94-155-1010-01-03-00
ASTP4	1251-0600	0	0	0	CONNECTOR-SGL CONT PIN 1,14-MM-BSC-SZ SQ	12360	94-155-1010-01-03-00
ASTP5	1251-0600	0	0	0	CONNECTOR-SGL CONT PIN 1,14-MM-BSC-SZ SQ	12360	94-155-1010-01-03-00
ASU1	1826-0371	1	1	1	IC-OP AMP LOW-BIAS H-IMPD 8-T0-99 PKG	28480	1826-0371
ASU2	1826-0412	1	1	1	IC-COMPARATOR PRCN DUAL 8-DIP-P PKG	27014	LM393N
ASU3	1820-3405	6	6	1	IC MISC CMOS 4-BIT	04713	MC145146P
ASU4	1820-2724	0	0	1	IC LCH TTL ALS TRANSPARENT OCTL	01295	SN74ALS73BN
ASU5	1826-1099	2	2	1	IC V RGLTR-ADJ NEG TO-92 PKG	27014	LM337LZ
ASU6	1826-0372	2	2	1	IC MISC 8-DIP-P PKG	28480	A251-0100
ASU7	1820-1383	5	5	1	IC CNTR ECL BDC POS-EDGE-TRIG	04713	MC10138L
ASU8	1820-3340	8	8	1	IC GATE ECL10KH OR-AND-INV	04713	MC10H121P
ASU9	1813-0213	3	3	1	IC WIDEBAND AMPL TO-39 PKG	04713	MWA130
ASU10	1820-1888	5	5	1	IC PRESCR ECL	04713	MC12013L
ASW1	8159-0005	0	0	2	RESISTOR-ZERO OHMS 22 AWG LEAD DIA	11502	YZ0 1/4
ASW2	8159-0005	0	0	2	RESISTOR-ZERO OHMS 22 AWG LEAD DIA	11502	YZ0 1/4

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

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

Reference	HP Part Number	C	D	Qty	Description	Mfr Code	Mfr Part Number
A6	05350-60006	1	1	1	IF AMP/HERM/DETECTOR (DATE CODE 9223 & ABOVE)	28480	05350-60006
A6C1	0160-4554	7	7	5	CAPACITOR-FXD .01UF +20% 50VDC CER	28480	0160-4554
A6C2	0160-4554	7	7	7	CAPACITOR-FXD .01UF +20% 50VDC CER	28480	0160-4554
A6C3	0160-4385	2	2	2	CAPACITOR-FXD 15PF +5% 200VDC CER 0+30	28480	0160-4385
A6C4	0160-4554	7	7	7	CAPACITOR-FXD .01UF +20% 50VDC CER	28480	0160-4554
A6C5	0160-3879	7	7	7	CAPACITOR-FXD .01UF +20% 100VDC CER	28480	0160-4554
A6C6	0160-3879	7	7	7	CAPACITOR-FXD .01UF +20% 100VDC CER	28480	0160-3879
A6C7	0121-0036	0	0	1	CAPACITOR-V TMMR-CER 5.5-18PF 350V	28480	DV11PR18A
A6C8	0160-3879	7	7	7	CAPACITOR-FXD .01UF +20% 100VDC CER	28480	0160-3879
A6C9	0160-4389	3	3	2	CAPACITOR-FXD 27PF +5PF 200VDC CER	28480	0160-3879
A6C10	0160-4389	6	6	2	CAPACITOR-FXD 100PF +5PF 200VDC CER	28480	0160-4389
A6C11	0160-3879	7	7	7	CAPACITOR-FXD .01UF +20% 100VDC CER	28480	0160-3879
A6C12	0160-3879	7	7	7	CAPACITOR-FXD .01UF +20% 100VDC CER	28480	0160-3879
A6C13	0160-4511	6	6	1	CAPACITOR-FXD 220PF +5% 200VDC CER	28480	0160-4511
A6C14	0121-0059	7	7	1	CAPACITOR-V TMMR-CER 2.8PF 350V PC-MTG	73899	DV11PR18A
A6C15	0160-3874	2	2	3	CAPACITOR-FXD 10-PF +.5PF 200VDC CER	28480	0160-3874
A6C16	0160-3872	0	0	1	CAPACITOR-FXD 22PF +.25PF 200VDC CER	28480	0160-3872
A6C17	0160-3879	7	7	7	CAPACITOR-FXD .01UF +20% 100VDC CER	28480	0160-3879
A6C18	0160-0576	5	5	2	CAPACITOR-FXD .1UF +20% 50VDC CER	28480	0160-0576
A6C19	0160-3879	7	7	7	CAPACITOR-FXD .01UF +20% 100VDC CER	28480	0160-3879
A6C20	0160-4387	4	4	3	CAPACITOR-FXD .01UF +20% 100VDC CER	28480	0160-4387
A6C21	0160-4493	3	3	7	CAPACITOR-FXD 27PF +5PF 200VDC CER	28480	0160-4389
A6C22	0160-3879	7	7	3	CAPACITOR-FXD 27PF +5PF 200VDC CER	28480	0160-4389
A6C23	0160-3873	2	2	1	CAPACITOR-FXD 4.7PF +10.64% 200V CER COG	12340	0160-3873
A6C24	0160-4385	2	2	2	CAPACITOR-FXD 15PF +5% 200VDC CER 0+30	28480	0160-4385
A6C25	0160-3879	7	7	7	CAPACITOR-FXD .01UF +20% 100VDC CER	28480	0160-3879
A6C26	0160-4547	8	8	1	CAPACITOR-FXD 150PF +5% 200VDC CER	28480	0160-4547
A6C27	0160-4527	4	4	1	CAPACITOR-FXD 56PF +5% 200VDC CER 0+30	28480	0160-4527
A6C28	0160-4804	0	0	1	CAPACITOR-FXD 56PF +5% 200VDC CER 0+30	28480	0160-4804
A6C29	0160-4521	8	8	2	CAPACITOR-FXD 12PF +5% 200VDC CER 0+30	28480	0160-4521
A6C30	0160-3879	7	7	7	CAPACITOR-FXD .01UF +20% 100VDC CER	28480	0160-3879
A6C31	0160-4554	7	7	1	CAPACITOR-FXD .01UF +20% 50VDC CER	28480	0160-4554
A6C32	0180-2662	6	6	3	CAPACITOR-FXD 10UF +10% 10VDC TA	25088	D4R7GS1A10K
A6C33	0160-0576	5	5	1	CAPACITOR-FXD .1UF +20% 50VDC CER	28480	0160-0576
A6C34	0160-4491	1	1	2	CAPACITOR-FXD 8.2PF +5PF 200VDC CER	28480	0160-4491
A6C35	0160-3879	7	7	7	CAPACITOR-FXD .01UF +20% 100VDC CER	28480	0160-3879
A6C36	0160-3879	7	7	7	CAPACITOR-FXD .01UF +20% 100VDC CER	28480	0160-3879
A6C37	0160-3879	7	7	7	CAPACITOR-FXD .01UF +20% 100VDC CER	28480	0160-3879
A6C38	0160-3879	7	7	7	NOT ASSIGNED	28480	0160-3879
A6C39	0160-4554	7	7	7	CAPACITOR-FXD .01UF +20% 50VDC CER	28480	0160-4554
A6C40	0160-4521	8	8	7	CAPACITOR-FXD 12PF +5% 200VDC CER 0+30	28480	0160-4521
A6C41	0160-3879	7	7	7	CAPACITOR-FXD .01UF +20% 100VDC CER	28480	0160-3879
A6C42	0160-3879	7	7	7	CAPACITOR-FXD .01UF +20% 100VDC CER	28480	0160-3879
A6C43	0160-4491	1	1	1	CAPACITOR-FXD 8.2PF +5PF 200VDC CER	28480	0160-4491
A6C44	0160-3879	7	7	7	CAPACITOR-FXD .01UF +20% 100VDC CER	28480	0160-3879
A6C45	0180-2662	6	6	6	CAPACITOR-FXD 10UF +10% 10VDC TA	25088	D4R7GS1A10K
A6C46	0160-3879	7	7	7	CAPACITOR-FXD .01UF +20% 100VDC CER	28480	0160-3879
A6C47	0160-3879	7	7	7	CAPACITOR-FXD .01UF +20% 100VDC CER	28480	0160-3879
A6C48	0160-3879	7	7	7	CAPACITOR-FXD .01UF +20% 100VDC CER	28480	0160-3879
A6C49	0160-3879	7	7	7	CAPACITOR-FXD .01UF +20% 100VDC CER	28480	0160-3879
A6C50	0160-3879	7	7	7	CAPACITOR-FXD .01UF +20% 100VDC CER	28480	0160-3879
A6C51	0160-3879	7	7	7	CAPACITOR-FXD .01UF +20% 100VDC CER	28480	0160-3879
A6C52	0160-4387	4	4	7	CAPACITOR-FXD 47PF +5% 200VDC CER 0+30	28480	0160-4387
A6C53	0160-3879	7	7	7	CAPACITOR-FXD .01UF +20% 100VDC CER	28480	0160-3879
A6C54	0160-3879	7	7	7	CAPACITOR-FXD .01UF +20% 100VDC CER	28480	0160-3879
A6C55	0160-3879	7	7	7	CAPACITOR-FXD .01UF +20% 100VDC CER	28480	0160-3879
A6C56	0160-4387	4	4	4	CAPACITOR-FXD 47PF +5% 200VDC CER 0+30	28480	0160-4387
A6C57	0180-0562	1	1	7	CAPACITOR-FXD .01UF +20% 100VDC CER	28480	0160-3879
A6C58	0160-3879	7	7	7	CAPACITOR-FXD .01UF +20% 100VDC CER	28480	0160-3879
A6C59	0160-4554	7	7	7	CAPACITOR-FXD .01UF +20% 50VDC CER	28480	0160-4554

Table 6-2. Replaceable Parts (Continued)

Table 6-2. Replaceable Parts (Continued)

Reference Designation	HP Part Number	C	D	Qty	Description	Mfr Code	Mfr Part Number
A6C60	0160-3874	2	2	2	CAPACITOR-FXD 10-PF +/-5PF 200VDC CER	28480	0160-3874
A6C61	0180-2662	6	6	6	CAPACITOR-FXD 10-PF +/-10% 10VDC TA	25088	D4R7G51A10K
A6C62	0160-3874	2	2	2	CAPACITOR-FXD 10-PF +/-5PF 200VDC CER	28480	0160-3874
A6CR1	1901-0535	9	9	8	DIODE-SM SIG SCHOTTKY	28480	1901-0535
A6CR2	1901-0535	9	9	9	DIODE-SM SIG SCHOTTKY	28480	1901-0535
A6CR3	1901-0535	9	9	9	DIODE-SM SIG SCHOTTKY	28480	1901-0535
A6CR4	1901-0535	9	9	9	DIODE-SM SIG SCHOTTKY	28480	1901-0535
A6CR5	1901-0535	9	9	9	DIODE-SM SIG SCHOTTKY	28480	1901-0535
A6CR6	1901-0535	9	9	9	DIODE-SM SIG SCHOTTKY	28480	1901-0535
A6CR7	1902-3059	0	0	1	DIODE-ZNR 3.83V 5% DO-35 PD=4W	28480	1902-3059
A6CR8	1901-0535	9	9	9	DIODE-SM SIG SCHOTTKY	28480	1901-0535
A6CR9	1901-0535	9	9	9	DIODE-SM SIG SCHOTTKY	28480	1901-0535
A6DS1	1990-1022	8	8	1	LED-LAMP LUM-INI=4MCD IF=25MA-MAX BVR=5V	28480	HLMF-5030
A6DS2	1990-1024	0	0	1	LED-LAMP LUM-INI=6MCD BVR=5V	28480	1990-1024
A6DS3	1990-0966	7	7	1	LED-LAMP LUM-INI=3MCD IF=20MA-MAX BVR=5V	28480	HLMF-5050
A6E1	9170-0029	3	3	1	CORE-SHIELDING BEAD	28480	9170-0029
A6L1	9135-0074	4	4	2	INDUCTOR RF-CH-MLD 47NH 6.17%	28480	9135-0074
A6L2	9135-0076	6	6	1	INDUCTOR RF-CH-MLD 39NH 6%	28480	9135-0076
A6L3	9135-0078	8	8	2	INDUCTOR RF-CH-MLD 82NH 5.61%	28480	9135-0078
A6L4	9135-0074	4	4	4	INDUCTOR RF-CH-MLD 47NH 6.17%	28480	9135-0074
A6L5	9135-0068	6	6	1	INDUCTOR RF-CH-MLD 33NH 6.36%	28480	9135-0068
A6L6	9135-0081	3	3	1	INDUCTOR RF-CH-MLD 68NH 5%	28480	9135-0081
A6L7	9140-0551	3	3	2	INDUCTOR RF-CH-MLD 10UH 5% .105DX.26LG	28480	9140-0551
A6L8	9140-0477	2	2	1	INDUCTOR RF-CH-MLD 270NH 1% .105DX.26LG	28480	9140-0477
A6L9	9140-0353	3	3	1	INDUCTOR RF-CH-MLD 430NH 1% .105DX.26LG	28480	9140-0353
A6L10	9140-0516	0	0	1	INDUCTOR RF-CH-MLD 160NH 5% .105DX.26LG	28480	9140-0516
A6L11	9135-0078	8	8	2	INDUCTOR RF-CH-MLD 82NH 5.61%	28480	9135-0078
A6L12	9100-0541	7	7	2	INDUCTOR RF-CH-MLD 250UH 10%	28480	9100-0541
A6L13	9140-0352	2	2	1	INDUCTOR RF-CH-MLD 330NH 1% .105DX.26LG	28480	9140-0352
A6L14	9140-0551	3	3	1	INDUCTOR RF-CH-MLD 10UH 5% .105DX.26LG	28480	9140-0551
A6L15	9140-0529	5	5	1	INDUCTOR RF-CH-MLD 130NH 5% .105DX.26LG	28480	9140-0529
A6L16	9140-0528	4	4	2	INDUCTOR RF-CH-MLD 120NH 5% .105DX.26LG	28480	9140-0528
A6L17	9100-1788	6	6	4	CORE-FERRITE CHOKE-WIDEBAND;IMP>680	28480	9100-1788
A6L18	9140-0477	2	2	1	INDUCTOR RF-CH-MLD 270NH 1% .105DX.26LG	28480	9140-0477
A6L19	9100-1788	6	6	6	CORE-FERRITE CHOKE-WIDEBAND;IMP>680	28480	9100-1788
A6L20	9100-0541	7	7	7	INDUCTOR RF-CH-MLD 250UH 10%	28480	9100-0541
A6L21	9100-0654	3	3	1	CORE-FERRITE CHOKE-WIDEBAND;IMP>800	28480	9100-0654
A6L22	9100-1788	6	6	6	CORE-FERRITE CHOKE-WIDEBAND;IMP>680	28480	9100-1788
A6L23	9140-0551	4	4	3	INDUCTOR RF-CH-MLD 10UH 5% .105DX.26LG	28480	9140-0551
A6L24	9140-0528	3	3	4	INDUCTOR RF-CH-MLD 120NH 5% .105DX.26LG	28480	9140-0528
A6L25	9140-0537	5	5	1	INDUCTOR RF-CH-MLD 22UH 5% .105DX.26LG	28480	9140-0537
A6L26	9100-2817	4	4	5	INDUCTOR RF-CH-MLD 100NH 5%	28480	9100-2817
A6L27	9100-2817	4	4	4	INDUCTOR RF-CH-MLD 100NH 5%	28480	9100-2817
A6L28	9100-2817	4	4	4	INDUCTOR RF-CH-MLD 100NH 5%	28480	9100-2817
A6L29	9100-2817	4	4	4	INDUCTOR RF-CH-MLD 100NH 5%	28480	9100-2817
A6L30	9100-2817	4	4	4	INDUCTOR RF-CH-MLD 100NH 5%	28480	9100-2817
A6L31	9100-1788	6	6	6	CORE-FERRITE CHOKE-WIDEBAND;IMP>680	28480	9100-1788
A6MP1	5000-9043	6	6	1	PIN-EXTRACTOR	28480	5000-9043
A6MP2	5040-6852	3	3	1	EXTRACTOR-CRN	28480	5040-6852
A6MP3	05350-00014	5	5	1	GROUND STRAP- RIGHT	28480	05350-00014
A6MP4	05350-00015	6	6	1	GROUND STRAP- LEFT	28480	05350-00015
A6P1	1251-7986	9	9	1	CONN-POST TYPE.100-PIN SFG 50-CONT	28480	1251-7986
A6Q1	1853-0036	2	2	3	TRANSISTOR PNP SI PD=310MW FT=250MHZ	27014	2N3906
A6Q2	1854-0215	1	1	2	TRANSISTOR NPN SI TO-92 PD=350MW	04713	2N3904
A6Q3	1853-0036	2	2	2	TRANSISTOR PNP SI PD=310MW FT=250MHZ	27014	2N3906
A6Q4	1854-0215	1	1	2	TRANSISTOR NPN SI TO-92 PD=350MW	04713	2N3904
A6Q5	1853-0036	2	2	2	TRANSISTOR PNP SI PD=310MW FT=250MHZ	27014	2N3906
A6Q6	1853-0352	5	5	1	TRANSISTOR PNP SI TO-92 PD=350MW FT=1GHZ	28480	1853-0352
A6Q7	1854-0345	8	8	1	TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW	04713	2N5179
A6Q8	1854-0591	6	6	4	TRANSISTOR NPN SI PD=180MW FT=4GHZ	25403	BFR90

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

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See introduction to this section for ordering information

Reference	HP Part Number	C	D	Qty	Description	Mfr Code	Mfr Part Number
AC9	1854-0591	6	6	6	TRANSISTOR NPN SI PD=180MW FT=4GHZ	25403	BFR90
AC10	1854-0591	6	6	6	TRANSISTOR NPN SI PD=180MW FT=4GHZ	25403	BFR90
AQ11	1854-0591	6	6	6	TRANSISTOR NPN SI PD=180MW FT=4GHZ	25403	BFR90
AR1	0757-0405	4	4	5	RESISTOR 162 1% .125W F TC=0+-100	24546	CT4-1/8-TO-162R-F
AR2	0757-0442	9	9	5	RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-TO-1002-F
AR3	0757-0442	9	9	5	RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-TO-1002-F
AR4	0757-0405	4	4	9	RESISTOR 162 1% .125W F TC=0+-100	24546	CT4-1/8-TO-162R-F
AR5	0757-0442	9	9	9	RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-TO-1002-F
AR6	0757-0279	0	0	6	RESISTOR 3.16K 1% .125W F TC=0+-100	24546	CT4-1/8-TO-3161-F
AR7	2100-3354	9	9	1	RESISTOR TMR 50K 10% C SIDE-ADJ 1-TRN	28480	CT4-1/8-TO-3161-F
AR8	0757-0405	6	6	2	RESISTOR 100K 1% .125W F TC=0+-100	24546	CT4-1/8-TO-1003-F
AR9	0757-0417	8	8	2	RESISTOR 562 1% .125W F TC=0+-100	24546	CT4-1/8-TO-562R-F
AR10	0757-0417	8	8	2	RESISTOR 562 1% .125W F TC=0+-100	24546	CT4-1/8-TO-562R-F
AR11	0757-0280	3	3	2	RESISTOR 1K 1% .125W F TC=0+-100	24546	CT4-1/8-TO-1001-F
AR12	0757-0465	6	6	2	RESISTOR 100K 1% .125W F TC=0+-100	24546	CT4-1/8-TO-1003-F
AR13	0698-3446	3	3	2	RESISTOR 383 1% .125W F TC=0+-100	24546	CT4-1/8-TO-383R-F
AR14	0698-3454	3	3	2	RESISTOR 215 1% .125W F TC=0+-100	24546	CT4-1/8-TO-2153-F
AR15	0757-0442	9	9	2	RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-TO-1002-F
AR16	0698-3454	3	3	3	RESISTOR 215K 1% .125W F TC=0+-100	24546	CT4-1/8-TO-2153-F
AR17	0699-0073	0	0	1	NOT ASSIGNED	24546	CT4-1/8-TO-2153-F
AR18	0699-0073	0	0	1	RESISTOR 10M 1% .125W F TC=0+-150	28480	0699-0073
AR19	0757-0279	8	8	1	RESISTOR 34.8K 1% .125W F TC=0+-100	24546	CT4-1/8-TO-3161-F
AR20	0757-0123	3	3	1	RESISTOR 34.8K 1% .125W F TC=0+-100	24546	CT4-1/8-TO-3161-F
AR21	0757-0398	4	4	1	RESISTOR 75 1% .125W F TC=0+-100	24546	CT4-1/8-TO-75R0-F
AR22	0757-0401	0	0	8	RESISTOR 100 1% .125W F TC=0+-100	24546	CT4-1/8-TO-1001-F
AR23	0757-0279	0	0	3	RESISTOR 3.16K 1% .125W F TC=0+-100	24546	CT4-1/8-TO-3161-F
AR24	0757-0280	0	0	3	RESISTOR 1K 1% .125W F TC=0+-100	24546	CT4-1/8-TO-1001-F
AR25	2100-3351	6	6	1	RESISTOR-TMR-TRM 500 10% C SIDE-ADJ 1-TRN	28480	2100-3351
AR26	0757-0279	0	0	0	RESISTOR 3.16K 1% .125W F TC=0+-100	24546	CT4-1/8-TO-3161-F
AR27	0757-0442	9	9	2	RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-TO-1003-F
AR28	0757-0394	0	0	2	RESISTOR 51.1K 1% .125W F TC=0+-100	24546	CT4-1/8-TO-511R1-F
AR29	0757-0401	0	0	0	RESISTOR 100 1% .125W F TC=0+-100	24546	CT4-1/8-TO-101-F
AR30	0757-0279	0	0	3	RESISTOR 3.16K 1% .125W F TC=0+-100	24546	CT4-1/8-TO-3161-F
AR31	0757-0180	2	2	3	RESISTOR 31.6 1% .125W F TC=0+-100	28480	0757-0180
AR32	0757-0401	0	0	0	RESISTOR 100 1% .125W F TC=0+-100	28480	0757-0180
AR33	0698-3446	3	3	0	RESISTOR 383 1% .125W F TC=0+-100	24546	CT4-1/8-TO-383R-F
AR34	0757-0405	4	4	0	RESISTOR 162 1% .125W F TC=0+-100	24546	CT4-1/8-TO-162R-F
AR35	0757-0394	0	0	0	RESISTOR 51.1K 1% .125W F TC=0+-100	24546	CT4-1/8-TO-511R1-F
AR36	0757-0180	2	2	2	RESISTOR 31.6 1% .125W F TC=0+-100	28480	0757-0180
AR37	0757-0279	0	0	0	RESISTOR 3.16K 1% .125W F TC=0+-100	28480	0757-0180
AR38	0698-7212	9	9	1	RESISTOR 100 1% .05W F TC=0+-100	24546	C3-1/8-TO-100R-F
AR39	0699-1542	8	8	4	RESISTOR 51 1% .125W F TC=0+-50	28480	0699-1542
AR40	0757-0401	0	0	4	RESISTOR 100 1% .125W F TC=0+-100	24546	CT4-1/8-TO-101-F
AR41	0699-1542	8	8	0	RESISTOR 51 1% .125W F TC=0+-50	28480	0699-1542
AR42	0757-0401	0	0	0	RESISTOR 100 1% .125W F TC=0+-100	28480	0699-1542
AR43	0757-0401	0	0	0	RESISTOR 100 1% .125W F TC=0+-100	24546	CT4-1/8-TO-101-F
AR44	0757-0405	4	4	0	RESISTOR 162 1% .125W F TC=0+-100	24546	CT4-1/8-TO-162R-F
AR45	0699-1542	8	8	0	RESISTOR 51 1% .125W F TC=0+-50	28480	0699-1542
AR46	0699-1542	8	8	0	RESISTOR 51 1% .125W F TC=0+-50	28480	0699-1542
AR47	0757-0401	0	0	0	RESISTOR 100 1% .125W F TC=0+-100	28480	0699-1542
AR48	0757-0180	2	2	0	RESISTOR 100 1% .125W F TC=0+-100	24546	CT4-1/8-TO-101-F
AR49	0757-0401	0	0	0	RESISTOR 100 1% .125W F TC=0+-100	24546	CT4-1/8-TO-101-F
AR50	0757-0405	4	4	0	RESISTOR 162 1% .125W F TC=0+-100	24546	CT4-1/8-TO-162R-F
ASTP1-TP4	1251-0600	0	0	4	CONNECTOR-SGL CONT PIN 1.14MM-BSC-SZ SQ	28480	1251-0600
AT1	1820-1197	9	9	1	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
ASU2	1826-0412	1	1	1	IC COMPARTOR PRCN DUAL 8-DIP-P PKG	27014	LM393N
ASU3	1813-0211	1	1	2	IC WIDEBAND AMPL TO-39 PKG	04713	MMA110
ASU4	1813-0211	1	1	2	IC WIDEBAND AMPL TO-39 PKG	04713	MMA110
AW1	05350-60101	7	7	1	CABLE AV-COAX TOPC	28480	05350-60101
AW2-W5	8159-0005	0	0	3	RESISTOR-ZERO-OHM 22AWG LEAD DIA	28480	0159-0005

Table 6-2. Replaceable Parts (Continued)



See Introduction to this section for ordering information

Reference Designation	HP Part Number	C D Qty	Description	Mtr Code	Mtr Part Number
A7U16	05348-80003	6	LBL EPROM 80003	28480	05348-80003
A7U17	1818-3981	8	IC CMOS 262144 (256K) STAT RAM 120-NS	54111	HM62256LP-12
A7U18	1818-4135	6	IC NMOS 8192 (8K) STAT RAM 100-NS 3-S	34335	AM2130-10DC
A7XU16	1200-0567	1	SOCKET-IC-DIP 28-CONT DIP DIP-SLDR	01295	C8728-01
A7Y1	1813-0605	7	CLOCK-OSCILLATOR-XTAL 16.0-MHZ 0.10%	00815	HS-113-16MHZ

Table 6-2. Replaceable Parts (Continued)

Table 6-2. Replaceable Parts (Continued)

Reference Designation	HP Part Number	C	D	Qty	Description	Mfr Code	Mfr Part Number
A8	05348-60008		9	1	POWER METER ANALOG ASSEMBLY	28480	05348-60008
ABC1	0180-2929	8	2	1	CAPACITOR-FXD 68UF 10V TA	12344	T140B686K010AS
ABC2	0160-4624	2	2	2	CAPACITOR-FXD 8200UF 50V	12344	C440C822J5G5CA
ABC3	0180-4134	1	1	3	CAPACITOR-FXD 22UF 15V TA	12344	T322D226K015AS
ABC4	0180-4134	1	1	1	CAPACITOR-FXD 22UF 15V TA	12344	T322D226K015AS
ABC5	0180-6399	2	2	1	CAPACITOR-FXD 0.15UF 50V	04222	S4405C154KAH
ABC6	0160-4801	7	4	4	CAPACITOR-FXD 100PF 100V	12344	C410C101J1G5CA
ABC7	0160-3723	0	2	2	CAPACITOR-FXD 0.33UF 50V POLY-C-MET	06156	MKC 4/0.33/10/100V
ABC8	0160-4824	4	2	1	CAPACITOR-FXD 680PF 100V	12344	C420C681J1G5CA
ABC9	0160-4624	2	2	1	CAPACITOR-FXD 8200UF 50V	12344	C440C822J5G5CA
ABC10	0160-5467	3	3	1	CAPACITOR-FXD 0.01UF 63V POLY-E-MET	06156	MKS 2
ABC11	0160-6430	2	3	3	CAPACITOR-FXD 0.01UF 63V POLY-C-MET	06156	MKC-2
ABC12	0160-5099	7	7	1	CAPACITOR-FXD 3300PF 100V	12344	C440C332J1G5CA
ABC13	0180-5931	6	6	1	CAPACITOR-FXD 0.22UF 50V POLY-T-MET	06156	MKS 2 0.22UF 50VDC
ABC14	0160-4801	7	7	1	CAPACITOR-FXD 100PF 100V	12344	C410C101J1G5CA
ABC15	0160-4801	7	7	7	CAPACITOR-FXD 100PF 100V	12344	C410C101J1G5CA
ABC16	0160-7142	5	2	2	CAPACITOR-FXD 1UF 63V POLY-C-MET	06156	MKC41.0/63/10
ABC17	0160-5928	1	1	1	CAPACITOR-FXD 0.68UF 100V POLY-C-MET	06156	MKC4.68UF/10%/100VDC
ABC18	0160-7142	2	2	5	CAPACITOR-FXD 1UF 63V POLY-C-MET	06156	MKC41.0/63/10
ABC19	0160-6430	5	2	2	CAPACITOR-FXD 0.1UF 63V POLY-C-MET	06156	MKC-2
ABC20	0160-6975	0	0	1	CAPACITOR-FXD 0.027UF 63V POLY-C-MET	06156	MKC2/027/63V/5%
ABC21	0160-6974	9	9	3	CAPACITOR-FXD 0.039UF 63V POLY-C-FL	06156	MKC2/039/63V/5%
ABC22	0160-3723	0	0	0	CAPACITOR-FXD 0.33UF 50V POLY-C-MET	06156	MKC 4/0.33/10/100V
ABC23	0160-7136	7	7	1	CAPACITOR-FXD 0.1UF 100V POLY-P-FL	84411	HEW660/0.1UF/2%/100VDC
ABC24	0160-4801	7	7	7	CAPACITOR-FXD 100PF 100V	12344	C410C101J1G5CA
ABC25	0160-6430	2	2	2	CAPACITOR-FXD 0.1UF 63V POLY-C-MET	06156	MKC-2
ABC26	0160-4554	7	7	16	CAPACITOR-FXD 0.01UF 50V	12344	C410C103M5R5CA
ABC27	0160-4554	7	7	7	CAPACITOR-FXD 0.01UF 50V	12344	C410C103M5R5CA
ABC28	0160-4554	7	7	7	NOT ASSIGNED	12344	C410C103M5R5CA
ABC29	0160-4554	7	7	7	CAPACITOR-FXD 0.01UF 50V	12344	C410C103M5R5CA
ABC30	0160-4554	7	7	7	CAPACITOR-FXD 0.01UF 50V	12344	C410C103M5R5CA
ABC31	0160-4554	7	7	7	CAPACITOR-FXD 0.01UF 50V	12344	C410C103M5R5CA
ABC32	0160-4554	7	7	7	CAPACITOR-FXD 0.01UF 50V	12344	C410C103M5R5CA
ABC33	0160-4801	7	7	1	CAPACITOR-FXD 100PF 100V	12344	C410C101J1G5CA
ABC34	0160-4491	1	1	1	CAPACITOR-FXD 8.2PF 200V	12344	C320C828D2G5CA
ABC35	0160-3878	6	6	1	CAPACITOR-FXD 1000PF 100V	12344	C320C102M1R5CA
ABC36	0160-4554	7	7	1	CAPACITOR-FXD 0.01UF 50V	12344	C410C103M5R5CA
ABC37	0160-4807	3	3	1	CAPACITOR-FXD 33PF 100V	12344	C410C33J1G5CA
ABC38	0160-4006	4	1	1	CAPACITOR-FXD 36PF 300V GL	04222	CY06C36J
ABC39	0160-4007	5	1	1	CAPACITOR-FXD 200PF 300V GL	04222	C706C20J
ABC40	0180-4134	1	1	1	CAPACITOR-FXD 22UF 15V TA	12344	T322D226K015AS
ABC41	0180-6974	9	9	9	CAPACITOR-FXD 0.039UF 63V POLY-C-FL	06156	MKC2/039/63V/5%
ABC42	0160-6974	9	9	9	CAPACITOR-FXD 0.039UF 63V POLY-C-FL	06156	MKC2/039/63V/5%
ABC43	0180-4130	8	8	3	CAPACITOR-FXD 2.2UF 20V TA	56289	173D225X9020V
ABC44	0180-4130	8	8	8	CAPACITOR-FXD 2.2UF 20V TA	56289	173D225X9020V
ABC45	0180-4130	8	8	8	CAPACITOR-FXD 2.2UF 20V TA	56289	173D225X9020V
ABC46	0160-4554	7	7	7	NOT ASSIGNED	12344	C410C103M5R5CA
ABC47	0160-4554	7	7	7	CAPACITOR-FXD 0.01UF 50V	12344	C410C103M5R5CA
ABC48 - C50					NOT ASSIGNED		
ABC51	0180-3943	2	2	3	CAPACITOR-FXD 10UF 25V AL-ELECT	00494	KMC25T10M
ABC52	0160-4554	7	7	7	CAPACITOR-FXD 0.01UF 50V	12344	C410C103M5R5CA
ABC53	NOT ASSIGNED				NOT ASSIGNED		
ABC54	0180-3943	2	2	2	CAPACITOR-FXD 10UF 25V AL-ELECT	00494	KMC25T10M
ABC55	0160-4554	7	7	7	CAPACITOR-FXD 0.01UF 50V	12344	C410C103M5R5CA
ABC56	0160-4554	7	7	7	CAPACITOR-FXD 0.01UF 50V	12344	C410C103M5R5CA
ABC57	0180-3943	2	2	2	CAPACITOR-FXD 10UF 25V AL-ELECT	00494	KMC25T10M
ABC58	0160-4554	7	7	7	CAPACITOR-FXD 0.01UF 50V	12344	C410C103M5R5CA
ABC59	0160-4554	7	7	7	CAPACITOR-FXD 0.01UF 50V	12344	C410C103M5R5CA
ABC60	0160-4554	7	7	7	CAPACITOR-FXD 0.01UF 50V	12344	C410C103M5R5CA

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

Table 6-2. Replaceable Parts (Continued)

Reference Designation	HP Part Number	C	D	Qty	Description	Mfr Code	Mfr Part Number
ABCE1	0160-4554	7		1	CAPACITOR-RXD 0.01UF 50V	12344	C410C103M5R5CA
ABCE2	0180-4131	8		1	CAPACITOR-FXD 4.7UF 35V TA	12344	T32C475K035AS
ABCE3	0160-4554	7		1	CAPACITOR-FXD 0.01UF 50V	12344	C410C103M5R5CA
ABCR1	1901-0996	6		2	DIODE-SCHOTTKY SM SIG	28480	1901-0996
ABCR2	1901-0996	6		2	DIODE-SCHOTTKY SM SIG	28480	1901-0996
ABCR3	1901-0996	6		1	DIODE-SCHOTTKY SM SIG	28480	1901-0996
ABCR4	1901-0050	3		1	DIODE-SWITCHING 80V 200MA ZNS DO-35	9N171	1N4150
ABCR5	1901-0518	8		2	DIODE-SCHOTTKY SM SIG	12403	5082-2800
ABCR6	1901-0518	8		8	DIODE-SCHOTTKY SM SIG	12403	5082-2800
ABCR7	0122-0299	9		1	DIODE-VVC 82PF 5% C2/C20-MIN=2 BVR=20V	28480	0122-0299
ABN1	1252-1034	8		1	CONN-POST TYPE .100-PIN SPCG 34-CONT	28480	1252-1034
ABN2	1252-2275	1		1	CONN-POST TYPE .100-PIN SPCG 9-CONT	28480	1252-2275
ABJ3	1250-1425	1		1	CONNECTOR-RF SMC M SGL-HOLE-RR 50-OHM	24931	37JR117-3
ABL1	9100-0566	6		1	INDUCTOR-RF-CH-MLD 4.7UH +-5%	91637	IM-2.47UH 5%
ABL2	9140-0574	0		1	INDUCTOR-RF-CH-MLD 100UH +-5%	91637	IM-2.100UH 5%
ABL3	9100-0566	6		1	INDUCTOR-RF-CH-MLD 4.7UH +-5%	91637	IM-2.47UH 5%
ABL4	9100-0566	6		1	INDUCTOR-RF-CH-MLD 4.7UH +-5%	91637	IM-2.47UH 5%
ABL5	00436-80001	1		1	COIL-VARIABLE	28480	00436-80001
ABL6	00436-80002	2		1	COIL 3-1/2 TURNS	28480	00436-80002
ABL7	9100-0539	3		3	INDUCTOR-RF-CH-MLD 10UH +-5%	28480	9100-0539
ABL8	9100-0539	3		3	INDUCTOR-RF-CH-MLD 10UH +-5%	28480	9100-0539
ABL9	9100-0539	3		3	INDUCTOR-RF-CH-MLD 10UH +-5%	28480	9100-0539
ABL10	9100-0566	6		6	INDUCTOR-RF-CH-MLD 4.7UH +-5%	28480	9100-0539
ABQ1	1854-0810	2		5	TRANSISTOR NPN SI PD=625MW FT=200MHZ	56289	CT-1058
ABQ2	1853-0459	3		2	TRANSISTOR PNP SI PD=625MW FT=200MHZ	28480	1853-0459
ABQ3	1854-0810	2		2	TRANSISTOR NPN SI PD=625MW FT=200MHZ	28480	CT-1058
ABQ4	1854-0810	2		2	TRANSISTOR NPN SI PD=625MW FT=200MHZ	56289	CT-1058
ABQ5	1854-0247	9		1	TRANSISTOR NP SI TO-39 PD=1W FT=800MHZ	28480	1854-0247
ABQ6	1855-0414	4		1	TRANSISTOR J-FET 2N4393 N-CHAN D-MODE	17856	2N4393
ABQ7	1854-0810	2		2	TRANSISTOR NPN SI PD=625MW FT=200MHZ	56289	CT-1058
ABQ8	1853-0459	3		2	TRANSISTOR PNP SI PD=625MW FT=200MHZ	28480	1853-0459
ABQ9	1854-0810	2		2	TRANSISTOR NPN SI PD=625MW FT=200MHZ	56289	CT-1058
ABR1	0698-3450	9		3	RESISTOR 42.2K +-5% .125W TF TC=0+-100	12498	CT4-1/8-TO-4222-F
ABR2	0698-6619	8		5	RESISTOR 15K +-0.1% .125W TF TC=0+-25	12498	CT4-1/8-TO-15K-F
ABR3	0757-0444	8		2	RESISTOR 56.2K +-1% .125W TF TC=0+-100	12498	CT4-1/8-TO-5622-F
ABR4	0757-0444	1		2	RESISTOR 12.1K +-1% .125W TF TC=0+-100	12498	CT4-1/8-TO-1212-F
ABR5	0757-0442	9		9	RESISTOR 10K +-1% .125W TF TC=0+-100	12498	CT4-1/8-TO-1002-F
ABR6	0757-0463	4		3	RESISTOR 82.5K +-1% .125W TF TC=0+-100	12498	CT4-1/8-TO-8252-F
ABR7	0698-3159	5		1	RESISTOR 26.1K +-1% .125W TF TC=0+-100	12498	CT4-1/8-TO-2612-F
ABR8	0698-3450	8		9	RESISTOR 42.2K +-5% .125W TF TC=0+-100	12498	CT4-1/8-TO-4222-F
ABR9	0698-3441	8		9	RESISTOR 215 +-1% .125W TF TC=0+-100	12498	CT4-1/8-TO-215R-F
ABR10	0698-3441	8		8	RESISTOR 215 +-1% .125W TF TC=0+-100	12498	CT4-1/8-TO-215R-F
ABR11	0698-3441	8		8	RESISTOR 215 +-1% .125W TF TC=0+-100	12498	CT4-1/8-TO-215R-F
ABR12	0698-3451	0		1	RESISTOR 133K +-1% .125W TF TC=0+-100	12498	CT4-1/8-TO-1333-F
ABR13	0698-3160	8		1	RESISTOR 31.6K +-1% .125W TF TC=0+-100	12498	CT4-1/8-TO-3162-F
ABR14	0698-0083	8		1	RESISTOR 1.96K +-1% .125W TF TC=0+-100	12498	CT4-1/8-TO-1961-F
ABR15	0698-0084	9		1	RESISTOR 2.15K +-1% .125W TF TC=0+-100	12498	CT4-1/8-TO-2151-F
ABR16	0811-3351	1		1	RESISTOR 11K +-0.025% .05W PN TC=0+-10	01686	R342
ABR17	0188-3348	6		2	RESISTOR 11K +-1% .125W TF TC=0+-100	12498	R342
ABR18	0757-0280	3		7	RESISTOR 10K +-1% .125W TF TC=0+-100	12498	R342
ABR19	0757-0465	6		5	RESISTOR 100K +-1% .125W TF TC=0+-100	12498	CT4-1/8-TO-1003-F
ABR20 - R23	0811-3350	0		1	NOT ASSIGNED	01686	R342
ABR24	0811-3349	7		1	RESISTOR 10K +-0.025% .05W PN TC=0+-10	01686	R342
ABR25	0811-3349	7		1	RESISTOR 1K +-0.025% .05W PN TC=0+-10	01686	R342
ABR26	0188-3348	6		2	RESISTOR 11K +-1% .125W TF TC=0+-100	12498	R342
ABR27	0757-0442	9		9	RESISTOR 10K +-1% .125W TF TC=0+-100	12498	R342
ABR28	0757-0123	3		2	RESISTOR 34.8K +-1% .125W TF TC=0+-100	12498	CT4-1/8-TO-1002-F
ABR29	0698-3450	9		2	RESISTOR 42.2K +-5% .125W TF TC=0+-100	12498	CT4-1/8-TO-4222-F

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



Table 6-2. Replaceable Parts (Continued)

Reference Designation	HP Part Number	C	D	Qty	Description	Mfr Code	Mfr Part Number
ABR30	0757-0278	9	1	1	RESISTOR 1.78K ±1%. 125W TF TC=0±100	12498	CT4-1/8-T0-1781-F
ABR31	0698-6619	8	1	1	RESISTOR 15K ±0.1%. 125W TF TC=0±25	12498	NESS
ABR32	0757-0463	4	4	1	RESISTOR 82.5K ±1%. 125W TF TC=0±100	12498	CT4-1/8-T0-8252-F
ABR33	0757-0439	4	2	1	RESISTOR 6.81K ±1%. 125W TF TC=0±100	12498	CT4-1/8-T0-6811-F
ABR34	0757-0442	9	9	1	RESISTOR 10K ±1%. 125W TF TC=0±100	12498	CT4-1/8-T0-1002-F
ABR35	0757-0442	9	9	1	RESISTOR 10K ±1%. 125W TF TC=0±100	12498	CT4-1/8-T0-1002-F
ABR36	0757-0442	9	6	1	RESISTOR 10K ±1%. 125W TF TC=0±100	12498	CT4-1/8-T0-1002-F
ABR37	0757-0465	6	2	1	RESISTOR 100K ±1%. 125W TF TC=0±100	12498	CT4-1/8-T0-1003-F
ABR38	0698-3453	2	2	1	RESISTOR 196K ±1%. 125W TF TC=0±100	12498	CT4-1/8-T0-1963-F
ABR39	0757-0444	1	1	1	RESISTOR 12.1K ±1%. 125W TF TC=0±100	12498	CT4-1/8-T0-1212-F
ABR40	0757-0463	4	4	1	RESISTOR 82.5K ±1%. 125W TF TC=0±100	12498	CT4-1/8-T0-8252-F
ABR41	0757-0470	3	1	1	RESISTOR 162K ±1%. 125W TF TC=0±100	12498	CT4-1/8-T0-1623-F
ABR42	0698-3162	0	1	1	RESISTOR 46.4K ±1%. 125W TF TC=0±100	12498	CT4-1/8-T0-4642-F
ABR43	0698-3455	4	1	1	RESISTOR 261K ±1%. 125W TF TC=0±100	12498	CT4-1/8-T0-2613-F
ABR44	0698-0199	3	1	1	RESISTOR 21.5K ±1%. 125W TF TC=0±100	12498	CT4-1/8-T0-2152-F
ABR45	0698-6619	8	8	1	RESISTOR 15K ±0.1%. 125W TF TC=0±25	12498	CT4-1/8-T0-2152-F
ABR46	0757-0442	9	9	1	RESISTOR 10K ±1%. 125W TF TC=0±100	12498	CT4-1/8-T0-1002-F
ABR47	0698-6360	6	2	1	RESISTOR 10K ±0.1%. 125W TF TC=0±25	12498	CT4-1/8-T0-1002-F
ABR48	0698-6320	8	4	1	RESISTOR 5K ±0.1%. 125W TF TC=0±25	12498	NESS
ABR49	0698-6320	8	4	1	RESISTOR 5K ±0.1%. 125W TF TC=0±25	12498	NESS
ABR50	0698-6643	2	1	1	RESISTOR 84.5K ±0.1%. 125W TF TC=0±25	12498	NESS
ABR51	0698-6343	5	1	1	RESISTOR 9K ±0.1%. 125W TF TC=0±25	12498	5033R-1/8-19-698R-R
ABR52	0698-7394	3	1	1	RESISTOR 699 ±0.1%. 125W TF TC=0±25	19701	5033R-1/8-19-698R-R
ABR53	0757-0280	3	3	1	RESISTOR 1K ±1%. 125W TF TC=0±100	12498	CT4-1/8-T0-1001-F
ABR54	0757-0465	6	6	1	RESISTOR 100K ±1%. 125W TF TC=0±100	12498	CT4-1/8-T0-1003-F
ABR55	0757-0280	3	3	1	RESISTOR 1K ±1%. 125W TF TC=0±100	12498	CT4-1/8-T0-1001-F
ABR56	0757-0465	6	1	1	RESISTOR 100K ±1%. 125W TF TC=0±100	12498	CT4-1/8-T0-1003-F
ABR57	0698-3447	4	0	1	RESISTOR 422 ±1%. 125W TF TC=0±100	12498	CT4-1/8-T0-422R-F
ABR58	0698-0085	4	2	1	RESISTOR 2.61K ±1%. 125W TF TC=0±100	12498	CT4-1/8-T0-2611-F
ABR59	0698-0085	0	0	1	RESISTOR 2.61K ±1%. 125W TF TC=0±100	12498	CT4-1/8-T0-2611-F
ABR60	0698-3154	0	2	1	RESISTOR 4.22K ±1%. 125W TF TC=0±100	2498	CT4-1/8-T0-4221-F
ABR61	0757-0200	7	2	1	RESISTOR 5.62K ±1%. 125W TF TC=0±100	12498	CT4-1/8-T0-5621-F
ABR62	0757-0460	1	1	2	RESISTOR 61.9K ±1%. 125W TF TC=0±100	12498	CT4-1/8-T0-6192-F
ABR63	0757-0460	1	1	2	RESISTOR 61.9K ±1%. 125W TF TC=0±100	12498	CT4-1/8-T0-6192-F
ABR64	0698-3154	0	0	1	RESISTOR 4.22K ±1%. 125W TF TC=0±100	12498	CT4-1/8-T0-4221-F
ABR65	0757-0200	7	7	1	RESISTOR 5.62K ±1%. 125W TF TC=0±100	12498	CT4-1/8-T0-5621-F
ABR66	0757-0279	0	1	1	RESISTOR 3.16K ±1%. 125W TF TC=0±100	12498	CT4-1/8-T0-3161-F
ABR67	0757-0280	5	3	1	RESISTOR 1K ±1%. 125W TF TC=0±100	12498	CT4-1/8-T0-1001-F
ABR68	0757-0422	5	1	1	RESISTOR 909 ±1%. 125W TF TC=0±100	12498	CT4-1/8-T0-909R-F
ABR69	0698-3446	3	3	1	RESISTOR 363 ±1%. 125W TF TC=0±100	12498	CT4-1/8-T0-363R-F
ABR70	0757-0123	3	3	1	RESISTOR 34.8K ±1%. 125W TF TC=0±100	12498	CT4-1/8-T0-348R-F
ABR71	0757-0442	9	9	1	RESISTOR 10K ±1%. 125W TF TC=0±100	12498	CT4-1/8-T0-1002-F
ABR72	0757-0442	9	9	1	RESISTOR 1.47K ±1%. 125W TF TC=0±100	12498	CT4-1/8-T0-1002-F
ABR73	0757-1094	9	1	1	RESISTOR 1.47K ±1%. 125W TF TC=0±100	12498	CT4-1/8-T0-1002-F
ABR74	0811-3682	1	1	1	RESISTOR 6.8K ±1%. 05W PN TC=0±10	01686	R342
ABR75	0757-0440	7	7	1	RESISTOR 7.5K ±1%. 125W TF TC=0±100	12498	CT4-1/8-T0-7501-F
ABR76	0698-6358	2	2	2	RESISTOR 100K ±0.1%. 125W TF TC=0±25	12498	NESS
ABR77	0757-0459	3	3	1	RESISTOR 1K ±1%. 125W TF TC=0±100	12498	CT4-1/8-T0-5622-F
ABR78	0757-0280	3	3	1	RESISTOR 1K ±1%. 125W TF TC=0±100	12498	CT4-1/8-T0-1001-F
ABR79	0757-0280	3	3	1	RESISTOR 1K ±1%. 125W TF TC=0±100	12498	CT4-1/8-T0-1001-F
ABR80	0698-6358	2	2	1	RESISTOR 100K ±0.1%. 125W TF TC=0±25	12498	NESS
ABR81	0757-0442	9	9	1	RESISTOR 10K ±1%. 125W TF TC=0±100	12498	CT4-1/8-T0-1002-F
ABR82	0757-0438	4	3	1	RESISTOR 5.11K ±1%. 125W TF TC=0±100	12498	CT4-1/8-T0-5111-F
ABR83	0757-0398	4	4	1	RESISTOR 75 ±1%. 125W TF TC=0±100	12498	CT4-1/8-T0-5111-F
ABR84	0757-0317	7	7	1	RESISTOR 1.33K ±15. 125W TF TC=0±100	12498	CT4-1/8-T0-1331-F
ABR85	0698-6364	0	0	1	RESISTOR 50 ±0.1%. 125W TF TC=0±25	2M627	CRB14 OR CR25
ABR87	2100-2030	6	1	1	RESISTOR-TRMR 20K 10% TRF TOP-ADJ 1-TURN	73138	82PR20K
ABR88	0757-0439	4	4	1	RESISTOR 6.81K ±1%. 125W TF TC=0±100	12498	CT4-1/8-T0-6811-F
ABR89	NOT ASSIGNED						
ABR90	0757-0346	2	2	2	RESISTOR 10 ±1%. 125W TF TC=0±100	DB439	MK2
ABR91	0757-0346	2	2	2	RESISTOR 10 ±1%. 125W TF TC=0±100	DB439	MK2

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

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 \*Indicates factory-selected value.

Reference	HP Part Number	C	D	Qty	Description	Mfr Code	Mfr Part Number
A8R2					NOT ASSIGNED		
A8R3					NOT ASSIGNED		
A8R4	0698-6619	8	8	1	RESISTOR 15K +0.1% .125W TF TC=0+25	NE55	12498
A8R5	0698-3158	4	4	1	RESISTOR 23.7 +1% .125W TF TC=0+100	CT4-1/8-T0-2372-F	12498
A8R6	0698-6320	8	8		RESISTOR 5K +0.1% .125W TF TC=0+25	NE55	12498
A8R7	0698-6320	8	8		RESISTOR 5K +0.1% .125W TF TC=0+25	NE55	12498
A8R8	0698-6360	6	6	2	RESISTOR 10K +0.1% .125W TF TC=0+25	NE55	12498
A8R9	0811-1557	5	5	1	RESISTOR 15 +5% 3W PMI TC=0+20	T2B-79	01686
A8R10	0757-0465	6	6		RESISTOR 100K +1% .125W TF TC=0+100	CT4-1/8-T0-1003-F	12498
A8R11	2100-2655	1	1	2	RESISTOR-TMR 100K 10% TRF TOP-ADJ 1-TRN	82P4100K	73138
A8R12	2100-2655	1	1	1	RESISTOR-TMR 100K 10% TRF TOP-ADJ 1-TRN	82P4100K	73138
A8R13	2100-3091	1	1	1	NOT ASSIGNED		
A8R14	2100-3091	1	1	1	RESISTOR-TMR 2K 10% TRF TOP-ADJ 17-TRN	3105W202	09969
A8R15	0698-6619	8	8		RESISTOR 15K +0.1% .125W TF TC=0+25	NE55	12498
A8R16	0698-6320	8	8		RESISTOR 5K +0.1% .125W TF TC=0+25	NE55	12498
A8R17	0698-3441	8	8		RESISTOR 215 +1% .125W TF TC=0+100	CT4-1/8-T0-215R-F	12498
A8R18	0757-0280	3	3		RESISTOR 1K +1% .125W TF TC=0+100	CT4-1/8-T0-1001-F	12498
A8S1	08780-00027	6	6	2	SHIELD RF REF BOTTOM	08780-00027	28480
A8S2	08780-00027	6	6	2	SHIELD RF REF BOTTOM	08780-00027	28480
A8S3	00437-00005	8	8	2	SHIELD RF REF TOP	00437-00005	28480
A8S4	00437-00005	8	8		SHIELD RF REF TOP	00437-00005	28480
A8T1-TP21	0360-0124	3	21		CONNECTOR-SGL CONT PIN .04-IN BSC-SZ RND	0360-0124	28480
A8U1	1826-3079	0	1	1	IC DCR CMOS/74HC 3-T0-8-LINE	MC74HC138N	04713
A8U2	1826-3082	5	1	1	IC FF CMOS/74HC D-TYPE POS-EDGE-TRIG	MC74HC374N	04713
A8U3	1826-1174	4	1	1	DA 8-BIT 18-CER DIP BPLR	DAC-888FX	06665
A8U4	1826-1021	0	1	1	NOT ASSIGNED		
A8U5	1826-1021	0	1	1	ANALOG MULTIPLEXER CHANNEL 16-DIP-P	DG508ACJ	17956
A8U6	1826-1441	8	1	1	IC V RGLTR V-REF ADJ 9.95/10.05V 8-DIP-C	REF-01HZ	06665
A8U7	1826-1075	4	3		IC OP AMP GP DUAL 8-DIP-P PKG	LF442CN	27014
A8U8	1826-1075	4	0		IC OP AMP GP DUAL 8-DIP-P PKG	LF442CN	27014
A8U9	1826-1075	4	0		IC OP AMP GP DUAL 8-DIP-P PKG	LF442CN	27014
A8U10	1826-0065	0	1	1	IC COMPARTOR PRON 8-DIP-P PKG	LM311N	27014
A8U11	1826-1553	3	1	1	IC OP AMP PRON QUAD 14-DIP-P PKG	LT1014DN	10899
A8U12	1826-1733	1	1	1	ANALOG SWITCH 4-SPST 16-DIP-P	D6221CJ	17856
A8U13	1826-0639	4	1	1	DA 8-BIT 16-PLASTIC CMOS	AD7524JN	24355
A8U14	1826-0606	5	1	1	ANALOG SWITCH 4-SPST 16-CER DIP	DG201ABK	17856
A8U15	1826-1076	5	2		IC OP AMP GP QUAD 14-DIP-P PKG	LF444CN	27014
A8U16	1826-1076	5	4		IC OP AMP GP QUAD 14-DIP-P PKG	LF444CN	27014
A8U17	1826-1075	4	4		IC OP AMP GP DUAL 8-DIP-P PKG	LF442CN	27014
A8U18	1858-0086	2	1	1	TRANSISTOR AFRAY 14-PIN PLSTC TO-116	MPQ6700	04713
A8V1	1902-0943	5	2		DIODE-ZNR 2.4V 5% DO-35 PD=4W TC=-037%	1902-0943	28480
A8V2	1902-0943	5	5		DIODE-ZNR 2.4V 5% DO-35 PD=4W TC=-037%	1902-0943	28480
A8V3	1902-0943	0	1	1	DIODE-ZNR 8.2V 5% DO-35 PD=4W TC=+065%	1902-0943	28480
A8V4	1902-0680	7	1	1	DIODE-ZNR 1N827 6.2V 5% DO-7 PD=4W	1N827	04713
A8V5	1902-0949	1	1	1	DIODE-ZNR 4.3V 5% DO-35 PD=4W TC=+017%	1902-0949	28480
ABW1 - WS	8159-0005	0	5		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	YZO 1/4	11502
	2190-0584	0	2		WASHER-LK HLCL 3.0 3.1-MM-ID 6.2-MM-OD	2190-0584	28480
	1200-0185	9	1		INSULATOR-XSTR NYLON	TO-5-009D	10454
	0361-0009	5	2		RIVET-SEMILUB DVH .123DIA .188-LG	0361-0009	28480
	0380-4026	2	2		SUPPRT-PC BOARD	0380-4026	28480
	0380-0993	6	2		SPACER-RVT ON 1.88-IN-LG .162-IN-ID	0380-0993	28480
	0380-1238	4	8		STANDOFF-RVT-ON 10-MM-LG M3.0 X 0.5-THD	0380-1238	28480
	0515-0886	3	8		SCREW-MACH M3 X 0.5 6MM-LG PAN-HD	0380-1238	28480
	0515-1430	5	8		SCREW-MACH M3 X 0.5 8MM-LG 90-DEG-FLH-HD	0515-1430	00000
	08780-00047	0	2		INSULATOR PLATE	08780-00047	00000

Table 6-2. Replaceable Parts (Continued)

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

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A9	05350-60123	3	1	DISPLAY DRIVER ASSEMBLY	28480	05350-60123

Table 6-2. Replaceable Parts (Continued)

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

Reference Designation	HP Part Number	C	D	Qty	Description	Mfr Code	Mfr Part Number
A10	05348-67004	9		1	FRONT PANEL MEMBRANE/KEYBOARD ASSEMBLY (FOR 5347A SERIAL NO. BELOW 3009A00647 5348A SERIAL NO. BELOW 3009A00504) INCLUDES: FRAME FRONT FRONT PANEL MEMBRANE SWITCH ASSEMBLY LABELS, HARDWARE, INSTALLATION NOTE	28480	05348-67004
A10	05348-60203	6		1	FRONT PANEL MEMBRANE/KEYBOARD ASSEMBLY (FOR 5347A SERIAL NO. 3009A00647 AND ABOVE 5348A SERIAL NO. 3009A00504 AND ABOVE) FRONT PANEL LABEL - 5347A FRONT PANEL LABEL - 5348A NUT-HEX W/LKWR 6-32 THD .109-IN-THIK	28480	05348-60203
	05347-80002	4		1		28480	05347-80002
	05348-80005	8		1		28480	05348-80005
	2420-0001	5		5		28480	2420-0001

Table 6-2. Replaceable Parts (Continued)

Table 6-2. Replaceable Parts (Continued)

Reference Designation	HP Part Number	HP Part C D	Qty	Description	Mfr Code	Mfr Part Number
A11	05350-60011	8	1	HP-IB INTERFACE ASSEMBLY (OPTION 011)	28480	05350-60011
A11C1	0180-4135	2	1	CAP-FXD 30UF 10 V TA	12344	1322D336K010AS
A11C2	0160-4554	7	1	CAP-FXD 0.01UF 50 V	12344	C410C103MSRSCA
A11C3	0160-4557	0	2	CAP-FXD 0.1UF 50 V	12344	C420C104MSRSCA
A11C4	0160-4557	0	0	CAP-FXD 0.1UF 50 V	12344	C420C104MSRSCA
A11H1	0361-0146	1	2	RIVET-SEMI TUB OWH .123DIA .25LG	59880	S-590
A11J1	1252-0268	8	1	CONN-RECT MICROBGN 24-CKT 24-CONT	28480	1252-0268
A11J2	8120-3671	1	1	FLAT RIBBON ASSY 14-COND NOTE: A11J2U1 IS PART OF J2.	00779	2-88256-2
A11L1	9100-1788	6	1	CORE-FERRITE CHOKER-WIDEBAND;IMP:>680	19701	VK200 20/48
A11L2	9100-1637	4	1	INDUCTOR RF-CH-MLD 120UH +-5%	91637	IM-4 120UH 5%
A11R1	0698-3155	1	2	RESISTOR 4.64K +-1% .125W TF TC:0+-100	12498	CT4-1/8-10-4641-F
A11R2	0698-0082	7	2	RESISTOR 464 +-1% .125W TF TC:0+-100	12498	CT4-1/8-10-4641-F
A11R3	0698-3155	1	2	RESISTOR 4.64K +-1% .125W TF TC:0+-100	12498	CT4-1/8-10-4641-F
A11R4	0698-0082	7	2	RESISTOR 464 +-1% .125W TF TC:0+-100	12498	CT4-1/8-10-4641-F
A11R5	1810-0247	7	1	NETWORK-RES 16-DIP 220.0 OHM X 8	11236	761-3-R220
A11R7	0698-3441	8	2	RESISTOR 215 +-1% .125W TF TC:0+-100	12498	CT4-1/8-10-215R-F
A11R8	0698-3441	8	2	RESISTOR 215 +-1% .125W TF TC:0+-100	12498	CT4-1/8-10-215R-F
A11S1	3101-2215	2	1	SWITCH-DIP RKR 7-1A 0.05A 30VDC	00779	1-435802-8
A11TP1	1251-8096	4	1	CONN-POST TYPE .150-PIN-SPCG 7-CONT	28480	1251-8096
A11U1	1820-2461	2	2	IC-INTERFACE XCVR INSTRUMENT BUS IEEE	04713	MC3447P3
A11U2	1820-2461	2	2	IC-INTERFACE XCVR INSTRUMENT BUS IEEE	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

See introduction to this section for ordering information

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

Reference	HP Part Number	C	D	Qty	Description	Mfr Code	Mfr Part Number
A12	05361-60012	2	2	1	MICROWAVE MODULE	28480	05361-60012
A12C1	0160-0576	5	5	12	CAPACITOR-FXD 0.1UF 50 V	09969	RPE121-105X7R104M50V
A12C2	0160-0576	5	5	5	CAPACITOR-FXD 0.1UF 50 V	09969	RPE121-105X7R104M50V
A12C3	0160-0576	5	5	5	CAPACITOR-FXD 0.1UF 50 V	09969	RPE121-105X7R104M50V
A12C4	0160-3875	3	3	2	CAPACITOR-FXD 22PF 200 V	09969	RPE121-105X7R104M50V
A12C5	0160-4385	2	2	1	CAPACITOR-FXD 15PF 200 V	09969	RPE121-105C0G220J200V
A12C6	0180-3771	0	0	2	CAPACITOR-FXD 1UF 35 V TA	12344	T398A105K035AS
A12C7	0180-3771	0	0	1	CAPACITOR-FXD 1UF 35 V TA	12344	T398A105K035AS
A12C8	0160-4804	0	0	1	CAPACITOR-FXD 56PF 100 V	09969	RPA10C0G560J100
A12C9	0160-3879	7	7	2	CAPACITOR-FXD 0.01UF 100 V	09969	RPE121-105X7R103M100V
A12C10	0160-0576	5	5	5	CAPACITOR-FXD 0.1UF 50 V	09969	RPE121-105X7R104M50V
A12C11	0160-0576	5	5	5	CAPACITOR-FXD 0.1UF 50 V	09969	RPE121-105X7R104M50V
A12C12	0160-4040	6	6	4	CAPACITOR-FXD 1000PF 100 V	09969	RPE121-105X7R104M50V
A12C13	0160-4040	6	6	6	CAPACITOR-FXD 1000PF 100 V	09969	RPE121-105X7R104M50V
A12C14	0160-0576	5	5	5	CAPACITOR-FXD 0.1UF 50 V	09969	RPE121-105C0G102J100V
A12C15	0160-4040	6	6	4	CAPACITOR-FXD 1000PF 100 V	09969	RPE121-105X7R104M50V
A12C16	0160-3875	3	3	3	CAPACITOR-FXD 22PF 200 V	09969	RPE121-105C0G220J200V
A12C17	0160-4040	6	6	2	CAPACITOR-FXD 1000PF 100 V	09969	RPE121-105C0G102J100V
A12C18	0160-0576	5	5	1	CAPACITOR-FXD 0.1UF 50 V	09969	RPE121-105X7R104M50V
A12C19	0160-4491	1	1	2	CAPACITOR-FXD 0.1UF 50 V	09969	RPE121-105X7R104M50V
A12C20	0160-0576	5	5	2	CAPACITOR-FXD 0.1UF 50 V	09969	RPE121-105C0G100D200V
A12C21	0160-4491	1	1	1	CAPACITOR-FXD 0.1UF 50 V	09969	RPE121-105C0G8R2D200V
A12C22	0160-6428	8	8	1	CAPACITOR-FXD 39PF 200 V	58288	1C10C0G390J200B(C15)
A12C23	0160-0576	2	2	2	CAPACITOR-FXD 0.1UF 50 V	09969	RPE121-105X7R104M50V
A12C24	0160-3874	2	2	2	CAPACITOR-FXD 0.1UF 50 V	09969	RPE121-105X7R104M50V
A12C25	0160-0576	5	5	2	CAPACITOR-FXD 0.1UF 50 V	09969	RPE121-105C0G100D200V
A12C26	0160-0576	5	5	1	CAPACITOR-FXD 0.1UF 50 V	09969	RPE121-105X7R104M50V
A12C27	0160-4040	6	6	1	CAPACITOR-FXD 1000PF 100 V	09969	RPE121-105X7R104M50V
A12C28	0160-4383	0	0	1	CAPACITOR-FXD 0.1UF 50 V	09969	RPE121-105C0G102J100V
A12C29	0160-3874	2	2	1	CAPACITOR-FXD 0.1UF 50 V	09969	RPE121-105C0G100D200V
A12C30	0160-0576	5	5	1	CAPACITOR-FXD 0.1UF 50 V	09969	RPE121-105C0G100D200V
A12J1	1250-1611	3	3	2	CONNECTOR-RF SMB M PC 50-OHM	98291	51-051-0289
A12J2	1250-1611	3	3	2	CONNECTOR-RF SMB M PC 50-OHM	98291	006-4801
A12J3	1251-6939	0	0	3	CONNECTOR-SGL CONT SKT .032-IN-BSC-SZ	98291	006-4801
A12J4	1251-6939	0	0	3	CONNECTOR-SGL CONT SKT .032-IN-BSC-SZ	98291	006-4801
A12J5	1251-6939	0	0	0	CONNECTOR-SGL CONT SKT .032-IN-BSC-SZ	98291	006-4801
A12J6	1252-0233	7	7	4	CONNECTOR-SGL CONT SKT .039-IN-BSC-SZ	00779	005-4801
A12J7	1252-0233	7	7	4	CONNECTOR-SGL CONT SKT .039-IN-BSC-SZ	00779	50865-3
A12J8	1252-0233	7	7	7	CONNECTOR-SGL CONT SKT .039-IN-BSC-SZ	00779	50865-3
A12J9	1252-0233	7	7	7	CONNECTOR-SGL CONT SKT .039-IN-BSC-SZ	00779	50865-3
A12L1	9140-0522	8	8	1	INDUCTOR RF-CH-MLD 360NH +5%	91637	IM-2 .36UH 5%
A12L2	9135-0072	2	2	2	INDUCTOR RF-CH-MLD 82NH +5.61%	24226	10M056X-1
A12L3	9135-0078	8	8	1	INDUCTOR RF-CH-MLD 82NH +5.61%	24226	10M056X-1
A12L4	9135-0072	2	2	2	INDUCTOR 56NH +5.893% 2.6D-MMX6.6LG-MM	24226	10M028X-1
A12L5	9135-0074	4	4	1	INDUCTOR RF-CH-MLD 47NH +6.17%	24226	10M047X-1
A12L6	9135-0081	3	3	1	INDUCTOR RF-CH-MLD 68NH +5%	06560	010150-056J
A12L7	9100-9922	1	1	1	INDUCTOR RF-CH-MLD 1UH +5%	91637	IM-2 1UH 5%
A12L8	9140-0531	4	4	6	INDUCTOR RF-CH-MLD 1UH +5%	28480	9100-9922
A12L9	9140-0531	9	9	6	INDUCTOR RF-CH-MLD 1UH +5%	91637	IM-2 1UH 5%
A12L10	9140-0531	9	9	9	INDUCTOR RF-CH-MLD 1UH +5%	91637	IM-2 1UH 5%
A12L11	9140-0531	9	9	9	INDUCTOR RF-CH-MLD 1UH +5%	91637	IM-2 1UH 5%
A12L12	9140-0531	9	9	9	INDUCTOR RF-CH-MLD 1UH +5%	91637	IM-2 1UH 5%
A12L13	9140-0531	9	9	9	INDUCTOR RF-CH-MLD 1UH +5%	91637	IM-2 1UH 5%
A12L14	9135-0080	2	2	1	INDUCTOR 27NH +5.556% 2.6D-MMX6.6LG-MM	91637	IM-2 1UH 5%
A12L15	9135-0076	6	6	1	INDUCTOR RF-CH-MLD 39NH +6%	24226	10M271X-1
A12L16	9140-0518	2	2	1	INDUCTOR RF-CH-MLD 200NH +5%	91637	IM-2 .2UH 5%
A12L17	9135-0068	6	6	1	INDUCTOR RF-CH-MLD 39NH +6.36%	24226	10M039X-1
A12L18	9140-0520	6	6	1	INDUCTOR RF-CH-MLD 240NH +5%	91637	IM-2 .24UH 5%
A12L19	9140-0531	9	9	9	INDUCTOR RF-CH-MLD 1UH +5%	91637	IM-2 1UH 5%

Table 6-2. Replaceable Parts (Continued)

Table 6-2. Replaceable Parts (Continued)

Reference Designation	HP Part Number	C	D	Qty	Description	Mfr Code	Mfr Part Number
A12MP1	1205-0213		4	1	HEAT SINK SGL TO-5/TO-39-CS	13103	2228B
A12Q1	1854-1003		7	1	TRANSISTOR NPN SI PD=200MW	S0562	2SC2676
A12Q2	1854-0990		9	1	TRANSISTOR NPN SI TO-39 PD=8.75W	04713	MRF630
A12R1	0699-7229		8	1	RESISTOR 511 +1% .05W TF TC=0+-100	12498	C3-1/8-TO-511R-F
A12R2	0757-0280		3	1	RESISTOR 1K +1% .125W TF TC=0+-100	12498	CT4-1/8-TO-1001-F
A12R3	0757-0400		9	2	RESISTOR 90.9 +1% .125W TF TC=0+-100	12498	CT4-1/8-TO-90R9-F
A12R4	0699-7210		7	1	RESISTOR 82.5 +1% .05W TF TC=0+-100	12498	C9-1/8-TO-82R5-F
A12R5	0699-7207		2	1	RESISTOR 61.9 +1% .05W TF TC=0+-100	12498	C3-1/8-TO-61R9-F
A12R6	0699-7212		9	1	RESISTOR 100 +1% .05W TF TC=0+-100	12498	C3-1/8-TO-100R-F
A12R7	0699-7277		6	1	RESISTOR 51.1K +1% .05W TF TC=0+-100	12498	C3-1/8-TO-5112-F
A12R8	0757-0400		9	9	RESISTOR 90.9 +1% .125W TF TC=0+-100	12498	CT4-1/8-TO-90R9-F
A12R9	0699-0083		8	1	RESISTOR 1.96K +1% .125W TF TC=0+-100	12498	CT4-1/8-TO-1961-F
A12R10	0699-7215		2	1	RESISTOR 133 +1% .05W TF TC=0+-100	12498	C3-1/8-TO-133R-F
A12U1					SEE CHASSIS PARTS	28480	5088-7079
A12U2	1813-0213		3	1	IC WIDEBAND AMPL TO-39 PKG	04713	MMA130

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

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

Reference Designation	HP Part Number	C	D	Qty	Description	Mfr Code	Mfr Part Number
A10	05348-60203			6	FRONT PANEL-MEMBRANE KEYBOARD ASSEMBLY (FOR 5347A SERIAL NO. 3009A00647 AND ABOVE) 5348A SERIAL NO. 3009A00504 AND ABOVE)	28480	05348-90006
A10	05348-67004			9	FRONT PANEL MEMBRANE/KEYBOARD ASSEMBLY (FOR 5347A SERIAL NO. BELOW 3009A00647 5348A SERIAL NO. BELOW 3009A00504)	28480	05348-67004
A13	05348-60207			0	TRANSFORMER-POWER PRIMARY ASSY	28480	05348-60207
B1	3160-0464			3	FAN- TUBEAXIAL 36-CFM 24VDC	28480	05348-60207
CR1	1906-0368			6	DIODE-FW BRIDGE 100V 10A	11699	CBR10F-010P
F1	2110-0007			4	FUSE (INCH) 1A 250V TD FE UL	75915	313 001
F2	2110-0010			9	FUSE (INCH) 5A 250V NTD FE UL	75915	312 005
U1	05350-60113			1	SAMPLER	28480	05350-60113
U1H1	0624-0097			9	SCREW-TPG 440.188-IN-LG PAN-HD-POZI	28480	0624-0097
W1	8120-5254			0	CABLE ASSY- COAX	28480	8120-5254
W2	05350-60102			2	CABLE ASSY- SYNTHESIZER	28480	05350-60102
W3	05350-60122			2	CABLE ASSY- DISPLAY	28480	05350-60122
W4	05350-60115			3	CABLE ASSY- SAMPLER POWER	28480	05350-60115
W5	05348-60210			5	CABLE ASSY- DC JUMPER	28480	05348-60210
W6	00438-60026			0	CABLE ASSY- RF OSCILLATOR	28480	05348-60210
W7	8120-5304			1	CABLE ASSY- FLAT RIBBON 34-COND	28480	00438-60026
W8	8120-5305			2	CABLE ASSY- COAX 150MM LG	28480	8120-5304
W9	05348-60208			1	CABLE ASSY- DC INPUT	28480	05348-60208
W10	05348-60205			8	CABLE ASSY- FW BRIDGE	28480	05348-60205
W11	05348-60204			7	CABLE ASSY- INPUT APC	28480	05348-60205
W12	05348-60209			2	CABLE ASSY- BATTERY	28480	05348-60204
W13	00437-60025			8	CABLE ASSY- FRONT	28480	00437-60025
W14	05347-60201			3	CABLE ASSY- INPUT N	28480	05347-60201
	08971-20030			6	POWER CORD SET 18-AWG 3-COND 90-IN-LG	08452	P34-SVT-C25 3X 18 AWG
	11730A			4	ADAPTER-CONNECTOR APC	28480	08971-20030
				4	CABLE-POWER SENSOR	28480	11730A

Table 6-2. Replaceable Parts (Continued)



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

Table 6-2. Replaceable Parts (Continued)

Reference Designation	HP Part Number	C	D	Qty	Description	Mfr Code	Mfr Part Number
MP1	05348-20201	0	1	1	FRAME-FRONT	28480	05348-20201
MP2	05348-20203	2	1	1	COVER ASSEMBLY	28480	05348-20203
MP3	05348-20204	3	1	1	HOLDER-CONT.	28480	05348-20204
MP4	05350-40001	4	1	1	MOUNT-LCD	28480	05350-40001
MP5	05348-00002	7	1	1	CHASSIS ASSEMBLY	28480	05348-00002
MP6	05348-00011	8	1	1	PAD-FOAM	28480	05348-00011
MP7	05350-80001	8	1	1	LCD-14-SEGMENT 24-CHARACTER	28480	05350-80001
MP8					NOT ASSIGNED		
MP9	05350-00005	4	1	1	COVER-RF CAVITY	28480	05350-00005
MP10	05350-00021	4	1	1	SHIELD-ESD	28480	05350-00021
MP12	2110-05655	9	1	1	FUSEHOLDER CAP 12A MAX FOR UL	H9027	031.1666
MP13	2110-05656	0	1	1	FUSEHOLDER XTR PST 12A 250V	H9027	031.1677
MP14	2110-05699	3	1	1	FUSEHOLDER COMPONENT NUT; THD M12.7	H9027	098-0043
MP15	0160-3036	8	4	4	CAPACITOR-FXD 5000PF OV	09535	2425-011 XSV 502Z
MP16	0380-1332	9	2	2	STANDOFF-HEX .18-IN-LG .186-IN-ID	28480	0380-1332
MP17	05348-00003	8	1	1	COVER- BATTERY	28480	05348-00003
MP18	05348-00006	1	1	1	BOARD RETAINER- LEFT	28480	05348-00006
MP19	05348-00007	2	1	1	BOARD RETAINER- RIGHT	28480	05348-00007
MP20	05348-00008	3	1	1	COVER PLATE	28480	05348-00008
MP21	05361-20202	8	1	1	RF CAVITY	28480	05361-20202
MP22	05350-40003	6	1	1	REFLECTOR	28480	05350-40003
MP23	08971-20030	4	1	1	COLLAR	28480	08971-20030
MP27	05361-00018	2	1	1	MODULE-MICROWAVE	28480	05361-00018
MP28	05361-00010	1	1	1	MODULE-MICROWAVE	28480	05361-00010
MP36	05350-20204	7	1	1	SPACER	28480	05350-20204
U111	08673-60040	9	1	1	CONNECTOR-APC-TYPE INPUT (S348A)	28480	08673-60040
U111	1250-2246	2	1	1	CONNECTOR-N-TYPE INPUT (S347A)	24931	29J191-1
	2190-0843	4	4	4	WASHER-LK INT T NO. 8, 165-IN-ID (USE WITH MP27)	00000	ORDER BY DESCRIPTION
	2190-0124	4	2	2	WASHER-LK INT T NO. 10, 195-IN-ID (USE WITH MP27)	00000	ORDER BY DESCRIPTION

CHASSIS MECHANICAL PARTS

Table 6-2. Replaceable Parts (Continued)

Reference Designation	HP Part Number	C	D	Qty	Description	Mfr Code	Mfr Part Number
H1	0515-1232	5		13	SCREW-MACH M3.5 X 0.6 8MM-LG PAN-HD	00000	00000
H2	0515-0964	8		1	SCREW-MACH M4 X 0.7 45MM-LG PAN-HD	00000	00000
H3	0400-0001	1		1	GROMMET-RND .562-IN-HD .75-IN GRV-OD	00000	00000
H4	0400-0011	3		1	GROMMET-RND .375-IN-HD .5-IN-GRV-OD	73734	1652
H5	0460-1750	5		2	TAPE-INDL 1.25-IN-W .187-IN-T POLYU-FM	85471	2175
H7	0515-0887	4		3	SCREW-MACH M3.5 X 0.6 8MM-LG PAN-HD	00000	00000
H8	0515-0892	7		4	SCREW-MACH M3.5 X 0.6 12MM-LG PAN-HD	00000	00000
H9	0515-1060	1		4	SCREW-MACH M3 X 0.5 25-MM-LG PDM-HD	00000	00000
H10	0515-0982	0		1	SCREW-MACH M4 X 0.7 20MM-LG PAN-HD	00000	00000
H11	0515-2364	6		4	SCREW-MACH M4 X 0.7 10MM-LG	00000	00000
H12	0515-1105	1		2	SCREW-MACH M3 X 0.5 10MM-LG PAN-HD	00000	00000
H13	0535-0004	9		6	NUT-HEX DBL-CHAM M3 X 0.5 2.9MM-THK	00000	00000
H14	0535-0056	1		2	NUT-HEX PVALG-TRQ M4 X 0.7 5MM-THK	00000	00000
H16	0515-0746	4		24	SCREW-THD RLG MAX0.7 25-MM-LG PAN HD	00000	00000
H17	2190-0084	5		1	WASHER-LK INTL T 1/4-IN .256-IN-HD	78189	1214-05
H18	2190-0124	4		2	WASHER-LK INTL T NO. 10 .195-IN-HD	16179	50222
H19	0624-0562	3		2	SCREW-TFG 10-32 .375-IN-LG PDM-HD POZI	00000	00000
H20	1250-1899	9		1	ADAPTER-COAX STR F-BND M-SMC	24931	29J1166-1
H21	1251-3352	7		1	NUT-AUDIO CONN	05876	91-T-422-6-9
H22	1252-2256	8		2	CONNECTOR-ELASTOMERIC SPONGE RUBBER	28480	1252-2256
H23	1460-1345	5		2	TLT STAND SST	28480	1460-1345
H24	1510-0039	9		1	BINDING POST ASSY SGL SGL-TUR BLK	58474	BP21B
H25	1510-0103	8		1	BINDING POST ASSY SGL SGL-TUR	28480	1510-0103
H26	2190-0004	9		3	WASHER-LK INTL T NO. 5 .115-IN-HD	28480	1510-0103
H27	2190-0007	2		2	WASHER-LK INTL T NO. 6 .141-IN-HD	U1453	1904
H28	2250-0078	9		2	NUT-HEX DBL-CHAM 10-32-THD .067-9N-THK	78189	1906-00-00-2580
H29	2250-0196	2		1	NUT-HEX DBL-CHAM 1/4-36 THD .06-IN-THK	28480	2250-0078
H30	2250-0068	5		2	WASHER-LK INTL T 1/2-IN .505-IN-HD	00000	00000
H31	0624-0227	2		1	SCREW-TFG 4-40 .25-IN-LG PAN-HD POZI STL	78189	1924-02
H32	2190-0104	0		2	WASHER-LK INTL T 7/16-IN .439-IN-HD	00000	1922-04
H33	0624-0324	5		14	SCREW-TFG 4-20 .312-IN-LG PAN-HD POZI	00000	1922-04
H34	2190-0577	1		2	WASHER-LK HLCL NO. 10 .194-IN-HD	00000	ORDER BY DESCRIPTION
H35	2940-0266	4		1	NUT-HEX DBL-CHAM 1/2-28-THD .095-IN-THK	28480	2190-0577
H36	2950-0001	8		5	NUT-HEX DBL-CHAM 3/8-32-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
H37	2950-0054	1		2	NUT-HEX DBL-CHAM 1/2-28-THD .125-IN-THK	00000	ORDER BY DESCRIPTION
H38	3050-1548	3		1	WASHER-TRANSFORMER MOUNTING	28480	3050-1548
H39	2950-0132	6		3	NUT-HEX DBL CHAM 7/16-28-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
H40	2190-0022	1		1	WASHER-LK INTL T 3/8-9N .364-IN-HD	78189	1920-00
H41	3050-1178	5		1	WASHER-FL MTLIC NO. 8 .188-IN-ID	28480	3050-0055
H42	3050-0891	7		4	WASHER-FL MTLIC 3.0 3.3-MM-ID 6.85-MM-OD	28480	3050-0891
H43	3050-0071	5		2	WASHER-FL MTLIC NO. 8 .169-IN-ID	28480	3050-0071
H44	8160-0097	3		1	RFI ROUND STRIP CONDUCT-ELSTRM .07-IN-OD	28480	3050-0071
H45	9220-4708	0		1	PAD	18565	10-04-1687-1215
H46	9220-4709	1		1	PAD-CORR SCRFD 16.937-IN-LG 5.825-IN-WD	28480	9220-4709
H47	5041-8801	8		2	FOOT	28480	5041-8801
H48	00438-20014	0		1	WASHER-AUDIO CON	28480	00438-20014
H49	0360-0016	2		1	TERMINAL-SLDR LUG LK-MTG FOR #4 SCREW	28480	00438-20014
	0361-1196	3		2	RIVET-PLASTIC	79963	523
	0624-0767	0		36	SCREW-MACH 3-48 .312-IN-LG PAN-HD POZI	28480	0624-0767
	05361-00016	0		3	RF BARRIER	00000	05361-00016

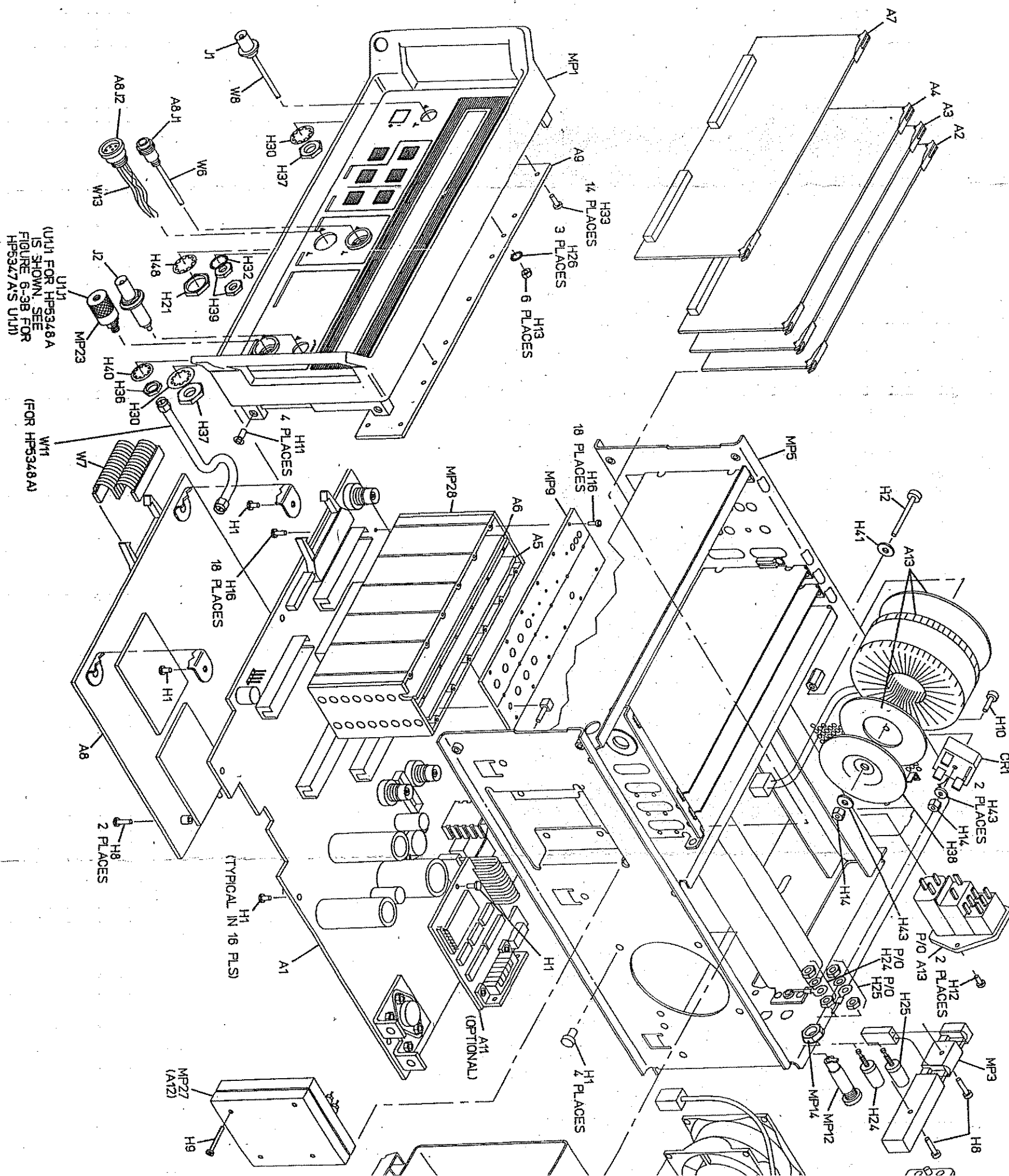
See introduction to this section for ordering information  
 \*Indicates factory-selected value

Table 6-2. Replaceable Parts (Continued)

Reference Designation	HP Part Number	C	D	Qty	Description	Mfr Code	Mfr Part Number
	05348-90006		0	1	MISCELLANEOUS PARTS GUIDE-QUICK REF	28480	05348-90006
	05348-60206		9	1	BATTERY-14.4V AH (OPTION 002)	28480	05348-60206
	05350-60011		8	1	HP-IB INTERFACE ASSEMBLY (A11-OPT 011)	28480	05350-60011
	05348-40002		1	1	COVER-PROTECTIVE (P/O OPTION 060)	28480	05348-40002
	05348-60211		6	1	STRAP-SHOULDER 5348A (P/O OPTION 060)	28480	05348-60211
	1540-1196		4	1	POUCH ACCESSORY (P/O OPTION 060)	28480	1540-1196
	05348-60212		7	1	KIT-BACK MOUNT (OPTION 913)	28480	05348-60212
					OPTIONS		

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







U11 FOR HP5348A  
IS SHOWN. SEE  
FIGURE 6-38 FOR  
HP5347A/S U11)

W11  
(FOR HP5348A)

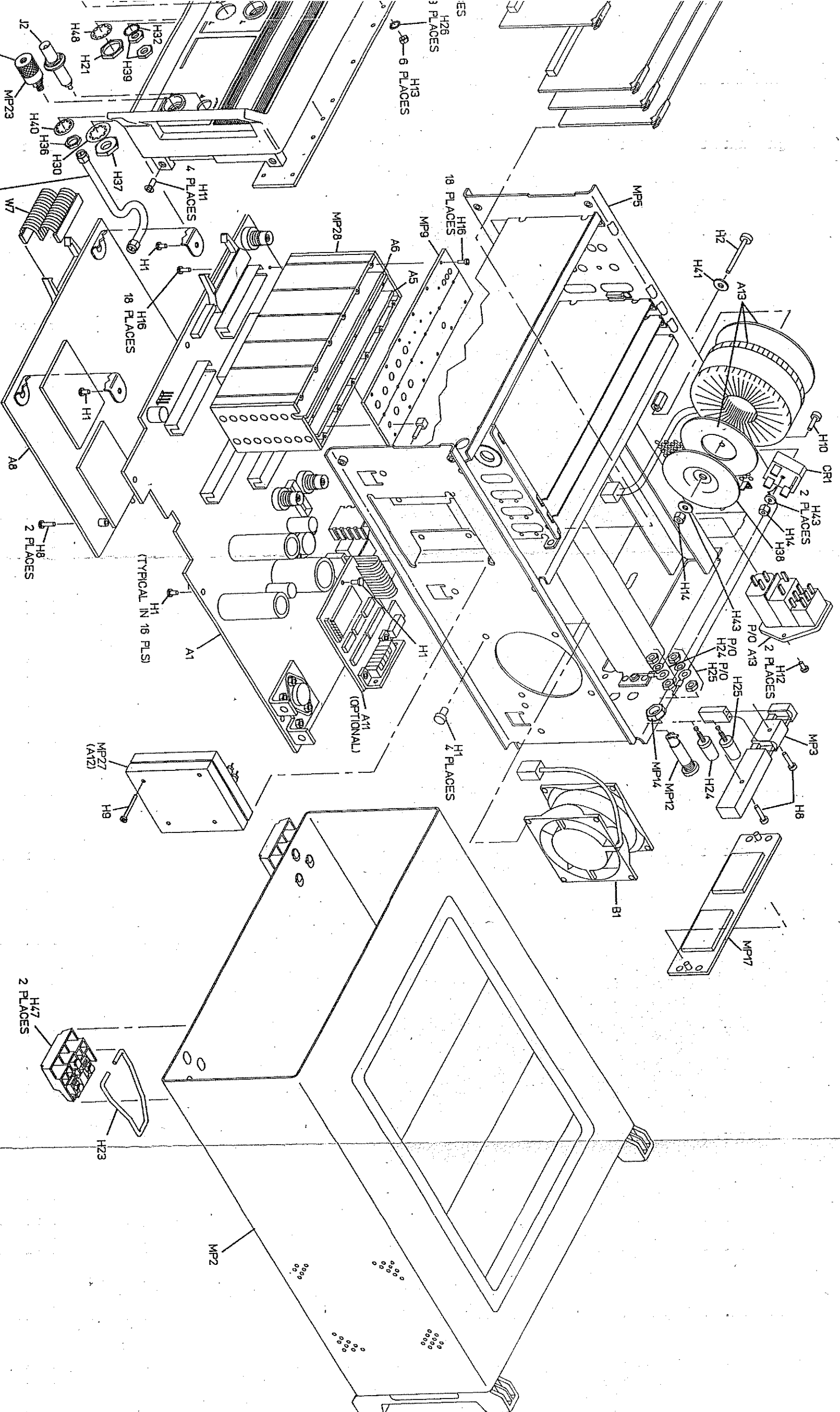


Figure 6-1. HP 5347A/48A Exploded View





Figure 6-2. Microwave Module Parts

Reference Designation	HP Part Number	CD	Qty	Description
A12	05361-60012	9	1	MICROWAVE ASSEMBLY (5347A/48A)
C1	0160-3036	8	1	CAPACITOR-FDTHRU 500 PF +80 -20% 200V
C2	0160-3036	8	1	CAPACITOR-FDTHRU 500 PF +80 -20% 200V
C3	0160-3036	8	1	CAPACITOR-FDTHRU 500 PF +80 -20% 200V
C4	0160-3036	8	1	CAPACITOR-FDTHRU 500 PF +80 -20% 200V
H9	0515-1060	7	4	SCREW-MACH M3 x 0.25MM-LG PAN-HD
H17	2190-0084	5	1	WASHER-LK INTL 1/4 IN 256-IN-ID
H18	2190-0124	4	4	WASHER-LK T NO. 10 195-IN-ID
H28	2950-0078	9	4	NUT-HEX-DBL-CHAM 10-32-6HD .067-IN-THK
H29	2950-0196	2	1	NUT-HEX-DBL-CHAM 1/4-36-THD .06-IN-THK
MP27	05361-00010	8	1	COVER-SAMPLER
MP28	05350-00010	1	1	BASE-COVER
MP36	05350-20204	7	1	SPACER
U1	05350-60113	1	1	SAMPLER (5347A/48A)
U1H1	0624-0097	9	2	SCREW-TPG 4040 .188-IN-LG PAN-HD-POZI

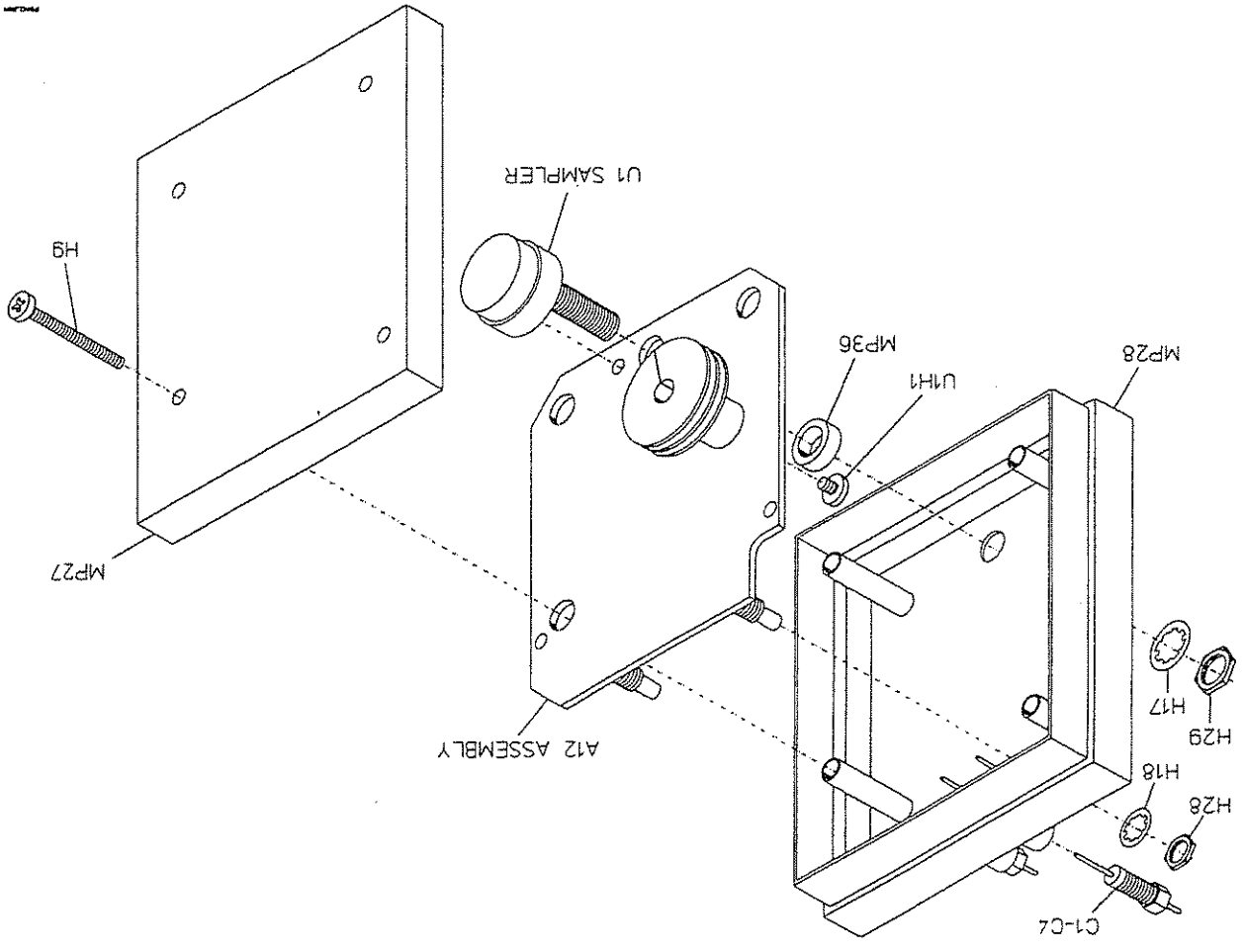


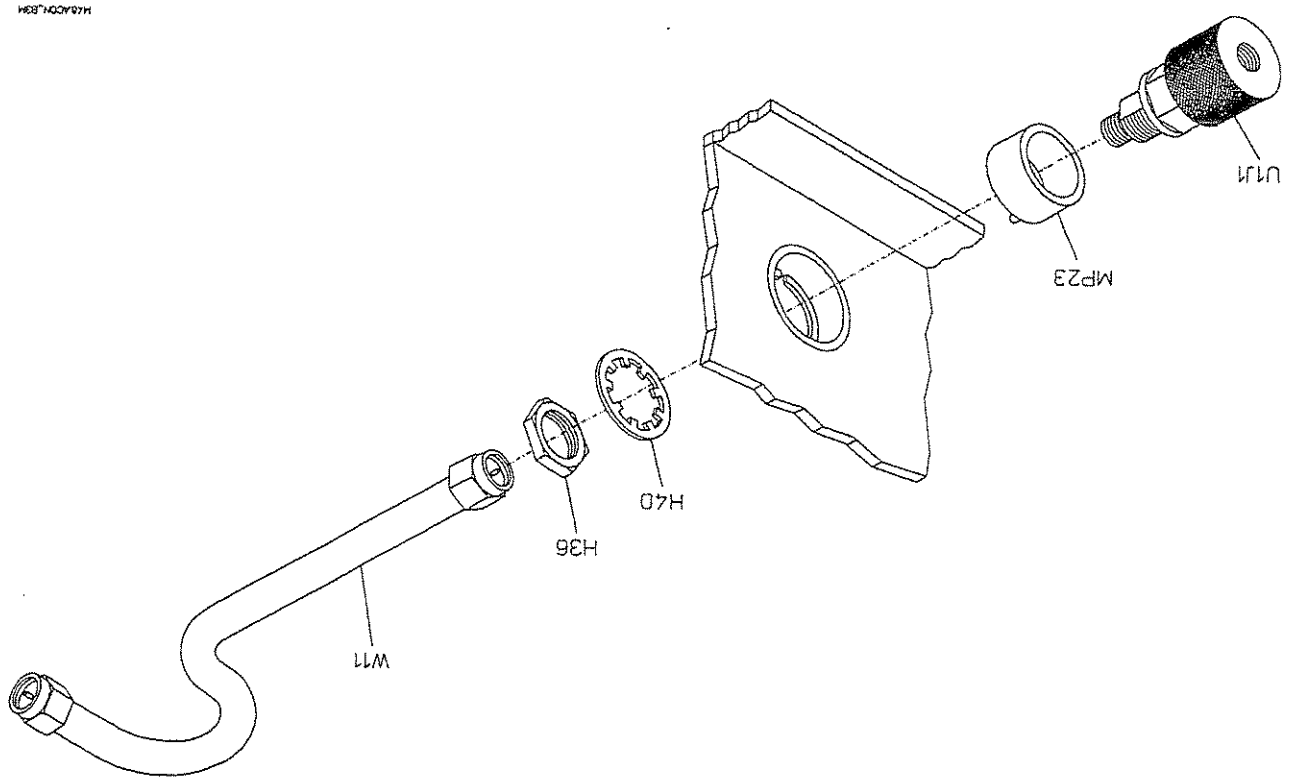
Figure 6-3. INPUT 1 Connectors

Option 006 limiter is installed between H36 Nut and Cable (05348-60215). Cable connector near H36 is female for Option 006. Delete "W1" cable reference designator for the 5348A Option 006.

NOTE

Reference Designation	HP Part Number	CD	Description
H36	2950-0001	8	NUT-HEX-DBL-CHAM 3/8-32-THD
H40	2190-0022	1	WASHER-LK INTL T 3/8 IN
MP23	08971-20030	4	COLLAR
U1J1	08673-60040	9	APC CONNECTOR
W11	08348-60204	8	CBL AY-INPUT - RIGID
(Option 006)	5088-7049	2	2.65 GHz LIMITER
(Option 006)	05348-60215	1	CABLE ASSEMBLY, LIMITER

HP 5348A



HP 5348A

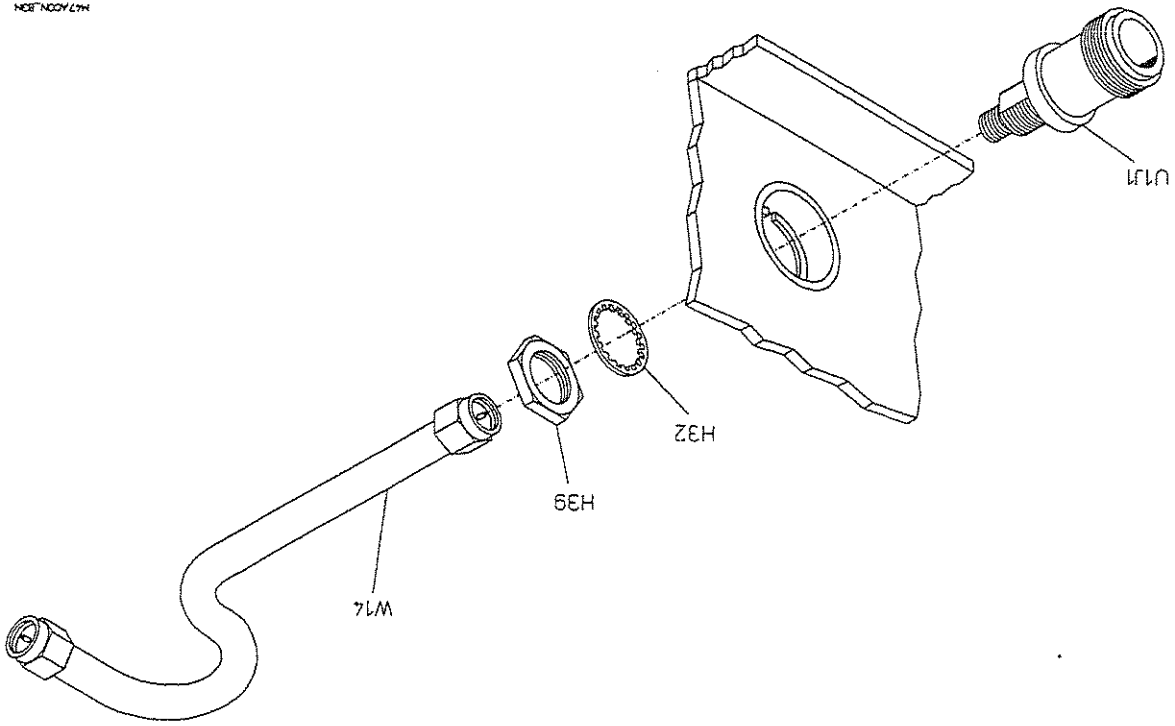
Figure 6-3. INPUT 1 Connectors (Continued)

Option 006 limiter is installed between H39 Nut and Cable (05348-60202). Cable connector near H39 is female for Option 006. Delete "W14" cable reference designator for the 5347A Option 006.

NOTE

Reference Designation	HP Part Number	CD	Description
H32	2190-0104	0	WASHER-LK INT T 7/16 IN
H39	2950-0132	6	NUT-HEX-DBL-CHAM 7/16-28-THD
U1J1	1250-2246	2	N-TYPE CONNECTOR
W14	05347-60201	3	CBL AY-INPUT - RIGID
(Option 006)	5088-7049	2	2.65 GHz LIMITER
(Option 006)	05348-60202	1	CABLE ASSEMBLY

HP 5347A

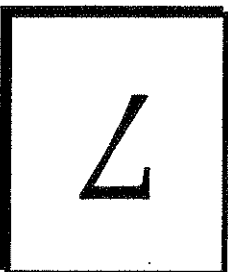


HP 5347A

Mfr Code	Manufacturer Name	Address	Zip Code
C1433	AB ELEKTRONIK GMBH	SALZBURG	A-501
08439	ROEDERSTEIN/RESISTA GMBH	LANDSHUT	8300
H9027	SCHURTER AG	LUZERN	CH-60
54013	HITACHI AMERICA LTD	TOKYO	94086
54111	TOKYO HATSUDOKI CO LTD	SUNNVALE	
01453	BARBER & COLEMAN LTD	TOKYO	
00000	ANY SATISFACTORY SUPPLIER	SALE CHES	
00494	ADDRESSOGRAPH FARRINGTON	PA	44117
00779	AMP INC	HARRISBURG	17111
00815	NEL FREQUENCY CONTROLS INC	BURLINGTON	53105
01686	RCL ELECTRONICS INC	DALLAS	75265
01852	THOMAS ELECTRONICS INC	WAYNE	60062
02768	ITW FASTEX	NJ	07470
04072	BELL INDUSTRIES INC MILLER JW DIV	IL US	60016
04222	AVX CORP	CA	90224
04713	MOTOROLA INC	IL US	60195
05791	LYN-TRON INC	IL US	60195
05876	U S POLYMERIC INC	CA US	91505
06132	COMPUTER TERMINAL CORP	CT	06904
06156	BAUM W A CO INC	TX	78784
06560	JEFFERS ELECTRONICS INC	NY	11726
06565	PRECISION MONOLITHICS INC	AZ US	85621
08261	SPECTRA-STRIP CORP	CA US	95054
08482	WESTINGHOUSE ELEC CORP WELDING EQPT	CA	92642
09595	JOHNSON MATHEW AND MALLORY LTD	MD	21784
09989	DALE ELECTRONICS INC	CA	95054
10454	GENERAL MFG CO	SD US	57078
10899	EASTERN AIR DEVICES INC	NY	11021
11045	AM CASTLE & CO INC	CA	91201
11236	CIS CORP	IN US	60131
11502	IRC INC	IN US	46514
11699	CHASE BRASS & COPPER CO INC	NC US	28607
11837	ELECTRO SCIENTIFIC INDUSTRIES INC	CT	06720
12360	ALBANY PROD CO DIV OF PHENUM DYN	WA	98031
12406	ELPAC INC	CT	06850
12498	CRYSTALONICS, DIV TELEDYNE	IN	47274
13103	THERMALOY INC	CA	92664
16179	M/A-COM INC	MA	02140
16596	DENNISON MFG CO	TX US	75234
17856	SILICONIX INC	MA US	01803
18324	SIGNETICS CORP	BURLINGHAM	01701
18565	CHOMERICS INC	MA US	01801
18873	DUPONT E I DE NEBOURS & CO	CA US	94086
19201	NORTH AMERICAN PHILIPS CORP	CA US	95054
24226	GOWANDA ELECTRONICS CORP	CA US	95054
24355	ANALOG DEVICES INC	CA US	95134
24931	SPECIALTY CONNECTOR CO	CA US	92507
25403	NY PHILIPS ELCOMA	CA US	95134
27014	NATIONAL SEMICONDUCTOR CORP	CA	94304
27264	MOLEX INC	CA	94304
28480	HEWLETT-PACKARD CO CORPORATE HQ	IL US	60532
30161	AAVID ENGINEERING INC	CA	94304
32997	BOURNS INC	NH US	03247
34335	ADVANCED MICRO DEVICES INC	CA US	95077
50088	SOS-THOMSON MICROELECTRONICS INC	CA US	94086
52763	STETNER & CO	AZ US	85022
55285	BERGQUIST CO	GM	D-856
56289	SPRAGUE ELECTRIC CO	MA	02173
58474	THE SUPERIOR ELECTRIC CO	MA US	02173
59880	THOMSON J L RIVET & MACH CO	CT US	06010
71744	GENERAL INSTRUMENT CORP	MA	02154
73138	BECKMAN INDUSTRIAL CORP	NJ US	07012
73957	FEDERAL SCREW PRODUCTS CO	CA US	92635
73734	GROOV-PIN CORP	IL	60618
75915	LITTELFUSE INC	IL US	60016
78189	ILLINOIS TOOL WORKS INC SHAKESPEARE	IL	60126
79963	ZIERICK MFG CO	NY	10549
82567	REEVES HOFFMAN	PA	17013
83330	KULKA-SMITH INC	NJ US	08736
84411	AMERICAN SHIZUKI CORP	CA US	91304
85471	BOYD CORP	CA US	94566
9N171	UNITRODE CORP	MA US	02173
91506	AUGAT INC	MA US	02048
98291	ITT SELECTRO CORP	NE US	68601
		CT US	06611

Table 6-3. Manufacturer's Code List

# MANUAL CHANGES



## 7-1. INTRODUCTION

This section contains information necessary to adapt this manual to apply to older instruments.

## 7-2. MANUAL CHANGES

This manual applies directly to HP 5347A/48A Microwave Counter/Power Meter with the serial prefix 3009 and up.

As engineering changes are made, newer instruments may have higher serial prefix numbers than the one shown on the title page of this manual. The manuals for these instruments will be supplied with MANUAL CHANGES sheets containing the required information. Replace the 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.

## 7-3. OLDER INSTRUMENTS

To adapt this manual to older instruments having a serial prefix lower than 3009, perform the backdating that applies to your instrument serial prefix as listed in Table 7-1.

Table 7-1. Manual Backdating

IF INSTRUMENT HAS SERIAL NUMBER	MAKE THE FOLLOWING CHANGES TO YOUR MANUAL
A3 Counter Assembly, Date Code 92051	1
A6 IF Amplifier/Detector, Date Code 92023	2
A6 IF Amplifier/Detector, Date Code 89292	3
HP 5347A S/N above 3009A00611 HP 5347A S/N above 3009A00431	4
FOR HP 5347A All Serial Prefix Numbers lower than 3009A	5
FOR HP 5348A All Serial Prefix Numbers lower than 3009A	5

CHANGE 1

Make this change for instruments that contain A3 Counter Assembly with Date Code below 92051:

Table 6-2. A3 Counter Assembly Replaceable Parts:

Change A3R24 and R28 from 0698-3439 (178 ohms) to 0698-3437, RESISTOR 133 ±1%. 125W TF  
 TC=0±400, 12498, CT4-1/8-TO-133R-F.

Change A3R30 from 0698-3439 (178 ohms) to 0698-3446, RESISTOR 383 ±1%. 125W TF  
 TC=0±100, 12498, CT4-1/8-TO-383R-F.

Change A3R31 from 0757-0399 (82.5 ohms) to 0757-0400, RESISTOR 90.9 ±1%. 125W TF  
 TC=0±100, 12498, CT4-1/8-TO-90R9-F.

Figure 8-40. A3 Counter Assembly Schematic Diagram:

Change A3R24, R28, and R30, values from 178 ohms to 133 ohms.  
 Change A3R31 value from 82.5 ohms to 90.9 ohms.

CHANGE 2

Make this change for instruments that contain A6 IF Amplifier/Detector Assembly with Date Code below 92023:

Table 6-2. A6 IF Amplifier/Detector Assembly Replaceable Parts:

Change A6C23 from 0160-3873 (4.7PF) to 0160-3874, CAPACTOR-FXD 10PF 200V, 12344, C320C100J2G5CA.

Change A6C24 from 0160-4385 (15PF) to 0160-3874, CAPACTOR-FXD 10PF 200V, 12344, C320C100J2G5CA.

Figure 8-43. A6 Amplifier/Detector Assembly Component Locator/Schematic Diagram:

Change the value of A6C23 from 4.7pf to 10pf.  
 Change the value of A6C24 from 15pf to 10pf.

CHANGE 3

Make this change for instruments that contain A6 IF Amplifier/Detector Assembly with Date Code below 89292:

Table 6-2. A6 IF Amplifier/Detector Assembly Replaceable Parts:

Change A6C23 from 0160-3874 (10PF) to 0160-4492 CAPACTOR-FXD 18PF ±.5PF 200VDC  
 CER.

Change A6C24 from 0160-3874 (10PF) to 0160-3872, CAPACTOR-FXD 2.2PF ±.5PF 200VDC  
 CER.

Figure 8-43. A6 Amplifier/Detector Assembly Component Locator/Schematic Diagram:

Change the value of A6C23 from 10PF to 18PF.  
 Change the value of A6C24 from 10PF to 2.2PF.

CHANGE 4

Make this change for 5347A instruments below Serial Number 3009A00611 and 5348A instruments below Serial Number 3009A00431:

Table 6-2. A5 Synthesizer Assembly Replaceable Parts:

Change A5C44 from 0160-4527 (56PF) to 0160-4511, CAPACTOR-FXD 220PF 5% 200V CER.  
Add A5Q1 and Q2, 1855-0540, TRANSISTOR J-FET P-CHAN D-MODE TO-18 SI, 27014,  
2N5115(SEL).  
Add A5Q8, 1854-0215, TRANSISTOR NPN SI TO-92 PD=350W, 04713, 2N3904.  
Add A5Q9, 1853-0036, TRANSISTOR PNP SI TO-92 PD=625MW, 04713, 2N3906(SEL).  
Add A5R2, 0698-3155, RESISTR 4.64K ±1%, 12W TF TC=0±100, 12498, CT4-1/8-  
TO-1472-F.  
Add A5R3 and R39, 0698-3156, RESISTOR 14.7K±1%, 125W TF TC=0±100, 12498, CT4-1/8-  
Change A5R20 from 0698-3152 (3.48K ohms) to 0757-0442, RESISTOR-FXD 10.0K 1% 12W F  
TC=0±100.  
Add A5R40, 0757-0438, RESISTOR-FXD 5.11K 1% 125W F TC=0±100.  
Add A5R41, 0757-0465, RESISTOR-FXD 100K 1% 12W F TC=0±100.

Figure 8-42. A5 Synthesizer Assembly Schematic Diagram:

Add A5Q1, Q2, Q8, and Q9, R2, R3, R39, R40 and R41 as shown in the Figure 7-1.  
Delete A5R2, R3, R39, R40 and R41.

CHANGE 5

Make this change for instruments that contain the Revision B A1 Motherboard Assembly and the Relay Assembly (05345-60009).

Table 6-2. Replaceable Parts, A1 Motherboard Assembly:

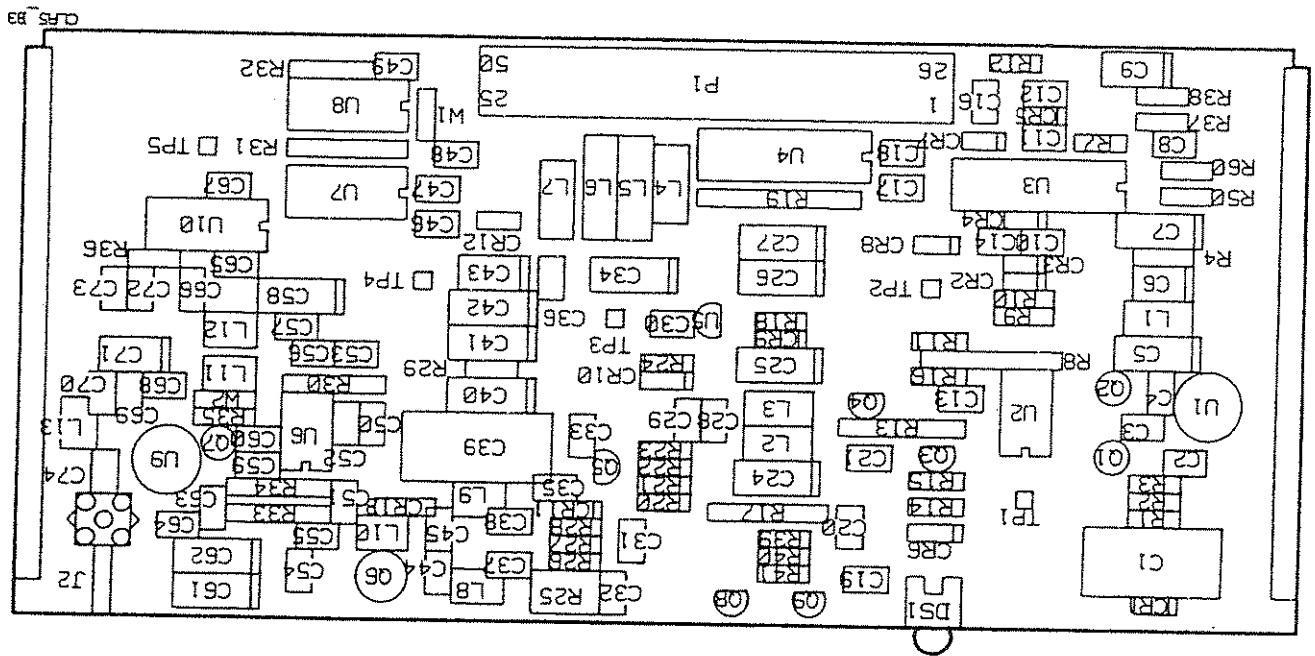
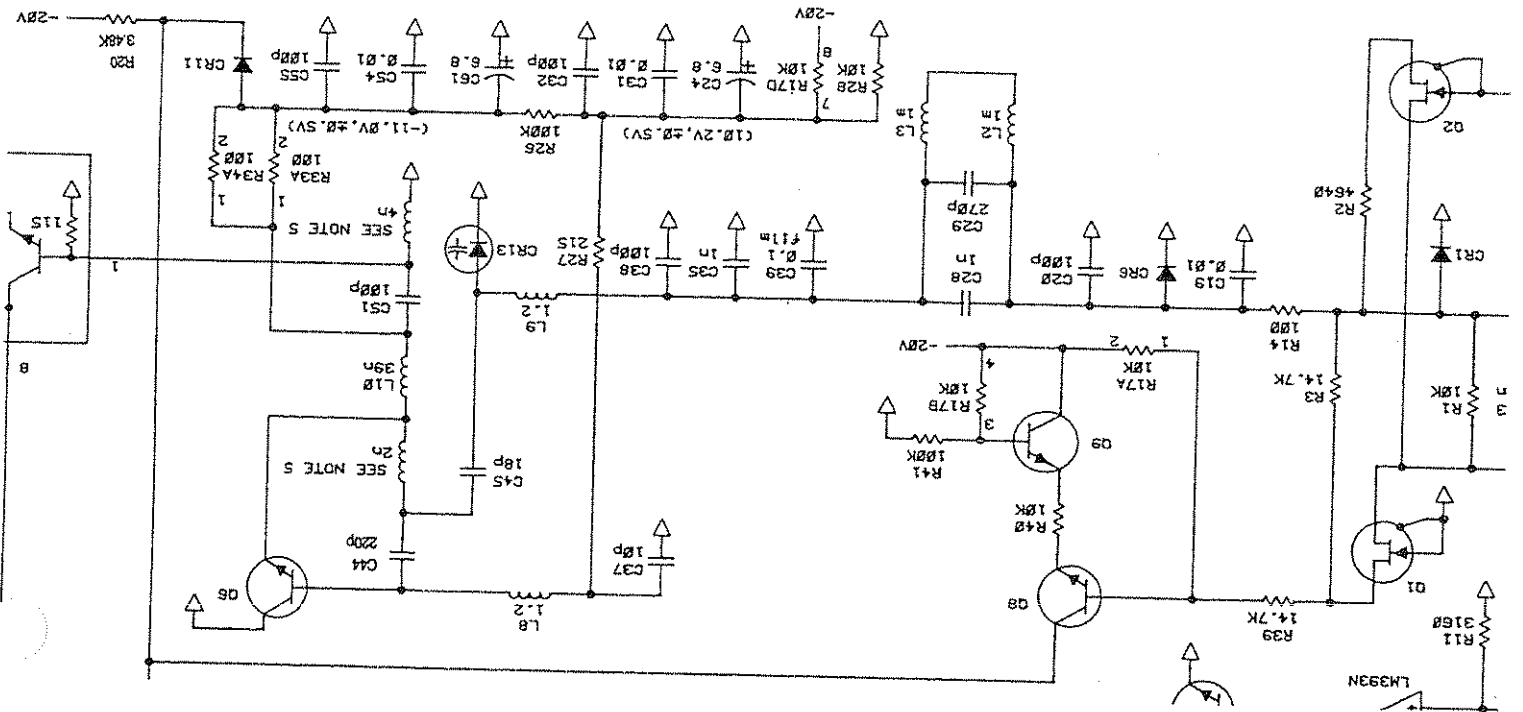
Delete A1K2, 0490-1689, RELAY - 1A 1B 5V PC MTG.  
Add the Relay Assembly (05345-60009) Replaceable Parts list (Table 6-2 on the next page) after the A1 Motherboard Assembly Parts list.

Section 8-43. ON/OFF Control Test:

Change procedure to read as follows:

For troubleshooting, verify the voltage readings in Table 8-6A.

Figure 7-1. A5 Synthesizer Assembly Component Locator and Partial Schematic Diagram (5347A's below Serial Number 3009A00611, and 5348A's below Serial Number 3009A00431)



CLS 33



1. Remove the cover as described in Section 8-90.
2. The Relay Assembly is now exposed and located on the bottom side of the A1 Motherboard Assembly as shown in Figure 8-5A.
3. Refer to Figure 8-5A. Remove the necessary wire(s) and screws (notated as A, B, and C in Figure 8-5A) to replace a component on the Relay Assembly.
4. Reinstall Relay Assembly by reversing the steps.

RELAY ASSEMBLY REMOVAL AND REINSTALLATION. Refer to Figures 8-5A and 8-38A for the removal illustration and the component locator, respectively.

Add the following procedure after the last step (step 7).

Change Section 8-96 heading "A1 Motherboard Assembly Removal" to "A1 Motherboard / Relay Assembly Removal".

Section 8-96. A1 Motherboard / Relay Assembly Removal:

CHANGE 5 (CONTINUED)

Conditions		110ACV Power Source		Unit Turned On		Voltmeter Ground Lead to Chassis	
TP3	+16V	K2-3	0V	U1	1	+5V	8
K2-6	+0.2V	K2-2	0V	U1	2	+5V	7
K2-5	+28.4V	K2-8	+16V	U1	3	0V	6
K2-1	0V	K2-7	+16V	U1	4	0V	5
				U3	1	+5V	14
				U3	2	+5V	13
				U3	3	+5V	12
				U3	4	0V	11
				U3	5	0V	10
				U3	6	+5V	9
				U3	7	+4.9V	8
				Q1	1	+1.25V	1
				Q1	2	+15.9V	2
				Q1	3	+16.1	3
				Q2	1	0V	1
				Q2	2	+7V	2
				Q2	3	+0.22V	3
				U2	1	+12.5V	8
				U2	2	+1.25V	7
				U2	3	0V	6
				U2	4	+1.25V	5

Table 8-6A. Relay Assembly (05348-60009) Voltage Readings

Change text under the subsection "ON/OFF CONTROL" - to read as follows:

#### ON/OFF CONTROL CIRCUIT (A1) AND RELAY ASSEMBLY. The purpose of the

ON/OFF Control Circuit (on AI Motherboard Assembly) and the Relay Assembly (05348-60009) are to connect or disconnect the power (+Vs) that drives the power supply circuits. The Relay Assembly also provides the current path for the input of the Battery Charger circuit.

The ON / OFF circuitry consists of the front panel POWER switch, the ON / OFF Control circuit on the AI Motherboard Assembly, and the ON/OFF Relay circuit on the

Relay Assembly.

The Relay Assembly was designed to replace the ON/OFF Relay (A1K2), which used to be mounted on the A1 Assembly. The Relay Assembly uses the signals present at the pins where A1K2 was installed as shown in *Figure 8-38A*, (Relay Assembly schematic diagram). An additional signal at A1TP3 (MAIN POWER IN) is used to supply current to relay (K1) on the Relay Assembly that switches the battery charging current.

In the following circuit description, the front panel POWER switch is discussed first. Then each functional stage of the ON/OFF Control circuit is described. Finally, the functional stages of the Relay Assembly are discussed. The board assembly under discussion is identified (in parentheses) at the beginning of each functional description, all reference designations in the description are in reference to the named assembly, unless otherwise indicated.

**POWER Switch (Front Panel).** The front panel POWER switch (S1) is a momentary switch, which means it returns to its normally-open circuit condition when the actuating force is removed. Referring to the schematic diagram, *Figure 8-38B (AI*

*Motherboard Assembly schematic diagram)*, the front panel POWER switch is connected to the input (PS IN) of the ON/OFF Control circuit. When the power switch is not activated, transistor A1Q11 is biased OFF, and there is no output to the +5V regulator A1U8(1). Thus, there is no voltage out at A1U8(3). This way, as long as the power switch is not depressed, the ON/OFF Control circuit draws no power. Hence,

when the instrument is OFF, the battery is not being drained.

**Power ON (A1).** Pressing POWER switch (S1) momentarily puts zero volts (ground) on the base of A1Q11. Thus, A1Q11 turns ON and the SYSTEM POWER input is momentarily present at the collector of A1Q11 which is connected to the input of the +5V regulator A1U8. A1U8 outputs regulated +5V to power the ON/OFF circuit. A1U13 keeps the output of A1U13(5) LOW until the voltage at A1U13(3) charges up to equal the +2.5V reference of A1U13(1) — this time constant is set to 1.3  $\mu$ s.

At this point, A1U13(5) outputs a positive edge which is fed to the one shot A1U14(10). A1U14(5) then outputs a positive squared pulse to NAND gate A1U10(1,4). If L<sub>μ</sub> P<sub>-</sub>RST line goes LOW (which it is if the instrument is OFF), it causes a negative pulse out at only A1U10(6) that triggers one shot A1U1A to output a negative pulse at A1U11(4), which turns on A1Q14 (H<sub>-</sub>ON pulses HIGH for approximately 13 ms).

Power ON (Relay Assembly). The positive pulse (H<sub>-</sub>ON) from A1Q14 collector is routed to U3B(6) on the Relay Assembly where it is inverted. The inverted pulse at U3B(6) resets RS latch (U3C,D); thus, U3C(8) is latched HIGH, causing transistor Q2 to turn ON. When Q2 turns ON, the 0V (ground) at its collector biases FET Q1 ON. Thus, the dc source (SYSTEM POWER) from A1K1(6,7) is connected to the +V<sub>S</sub> line (or rest of the instrument), turning the instrument ON.

Power OFF (A1). When the instrument is ON, the pressing of the POWER switch starts the same sequence events described in the previous paragraph, except L<sub>μ</sub>P<sub>-</sub>RST is already HIGH. Thus, the pulse generated by A1U13(5) passes through A1U10A(3) instead of A1U10B(6). This triggers the one shot A1U11B(9), producing a negative pulse at A1U11B(12). This turns on A1Q13, and the collector (H<sub>-</sub>OFF) of Q13 pulses HIGH for approximately 13 ms.

Power OFF (Relay Assembly). The positive pulse (H<sub>-</sub>OFF) from A1Q13 collector is routed to U3A(1,2) on the Relay Assembly where it is inverted. The inverted pulse at U3A(3) sets the RS LATCH; thus, U3C(8) is latched LOW, causing Q2 to turn OFF. When Q2 turns OFF, the FET Q1 is biased OFF. Thus, the SYSTEM POWER is disconnected from the rest of the instrument, turning the instrument OFF (Standby mode). (Note that some circuits may still be ON when the instrument is in the Standby mode; also, high voltages may be present.)

Resistor R9 and zener diode CR3 on the Relay Assembly protect the gate of FET Q1 by limiting the voltage at the gate to 15 volts.

ON/OFF Condition Latch (Relay Assembly). This circuit consists of NAND gates U3A and U3B, RS latch (U3C,D), voltage regulator U2, zener diode CR2, resistor R3, and capacitors C4, C6, and C7. This circuit supplies the V<sub>cc</sub> that drives the QUAD NAND gate U3, limits the V<sub>cc</sub> to +24V, and remembers the ON and OFF state of the instrument prior to lost of power.

The combination of the RS latch (U3C,D), capacitor C5, and resistors R4 and R7 enables the instrument to power up in its last state (ON or OFF) prior to losing power. When power is reapplied to the instrument, C5, R4, and R7 momentarily force the H<sub>-</sub>OFF line, U3(I), HIGH immediately after powering up to set the RS latch output U3(8) LOW; thus, making sure the instrument is always in its OFF state when first powered up.

The +5V voltage regulator U2 generates the +5 Vcc to drive the NAND gates of U3. The Vcc is derived from the instrument's +Vs dc source. If the dc source goes above +24V, R3 and zener diode CR2 will limit the voltage that U2(8) receives to +24 volts. Thus, R3 and CR2 protect U2 from over-voltage damage.

Battery Charger Path (Relay Assembly). This circuit consists of the non-latching relay K1, U1 voltage regulator, and the associated components. The purpose of this circuit is to turn the Battery Charger circuit (on A1) OFF when the instrument is operating, and turn the circuit ON when the instrument is not operating.

The same signal, U3C(8), that controls the FET Q1 ON and OFF states also controls the ON and OFF states of relay K1. When the instrument is operating from ac power, the charging voltage from full-wave rectifier A1CR6 is connected to K1 (8). Also, the rectified MAIN POWER IN (A1TP3) and the HIGH signal at U3C(8) are fed to U1(8) and U1 (3), respectively. Sensing both of these inputs, U1 (1) outputs approximately 12V to K1(4). This energizes the relay coil, causing the normally-open relay switch to close. The closed relay switch connects the charging voltage at K1 (8) to the Battery Charger circuit input (A1CR24) which turns the circuit ON.

When no external source of power is applied to the instrument, there is no output at U1(1) and the relay coil of K1 is de energized. This leaves the normally-open relay switch opened; thus, the Battery Charger circuit is turned OFF. If the external dc is applied, but not ac, the coil will be energized, but there will be no voltage applied to K1(8) so again, the charger circuit is OFF.

Note that the Battery Charger circuit can charge the battery pack only when the instrument is connected to ac power.

#### Section 8-174. Schematic Diagrams:

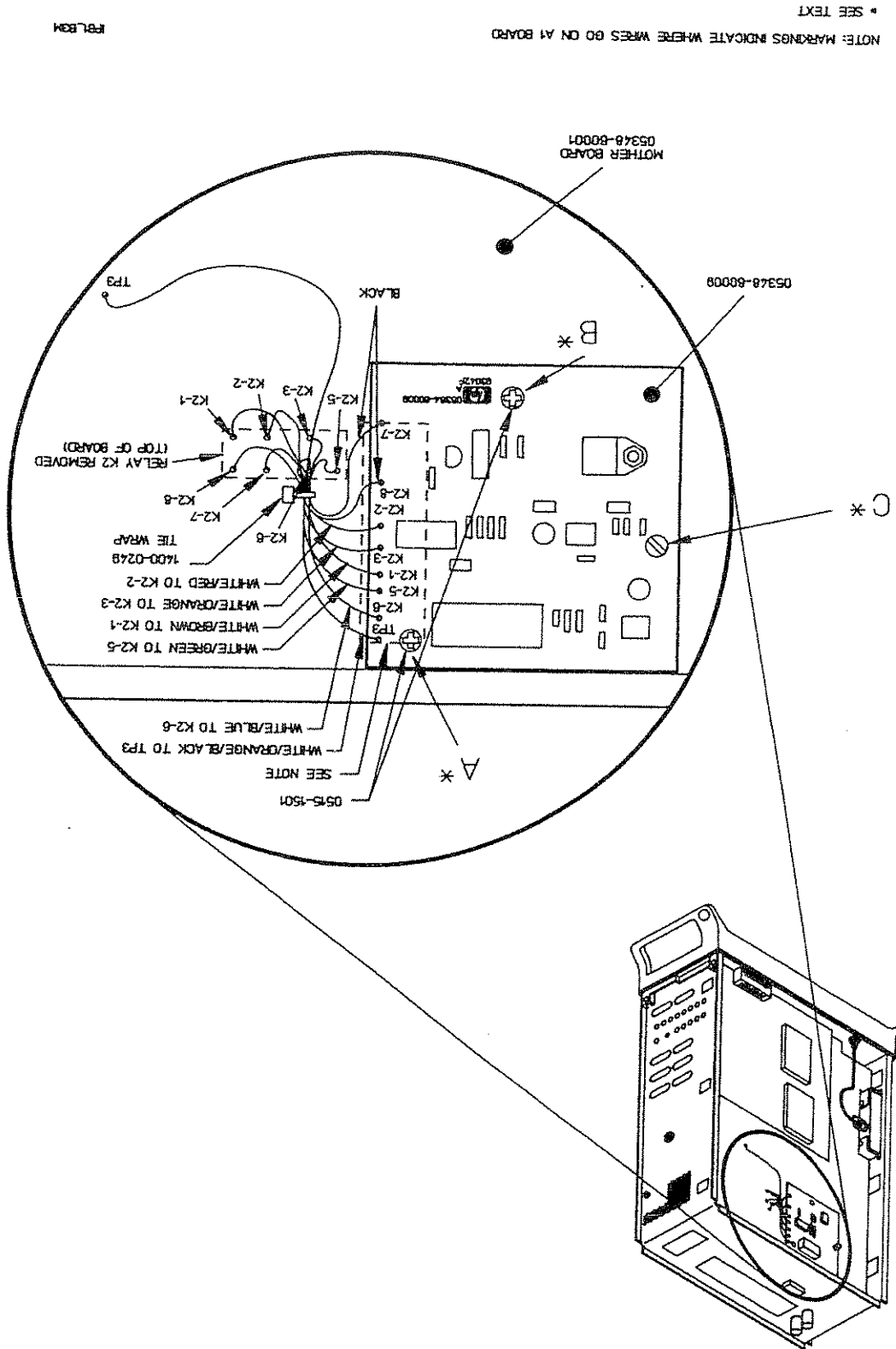
Add Figure 8-38A (Relay Assembly Component Locator/Schematic Diagram) of this manual change section before the A1 Component Locator (P/O Figure 8-38) on page 8-229. Note that Figure 8-38A is page 8-227A.

Replace pages 8-229, 8-231, and 8-233 with the attached pages 8-229 through 8-233 in this change sheet.

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	C D Qty	Description	Mtr Code	Mtr Part Number
C1	0160-0576	5	CAP-FXD 0.1uF 50 V	09969	RPE121-105X7R104M50V
C2	0160-3879	7	CAP-FXD 0.10uF 100 V	09969	RPE121-105X7R103M100V
C3	0180-3831	3	CAP-FXD 10uF 35 V TA	12344	T398G106K035AS
C4	0160-3879	7	CAP-FXD 0.01uF 100 V	09969	RPE121-105X7R103M100V
C5	0160-4535	4	CAP-FXD 1uF 50 V	04222	SR305C105KAAH
C6	0160-0576	5	CAP-FXD 0.1uF 50 V	09969	RPE121-105X7R104M50V
C7	0180-3831	3	CAP-FXD 10uF 35 V TA	12344	T398G106K035AS
C8	0160-4535	4	CAP-FXD 1uF 50 V	04222	SR305C105KAAH
C9	0160-4535	4	CAP-FXD 1uF 50 V	04222	SR305C105KAAH
C20	0160-4557	0	CAP-FXD 0.1uF 50 V	09969	RPA30X7R104M50V
C21	0160-4557	0	CAP-FXD 0.1uF 50 V	09969	RPA30X7R104M50V
CR1	1901-0050	3	DIODE-SWITCHING 80V 200MA ZNS DO-35	9N171	1N4150
CR2	1902-0967	3	DIODE-ZNR 15V 5% PD=1u IR=5UA	28480	1902-0967
CR3	1902-0202	1	DIODE-ZNR 15V 5% PD=1u IR=5UA	28480	1902-0202
K1	0490-1701	9	RELAY 1A8 12VDC-COIL 8A 380VAC	01852	ST1E-DC12V
K2-1	8150-0140	6	WIRE 22AWG W/BR 300V PVC 7X30 105C	28480	8150-0140
K2-2	8150-0037	9	WIRE 22AWG W/R 300V PVC 7X30 105C	28480	8150-0037
K2-3	8150-0036	9	WIRE 22AWG W/O 300V PVC 7X30 105C	28480	8150-0036
K2-5	8150-0035	8	WIRE 22AWG W/G 300V PVC 7X30 105C	28480	8150-0035
K2-6	8150-0142	8	WIRE 22AWG W/BL 300V PVC 7X30 105C	28480	8150-0142
K2-7	8150-0143	9	WIRE 22AWG W/V 300V PVC 7X30 105C	28480	8150-0143
K2-8	8150-0144	0	WIRE 22AWG W/GY 300V PVC 7X30 105C	28480	8150-0144
Q1	1855-0804	6	TRANSISTOR NPN SI 10-92 PD=350mW	04713	MTHS5P06
Q2	1854-0215	1	TRANSISTOR NPN SI 10-92 PD=350mW	04713	ZN3904
R1	0698-8826	3	RESISTOR 825K +-1% .125W TF TC=0+-100	12498	CT4
R2	0757-0465	6	RESISTOR 100K +-1% .125W TF TC=0+-100	12498	CT4-1/8-10-1003-F
R3	0757-0428	1	RESISTOR 1.62K +-1% .125W TF TC=0+-100	12498	CT4-1/8-10-10-1621-F
R4	0757-0199	3	RESISTOR 21.5K +-1% .125W TF TC=0+-100	12498	CT4-1/8-10-10-2151-F
R5	0698-3161	9	RESISTOR 38.3K +-1% .125W TF TC=0+-100	12498	CT4-1/8-10-3832-F
R6	0698-3161	9	RESISTOR 38.3K +-1% .125W TF TC=0+-100	12498	CT4-1/8-10-3832-F
R7	0757-0199	3	RESISTOR 21.5K +-1% .125W TF TC=0+-100	12498	CT4-1/8-10-10-2151-F
R8	0698-0084	9	RESISTOR 2.15K +-1% .125W TF TC=0+-100	12498	CT4-1/8-10-2151-F
R9	0698-3159	5	RESISTOR 26.1K +-1% .125W TF TC=0+-100	12498	CT4-1/8-10-2612-F
R10	0698-3408	7	RESISTOR 2.15K +-1% .5W TF TC=0+-100	K8479	HZ
R20	0698-0084	9	RESISTOR 2.15K +-1% .125W TF TC=0+-100	12498	CT4-1/8-10-2151-F
R21	8150-0147	3	WIRE 22AWG W/BR/O 300V PVC 7X30 105C	28480	8150-0147
TP5	1251-4707	6	CONNECTOR-SGL CONT PIN .031-IN-BSC-SZ	12360	460-2983-02-03
TP6	1251-4707	6	CONNECTOR-SGL CONT PIN .031-IN-BSC-SZ	12360	460-2983-02-03
U1	1826-1968	4	IC V RGLTR-ADJ-POS 4.975/5.025V 8-DIP-P	27014	LFP2951ACN
U2	1826-1968	4	IC V RGLTR-ADJ-POS 4.975/5.025V 8-DIP-P	27014	LFP2951ACN
U3	1820-2922	0	IC GATE CMOS/74HC NAND QUAD 2-INP	04713	HC74HC00N
XU3	1200-0483	0	SOCKET-IC-DIP 14-CONT DIP-SLDR	55322	IC-314-SG1
			RELAY ASSEMBLY MISCELLANEOUS		
			SPCR-CAPTIVE	28480	05100-2052
			STANDOFF-RVT-ON .156-IN-LG 4-40-THD	28480	0380-0885
			SCREW-MACH M3.5 X 0.6 8TH-LG PAN-HD	00000	ORDER BY DESCRIPTION
			NUT-HEX DBL-CHAM M3.5 X 0.6 3.3M-TM-TM	00000	ORDER BY DESCRIPTION
			SCREW-MACH 4-40 .5-IN-LG RD-HD-SLT	00000	ORDER BY DESCRIPTION
				28480	05348-60009

Figure 8-5A. Removal of the Relay Assembly (05348-60009)



# 8

## SERVICE

### 8-1. INTRODUCTION

This section contains the information needed to service the HP 5347A/48A. Service information includes troubleshooting procedures, diagnostics, theory of operation, component locators, and schematic diagrams. The information contained in this section is organized as follows:

- Safety Considerations, Section 8-2: Describes the safety considerations applicable during maintenance, adjustments and repair.
- Recommended Test Equipment, Section 8-4: Refers to test equipment specified in Appendix B of this manual.
- Repairs and After Service Checks, Sections 8-5 through 8-9: Describes Hewlett-Packard recommendations for preventing corrosion and electrostatic damages to printed circuit boards and assemblies. After servicing safety checks are also described.
- Service Accessories, Section 8-10: Describes the function and use of extender boards available for testing printed-circuit boards, and provides a list of contents in an available Service Accessories Kit.
- Schematic Diagram Symbols and Reference Designations, Section 8-11: Describes the symbols used on the schematic diagrams and the reference designations used for parts, subassemblies and assemblies.
- Identification of Boards and Assemblies, Section 8-13: Describes the method used by Hewlett-Packard for identifying printed-circuit boards and assemblies, and lists all HP 5347A/48A assemblies and their part numbers.
- Logic Symbols, Section 8-17: References to ANSI/IEEE standards.
- Troubleshooting, Sections 8-18 through 8-88: Provide troubleshooting information and procedures, diagnostics information, and signal tracing techniques that are designed to isolate trouble to the assembly and then to the component group level.
- Disassembly and Reassembly, Section 8-89: Describes procedures for removal of covers and assemblies to gain access to parts.

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

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 cover, are for use by service-trained personnel only. To avoid dangerous electric shock, do not perform any servicing or make any adjustments with the cover removed, unless qualified to do so.

## 8-2. SAFETY CONSIDERATIONS

- Theory of Operation, Section 8-99: Provides a block diagram description of the overall instrument operation.
- Description of User-Callable Diagnostics, Section 8-118: Lists and describes all of the built-in diagnostics which can be used to verify various functional subsections of the HP 5347A/48A circuitry.
- Detailed Circuit Descriptions, Section 8-160: Provides detailed description of the circuits of each assembly.
- Schematic Diagrams, Section 8-174: Provides front and rear panel views, top and bottom internal views, an overall block diagram, and a schematic diagram for each of the circuit-board assemblies in the HP 5347A/48A. Each schematic diagram includes a component locator for each field repairable assembly. Where applicable, test and troubleshooting waveforms are placed adjacent to the schematic diagram.



### 8-3. Safety Symbols

The safety symbols used on equipment and the manual are shown in *Table 8-1*.

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. 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.

**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.**

**WARNING**

## 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).

Verify that the product is set to match the available line voltage and the correct fuse is installed. Refer to instructions in this appendix.

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 earth (ground) terminal.



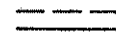
Indicates terminal is connected to chassis when such connection is not apparent.



Alternating current.



Direct current.



### WARNING

THIS 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

This 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.

### 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.

## 8-4. RECOMMENDED TEST EQUIPMENT

Test equipment recommended for testing and troubleshooting the HP 5347A/48A is listed in Appendix B of this manual. Substitute equipment may be used if it meets or exceeds the required characteristics listed in the table.

## 8-5. REPAIRS AND AFTER SERVICE CHECKS

### 8-6. Cleaning Printed-Circuit Boards

After soldering a component to a printed-circuit (PC) board, HP recommends that you DO NOT remove the flux from the soldered area. It has been found that after a hand soldering operation, the solder flux from RMA-P2 (Rosin, Mildly Active) solder does no harm if left in place on a PC board; the flux residue is inert and nonconductive. However, when the flux is dissolved with a chemical, in an attempt to remove it from the board, it spreads over the board, releasing several activators (chlorides, bromides, etc.). Now, instead of having a harmless flux residue with the water soluble activators trapped inside, you have a potential corrosion problem. If the instrument is stored in a humid environment, over time moisture will be absorbed which can start the corrosion process.

### 8-7. Repair of Multilayer Circuit Boards

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 components.

### 8-8. Electrostatic Discharge

Electronic components and assemblies in the HP 5347A/48A 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.)

## 8-9. After Service Product Safety Checks

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 1 $\Omega$ . 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 2M $\Omega$ . 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.

## 8-10. SERVICE ACCESSORIES

Service accessories to aid in troubleshooting the HP 5347A/48A are available from Hewlett-Packard. Table 8-2 lists the items in HP 5347A/48A Service Accessory Kit. The list includes the name, the HP part number, and a brief description and use of each item.

Table 8-2. Service Accessories Kit (05348-67001) Contents

ACCESSORY	HP PART NO.	DESCRIPTION AND USE
Extender Boards (2 each)	5060-0175	50-pin dual connector extender board used for A2, A3, A5, A6, and A7 assemblies.
Extender Boards (2 each)	05361-60050	60-pin dual connector extender board for A4 assembly.
Extender Cable or 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. Also used for viewing the 10 MHz and IF test ports on the motherboard.
HP-IB Interface	05350-60011	HP-IB Interface Assembly (A11) allows testing via a controller. (Used during Troubleshooting with HP 5347A/48A's sold without option.)
HP-IB Verification Diskettes	05348-13502 (5¼ inch) 05348-13501 (3½ inch)	5 ¼-inch and 3½-inch floppy disc with HP 5347A/48A HP-IB Verification Tests written in BASIC.
Service Manual	05348-90003	This manual contains information that describes how to test and repair the HP 5347A/48A.
Operating and Programming Manual	05348-90001	This manual contains information that describes how to operate and program the HP 5347A/48A.

## 8-11. SCHEMATIC DIAGRAM SYMBOLS AND REFERENCE DESIGNATIONS

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.

### 8-12. Reference Designations

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.

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.

## 8-13. IDENTIFICATION OF BOARDS AND ASSEMBLIES

### 8-14. Identification Markings On Printed-Circuit Boards

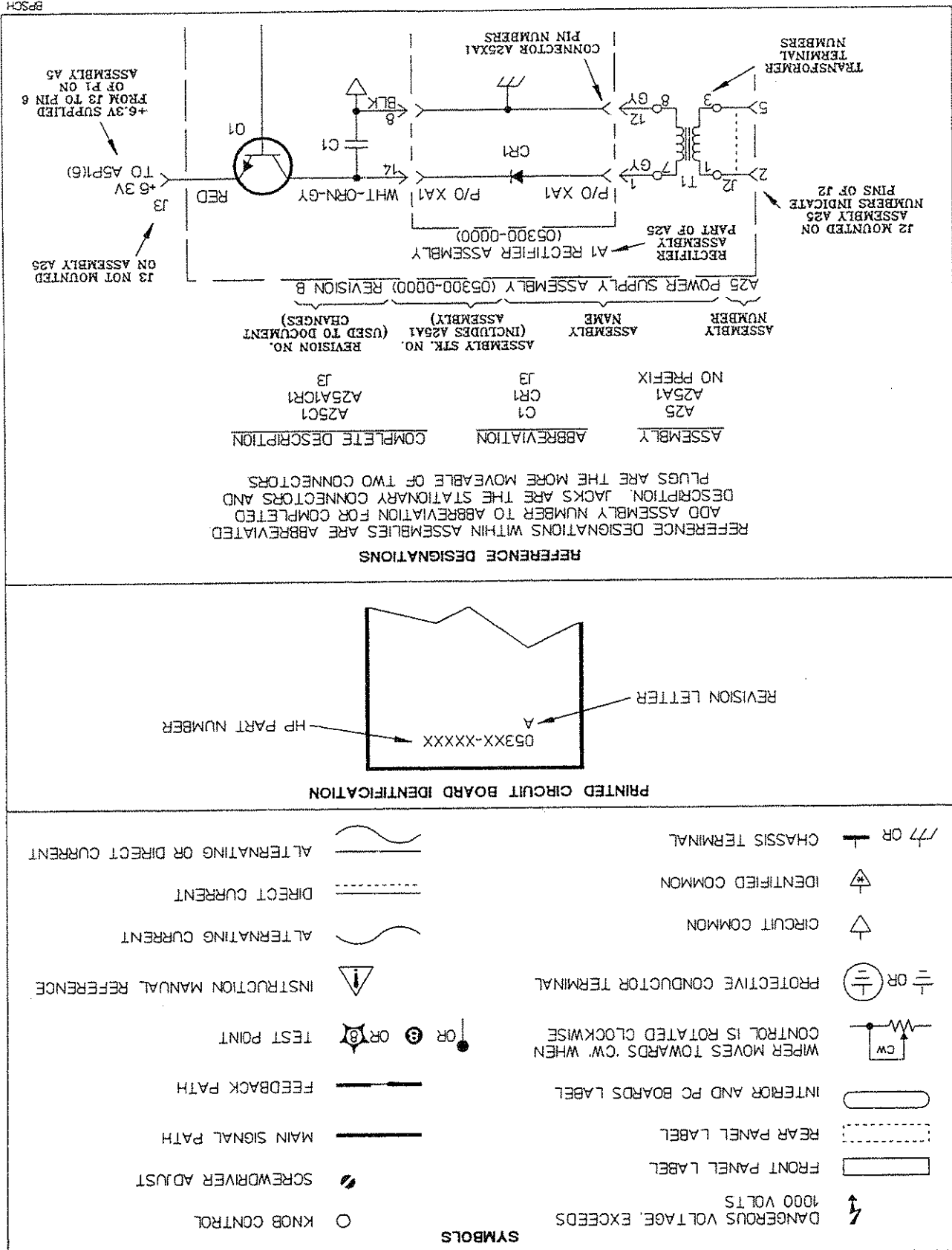
Printed-circuit boards in this instrument (see Figure 8-1) have three identification numbers: an assembly part number, a revision letter, and a production code. The assembly part number has 10 digits (such as 05350-60001) and is the primary identification. All assemblies with the same part number are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

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.

### 8-15. Identification of Multilayer Circuit Boards

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.

Figure 8-1. Schematic Diagram Notes



8-16. Assembly Identification and Location  
 The assembly number, name and Hewlett-Packard part number of HP 5347A/48A assemblies are listed in Table 8-3. Top and bottom internal views of the instrument are shown in Figures 8-33 and 8-34, respectively.

Table 8-3. HP 5347A/48A Assembly Identification

ASSEMBLY	NAME	HP PART NO.
A1	Motherboard/Power Supply/10 MHz Timebase	05348-60001
A2	Low Frequency Input	05350-60002
A3	Counter	05350-60003
A4	Microprocessor	05348-60004
A5	Synthesizer	05350-60018
A6	IF Amplifier/Detector	05350-60006
A7	Power Meter Digital	05348-60007
A8	Power Meter Analog	05348-60008
A9	Display/Driver	05350-60123
A10	Front Panel Membrane Keyboard	05348-60203
A11	HP-IB Interface (Option 011)	05350-60011
A12	Microwave Module (A12 Assembly/UI Sampler)	05361-60012

8-17. LOGIC SYMBOLS

Logic symbols used in this manual conform to the American National Standard publication IEEE Standard Graphic Symbols for Logic Functions, ANSI/IEEE Std. 91-1984. This standard supersedes MIL-STD-806B. Another useful reference source is the *The TTL Data Book*, "Explanation of New Logic Symbols" by F.A. Mann (Texas Instruments Incorporated).



## 8-18. TROUBLESHOOTING

The following paragraphs contain troubleshooting procedures for the HP 5347A/48A. 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 5347A/48A. The troubleshooting procedures are listed in Table 8-4.

Table 8-4. Troubleshooting Procedures

SECTION NUMBER	TROUBLESHOOTING PROCEDURE
8-19	Overall Troubleshooting
8-32	Power Supply Block Troubleshooting (Part of A1)
8-49	Microwave Module Sleep Block Troubleshooting (Part of A1)
8-50	System Reset Block Troubleshooting (Part of A1)
8-51	10 MHz Timebase Circuits Block Troubleshooting (Part of A1)
8-56	Keyboard/Display Logic Block Troubleshooting (Part of A1)
8-57	A2 Low Frequency Input Assembly Troubleshooting
8-58	A3 Counter Assembly Troubleshooting
8-59	A4 Microprocessor Assembly Troubleshooting
8-60	A5 Synthesizer Assembly Troubleshooting
8-61	A6 IF Amplifier/Detector Assembly Troubleshooting
8-62	A7 Power Meter Digital Assembly Troubleshooting
8-62	A8 Power Meter Analog Assembly Troubleshooting
8-85	A9 Display/Driver Assembly Troubleshooting
8-86	A10 Membrane Keyboard Troubleshooting
8-87	A11 HP-IB Interface Assembly Troubleshooting
8-88	Microwave Module Troubleshooting (A12/U1 Sampler)

Whenever repairs or adjustments are made, the instrument should be checked for proper performance. Refer to the adjustments in Section 5, and to the Operation Verification procedures and Performance Tests in Section 4.

## 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.)

## 8-19. OVERALL TROUBLESHOOTING

Before removing the 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.

## 8-20. General Diagnostics Information

The diagnostics in the HP 5347A/48A have been designed using the kernel technique (that is, 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 8-2*, facilitate this.

There are two types of diagnostics as follows:

1. Power-Up Self Test: A sequence of tests automatically executed on power-up. These tests include subset of the User-Callable Diagnostics. (Refer to Section 8-31.)
2. User-Callable Diagnostics: These are individual tests which can be initiated manually or via the HP-IB. (Refer to Section 8-24.)

*Table 8-5* lists the available diagnostics, with identifying numbers ranging from 0 to 97. For the diagnostics numbered from 10 to 65, 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. (For the diagnostics numbered from 70 to 80, the first and second digits do NOT identify the assembly or test being performed.) Note that not all numbers between 0 and 97 are used.

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. Diagnostic 73 is another special auxiliary function which is used for turning the Power Meter reference oscillator ON.

The Power-Up Self Test diagnostic routine is 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.

## 8-21. Diagnostics Inference Chart

Once a particular assembly has been identified as failing a diagnostic test or self test routine, the operator should refer to the Diagnostics Inference Chart, *Figure 8-2*, 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.

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 HP 5347A/48A 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 assemblies which are not tested in some form by the diagnostics are the Microwave Module (A12 Microwave Assembly/VI Sampler) and A8 Power Meter Analog Assembly.

Refer to Section 8-118 for detailed information on every diagnostic.

## 8-22. Assembly Troubleshooting Techniques

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 B-1*, Recommended Test Equipment, in the Appendix B of this manual). 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 illustrations shown in this manual.

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.

The troubleshooting procedures for each assembly are arranged in the following order:

1. Possible symptoms which may appear if the assembly is faulty.
2. A list of diagnostic tests that pertain directly to the assembly.
3. Points to consider when troubleshooting the assembly.
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.

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.). Additionally, reference will be given in terms of actual circuit location; that is, the base of Q1, junction of R1 and C12, 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 (that is, the board is in its upright position with the instrument's front panel facing the operator). The A8 Power Meter Analog Assembly is viewed with the instrument upside down with the front panel facing the operator. It is assumed that the board in question, where applicable, is mounted on an extender board (HP P/N 5060-0175 or 05361-60050, as applicable). (See *Table 8-2*.)

Manual.

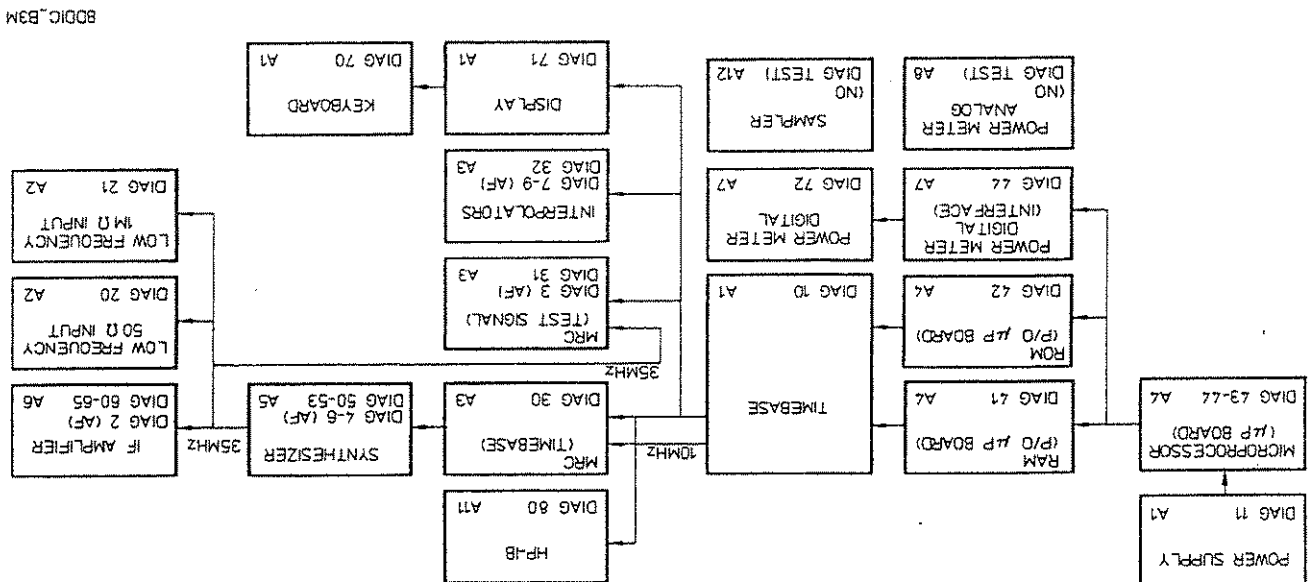
For a complete discussion on HP-IB, refer to Appendix C in the Operating and Programming Manual. Where HP-IB is needed, the appropriate HP-IB command string will be shown, along with instructions for use. BASIC will be the language used. Additional HP-IB information can be found in Appendix C of the Operating and Programming Manual.

To use HP-IB, a simple controller and interface is all that is needed. Of course, the HP 5347A/48A must have the HP-IB Interface (Option 011) installed. For these instruments sold without HP-IB, the necessary hardware is available in the Service Accessories Kit HP Part Number 05348-67001 (see Table 8-2).

To keep the HP 5347A/48A simple to operate, many advanced functions are not available from the Front Panel. However, these functions are available via HP-IB and can be used to advantage for troubleshooting the Power Meter section.

### 8-23. HP-IB Aids For Troubleshooting

Figure 8-2. Diagnostics Inference Chart



80D1C.B3M

8-24. User-Callable Diagnostics

Table 8-5 is a list of all the User-Callable Diagnostics by number, and includes the diagnostic name, the assembly (or assemblies) being tested, and the section number where a description of the given diagnostic can be found. Each User-Callable Diagnostic can be executed as an individual test. Detailed descriptions of each diagnostic can be found in Section 8-118. Diagnostics can be called via the HP 5347A/48A rear panel DIP switch or via the HP-IB. In Table 8-5 an asterisk adjacent to a diagnostics name indicates that the diagnostic is only accessible via the HP-IB.

Table 8-5. User-Callable Diagnostics

DIAG.	NAME	ASSEMBLY TESTED	SECTION NO.
1	Counter and System Self Test	A1, A2, A3, A4, A5, A6	8-123
2	Display IF	Auxiliary Function	8-124
3	Display MRC E & T Register Contents	Auxiliary Function	8-125
4	Display LO Frequency	Auxiliary Function	8-126
5	Display N (integer) and Sideband	Auxiliary Function	8-127
6	Display N (fraction) and Sideband	Auxiliary Function	8-128
7	Display Interpolator Short Calibration	Auxiliary Function	8-129
8	Display Interpolator Long Calibration	Auxiliary Function	8-130
9	Display Interpolator Measurement	Auxiliary Function	8-131
10	Timebase Verification	A1 Timebase/Timebase Buffer Block	8-132
11	Power Supply Verification	A1 Power Supply Block	8-133
20	Low Frequency 50 Ohm Verification: 35 MHz	A2 Low Frequency Input Assembly	8-134
21	Low Frequency 1 MOhm	A2 Low Frequency Input Assembly	8-135

DIAG.	NAME	ASSEMBLY TESTED	SECTION NO.
30	MRC CH A Verification: 10 MHz Timbase	A3 Counter Assembly	8-136
31	MRC CH B Verification: 35 MHz	A3 Counter Assembly	8-137
32	Interpolator Check	A3 Counter Assembly	8-138
40	ROM Version Number	A4 Microprocessor Assembly	8-139
41	RAM Test	A4 Microprocessor Assembly	8-140
42	ROM Test	A4 Microprocessor Assembly	8-141
43	Repeated Reset	A4 Microprocessor Assembly	8-142
44	Dual Port RAM	A4 to A7 communications	8-143
50	LO Verification: 29.5 MHz, 35.0 MHz	A5 Synthesizer Assembly	8-144
51	LO Verification: User-Entered Frequency*	A5 Synthesizer Assembly	8-145
52	LO Sweep: 275.0 > 375.0 MHz	A5 Synthesizer Assembly	8-146
53	LO Lower/Upper Frequency Bounds	A5 Synthesizer Assembly	8-147
60	IF Verification: 35 MHz; Disable INPUT 1 and IF	A6 IF Amplifier/Detector	8-148
61	Overload Status	A6 IF Amplifier/Detector Assembly	8-149
62	Disable Hardware IF Detector Flag; Display Measurement	A6 IF Amplifier/Detector Assembly	8-150
63	Disable Hardware and Software IF Detector Flag; Display IF	A6 IF Amplifier/Detector Assembly	8-151
* HP-IB ONLY			

Table 8-5. User-Callable Diagnostics (Continued)

Diag 1 is a test routine that runs as the Power-Up Self Test (refer to Section 8-31). 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 A1 Motherboard/Power Supply Block Assembly. Diag 97 is not a test, but instead is a special diagnostic that sets the HP 5347A/48A 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 5, Adjustments.) This diagnostic can only be exited by setting the POWER key OFF (Standby) momentarily, or by removing ac power from the HP 5347A/48A.

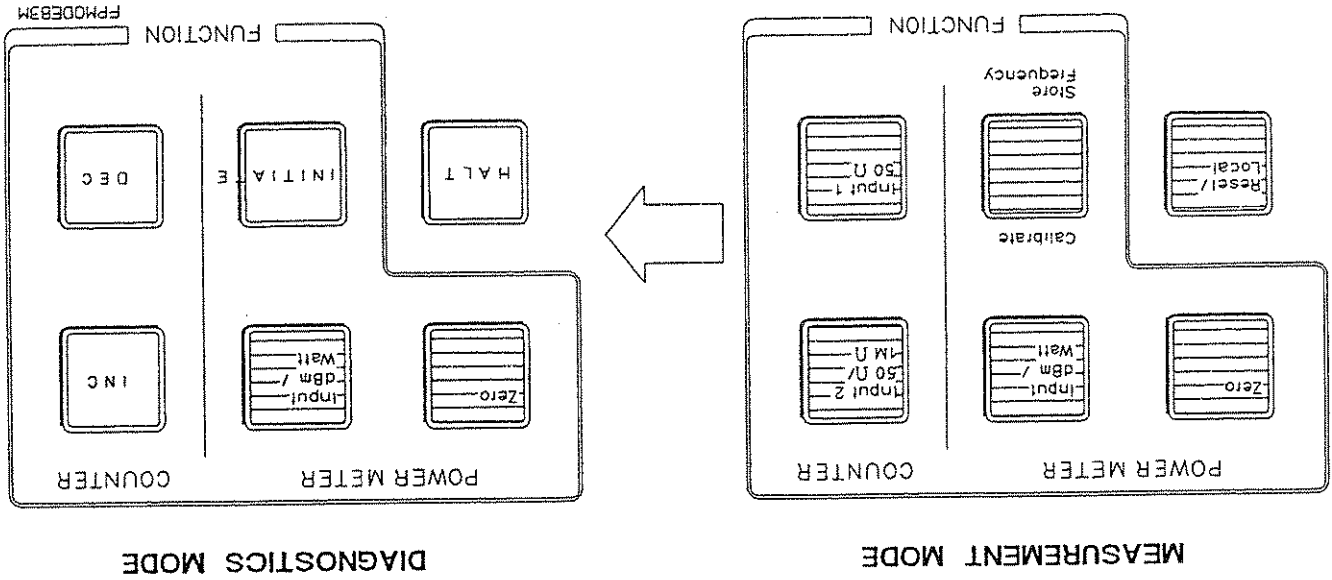
While diagnostics may be individually called from the front panel, they are best used in particular combinations and sequences to obtain the maximum amount of testing and troubleshooting information. Detailed descriptions of the User-Callable Diagnostics begin in Section 8-118. Refer to Sections 8-25 through 8-29, and the troubleshooting procedures in this section for information on using the User-Callable Diagnostics.

DIAG.	NAME	ASSEMBLY TESTED	SECTION NO.
64	Disable Software IF Detector Flag: Display IF	A6 IF Amplifier/Detector Assembly	8-152
65	IF Verification: 35 MHz; Disable INPUT 1	A6 IF Amplifier/Detector Assembly	8-153
70	Keyboard Test	Keyboard/Display Logic Assembly (Part of A1)	8-154
71	Display Test (flash on/off)	Keyboard/Display Logic Assembly (Part of A1)	8-155
72	RAM Test	A7 Digital Assembly	8-156
	ROM Test	A7 Digital Assembly	8-156
	PIA Test	A7 Digital Assembly	8-156
	PTM Test	A7 Digital Assembly	8-156
	A/D Test	A7 Digital Assembly	8-156
73	Power Meter Reference Oscillator - ON	Auxiliary Function	8-157
80	HP-IB Verification	A11 HP-IB Interface Assembly	8-158
97	IF 175MHz Filter Adjust	Not Applicable	8-159

Table 8-5. User-Callable Diagnostics (Continued)

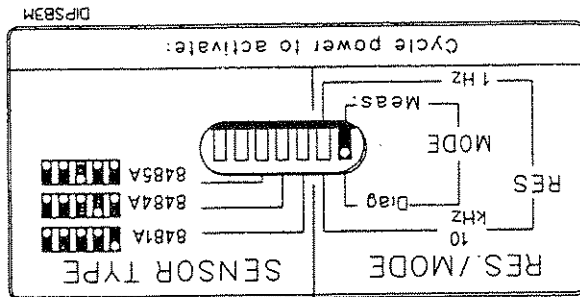


Figure 8-4. Keys for Operating the Diagnostics Mode



After power-up, the front panel's Diag annunciator will light to indicate the HP 5347A/48A is operating in Diagnostics mode. Figure 8-4 shows the transformation of the power meter and counter front panel keys when the Diagnostics mode is selected. To call a diagnostic, use the Input 2 50 $\Omega$ /1M $\Omega$  key to increment to the desired diagnostic test number, and press Input 1 50 $\Omega$  key to decrement to the desired diagnostic test number. Numbers that contain no diagnostics are skipped, and the next valid diagnostic number is displayed.

Figure 8-3. Rear Panel DIP Switch Diagnostics Setting



The Diagnostics (Diag.) mode may be entered by setting the mode selection switch of the rear panel DIP switch, shown in Figure 8-3, to "Diag." before turning on the instrument.

8-25. Diagnostics Mode Entry (Not for HP-IB Only Diagnostics)

The HP 5347A/48A 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 97). 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".

1. Turn the HP 5347A/48A off.
2. Set DIP switch to Diagnostics mode.
3. Turn the HP 5347A/48A on.
4. Press Input 2 502/1M2 key or Input 1 502 key (depending on whether you want to increment or decrement to get to Diagnostic 32)
5. Press Calibrate/Store key.

For example, to enter the diagnostic mode and set Diagnostic 32 (Interpolator Check, A3 Counter Assembly), press the following key sequence:

1. Press Calibrate/Store (INITIATE) key - initiates the selected diagnostic test.
2. Press Calibrate/Store key again - stop tests that continually run.

Once you select the diagnostic-test number perform the following:

1. Set Rear Panel DIP switch to Diagnostics mode ("up" position) as shown in Figure 8-3.
2. Press Input 2 502/1M2 key (increments to next higher number diagnostic test), or press Input 1 502 key (decrements to next lower numbered diagnostic test).

Therefore, a new diagnostic number (from 1 to 97) may be entered using the following key sequence:

Once you have completed the desired testing, the power to the instrument must be turned off, and the selection switch on the rear panel must be returned to the "Meas." (Measurement mode) position.

Once you have the desired diagnostic number displayed, press the Calibrate/Store (INITIATE) key to initiate the diagnostic execution. The diagnostic will execute continuously, displaying the results. Pressing the INcReMent or DEcReMent keys will halt execution of the running diagnostic and move to the next one in sequence. Pressing the ReSet/Local (HALT) key halts execution of the current diagnostic, and returns to Diagnostic 1.

Pressing the DEcReMent key while the instrument is in the Diagnostic 1 test mode ("DIAG 01" is displayed) will cause the instrument to automatically decrement to Diagnostic 97 test mode ("DIAG 97" is displayed). Similarly, pressing the INcReMent key while the instrument is in the Diagnostic 97 test mode will cause the instrument to automatically increase to Diagnostic 1 test mode.

## 8-26. Diagnostics Mode Exit and Special Conditions

For most diagnostics, the Diagnostics mode can be exited by pressing Reset/Local key or by turning off the HP 5347A/48A, and then resetting the rear panel DIF switch to Measurement (Meas.) mode.

There are a few diagnostics which have special conditions attached to their use; for example, some diagnostics are not accessible via HP-IB. Table 8-6 lists these and other special conditions. Refer to Section 8-28 for more information on the diagnostics not available over the HP-IB.

Table 8-6. Special Diagnostic Conditions

SPECIAL CONDITION	DIAGNOSTIC	
Not accessible via HP-IB. (Refer to Section 8-28 for explanation.)	Self Test	DIAG 1 -
Not accessible via HP-IB. (Refer to Section 8-28 for explanation.)	RAM Test	DIAG 41 -
Not accessible via HP-IB. (Refer to Section 8-28 for explanation.)	ROM Test	DIAG 42 -
Not accessible via HP-IB. (Refer to Section 8-28 for explanation.)	Repeated Reset	DIAG 43 -
a) ENTER key interpreted as "1"; Press Reset/Local key to exit. b) Parameter entry possible after enabling. Defaults to current LO frequency when enabled.	LO Verification: User-Entered Frequency via HP-IB only.	DIAG 51 -
Reset/Local key exits, clears overload status flag; ENTER key exits, leaves overload status flag as is. Reset/Local key must be pressed to exit.	Overload Status	DIAG 61 -
Not accessible via HP-IB. (Refer to Section 8-28 for explanation.)	Keyboard Test	DIAG 70 -
Not accessible via HP-IB. (Refer to Section 8-28 for explanation.)	HP-IB Verification	DIAG 80 -
a) Counter must be powered down to exit. b) Not accessible via HP-IB. (Refer to Section 8-28 for explanation.)	IF 175 MHz Filter Adjust	DIAG 97 -

### 8-27. Invalid Diagnostic Numbers

If you use the INC or DEC key to move through the list of diagnostics, the HP 5347A/48A will skip to the next valid diagnostic in the sequence. If you attempt to enter via the HP-IB an invalid diagnostic number, the HP 5347A/48A will display the message: "NOT AVAILABLE DIAG XX", where XX represents the invalid number. The only exception is if 100 is entered as the diagnostic number, in which case the HP 5347A/48A will automatically default to Diag 1.

### 8-28. Calling Diagnostics Over the HP-IB (Option 011 Only)

Most of the User-Callable Diagnostics available from the front panel are also available over the HP-IB by using the "DIAGENT", "DIAG", "DIAGPARM", and "DIAG?" commands. After switching to Diagnostics mode, specific diagnostics are enabled over the HP-IB using the "DIAG" command. For example, the command "DIAG,32,ON" will cause the HP 5347A/48A 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 you to enter a frequency parameter for local oscillator verification. Refer to Appendix C, Remote Programming via the HP-IB, for detailed information on use of the HP-IB. (Appendix C is in the Operating and Programming Manual.) There are five diagnostics not available over the HP-IB, because they may erase needed memory or reset hardware. The diagnostics not available are as follows:

- Diag 1: Self Test
- Diag 41: RAM Test
- Diag 42: ROM Test
- Diag 43: Repeated Reset
- Diag 80: HP-IB Verification

In addition, Diag 97 (IF 175 MHz Filter Adjust) is available via the HP-IB; however, power to the instrument must be cycled to exit this diagnostic.

### 8-29. Switching Between Measurement and Diagnostics Modes Via HP-IB (Option 011)

Two commands are used to switch the HP 5347A/48A from the Measurement mode to the Diagnostics mode, and vice versa. These two commands are as follows:

- DIAGENT
- MEASENT

The DIAGENT command is used to enter the Diagnostics mode. While the HP 5347A/48A is in the Diagnostics mode, it recognizes only the diagnostics commands. To exit the Diagnostics mode use the MEASENT command.

The MEASENT command is used to exit the Diagnostics mode and return to the Measurement Mode, which is the instrument's normal mode of operation. While the HP 5347A/48A is in the

Measurement mode, it recognizes only the measurement commands and HP-IB status commands.

An entry error will be indicated when measurement commands are sent while the HP 5347A/48A is in the Diagnostics mode, and vice versa.

Refer to Appendix C of the HP 5347A/48A Operating and Programming Manual for detailed information on these and other HP-IB commands.

### 8-30. Auxiliary Functions

The HP 5347A/48A diagnostics include a set of auxiliary functions (Diags 2 through 9) which enable the HP 5347A/48A to display various parameters of the measured input frequency. When the HP 5347A/48A is in the auxiliary function mode, it sequences through the normal measurement cycle, and will display one of the parameters needed to compute the input frequency. The auxiliary functions are as follows:

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

DIAG 73 (Power Meter Reference Oscillator - ON) is special auxiliary function for turning the Power Meter 50 MHz reference ON.

Refer to Section 8-118, Description of User-Callable Diagnostics for detailed information on each auxiliary function.

### 8-31. Power-Up Self Test

When the HP 5347A/48A is powered-up, an automatic internal check (an expanded version of Diag 43 Repeated Reset) is made of several major components, including the microprocessors 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 (if HP-IB Option 011 is installed). On successful completion of all tests, the normal measurement display will appear.

1. Display test - 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 - Timbase Verification
- c. DIAG 30 - MRC Channel A Verification: 10 MHz Timbase
- 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 502 Verification: 35 MHz
- i. DIAG 21 - Low Frequency 1M2 Verification: 35 MHz
- j. DIAG 72 - Power Meter Digital Check
7. DIAG 80 - HP-IB Verification, and display address or a message indicating that HP-IB is not installed.
8. Sets instrument status and annunciators to default conditions: Counter mode measuring from INPUT 1.

During the power-up cycle, the HP 5347A/48A performs the following test sequence:

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 HP 5347A/48A to proceed with the Power-Up test sequence. When the last test is complete, the HP 5347A/48A 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.

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 (refer to Section 8-118).

- Instrument powers up, but turns itself off (once or repeatedly).
  - Instrument works properly, but cannot be turned off (no response to the POWER key).
- A particular power supply output has incorrect voltage level, indicated by a Diagnostic 11 (A1 Power Supply Verification) failure message during power-up or by a turned OFF green LED (A1DS1) near the fan (B1). The light-emitting diode can be seen through the fan exhaust vents on the right side of the instrument. (Note: Diagnostic 11 and the LED indication do not verify all the voltages. Measure the voltages on the Power Supply Test Connector, A1X1. Refer to Section 8-48.)

- Fuses and front panel display are okay, but other voltages out of regulation.
- Fuses okay, but instrument is dead (no indication on the front panel display).
- One of the supply fuses (F1, F2, or A1F2) "blows" (opens).

The most probable power supply failure symptoms are as follows:

### 8-33. Power Supply Failure Symptoms

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*Probing from the bottom of the A1 Motherboard may be the easiest way to probe the test points given in the following troubleshooting procedures.*

---

#### NOTE

### 8-32. POWER SUPPLY BLOCK TROUBLESHOOTING (PART OF A1)

In addition to failure messages, the HP 5347A/48A may display "HP-IB NOT INSTALLED" if the ribbon cable from the A11 HP-IB Interface Assembly to the A1 Motherboard Assembly is not properly connected.

9. Check for external reference, overload, 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.

## NOTE

The variable transformer technique is used to detect the short circuit that is blowing the fuse. Therefore, make sure you use the variable transformer to supply enough current to locate a short circuit, but not blow the ac line or main fuse. Typically, this current should be about one-third that of the ac line fuse current rating. The ac line fuse will not blow since it is a time-delay (slow-blow) fuse. (The ac line fuse is located in the rear panel power module.)

If AC Line fuse (F1) is blown:

1. Verify proper orientation of turret wheel in the Line Power Module on the rear panel. Make sure the correct voltage is displayed in the window of the Line Power Module.
2. Verify AC line fuse (F1) value is correct. Install proper fuse if needed (see Section 8-35, Fuse Replacement).
3. Plug in (connect to ac) the HP 5347A/48A. If fuse still blows, the problem may be in the secondary windings of the transformer or the Crowbar circuit. Perform the Input Transformer Secondary Test in Section 8-41.

If External DC Input fuse (F2) is blown:

1. Make sure the input path common to ac and dc is not shorted when the instrument is powered up by plugging into the ac line. If the short is at the MAIN\_POWER\_IN node or beyond, then 0V will be observed at A1TP3 (MAIN\_POWER\_IN). If not shorted, go to step 2.

2. Check A1C100, A1C101, A1CR4, and connector J11(1,2) for shorts. Replace as necessary. If A1TP3 is shorted, skip to the next procedure (If AC or DC fuses are blown).

If AC Line fuse (F1) or External DC Input fuse (F2) are blown:

1. Perform the Overvoltage Protection Circuit Test in Section 8-42.

If a short still exists, go to step 3.

If ac, dc, or battery input fuse is blown go to step 2.



Instructions and all the appropriate cautions and warnings for replacing these fuses are in Appendix A (INSTALLATION) in the Operating and Programming Manual.

The AC Line or main fuse is located on the rear panel in the Line Power Module. The Line Power Module contains a turret wheel to select the 100-, 120-, 220-, or 240-volt ac operations.

- AC Line (F1)
- External DC Input (F2)
- Battery Input (A1F2)
- AC (Battery) Charger Input (A1F1)

There are four fuses in the Power Supply block to protect the following inputs:

### 8-35. Fuse Replacement

8-47.

If A1TP13 is the lowest, then the shorted component is in either the Pulse Width Modulator or Switching FET Drivers circuits. Perform the appropriate tests in Section

If A1TP16 is the lowest voltage, then check and replace as necessary A1C47, A1C54, and A1C55.

4. Verify A1Q12 is shorted by making sure that the voltage at A1TP11 is lower than the voltage at A1TP13 or A1TP16. If A1TP11 is lowest, then replace A1Q12.

If excess current is drawn while the input voltage is still increasing, FET A1Q12 is probably shorted. If this is the case, go to step 4.

If the voltage can be adjusted to the full line voltage without blowing the fuse, then perform the Overcurrent Feedback Regulation Test in Section 8-47. The Overvoltage Feedback circuit should be prevented from blowing when A1W2 is reinstalled by turning the Pulse Width Modulator (PWM) circuit off.

3. Using the variable transformer, slowly increase voltage.

2. Remove jumper A1W2 (see P/O Figure 8-38. A1 Component Locator).

1. Make sure jumper A1W1 is installed (see P/O Figure 8-38. A1 Component Locator).

If AC, DC, or Battery input fuse is blown (but full power can be applied without a short with jumper A1W1 removed), perform the following:

3. Check A1U2, A1U3, or A1U6 for shorts to ground. Replace as necessary.

2. Remove jumper A1W1 (see P/O Figure 8-38. A1 Component Locator). If the short goes away, skip to the next procedure (If AC, DC, or Battery fuses are blown); otherwise, go to step 3.

The HP 5347A/48A uses a 1.0A time-delay fuse (HP P/N 2100-0007) for 100/120-volt operation and a 0.5A time-delay fuse (HP P/N 2100-0202) for 220/240-volt operation. The External DC Input is located on the rear panel of the HP 5347A/48A. A 5A, 250-volt rating fuse (HP P/N 2110-0010) is used for operation from the DC External Input. DC voltages of between 12V to 26V can be connected into the binding posts to operate the instrument. The Battery Input fuse is located on the A1 Motherboard. The instrument uses a 10A, 250-volt rating fuse (HP P/N 2110-0713) for battery operation. The battery provides dc input between 12 to 14.4V dc to operate the instrument.

The AC (Battery) Charger Input fuse is located on the A1 Motherboard. The instrument uses a 2A, 250-volt rating fuse (2110-0002) to protect the transformer from a short in the Battery Charger circuit.

### 8-36. Fuse Not Blown But Instrument Dead

If the failure is with the ac or external dc supply, go to step 4. If not, perform steps 1 through 3.

1. Verify battery pack is not discharged.
2. Verify Battery Input fuse (A1F2) is good.
3. Make sure that the External DC, AC line, and the Battery Pack inputs are disconnected, and then perform the following:
  - a. Wait one minute for capacitors to discharge, then measure resistance from AIK1(5) to AIK1(6). These pins should be shorted. If not, replace relay AIK1, and perform K1 Relay Inrush Protection Circuit Test in Section 8-42.
  - b. If there is still a problem, perform the Undervoltage Protection Circuit Test in Section 8-45.

4. Connect the HP 5347A/48A to either the ac line, or connect an external dc power supply that is set to output +15V dc (HP 6024A or HP 6291A) to J11(1,2) (the External DC Input) of the HP 5347A/48A and observe the following:

- MAIN\_POWER\_IN (A1TP3) — Voltage level should be from +12 to +23V dc if the ac line is being used, or +14 to +15V dc if an external power supply is being used. An incorrect voltage at A1TP3 when using the ac line as the source indicates a faulty A13 Power Transformer Primary Assembly or CR1 on the chassis. Perform the Input Transformer Secondary (Section 8-41) and the Overvoltage Protection Circuit (Section 8-42) tests. An incorrect voltage at A1TP3 when using an external power supply as the source indicates a fault in AIR64 or AICR8 of the External DC Input circuit.

1. With instrument powered ON, observe from the right side of the instrument through the fan exhaust vents that the green LED (A1DS1) of the Power Supply Status Circuit is lit or ON. (Note that observing the status of the LED is the quickest way to check to see if the  $\pm 5V$ ,  $\pm 18V$ , and  $-24V$  supplies are present without removing the instrument's cover.)

The following procedures assume that the instrument is in a state where it can be powered by an ac source or external dc source without blowing the fuses. Use the normal line voltage (not a variable transformer) for the following troubleshooting procedure.

*If all or most of the "daughter" boards (printed circuit assemblies that plug into the A1 Motherboard Assembly) are removed, the dc supply voltages may go slightly out of specification (up to 20%). This should not damage anything and the voltage should go back to specification when normal current load is reapplied.*

**NOTE**

**8-37. Voltages Out of Regulation**

- SYSTEM POWER (A1TP4) — Voltage level should be the same as A1TP3 (from +12 to +23V dc if ac line is used, or +14 to +15V dc if an external power supply is used). An incorrect voltage indicates a faulty External Power Sense circuit or relay A1K1. First, perform the External Power Sense Circuit Test in Section 8-42. If the External Power Sense Circuit is not faulty, replace relay A1K1. If there is still a problem, perform K1 Relay Inrush Protection Circuit Test in Section 8-42.
- +VS, A1K2(7), — Voltage level should be the same as A1TP3 or A1TP4, above. An incorrect voltage indicates a faulty ON/OFF Control circuit or relay A1K2. Perform the ON/OFF Control Test in Section 8-43. If the ON/OFF Control circuit is not faulty, then replace relay A1K2 and perform K2 Relay Inrush Protection Circuit Test in Section 8-44.
- +VB (A1TP13) — If +VS is present (voltage level same as A1TP3), but +VB is not, replace jumper A1W1.
- +V SWITCH (A1TP16) — If +VB is present (voltage level same as A1TP3), but  $\bar{V}$  SWITCH is not, replace inductor L6.
- +5V, A1L9(4) or A1L9(5), — If +5V is not present, perform the DC to DC Switchmode Converter Test in Section 8-47.
- If +5V is available (but the front panel display does not work) — Perform the System Reset Test in Section 8-50. If that is not the problem, then troubleshoot the A4 Microprocessor and the A9 Display/Driver assemblies.

Another quick way of checking the status of these five power supplies ( $\pm 5V$ ,  $\pm 18V$ ,  $-24V$ ) without removing the cover is as follows:

Put the instrument in its Diagnostic mode (refer to Sections 8-25 and 8-26 for information on how to enter and exit the Diagnostic mode), and enter and run Diagnostic 11: A1 Power Supply Verification, which gives test pass or fail indications. If a failure is indicated, perform steps 2 through 7 of this procedure.

If the LED is OFF, then there is a problem with one of the power supplies. Go to step 2. If the LED is ON, then the five power supplies are most likely good, but the voltage regulator circuit(s) for the other voltage(s) that are derived from these power supplies are faulty. Go to step 2.

2. Check the voltages at the Power Supply Test Connector (A1X1) which are shown in Table 8-7 in Section 8-48. Once the faulty supply voltage is discovered, go to step 3. If the  $\pm 5V$  supply is out of regulation, go through all sections of the DC to DC Switchmode Converter Test in Section 8-47.

3. If the voltage that is out of regulation is being loaded down, turn the HP 5347A/48A OFF, and remove or unplug all "daughter" assemblies fed by the voltage to be sure that there isn't a short or partial short. Use the "Interconnections Drawing" in P/O Figure 8-38 to determine which assemblies should be unplugged.

4. Turn the HP 5347A/48A back ON. If the voltage has recovered then the problem is in one of the assemblies that was unplugged from the A1 Motherboard Assembly, go to step 5. If the voltage has not recovered, the problem is not in one of the assemblies that was unplugged. Go to step 6.

5. Troubleshoot to the assembly level by plugging one assembly in at a time until the problem assembly is found.

## NOTE

Do NOT plug an assembly in with the instrument powered ON. Turn the instrument OFF between installation of each assembly. Be sure the instrument is OFF by verifying that A1DS1 turns off, or by measuring the  $\pm 5V$  node.

## NOTE

### 8-38. Instrument Powers Up But Turns Itself Off

If the HP 5347A/48A turns ON and OFF repeatedly, this indicates that the Pulse Width Modulator (PWM) circuit is turning ON and OFF. Proceed as follows:

1. Check for a problem with the +VB. Using an oscilloscope, observe at A1TP13 a dc voltage level greater than +10.5V. For A1U16 to operate properly, this voltage at A1TP13 must remain above +10.5V at all times. If the voltage drops below +10.5V, trace back from +VB to find where there is excessive voltage drop.

2. Perform the Overvoltage Feedback Test in Section 8-47.
3. Perform the Overcurrent Feedback Test in Section 8-47.

If a problem still exists, replace A1U16.

If the HP 5347A/48A turns itself OFF, and stays OFF. Proceed as follows:

1. Recheck the fuses (see "Fuse Blown" in Section 8-34).

2. If the instrument turned OFF while operating from the battery, verify that the instrument operates from ac source or line. If instrument operates properly from the ac source, go to step 3. If the instrument does not operate properly, go to step 4.

3. Check the battery pack.

*Hint:* If the battery is discharged, install a fully charged battery, or connect a +15V, 2A power supply to J5(1,2). Try to turn the instrument ON. If the instrument stays ON, the original battery is not charged.

4. Perform the ON/OFF Control Test in Section 8-43. If there is still a problem, go to step 5.
5. Perform the Undervoltage Protection Circuit Test in Section 8-45.

7. If one of the post-regulated supplies is still out of the limits shown in Table 8-7, troubleshoot the appropriate post-regulation circuit (i.e., A1U17, A1T1, A1L8, A1U15, A1U21, A1Q19, and A1Q4). Replace as necessary.

6. Perform the Secondary Voltage Outputs Test in Section 8-47. If the waveforms are correct, then the +5V, -5V, +18V, -18V, and -24V supplies should be within the limits shown in Table 8-7. Go to step 7.

3. Reconnect A1J2 and A1J3 wires one at a time to the motherboard, and repeat steps 1 and 2 each time. This will determine which input on the motherboard, either the MAIN\_POWER\_IN circuits or the AC Charger Input circuit is faulty.
  2. Turn the variable transformer control knob to its fully CCW position.
- If the variable transformer output voltage can be raised to its full selected ac voltage (i.e., 110/120, 220/240), go to step 2.

1. While slowly increasing the variable transformer output, observe that the current as indicated on the variable transformer is nearly zero amps. If the current starts to rise to 1/3 of the line fuse current rating, the winding is shorted. Replace A13 Power Transformer Primary Assembly (HP P/N 05348-60207).

Procedure

3. Connect the HP 5347A/48A to a variable transformer. Make sure the variable transformer control knob is set to its fully CCW position.
2. Unplug A1J2 and A1J3 from the motherboard. This disconnects the transformer secondary windings from the Overvoltage Protection and AC Charger Input circuits on the motherboard.
1. Disconnect the ac line from the HP 5347A/48A.

Setup

- A1J2 pin 1 (red wire from bridge rectifier CR1)
- A1J2 pin 2 (black wire from bridge rectifier CR1)
- A1J3 pin 1 (pink wire)
- A1J3 pin 2 (pink wire)

The transformer secondaries are connected to the motherboard at the following points (refer to schematic diagram in Figure 8-50 and Figures 8-33 and 8-34 for internal views of the instrument):

8-41. INPUT TRANSFORMER SECONDARY TEST

8-40. A1 Power Supply Individual Circuits Troubleshooting Procedures

3. If no other problems are found replace relay A1K2, then perform the K2 Relay Intrush Protection Circuit Test in Section 8-44.
2. Perform the ON/OFF Control Test in Section 8-43.
1. Disconnect the HP 5347/48A from all power sources (i.e., ac, external dc, and battery), and measure the resistance from A1K2(5) to A1K2(6). If a short is not measured, perform the K2 Relay Intrush Protection Circuit Test in Section 8-44.

8-39. Instrument Works Properly But Cannot Turn Off

## Overvoltage Protection Circuit Test

This circuit triggers when the dc external source or the rectified ac goes over 26V dc. Verify that this crowbar circuit is properly triggering the SCR (A1CR1) by performing the following steps:

## Setup

1. Connect a DMM or an oscilloscope to A1TP3 (MAIN\_POWER\_IN).

2. Remove jumper A1W1 (see P/O Figure 8-38. A1 Component Locator).

3. Connect the HP 5347A/48A to a variable dc power supply. Start with the supply set at 0V. Set the current limit to 1A so that the input fuse will not blow if the crowbar fires.

## Procedure

**NOTE**

Read through step 1 BEFORE performing.

1. Gradually adjust the dc power supply until the voltage is 10.6V. Observe +10V at A1TP3. If the correct voltage is observed at A1TP3, this means the circuit has not triggered yet. Go to step 2.

If the voltage is incorrect or 0V is observed, note whether the dc supply is supplying any current, then quickly turn dc supply voltage down. If no current is flowing, check and replace as necessary A1R64 and A1CR8; otherwise, a 0V reading at this point means that the circuit is triggering at the wrong voltage, or something else is shorted. Check and replace as necessary A1U1, A1CR1, A1C2, A1R1, A1R2, A1R3, A1R7, A1R8, or A1CR4.

2. Continue to slowly increase the dc power supply output until a voltage of 26.0V is read at A1TP3. The crowbar circuit should not trigger yet. If it does, check the components mentioned in step 1; otherwise, go to step 3.

3. Now, slightly increase the output of the dc supply. The crowbar circuit should trigger when the voltage at A1TP3 is between 26.5 to 30V; thus, observe 0V at A1TP3. Quickly turn the dc supply off. If the circuit triggered, the Overvoltage Protection circuit is working properly. Replace fuse if blown.

4. Reinstall jumper A1W1.

## External DC Input Test

1. Apply +20V dc input to rear panel Ext. DC Input.
2. Verify that +19 to +20V dc is present at A1TP3. If the voltage at A1TP3 is incorrect, check and replace A1CR8, A1CR4, A1R64, or F2 (External DC Input fuse).

## AC (Battery) Charger Input Circuit Test

This circuit is comprised of two parts: the AC Charger Input circuit (A1F1, A1C17, A1CR6, A1C16, and A1R26) and the Battery Charger circuit (A1F2, A1R73, A1U18, and A1CR24).

## Setup

1. Install a charged battery pack.

2. Connect the HP 5347A/48A to the ac line.

## Procedure

1. Turn the HP 5347A/48A off, and verify there is a voltage between +22.25 and +39V dc at the anode of A1CR24. If this voltage is incorrect, or the AC Charger Input circuit appears to be shorted, go to step 2.
- If this voltage is correct, go to step 3.

2. Measure the voltage at A1TP2 (CHARGER\_IN). If the voltage is greater than 22.25V, replace A1K2, and perform the K2 Relay Inrush Protection Circuit Test in Section 8-44; otherwise, check A1C17, A1C16, A1R26, and A1F1. If these components are good, replace A1CR6.

3. Measure the battery voltage at A1X1(20) (BATTERY\_TEST) of the Power Supply Test Connector (see the illustration of A1X1 in *Table 8-7* located in Section 8-48). The voltage should be from 11V to 18V.

4. Measure the voltage at A1X1(19) (CHARGER\_TEST). Verify that this voltage is 1.25 volts greater than the voltage measured at A1X1(20) in step 3. If the voltage from A1X1(19) to A1X1(20) is correct, A1U18 is working properly; otherwise, replace A1U18.
5. Unplug or disconnect the ac line, and wait one minute. Measure the voltage at A1TP2 (CHARGER\_IN). It should be decaying to zero volts. If it is still above 10V, replace A1CR24.

6. Disconnect the ac line and battery pack, and measure the resistance of A1R73. If A1R73 measures between 3.1 and 3.5 ohms, and A1U18 is working properly, then the Battery Charger circuit is working properly.

If A1R73 resistance is incorrect, replace A1R73.



## External Power Sense Circuit Test

This circuit, which consists of A1U2 and its associated components, provides the coil voltage to relay A1K1 (Power Supply Source Selector Relay), and limits the voltage to 11.5V dc.

## Setup

Apply ac line to the HP 5347A/48A.

## Procedure

1. Check for +10 to +11.5V dc at A1U2(1). If the voltage is incorrect, check and replace as necessary A1U2, A1C10, A1C4, A1R10, and A1R11.

If a problem still exists, replace A1K1. If A1K1 is replaced, perform the K1 Relay Intrush Protection Circuit Test in this section (Section 8-42).

## Power Source Identifier Test

Transistor A1Q1, resistors A1R9 and A1R17 form a simple switching circuit that tells the A4 microprocessor whether the instrument is operating from an external source or the optional battery. This circuit output is also used as an important input to the Undervoltage Protection Circuit.

To check this circuit, perform the following steps:

## Setup

Connect the HP 5347A/48A to the ac line.

## Procedure

1. Turn the HP 5347A/48A on, and observe 0V at the collector of A1Q1. If the voltage is incorrect, look for approximately .6V at the base of A1Q1. If ~.6V is present, replace A1Q1; otherwise, check A1R9.

If the voltage at A1Q1 collector is correct, go to step 2.

2. Turn the HP 5347A/48A off, apply battery voltage to BATT\_IN input line, and remove the external source.

3. Turn the HP 5347A/48A on, and observe +5V at the collector of A1Q1. Note that it may take up to one minute to see +5V after removal of the external source. If this voltage is incorrect, check and replace as necessary A1Q1, A1R17, or A1U6 (of the Undervoltage Protection Circuit).

Setup

1. With the HP 5347A/48A powered ON, press the POWER key until the instrument is OFF.

2. Remove all sources of power (ac, dc, or battery).

3. Wait one minute (A1C15 must be discharged).

Procedure

1. Connect a storage oscilloscope to A1TP4. Trigger the oscilloscope on the rising edge of the signal at A1TP4 at some voltage less than 10 volts. Set the oscilloscope to measure 20V, maximum.

2. With the external DC supply disconnected, set it to output +15V. Turn the external supply off, and connect it to the HP 5347A/48A External DC Input. With the storage oscilloscope ready, turn the external supply on. (Note: the rise time of the external dc supply must be less than 5 ms.)

3. The voltage at A1TP4 should rise to about 8 to 13V dc in 2 to 10 ms, then it should level out at that value for 2 to 10 ms, and finally rise the rest of the way to +15V dc when the relay closes. See *Figure 8-38* (waveform A). If it does this, the K1 Relay Intrush Protection circuit is working properly.

If it does not rise, there is problem somewhere in the Power Supply Input circuit.

If it rises straight to +15V dc with no plateau, then there is a problem in the K1 Relay Intrush Protection circuit. Check and replace as necessary A1Q201, A1CR203, A1CR202, and A1R205.

8-43. ON/OFF CONTROL TEST

The purpose of this circuit is to latch the ON/OFF Relay K2 to power the instrument ON or OFF. Relay K2 is a latching relay; hence, the relay switches will lock in either the ON or OFF position. When the instrument is ON (K2 pins 7 and 8 closed) the Battery Charger circuit is disabled (K2 pins 5 and 6 opened). The Battery Charger circuit is connected (K2 pins 5 and 6 closed) only when the instrument is OFF (K2 pins 7 and 8 opened).

Setup

1. Apply ac power to the HP 5347A/48A.
2. Connect a storage oscilloscope or voltmeter at the test points stated in the following procedure to monitor the signals.

1. Check the voltage at A1K2(7), +VS. If there is a dc voltage from 10.5 to 26V, the unit should be powered on and operating. If not, follow the procedures in Section 8-36 (Fuse Not Blown But Instrument Dead).

If the voltage at A1K2(7) is between 0V and 10.5V, perform K2 Inrush Protection Test in Section 8-44.

If the unit is powered on, or if there is zero volts at A1K2(7), go to step 2.

2. Press the POWER key once firmly. Verify the voltage at A1K2(7) switches from 10.5 - 26V to 0V, or from 0V to 10.5 - 26V. You may be able to hear the relay click when the power is switched.

If the POWER key relay does switch, press the POWER key until the instrument turns OFF. This can be determined by a 0V reading at A1K2(7). If the relay A1K2(7) can switch ON and OFF, the ON/OFF circuit is working properly.

If the voltage at A1K2(7) does not change when the POWER key is pressed, go to step 3.

3. Connect a DMM or oscilloscope to A1TP7 (PS<sub>-</sub>IN). This point should be between 10.5 and 26V dc when the POWER key is NOT pressed. If not, check A1R37. Now, press and hold the POWER key. A1TP7 should go to ground. If not, check A1R37 and A1R38; then, check connection at A1J6. If this is correct, the membrane keyboard/front panel must be at fault (see Section 8-56, Keyboard/Display Logic Block Troubleshooting); otherwise, go to step 4.

4. Connect a DMM or oscilloscope to the collector (pin 2) of A1Q11. The voltage at A1Q11(2) should normally be 0V and should go to at least 10V when the POWER key is pressed and held.

If not, replace A1Q11 and be sure to recheck the voltages in this step. If the voltages are still incorrect, replace A1U8.

If the voltages are correct, go to step 5.

5. Connect an oscilloscope or DMM to A1TP5. A1TP5 should normally (when the POWER key is NOT pressed) be at 0V. When the POWER key is pressed and held, A1TP5 should be at +5V. If this is correct, go to step 6.

If this is incorrect, replace A1U8.

6. While observing the voltage at A1K2(7), measure the voltage at A1U10(2). If A1K2(7) is above 10.5V, then A1U10(2) should be a TTL high. If A1K2(7) is 0V, then A1U10(2) should be 0V. If one of these conditions is correct, go to step 7.

If the voltage at A1U10(2) is incorrect, check A1R79, and then perform the System Reset Test in Section 8-50.

7. Connect a storage oscilloscope to AIU13(5). This point should normally be at 0V. Approximately 13 ms after the POWER key is pressed, AIU13(5) should go to +5V. If this is correct, got to step 8.
8. Connect a storage oscilloscope to AIU14(5). The rising edge from AIU13(5) should trigger a high pulse at AIU14(5) that lasts approximately 20  $\mu$ s; press the POWER key to observe this pulse. If the pulse is correct, go to step 9.
- If the pulse is incorrect, replace AIU14, or check and replace as necessary AIR52 and A1C42.
9. AIU10 should invert the pulse and steer the pulse from AIU14 to either AIU11(9) or AIU11(1). If AIU10(2) is a TTL low, connect the storage oscilloscope to AIU11(1). If AIU10(2) is a TTL high, connect the storage oscilloscope to AIU11(9). Press the POWER key and observe the inverted 20  $\mu$ s pulse (goes low for 20  $\mu$ s). If this signal is correct, go to step 10.
- If this signal is incorrect, replace AIU10. (If the pulse appears at both AIU11(1) and AIU11(9), this is also incorrect; thus, AIU10 should be replaced.)
10. If the pulse in step 9 went to AIU11(1), connect the storage oscilloscope to AIU11(4). If the pulse in step 9 went to AIU11(9), connect the storage oscilloscope to AIU11(12). The pulse input to AIU11 should generate a negative pulse (low) for approximately 20 ms. Press and hold the POWER key. (If the POWER key is not held for more than 30 ms, the output of AIU11 may go to low, but not go high after the expected 20 ms.) If there is a negative pulse for approximately 20 ms, go to step 11.
- If not, replace AIU11, or check and replace as necessary AIR70, AIR71, A1C36, and A1C37.
11. If the pulses in step 10 were at AIU11(1) and AIU11(4) (this implies that the instrument is OFF), connect the storage oscilloscope to AITP6 (H<sub>-</sub>ON). If the pulses were at AIU11(9) and AIU11(12) (this implies that the instrument is presently ON), connect the storage oscilloscope to AITP8 (H<sub>-</sub>OFF). Press and hold the POWER key. The test point(s) should have present a +5V pulse that is 20 ms long. If this is correct, go to step 12.
- If this is incorrect, check and replace as necessary AIQ13, AIQ14, AIR34, A1CR7, and A1CR11.
12. If the instrument still does not switch on and off, observe AITP6 (H<sub>-</sub>ON) and AITP8 (H<sub>-</sub>OFF) simultaneously while the POWER key is pressed. If both test points have a pulse present, trace back to find where the extra pulse is coming from.
- If only one test point is getting a pulse (AITP6 if the instrument is OFF, AITP8 if the instrument is ON), then replace AIK2. If AIK2 is replaced, also perform the K2 Relay Intrush Protection Circuit Test is Section 8-44.

## 8-44. K2 RELAY INRUSH PROTECTION CIRCUIT TEST

### Setup

1. With the HP 5347A/48A powered ON, press the POWER key until the instrument is OFF.

2. Remove all sources of power (ac, dc, or battery).
3. Remove jumper A1W1 (see P/O Figure 8-38. A1 Component Locator).
4. One side of A1R206 is connected to the H<sub>-</sub>ON node (also connected to pin 2 of A1K2). Lift this side of A1R206.
5. Apply ac power to the HP 5347A/48A.

### Procedure

1. Measure the voltage at A1K2(7). It should be 0V. If not, recheck the setup above. If the setup is correct, then A1Q202 is faulty and should be replaced.  
If it is 0V, go to step 2.
2. Apply +5V dc to the lifted side of A1R206. Now, measure the voltage at A1K2(7). It should now be 8 to 20V dc. If it is, this circuit is working properly. Disconnect the power sources and replace all parts (A1W1 and A1R206).  
If the voltage didn't rise as expected, go to step 3.
3. With the +5V dc still applied to A1R206, check for 0V at the collector of A1Q203. If 0V not present, replace A1Q203.
4. Check for a dc voltage between 10.5 to 26V at the collector of A1Q200. If the voltage is incorrect, replace A1Q200.
5. Check for a dc voltage between 10.5 to 26V at the gate (pin 1) of A1Q202. If the voltage is incorrect, check and replace as necessary A1Q202, A1CR201, or A1R203.
6. Check for a dc voltage between 7 to 24V at A1K2(7). If not, check and replace as necessary A1Q202, A1CR201, or A1R204.

If the voltage is correct, then the K2 Relay Inrush Protection circuit is working properly.

## 8-45. UNDERVOLTAGE PROTECTION CIRCUIT TEST

This circuit latches the ON/OFF Relay K2 to its OFF state when the voltage level of the optional battery drops below +12V. This circuit also detects when the battery voltage level drops to +13V, sending a warning indication to the instrument that the battery power is low.

## Setup

1. Turn the HP 5347A/48A off, and remove all power sources including the battery pack if there is one.

2. Remove jumper AIW1 (see P/O Figure 8-38. AI Component Locator).

3. Connect a variable power supply (+) side to AIR27 and AIU6 junction (+VS), and connect the (-) side to ground (chassis or any circuit ground node).

4. Adjust the variable power supply output to +15V dc (DO NOT go above +26V dc).

## Procedure

1. Check for  $+2.5 \pm 0.05V$  dc at A1TP15 (VREF). If the voltage is incorrect, check and replace as necessary AIU15, AIR65, AIR66, and AIR32 of the +2.5V Reference Voltage circuit.

2. Check for +5V at AIU6(1). If the voltage is incorrect, replace AIU6. If the voltage at AIU6(1) is still low, check and replace as necessary AIQ5, AIQ6, and AIQ8.

If the voltage at AIU6(1) is correct, go to step 3.

3. Check for 0 volts at A1TP8 (H<sub>-</sub>OFF). If the voltage is correct, go to step 4; otherwise, check the voltage at the emitter and base of AIQ13. Both should be 0V. If not, perform the ON/OFF Control Test in Section 8-43.

If both voltages are 0V, then check the voltages at the base of AIQ5 (should be +5V) and at the base of AIQ8 (should be +2.5V). If these voltages are incorrect, replace AIU3. If the voltages are correct, check and replace as necessary AIQ5 and AIQ8.

4. Check the comparators of AIU3 and transistors AIQ5, AIQ8, and AIQ6 as described in the following steps.

- a. Adjust the power supply down to +12.7V, and check for ~0 volts at AIQ6 collector. If the voltage is incorrect, check for ~0.7V at Q6 base. If this voltage is correct, replace Q6.

If the voltage is incorrect at the base of Q6, check the voltage at AIU3(6) and AIU3(7). The voltage at AIU3(6) should be a lower voltage than that of AIU3(7). If not, check and replace as necessary AIR27, AIR28, AIR29, and AIR30.

If AIU3(6) is lower than AIU3(7), replace AIU3.

- b. Adjust the power supply down to +11.5V, and check for 5 volts at A1TP8 (H<sub>-</sub>OFF). If the voltage is incorrect, check the voltage at AIU3(4); it should be +5V.

If AIU3(4) is not +5V, perform the Power Source Identifier Test in Section 8-42.

## 8-46. POWER SUPPLY STATUS CIRCUIT TEST

This circuit drives the Diagnostic II (A1 Power Supply Verification) test via L\_PWRSP OK line, which is fed to the A4 microprocessor. It also lights the power supply indicator LED, AIDS1.

If this circuit is suspected, perform the following:

1. Turn the HP 5347A/48A on.
2. Check for  $+2.5 \pm 0.05V$  dc at A1TP15 (VREF). If the voltage is incorrect, check and replace as necessary A1U15, A1R65, A1R66, and AR32 of the +2.5V Reference Voltage circuit.
3. If the voltage at A1TP15 (VREF) is correct, go to step 3.
4. Check for +1V at A1U12(3). If the voltage is incorrect, check and replace as necessary A1R66, A1R67, and A1R68. If there is still a problem, replace A1U12.
5. If the voltage is correct, go to step 4.
6. Check for +0.6V at A1U12(6).
7. Measure the voltage at A1U12(2,5). It should be between +0.7 and +0.9V dc. If not, check the five main power supply voltages ( $\pm 5V$ ,  $\pm 18V$ , and  $-24V$ ) at A1X1 (see Table 8-7). Verify that these supplies are within specifications as shown in Table 8-7. If the voltages are within specifications, check and replace as necessary A1R55, A1R56, A1R58, A1R59, A1R60, and A1CR12.
8. If not, perform the procedure in Section 8-37 (Voltages Out of Regulation).
9. Check for -0.7V at A1U12(1,7). If the voltage is 0V, replace A1U12. If the voltage is greater than 1V, check and replace as necessary A1R84 or A1Q15.
10. If the voltage at A1U12(1,7) is correct, go to step 7.
11. Check for 0 volts at A1Q15 collector. If the voltage is incorrect, replace A1Q15.
12. If all voltages in the circuit are correct and AIDS1 does not light, check and replace as necessary A1R85 or AIDS1.

- c. Check the voltage at A1U3(9); it should be lower than the voltage at A1TP15. If not, check and replace as necessary A1R27, A1R28, A1R29, and A1R30.
- d. If the voltages at A1U3(4) and A1U3(9) are correct, but A1U3(2) and A1U3(14) are not 0V, replace A1U3; otherwise, check and replace as necessary A1R33, A1R34, A1Q5, or A1Q8.

A failure in the DC to DC Switchmode Converter circuit is indicated when the +VB power line (A1TP13) is functioning properly, but one or more of the main power supplies ( $\pm 5V$ ,  $\pm 18V$ ,  $-24V$ ) are not functioning properly.

The only input to the DC to DC Switchmode Converter is the +VB (A1TP13), which should always be from 10.5V (minimum) to 26V (maximum) including any ac ripple. The only outputs of this circuit are the five main power supplies ( $\pm 5V$ ,  $\pm 18V$ ,  $-24V$ ). These supplies should be dc levels within the specifications shown in *Table 8-7*.

Within the DC to DC converter circuit is a feedback loop. To troubleshoot any problems, first break the loop and verify proper open loop operation. If the open loop operation is good, then close the loop to find the problem in the feedback circuit. Procedures for this follow below.

The DC to DC Converter circuit consists of the following sections:

- Pulse Width Modulator (PWM)
- Switching FET Drivers
- Secondary Voltage Outputs
- Feedback Regulation
- Overvoltage Feedback
- Overcurrent Feedback

#### Preliminary Test

If a faulty DC to DC Converter circuit is suspected, perform the following steps:

1. With the HP 5347A/48A OFF, remove jumper A1W2 to isolate the control circuitry (PWM, Switching FET Drivers, and Feedback Regulation) from the high current circuitry (Power FET Q12 and Secondary Voltage Outputs). Then apply +20V dc to the External DC input of the instrument, and turn the instrument ON (the Display will NOT power up).
2. Verify that +VB (A1TP13) is present. With the input voltage at +20V, +VB should be approximately +19V dc. Check this voltage at A1U16(3), A1U16(19), A1U15(1), and A1U9(3).
3. Verify that +2.5  $\pm$  0.05V dc is present at A1U15(2). If the voltage at A1U15(2) is incorrect, replace A1U15. If the voltage is correct, go to step 4.
4. Verify that +10 to +12.5V is present at A1U9(1). If the voltage at A1U9(1) is incorrect, replace A1U9. If the voltage is correct, perform the Pulse Width Modulator Test in this section (Section 8-47).



**NOTE**

With jumper A1W2 removed, the instrument can be turned ON via the POWER key, but cannot be turned OFF via the POWER key. Therefore, to turn the instrument OFF, REMOVE the line cord from the instrument before reinstalling A1W2.

**DC to DC Converter Open Feedback Loop Test**

1. If jumper A1W2 has not been removed, remove power to the HP 5347A/48A; then, remove A1W2.

2. Apply +20V dc to the External DC Input on the rear of the HP 5347A/48A.
3. Check for a square wave (0V to 12V dc) of approximately 45% duty cycle at the drain (pin 3) of A1Q10. If this is correct, go to the next section that describes DC to DC Converter Closed Feedback Loop Test.

If the waveform at A1Q10(3) is incorrect, go to step 4.

4. Check for a square wave at A1TP9 of approximately 55%, 0 to 12V dc. (This should be the inverse of the signal at A1Q10(3)). If this signal is correct, perform the Switching FET Drivers Test in this section (Section 8-47).

If there is no square wave at A1TP9, perform the Pulse Width Modulator (PWM) Test in this section with A1W2 still removed.

**DC to DC Converter Closed Feedback Loop Test**

1. Unplug power from the HP 5347A/48A. Reinstall jumper A1W2. Reapply the +12V dc to the External DC Input.

2. Perform the Feedback Regulation Test in this section (Section 8-47).

3. Perform the Overvoltage Feedback Test in this section.

4. Perform the Overcurrent Feedback Test in this section.

5. Connect an oscilloscope to A1TP9, and vary the voltage to the External DC Input from 12 to 26V dc. The duty cycle at A1TP9 should vary linearly from approximately 55% at 12V dc to approximately 85% at 26V dc. If this doesn't happen, perform the Pulse Width Modulator Test with A1W2 installed. The Pulse Width Modulator Test is the next test in this section (Section 8-47).

6. Next, check the waveform at the drain (pin 3) of A1Q10. It should be the inverse of the waveform at A1TP9 (15% to 45% duty cycle). If not, perform the Switching FET Drivers Test in this section.

7. Perform the Secondary Voltage Outputs Test in this section.

Perform the Preliminary Tests at the beginning of the DC to DC Switchmode Converter Test section if the tests have not been performed.

Perform the following procedure until the proper waveform appears at A1TP9:

1. Connect the oscilloscope to A1TP9 [the output of A1U16(4,5)] and compare the displayed waveform to *Figure 8-38* (waveform B). The duty cycle of the waveform should never be less than 50% whether or not jumper A1W2 is installed. With A1W2 removed, the duty cycle should be 55 to 65% as shown in *Figure 8-38* (waveform C). The nominal frequency of this waveform is 80 kHz, but the frequency may vary from 65 to 95 kHz. If A1W2 is installed, the duty cycle will be between 55% to 85%.
2. Check for a repetitive ramp waveform at A1U16(13). The ramp should go from about 2V to about 5V. It may not be a perfect sawtooth; the top and bottom may be clipped as shown in *Figure 8-38* (waveform D). The frequency of the waveform should be from 65 to 95 kHz. If the waveform looks correct, go to step 3.

If the waveform is incorrect, check and replace as necessary the following components: A1R75, A1C53, A1R76, and A1C51. If the problem remains, replace A1U16.

3. Check the pull-up resistor A1R39 at the output of the PWM (A1U16). If the problem remains, go to step 4.

4. Check the Symmetry Control input at A1U16(6,24). With jumper A1W2 removed, A1U16(6,24) should be at ground. (If A1W2 is in place, A1U16(6,24) should have a waveform from -0.5 to +3V dc with approximately the same duty cycle as at the drain (pin 3) of A1Q10; see *Figure 8-38* (waveform E). If the signal is good, go to step 5.

If there is a problem, check for 2.5V dc output at A1U16(2), and check and replace as necessary A1C56, A1CR21, A1CR22, and A1R78. If the discrete components are good, replace A1U16.

5. Check the A1U16(8), the Soft Start pin. A1U16(8) should be at +5V. If not, check A1C52. If A1C52 is good, replace A1U16.

6. Check the voltage at A1U16(16), -Iamp. This is the error amplifier input. A1U16(16) should be half the voltage at the +5V node, A1X1(1), whether or not A1W2 is installed. If jumper A1W2 is removed, both points should be 0 volts, allowing the PWM to free run. If this voltage is incorrect, perform the Feedback Regulation circuit test in this section (Section 8-47) to see what is causing the incorrect signal.

7. Check the voltage at A1U16(17). The voltage should be 2.5V dc. If not, check the VREF regulator A1U15 and its associated components.

8. Check the voltage at A1U16(14,15); this is the output of the error amplifier. With jumper A1W2 removed, A1U16(14,15) should be high, about +5V dc. If the nodes in step 6 and 7 (pins 16 and 17 of A1U16) are good, but A1U16(14,15) is not, replace A1U16. Otherwise, go to step 9. (If A1W2 is installed, the voltage at A1U16(14,15)

should be between +2 Vdc and +5 Vdc and inversely proportional to +VB (as +VB increases, A1U16(14,15) should decrease).

9. Check the voltage at A1U16(21). With jumper A1W2 removed, this voltage should be 0V. If not, perform the Overvoltage Feedback Circuit Test to find what is affecting the signal. (If A1W2 is installed, A1U16(21) is proportional to the +18V output, and should never be greater than +2.5 V dc - typically +2.0V.)

10. Check the voltage at A1U16(23). It should be about 60 mV dc. If not, look for 2.5 Vdc at A1U16(2), check A1R74 and A1R77, and replace the faulty component. Check the voltage at A1U16(22). If A1W2 is removed, A1U16(22) should be at 0V. (With A1W2 installed, A1U16(22) should show a dc signal with ripple at 80 KHz frequency. The amplitude of this pulsed waveform should never go above the voltage at A1U16(23) - about 60 mV). If there is a problem at A1U16(22), perform the Overcurrent Feedback Circuit Test.

11. If there is still a problem, replace A1U16.

### Switching FET Drivers Test

Perform the following steps if the PWM circuit is working properly.

#### Setup

1. Make sure jumper A1W2 is removed.
2. Verify +12V at A1U9(1).

#### Procedure

1. With the oscilloscope connected to the junction of resistors A1R46 and A1R47, compare the displayed waveform to Figure 8-38 (waveform F). If the waveform is incorrect, go to step 2.

If the displayed waveform at R46 and R47 junction is correct, the Switching FET Drivers circuit is working properly.

2. Connect the oscilloscope to the emitter of A1Q7, and compare the displayed waveform to Figure 8-38 (waveform G). If the waveform is incorrect, replace in order: A1Q7, A1CR9.

If the waveform is correct, replace in order: A1Q9, A1Q10.

### Secondary Voltage Outputs Test

Perform this test when the Power Supply Input, PWM, and Switching FET Drivers circuits are working properly.

Setup

1. Remove the line cord from the instrument to turn OFF the instrument. (Note that the instrument cannot be turned off via the POWER key when jumper AIW2 is removed; that is, when +5V is not present.)
2. Install jumper AIW2.

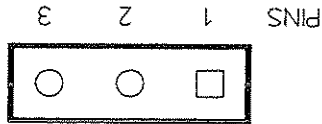
Procedure

1. Connect the oscilloscope to the drain (pin 3) of A1Q12 at A1TP11.
  2. Turn the HP 5347A/48A on.
  3. Compare the displayed waveform to Figure 8-38 (waveform H). If the waveform is incorrect, replace in order: A1Q12, A1CR13. Note that the duty cycle and amplitude can vary inversely; the shape of the waveform is the important thing.
- If the waveform at A1Q12(3) is correct, go to step 4.

4. Determine the faulty secondary supply circuit by checking each individual supply at A1X1 Test Connector (see Table 8-7) for the correct voltage. Take note of the voltage(s) that are incorrect, and go to step 5.

5. Connect an oscilloscope to the points listed below, and compare the displayed waveform to the appropriate waveform in Figure 8-38. Use both the blown-up illustration of A1CR15 and A1CR14 below, and A1 Motherboard Assembly component locator to help located the following test points.

CR14 AND CR15 VIEWED FROM CIRCUIT SIDE OF A1 MOTHERBOARD ASSEMBLY



MCR\_33M

NOTE

The duty cycle and amplitude of the following waveforms can vary from the picture shown. However, the duty cycle should remain the same from point to point with a given power supply input voltage (+VB).

A1CR15(2) — compare to waveform I.

A1CR14(2) — compare to waveform J.

A1CR16(1, cathode) — compare to waveform K.

A1CR19(1, cathode) — compare to waveform L.

A1CR23(1, cathode) — compare to waveform M.

Positive side of A1C65 — measure a dc voltage level of +5V.

Negative side of A1C48 — measure a dc voltage level of -5V.

Positive side of A1C58 — measure a dc voltage level of +18V.

Negative side of A1C34 — measure a dc voltage level of -18V.

Negative side of A1C59 — measure a dc voltage level of -24V.

When the faulty secondary circuit is discovered, use conventional troubleshooting techniques to trace down the bad component(s).

### Feedback Regulation Test

#### Setup

1. Make sure jumper A1W2 is installed.

2. Turn the HP 5347A/48A on.

#### Procedure

1. Check A1TP15 for 2.5 ±0.05V dc. If the voltage is incorrect, check and replace as necessary A1U15, A1R65, and A1C44 of the +2.5V Reference Voltage circuit.

If the voltage is correct, go to step 2.

2. While observing the voltage at A1C65(1), +5V, measure the voltage at A1TP17, A1TP17 should be half the voltage of A1C65(1).

If the voltage is incorrect, check and replace as necessary A1R80, A1R88, A1C50, A1C57, A1R89, A1R82, and A1R83.

If this voltage is still a problem, go to step 3.

3. Check the voltage at A1U16(17). The voltage should be +2.5 Vdc. If not, check and replace as necessary A1U15, A1R65, and A1C44.

1. Apply +12V dc to the External DC Input on the rear panel of the HP 5347A/48A.
2. Connect oscilloscope probes to A1U16(22) and A1U16(23). Note: use short ground leads on the probes to prevent the oscilloscope from picking up unwanted noise from the switching power supply.
3. Turn the HP 5347A/48A on.

## Setup

## Overcurrent Feedback Regulation Test

1. The signal at A1U16(21) should be 0.11 times the level at A1C58(+), or slightly more than one tenth of the level at A1C58(+). If A1C58(+) is +18V, then A1U16(21) should be +1.9V. If the ratio between these two points is correct, go to step 2.
- If the ratio is incorrect, check and replace as necessary A1R53 and A1R43.
2. Move the oscilloscope probe from A1C58(+) to A1U16(20) - leave probe on A1U16(21) connected.  
Measure the voltage at A1U16(21). If it is less than +2.5V, then A1U16(20) should be a TTL low. If A1U16(21) is greater than +2.5V, A1U16(20) should be a TTL high level. If this is correct, go to step 3.
- If A1U16(20) is not correct, check and replace as necessary A1C56 and A1U16.
3. If A1U16(21) goes above +2.5 Vdc (overvoltage condition), move the oscilloscope probe from A1U16(20) to A1TP9. While A1U16(21) is above +2.5 Vdc, the signal at A1TP9 should be at +12V dc and should stay there until A1U16(21) goes below +2.5V. If not, replace A1U16.
4. If A1U16(21) goes above +2.5V, an overvoltage condition is present. This must be corrected before proper operation can resume. Go to the Section 8-37 (Voltages Out of Regulation).
5. If no problems are indicated in steps 1 through 3, then the Overvoltage Feedback circuit is operating properly.

## Setup

## Overvoltage Feedback Regulation Test

1. Apply power to HP 5347A/48A.
2. Connect an oscilloscope to A1C58(+) and to A1U16(21).
3. Turn the HP 5347A/48A on.

1. Measure the voltage at A1U16(23). It should be about 60 mV. If not, check for +2.5 Vdc out of A1U16(2), and check and replace as necessary A1C56, A1R74, and A1R77. If A1U16(2) is not at +2.5V dc, replace A1U16.

If this voltage is correct, go to step 2.

2. Check the voltage at A1U16(22). It should be less than A1U16(23) at all times. Look especially for spikes at the turn-on part of the pulse. (This is where short ground leads on the oscilloscope probes are especially important.)

The signal at A1U16(22) should be a dc signal with ripple that is between 0V to approximately 20 to 60 mV with the same frequency as the DC to DC converter. If this is incorrect, check and replace as necessary A1R61, A1R45, A1R44, and A1C43. If this signal is correct, then the Overcurrent Feedback circuit is working properly.

If the signal at A1U16(22) goes higher than 60 mV, and the above discrete components are good, an overcurrent condition exists. This must be corrected. Go to step 3.

3. To trigger the overcurrent circuit, the fault must be in either the Switching FET A1Q12, the Switching Transformer A1T2, the Secondary Voltage Outputs, or a circuit fed by one of the secondary voltage outputs.

To isolate the problem, unplug the other assemblies from the A1 Motherboard Assembly; that is, A2, A3, A4, A5, A6, A7, A8, optional A11, A12, and the Fan (12). (Note: when plugging and unplugging the assemblies, the instrument must be powered down, otherwise damage may occur.)

Now, plug each assembly in one by one to find the assembly that is causing the overcurrent condition.

If the overcurrent condition still exists with all assemblies unplugged, then the problem is on the A1 Motherboard. The problem can be further isolated by removing the following inductors as if they were jumpers: A1L7, A1L10, A1L5, and A1L11 - all in the Secondary Voltage Output section, and also A1L4 in the 10 MHz Timebase section.

Use standard troubleshooting techniques to find and repair the overcurrent condition.

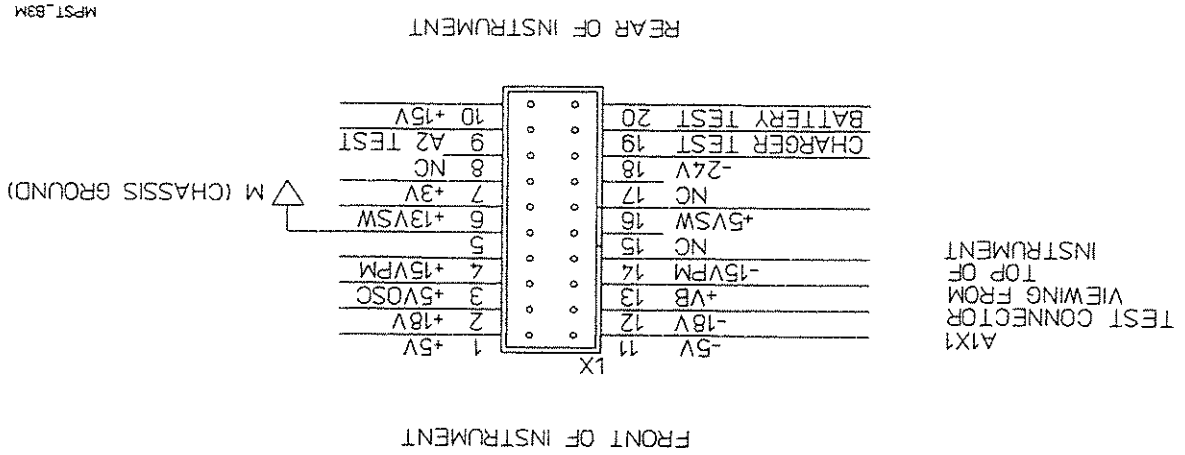
## 8-48. POWER SUPPLY TEST CONNECTOR AND OTHER SUPPLIES TEST POINTS

### NOTE

Probing from the bottom of the A1 Motherboard may be the easiest way to probe some of the test points given in the following table.

When verifying power supply voltages in the HP 5347A/48A, it is recommended that as many measurements as possible be made at the Power Supply Test Connector (A1X1) located on the

\*Adjustable voltage. See the adjustment procedure for the A3 Counter Assembly in Section 5 if the voltage is out of adjustment.



TEST PIN	BLOCK LOCATION	DC VOLTAGE RANGE	TEST SUPPLY NAME
1		+4.75 to +5.25V	+5V
2		+17.00 to +19.00V	+18V
3	T (Supply for Timebase circuits)	+4.30 to +5.30V	+5V OSC
4	H (Supply for HP-IB Assembly)	+4.75 to +5.25V	+5V CMC
5		+14.25 to +15.75V	+15V PM
6	L (Supply for Microwave Module)	+12.35 to +14.50V	+13V SW
7	From A3 Assembly	+2.98 to +3.02V*	+3V
8		-17.00 to -19.00V	-18V FAN
9		-23.00 to -26.50V	-24V
10	M	+14.25 to +15.75V	+15V
11		-4.85 to -5.35V	-5V
12		-17.00 to -19.00V	-18V
13	T (Supply for Timebase circuits)	+4.75 to +5.25V	+5V BUF
14	P (Supply for Power Meter circuits)	+14.25 to +15.75V	+15V PM
15	P (Supply for Power Meter circuits)	-14.25 to -15.75V	-15V PM
16	L (Supply for Microwave Module)	+4.30 to +5.30V	+5V SW
17	L (Supply for Microwave Module)	+12.35 to +14.50V	+13V SW
18		-17.00 to -19.00V	-18V FAN
19		-23.00 to -26.50V	-24V
20		+14.25 to +15.75V	+15V
5		0V	Ground (chassis)

Table 8-7. Power Supply Voltages

Refer to the A1 component locator in P/O Figure 8-38. All of the voltages to the connector (except ground) are protected with series resistors, or are otherwise current limited to prevent damage to the instrument should pins be accidentally shorted together or shorted to ground. See Table 8-7 (Power Supply Voltages) for acceptable limits of the voltage ranges of each supply. Note that Table 8-7 includes for your convenience, an illustration which indicates pin locations for each power supply voltage.



## 8-49. MICROWAVE MODULE SLEEP BLOCK TROUBLESHOOTING (PART OF A1)

### NOTE

Probing from the bottom of the A1 Motherboard may be the easiest way to probe the test points given in the following troubleshooting procedures.

The Microwave Sleep section turns off two of the dc supplies (+5V SW, +13V SW) to the A12 Microwave Assembly during certain measurements as described in the next paragraph. The two supplies should be OFF when the HP 5347A/48A is set for measurement at INPUT 2 or is in the Power Meter mode. The supplies should be ON when the HP 5347A/48A is set for measurement at INPUT 1. Thus, to troubleshoot the Microwave Sleep section, perform the following:

### Setup

1. Connect a DMM to A1U21(2).

2. Turn the HP 5347A/48A on, and verify the instrument is in the INPUT 1 measurement mode as indicated by the Input 1 front panel annunciator.

### Procedure

1. Verify a dc voltage within the range of +12.7 to +14.3V. If the voltage is incorrect, check and replace as necessary A1U21, A1Q16, and A1Q17.  
If the voltage at A1U21(2) is correct, go to step 2.
2. Connect the DMM to the collector of A1Q19.
3. Verify a dc voltage within the range of +4.30 to +5.25V. If the voltage is incorrect, check and replace as necessary A1Q18 and A1Q19.  
If the voltage at the collector of A1Q19 is correct, go to step 4.
4. Press the Input 2 50  $\Omega$ /1M $\Omega$  key, and verify the front panel Input 2 annunciator is ON.  
Verify that there is approximately -1V at the collector of A1Q19, and approximately +1.3V at A1U21(2). If the voltage levels are incorrect, trace back to the faulty component in the Microwave Sleep section.

**NOTE**

Probing from the bottom of the A1 Motherboard may be the easiest way to probe the test points given in the following troubleshooting procedures.

The System Reset circuit consists of A1U20 and its associated components. U20 ensures that all of the microprocessors in the HP 5347A/48A reset at power-up and after power glitches. Thus, if the HP 5347A/48A fails to power on properly, the problem may be due to the System Reset circuitry, which generates the  $L_{UP\_RST}$  signal.

**Setup**

1. Turn the HP 5347A/48A off.

2. Connect a storage oscilloscope to pin 5 of A1U20 ( $L_{UP\_RST}$ ).

**Procedure**

1. Turn the HP 5347A/48A on, and verify A1U20(5) is momentarily low (for approximately 130 ms) then goes to a TTL high (about +5V). This 130 ms delay during power-on allows the clock in the HP-IB microprocessor, A11U5 (on the optional A11 HP-IB Interface Assembly), time to stabilize. After the 130 ms delay, A1U20(5) goes to TTL high and resets the microprocessors of the A11, A4, and A7 assemblies.  
If A1U20(5) never goes low or is low for too short of a time (100 ms minimum), check and replace as necessary, A1U20, A1C63, and A1C62.  
If A1U20(5) doesn't go high, check A1R81, or unplug A4, A7, and A11 assemblies to verify that they are not pulling the signal low.

## 8-51. 10 MHZ TIMEBASE CIRCUITS BLOCK TROUBLESHOOTING (PART OF A1)

### NOTE

Probing from the bottom of the A1 Motherboard may be the easiest way to probe the test points given in the following troubleshooting procedures.

The following is a list of likely symptoms if the Timebase block is faulty:

- Failure on Diagnostic 10: Timebase Verification, but HP 5347A/48A may function properly otherwise.
- HP 5347A/48A fails to recognize an external reference.
- HP 5347A/48A always displays 00 000 000 000. (The 10 MHz reference signal is not present. This may also be a fault in the timebase oscillator.)

Board level diagnostics which could indicate faults in this circuitry are as follows:

- Diagnostic 10: Timebase Verification.
- Diagnostic 11: Power Supply Verification. (Refer to Power Supply Troubleshooting, Section 8-32.)
- Diagnostic failures on the A2 through A7 assemblies (see the Inference Chart, Figure 8-2).
- Diagnostic 1: Self Test failure.

Before attempting to troubleshoot any portion of this block, verify the power supply voltages listed in Table 8-8.

*Table 8-8. 10 MHz Timebase Circuits Block Supply Voltages Verification*

SIGNAL NAME	TEST POINT	VOLTAGE RANGE	CONDITION OR COMMENT
+5V <sub>-</sub> BUF	Emitter of A1Q4	+4.75 to +5.25 V	If voltage is bad, perform Internal Timebase Test in Section 8-52.
+5V OSC	A1Y1(2)	+4.60 to +5.25 V	Critical for Timebase. If voltage is bad, perform Internal Timebase Test in Section 8-52.

The 10 MHz Timebase Circuits Block can be broken into the following major sections:

- Internal (TCXO) Timebase
- External Timebase Buffer
- 10 MHz Detector
- Line Drivers

To troubleshoot these sections, perform the following procedures.

### 8-52. 10 MHZ TIMEBASE CIRCUIT TEST (INTERNAL)

This Internal Timebase section generates the internal 10 MHz timebase for the HP 5347A/48A.

#### Setup

1. Check the +5V<sub>-</sub>BUF at the emitter of A1Q4. If it is not between +4.75 and +5.25V, then make sure the +5V supply at the Power Supply Test Connector (A1X1) is within the specification as shown in *Table 8-7*. If the voltage at A1X1 is not within specification, perform the DC to DC Switchmode Converter Test in Section 8-47.
- If the +5V supply is good, then check A1L4, which buffers the +5V<sub>-</sub>BUF from the +5V.

2. Make sure no external reference is connected to the front panel External Reference connector.

#### Procedure

1. Using a frequency counter or an oscilloscope, verify a 10 MHz signal at A1Y1(1). If the signal is incorrect, go to step 2.
  2. Check for a dc voltage within the range of +4.60 to +5.25V at A1Y1(2). If the voltage at A1Y1(2) is correct, replace Y1.
  - If the voltage at Y1(2) is incorrect, check and replace as necessary A1Q4, A1C7, A1C8, and A1L2.
  3. Verify that the rest of the internal timebase section is working properly by tracing the signal flow from A1U5(10) through A1U5(11), and out to the line drivers (A1U7 pins 10, 13, 1).
- If the signal is not getting through A1U5, make sure it is not being disabled by performing the 10 MHz Detector Test in Section 8-54.

## 8-53. 10 MHZ TIMEBASE BUFFER (EXTERNAL) TEST

The External Timebase Buffer section detects and conditions the external reference signal applied to the front panel External Reference connector.

## Setup

Connect a 1.0 Vp-p, 10 MHz sine wave signal to the front panel External Reference connector.

## Procedure

1. Check for a TTL, 10 MHz square wave at A1U5(3). If this signal at A1U5(3) is incorrect, go to step 2.

If the signal at A1U5(3) is correct, the External Timebase Buffer section is operating properly.

2. Check for a 10 MHz sine wave with an amplitude of 6 to 10 Vp-p signal with a 1V dc offset at A1TP1. If the signal is incorrect, check and replace as necessary A1Q2, A1CR2, and A1CR3.

If the signal is correct, replace in order: A1Q3, A1U5, A1CR5.

## 8-54. 10 MHZ DETECTOR TEST

The 10 MHz Detector section indicates to the HP 5347A/48A on which timebase (internal or external) it is operating. This circuit and the A4 microprocessor drives the front panel Ext Ref annunciator. The annunciator is OFF when the internal timebase is used, and turned ON when an external reference timebase signal is used.

## Setup

Connect a 2.0 Vp-p, 10 MHz sine wave signal to the front panel External Reference connector.

## Procedure

1. Check for a TTL 10 MHz square wave at A1U4(9). If the signal is incorrect, perform the External Timebase Test in Section 8-53.

2. Check for TTL low at A1U4(12), and a TTL high at A1U4(5). If the signals are incorrect, replace A1U4.

If the signals at A1U4(12) and A1U4(5) are correct, go to step 3.

3. Check for a TTL low at A1U4(4). If incorrect, check and replace as necessary A1U4 and A1U5.

4. Disconnect the external reference signal from the front panel External Reference connector.

- Diagnosics that may aid troubleshooting the Keyboard/Display Logic circuit are as follows:
- The Liquid Crystal Display does not operate at all during a display test.
  - The instrument fails to recognize entries from the front panel, but operates properly via the HP-IB.
  - The instrument will not go from POWER OFF to POWER ON or vice versa (Note: this is actually a separate circuit. Perform the ON/OFF Control Test in Section 8-43.)
- Possible symptoms if the Keyboard/Display Logic circuit is faulty:
- Diagnostic 70: Keyboard Test
  - Diagnostic 71: Display Test

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*Probing from the bottom of the A1 Motherboard may be the easiest way to probe the test points given in the following troubleshooting procedures.*

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#### NOTE

### 8-56. KEYBOARD/DISPLAY LOGIC BLOCK TROUBLESHOOTING (PART OF A1)

1. Turn the HP 5347A/48A on.
  2. Check for a TTL 10 MHz signal at A1U5(11). If not correct, perform the Internal Timebase Test in Section 8-52.
  3. Using a frequency counter, verify a 10 MHz signal at A1U7(10), A1U7(13), and A1U7(1). If the signal is incorrect or is not present, replace A1U7.
- The Line Driver section supplies the 10 MHz timebase signal to the A3 Counter Assembly, A5 Synthesizer Assembly, and to the internal 10 MHz Monitor connector. The 10 MHz timebase signal is essential for the A3 and A5 assemblies to function properly.

### 8-55. LINE DRIVER TEST

- If the signal is correct, the 10 MHz Detector section is operating properly.
6. Check for a TTL low at A1U4(4). If the signal is incorrect replace A1U4.
- If the signal at A1U5(11) is correct, go to 6.
5. Check for a 10 MHz pulse train at A1U5(11). If this signal is incorrect, trace back to see where the signal drops out.

Points to consider when troubleshooting the Keyboard/Display Logic are as follows:

- It is suggested that Diagnostics 70 and 71 be used initially to determine if the Keyboard/Display Logic circuit is faulty.
  - Test points for the Keyboard/Display Logic circuit are available at the pins of the Keyboard Decoder IC, A1U23. Probe from the bottom side of the instrument.
  - Flat ribbon cable from the keyboard (membrane) must be properly seated in its motherboard connector (A1J7) for the Keyboard/Display Logic circuit to work. Verify the cable connection before disassembling the front panel. To unplug the flat cable of the membrane keyboard, squeeze the ears of connector A1J6, and lift up, part of the connector will slide up, releasing the cable. The connector has teeth that should fit into the slots in the flat cable before sliding both parts into the connector.
- Verify a voltage within the range of +4.75 to +5.25V dc at A1X1(1), the Power Supply Test connector.

If the HP 5347A/48A fails to recognize keyboard entries, proceed as follows:

1. Remove ac power from the rear panel of the instrument, and disconnect the A11 HP-IB Interface Assembly ribbon cable (A11J2W1) from the motherboard if installed.
2. With a test clip, connect A4J1A to a ground test point. These test points are located at the top of the A4 Microprocessor Assembly. (See A4 Microprocessor Assembly component locator and schematic diagram for details.) Reapply power to the rear panel of the instrument and turn it on. The HP 5347A/48A will now be in the Keyboard Test (same as Diagnostic 70) until the test clip is removed and the Power is cycled OFF then ON.

3. Probe A1TP18 (H\_KB\_DAVL) on the A1 board and verify that the signal goes TTL high when a key is pressed and goes TTL 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 A1U25(10).
4. Probe A1U25(13) and verify that this signal pulses TTL high for each key press, but goes low (i.e. does not stay high if the key is held down).
5. Probe A1U24(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 Microprocessor and A1 Motherboard assemblies as well as the connection of the Keyboard flat cable.

If the above procedures do not isolate the key failure, verify that A1U23(12) pulses high when pressing the Input 1 50  $\Omega$  key. Do the same for the Calibrate/Store, Input 2 50 $\Omega$ /1M $\Omega$ , and Input dBm/Watt keys at pins 11, 9, and 8, respectively. Pins 11, 9, and 8 should also pulse high when the appropriate key is pressed.

- Self Test and Diagnostics 20 and 21 during a Diag 1 routine.
  - Diagnostic 21: Low Frequency 1 Mohm Verification — if the 1M $\Omega$  channel is faulty.
  - Diagnostic 20: Low Frequency 50 Ohm Verification — if the 50 $\Omega$  channel is faulty.
- Diagnostics that may fail if the A2 assembly is faulty:
- The HP 5347A/48A fails to count properly on either the 50 $\Omega$  or the 1M $\Omega$  channel: a component or components are faulty in the appropriate amplifier/signal conditioning chain.
  - The HP 5347A/48A fails to count in both the 50 $\Omega$  and 1M $\Omega$  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: MRC CH A Verification and Diagnostic 31: MRC CH B Verification). See the Inference Chart, Figure 8-2.
  - The HP 5347A/48A counts on INPUT 1, but not on INPUT 2.
- Possible symptoms if the A2 assembly is faulty are as follows:

### 8-57. A2 LOW FREQUENCY INPUT ASSEMBLY TROUBLESHOOTING

If the membrane keyboard is found to be faulty, refer to Section 8-86 for A10 Membrane Keyboard Removal and Installation procedures.

If the Liquid Crystal Display is not operating properly, perform the A9 Display/Driver Assembly troubleshooting procedure in Section 8-85.

A1U23 PIN NO.	KEY	15	16	17	18	19
RESET/LOCAL		0	0	1	1	0
ZERO		0	0	1	1	1
INPUT dBm/WATT		0	0	0	1	1
CALIBRATE/STORE FREQUENCY		0	0	0	0	1
INPUT 2 50 $\Omega$ /1M $\Omega$		0	0	0	0	0
INPUT 1 50 $\Omega$		0	0	0	0	0

Note: "1" = TTL high, "0" = TTL low

Table 8-9. Front Panel Keys and Corresponding A1U23 Output Codes

Table 8-9 identifies the code that should be present for each key at the output pins of A1U23. The appropriate code should remain on the data lines until another key is pressed. A1U22 is a three-state buffer to the bidirectional data bus shared with the LCD data. Since the data at the outputs of A1U22 depends on whether key data or other activity is present on the data bus, a fault in A1U22 is best determined by first eliminating A1U23 as a possible cause.



1. Enter Diagnostic 20, and 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. Enter Diagnostic 21, and 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 for 1M $\Omega$  operation, and TTL low for the 50 $\Omega$  operation. (Note that the front panel 50 $\Omega$  and 1M $\Omega$  annunciators indicate input impedance mode of INPUT 2)

Check the following inputs to the A2 Assembly (refer to Sections 8-25 and 8-26 for information on how to enter and exit the Diagnostics mode):

SUPPLY NAME	A2 TEST POINT	ACCEPTABLE RANGE
+15V	CR11 cathode	+14.75 to +15.25 V
+5V	U8(1)	+4.93 to +5.07V

Check the following power supplies at the listed node before attempting further troubleshooting.

- The 50 $\Omega$  channel contains a divide-by 10 counter (U1). The microprocessor firmware multiplies the A3 count by 10 to correct for the division. Since the disabling circuit for the 1M $\Omega$  channel is at the U3 multiplexer, a fault in U3 could cause the 1M $\Omega$  signal to be sent to the A3 Counter Assembly even though the microprocessor has selected the 50 $\Omega$  channel, resulting in the displayed count being multiplied by 10.
- If both Diagnostic 20 and 21 pass, but a channel does not work properly, note that the 35 MHz test signal enters the 1M $\Omega$  channel after Q9, and enters the 50 ohm channel after U5. Faults in the signal path before these points may be undetected by the diagnostics.
- Diagnostics 20 and 21 depend on the AUX A/B (35 MHz) test signal from the A5 Synthesizer Assembly being good and the A3 Counter Assembly working properly.
- The 50 $\Omega$  and 1M $\Omega$  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.

The following is a list of points to consider when troubleshooting the A2 assembly:

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 or U5 pin 2). Compare with waveform D in Figure 8-39. Note that U5 should also have a gain of about 3 (2.6 to 3.4).

If the HP 5347A/48A 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 50 $\Omega$  impedance mode, connect a 50 MHz, 100 mV p-p signal to INPUT 2 of the counter and select the 50 $\Omega$  mode. Connect an oscilloscope probe to the junction of CR7 and CR8. Observe that the signal goes away when switching the HP 5347A/48A to 1M $\Omega$ . Set the HP 5347A/48A to the 50 $\Omega$  mode again and connect the scope probe to the output of U7 (lower leg of R36 or U7 pin 2). Compare this waveform with waveform C in Figure 8-39. Note that the level of this signal is about 300 mV p-p. U7 should have a gain of 2.6 to 3.4.

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.

4. Repeat steps 1, 2, and 3 for LF OUT B (collector of Q2). This signal should be similar to LF OUT A, but inverted.
3. Switch the HP 5347A/48A to the 1M $\Omega$  mode and repeat steps 1 and 2. Compare the signal with waveform B in Figure 8-39. 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.
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 50 $\Omega$  channel (25 mV rms). When the signal goes below the sensitivity, LF OUT A should be about 2 volts, dc (i.e. the ac portion of the signal is not present).
1. Set the HP 5347A/48A to the 50 $\Omega$  channel by setting Input 2 key for 50 $\Omega$  operation, and connect a 50 MHz signal at -10 dBm to INPUT 2. Compare LF OUT A (collector of Q1) with waveform A in Figure 8-39. 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 +2.65 volts).

Check the following outputs of the A2 Assembly:

6. Verify that the H LF 50 line (U9 pin 3) is TTL low for 1M $\Omega$  operation, and during Diagnostics 20, 21; the H LF 50 line should be TTL high for 50 $\Omega$  operation.

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Once the HP 5347A/48A is set to 50 $\Omega$ , further pressing of the Input 2 50 $\Omega$ /1M $\Omega$  key should pulse the LF OUT SEL line high momentarily.

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NOTE

To check the 1M $\Omega$  channel before the point where the test signal enters the circuit, press the 1M $\Omega$  key and connect the oscilloscope probe to the source of Q9 (lower leg of R48). Set the input to -10 dBm level, 50 MHz. Compare this signal with waveform E in *Figure 8-39*. Note that Q8 must be turned off by Q7 during normal operation and turned on by Q7 during diagnostic tests.

For failures on the 50 $\Omega$  channel, check the output levels of U7 and U5 as described in the previous paragraphs. Set the signal level at the output of U5 to 100 mV p-p (input level at INPUT 2 ~5 mV) and compare the output of U4, pin 2 (lower leg of R24) to waveform F in *Figure 8-39*. The U4 output should be about 300 mV p-p; U4 should have a gain of about 3 (2.6 to 3.4).

Next, check U1(8) for proper output as shown in waveform G in *Figure 8-39*. 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 +5 volts.

Verify the proper operation and adjustment of the peak detector circuit by monitoring the voltage at TP1. Select the 50 $\Omega$  channel of the HP 5347A/48A 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 +4 volts for signals greater than 17 mV and about +2 volts for signals less than 17 mV.

Verify that U3C and U3D pass the output of U1 to Q1 and Q2 when the HP 5347A/48A is in the 50 $\Omega$  channel.

For failures in the 1M $\Omega$  mode, set INPUT 2 to the 1M $\Omega$  mode, and adjust a 50 MHz input signal level for a 100 mV p-p level at pin 10 of U6. Compare the output of U6(7) with waveform H in *Figure 8-39*. The output should be about 400 mV p-p for a gain of about 4. Repeat this procedure for U6A by setting the input (pin 5) to 100 mV and comparing the output (pin 2) to waveform I in *Figure 8-39*. The gain should be between 4 and 6.

Next, check the output of the Schmitt trigger, U6C at pin 15. Observe the waveform shown in waveform J in *Figure 8-39*.

Verify that the signal is passed through U3B and U3D to Q1 and Q2 when the HP 5347A/48A is in the 1M $\Omega$  channel.

## 8-58. A3 COUNTER ASSEMBLY TROUBLESHOOTING

The following is a list of possible symptoms which may occur if the A3 Assembly is faulty:

- Diagnostics that count a test signal fail.
- HP 5347A/48A does not count or counts improperly in one or both inputs.

Diagnostics that may fail if the A3 Assembly is faulty:

- Diagnostics 20: Low Frequency 50 Ohm Verification and 21: Low Frequency 1 MOhm Verification

- Diagnostics 30: MRC CH A Verification and 31: MRC CH B Verification

- Diagnostic 43: Repeated Reset

- Diagnostic 50: LO Verification 29.5 MHz, 35.0 MHz

- Diagnostics 60: IF Verification (Disable INPUT & IF) and 65: IF Verification (Disable INPUT I)

- Self Test and any of the above diagnostics during a Diag 1 test.

The following Diagnostics may provide additional information on the status of the A3 assembly (refer to Sections 8-25 and 8-26 for information on how to enter and exit the Diagnostics mode):

- Diagnostic 7: Display Interpolator Short Calibration — 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: Display Interpolator Long Calibration — 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: Interpolator Measurement — 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 HP 5347A/48A (INPUT 1 or INPUT 2) for the above diagnostics to display results other than 00.

Verify that there is activity on data bus lines 0 through 7 (DBUS 0 - DBUS 7).

1. Input a 50 MHz signal at -20 dBm into INPUT 2 and select the 1M2 mode. Set the HP 5347A/48A to minimum resolution (10 kHz) and the fastest sample rate by sending the HP-IB command: OUTPUT 7XX;"RESOL,4";SAMPLE,FAST" — where XX is the instrument's HP-IB address number, selected via the rear panel HP-IB switches.

Check the following inputs to the A3 Counter Assembly:

SUPPLY NAME	A3 TEST POINT	ACCEPTABLE RANGE
+5V	R5 (right leg)	+4.75 to +5.25V
+3V	TP1	+2.98 to +3.02 V
5V	R37 (right leg)	-4.85 to -5.35 V (adjustable at R4)

Check the following power supplies at the listed node before attempting further troubleshooting:

- Most of the other assemblies in the HP 5347A/48A 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 HP 5347A/48A 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 3 volt supply. This voltage is regulated from the +5 volt supply and the regulator circuitry is on the A3 Assembly (A3U1).

Points to consider when troubleshooting the A3 Counter Assembly:

- Diagnostic 30: MRC CH A Verification, 10 MHz Timebase — the internal 10 MHz timebase reference signal is counted by U7 (MRC). If this diagnostic passes, but Diagnostic 31: MRC CH B Verification fails, the A5 Synthesizer may be faulty.
- Diagnostic 31: MRC CH B Verification, 35 MHz — similar to Diagnostic 30 except that the AUX B (35 MHz) test signal is counted by U7 (MRC). If this diagnostic passes, but Diagnostic 30 fails, the 10 MHz reference signal may be faulty.
- Diagnostic 32: Interpolator Check — this diagnostic fails if the difference between the two short or the two long calibration counts is greater than 20.

2. Verify that there is activity on the following control lines. The HP 5347A/48A should be in the normal (Measurement) 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 HP 5347A/48A. Set the HP 5347A/48A to the Manual mode (via HP-IB) with a 1 GHz center frequency. Verify that an IF signal of 70 MHz is at the base of Q2 (left leg of W1), as shown in waveform A in *Figure 8-40*. 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 HP 5347A/48A 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 1M $\Omega$  channel. Verify that the 10 MHz signal appears at the left leg of R31 or U7(26), as shown in waveform B in *Figure 8-40*. 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 (10 MHZ INT CTR).

8. Verify that both the L INTP EN (U6, pin 1) and H INTP RST (U4A, pin 2) lines have activity on them.

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 8-40*).

If the HP 5347A/48A 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 IF MON SMB connector, A1J8, (use the SMB/BNC adapter cable (HP P/N 05350-60121) in the Service Accessories Kit) and the IF signal at pin 30 of U7 with waveforms C and D in *Figure 8-40*.

To troubleshoot the Interpolator, perform the following:

1. Input a 10 MHz, -20 dBm signal to INPUT 2.
2. Set the HP 5347A/48A to the INPUT 2, 1M $\Omega$  mode.

SUPPLY NAME	A4 TEST POINT	ACCEPTABLE RANGE
+5V	C1(+)	+4.8 to +5.2 V
+Vcc	J1G	+4.75 to +5.25V
+5V MEM	C3(+)	+4.75 to +5.25V

Verify the following power supplies:

To troubleshoot the A4 Assembly, perform the following procedures.

- The microprocessor itself (A4U8) 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<sub>UP</sub>\_RST (Reset) signal generated in the 10 MHz Timebase Circuits on the A1 Assembly. Refer to the System Reset Test in Section 8-50, for a description of this signal.

Points to consider when troubleshooting the A4 Assembly:

- Diagnostic 40: Firmware revision code
- Diagnostic 41: RAM test
- Diagnostic 42: ROM test
- Diagnostic 43: Repeated Reset sequence
- Diagnostic 44: Dual Port RAM Test

Diagnostics that may indicate an A4 Assembly failure:

- LCD display is blank or displays nonsense characters.
- Instrument fails to initiate its power-on sequence properly.

Possible symptoms of a faulty A4 Microprocessor Assembly:

### 8-59. A4 MICROPROCESSOR ASSEMBLY TROUBLESHOOTING

3. Connect an oscilloscope probe to pin 3 of U2.
4. Using the normal trigger mode of the oscilloscope, look for a burst of four or five very narrow negative going pulses. Slope settings of 0.5 msec/div and high intensity levels are needed. If you are using a digital oscilloscope, seeing these pulses may be very difficult. If these signals are not present or deviate from waveform E in Figure 8-40, and U7 has been verified, replace the transistor array IC, U5, in the pulse stretcher circuit.
5. 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.

If the instrument fails to power on properly, verify the following signals:

1. The L<sub>UP</sub>RST signal at test point A41E should be TTL high. (less than 200 ms after power is switched on).

2. The IRQ1 signal at test point A41F should be a dc level (ie., 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).

3. The clock signal at test point A41G should be a 2 MHz square wave at TTL levels.

If the above signals are incorrect, trace back through the circuitry to determine the cause. These signals must be correct.

If after performing the above procedures and the problem has not been discovered, replace in order: A4U14, A4U15, A4U8.

If problem still exists, the A4 Microprocessor Assembly should be removed and replaced with another A4 Assembly. This can be arranged by contacting your nearest HP Sales and Support Office.

### 8-60. A5 SYNTHESIZER ASSEMBLY TROUBLESHOOTING

Possible symptoms that may be seen if the A5 Synthesizer Assembly is faulty are listed below:

- HP 5347A/48A fails to acquire signals at INPUT 1, 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 HP 5347A/48A, 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.



If Diagnostics 5 (Display N - Integer) and 6 (Display - Fraction) indicate the input frequency is on the lower sideband (LSB), the IF must be subtracted from  $N \cdot LO$ . If the upper sideband is indicated (USB), the IF must be added to  $N \cdot LO$ .

$$f = N \cdot LO \pm IF$$

If the HP 5347A/48A fails to operate properly for inputs to INPUT 1, it is important to use the above diagnostics to determine what data the HP 5347A/48A is using to determine the input frequency. Verify that the A5 Assembly has detected an IF by using Diagnostic 2 (Display IF). Next, verify what LO frequency and what harmonic of the LO has been used. Use these values in the fundamental tuning equation:

Below are some points to consider when troubleshooting the A5 Assembly.

- Diagnostics 2 (Display IF), 4 (Display LO Frequency), 5 (Display N (integer) and Sideband), and 6 (Display N (fraction) and Sideband) — will give measurement parameter information (LO frequency, harmonic number, and IF)
- Diagnostics 52 (LO Sweep 2/75.0 > 375.0 MHz) and 53 (LO Lower/Upper Frequency Bounds) — will not display PASS OR FAIL information, but may give further insight to the failure.

Refer Section 8-145 for an explanation of the PASS/FAIL indication of Diagnostic 51.

*Diagnostic 51 is only accessible via the HP-IB by executing the commands described above.*

**NOTE**

The above commands can also be sent with one statement line: for example, `OUTPUT 7XX;"DIAGENT;DIAG,51;DIAGPARAM,3105"`.

where XX is the instrument's HP-IB address number, selected via the rear panel HP-IB switches.

```

OUTPUT 7XX;"DIAGENT"
OUTPUT 7XX;"DIAG,51"
OUTPUT 7XX;"DIAGPARAM,3105"
- Enters the instrument into Diagnostics mode.
- Enables Diagnostic 51 Test.
- Sets A5 LO frequency to 310.5 MHz

```

- Diagnostics 50 (LO Verification 29.5 MHz, 35.0 MHz) and 51 (LO Verification User-Entered Frequency). Diagnostic 51 can be initiate via the HP-IB only; thus to enter the Diagnostics mode and to initiate Diagnostic 51 for 310.5 MHz, the following commands would have to be sent.

Diagnostics that may fail or give further information if the A5 Synthesizer Assembly is faulty are as follows (refer to Sections 8-25 and 8-26 for information on how to enter and exit the Diagnostics mode):

Pressing the Reset/Local key will display the frequency measurement at INPUT 2. Sending another "DIAGARM,YY" command with a different value for YY, 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.

where XX is the instrument's HP-IB address number, selected via the rear panel HP-IB switches, and YY is the user selected frequencies.

OUTPUT 7XX;"DIAGARM,YY"  
OUTPUT 7XX;"DIAGNT;DIAG,51"

HP-IB commands:  
Various frequencies to be measured at INPUT 2 — Perform this by sending the following Diagnostic 51 (LO Synthesizer Verification: User-Entered Frequency), and set the LO to 2 connector via a 6, 10, or 20 dB attenuator. First select INPUT 2, 50Ω. Next enter

- To verify the A5 Synthesizer frequency, 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
- 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.
- The output of the synthesizer should be +15 dBm ±3 dB. Use sufficient attenuation when making spectrum analyzer measurements.

70 MHz is the IF generated by this configuration

where CF = MANUAL mode center frequency  
 $LO_{des} = \text{desired LO frequency}$

$$CF = (LO_{des} \cdot 2) + 70 \text{ MHz}$$

- Diagnostic 51 (LO Verification, User-Entered Frequency) allows the synthesizer to be set to a particular frequency via HP-IB only. However, to actually use a particular LO frequency to make measurements at INPUT 1, the Manual mode (via HP-IB) 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:
- The red LED at the top of the A5 Assembly when lit, indicates that the synthesizer circuitry is NOT phase-locked.
- Note the fractional portion of the harmonic number displayed by Diagnostic 6 (Display - Fraction). If this fractional portion deviates more than 0.30 from an integer value (e.g. 3.30 to 3.70), the HP 5347A/48A will not display a measurement. For fractional portions less than 0.30 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).

- 1) Turn the HP 5347A/48A off.
- 2) Set rear panel MODE switch to the Diagnostics mode ("up" position).
- 3) Turn the HP 5347A/48A on.
- 4) Press Input 2 50Ω/1Ω or Input 1 50Ω key (depending on whether you need to increment or decrement to get to Diagnostic 53).
- 5) Press Calibrate/Store key to initiate the Diagnostic 53 test.

a. To set the HP 5347A/48A to Diagnostic 53 by using the rear panel DIP switch, perform the following:

b. For instruments equipped with the HP-IB, proceed to step b.

For instruments not equipped with the HP-IB or where the use of the HP-IB is not desired, proceed to step a.

- HP-IB (for instruments with Option 011)
- Rear Panel DIP switch

4. Using Diagnostic 53 (LO Lower/Upper Frequency Bounds), verify that the lower frequency limit of the synthesizer is less than 275 MHz and the upper limit is greater than 375 MHz. Perform one of the following procedures to run Diagnostic 53. (Two methods exist for running Diagnostic tests.):

3. Verify that base of Q5 is approximately +4.75V. If this signal is near ground, it will turn off the VCO.
2. The A5 Assembly actually uses a -20V supply which is regulated from the -24V supply. This supply can be verified at U5(3). The allowable range at this pin is -18.7V to -21.5V when the HP 5347A/48A is on. When the HP 5347A/48A is in STANDBY the voltage at this pin should be about -1.35V.

SUPPLY NAME	TEST PIN ON A1X1	ALLOWABLE RANGE
+5V	1	+4.75 to +5.25V
-5V	11	-4.85 to -5.35V
-24V	18	-23.00 to -26.50V

1. Check the following supplies at the Power Supply Test Connector (A1X1) on the motherboard (see Table 8-7):

Making the following measurements before removing the RF shielding cover, may give you further insight to the cause of the failure.

- ASU10 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 falls and shows a frequency of about 44 MHz, the VCO and related circuitry is a likely fault.

- b. To set the HP 5347A/48A to Diagnostic 53 via HP-IB, perform the following:
  - 1) Connect a controller to the HP 5347A/48A rear panel HP-IB connector.
  - 2) Check the address setting of the HP 5347A/48A rear panel HP-IB switch
  - 3) Send the command `OUTPUT 7XX;"DIAGENT"` (where XX is the address selected in step b, above). This will put the HP 5347A/48A into the Diagnostics mode.
  - 4) Now, send the command `OUTPUT 7XX;"DIAG,53,ON"`. This will cause the HP 5347A/48A to run Diagnostic 53.

Use the above methods for all other diagnostics mentioned in this section. Note that Diagnostic 51 can only be executed via the HP-IB as discussed previously.
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 at 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  $\pm 3$  dB. See waveform A in Figure 8-42.
6. Without a signal connected at INPUT 1, and with the HP 5347A/48A in Auto mode, measure the waveform at U1(6) with an oscilloscope. Compare with waveform B in Figure 8-42. 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 U1(6), set the HP 5347A/48A to Diagnostic 52 (LO Sweep  $275.0 > 375.0$  MHz). A relatively slow time varying voltage should be seen ranging from approximately  $-1$  V to  $-12$  V. This is the VCO drive signal during the LO sweep.

The power supplies and their allowable ranges on the A5 Synthesizer Assembly are listed below:

SUPPLY NAME	A5 TEST POINT	ALLOWABLE RANGE
+5VD	C41(+)	+4.75 to +5.25 V
+5VA	C42(+)	+4.73 to +5.24 V
-5.2V	C34(-)	-4.85 to -5.35 V
-24V	C27(-)	-23.00 to -26.50 V
-20V	U5(3)	-18.7 to -21.5V (after oscillator warmup)
		(-1.35V when unit is in Standby mode)

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 waveform C in *Figure 8-42*. Note that measuring this signal at U3(7) may cause the dc bias to be shifted slightly. At A5P1, the signal is ac coupled.

2. Set the HP 5347A/48A 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(11) should have activity during this diagnostic. U4(8) should always be low, as this address line is only used during the initialization process at power-up.

3. Enter Diagnostic 50 (LO Verification 29.5 MHz, 35.0 MHz) and verify that that U8(11) toggles between 0 and 4 volts during this diagnostic.

Enter Diagnostic 50 and verify the pulsed 29.5 MHz and 35 MHz signal at U8(2) and U8(3). These signals should have a dc offset of about +3.7V with a peak-to-peak amplitude of about 0.8V.

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 phase locked (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.

The following paragraphs provide suggestions for how to troubleshoot each of the symptoms listed above.

If the synthesizer output level is below +12 dbm, proceed as follows:

1. The suspect circuitry is U6, U9, or the VCO. The schematic denotes 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).

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 (LO Lower/Upper Frequency Bounds). The output should be alternating between the high end frequency and the low end frequency for normal operation. Monitoring the PLL OUT at U1(6) 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 HP 5347A/48A to Diagnostic 51 (via HP-IB only) with an entered frequency of 300.1 MHz. As a starting point to troubleshooting the phase-lock 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). U3(8) 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(3). The frequency at this node should be between 5 and 8 MHz typically. However, at this point it is not important to measure an exact frequency, but rather to determine that a signal exists at all and is stable. If the signal is absent at U3(3), trace back through U7 to U10 to locate the faulty component. Refer to waveform H in Figure 8-42 (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(3) as described above and the signal at U3(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 phase-lock 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 at the junction of R14, C19, and CR6. 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 HP 5347A/48A set to ON, verify the dc bias measurements around the VCO circuitry. 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 HP 5347A/48A be set to Diagnostic 51 (via HP-IB only) with an LO frequency of 300.0 MHz.

8. First, verify the signal at U10(2) as shown in waveform J in Figure 8-42, using an oscilloscope. Display this trace on Channel A of the oscilloscope.

9. Display the signal at U7(11) on Channel B of the oscilloscope. Compare to waveform D in Figure 8-42. Now display the signal at U7(3) on Channel B. Compare to waveform E in Figure 8-42. These are the signal relationships represented in Figure 8-20 of the detailed circuit description for the A5 Assembly. Note that it is not possible to probe U7(13) as shown in Figure 8-20, 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(4) on channel A of the oscilloscope and the signal at U7(14) on channel B. Compare to waveform F in Figure 8-42 and note how the signal at pin 14 lags the signal at pin 4. Repeat this procedure, comparing the signals at U7(3) (Channel A) and U7(14). Compare with waveform G in Figure 8-42. These measurements should isolate failures of U7 or U10.

11. To check U3, display the signal at U3(3) on channel A of the oscilloscope and the signal at U3(14) on channel B. Set the LO to 300.1 MHz using Diagnostic 51. Compare to waveform H in Figure 8-42. If the LO frequency is a multiple of 5 MHz, the signal at U3(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 phase lock loop broken at R14, the output of the integrator will be held to approximately +0.7V or -18.5V.

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 HP 5347A/48A in Diagnostic 52 (LO Sweep). If the output is completely absent, refer to the procedure described under the paragraph "If the synthesizer output level is below +12 dBm ..."; if the output is "stuck" at a particular frequency, refer to the procedure under the paragraph "If the synthesizer is "stuck" at one end of the frequency range ...". Finally, if the output is oscillating, refer to the following troubleshooting suggestions.
2. Diagnostic 52 (LO Sweep) may give an indication as to what frequencies or set of conditions made the phase-lock loop 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 phase-lock 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.

If the synthesizer is phase-locked (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 (50 $\Omega$ ) via a 6, 10, or 20 dB attenuator. Next, set the LO to a particular frequency using Diagnostic 51. Press Reset/Local key, and the LO frequency should be displayed on the HP 5347A/48A.
2. Set the HP 5347A/48A 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(11), should have activity during this diagnostic. U4(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, check U4 by verifying that pins 12 and pins 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 M $\Omega$  probe).



3. For a specific starting point to troubleshoot, monitor U3(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 not multiples of 5 MHz will cause the U7-U10 combination of counters to divide by 50 always. Thus, U3(14) will be in a static state. See waveform I in Figure 8-42.
  4. After verifying the signal at U3(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 waveform J in Figure 8-42.
  5. If U3(14) has activity as verified above, U10, U7, and U3 can be checked as described in the next three steps. (The HP 5347A/48A should be set to Diagnostic 51 with an LO of 300.0 MHz for the following measurements.)
    6. Display the signal at U10(2) on Channel A of the oscilloscope. Next, display the signal at U7(11) on Channel B of the oscilloscope. Compare to waveform D in Figure 8-42. Now, display the signal at U7(3) on Channel B. Compare to waveform E in Figure 8-42. These are the signal relationships represented in Figure 8-20 of the detailed circuit description for the A5 Assembly. Note that it is possible to probe U7(13) as shown in Figure 8-20, 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(4) on Channel A of the oscilloscope and the signal at U7(14) on Channel B. Compare to waveform F in Figure 8-42, and note how the signal at U7(14) lags the signal at U7(4). Repeat this procedure, comparing the signals at U7 pin 3 (Channel A) and U7(14). Compare with waveform G in Figure 8-42. These measurements should isolate failures with U7 or U10.
    8. To check U3, display the signal at U3(3) on Channel A of the oscilloscope and the signal at U3(14) on Channel B. Set the LO to 300.1 MHz using Diagnostic 51. Compare to waveform H in Figure 8-42. If the LO frequency is a multiple of 5 MHz, the signal at U3(14) will be a constant dc level (Modulus Control).
- 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 phase-lock 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(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 M $\Omega$  probe when measuring waveforms at U3(5).

## 8-61. A6 IF AMPLIFIER/DETECTOR ASSEMBLY TROUBLESHOOTING

Possible symptoms that may be seen if the A6 IF Amplifier Assembly is faulty are as follows:

- HP 5347A/48A 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 through the use of Diagnostics 2 and 4.

- HP 5347A/48A fails to indicate an overload condition or indicates an overload condition for signals in the HP 5347A/48A operating range.

Diagnostics that may fail if the A6 Assembly is faulty:

- Diagnostics 60 (IF Verification, 35 MHz, Disable INPUT 1 and IF) and 65 (IF Verification, 35 MHz, Disable INPUT 1)

- Diagnostics 2 (Display IF), 62 (Disable Hardware IF Detector Flag), 63 (Disable Hardware and Software IF Detector Flag), and 64 (Disable Software IF Detector Flag) — will only display measurement information rather than explicit PASS or FAIL indication.

- Diagnostic 61 (Overload Status) will display whether or not an overload condition was detected by the A6 Assembly.

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.

Points to consider when troubleshooting the A6 Assembly are as follows:

- If the HP 5347A/48A fails to operate properly on INPUT 1, it is important to use the above diagnostics to determine what data the HP 5347A/48A is using to determine the input frequency. Verify that the A6 Assembly has found an IF frequency by using Diagnostic 2 (Display IF). Next, verify what LO frequency and what harmonic of the LO has been used. Use these values in the fundamental tuning equation:

$$f_x = N \cdot LO \pm IF$$

- If Diagnostics 5 and 6 indicate the input frequency is on the lower sideband (LSB), then the IF must be subtracted from  $N \cdot LO$ . If the upper sideband is indicated (USB), then the IF must be added to  $N \cdot LO$ .

- Note the fractional portion of the harmonic number displayed by Diagnostic 6. If this fractional portion deviates more than 0.30 from an integer value (e.g., 3.30 to 3.70), the HP 5347A/48A 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

1. Set the HP 5347A/48A to Manual mode via the HP-IB with a 1 GHz center frequency by executing the HP-IB command `OUTPUT 7XX;"MANUAL,IE+9"` — where XX is the instrument's HP-IB address number, selected via the rear panel HP-IB switches.
- 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:

---

An IF signal is generated in the A12 Microwave Assembly. For this to occur, a drive signal is required from the A5 Synthesizer Assembly. If the shielding cover is removed, the output from A5 to A12 is disconnected. Use the adapter cable HP P/N 05350-60102 (in the Service Accessories Kit) to reconnect A5 to A12 for troubleshooting.

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#### NOTE

- 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.
  - 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.
  - Diagnostic 63 (Disable Hardware and Software IF Detector Flag; Display IF) disables the software flags, enabling verification of the hardware detection circuitry. Diagnostic 2 (Display IF) 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.
  - The effective width of the IF bandpass filter can be seen by putting the HP 5347A/48A in the MANUAL mode via HP-IB and entering Diagnostic 64 (Disable Software IF Detector Flag; Display IF). 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 (Disable Hardware and Software IF Detector Flag; Display IF) disables the software flags, enabling verification of the hardware detection circuitry. Diagnostic 2 (Display IF) can be used to verify the software flags at 43 MHz and 97 MHz.
  - If the IF detector is not functioning properly, the HP 5347A/48A may never acquire a microwave signal or always attempt to acquire the signal with an LO of 350 MHz.
  - 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.
  - The IF detector is not functioning properly, the HP 5347A/48A 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 HP 5347A/48A in the MANUAL mode via HP-IB and entering Diagnostic 64 (Disable Software IF Detector Flag; Display IF). 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 (Disable Hardware and Software IF Detector Flag; Display IF) disables the software flags, enabling verification of the hardware detection circuitry. Diagnostic 2 (Display IF) 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.
- 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 HP 5347A/48A.

2. Input a 1 GHz signal at -10 dBm to INPUT 1.
  3. The green LED at the top of the A6 IF 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 05350-60119) 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 HP 5347A/48A to Manual mode with a 770 MHz center frequency by executing the HP-IB command OUTPUT 7XX;"MANUAL,770E+6".
    - d. Input a 770 MHz, -10 dBm signal to INPUT 1.
    - e. Compare the waveform with waveform A in Figure 8-43.
  4. 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. Set the Manual center frequency to 1 GHz by executing the HP-IB command OUTPUT 7XX;"MANUAL,1E+9". A 1 GHz. Manual center frequency will result in a 310 MHz LO. This signal should be +15 dBm  $\pm$  3 dB.
  5. If the LO signal is present, but the IF signal differs from that shown in waveform A in Figure 8-43, refer to the A12 Microwave Assembly troubleshooting procedures.
  6. If the LO signal is not present, or is below +12 dBm, refer to the A5 Synthesizer Assembly troubleshooting procedures.
- Disconnect the adapter cables and reconnect the A6W1 cable to A12J1, and the W2 cable to A12J2.

1. Set the HP 5347A/48A to the Manual mode with a 1 GHz center frequency by executing the HP-IB command OUTPUT 7XX;"MANUAL,1E+9". Input a 1 GHz signal at the front panel INPUT 1 connector and compare the signal at the collector of Q8 with waveform B in Figure 8-43.

An IF signal is generated in the A12 Microwave Assembly. For this to occur, a drive signal is required from the A5 Synthesizer Assembly. If the shielding cover is removed, the output from A5 to A12 is disconnected. Use the adapter cable HP P/N 05350-60102 (in the Service Accessories Kit) to reconnect A5 to A12 for troubleshooting.

**NOTE**

Verify the following outputs of the A6 Assembly:

1. Verify that the AUX A 35 MHz signal (upper leg of R24) pulses on and off when the HP 5347A/48A is executing Diagnostics 60 (IF Verification: 35 MHz; Disable INPUT 1 and IF) and 65 (IF Verification: 35 MHz; Disable INPUT 1). 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 HP 5347A/48A to Manual with a 770 MHz center frequency (with HP-IB command OUTPUT 7XX;"MANUAL,770E+6"), applying a 770 MHz, -10 dbm signal to INPUT 1, and probing the upper leg of L1. Compare with waveform A in Figure 8-43.
5. Verify the L NO IF RST (TP1) and L OVL D 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 HP 5347A/48A to 1 MHz for a faster measurement time and therefore easier viewing on an oscilloscope.

Verify the following inputs to the A6 Assembly:

SUPPLY NAME	A6 TEST POINT	ACCEPTABLE RANGE
+5D	L21A (top right leg)	+4.75 to +5.25V
+5L	L21B (bottom right leg)	+4.75 to +5.25V
-5V	L17 (top leg)	-4.85 to -5.35V

Verify the following power supplies:

2. Verify that for signals above the sensitivity of the HP 5347A/48A, 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 Appendix A, Specifications.)
  3. Set the input to +10.5 dbm and verify that the L OVL D 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.
- 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.
- It is recommended that when troubleshooting the A6 Assembly that the HP 5347A/48A be placed in the Manual (via HP-IB). This will bypass the automatic acquisition routine found in the Auto mode, thereby eliminating a periodic sweep of the IF signal as the HP 5347A/48A attempts to search for the signal.

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 HP 5347A/48A in Manual mode and a center frequency of 1 GHz (HP-IB command OUTPUT 7XX;"MANUAL,1E+9"), apply a 1 GHz signal to the HP 5347A/48A at a level to produce a 100 mV p-p, 70 MHz IF signal at L5. Compare the output of U3(2) with waveform C in Figure 8-43.
3. Verify the IF bandpass sensitivity adjustment (SENS ADJ) R25. Refer to Section 5, Adjustments.
4. Repeat the U3 procedure above with U4 by setting the input of U4(1) to 100mV p-p and comparing the output with the output of U4(2), shown in waveform D of Figure 8-43.
5. If Diagnostics 60 and 65 indicate failures, and U3 and U4 are good, verify that the 35 MHz test signal is seen at the collector of Q6 (bottom leg of L23), while the HP 5347A/48A is in Diagnostics 60 and 65. The signal should be 35 MHz with a 800 mV p-p amplitude.
6. Verify the dc bias voltages at the collectors of Q10 (bottom leg of R36) and Q11 (bottom leg of L29). These voltages should be about +4V ±0.2V at the collector of Q10, and about +3V ±0.2V at the collector of Q4. Perform these measurements with no signal applied to INPUT 1.
7. Verify differential amplifier pair Q10 and Q11 by setting the signal level at the base of the input transistor Q10 to 100 mV p-p and comparing the signal at the collector of Q11 with waveform E in Figure 8-43.

Also, failure to zero or calibrate may be caused by either board assembly (A7 or A8), as well as connector problems. These areas will be highlighted in the following sections.

- Instrument powers up properly, but will not measure power.
- Instrument will measure frequency, but not power.

Possible symptoms of a faulty A8 Analog Assembly:

- Failed to pass Diagnostic 72 (A7 Power Meter Digital Check).
- Failed to pass Power-up Self Test, stopping at Diagnostic 72 (A7 Power Meter Digital Check).
- Failed to pass Diagnostic 72

Possible symptoms of a faulty A7 Digital Assembly:

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All other HP 5347A/48A functions must be operating correctly before proceeding to troubleshooting A7 or A8 problems.

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#### NOTE

### 8-62. A7/A8 POWER METER ASSEMBLIES TROUBLESHOOTING

To troubleshoot the Detector, proceed as follows:

During Diagnostic 60 (IF Verification: 35MHz; Disable INPUT 1 and IF) and 65 (IF Verification: 35MHz; INPUT 1), 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.

Compare the waveform at the emitter of Q7 (upper leg of R28) with waveform F in Figure 8-43. Next, verify the operation of the detector circuit by probing at TP2 (R12). Input a 770 MHz signal to INPUT 1 with the HP 5347A/48A in Manual mode via HP-IB (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, TP2 voltage should be about 1.0V to 1.2V. The comparator output (U2A, pin1) should swing between TTL levels as TP2 swings between the above voltage levels. The trigger voltage at U2(3) should be about 0.9V.

To check the overload peak detector, set the input to 1 GHz at +5 dBm. The voltage at U2(5) should be about 1V to 1.3V. Increase the input level to +10 dBm. The voltage at U2(5) should now be about 700 to 900 mV. The trigger voltage at U2(6) should be about 0.9V.

Diagnosics that may indicate an A7 Assembly failure:

- Diagnostic 72 RAM Test
- ROM Test
- PIA Test
- PTM Test
- A/D Test

The above diagnostic tests the A7 Digital Assembly. No Diagnostics are available for testing the A8 Analog Assembly.

### 8-63. Determining the Failed Assembly in the Power Meter Section

The following paragraphs provide troubleshooting checks. The checks are used to isolate a malfunction to one of the two assemblies:

- A7 Power Meter Digital Assembly
- A8 Power Meter Analog Assembly

The checks start with the A7 Digital Assembly and then proceeds to the A8 Analog Assembly. The checks are easy to perform and provide key information. In most instances the checks isolate a failure to the particular assembly. The comments associated with each procedure summarize the known information as a result of passing or failing the check.

Note that the HP-IB commands will be used as needed, as explained in Section 8-23 (HP-IB Aids for Troubleshooting). Review Section 8-23 as needed.

### 8-64. A7 Versus A8 Isolation

#### A7 ASSEMBLY SETUP AND VERIFICATION.

To verify the A7 Digital Assembly power-up routine press **POWER** key to cycle from the power OFF to power ON condition. This will initiate a diagnostic routine, described in Section 8-31. If the HP 5347A/48A completes this power-up sequence, but will not measure power, or zero or calibrate, then the the A8 Analog Assembly is probably at fault. (A defective power sensor, cable and connector problems, and A1 Motherboard Assembly faults also need consideration. Try another known good sensor and/or cable, and inspect all connections carefully).



**Abnormal Indication**

- Failure Message indicating a Test under Diagnostic 72 has failed. The six failure messages that can appear in the display when problems exist during the Diagnostic 72 test are listed below:

- FAIL	1	A7 D72
- FAIL	2	A7 D72
- FAIL	3	A7 D72
- FAIL	4	A7 D72
- FAIL	5	A7 D72
- FAIL		PM INTERFACE
- FAIL		A7 D72

If any of these indications occur, perform the procedures in Section 8-65 (A7 Power Meter Digital Assembly Troubleshooting) and Section 8-66 (Diagnostic 72 Tests and Actions).

**A8 ASSEMBLY SETUP AND VERIFICATION (ZERO/CALIBRATE PROCEDURE).**

**NOTE**

A7 Digital Assembly must be working properly to perform the following procedural checks. Stop and repair any A7 problems uncovered by Diagnostic 72. Refer to Section 8-65 for details.

As a check of the A8 Analog Assembly, two approaches can be taken depending on the test equipment available. The HP 11683A Range Calibrator is the preferred source for troubleshooting since its output signal is independent of the circuitry in the HP 5347A/48A. Also, the HP 11683A output level can be set to supply signals levels of an amplitude high enough to allow easy viewing of the waveforms on the oscilloscope.

If an HP 11683A Range Calibrator is not available, a power sensor can be used with the 1 mW, 50 MHz Power Ref of the HP 5347A/48A to set up some known conditions for troubleshooting. However, the resulting signal levels present in some A8 circuits are very low, making viewing on an oscilloscope difficult. Use of the calibrator also removes the variations that can be caused by different sensors when used with the internal 1 mW reference. Using this method assumes that these circuits are operating properly.

These approaches for verifying the A8 Analog Assembly are described in the following procedures.

POWER SENSOR	DISPLAYED POWER
HP 8481A	1.000 -3 Watt or 0 dbm
HP 8484A (with HP 11708A 50 MHz Reference Attenuator)	1.000 -6 Watt or -30 dbm
HP 8485A	1.000 -3 Watt or 0 dbm

Table 8-10. Power Displayed for 1 mW Power Reference

The display should indicate as shown in Table 8-10.

1. Connect the correct power sensor (HP 8481A, HP 8484A, or HP 8485A) to the HP 5347A/48A and to the Power Ref (1.00 mW 50 MHz).
2. Press Input dbm/Watt key to put instrument in the Power Meter mode.
3. Press Zero key and wait for the routine to finish.
4. Press Calibrate/Store key and wait for the routine to finish. (When the calibration routine is completed, the internal reference oscillator shuts off. HP-IB commands can be used to turn it ON; the procedure for using the HP-IB commands is described in the first "NOTE" in Section 8-69.)

Procedure II (Using Power Sensor and 1 mW, 50 MHz Power Ref)

1. Observe that the HP 5347A/48A display indicates 1.000 3 WATT (mW) and follows the range calibrator as the range is changed.
2. Press the Zero key on the HP 5347A/48A, and wait for the routine to finish.
3. Change the range calibrator FUNCTION control to the CALIBRATE position.
4. On the HP 5347A/48A, press Calibrate/Store.
5. Observe that the HP 5347A/48A display indicates 1.000 3 WATT (mW) and follows the range calibrator as the range is changed.

FUNCTION ..... STANDBY  
 POLARITY ..... NORMAL  
 RANGE ..... 1 mW  
 LINE ..... ON

1. Using the HP 11730A power sensor cable, connect the HP 11683A Range Calibrator to Sensor INPUT of the HP 5347A/48A. Set the Range Calibrator switches as shown below:

Procedure I (Using the HP 11683A Range Calibrator)

## Abnormal Indications for Both Procedures

- An error message indicating a faulty sensor.
- Zero or Calibrate will not work or an error occurs.
- Power Measurement is incorrect.
- Display indicates the message "NO REF" (no power reference).

If one of the above indications occurs, perform the procedures in Section 8-67 (A8 Power Meter Analog Assembly Troubleshooting).

## 8-65. A7 Power Meter Digital Assembly Troubleshooting

### PRELIMINARY TESTS.

#### System Reset Voltage Checks

Perform this check before performing any of the following diagnostic based troubleshooting procedures.

1. Ensure the HP 5347A/48A is turned on.

2. Verify that the  $L_{\mu P\_RST}$  line at A7U13(37) is a TTL HIGH. If the measured voltage is correct, go to the Timing Check section, below. If the measured voltage is incorrect, go to step 3.

3. Verify that A1U20(5) is a TTL HIGH. If pin 5 is incorrect, check the +5V supply side of A1R81. If the +5V supply is correct, check A1R81 for an open or wrong value. If the +5V supply is incorrect, refer to the A1 Power Supply Troubleshooting section.

#### System Reset Timing Check

The purpose of this check is to test timing relationship between  $L_{\mu P\_RST}$  signal and the +5V presence.

1. Connect the oscilloscope to A7U13(37).
2. Connect the oscilloscope's External Trigger Input to A4J1G (+5V test point).
3. Set the controls on the oscilloscope as follows:

Vertical Scale — 2 volts/division  
Horizontal Scale — 20 ms/division  
Trigger Mode — Normal, external  
Trigger Level — Slightly positive  
Trigger — Positive Edge

4. At turn-on, the oscilloscope should display a waveform that is at 0 volts for >80 ms, and then rise up to +5 volts.

## 8-66. DIAGNOSTIC 72 TESTS AND ACTIONS

Diagnostic 72 tests five individual components (or circuits) on the A7 Power Meter Digital Assembly and indicates a failure message if a component fails; thus, troubleshooting the A7 Assembly is simplified.

Perform one of the following procedures to run Diagnostic 72. (Two methods exist for running Diagnostic tests):

- Rear Panel DIP switch

- HP-IB (for instruments with Option 011)

For instruments not equipped with the HP-IB or where the use of the HP-IB is not desired, proceed to step 1.

For instruments equipped with the HP-IB, proceed to step 2.

1. To set the HP 5347A/48A to Diagnostic 72 by using the rear panel DIP switch, perform the following:

- a. Turn the HP 5347A/48A off.
- b. Set rear panel MODE switch to the Diagnostics mode ("up" position).
- c. Turn the HP 5347A/48A on.
- d. Press Input 2 50  $\Omega$ /1M $\Omega$  or Input 1 50  $\Omega$  key (depending on whether you need to increment or decrement to get to Diagnostic 72).
- e. Press Calibrate/Store key to initiate the Diagnostic 72 test.

2. To set the HP 5347A/48A to Diagnostic 72 via HP-IB, perform the following:

- a. Connect a controller to the HP 5347A/48A rear panel HP-IB connector.
- b. Check the address setting of the HP 5347A/48A rear panel HP-IB switch
- c. Send the command OUTPUT 7XX;"DIAGENT" (where XX is the address selected in step b, above). This will put the HP 5347A/48A into the Diagnostics mode.
- d. Now, send the command OUTPUT 7XX;"DIAG,72,ON". This will cause the HP 5347A/48A to run Diagnostic 72.

The six possible failure messages that might occur and the mostly likely faulty component(s) are listed below. (If one of the messages listed below is displayed during Diagnostic 72 test, replace the appropriate component(s) to repair the circuit):

**FAIL 1 A7 D72**

Replace in order: A7U17 SRAM, A7U15 Memory Buffer.

**FAIL 2 A7 D72**

Replace in order: A7U16 EPROM, A7U15 Memory Buffer.

**FAIL 3 A7 D72**

Replace in order: A7U7 PIA, A7U12 I/O Buffer.

Additional cause for PIA failure could be missing clock signal at A7U7(25).

**FAIL 4 A7 D72**

Using an oscilloscope, verify the presence of 1 ms pulse train at A7U8(3), INTR\_1 MS. If not present, the 2 MHz clock signal at U7U8(17) might be missing, or the 0.5 MHz clock signal at U7U8(28) might be missing. Trace back until the faulty component is found.

If the 1 ms pulse train is present at A7U8(3), replace in order: A7U8 PTM, A7U12 I/O Buffer, U9 Ramp Counter.

**FAIL**

**5 A7 D72**

If this failure message is indicated, the actual Analog-to-Digital conversion processed that is controlled by the microprocessor is faulty.

Check for an 8 MHz clock signal at A7U9(2). If not present, trace back to the faulty area or component.

If the clock signal at A7U9(2) is present, then replace or repair in order: A7U9 Ramp Counter, A8U12 I/O Buffer, A8 Analog Assembly.

Additional cause for failure could be a missing 8 MHz clock signal at pin 2 of A7U9(2).

**FAIL PM INTERFACE A7 D72**

This message will occur if a timeout in communications between the power meter and counter circuits occurs. However, any of the previous mentioned power meter failure messages could be the cause of the timeout problem. Perform the following procedure to troubleshoot this failure.

1. Using a DVM check for the presence of +5V. Connect the negative lead to A7TP1D (ground), and connect the positive lead to A7U4A(4). Verify +5  $\pm$ 0.25V.
2. Check the following clock signals for 50% duty cycle:
  - a. 16 MHz square wave at A7Y1(8) and A7U2(1).
  - b. 8 MHz square wave at A7U2(5), A7U4(1), A7U4(13), A7U5(3), and A7U9(2).
  - c. E System clock (2 MHz square wave): A7TP1A, A7U14(4), A7U3(5), A7U6(2), A7U6(12), A7U8(17), A7U7(25), A7U4(2), and A7U1(13).
  - d. Q System clock (2 MHz square wave): A7TP1B, A7U4(5), A7U4(11).
  - e. Check that Q System clock leads E System clock by 90°.
  - f. ~BUSY, low true, halts clock activity at A7U3(11) and A7U18(3).
3. Check the following signal conditions on Microprocessor A7U13:
  - a. R/~W line should be active at A7TP1C, A7U13(32), A7U14(1), A7U3(9), A7U6(1), and A7U10(5).
  - b. Address and data lines should be active at A7U13(8-13) and A7U13(24-31).
4. Compare the inputs and outputs of each of the Bus Buffers (U15, U12, U11). First ground pins 1 and 19 of each of the buffers. Verify that output lines (pins 14, 16-23) equal input lines (pins 1-11, 13).
5. Check the Address Decoding and Control circuit for activity on the input and output lines of A7U14(PAL).
  - a. A7U14(23), L<sub>MEM</sub>\_EN, line should be the easiest to determine activity.
  - b. A714(14), L<sub>IRQ</sub>\_RST, line should be periodically LOW.
  - c. A7U10 (Address and Control Buffer — it is always enabled) signals on the input and output lines should equal.
6. Check the A4 Microprocessor Assembly by performing the procedure described in Section 8-59 (A4 Microprocessor Assembly Troubleshooting).

## 8-67. A8 Power Meter Analog Assembly Troubleshooting

### NOTE

Before doing the following procedures it is assumed that the HP 5347A/48A did the following:

- Operated properly in all respects except for the Power Meter functions.
- Passed all Diagnostic 72 Tests of the A7 Digital Assembly.

## 8-68. INTRODUCTION

Since no diagnostics are available for the A8 Analog Assembly, the HP-IB aids are used extensively in this section as a means to actuating various circuit elements. Review information in Section 8-23 as needed.

## 8-69. FAULT ISOLATION PROCEDURE

The following procedures will help isolate a problem in one of the following circuits:

- Input Amplifier
- Range Attenuators
- Variable Gain Amplifier
- 220 Hz Bandpass Filter/Amplifier
- Synchronous Phase Detector
- Low Pass Filter
- A/D Input Multiplexer
- Voltage References
- A/D Ramp Generator
- Comparator

## Equipment Required

Controller/Interface	HP 200 or 300 Series Desktop Computer (BASIC)
HP-IB Interface Assembly	... 05350-60011 (if not installed)
Digital Oscilloscope	HP 54100, HP 54111D, or HP 1725A Oscilloscope
Range Calibrator	HP 11683A
Power Sensor	HP 8481A or 8485A (HP 8484A with 30 dBm Attenuator)
Power Sensor Cable	HP 11730A
Digital Voltmeter	HP 3466A
Frequency Counter	HP 5384A
Power Meter	HP 437A

FUNCTION	.....	CALIBRATE
POLARITY	.....	NORMAL
RANGE	.....	1 mW
LINE	.....	ON

**NOTE**

The HP 11683A Range Calibrator is the preferred source for troubleshooting since its output is independent of any of the circuitry in the HP 5347A/48A, and avoids variations in signal levels caused by various sensor specifications. Also, because of the HP 11683A's greater output power, signals in the analog chain can be easily viewed on an oscilloscope display. The HP 11683A allows known waveform levels to be input to the analog chain. A power sensor can be used with the internal 1 mW Reference, but this requires that the circuits in the power sensor and the HP 5347A/48A be functional. To use the 1 mW Reference, it must be turned ON by sending the following commands:

OUTPUT 7XX;"LN:PR"  
 OUTPUT 7XX;"OC1"

where XX is the instrument's address, selected via the rear panel HP-IB switches.

Normally, the internal reference is only ON during the Calibration routine.

**Power Supply Check**

The Analog circuitry of the Power Meter requires precise voltages for proper operation. Therefore, check +15V and -15V with a Digital Voltmeter (DVM).

1. Connect the negative lead of the DVM to CGND at the junction of A8C51 and A8C54.
2. Connect the positive lead to positive side of A8C51. Verify a reading of  $\pm 0.75V$ .
3. Now, connect the positive lead to the positive side of A8C54. Verify a reading of  $-15 \pm 0.75V$ .



1. Connect the HP 11683A Calibrator to Sensor INPUT of the HP 5347A/48A, and set up the Range Calibrator as follows:  
 FUNCTION ..... CALIBRATE  
 POLARITY ..... NORMAL  
 RANGE ..... 1 mW  
 LINE ..... ON  
 If the internal reference is used, skip step 4.
2. Connect the controller to the rear panel HP-IB connector of the HP 5347A/48A.
3. Press POWER key to turn on the HP 5347A/48A.
4. Execute the HP-IB command OUTPUT 7XX;LN;PR" — where XX is the instrument's HP-IB address number, selected via the rear panel HP-IB switches. This command causes the HP 5347A/48A to go into the Power Meter (Watts) mode, presets the instrument to a known state.
5. Verify that A8U2(2) is a TTL high (> 2.0V). This indicates the "Fast" filter output selection (High input power level).
6. Select "Slow" filter by executing the HP-IB command OUTPUT 7XX;LN;RM2". This command causes the HP 5347A/48A to output a signal to cause the Low Pass Filter on the A8 Assembly to switch to the Slow filter.
7. Verify that A8U2(2) is a TTL low (< 0.8V). If not, replace A8U2.

1. Connect the HP 11683A Calibrator to Sensor INPUT of the HP 5347A/48A, and set up the Range Calibrator as follows:

FUNCTION ..... CALIBRATE  
 POLARITY ..... NORMAL  
 RANGE ..... 1 mW  
 LINE ..... ON

The following tests indicate if the Power Meter microprocessor on the A7 Digital Assembly is talking to the analog circuits on the A8 Analog Assembly, and provide for other basic checks. Values shown below are typical with a 1 mW input if the instrument is zeroed and calibrated.

**NOTE**

**A8 Overall Troubleshooting Outline**

These voltages can also be checked at the A1X1 Power Supply connector pins 4 (+15VPM) and 14 (-15VPM). However, to be on the safe side, check them on the A8 Assembly to eliminate the possibility of overlooking connector problems, etc.

**NOTE**

The +15V and -15V readings MUST BE within ±0.15V of each other.

8. The waveforms from A8TP6 (RAMPEND) and A8TP7 (RAMP) tend to be unstable. To stabilize the display for easier viewing, first set the voltage trigger level for A8TP7 to 7.0 volts or greater. Then trigger A8TP6 to the positive or negative edge of the waveform at A8TP7. (If you are using an analog oscilloscope, adjust trigger level until the waveforms stabilize). Compare the triggered results with Figure 8-46 (waveform A, RAMPEND waveform triggered to RAMP waveform).
  9. Connect the oscilloscope to A8TP6 and compare the displayed waveform with Figure 8-46 (waveform B, RAMPEND waveform).
    - a. Compare the waveform at A8TP7 (RAMP) with Figure 8-46 (waveform C, Analog/Digital Converter Ramp Waveform).
      - If the signal is incorrect, perform the Voltage References and A/D Ramp Generator test in Section 8-84. If the waveform is normal, continue to step b.
      - b. Compare the waveform at A8TP3 (VAR GAIN) with Figure 8-46 (waveform D, Variable Gain Amplifier Waveform). If the waveform is incorrect, perform the Range Attenuator 1 (+1, +100) Test in Section 8-77, and the Variable Gain Amplifier tests in Section 8-78. If the waveform is normal, continue to step c.
      - c. Compare the waveform at A8TP16 (BPF OUT) with Figure 8-46 (waveform E, 220 Hz Bandpass Filter Amplifier Waveform). If the waveform is incorrect, perform the Range Attenuator 2 (+1, +10, +100) Test in Section 8-79, and the 220 Hz Bandpass Filter/Amplifier Test in Section 8-80. If the waveform is normal, continue to step d.
      - d. Check for dc voltage of  $+3.13 \pm 0.06$  Vdc at A8TP10 (FLT OUT). If the voltage at A8TP10 is incorrect, perform the Synchronous Phase Detector test in Section 8-81, and the Low Pass Filters test in Section 8-82. If the voltage is normal, continue to step e.
      - e. Compare the waveform at A8TP2 (ADC IN) with Figure 8-46 (waveform F, Analog-to-Digital Converter Input Waveform). If the waveform is incorrect, perform the A/D Input Multiplexer test in Section 8-83.
- If the waveform is normal, replace A8U10, A8R53, A8R54, or A8R55.

8-70. INPUT AMPLIFIER TEST

Setup

Set the HP 11683A Range Calibrator switches as follows:

FUNCTION ..... CALIBRATE  
 POLARITY ..... NORMAL  
 RANGE ..... 100 mW  
 LINE ..... ON

NOTE

Use of the Range Calibrator for the following checks is highly preferred, because its 100 mW output allows signal levels that are easily viewable. The built in Power Reference Oscillator output is only 1 mW, and makes viewing on the oscilloscope difficult at best. Signal levels listed in the procedures assume the Range Calibrator is being used, and the instrument is zeroed and calibrated.

Procedure

1. Press POWER key to turn on the HP 5347A/48A or press Reset/Local key.
2. Press Input dbm/Watt key to enable the Power Meter mode.
3. Connect oscilloscope to A8TP5 (1st AMP).
4. Compare the waveform on the oscilloscope to Figure 8-46 (waveform G, Input Amplifier AC Signal). If the waveform is similar, the Input Amplifier section is working properly. If the waveform is not good, go to step 7.
5. Verify that the voltage at A8TP14 (AGND) is 0 volts  $\pm 500\mu\text{V}$  (microvolts). If the voltage is not correct, replace A8U9. Use the GND as ground, which is can easily be accessed at the junction of A8C51 and A8C54. Also, the ground trace area around the Input Amplifier circuits is the GND. The four screws used to retain the shield cover can be used as clip lead attach points.
6. Verify that the following conditions are found at A8TP5 (1st AMP):
  - ac voltage ..... 12 Vp-p  $\pm 1.0$  volts
  - dc offset voltage .....  $-0.9$  Vdc  $\pm 0.2$  volts (To measure this easily, switch the Range Calibrator to STANDBY.)
  - Frequency .....  $227.5 \pm 7.5$  Hz

If the signals are correct, perform the 220 Hz Multivibrator Test in Section 8-71.

If the signals are incorrect, check the following list of possible problems and causes:

- a. Voltage at A8TP5 (1st AMP) is approximately -12 Vdc; possible causes are as follows (Remove shield cover for access to circuits):

- 1) Jumper A8W1 and/or A8W2 open.
- 2) A8U9 is defective.
- 3) Open in main feedback path — A8R4, A8R5.
- 4) DC bias network bad — A8R1, A8R2, A8R3.

b. Voltage at A8TP5 is -0.9 Vdc, no ac:

- 1) Improperly adjusted or defective potentiometer A8R87 in the 220 Hz Multivibrator circuit.
- 2) Multivibrator and/or Differential Amplifier (A7U18) of the 220Hz Multivibrator section is defective. Perform the 220Hz Multivibrator Test in Section 8-71.

c. The dc voltage at A8TP5 (1st AMP) is too high:

- 1) Shorted or leaky A8C1.
- 2) DC bias network defective — A8R1, A8R2, A8R3.
- 3) A8U9 is defective.

d. The dc voltage at A8TP5 is too low:

- 1) Shorted or leaky A8C3.
- 2) DC bias network defective — A8R1, A8R2, A8R3.

### 8-71. 220 HZ MULTIVIBRATOR TEST

#### Setup

Set the HP 11683A Range Calibrator switches as follows:

FUNCTION ..... CALIBRATE  
 POLARITY ..... NORMAL  
 RANGE ..... 1 mW  
 LINE ..... ON

#### Procedure

- 1. Using the oscilloscope, check A8TP18 (220 Hz) for a square wave of  $227.5 \pm 7.5$  Hz and  $11.0$  Vp-p  $\pm 1.0$  V as shown in Figure 8-46 (waveform K). If the signal at TP18 is good, the 220 Hz Multivibrator is working properly.
- If the signal at A8TP18 (220 Hz) is not good, go to step 2.

Using a digital voltmeter, check for a voltage of  $0 \pm 0.01$  volts at A8T14 (AGND) and A8U9(5). If these voltages are correct, the A-GND circuit is operating properly. If these voltages are not  $0 \pm 0.01$  volts, check A8U9, A8Q1, A8Q2, and associated discrete components. Under normal conditions, the voltage at A8U9(7) is  $-0.7 \pm 0.1$  Vdc. Figure 8-5 shows the feedback path for the A-GND circuit.

#### Procedure

2. Remove the shield covering the Input Amplifier circuit.
1. Remove all Power Meter inputs; however, leave a sensor or Range Calibrator connected to the Sensor INPUT connector on the HP 5347A/48A. Make sure that the Range Calibrator FUNCTION switch is set to STANDBY.

#### Setup

#### 8-73. A-GROUND (A-GND) SOURCE TEST

1. A8U9 Pin 8 > +14 Vdc — If the voltage is not correct, check A8R90, A8C43, and A8U9.
2. A8U9 Pin 4 < -14 Vdc — If the voltage is not correct, check A8R91, A8C44, and A8U9.

Check for the proper voltages at the following points:

#### 8-72. POWER SUPPLY DECOUPLING TEST

Emitter = -13.4V  
Base = -12.7V  
Collector = -13.1V

#### Measurements for A8Q9:

If signals at both A8U18(1) and A8U18(14) are bad, the problem is probably transistor A8Q9 — replace A8Q9. Figure 8-46 (waveforms H and I) show signals and voltages which are present when the multivibrator is operating normally.

If A8U18(14) is good, then replace A8U18.

2. Since A8T18 (220 Hz) is the same point as A8U18(1) this output of the differential amplifier (A8U18, A8Q9) has already been determined bad. Therefore, check for a square wave of  $227.5 \pm 7.5$  Hz and  $11.0$  Vp-p  $\pm 1.0$  V at A18U18(14).

### 8-74 AUTO-ZERO DAC TEST

#### Setup

Remove all Power Meter inputs; however, leave a sensor or Range Calibrator connected to Sensor INPUT connector on the HP 5347A/48A. Make sure that the Range Calibrator FUNCTION switch is set to STANDBY.

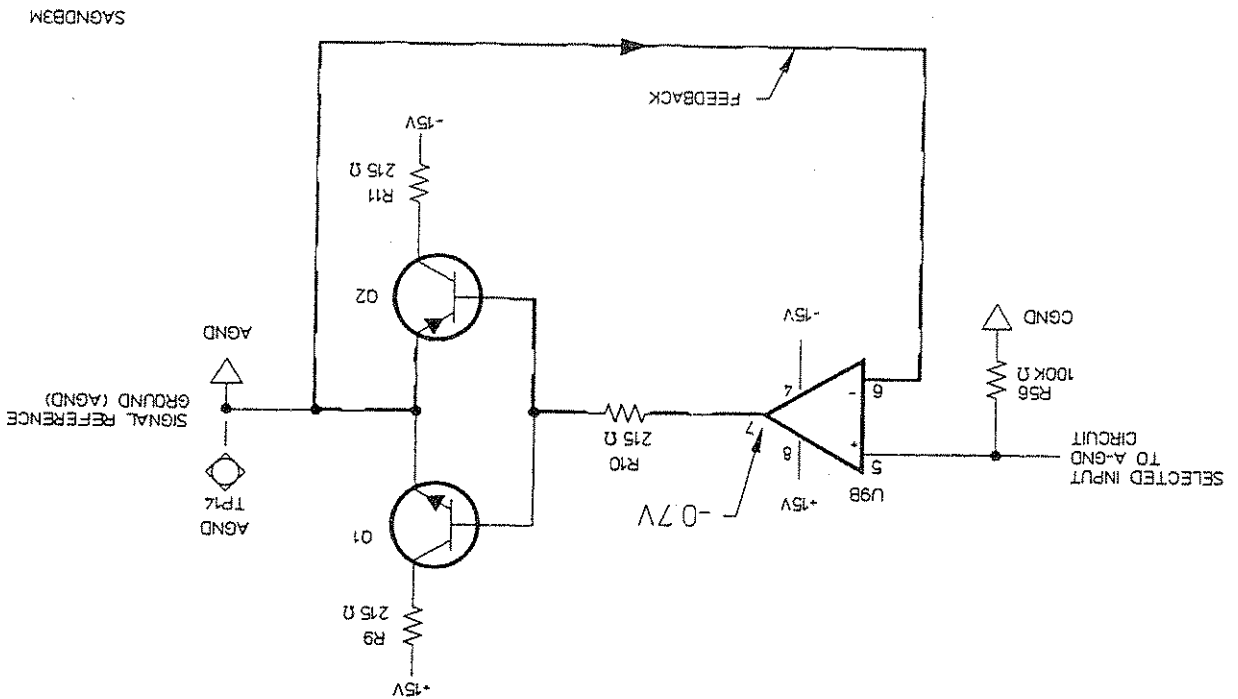
#### Procedure

Using the DVM, measure the dc voltage at A8U3(14).

If the dc level falls between -15 mV and +15 mV, the circuit is operating properly.

If the voltage does not fall within the specified range, measure the +10V REF at A8TP8. If the +10V reference voltage is  $\pm 10 \pm 0.05$  Vdc, replace Auto-Zero DAC U3.

Figure 8-5. A-GND Circuit Showing Feedback Path



SAGNDB3M

**NOTE**

Note that if a defect in the 50 MHz Reference Oscillator is isolated and repaired, the correct output level (1 mW  $\pm 0.7\%$ ) must be set by a very accurate power measurement system. Hewlett-Packard employs a special system, accurate to  $\pm 0.5\%$  and traceable to the National Bureau of Standards. When setting the power level, transfer error of  $\pm 0.2\%$  is introduced making the total error  $\pm 0.7\%$ . If a system this accurate is available it may be used to set the proper output level. Otherwise, Hewlett-Packard recommends returning the HP 5347A/48A to the nearest service facility. Contact your nearest HP Sales and Service office for more information.

**Setup**

1. Disconnect the cable to A8J3.

2. Turn on the 50 MHz Power Reference Oscillator by executing the HP-IB Command OUTPUT ZXX;"LN;OC1" — where XX is the instrument's HP-IB address number, selected via the rear panel HP-IB switches. This command sets the Power Meter's A8U2(19), CALOSC line to a TTL high, enabling the 50 MHz Power Reference Oscillator circuit.

**Procedure**

1. Remove the shield cover in the 50 MHz Power Reference Oscillator section. Verify the presence of +15V0 at the junction of A8L3 and A8 C30, and -15V0 at the junction of A8L4 and A8C31.

If the -15 Vdc supply is not correct, go to the Power Reference Switch Test in Section 8-76.

2. Check for an output of  $-3V \pm 2.0$  volts at A8TP17 (CTL). If the voltage is incorrect the ALC loop is not operating properly, go to step 5. (Make sure the oscillator is turned on via execution of HP-IB command OUTPUT ZXX;"LN;OC1".)
3. Using the HP 437A Power Meter and the 90°-SMB (female) to BNC (male) adapter cable (HP P/N 05350-60121 in the Service Accessories Kit) with adapters for the sensor, measure  $1 \text{ mW} \pm 0.7\%$  at A8J3. If correct, the cable of J3 to the Power Ref OUTPUT of the Power Meter may be suspect.

If power measured is correct, go to step 5.

4. Using the HP 5384A Counter, measure  $50 \pm 0.20$  MHz at A8J3. Use an oscilloscope to observe if the output frequency has modulation or spurious signals. If modulation and spurious signals were observed, A8R80, A8R79, A8R78, or A8C62 of the ALC Loop circuit might be detected.

1. Monitor the collector of A8Q7 with an oscilloscope or DVM, and observe a voltage of  $-14.8V \pm 0.2V$ .
2. Now, execute HP-IB command OUTPUT 7XX;"LN;OC0" — where XX is the instrument's HP-IB address number, selected via the rear panel HP-IB switches. Observe a voltage of  $0.5 \pm 0.1V$  at the collector of A8Q7. If the correct voltage is observed at the collector of A8Q7, continue with step 2 of the 1mW 50 MHz Power Reference Oscillator Test in Section 8-75 (Be sure to execute the OUTPUT 7XX;"LN;OC1" HP-IB command before performing step 2 in Section 8-75).
3. Use the oscilloscope or DVM to monitor the TTL control signal at A8TP21 (OSC OFF).  
If the voltage at A8Q7 is incorrect, go to step 3.
4. Observe that A8TP21 (OSC OFF) is a TTL low (0.0V) with the 50 MHz Power Reference Oscillator OFF.  
If the voltage level at TP21 is incorrect, replace U2.

Procedure

8-76. POWER REFERENCE SWITCH TEST

- |    |   |
|----|---|
| a. | A8U17B(5,6) = $0.0 \pm 0.0005V$   |
| b. | A8U17B(7) = $+4.4 \pm 0.1V$   |
| c. | A8Q4 Emitter = $-7.3 \pm 0.5V$<br>Base = $-6.6 \pm 0.5V$<br>Collector = $-6.3 \pm 0.5V$                             |
| d. | A8TP19 (PWR REF) = $4.5 \pm 1V$   |
| e. | A8U17A(2,3) = $4.0 \pm 0.2V$  |
| f. | A8U17A(1) = $-2.8 \pm 0.2V$   |
| g. | A8TP17 (CTL) = $-3 \pm 0.2V$  |
| h. | A8Q5 Emitter = $-10.5 \pm 0.5V$ at A8R83<br>Base = $-9.8 \pm 0.5V$ at A8C35<br>Collector = $0.0 \pm 0.05V$ at A8C37 |

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Use the side of A8R71 that connects to RGND as the ground when checking the voltages below.

---

NOTE

5. If the above components are good, perform the dc voltage checks for A8U17 and A8U19 as shown below:



1. Execute HP-IB command OUTPUT ZXX;"LN; RA" to set the instrument to Auto Range.
2. Using the HP 11683A Range Calibrator, apply a 1 mW input to the Sensor INPUT connector on the HP 5347A/48A by switching the Range Calibrator FUNCTION switch to CALIBRATE.

## Setup

## 8-78. VARIABLE GAIN AMPLIFIER TEST

6. After replacing A8U14, recheck voltages at A8TF10 and TP20. If the voltages are still incorrect, replace A8R16 and A8R17.
5. Monitor the voltage at A8TF20 or A8U12(3). It should be  $50 \pm 5$  mV (5V + 100). If voltage at A8TF20 is incorrect, replace A8U14.
4. Execute HP-IB command OUTPUT ZXX;"LN; RM4". This command activates the Divide-by 100 Attenuator.
3. Measure the voltage at TP20 (ATTN 1) or A8U12(3). If this voltage is not equal to the voltage at the +5V junction of C58/L9 ( $\pm 0.01$  volts), replace A8U12.
2. Connect a jumper from the +5V junction of C58/L9 to A8U12(2). This voltage will serve as a test signal to check the attenuation action of the Attenuator circuits.
1. Measure the +5 volt supply at A8C58 and A8L9 junction of the Power Supply Decoupling circuit. Use A8TF1 (DGND) as ground.

Use a Digital Voltmeter (DVM) to measure the voltage levels in the following steps.

## Procedure

2. Execute HP-IB command OUTPUT ZXX;"LN;RM3". This string of commands puts the HP 5347A/48A into the Power Meter mode and selects Manual Range 3, which activates the Divide-by 1 Attenuator.
1. Remove all Power Meter inputs; however, leave a sensor or Range Calibrator connected to the Sensor INPUT connector on the HP 5347A/48A. If using the Range Calibrator, set FUNCTION to the STANDBY position.

## Setup

## 8-77. RANGE 1 ATTENUATOR (Divide-by 1, Divide-by 100) TEST

If the voltage is correct check and replace Q7, Q8, and associated components as needed. Return to step 2 in this section (Section 8-76).

5. Execute HP-IB command OUTPUT ZXX;"LN;OC1", and observe a TTL high.

**NOTE**

Values shown below are typical with a 1 mW input if the instrument is zeroed and calibrated.

If using a the 1 mW, 50 MHz Power Reference Oscillator OUTPUT on the HP 5347A/48A, connect an appropriate sensor to it. Execute the HP-IB command OUTPUT 7XX;"LN;OCI" to turn on the reference oscillator.

1. Measure the ac voltage with a DVM at A8TP3 (VAR GAIN) and divide it by the ac voltage at A8TP20 (ATTEN 1). If the calculated value is between 23 and 30, the circuit is operating properly.

2. If the gain is not between 23 and 30, replace A8U8.

3. If the gain still is not correct, replace A8U13.

**8-79. RANGE 2 ATTENUATOR (Divide-by 1, Divide-by 10, Divide-by 100) TEST**

**Setup**

1. Remove all Power Meter inputs; however, leave a sensor or Range Calibrator connected to the Sensor INPUT connector on the HP 5347A/48A. If using a Range Calibrator, set FUNCTION to the STANDBY position.

2. Execute the HP-IB command OUTPUT 7XX;"LN;RM1" to put the HP 5347A/48A in the Power Meter mode, and select Manual Range 1. The Divide-by 1 Attenuator is activated when Manual Range 1 is selected.

**Procedure**

Use a Digital Voltmeter (DVM) to measure the voltage levels in the following steps.

1. Measure the +5 volt supply at A8C58 and A8L9 junction of the Power Supply Decoupling circuit. Use A8TP1 (DGND) as ground.

2. Connect a jumper from the +5V junction of C58/L9 to A8U12(11). This voltage will serve as a test signal to check the attenuator action.

3. Measure the voltage at A8TP12 (ATTEN 2). If this voltage is not equal to the voltage of the +5V junction of C58/L9 ( $\pm 0.01V$ ), replace A8U12.

4. Execute HP-IB command OUTPUT 7XX;"LN;RM4". This activates the Divide-by 10 Attenuator.

5. Measure the voltage at A8TP12 (ATTEN 2). If this voltage is not equal to the voltage at A8U12(11) divided by  $10 \pm 0.01$  volts, replace A8U12, A8R24, A8R25, or A8R26.

Using the HP 11683A Range Calibrator, apply a 1 mW input to the Sensor INPUT connector on the HP 5347A/48A. Make sure that the Range Calibrator FUNCTION switch is set to CALIBRATE.

## Setup

## 8-81. SYNCHRONOUS PHASE DETECTOR TEST

Check the ac gain of the second half of the circuit, which should be equal to the voltage at A8TP16 divided by the voltage at A8U15(14). The gain should equal  $10.7 \pm 0.8$ . Isolate failed parts as necessary.

Check the ac gain of the first half of the circuit. This is equal to the voltage at A8U15(14) divided by the voltage at A8TP12. The gain should equal  $15.1 \pm 1.1$ . If the gain is incorrect, use the schematic diagram in *Figure 8-46* to help isolate failed parts.

2. If after replacing A8U15, the gain is still not correct, check the midpoint gains of the circuit to isolate failed resistors or capacitors.

If there is NO signal at A8TP16 (BPF OUT) or the ac gain of the circuit does not fall within the specified range, replace A8U15.

1. Using an oscilloscope, Measure the ac gain of the 220 Hz Bandpass Filter Amplifier circuit. The gain is equal to the amplitude at A8TP16 (BPF OUT) (about 6.50 volts) divided by the amplitude at A8TP12 (ATTEN 2) (about 40.0 millivolts). The gain should be about  $162 \pm 16$ .

---

*Values shown below are typical with a 1 mW input if the instrument is zeroed and calibrated.*

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## NOTE

## Procedure

3. Execute HP-IB command OUTPUT 7XX;"LN;RA" to set the instrument to Auto Range operation.
2. Zero and calibrate the instrument.
1. Using the HP 11683A Range Calibrator, apply a 1 mW input to the Sensor INPUT connector on the HP 5347A/48A. Make sure that the Range Calibrator FUNCTION switch is set to CALIBRATE.

## Setup

## 8-80. 220 HZ BANDPASS FILTER AMPLIFIER TEST

7. Measure the voltage at A8TP12 (ATTEN 2). If this voltage is not equal to the voltage at A8U12(11) divided by  $100 \pm 0.01$  volts, replace A8U12, A8R25, or A8R26.

6. Execute HP-IB command OUTPUT 7XX;"LN;RM5". This activates the Divide-by 100 Attenuator.

**NOTE**

Values shown below are typical with a 1 mV input if the instrument is zeroed and calibrated.

1. Using the oscilloscope, compare the waveform at A8TP15 (PHS DET) to Figure 8-46 (waveform J, Synchronous Phase Detector Output Waveform).
2. The peak-to-peak (p-p) amplitude of the waveform at A8TP15 (PHS DET) should be equal to the peak amplitude of the signal at A8TP16 (BPF OUT). Typical p-p amplitude at TP15 is between 3.2 to 3.4 volts, and the typical p-p amplitude at TP16 ranges from 6.4 to 6.8 volts.

If the signals are correct, the circuit is operating properly. If the signals are incorrect, go to step 3.

3. If the p-p amplitude at A8TP15 does not equal half the p-p amplitude at A8TP16, check A8R34, A8R35, and A8R36. Replace as necessary.

If the signal appears to be only halfwave rectified, check for an open A8R34.

4. If the signal at A8TP15 (PHS DET) is equal to the signal at A8TP16 (BPF OUT), compare the waveform at A8TP18 (220 Hz) with Figure 8-46 (waveform K, A8TP18 (220 Hz) 220 Hz Waveform).

If the signal is incorrect, perform the 220 Hz Multivibrator Test in Section 8-71.

5. Compare the signal at A8U15(5) to Figure 8-46 (waveform L, Phase Detector Control Waveform).

If the signal is correct, check for an open A8R34. If the signal is incorrect, check the collectors of the 220 Hz Multivibrator — A8U18(1,14). The signal should be similar to Figure 8-46 (waveform H).

If the signals are incorrect, replace A8U18.

**8-82. LOW PASS FILTERS TEST**

**Setup**

Remove all Power Meter inputs; however, connect a Range Calibrator to the Sensor INPUT connector on the HP 5347A/48A. If using a Range Calibrator, set FUNCTION to the STANDBY position.

**Procedure**

1. Select Low Pass Filter "Fast" filter by executing the HP-IB command LN; RMA3. This command should cause a TTL low at A8U14(9).

10. Verify that the voltages at A8TP11 (FST FLT) and A8TP9 (SLO FLT) are approximately equal to 0.6 times the peak voltage at A5TP15 (PHS DET)  $\pm 0.3$  volts.
- Make sure the 1 mW input signal is applied to the Sensor INPUT connector on the HP 5347A/48A for the following checks.

*At this point, the Filter Output Select circuit has been fully verified. The following steps specifically check the Slow and Fast filter circuits.*

### NOTE

9. Remove the jumper from A8TP11 (FST FLT) and verify there is no change in the voltage at A8TP10. If moving the jumper causes a change in the voltage at A8TP10, replace U14.
8. Select Slow filter by executing HP-IB command OUTPUT 7XX;"LN;RM2". Note the voltage at A8TP10 (FLT OUT), because it will be compared in the next step.
7. Connect a jumper from the +5 volt supply junction of C58/L9 to A8TP11 (FST FLT) and measure the voltage at A8TP10. If the voltage is equal to  $8.4 \pm 0.4$  Vdc, go to step 8.
6. Remove the jumper from A8TP9 (SLO FLT) and verify there is no change in the voltage at A8TP10 (FLT OUT). If moving the jumper causes a change in the voltage at A8TP10, replace A8U14. (This test checks for CMOS switch leakage or other problems.)
5. Select Fast filter by executing HP-IB command OUTPUT 7XX;"LN;RM3" — where XX is the instrument's HP-IB address number, selected via the rear panel HP-IB switches. Note the voltage at A8TP10 (FLT OUT), because it will be compared in the next step.
4. Check the voltage at A8U16(3). If the voltage at pin 3 is equal to the +5 volt supply, replace A8U16, A8R46, or A8R45. If the voltage is still incorrect, replace A8U14.
3. Connect a jumper from the +5 volt supply junction of C58/L9 to A8TP9 (SLO FLT) and measure the dc voltage at A8TP10 (FLT OUT). The voltage should be  $8.4 \pm 0.4$  Vdc. If the voltage at TP10 is incorrect, go to step 4.

*At this point, the control lines for the Filter Output Selection circuit have been verified. The following steps will verify that the filter selection circuit will pass and block a signal.*

### NOTE

2. Select Low Pass Filter "Slow" filter by executing HP-IB command LN;RM2. This command should cause a TTL low A8U14(8). If the Fast and Slow filter control signals in step 1 or 2 are incorrect, replace A8U2, A8U1, and recheck the signals.

1. Check for a TTL waveform at A8U14(1). If no signal is present, run Diagnostic 72 (use the procedure described in Section 8-66, Diagnostic 72 Tests and Actions). If PIA failure is indicated, replace A7U7.
  2. Check for  $+2.5 \pm 0.02$  Vdc at A8U11(8). If the voltage at pin 8 is incorrect, check for  $\pm 0.05$  Vdc at A8U7(6). If the voltage at pin 6 is incorrect, replace A8U7 or A8U11.
- If voltage is correct at A8U11(8), continue to step 3.

---

*Values shown below are typical with a 1 mW input if the instrument is zeroed and calibrated.*

---

**NOTE**

Procedure

Using the HP 11683A Range Calibrator, apply a 1 mW input to the Sensor INPUT connector on the HP 5347A/48A. Make sure that the Range Calibrator FUNCTION switch is set to CALIBRATE.

Setup

**8-84. VOLTAGE REFERENCES AND A/D RAMP GENERATOR TEST**

1. Compare the waveform at A8TP2 (ADC IN) with Figure 8-46 (waveform M, Analog/Digital Converter Input).
2. The peak-to-peak amplitude of waveform O should be equal to the dc voltage at A8TP10 (FLT OUT).
3. If the voltage is not as indicated in step 2, replace A8U5.

---

*Values shown below are typical with a 1 mW input if the instrument is zeroed and calibrated.*

---

**NOTE**

Procedure

Using the HP 11683A Range Calibrator, apply a 1 mW input to the Sensor INPUT connector on the HP 5347A/48A. Make sure that the Range Calibrator FUNCTION switch is set to CALIBRATE.

Setup

**8-83. A/D INPUT MULTIPLEXER TEST**

If the voltage is incorrect at only one of the test points, A8TP11 or A8TP9, the problem is more likely to be with the resistors and capacitors associated with the defective filter. If the voltages at A8TP11 and A8TP9 are incorrect, replace A8U16.

1. Verify that the keyboard's flat ribbon cable (keyboard to motherboard cable) is not loose.
2. Verify that the A1 Keyboard/Display Logic Block is operating properly by performing the troubleshooting procedures in Section 8-56.

To troubleshoot this assembly, perform the following:

The A10 Membrane Keyboard Assembly is supported on a throw-away basis when it is determined that it is bad.

### 8-86. A10 MEMBRANE KEYBOARD ASSEMBLY TROUBLESHOOTING

1. Verify that the keyboard's flat ribbon cable (keyboard to motherboard cable) is not loose.
2. Verify that the +5V is present at the A9 Display/Driver Assembly by measuring at A9J1 (connector with a red and black wire leading to it). If +5V is verified, replace the A9 Assembly as described in the disassembly and reassembly procedure in Section 8-93.

If the LCD is not operating properly, proceed as follows:

- Power-Up Self Check Display Test fails.
- The Liquid Crystal Display (LCD) is missing segments during a display test or does not operate at all.

Possible symptoms if A9 Assembly is faulty are as follows:

The A9 Display/Driver Assembly is supported on a throw-away basis when it is determined to be bad. Perform the following checks to determine if the A9 Assembly is bad.

### 8-85. A9 DISPLAY/DRIVER ASSEMBLY TROUBLESHOOTING

3. Check for +10 ±0.05 Vdc at A8TP8 (+10V REF). If voltage is incorrect, replace A8Q3, A8R118, or A8U11.
  4. Compare the waveform at A8U14(1) with Figure 8-46 (waveform N, Ramp Generator Gate Waveform). If the waveform is not present, replace A8U11 or A8U14.
  - HINT:* To view a stabilized waveform, trigger the waveform at A8U14(1) to the Signal at A8TP7 (RAMP).
  5. Compare the waveform at A8TP7 (RAMP) with Figure 8-46 (waveform O, Analog to Digital Converter Ramp Waveform).
- If the signal is correct, the Ramp Generator is operating properly. If the signal is incorrect, replace A8U11, A8R52, or A8C23.

If there is no problem found after performing the steps above, but a problem still exists in the keyboard, replace the A10 Membrane Keyboard Assembly by following the disassembly and reassembly instructions in Section 8-94.

## 8-87. A11 HP-IB INTERFACE ASSEMBLY TROUBLESHOOTING

Possible symptoms that may be seen if the A11 HP-IB Interface Assembly is faulty are as follows:

- HP 5347A/48A does not recognize the HP-IB during the Power-Up Self Test.
- HP 5347A/48A will not respond to any of the HP-IB commands.

Diagnostic 80 (HP-IB Verification) can be used to determine if the HP-IB processor is able to respond to the main processor. This diagnostic cannot determine if all of the HP-IB Interface circuits are functioning properly.

If Diagnostic 80 fails and the counter passes all other diagnostics, verify that the ribbon cable, A11J2W1 is properly seated in its motherboard connector, A1J7.

Verify the following voltages on the A11 Assembly:

SIGNAL NAME	TEST POINT	RANGE
+5V	+5 (TP1)	+4.75 to +5.25 V
+5V CMC	U2, pin 24	+4.75 to +5.25V

For problems involving a particular controller, it is recommended that a 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 Verification program found in Section 4 for HP 9000 series 200 or 300 Desktop Computers. The HP-IB Verification program is available on floppy discs 05348-13502 (5 1/4-inch) or 05348-13501 (3 1/2-inch). Also verify that the controller interface is functioning properly.

Install the A11 assembly into the instrument and reset the A11S1 DIP switch to its original setting. Enter the following program into an HP Desktop Computer and connect the HP-IB interface to the HP 5347A/48A. 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

```

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.



**8-88. A12 MICROWAVE MODULE TROUBLESHOOTING (U1 SAMPLER)**

Possible symptom that may be seen if the A12 Assembly is faulty is as follows:

- Counter portion of the HP 5347A/48A will not measure an input of proper frequency and level at INPUT 1.

There are no diagnostics available which directly test the A12 Microwave Assembly or the U1 Sampler.

Verify that all the following tests and diagnostics return a "PASS" indication before attempting to troubleshoot the Microwave Module.

Points to consider when troubleshooting the Microwave Module:

- 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 IM2 oscilloscope probe does not have the required 400 MHz bandwidth, resulting in inaccurate signal level measurements.

Refer to Section 8-92 for the Microwave Module disassembly procedures and remove the cover of the Module, and verify the following power supply voltages:

SUPPLY NAME	A12 TEST POINT	ACCEPTABLE RANGE
-5V	feedthrough pin with blue wire attached	-4.85 to -5.35V
+5V SW	feedthrough pin with yellow wire attached	+4.75 to +5.25V
+13V SW	feedthrough pin with red wire attached	+12.35 to +14.50V

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 diagnostic test signal enters the main signal path.

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.

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  $\pm 3$  dB across the range of 10 MHz to 175 MHz at a level between -21 and -26 dbm.
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 by executing the HP-IB command `OUTPUT 7XX;"MANUAL,770E+6"`.
2. Connect the BNC end to the spectrum analyzer and set the spectrum span to 20 MHz per input attenuation and a -10 dbm reference level. Set the frequency span to 20 MHz per division.
1. Disconnect the IF OUTPUT A6W1 cable and connect the SMB to BNC adapter to the IF OUTPUT of the A12 Assembly.

Verify the IF OUTPUT signal as follows:

5. Set the counter to Diagnostic 52 (LO Sweep  $275.0 > 375.0$  MHz) and verify that the signal sweeps across the entire display (275 MHz to 375 MHz) and is level at  $+14 \pm 1$  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.
4. Center the output on the spectrum analyzer display with a frequency span of 10 MHz per division.
- where XX is the instrument's HP-IB address number, selected via the rear panel HP-IB switches.

```
OUTPUT 7XX;"DIAGENT,DIAG,51"
OUTPUT 7XX;"DIAGPARM,325"
```

3. Set the HP 5348A to Diagnostic 51 (LO Verification, User-Entered Frequency) and set the LO frequency to 325.0 MHz via the HP-IB (cannot be done from front panel). Execute the following HP-IB commands:
2. Set the spectrum analyzer for 30 dB input attenuation with a 20 dbm reference level.
1. Connect the SMB to BNC adapter to the A12 end of W2. Connect the BNC end of the adapter to a spectrum analyzer.

Verify the output of the A5 Synthesizer Assembly as follows:

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

4. Display/Driver Module removal and installation (Section 8-93)
3. Microwave Module disassembly (Section 8-92)
2. Front panel assembly removal (Section 8-91)
1. Cover removal (Section 8-90)

The following procedures are divided into four categories, as follows:

### 8-89. DISASSEMBLY AND REASSEMBLY

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, Section 8-92.

Set the counter to Manual mode with a 1 GHz Manual Center Frequency via HP-IB. Apply a 1 GHz, 0 dBm signal to INPVT 1. Using the 1120A active probe with the standard tip, compare the outputs of Q1, U1, and U2 with waveforms B, C, and D in *Figure 8-49*. 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.

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.

To check the IF preamplifier network, proceed as follows:

1. Check the bias voltage at the R8-R9 node. This voltage should be at about +13V. 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 waveform A in *Figure 8-49*. 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.

To check the LO amplifier network, proceed as follows:

1. Turn the HP 5347A/48A off.
2. Remove ac line power cord from rear panel power module.

Before performing any disassembly or reassembly procedures, the following steps must be performed:

- Large (2 point) Pozidriv screwdriver.
- Small (1 point) Pozidriv screwdriver.
- Needle-nose pliers.
- 1/4-inch open-end wrench.
- 1/16-inch Allen driver.
- 5/16-inch open-end wrench.
- 5.5 mm hex nut driver.
- Small flat-bladed screwdriver.

The following tools are required for these procedures:

---

*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 Section 8-8.*

---

**CAUTION**

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 6, Replaceable Parts, for exploded views of all instrument assemblies discussed in the following procedures.

Replacing the A12 Microwave Assembly or the UI 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.

## 8-90. Cover Removal

Perform the following procedure to remove the cover and optional battery pack (if present):

### WARNING

WHEN THE COVER IS REMOVED FROM THE HP 5347A/48A, LINE VOLTAGES ARE EXPOSED WHICH ARE DANGEROUS AND MAY CAUSE SERIOUS INJURY IF TOUCHED. DISCONNECT POWER.

1. Turn the HP 5347A/48A off, remove all power connections, and be sure any cables or adapters are removed from front panel.
2. If the Option 002 Battery Pack is present, temporarily remove the pack by performing the following:

- a. Loosen two screws that hold rear panel's battery compartment door in place, and remove door. The screws are retained in the door. To remove the battery, tip front of instrument slightly. Battery will slide out.

- b. Obtain the battery's protective cap or other protective device, and place it on the terminal end of the battery pack to protect the battery from short circuits. Retain the protective device with rubber band or tape if necessary.

3. Stand HP 5347A/48A on its front handles, and loosen recessed Pozidriv screw located in center of each rear foot. The screws are retained in the feet.

4. Slide the cover off the chassis from the rear. You may have to gently tap, with your hands, the sides of the cover to enable the cover to slide off the chassis.

## 8-91. Front Panel Assembly Removal

To remove the front panel assembly from the instrument (see *Figure 6-1*), proceed as follows:

1. Remove the cover as described in Section 8-90.
2. Turn the HP 5347A/48A over so the bottom faces up.
3. Loosen semi-rigid coax nuts at the Microwave Module and Front Panel Microwave connector. Carefully remove entire coax assembly.
4. From the bottom side of the instrument, remove Power Meter Sensor INPUT connection at edge of A8 Power Meter Analog Assembly.
5. Now, disconnect the Power Meter Reference Output cable, W6 (00438-60026), from Power Meter Analog Assembly.
6. Turn the HP 5347A/48A top side up. Remove four Pozidriv screws at corners of Front Panel.

1. Remove the cover as described in Section 8-90.
2. Remove the semi-rigid coax line between the Front Panel connector and the Microwave Module.

The following procedure describes how to disassemble the Microwave Module without removing the front panel assembly (see Figure 6-2). Proceed as follows:

---

**AVOID touching component leads.**

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

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

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

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

---

**CAUTION**

**8-92. A12 Microwave Module Disassembly**

- To replace the Front Panel/A10 Membrane Keyboard assemblies, perform the procedure in Section 8-94.
7. Ease Front Panel clear of chassis by 1/2 inch. DO NOT pull on remaining cables.
  8. Disconnect remaining cables:
    - Four wire cable, W3 (05350-60122), at rear of A9 Display/Driver Assembly.
    - Low Frequency input cable, W1 (8120-5254).
    - Keyboard ribbon cable at A1 Motherboard Assembly (squeeze ears on connector and pull up to release cable).
    - External Reference Input connector cable, W8 (8120-5305), at A1 Motherboard Assembly side.
  9. Place Front Panel Assembly on its handles for ease of subsequent work.
  10. To reinstall the Front Panel Assembly, reverse the steps executed for the removal of the assembly.
- To replace the Front Panel/A10 Membrane Keyboard assemblies, perform the procedure in Section 8-94.

- 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
  - 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 re-use the old screws, because the self locking feature has been degraded.
- 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:

### A12 MICROWAVE MODULE/U1 SAMPLER REASSEMBLY.

10. 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.
9. 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.

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

### CAUTION

3. Remove the two screws on the top of the Microwave module cover, and pull the cover away from the module.
  4. At the rear of the module, carefully remove the connecting cables.
  5. Remove the two screws that can be seen through the holes in A12 Microwave Assembly. Remove A12 Assembly.
  6. Loosen and remove the nut and lockwasher on the semi-rigid connector on the backside of U1 Sampler, using the 5/16-inch wrench.
  7. Remove the two nuts and lockwashers from the SMB connectors, using the 1/4-inch wrench.
  8. CAREFULLY push A12 Assembly up and out of the module bottom cover by pressing on the SMB connectors, taking care not to bend the pins of the four feedthrough capacitors which are plugged into pin sockets on A12 Assembly.
- BE CAREFUL, not to lose the plastic spacer (MP36) which fits around the sampler SMA connector, between the A12 Assembly and the bottom cover.

1. Remove cover as described in Section 8-90.

To remove the Display Module, proceed as follows (see Figure 6-1):

---

*The Display Module is not a repairable assembly. A replacement Display Module assembly (HP P/N 05350-60123) is available from the factory. Refer to Section 6 for ordering information.*

---

**NOTE**

**AVOID touching circuit traces and component leads.**

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

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

**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.**

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

**CAUTION**

**8-93. A9 Display/Driver Module Removal And Installation**

- Blue (top feedthrough) — -5V
- Yellow (bottom feedthrough) — +5V
- Gray (top feedthrough) — Ground
- Red (bottom feedthrough) — +13V

- Be sure that the Microwave Module dc power cable is connected correctly to the four feedthrough capacitor leads between the two SMB connectors, as follows:
  - 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 to tighten the hex nuts snugly (about 8-10 inch pounds).
- 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.
- not to bend the leads of the capacitors when installing the board. Check at the back of each of the sockets for visual indication of the four feedthrough capacitor leads.



- External Reference Input connector
- INPUT 1 connector
- INPUT 2 connector
- Power Ref OUTPUT connector
- Sensor INPUT connector.
- A9 Display/Driver Assembly

2. Remove the following parts from old assembly (see *Figure 6-1*):
  1. Order 05348-67004 Assembly, which is the replacement Front Panel/A10 Keyboard Assembly.

Thus, to replace the assembly, perform the following:

The membrane Keyboard is not repairable or replaceable as an individual item; it is glued to the Front Panel bezel with very strong adhesive. Thus, in event that a Keyboard failure or damage to the Front Panel Assembly requires replacement, a new Front Panel/A10 Keyboard Assembly must be installed.

#### 8-94. A10 Membrane Keyboard/Front Panel Removal and Installation

1. Check the display window (MP35) to be sure it is clean, and located properly in the MP21 sub-panel.
  2. Slide the Display Module and attached shield down over the four studs on the sub-panel.
  3. 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.**
  4. This completes the Display Module installation. The Front Panel Assembly can now be installed back into the instrument. Reverse the steps in Section 8-91.
- To install a replacement Display Module into the front panel assembly, proceed as follows:

1. Pull the Display Module, up off of the rivet-on studs.
2. Remove the Front Panel Assembly from the instrument as described in Section 8-91.
3. Remove four nuts (H11) and lockwasher (H21) from the back of the Display Module with a 5.5 mm nut driver. Also, remove the ground lead from the Power Sensor connector.

1. Remove cover as described in Section 8-90, and Front Panel Assembly as described in Section 8-91.
2. Remove all plug-in Printed Circuit (PC) boards (or assemblies), the battery, and the HP-IB Interface Assembly.
3. Remove one screw at side securing IF and Synthesizer housing to side frame (see *Figure 6-1*).
4. Remove all connections between A1 Assembly and any other components: such as, fan, AC input connector, Microwave Module, and battery box.
5. Remove 12 Pozidriv retaining screws.
6. Lift out A1 Assembly.
7. Reverse instructions to reinstall A1 Assembly.

**8-96. A1 Motherboard Assembly Removal**

1. Remove cover as described in Section 8-90, and Front Panel Assembly as described in Section 8-91.
2. Remove flat ribbon cable (W7) at front edge of A8 Power Meter Analog Assembly and A1 Motherboard Assembly (see *Figure 6-1*).
3. Remove two Pozidriv screws at rear edge of A8 Assembly.
4. Swing out A8 Assembly to expose the hinges, and remove Pozidriv screw from each hinge.
5. Remove A8 Assembly.
6. Reinstall A8 Assembly by reversing the steps.

**8-95. A8 Power Meter Analog Assembly Removal**

3. Transfer all the previously mentioned connectors to the new Front Panel Assembly.
4. Transfer the Display/Driver Assembly to the new Front Panel Assembly. Be sure to reconnect the ground lead from the Power Sensor connector to the Display/Driver Assembly.
5. Install the new Front Panel Assembly as described in Section 8-91.

**WARNING**

**WHEN THE COVER IS REMOVED FROM THE HP 5347A/48A, LINE VOLTAGES ARE EXPOSED WHICH ARE DANGEROUS AND MAY CAUSE SERIOUS INJURY IF TOUCHED. DISCONNECT POWER.**

8. Turn the HP 5347A/48A off, and remove all power connections.
9. If the Option 002 Battery Pack is present, temporarily remove the pack by performing the following:
  - a. Loosen two screws that hold the rear panel battery compartment door in place, and remove door. The screws are retained in the door.
  - b. Tip front of instrument up to slide out battery pack.
  - c. Obtain the protective plastic cap or other protective device, and place the protective device on the terminal end of the battery to prevent accidental shorting. Retain the protective device with rubber band or tape if necessary.
10. Remove the cover by performing the following:
  - a. Be sure any cables or adapters are removed from front panel.
  - b. Stand HP 5347A/48A on its front handles, and loosen recessed Pozidriv screw located in center of each rear foot. The screws are retained in the feet.
  - c. Slide the cover off chassis from the rear. You may have to gently tap, with your hands, the sides of the cover to enable the cover to slide off the chassis.
11. Disconnect the HP-IB Interface Assembly's cable from A115, located on A1 Motherboard Assembly.
12. Remove screw that goes through the HP-IB Assembly and into the standoff on the motherboard.
13. Remove the two black standoff studs and lockwashers that attached the HP-IB Assembly to rear panel.
14. Pull and remove HP-IB Interface Assembly.
15. Reverse steps to reinstall assembly.

## 8-98. Option 002 Battery Pack Removal and Installation

If it becomes necessary to replace the battery pack, use only another Hewlett-Packard Option 002 Battery Pack (HP Part Number 05348-60206). The battery pack must always be charged upon initial installation. Refer to Appendix A of the Operating and Programming Manual for detailed information on battery care, usage, storage, and charging.

Installation of the battery pack is described in the following procedure.

### CAUTION

Use of any batteries other than the Hewlett-Packard Option 002 Battery Pack (HP P/N 05348-60206) may result in damage to your instrument.

To install or replace the NiCad battery pack use the following procedures:

1. Turn the HP 5347A/48A off, and remove all power connections.
2. Loosen two screws that hold the rear panel battery compartment door in place, and remove door. The screws are retained in the door. To remove the existing battery, if one is installed, tip front of instrument up slightly. Battery will slide out.
3. Obtain the protective cap or other protective device and place the protective device on the terminal end of the battery pack to protect it from short circuits. Retain the protective device with rubber band or tape if necessary.

4. The new battery pack is supplied in a shipping carton and should have a plastic cap over the terminal end. BEFORE installation, remove this cap and save it for subsequent re-use when the battery is removed from the instrument.

5. Note that the back wall of the battery compartment has a connector strip mounted to it. There are two contacts on the right side of the connector that must make contact with the two exposed terminals on the battery pack. Insert the battery pack in such a way that the battery terminals meet the contacts. The pack is correctly installed if the label on the pack is visible.

6. Reinstall battery compartment door, and tighten holding screws.
7. Perform the battery charging procedure in Appendix A of the Operating and Programming Manual.

### NOTE

All Option 002 Battery Packs may be discharged when shipped.

The following pages describe the operation of the HP 5347A/48A. 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 and power meter operations are described, showing the function and relationships of the major assemblies (A component level description for each field repairable board assembly is provided, beginning at Section 8-160.)

8-100. HARMONIC HETERODYNE TECHNIQUE

The microwave frequency counter portion of the HP 5347A/48A 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.

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  $N$ th harmonic of an accurately known local oscillator frequency,  $f_{LO}$ , such that the difference frequency,  $f_{IF}$  (defined as  $f_x - N \cdot f_{LO}$  if  $f_x < N \cdot f_{LO}$ , or as  $N \cdot f_{LO} - f_x$  if  $f_x > N \cdot f_{LO}$ ), 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  $N$ th multiple of the local oscillator frequency to determine the input frequency.

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,  $N \cdot f_{VCO}$ , 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 ( $f_x = N \cdot f_{VCO}$ ).

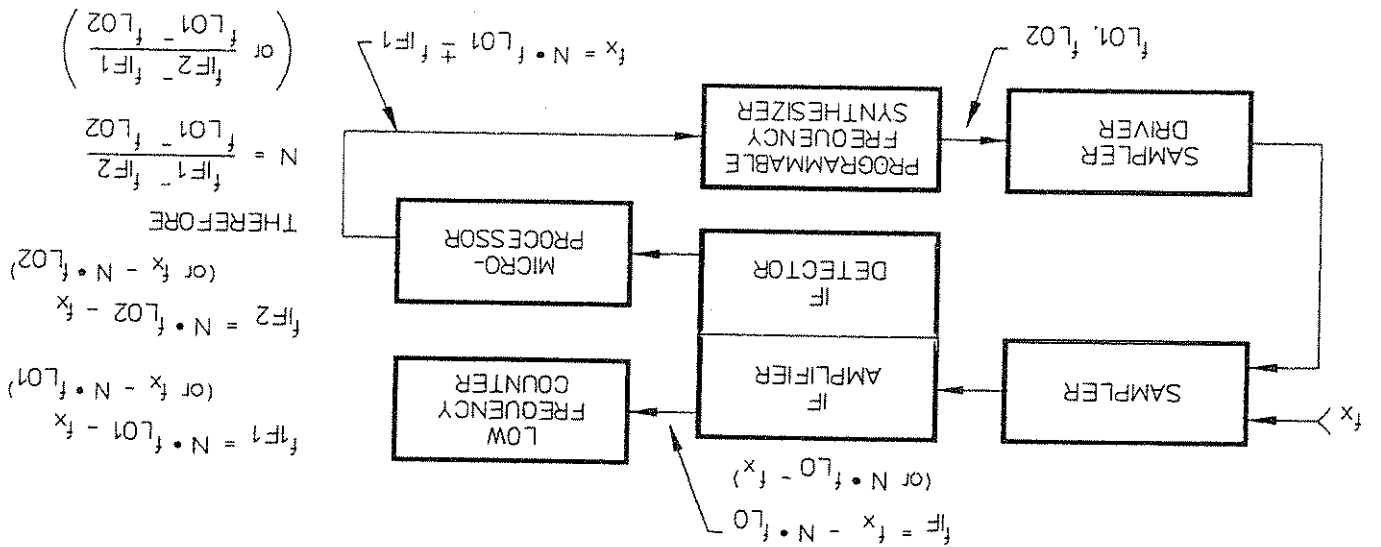
Figure 8-6 is a simplified block diagram of the harmonic heterodyne technique. In this technique, all of the harmonics of an internal oscillator (a programmable frequency synthesizer locked to the counter's time base) are simultaneously mixed with the unknown signal by the sampler and sampler driver (samplers are like harmonic mixers - the sampling diodes in the HP 5347A/48A sampler conduct only for a few picoseconds during each period) of the sampling signal, generating a comb of frequencies 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.

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 ( $\pm$ ) of the IF (the sign of  $f_{IF1}$  will be (+) if  $N \cdot f_{LO1}$  is less than  $f_x$ ; the sign of  $f_{IF1}$  will be (-) if  $N \cdot f_{LO1}$  is greater than  $f_x$ ).

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

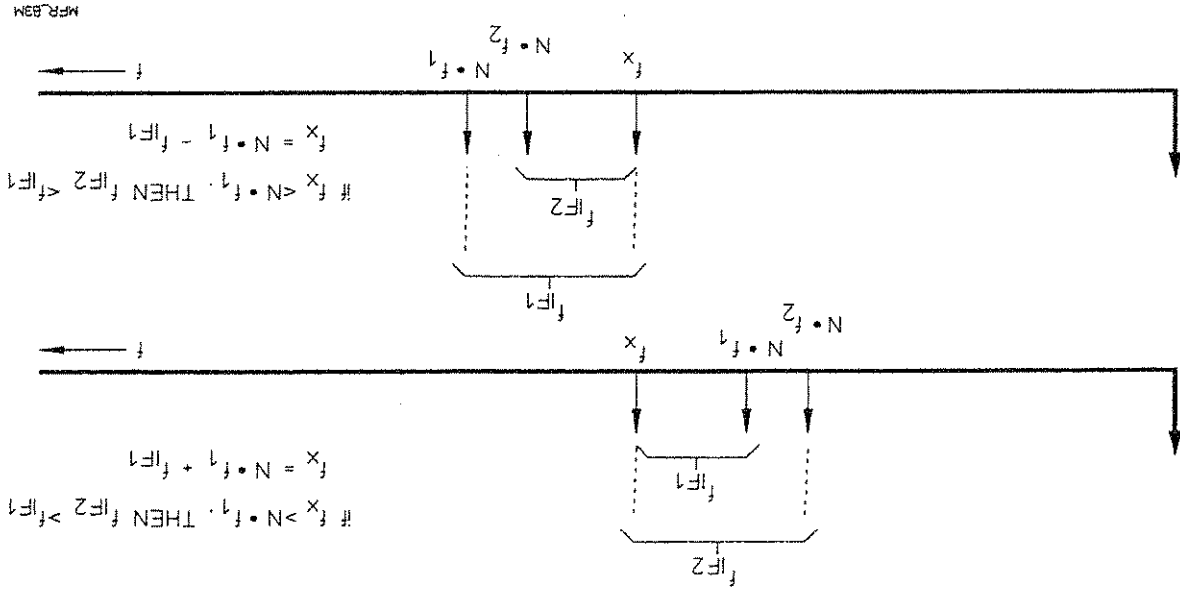
Figure 8-6. Harmonic Heterodyne Technique

WHERE  $f_x$  = UNKNOWN FREQUENCY  
 $N$  = HARMONIC OF FREQUENCY SYNTHESIZER WHICH IS MIXED WITH THE UNKNOWN SIGNAL TO PRODUCE COUNTABLE IF  
 $f_{LO1}, f_{LO2}$  = PROGRAMMED FREQUENCIES OF SYNTHESIZER  
 $f_{IF1}$  = IF PRODUCED BY  $N \cdot f_{LO1}$  MIXING WITH  $f_x$   
 $f_{IF2}$  = IF PRODUCED BY  $N \cdot f_{LO2}$  MIXING WITH  $f_x$



MHHT\_B3M

Figure 8-7. Frequency Relationships



Referring to Figure 8-7, it is seen that if  $f_x$  is greater than  $N \cdot f_{LO1}$ , then  $f_{F1}$ , produced by mixing  $N \cdot f_{LO1}$  with  $f_x$ , will be less than  $f_{F2}$ , produced by mixing  $N \cdot f_{LO2}$  with  $f_x$ , since  $f_{LO2}$  is less than  $f_{LO1}$ , by  $\Delta f$ . However, if  $f_x$  is less than  $N \cdot f_{LO1}$ , then  $f_{F1}$  will be greater than  $f_{F2}$ .

$$\text{therefore } N = \frac{f_{F2} - f_{F1}}{f_{LO1} - f_{LO2}} \text{ (rounded to the nearest integer)}$$

$$f_{F2} = f_x - N \cdot f_{LO2} \quad (\text{if } N \cdot f_{LO2} < f_x)$$

$$f_{F1} = f_x - N \cdot f_{LO1} \quad (\text{if } N \cdot f_{LO1} < f_x)$$

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

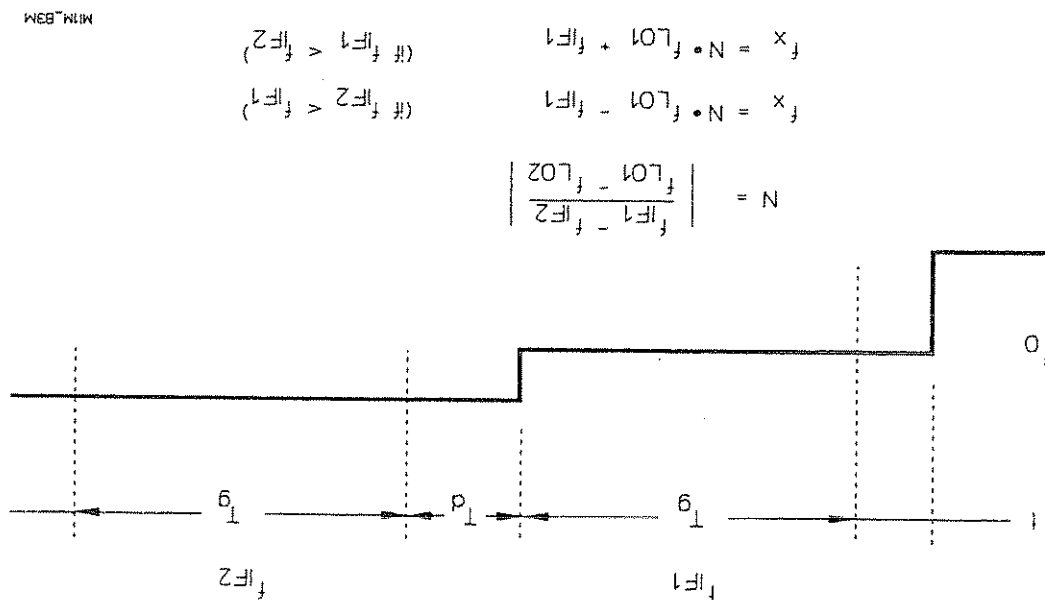
$$\text{therefore } N = \frac{f_{F1} - f_{F2}}{f_{LO1} - f_{LO2}} \text{ (rounded to the nearest integer)}$$

$$f_{F2} = N \cdot f_{LO2} - f_x \quad (\text{if } N \cdot f_{LO2} > f_x)$$

$$f_{F1} = N \cdot f_{LO1} - f_x \quad (\text{if } N \cdot f_{LO1} > f_x)$$

same  $N$  number and sideband as  $f_{F1}$ ), which is counted by the low frequency counter.  $N$  is determined by the following:

Figure 8-8. INPUT 1 Measurement Timing Diagram



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 8-8.)

### 8-101. FM TOLERANCE

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 timebase error and the residual stability of the synthesizer.

The unknown frequency is then computed from the following:

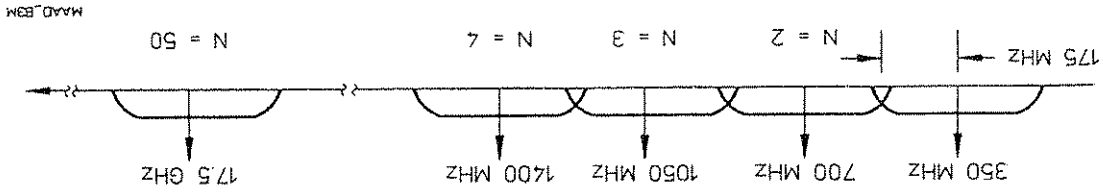
$$N = \left| \frac{f_{F1} - f_{F2}}{f_{LO1} - f_{LO2}} \right|$$

The value of  $N$  is computed from:

$$f_x = N \cdot f_{LO1} - f_{F1} \quad (\text{if } f_{F2} > f_{F1})$$

$$f_x = N \cdot f_{LO1} + f_{F1} \quad (\text{if } f_{F1} > f_{F2})$$





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.

Amplitude discrimination is a feature of the HP 5347A/48A 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.)

The HP 5347A/48A has the ability to automatically discriminate against lower amplitude signals in its range of 0.5-20 GHz [26.5 GHz for HP 5348A] 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 for HP 5348A] range, the counter automatically measures the highest amplitude signal.

### 8-102. AUTOMATIC AMPLITUDE DISCRIMINATION

As long as  $\Delta N$  is less than 0.5, the correct  $N$  can be computed. However,  $\Delta N$  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  $\Delta f_x$  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 5347A/48A. 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.

where  $\Delta f_{LO} = f_{LO1} - f_{LO2}$   
 $\Delta f_x$  = peak frequency deviation of input signal  
 $f$  = rate by which the input signal is frequency modulated  
 $t_d$  = time interval between the two consecutive measurements  
 $t_g$  = gate time

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

If the input signal has FM with peak deviation  $\Delta f_x$  at a rate  $f$ , we could have a maximum error in harmonic number  $\Delta N$  given by:

The local oscillator (LO) is swept across the band until the input signal is found. At this point, there is a short delay for the LO to stabilize. Now the first measurement  $f_{F1}$  is taken during gate time  $t_g$ . The LO frequency is now offset by  $\Delta f_{LO}$  during  $t_d$ . The dead time  $t_d$  must be long enough for the LO to stabilize. After this the second measurement  $f_{F2}$  is taken during gate time  $t_g$ .

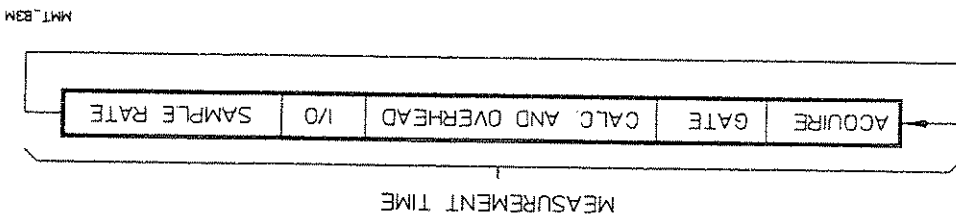
### 8-103. SENSITIVITY

The limiting factors in determining the sensitivity of the HP 5347A/48A 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.

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. Both parameters have to be true for a measurement to be valid. Thus, information from the IF detector 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.

### 8-104. MEASUREMENT TIME

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:



Measurement time tells 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 (that is, 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 as these go directly into the counting circuit.

In Auto mode, acquisition time is comprised of a local oscillator sweep to set the LO to its proper value, plus 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.

Gate time is a function of the resolution setting. A resolution of 1 Hz denotes a maximum gate time of 1 second. For 1M $\Omega$  (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.

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.

Sample rate time is a method for controlling the display update rate. Sample rates for the HP 5347A/48A 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.

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.

## 8-105. COUNTER TO POWER METER INTERFACE TECHNIQUE

The HP 5347A/48A Microwave Counter/Power Meter uses two microprocessors to implement counter and power meter functions (one microprocessor for each function). The Input/Output (I/O) circuits (such as keyboard, display, and HP-IB) serve both the counter and power meter, but they are controlled by the counter microprocessor. An interface circuit like that shown in Figure 8-9 allows the power meter use of the counter's I/O circuits.

As shown in Figure 8-9, a Dual-Port RAM (DPRAM) is the heart of the interfacing circuit, allowing data to be passed from one microprocessor to the other. The DPRAM has two separate I/O ports, which allow independent access for read or write of power meter configuration data, display data, and HP-IB data. Data transfer through the DPRAM is controlled through a handshaking scheme implemented in the firmware (ROM) of both microprocessors.

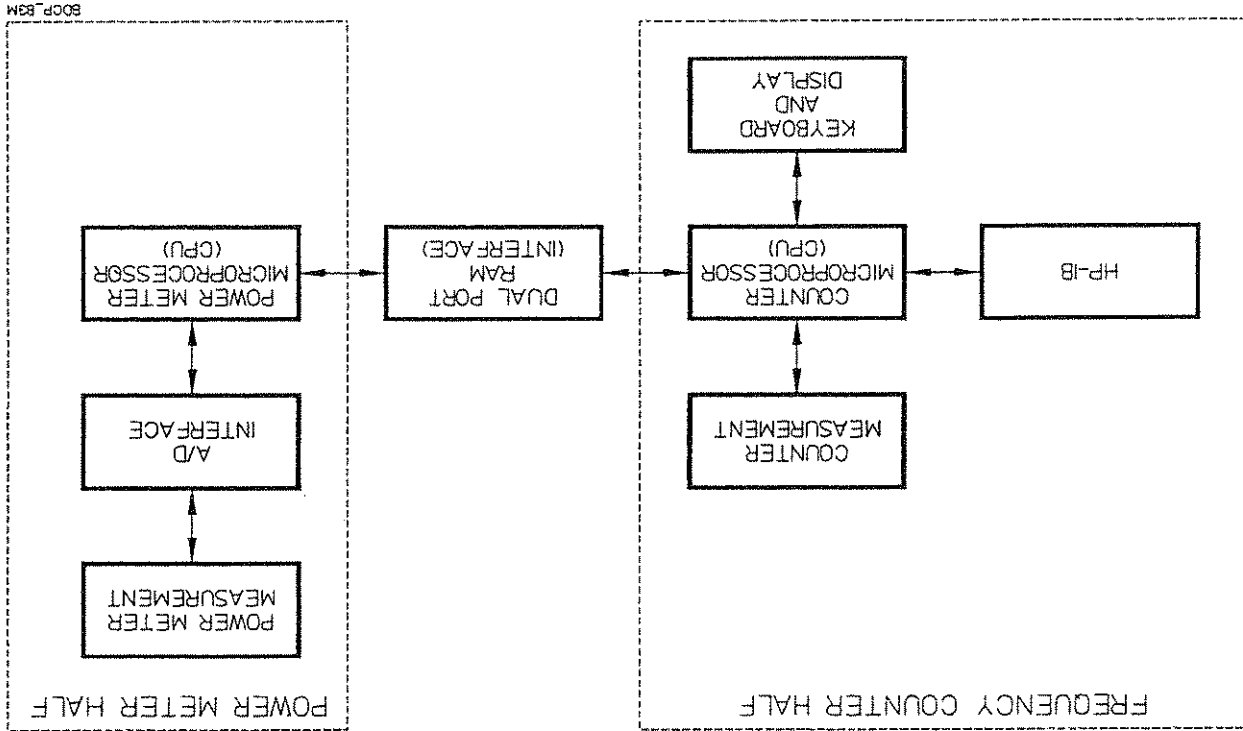


Figure 8-9. Counter to Power Meter Interface

The firmware divides the DPRAM into two halves, with each half handling data transfer in a single direction. The memory space in each half is allocated for control and status bytes and data transfer.

The Counter-to-Power Meter data transfer is used to pass setup and configuration data to the power meter microprocessor. Also, a frequency value may be passed from the counter microprocessor to be used by the power meter microprocessor for choosing a sensor calibration factor.

The Power Meter-to-Counter data transfer is used to send display and measurement result data (for HP-IB, diagnostic messages, error messages, etc.) from the power meter microprocessor to the counter microprocessor.

The DPRAM is only used as a buffer for transferring data. Each microprocessor reads the data from the DPRAM into its own static RAM prior to performing any processing on the data. Information in the DPRAM buffer is read as a complete set each time the DPRAM is accessed for reading data. In this manner, each processor "dumps" the data contained in the DPRAM to its own memory for future use. Writing to the DPRAM is accomplished in much the same manner. Any time it is desired to update any of the information in the DPRAM buffer, the entire byte of information to the DPRAM buffer must be rewritten.

## 8-106. HP 5347A/48A BLOCK DIAGRAM DESCRIPTION

Figure 8-35, is an overall block diagram of the HP 5347A/48A Microwave Counter/Power Meter that shows all the assemblies in the instrument. The six major sections are as follows:

- Low Frequency Input
- Microwave Input and Down Converter
- Synthesizer
- IF Amplifier/Detector
- Counter
- Power Meter

Auxiliary sections include as follows:

- Membrane Keyboard and Display Modules (Part of Front Panel Assembly)
- Keyboard/Display Logic (Part of A1 Motherboard Assembly)
- 10 MHz Timebase Circuits (Part of A1 Motherboard Assembly)
- Power Supply (Part of A1 Motherboard Assembly)
- Optional HP-IB Interface

Most of the above sections are made up of single-board circuits, except for the keyboard/display, timebase/timer, and the power supply sections which are part of the A1 Motherboard Assembly.

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 Section 8-160.

### 8-107. Low Frequency Input Section (A2 Assembly)

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 502 input from 10 MHz to 525 MHz and a direct count 1M2 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 1M2 or the 502 path by pressing the appropriate function of the Input 2 502/1M2 front panel key located in the FREQUENCY FUNCTION section. The low frequency output multiplexer on the A2 Assembly is controlled by the A4 Microprocessor Assembly. The low frequency signal is routed by the multiplexer 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 microprocessor of A4 Assembly.

### 8-108. Microwave Section (A12 Microwave Assembly/U1 Sampler)

The basic function of the microwave section (The Microwave Module, which includes the A12 Microwave Assembly and U1 Sampler) is to down-convert microwave signals in the 500 MHz to 26.5 GHz region to the intermediate frequency (IF) region of the counter. (The resultant IF signal can then be detected and amplified by the A6 Amplifier/Detector Assembly, and counted by the A3 Counter Assembly.) To perform this function, A12 Microwave Module uses the instrument's high power local oscillator (LO) signal from the A5 Synthesizer Assembly. The A12 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.

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 very narrow pulses at the LO frequency. These pulses control the sampling of the input microwave signal entering the sampler RF connector (via the front panel INPT 1 connector). When a harmonic of the LO sampling frequency is close to the input signal frequency, a signal within the IF bandwidth results, and is sent to the IF preamplifier.

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.

### 8-109. IF Amplifier/Detector Section (A6 Assembly)

The main functions of the IF Amplifier/Detector section are to amplify, filter, and detect specific information from the IF signal that arrives from the A12 Microwave Assembly. The resulting signal is passed on to the A3 Counter Assembly where it is counted. The A6 Assembly also generates several status and warning signals to the A4 Microprocessor Assembly.

The output signal of the +32 dB amplifier on the Microwave Assembly is routed to the input of a 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.

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.

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.

### 8-110. Synthesizer Section (A5 Assembly)

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 single phase-lock loop (PLL), which allows the wideband tunable oscillator (VCO) in the synthesizer to have the same frequency accuracy and drift characteristics as the crystal oscillator (TCXO) timebase.

The 10 MHz signal from the timebase buffer is divided by 100 to obtain a 100 kHz reference for the phase-locked loop. The voltage controlled oscillator (VCO) frequency is divided by the programmable frequency dividers which are controlled by the A4 microprocessor. The dividers output 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 feedback system. The feedback adjusts the VCO frequency such that the output of the programmable dividers is to equal the 100 kHz reference. Thus, the VCO frequency will always be a programmable multiple of 100 kHz.

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.

## 8-111. Counter Section (A3 Assembly)

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 counts the low frequency measurements. Gating, channel selection, the interpolator, and all other MRC setups are controlled by the A4 Microprocessor Assembly.

Operation of the counter centers on the interaction between the A4 microprocessor and the MRC. 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.

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.

For increased measurement resolution, the 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 gate timing error, and provides start and stop pulses to the interpolator circuit. The interpolator circuit measures the error and sends the data to the microprocessor, which then uses the interpolator data in the measurement calculations to compensate for the uncertainty.

## 8-112. Microprocessor Section (A4 Assembly)

The HP 5347A/48A's CPU is designed around an MC6803 8-bit microprocessor, using a memory-mapped architecture. An 8-bit bidirectional data bus (DBUS0-DBUS7) 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. The microprocessor also controls interfacing between the keyboard/display and the power meter microprocessor.

A4 Microprocessor Assembly receives overload, acquisition, and guardband signals from the IF section, after which the dividers on the synthesizer are programmed and implemented 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 communication over the HP-IB.

The A4 assembly contains a 32K byte ROM and a 8K byte RAM. The ROM contains the HP 5347A/48A's operating firmware while the RAM provides read/write memory for storing user selected data.

Since the processor is the center of the instrument, any failure or inconsistency on its part greatly influences the instrument's performance. The processor assembly has several levels of diagnostics available for testing and servicing.

### 8-113. Keyboard/Display Logic Section

#### (Part of A1 Assembly and A9/A10 Assemblies)

The Keyboard/Display section consists of the front panel Keyboard Membrane (A10), the front panel Display Module (A9), and the Keyboard/Display interface circuits on A1 Membrane is a Liquid Crystal Display that contains display driver circuits. The Keyboard/Display Logic circuit on the motherboard consists of encoding and interfacing circuitry for sending front panel entry data to the A4 microprocessor. This circuit also contains the display logic and interface circuitry for receiving and displaying data from the processor.

The Display is controlled by two lines from the A4 Microprocessor Assembly, with all data serialized and encoded. All data flow to and from the Keyboard/Display Logic circuit is over five data bus lines, and three control lines from the microprocessor. The microprocessor directs the timing and synchronization of input and display activity. The Keyboard section also contains the front panel POWER switch (or key) circuit which drives the ON/OFF circuits on the motherboard.

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

### 8-114. Power Meter Section (A7 Digital Assembly/A8 Analog Assembly)

The Power Meter section is a microprocessor controlled single channel power meter with a built in 1 mW 50 MHz power reference. The power meter consists of the A7 Power Meter Digital Assembly, the A8 Power Meter Analog Assembly, and an externally connected Power Sensor.

The A8 Analog Assembly receives the analog signal to be measured via the Power Sensor. Under A7 microprocessor control, the analog input signal is amplified, attenuated, and digitized by A8 Analog Assembly.

The microprocessors on A4 Microprocessor Assembly and A7 Digital Assembly interact to provide timing, calculation, and control of the power meter measurements and display. The microprocessors execute instructions stored in their Read-only Memory (ROM).



The A11 Assembly controls all HP-IB interfacing between the HP 5347A/48A 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 5347A/48A HP-IB address; the address is also selectable via the front panel keyboard.

### 8-117. HP-IB Interface Section (A11 Assembly)

At the rear edge of A1 Motherboard is a DIP switch that is used to select Diagnostics/Measurement operating mode, power sensors (HP 8481A or HP 8485A), and resolution (1 Hz or 10 KHz). Voltage and current feedback lines are used by the pulse width control IC, which in turn sends voltage drive to regulate the supplies.

The power supply circuitry consists of ac, external dc, and battery input circuits, power on/off circuit, pulse width control circuit, dc to dc switchmode converter, current and voltage feedback circuits, and power supply status circuit. The ac, dc, or optional battery input supplies an unregulated dc source voltage (+VB), which varies from 10.5 to 26V dc, to the power supply circuits. The power supply produces regulated +5, -5, +18, -18, and -24 volt supplies for all assemblies in the instrument, as well as +15 volts (regulated from the +18V supply), special purpose supplies for the Microwave Module (+5V SW, +13 SW), and precision supplies for the Power Meter Analog circuits ( $\pm 15V$  PM).

### 8-116. Power Supply Section (Part of A1 Motherboard Assembly)

The front panel has an input for a 10 MHz external reference signal. A detection circuit on A1 Assembly detects if an external reference source is being used for the timebase, and sends a signal to the microprocessor, which indicates 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 Timebase Buffer, also on A1 Assembly, has five main output signals. The 10 MHz main signal goes to the A3 Counter and A5 Synthesizer Assemblies.

The instrument's timebase oscillator is a Temperature Compensated Crystal Oscillator (TCXO) on A1 Motherboard Assembly. The TCXO provides a 10 MHz timebase reference frequency to the Timebase Buffer circuit.

### 8-115. 10 MHz Timebase Circuits Section (Part of A1 Motherboard Assembly)

## 8-118. DESCRIPTION OF USER-CALLABLE DIAGNOSTICS

### 8-119. Introduction

The HP 5347A/48A is a microprocessor-based system with 38 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.

There are two 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 list in *Table 8-5*.)
- b. Power-Up Self Test: A sequence of tests automatically executed when the instrument is powered-up. (Refer to Section 8-31.)

The diagnostic routines are designed to isolate faults in the HP 5347A/48A 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.

The User-Callable diagnostics consist of tests which can be called individually, while the Power-Up 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 Appendix B (Recommended Test Equipment) of this manual for test equipment specifications.

The following paragraphs provide descriptions of each diagnostic available in the HP 5347A/48A. 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 8-25, Diagnostics Mode Entry.
  - Section 8-26, Diagnostics Mode Exit and Special Conditions.
  - Section 8-27, Invalid Diagnostic Numbers.
- b. Information for calling diagnostics over HP-IB:

Section 8-28, Calling Diagnostics Over the HP-IB.  
Appendix C (Remote Programming Via HP-IB) in the Operating and Programming Manual.

Section 8-19, Overall Troubleshooting.  
Sections 8-57 through 8-88.

The following diagnostic descriptions include examples of the PASS/FAIL messages which will appear on the display for a given test. In these messages 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.

### 8-120. Overload Display

If an overload condition occurs while the counter is in the diagnostic mode, an OVL D warning will appear in the diagnostic display. For most diagnostics, the OVL D 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 "OVL D" to appear in place of the normal "A4 D" in the display, as shown below:

**PASS RAM OVL D 41**

A few diagnostics display the OVL D 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 OVL D 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**

**OVL D 41**

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.

### 8-121. Keyboard Versus HP-IB

**CALLING DIAGNOSTICS VIA KEYBOARD.** The Diagnostics (Diag.) mode may be entered by setting the mode selection switch of the rear panel DIP switch to "Diag." before turning on the instrument.

After power-up, the front panel's Diag annunciator will light to indicate the HP 5347A/48A is operating in Diagnostics mode. To call a diagnostic, use the Input 2 50 Ω/1M Ω key to increment to the desired diagnostic test number, and press Input 1 50 Ω key to decrement to the desired diagnostic test number. Numbers that contain no diagnostics are skipped, and the next valid diagnostic number is displayed.

Pressing the DECREMENT key while the instrument is in the Diagnostic 1 test mode ("DIAG 01" is displayed) will cause the instrument to automatically decrement to Diagnostic 97 test mode

**CALLING DIAGNOSTICS VIA HP-IB.** Most of the User-Callable Diagnostics available from the front panel are also available over the HP-IB using the "DIAGENT", "DIAG", "DIAGPARM", and "DIAG?" commands. Diagnostics are initiated over the HP-IB using the

The HP 5347A/48A 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 97). 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".

1. Turn the HP 5347A/48A off.
2. Set DIP switch to Diagnostics mode.
3. Turn the HP 5347A/48A on.
4. Press Input 2 50  $\Omega$ /1M  $\Omega$  key or Input 1 50  $\Omega$  key (depending on whether you want to increment or decrement to get to Diagnostic 32)
5. Press Calibrate/Store key.

For example, to enter the diagnostic mode and set Diagnostic 32 (Interpolator Check, A3 Counter Assembly), press the following key sequence:

Press Calibrate/Store key - initiates the selected diagnostic test.

Once you select the diagnostic-test number perform the following:

1. Set Rear Panel DIP switch to Diagnostics mode ("up" position) as shown in Figure 8-3.
2. Press Input 2 50  $\Omega$ /1M  $\Omega$  key (increments to next higher number diagnostic test), or Press Input 1 50  $\Omega$  key (decrements to next lower numbered diagnostic test).

Therefore, a new diagnostic number (from 1 to 97) may be entered using the following key sequence:

Once you have completed the desired testing, the power to the instrument must be turned off, and the selection switch on the rear panel must be returned to the "Meas." (Measurement mode) position.

Once you have the desired diagnostic number displayed, press the Calibrate/Store key to initiate the diagnostic execution. The diagnostic will execute continuously, displaying the results. Pressing the increment or decrement keys will halt execution of the running diagnostic and move to the next one in sequence. Pressing the Reset/Local key halts execution of the current diagnostic, and returns to diagnostic 1.

("DIAG 97" is displayed). Similarly, pressing the INcrement key while the instrument is in the Diagnostic 97 test mode will cause the instrument to automatically increase to Diagnostic 1 test mode.

DIAG command. For example, the command "DIAG,32,ON" will cause the HP 5347A/48A to cycle through the Interpolator Check until the command "DIAG,OFF" or another diagnostic number is sent. Diagnostic results can be obtained over the HP-IB by using the DIAG command. The DIAGPARM command is used only with DIAG 51 to allow you to enter a frequency parameter for local oscillator verification. Refer to Appendix C, Remote Programming via the HP-IB, for detailed information on use of the HP-IB. (Appendix C is in the Operating and Programming Manual.)

There are five diagnostics not available over the HP-IB, because they may erase needed memory or reset hardware. The diagnostics not available are as follows:

Diag 1: Self Test  
 Diag 41: RAM Test  
 Diag 42: ROM Test  
 Diag 43: Repeated Reset  
 Diag 80: HP-IB Verification

In addition, Diag 97 (IF 175 MHz Filter Adjust) is available via the HP-IB; however, power to the instrument must be cycled to exit this diagnostic.

## 8-122. Switching Between Measurement and Diagnostics Modes Via HP-IB (Option 011)

Two commands are used to switch the HP 5347A/48A from the Measurement mode to the Diagnostics mode, and vice versa. These two commands are as follows:

- DIAGENT
- MEASENT

DIAGENT command is used to enter the Diagnostics mode. While the HP 5347A/48A is in the Diagnostics mode, it recognizes only the diagnostics commands. To exit the Diagnostics mode use the MEASENT command.

MEASENT command is used to exit the Diagnostics mode and return to the Measurement Mode, which is the instrument's normal mode of operation. While the HP 5347A/48A is in the Measurement mode, it recognizes only the measurement commands and HP-IB status commands.

An entry error will be indicated when measurement commands are sent while the HP 5347A/48A is in the Diagnostics mode, and vice versa.

Refer to Appendix C of the HP 5347A/48A Operating and Programming Manual for detailed information on these and other HP-IB commands.

For keyboard operation, the diagnostic number will remain "1", regardless of whether the diagnostic passed or failed. For example, if the instrument failed Diag 31 during Diag 1 and the user pressed the Reset/Local key to continue testing, then pressing increment (Input 2 502/1M  $\Omega$ ) key will move testing on to Diag 2.

FAIL POWER A1 D 11  
 FAIL TIMEBASE A1 D 10  
 FAIL INTERPOL A3 D 32

The failure display formats for Diag 11, 10, or 32 are exceptions to the format shown above. The possible messages are:

FAIL XX XXX XXX A2 D 01

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 Direct Count test failed during Diag 1, the display would be:

PASS 35 000 0\*\* D 01  
 PASS 35 000 0\*\* OVL D 01

If the counter passes Diag 1, the messages are:

DIAG NUMBER	TEST	ASSEMBLY
Diag 11	Power Supply Verification	A1
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 502 Verification: 35 MHz	A2
Diag 21	Low Frequency 1M $\Omega$ Verification: 35 MHz	A2

Table 8-11. Diag 1 Self Test Sequence

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 Power-up Self Check function, but will stay in a loop, repeating the test sequence until 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 8-11.

8-123. Diagnostic 1: Counter and System Self Test  
 (Not Available Via HP-IB)

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.

**E X X X X X X X T Y Y Y Y Y Y . Y Y**  
**E X X X X X X X T Y Y Y Y Y Y O V L D**

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). The fraction calculated from interpolator data is included in the display. The messages are:

### 8-125. Diagnostic 3: Display MRC E and T Register Contents

For some input frequencies, the LO will not have settled sufficiently to insure consistent results between Diagnostics 2, 4, and 5. Send a "CLR" command prior to executing these diagnostics to avoid this condition.

#### NOTE

This diagnostic performs a normal measurement cycle. Use serial polling of the Measurement Complete bit to determine when the diagnostic has completed.

#### NOTE

where digit "x" is random since the guaranteed resolution is only 10 KHz.

**IF 75 00 X \* \* D 02**

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 10 KHz (gate time = 1 ms), the IF would be displayed as follows:

**IF 75 000 000 .XX O V L D D 02**  
**D 02**

Every time the display is updated, the current IF is displayed, with the chosen resolution. An IF will only be displayed for an INPUT 1 measurement. The IF display will be in the format shown below (assuming an IF of 75 MHz, and a chosen resolution of 1 Hz):

### 8-124. Diagnostic 2: Display IF

8-126. Diagnostic 4: Display LO Frequency

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. The messages are as follows (assuming an LO frequency of 345.8 MHz for this example):

LO	345.8 MHZ	DIAG 04
LO	345.8 MHZ	OVL0 04

NOTE

This diagnostic performs a normal measurement cycle. Use serial polling of the Measurement Complete bit to determine when the diagnostic has completed.

NOTE

For some input frequencies, the LO will not have settled sufficiently to insure consistent results between Diagnostics 2, 4, and 5. Send a "CLR" command prior to executing these diagnostics to avoid this condition.

8-127. Diagnostic 5: Display N (integer) Harmonic Number and Sideband

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. The messages are:

HARM	USB	XX	DIAG 05
HARM	LSB	X	DIAG 05
HARM	USB	XX	OVL0 05
HARM	LSB	X	OVL0 05

NOTE

This diagnostic performs a normal measurement cycle. Use serial polling of the Measurement Complete bit to determine when the diagnostic has completed.



For some input frequencies, the LO will not have settled sufficiently to insure consistent results between Diagnostics 2, 4, and 5. Send a "CLR" command prior to executing these diagnostics to avoid this condition.

**NOTE**

**8-128. Diagnostic 6: Display N (traction) Harmonic Number and Sideband**

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. The messages are:

HARM	XX.XX	USB	DIAG 06
HARM	X.XX	LSB	DIAG 06
HARM	XX.XX	USB	OVL D 06
HARM	X.XX	LSB	OVL D 06

**NOTE**

This diagnostic performs a normal measurement cycle. Use serial polling of the Measurement Complete bit to determine when the diagnostic has completed.

**8-129. Diagnostic 7: Display Interpolator Short Calibration**

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  $\pm 20$  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	SH CAL	xxx yyy
DIAG 07		OVL D 07	

**NOTE**

This diagnostic performs a normal measurement cycle. Use serial polling of the Measurement Complete bit to determine when the diagnostic has completed.

PASS	TIMEBASE	A1 D 10
FAIL	TIMEBASE	A1 D 10
PASS	TIMEBASE	OVL D 10

This test confirms the presence of either an external or internal time base 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:

8-132. Diagnostic 10: Timebase Verification

*This diagnostic performs a normal measurement cycle. Use serial polling of the Measurement Complete bit to determine when the diagnostic has completed.*

NOTE

MEAS	xxx yyy	DIAG 09
MEAS	xxx yyy	OVL D 09

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:

8-131. Diagnostic 9: Display Interpolator Measurement

*This diagnostic performs a normal measurement cycle. Use serial polling of the Measurement Complete bit to determine when the diagnostic has completed.*

NOTE

LONG CAL	xxx yyy	DIAG 08
LONG CAL	xxx yyy	OVL D 08

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:

8-130. Diagnostic 8: Display Interpolator Long Calibration

### 8-133. Diagnostic 11: Power Supply Verification

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 main supply voltages in the instrument 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	OVL D 11

### 8-134. Diagnostic 20: Low Frequency 50 $\Omega$ Verification: 35 MHz

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 50 $\Omega$  input (INPUT 2) and the MRC counts the signal, verifying the frequency to  $\pm 100$  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**	OVL D 20

### 8-135. Diagnostic 21: Low Frequency 1M $\Omega$ Verification: 35 MHz

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 1M $\Omega$  input (INPUT 2) and the MRC counts the signal, verifying the frequency to  $\pm 100$  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**	OVL D 21

### 8-136. Diagnostic 30: MRC Channel A Verification, 10 MHz Timebase

The microprocessor programs the MRC to count its own 10 MHz time base in both registers. The result is checked to  $\pm 100$  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**	OVL D 30

8-137. Diagnostic 31: MRC Channel B Verification, 35 MHz

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  $\pm 100$  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**
OVL D 31
    
```

8-138. Diagnostic 32: Interpolator Check

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
OVL D 32
    
```

8-139. Diagnostic 40: ROM Version Number

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
OVL D 40
    
```

8-140. Diagnostic 41: RAM Test (Not Available Via HP-IB)

A test algorithm is performed on the RAM (A4U20). This test erases whatever is stored in the external RAM. The messages are:

```

PASS RAM
4 D 41
FAIL RAM
A4 D 41
PASS RAM
OVL D 41
    
```

**8-142. Diagnostic 43: Repeated Reset (Not Available Via HP-IB)**

A4 D 42	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
OVL D 42		

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:

**8-141. Diagnostic 42: ROM Test (Not Available Via HP-IB)**

This diagnostic performs a test sequence similar to the power-up self check. The sequence of tests for Diag 43 is as follows:

1. Display test - all segments lit, all annunciators lit.
  2. Diagnostic 42: ROM Test.
  3. Diagnostic 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 502 Verification: 35 MHz
  - i. Diag 21 - Low Frequency 1M2 Verification: 35 MHz
4. HP-IB verification and address display.
5. Check for external reference, overload, overv; update annunciators.
6. Set current Diagnostic number to 43.

The Diag 43 routine continuously cycles through the above tests. 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:

XX HP-IB  
OVL D

where xx is a number from 0 to 31.

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. Pressing the Reset/Local key for this diagnostic only, continues testing after a failure, instead of returning to Diag 1.

8-143. Diagnostic 44: Dual Port RAM Test

Diag 44 tests communications between the A4 Microprocessor Assembly and the A7 Power Meter Assembly via the Dual Port RAM (A7U18). The messages are:

PASS DPRAM  
FAIL DPRAM  
A7 D44  
A7 D44

8-144. Diagnostic 50: LO Synthesizer Verification - 29.5 MHz, 35.0 MHz

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 = 350/10) will be displayed. The messages are:

PASS 35 000 0\*\*  
FAIL XX XXX XXX  
A5 D 50  
OVL D 50

8-145. Diagnostic 51: LO Synthesizer Verification - User-Entered Frequency (Not Available Via Keyboard)

This diagnostic performs identically to Diag 50, but the user is allowed to enter (via HP-IB only) 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).

A new LO frequency may be entered at any time during the test. Execute "DIAGPARK xxxy". 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.

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).

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.

LO        HI        HI        HI        HI        HI        HI        HI  
 LO        HI        HI        HI        HI        HI        HI        HI  
 A5 D 53    OVL D 53

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:

**8-147. Diagnostic 53: LO Synthesizer Lower, Upper Frequency Bounds**

275-375    LO SWEEP    A5 D 52    OVL D 52  
 275-375    LO SWEEP    A5 D 52    OVL D 52

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:

**8-146. Diagnostic 52: LO Synthesizer Sweep**

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.

ENTER LO 495.5 \*    A5 D 51

If the user enters 495.5 MHz (which is out of range), the message will be:

ENTER LO 295.9    A5 D 51    OVL D 51  
 ENTER LO 295.9    A5 D 51    OVL D 51

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, Section 8-147). 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:

If the user calls any other diagnostic (except for Diag 63), or resets the diagnostic mode (by pressing Reset/Local), the IF flag will once again be enabled, and measurements will proceed normally.

*This diagnostic performs a normal measurement cycle. Use serial polling of the Measurement Complete bit to determine when the diagnostic has completed.*

**NOTE**

XX XXX XXX XXX  
 XX XXX XXX XXX  
**DIAG 62**      **OVL D 62**

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:

**8-150. Diagnostic 62: Disable Hardware IF Detector Flag; Display Measurement**

NOOVL D OCCURRED      A6 D 61  
 OVL D OCCURRED      A6 D 61

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). The messages are:

**8-149. Diagnostic 61: Overload Detector**

PASS      35 000 0\*\*  
 FAIL      XX XXX XXX  
**A6 D 60**      **OVL D 60**

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 145100 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:

**8-148. Diagnostic 60: IF Verification: 35 MHz; Disable INPUT 1 and IF**



**8-151. Diagnostic 63: Disable Hardware and Software IF Detector Flags; Display IF**

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:

IF       XX XXX XXX .XX  
D 63  
OVID   XX XXX XXX .XX  
D 63

**NOTE**

*This diagnostic performs a normal measurement cycle. Use serial polling of the Measurement Complete bit to determine when the diagnostic has completed.*

**8-152. Diagnostic 64: Disable Software IF Detector Flag; Display IF**

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:

IF       XX XXX XXX .XX  
D 64  
OVID   XX XXX XXX .XX  
D 64

**NOTE**

*This diagnostic performs a normal measurement cycle. Use serial polling of the Measurement Complete bit to determine when the diagnostic has completed.*

**8-153. Diagnostic 65: IF Verification: 35 MHz; Disable INPUT 1**

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  $\pm 100$  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:

PASS   35 000 0\*\*  
FAIL   XX XXX XXX  
A6 D 65  
OVID 65

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:

ZERO  
DBM/WATT  
CAL/STR  
INPUT 2  
INPUT 1  
RESET

Before a key is pressed, the messages are:

KEY TEST  
A10 D 70  
OVL D 70

When a key is pressed, the display changes to show the function name of the pressed key. For example, if the user presses the Zero key, the message will be:

KEY ZERO  
A10 D 70

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 Diagnostic 1.

### 8-155. Diagnostic 71: Display Test

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.

### 8-156. Diagnostic 72: Power Meter Digital Check

This test exercised five functional circuit blocks on the A7 Power Meter Digital Assembly. Possible display messages are as follow:

PASS POWER METER A7 D72  
FAIL X X X X X A7 D72

where x x x x represents numbers 1 2 3 4 5, respectively.

When a failure occurs, between one and five numbers will be displayed, identifying the functional area. If more than one number is displayed, a multiple failure is indicated. The numbers displayed correspond to the following circuits:

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 instrument (POWER key to STBY). This is true even if the diagnostic was entered via an HP-IB command. When the instrument is powered up again, the diagnostic number defaults to 1.

**ADJUST IF 175 FILTER D97**

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 5, Adjustments). The message is:

**8-159. Diagnostic 97: IF 175 MHz Filter Adjust**

<b>PASS</b>	<b>HP-IB</b>
<b>FAIL</b>	<b>HP-IB</b>
<b>PASS</b>	<b>HP-IB</b>
<b>A11 D 80</b>	
<b>A11 D 80</b>	
<b>OVL D 80</b>	

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:

**8-158. Diagnostic 80: HP-IB Verification (Not Available Via HP-IB)**

**DIAG 73 OFF**  
**RESET (keyboard or HP-IB)**  
**MEASENT (HP-IB only)**  
**INIT (HP-IB only)**

The oscillator will remain ON until one of the following commands is executed:

**REF OSCILLATOR ON A7 D73**

This diagnostic is not a test, but an auxiliary function for turning ON the Power Meter 50 MHz Reference Oscillator. Initiating Diag 73 will turn on the oscillator and cause the following message to be displayed:

**8-157. Diagnostic 73: Power Meter Reference Oscillator - ON**

**FAIL PM INTERFACE A7 D72**

In addition, if the A4 Assembly experiences a timeout indication that the A7 Assembly is not responding at all, then the following will be displayed:

- 1 RAM
- 2 ROM
- 3 Peripheral Interface Adapter (PIA)
- 4 Timer
- 5 Analog to Digital Converter (ADC)

## 8-160. DETAILED CIRCUIT DESCRIPTIONS

The following paragraphs describe 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 Section 8. The descriptions are arranged in numerical order by assembly reference designation. Even though a detailed block diagram is referred to and provided with each of the circuit descriptions, you may at times need to refer to the corresponding schematic diagram for a better understanding of the circuit. (Note that the overall block diagrams for the A1 Motherboard Power Supply and A8 Power Meter Analog assemblies are located near their respective schematic diagrams.)

### 8-161. Power Supply Block (Part of A1 Motherboard)

The HP 5347A/48A Power Supply Block Assembly is on the A1 Motherboard Assembly. As shown in *Figure 8-37*, it is a switching power supply that consists of the following major sections:

- Power Supply Input
- K1 and K2 Relay Inrush Circuits
- ON/OFF Control
- Mechanical Shock Protection
- Undervoltage Protection Circuit
- DC to DC Switchmode Converter
- Miscellaneous Circuits

**GENERAL.** The HP 5347A/48A can be powered from several different sources: internal battery (an option), external dc voltage (12 to 26V dc), or ac line voltage. When the instrument is OFF, the power is routed to the battery charger circuit for charging the internal battery, if appropriate. When the instrument is ON, the power is routed to a dc to dc converter which generates the voltages that are needed to power the instrument. Some of these output voltages are post-regulated, and then all of these voltage supplies are routed on the motherboard to the appropriate circuits. Error condition control is provided to protect the battery and circuitry from potentially damaging situations.

In the following paragraphs, all of the Power Supply circuits will be discussed.

**POWER SUPPLY INPUT.** As shown in *Figure 8-37*, the Power Supply Input section can receive either an ac line voltage that is rectified into dc, an external dc voltage, or a battery. When an ac line voltage or an external dc voltage is used as the power source, either of these sources will be filtered, and then selected by relay K1. The battery is simply selected by relay K1 when it is used as the power source.

**AC Line Voltage Input** (This is the A13 Power Transformer Primary Assembly (05348-60207) shown in *Figure 8-50*). The circuit consists primarily of an input power module with a line filter, a step-down transformer (T1), and a bridge rectifier CR1 (mounted on the chassis). This circuit produces a dc signal which is then filtered by capacitor A1C15 at the A1 Motherboard MAIN POWER IN input, providing a dc supply voltage between +12.0 and +23.0V to power the system. A second tap on the transformer provides ac at A1J3, which is rectified and filtered on the A1 Motherboard Assembly. This provides a dc voltage between +22.25 and +38.5V dc to charge the battery.

The step-down transformer provides its two secondary output voltages for inputs of 105 and 120V ac at 50, 60, or 400 Hz, and 210 and 240V ac at 60 Hz. These input voltages can be selected by using the 4-position turret wheel in the power module.

The lower limit of 22.25V is set to allow for charging the battery pack. As shown in *Figure 8-38*, Fullwave Rectifier CR6, capacitor C16, and resistor R26, generate the +22.25V dc charging voltage (refer to paragraph on Battery Charger circuit).

**External DC Input Source.** Plug/Binding posts are provided on the rear panel as an alternative method of powering the HP 5347A/48A. A dc voltage between +12 and +26V dc can be plugged in to run the instrument. The dc voltage passes through diode CR8. Diodes CR4 and CR8 protect the instrument when a reversed voltage is accidentally applied to the External DC Input. If the dc input voltage level exceeds +26V dc, F2 opens.

**Overvoltage Protection.** This circuit consists of U1, Silicon Controlled Rectifier (SCR) CR1, and their associated components. The circuit temporarily shorts the dc voltage from the fullwave bridge rectifier CR1 (located on the chassis) to ground and blows the main fuse (F1) in the power module.

When the rectified ac input or external dc input exceeds 26V dc, U26 generates a positive pulse to the gate of CR1. The positive pulse causes CR1 to conduct, dropping the input voltage to zero volts, blowing the main fuse. This action protects the instrument from excessive input voltage.

**External Power Sense Circuit.** This circuit consists of voltage regulator U2, resistors R10 and R11, and capacitors C10 and C4. This circuit limits the voltage to the coil of the Power Source Selector Relay (K1) to +11.5V, preventing damage to the relay. If neither external source (ac or dc) is present, the output will be zero volts; thus, K1 will be deenergized, automatically selecting the battery input.

**Battery Charger.** This circuit (which consists of Schottky diode CR24, voltage regulator U18, and resistor R73) receives its input from the fullwave rectifier circuit (CR6, C16, R26). The rectifier (or AC Charger Input circuit) provides a minimum of +22.25V dc input to drive the Battery Charger circuit.

The Battery Charger circuit provides a constant-current, trickle charge to the battery. The charger is ON only if the HP 5347A/48A is OFF, the battery is installed, and the ac line is plugged in. The battery will not charge from a dc source. Voltage regulator U18 provides a constant voltage of 1.25V between  $V_{out}$  and  $V_{adj}$  (pins 3 and 1, respectively). R73, which is connected between the voltage, determines the amount of current flowing from the charger circuit. Diode CR24 provides protection for U18 during error conditions, preventing a reverse voltage from appearing across U18.

**OPTION 002 BATTERY PACK.** The battery is made up of 12 NiCad D cells in series (nominally 14.4V). The battery pack provides a dc input between +12.1 to +14.4V dc. In typical operation it can provide enough power for 1 to 2 hours of continuous operation.

The NiCad battery pack can withstand a constant current of 400 mA or less indefinitely. The battery takes 10 to 15 hours to charge at this rate (less if the battery is not fully discharged). Once the battery is charged, the excess energy from the charger is dissipated in the form of heat; thus, the battery will get noticeably warmer.

**Power Source Identifier.** This switching circuit, Q1, R9, and R17 tells the A4 microprocessor if the instrument is being powered by the external dc supply or by the battery. When the instrument is being powered by the external dc supply, Q1 is turned ON and its collector or the H BAT SENSE line goes LOW. This LOW line tells the microprocessor that the instrument is being powered by the external dc supply. When the instrument is powered by the battery the H BAT SENSE line goes HIGH, telling the microprocessor the instrument is battery powered.

**Power Source Selector Relay (K1).** When +9 to +12V dc is present at K1(4) the coil is energized and the normally-open relay switch is closed, permitting the unregulated external power source (dc or rectified ac) input signal to connect to relay K2(8). The power supply external source input may vary from +12 to +26V dc; thus, it is limited to +12V by U2 to protect relay K1. If the external source is not present, then the relay deenergizes to its normal condition — the switch from the external source is normally open, and the switch K1 (5,6) for the battery is normally closed. If a battery is present, it will now connect to K2(8), ready to provide power if the instrument is ON. In this way, the battery will be selected to provide power only if no external sources are present.

**K1 AND K2 INRUSH PROTECTION CIRCUITS.** These circuits protect the relays (A1K1 and A1K2) from large inrushes of current that occur as the relay switches close; thus, this prevents "contact welding" which is a common failure mode in relays.

Both inrush circuits bypass the relay with a field-effect transistor (FET), which gets a control signal at the same time as the relay coil. Since the FET turns ON faster than the relay, the FET pulls up the voltage on the output side of the relay, charging all circuits there. The FET will pull the voltage up to within 6 volts of the voltage at the drain of the FET, and hold it there until the relay closes. Then the relay shorts out the entire inrush protection circuit, disabling and isolating it from the rest of the instrument. The FET will not pull the voltage all the way up to the input voltage as it begins to turn OFF when the drain voltage gets within 4 to 6 volts of the gate voltage. Instead, it will reach a point where the FET is ON just enough to keep the output voltage constant.

The K1 Relay Inrush Protection circuit FET (Q201) is turned ON by resistor R205. R205 pulls Q201 gate up to the MAIN\_POWER\_IN line or node. Thus, Q201 begins to turn ON anytime an external power source is connected. Zener diode CR203 provide overvoltage protection for the gate of Q201. The power diode CR202 blocks any battery voltage from going back to the MAIN\_POWER\_IN node.

The K2 Relay Inrush Protection circuit FET (Q202) is turned ON whenever a H\_ON pulse is present from the ON/OFF Control circuit. Transistors Q200 and Q203 provide level shifting to drive the gate of Q202. Zener diodes CR200 and CR201 provide overvoltage protection for K2 inrush circuit.

**ON/OFF CONTROL.** The purpose of the ON/OFF Control section is to connect or disconnect the power (unregulated +VB) that drives the power supply circuits. This is performed by the ON/OFF relay K2. K2 is a latching relay. A pulse to one coil will set it in one state, whereas a pulse to the other coil will reset it to the other state. When no power is applied to either coil the relay will remain in its last state; thus, even if there is a brownout or if all power is removed, when power is reapplied the instrument will be in its last state (either ON or OFF).

The front panel POWER key (S1) is a momentary switch, which means it returns to its normally-open circuit condition when the actuating force is removed. Referring to the schematic diagram, Figure 8-38, the front panel POWER key is connected to the input (PS IN) of the ON/OFF Control Circuit. When the power switch is not activated, transistor Q11 is biased OFF, and there is no input to the +5V regulator U8(1). Thus, there is no voltage out at U8(3). This way, as long as the power switch is not depressed, the ON/OFF Control circuit draws no power. Hence, when the instrument is OFF, the battery is not being drained.

**Power ON.** Pressing POWER key S1 momentarily draws current from the base of transistor Q11. Thus, Q11 turns ON and the dc source (SYSTEM POWER) input is momentarily present at the collector of Q11 which is connected to the input of the +5V regulator U8. U8 outputs regulated +5V to power the ON/OFF circuit. U13 keeps the output of U13(5) LOW until the voltage at U13(3) charges up to equal the +2.5V reference of U13(1) — this time constant is set to 13 ms.

At this point, U13(5) outputs a positive edge which is fed to the one shot U14(10). U14(5) then outputs a positive squared pulse to NAND gate U10(1,4). If  $L_{UP\_RST}$  line is LOW (which it is if the instrument is OFF), it causes a negative pulse out at only U10(6) that triggers one shot U11A to output a negative pulse at U11(4), which turns on Q14. When Q14 is ON, its collector current energizes the first coil of the relay K2 causing the normally-open relay switch to close and the normally-closed relay switch to open. The closed relay switch connects the SYSTEM POWER input to the Power Supply Input circuit via the +VB line to the rest of the instrument, turning the instrument ON.

**Power OFF.** When the instrument is ON, the pressing of the POWER key starts the same sequence of events described in the previous paragraph, except  $L_{UP\_RST}$  is already HIGH. Thus, the pulse generated by U13(5) passes through U10A(3) instead of U10B(6). This triggers the one shot U11B(9), producing a negative pulse of approximately 13 ms at U11B(12). This turns on Q13, and the collector current from Q13 energizes the second coil of the relay K2 resetting the relay. This disconnects the SYSTEM POWER input from the +VB line, turning the instrument to Standby (OFF). (Note that some circuits may still be ON when the instrument is in Standby; also, high voltages may be present.)

**MECHANICAL SHOCK PROTECTION.** Relay K2 is a latching relay, and it is susceptible to mechanical shocks that can cause the relay to switch states (OFF to ON, or vice versa). The Mechanical Shock Protection (MSP) circuit prevents instruments that have a battery installed from accidentally turning ON from a physical shock, thus preventing unwanted draining of the battery.

Whenever relay K2 turns ON or switch K2(7,8) closes, the MSP circuit checks the ON/OFF control circuit to see if the POWER key was pressed. If it was not pressed (noted by the ON\_OFF\_POWER node staying at zero volts), then the MSP circuit immediately sends an OFF pulse to AIK2 if the instrument is operating on battery power. If the ON\_OFF\_POWER signal is present at turn on, then the MSP circuit is inactive.

The MSP circuit works in conjunction with the Undervoltage Protection Circuit. In the Undervoltage Protection circuit, operational amplifier U3B turns ON transistor Q8 if the instrument is battery powered. If the MSP circuit is activated, it pulls the base of transistor Q5 LOW, causing it to turn ON. When Q5 and Q8 are both ON, a H\_OFF signal is sent to relay AIK2, shutting it OFF.

When the HP 5347A/48A first turns on normally (via the POWER key), the ON\_OFF\_POWER node is momentarily pulsed HIGH. This positive pulse pulls the junction of the three cathodes of diodes CR100, CR101, and CR102 HIGH via input diode CR102. Since this junction is momentarily HIGH (only when the POWER key is held down), the +5V\_BUF supply (which will be present after the POWER key is pressed) that is connected to the anode of CR100 keeps the three-diode junction HIGH after the POWER key is released and as long as the instrument is ON.

Diodes CR100, CR101, and CR102 isolate the MSP circuit from the rest of the instrument when the MSP circuit is inactive. More specifically, CR102 isolates the MSP circuit from the ON/OFF control circuit, CR101 isolates the MSP circuit from the Undervoltage Protection Circuit, and CR100 isolates the MSP circuit from the 10 MHz Timebase Circuits.

The MSP circuit is only active as long as there is a LOW at the three-diode junction. Note, if +5V\_BUF were to drop out and the instrument was operating off battery, the MSP circuit would then turn AIK2 off.

**UNDERVOLTAGE PROTECTION CIRCUIT.** The purpose of the Undervoltage Protection Circuit section is to detect when the battery (Option 002) voltage level goes below +12V dc. This circuit also detects when the battery voltage level drops to +13V, sending a warning indication to the instrument that the battery power is low.

This circuit monitors +VS. +VS is divided by voltage divider R27, R28, R29, R30 and R31. Comparators U3 compare the voltages at pins 9, 4, and 6 to the +2.5V reference at pins 8, 5, and 7, respectively. The +2.5V reference comes from voltage regulator U15. The first comparator circuit U3 (9,8,14) and transistor Q5 detect when the battery voltage (+VS) goes below +12V. This voltage turns on transistor Q5, passing through transistor Q8 which is always ON when the battery is the power source. Q8 collector goes HIGH and energizes the coil that is connected to diode CR11, causing K2 to reset; thus, the battery is disconnected, preventing further draining of the battery.

The second comparator circuit U3(5,4,2) and transistor Q8 enables the cutoff point of +12V for the battery only. When an external source is present, U3(4) is LOW. This LOW causes U3(2) to go HIGH, turning OFF transistor Q8. The turned-off Q8 isolates the collector of Q5 from the H\_OFF line that is connected to coil of relay K2. Thus, when +VS goes below +12V and Q5 turns ON, the H\_OFF line remains LOW, leaving relay K2 in its ON state. When the battery is used as the source, U3(4) is HIGH. This HIGH pulls U3(2) LOW, turning on transistor Q8.



Now, Q5 becomes the switch that controls the H<sub>OFF</sub> line since Q8 is now a short to the collector of Q5 and the H<sub>OFF</sub> line.

In the last comparator circuit, U3(1) goes LOW if +VS goes below +13.4V. This voltage at transistor Q6 pulls the L\_BAT\_LOW line to the A4 microprocessor LOW, warning the microprocessor that the battery voltage is LOW. The microprocessor in turn sends a signal to the Display Logic Circuit, which causes the "Bat" annunciator to flash on the HP 5347A/48A.

**DC TO DC SWITCHMODE CONVERTER.** Figure 8-10 shows a simplified block diagram of the DC to DC Switchmode Converter section. It consists of the Pulse Width Modulator, the Switching FET Drivers, the Switching Transformer, the Secondary Voltage Outputs, and the Regulator Feedback circuits. The DC to DC Switchmode Converter is a fixed-frequency, variable pulse-width regulator. The pulse rate or frequency of switching is established by the internal Variable Control Oscillator (VCO) of the Pulse Width Modulator, U16. Regulation is accomplished by permitting the pulse width or "on" time to vary; this technique is referred to as duty-cycle or pulse width modulation. This square wave is then stepped up by the transformer and averaged by the rectifier/filter outputs.

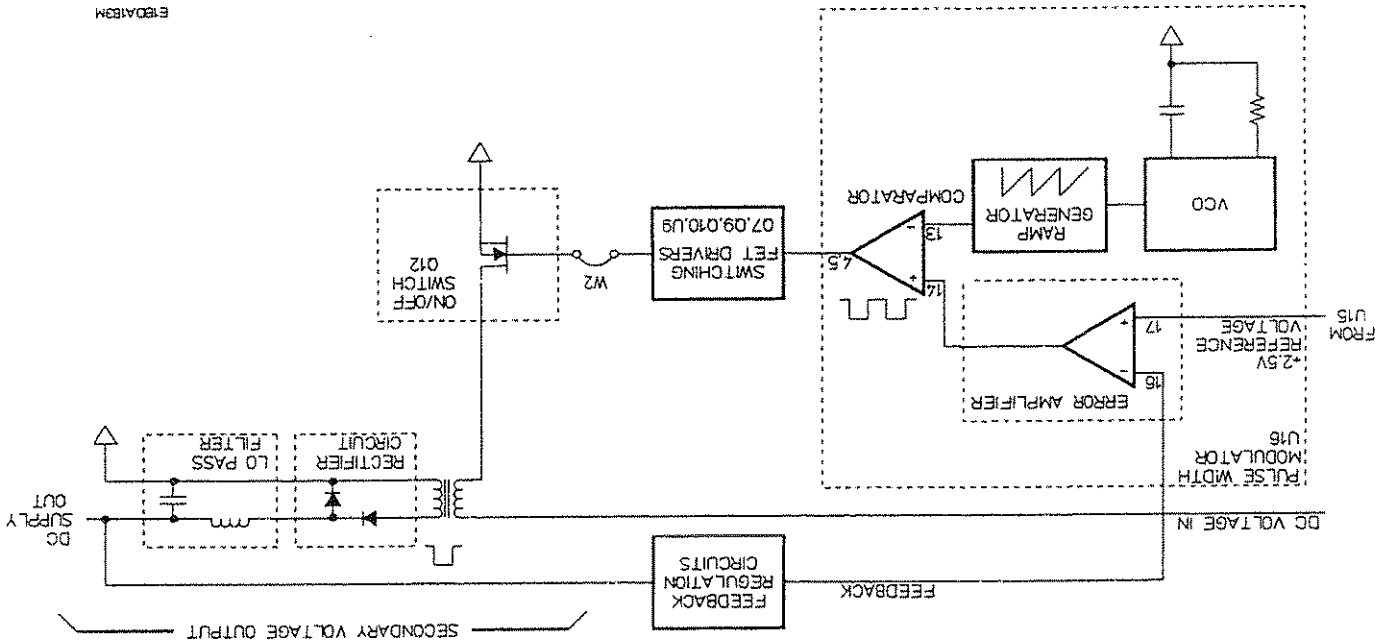


Figure 8-10. Simplified Block Diagram of the DC to DC Converter

The DC to DC Switchmode Converter circuits are discussed in detail in the following paragraphs.

Pulse Width Modulator (PWM). The PWM integrated circuit, shown in Figure 8-11, controls the power supply's regulation by varying the pulse width of its outputs, U16(4,5), which drive the Switching FET Driver circuit.

The output of PWM IC, U16(4,5), pulse width or duty cycle is proportionally varied depending on the unregulated +VB supply. U16 receives two inputs: the +2.5V reference voltage from U15(2) at U16(17) and the feedback voltage from the Feedback Compensation circuit at U16(16). These two voltages are compared by the internal operational amplifier (op amp) of U16. This op amp functions as an error amplifier. Any difference in the input voltages at pins 17 and 16 causes the op amp to output at U16(15) an output error voltage. The error amplitude and polarity of this error voltage will be proportional to the difference. The error voltage is fed to U16(14), the input to U16's internal comparator. This comparator compares the error voltage with the fixed-frequency ramp voltage of the internal VCO and ramp generator circuit. The output of the comparator is used to drive the internal pulse circuit of U16. The internal pulse circuit output is U16(4,5), the varied pulse that drives the Switching FET Driver circuit.

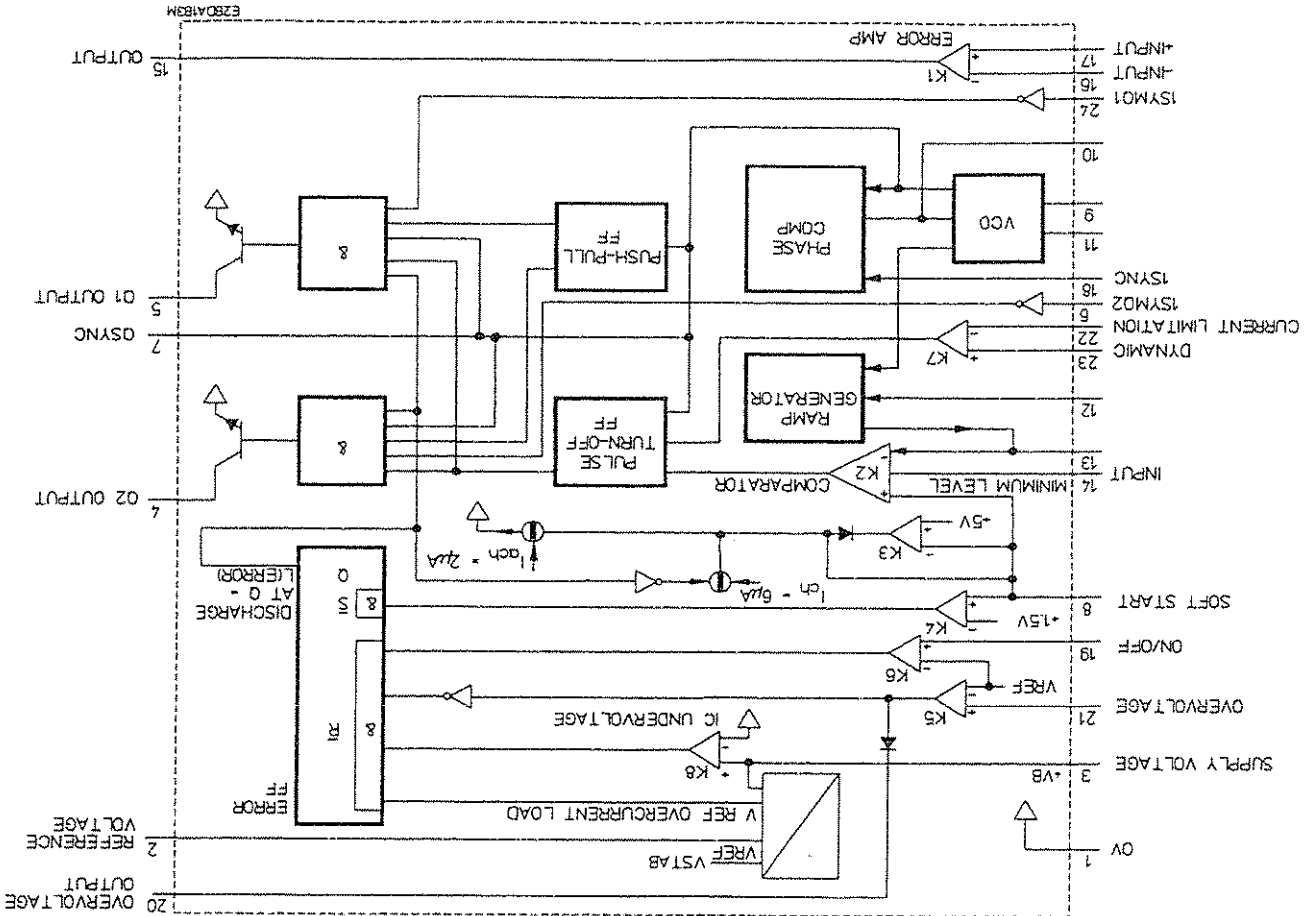


Figure 8-11. Pulse Width Modulator IC (U16)

The duty cycle of the ON/OFF waveform (at the gate of Q12) is between 15% - 45%, and Q12 is never ON more than 50% of each cycle; thus, the fields for the core reverse and will reset the core. To guarantee this, the voltage at T2(11) is fed back through R78 to U16(6,24). The voltage at U16(6,24) is also limited by CR21 and CR22 to swing between about -0.5 volts and + 3.0 volts. When T2(11) is HIGH, pulling U16(6,24) HIGH, this inhibits outputs U16 (4,5). When T2(11) is LOW, and U16(6,24) are LOW, the outputs U16(4,5) are not inhibited. The only time

additional fast inductive spikes at the transitions. With this clamp, the source for Q12 will swing from about 0 volts to twice +VB, with some inductance is thus not actually dissipated, rather it is pumped back into the dc supply filter. The energy stored in the leakage then collapse, and the windings will all go back to zero volts. The energy stored in the leakage clamping diode CR13 starts conducting until the leakage energy is dissipated. The fields will on the windings will continue to rise until the clamp winding T2(11) goes above +VB. Then leakage inductance with stored energy. In trying to dissipate this energy the reversed voltages The transformer T2 is designed to transfer all energy, and store none, but there will be some

transition of current flow from the series diodes and the freewheeling diodes. All these diodes are actually faster than the power FET Q12, so there is a smooth until the freewheeling diode turns ON and begins to conduct (CR15 (3,2), CR14 (3,2)), CR18, Since current is still flowing in L9, the voltage on the rectifier side of each winding will drop

When Q12 turns OFF, the voltage across the primary winding reverses, as do all the secondaries. This causes all the series diodes to reverse bias. At this point, all leads from the transformer T2 are cutoff, except T2(9), the dc supply for the primary.

When Q12 turns ON, current begins to flow through the primary of T2 into Q12. There is also a voltage drop across the primary winding of +VB [T2(9) to T2(10)]. This voltage transition is transformed to the four output secondaries and the one clamp secondary. When Q4 is ON, all the output series diodes are conducting (CR15 (1,2), CR14 (1,2), CR16, and CR19) and all the freewheeling diodes (CR15 (3,2), CR14 (3,2), CR18, and CR17) are reversed biased. While Q12 is ON, this allows the current in all windings of L9 to ramp up.

When Q12 turns OFF, the voltage across the primary winding reverses, as do all the secondaries. This causes all the series diodes to reverse bias. At this point, all leads from the transformer T2 are cutoff, except T2(9), the dc supply for the primary.

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T2(11) is HIGH is after Q12 has turned OFF, and there is still some energy stored in T2. Therefore, with U16(4,5) inhibited, Q12 cannot turn ON again until all energy stored in T2 is dissipated.

High Frequency Noise Filtering. This filter consists of the inductor L6, capacitors C46, C47, C54, C55 and diode CR20. While Switching FET Q12 is ON, it draws a sharp current pulse from C47, generating high frequency noise. L6, C46, C47, C54, and C55 form a filter to block this noise from feeding back to the power sources. L6 also acts as a surge suppressor, slowing down the current surge into C47 at turn on. CR20 protects the circuits from voltage overshoots from L6 at turn on and turn off.

Secondary Voltage Outputs. This circuit consists of the fast switching halfwave rectifiers CR15, CR14, CR16/CR18, CR19/CR17, and their associated inductor and capacitor. The inductor and capacitor combination after the switching rectifiers are Low Pass Filters that essentially average the output voltage of the rectifiers, converting the switching voltage to a dc voltage.

The secondary supply voltages are determined by the turns ratio of the switching transformer, the input voltage, the duty cycle and a voltage drop across the series and freewheeling diode as described in the Switching FET Drivers section. Refer to the Switching FET Drivers section for details on how the Secondary Voltage Outputs circuit operates.

The -24V supply is slightly different than the other four supplies. Its energy is transferred in from the coupled inductor L9(7,12) only, not from the switching transformer. During the ON part of the switching cycle, energy is coupled in from the other windings of L9 and stored in the -24V winding, L9(7,12). During this time diode CR23 is reverse biased. Then during the OFF portion of the switching cycle, the voltage across L9(7,12) reverses, diode CR23 starts to conduct, and this circuit is now in the freewheeling mode, with the energy supplied to the -24V supply coming from the stored energy in the inductor. The -24V dc level is again set by pulse width and the voltage in (determined by the turns ratio between the +5V winding, L9(3,4), L9(2,5), and the -24V winding L9(7,12)).

Feedback Regulation. The Feedback Regulation circuit is part of the feedback regulation loop of the DC to DC Switchmode Converter. It is composed of C57, R80, R82, R89, R83, R88, and C50. This resistor and capacitor network divides the regulated +5V in half and sends it to U16(16) where it is compare to the 2.5V reference at U16(17).

A1 POWER SUPPLY BLOCK MISCELLANEOUS CIRCUITS. The following paragraphs describe additional circuits in the Power Supply Block which are not actually part of the Power Supply.

Power Supply Status Circuit. This circuit monitors all power supplies ( $\pm 5V$ ,  $\pm 18V$ , and  $-24V$ ) of the Secondary Voltage Outputs circuit. The Dual operational amplifier U12 and all the resistor networks are essentially a summing amplifier circuit that sums all of the supply voltages to determine if all supplies are good, or if one or more are bad. If all supplies are within their specifications U12(1,7) is HIGH, turning on transistor Q15. Q15 collector goes LOW and turns ON light-emitting-diode (LED), D51. Q15 collector is tied to the L\_PWRSP\_OK line which will also be LOW when D51 is lit. This LOW Line tells the A4 microprocessor that all supplies are good. If at least one supply is bad, U12(1,7) is pulled LOW. This LOW turns OFF transistor Q15 and D51, causing the L\_PWRSP\_OK line to go

HIGH Diode CR12 keeps U12 inputs from going below zero volts, preventing damage to the inputs of U12.

+5V Power Supply Filter for HP-IB (for Option 010). This filter keeps signals from the HP-IB circuit out of the +5V supply. 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 Assembly. The CMC filter consists of T1, C32, and C33.

Power Meter Dual Tracking Regulator (U17). U17 and its associated components provide balanced +15V and -15V outputs at current up to 100 mA to the Power Supply Decoupling circuit of A8 Power Meter Analog Assembly. Balanced voltage outputs are needed because of the precision requirements of the Power Meter Analog circuits.

Fan Supply Voltage. The instrument is cooled by a dc fan, B1. The fan is driven by the -18V dc supplied from the Regulated Voltage Outputs circuit via the Fan Connector, A1J1.

Power Supply Test Connector. Connector X1 on the A1 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. R50, R49, and R51 protect the V SENSE lines; protection resistors for other signals are on the plug-in board assemblies which generate the signals.

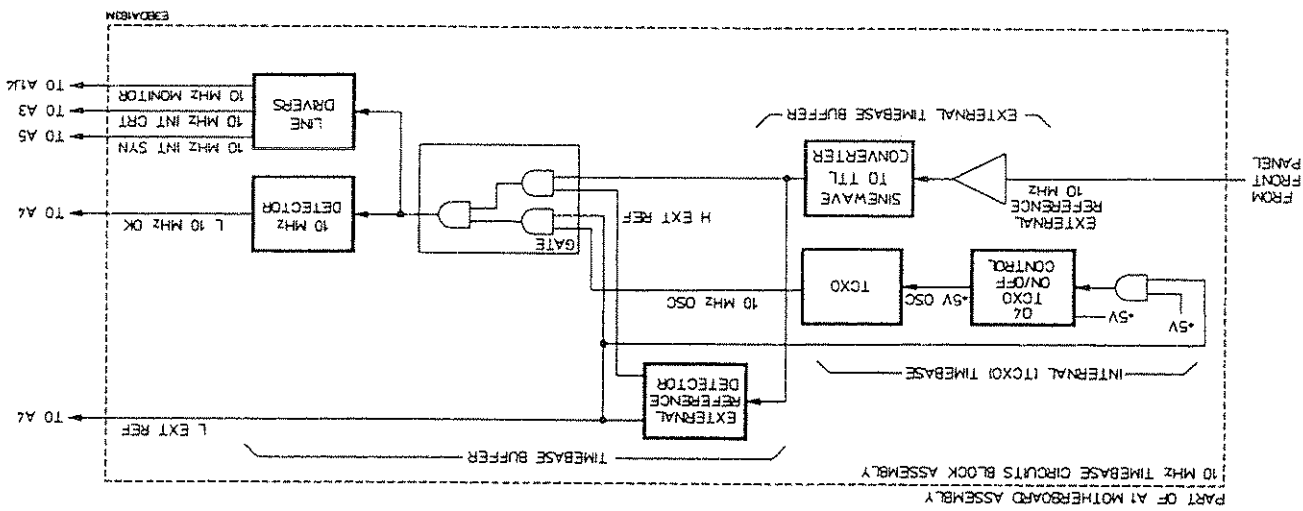
In addition to the main power supply voltages ( $\pm 5V$ , +15V, -24V), the test connector has pins for monitoring the  $\pm 15V_{PM}$  of the Dual Tracking Regulator for the Power Meter, the +5V OSC supply (from the Timebase part of A1), the A2 TEST (from the A2 Low Frequency Assembly), the MRC's +3V (from the A3 Counter Assembly), the Battery Charger circuit output, and the Battery voltage level.

System Reset. The System Power-Up Reset circuit consists of integrated circuit U20 and its associated components. U20 is a supply voltage supervisor that is used as a RESET controller in the HP 5347A/48A. During power-up, U17 tests the regulated supply voltage (+5V) and keeps output U16(5) LOW as long as the voltage has not reached +4.8V. The output U20(5) is the L UP RST or system reset signal. When the supply voltage reaches +4.8V, U20(5) remains LOW for a minimum of 100 ms, which allows the clock in HP-IB microprocessor (U5) of the optional A11 HP-IB Interface Assembly time to stabilize. After the 100 ms delay, U20(5) goes HIGH and resets the microprocessors of the A11 HP-IB Interface Assembly, the A4 Microprocessor Assembly, and the A7 Power Meter Digital Assembly.

+15V Regulator (U19). From the +18V supply, U19 generates +15V to drive circuits in A2 Low Frequency Input and A8 Power Meter Analog assemblies.

Microwave Sleep. To reduce forms of electromagnetic interference at particular times, a microwave turn-off on the motherboard allows 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.

Figure 8-12. 10 MHz Timebase Circuits Block Diagram



The 10 MHz Timebase Circuits block, shown in Figure 8-12, on the A1 Assembly conditions an internal or external timebase reference signal so that it can operate the instrument synthesizer, its MRC Counter, and provide a reference signal from which other instruments may be operated. The internal timebase reference source is a 10 MHz Temperature Compensated Crystal Oscillator (TCXO). An external reference source must provide a sine or square wave at 10 MHz, 0.7V p-p minimum to 8V p-p maximum into 1 k $\Omega$  shunted by 30 pF.

8-162. 10 MHz Timebase Circuits Block (Part of A1 Motherboard Assembly)

The microwave turn-off circuit is controlled by the L uW OFF line from A4 microprocessor. U21, Q16, Q17, R96, and R94 gate the +13V SW to the sampler driver part of A12 Assembly. Q18, Q19, R93F and R98 gate the +5V SW to the IF preamplifier part of A12 Assembly.

The Keyboard/Display Logic block, as shown in Figure 8-13, consists of two major sections: the Keyboard circuit, and the Display Logic circuit. The Keyboard circuit includes the 6-key matrix membrane keyboard, the Key Encoder (U23), the Keyboard Microprocessor Interface circuitry (U22), and the Synchronization and Timing circuit (U24). Both the Keyboard and

### 8-164. Keyboard and Display Logic Block (Part of A1 Assembly)

Inductor L9, and capacitors C14 and C61 filter, decouple, and bypass the +5 volt dc (+5V OSC) supply to Y1 as shown in the A1 Motherboard schematic diagram, Figure 8-38. This +5V supply remains ON when the instrument is in Standby mode, but is OFF whenever an external frequency standard is used.

The Temperature Compensated Crystal Oscillator (TCXO) circuit, shown in Figure 8-12, supplies the internal 10 MHz reference signal to the Time Base Buffer circuit on the A1 Assembly. The TCXO, Y1, generates a TTL compatible 10 MHz signal. Y1 output frequency is adjustable through a hole in the rear panel of the instrument (TCXO ADJ.).

### 8-163. Temperature Compensated Crystal Oscillator (TCXO - part of A1)

When there is no external reference, Schmitt trigger U5(3) is LOW. Consequently, the internal 10 MHz reference signal passes through gates U5(8) and U5(11) to the output line drivers.

The 10 MHz reference is distributed to the A5 Synthesizer Assembly, the MRC on the A3 Counter Assembly. R23 and C21 form a 10 MHz low-pass filter that minimizes transmission of frequency components in the synthesizer's tuning range.

10 MHz Detector U4(1) works in a similar manner to the external reference detector U4(9). 10MHz OK, U4(4), is LOW whenever a 10 MHz reference exists at the output of gate U5(11).

Gate U5(11) transmits either the internal or external pulse train. Two pulse trains cannot appear at the input of U5(12,13) simultaneously; the internal reference will appear at U5(12), or the external reference will appear at U5(13). U5(11) will always transmit whichever of the two pulse trains is present, since the nonpulsed input will always be HIGH.

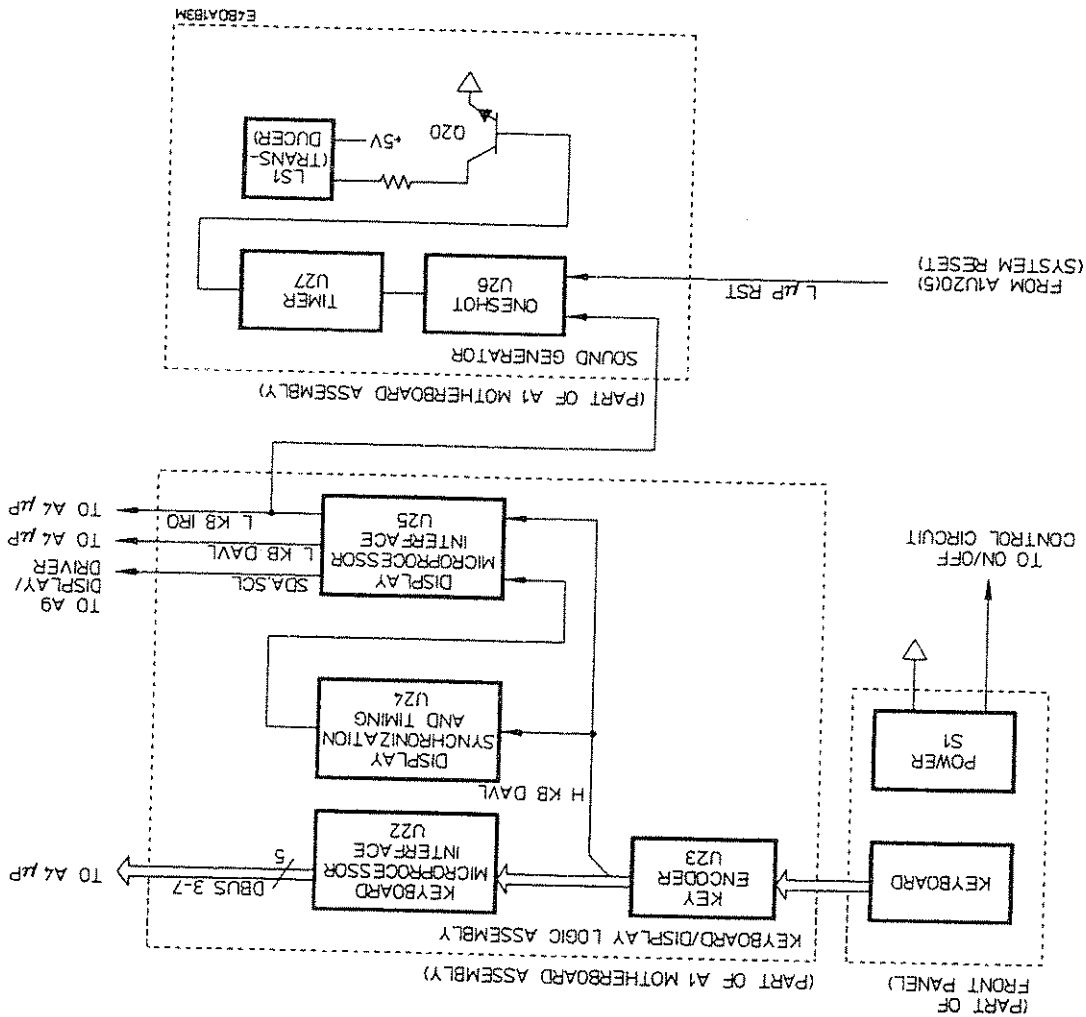
An external timebase reference will always disable the internal reference. Because the L EXT REF line is LOW when an external timebase reference is present, this line will cause a HIGH output at NOR gate U7(4), and turns off transistor switch Q4. When Q4 is OFF the +5V dc source power for the Internal TCXO Timebase circuit (L2, C7, C8, and Y1) is removed, disabling the circuit.

U4 is a retriggerable one-shot serving as a detector for external reference 10 MHz pulses. The values of R36 and C24 correspond to a triggered pulse width of 1.2  $\mu$ s. Any periodic retrigger pulse with an interval less than 1.2  $\mu$ s will keep the output of U4(12), L EXT REF, LOW, indicating the presence of an external timebase reference.

When a 10 MHz external reference is applied to the front panel External Reference Input 10 MHz (I1), the signal is amplified by transistors Q2 and Q3 and sent to trigger U5. CR2 and CR3 provide input protection. U5(3) produces a TTL level, 10 MHz square wave as the timebase reference signal. U5(3) output is HIGH in the absence of an external timebase reference.

KEYBOARD DECODE AND DISPLAY LOGIC. The HP 5347A/48A keyboard is a 6-key matrix membrane that is used for front panel function selections. The CMOS key encoder, U23, 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 C70 on the KBM input of the encoder, U23(7) as shown in A1 Motherboard schematic diagram, Figure 8-38. Scan rate is controlled by C67 on the OSC input, U23(6). U23 contains internal pull-up resistors on columns 1 through 4 of about 1M $\Omega$  each, and additional pull-up is provided by external resistor pack R99.

Figure 8-13. Keyboard/Display and Sound Generator Block Diagram



Display circuits buffer some signals through the Interface circuit (U25). The Sound Generator circuit makes up the remainder of the Keyboard and Display Assembly. The Keyboard's flat cable provides all connections between the Keyboard and the Keyboard/Display Logic and Interface circuits that reside on the A1 Motherboard Assembly. The POWER key is an independent key on the membrane panel. However, the ON or OFF pulse signal from the POWER key also goes through the keyboard's flat cable to the A1 Motherboard Assembly, and then to the ON/OFF circuit described in Section 8-161.



The A2 Assembly, shown in Figure 8-14, consists of a 1M $\Omega$  impedance 10 Hz to 80 MHz amplifier circuit, and a 50 $\Omega$  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. This connects the 50 $\Omega$  load (internal to U7) to the input from A2W1. For high impedance operation, the opposite action occurs.

### 8-165. A2 Low Frequency Input Assembly

Rear Panel Dip Switch. Rear panel dip switch S1 and pull-up resistors R25A through R25I indicate to the A4 microprocessor the instrument operating mode; that is, Measurement or Diagnostics mode, 1Hz or 10 KHz resolution, 8481A, 8484A (8481D), or 8485A sensor type.

Miscellaneous Jumpers and Pullups. Jumpers of J9 and pull-up resistors R63A through R63I are factory set connectors which indicate to the A4 microprocessor the instrument configuration and options.

KEYBOARD AND DISPLAY MISCELLANEOUS CIRCUIT. The following paragraphs describe two miscellaneous circuits.

**SOUND GENERATOR.** The Sound Generator circuit consists of one-shot U26, timer U27, transistor Q20, audio transducer L51, and their associated components. This circuit is actuated when a keypress sends the L\_KB\_IRQ interrupt signal out of U25(12) to U26(1). U26(13) outputs a positive pulse to U27(4). U27(3) generates a frequency burst for a duration determined by capacitor C79, and resistors R105 and R104. This pulse makes Q20 oscillate on and off at approximately 2 KHz, causing the piezoelectric device (L51) to "beep".

The L\_DSP\_SDA and L\_DSP\_SCL input lines are from the A4 microprocessor. These lines enables the microprocessor to interface with the A9 Display/Driver Assembly. When the L\_DSP\_SDA (Low Display Synchronization Data) goes LOW, it enables display data to be sent to the A9 Assembly. The data is accepted and displayed when L\_DSP\_SCL (Low Display Synchronization Clock) signal goes LOW.

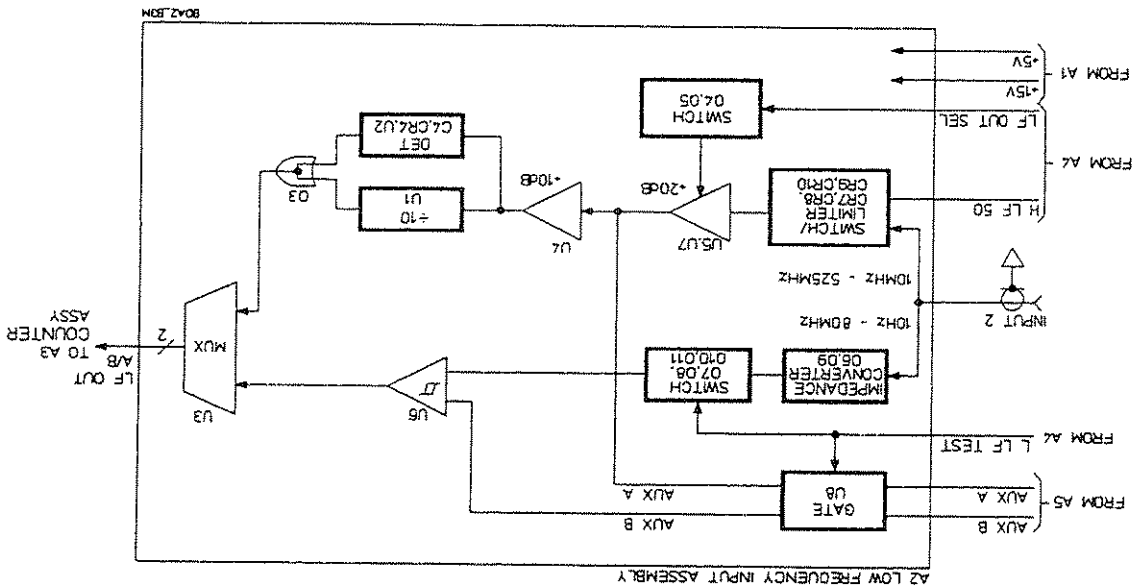
Once the keypress has passed the debounce time, the AVAIL (Data Available) output at U23(13) goes HIGH. The AVAIL signal is latched by flip-flop U24 to produce an interrupt signal for the A4 microprocessor. The output of U24 is buffered by inverter U25(12), which sends the inverted interrupt signal (L\_KB\_IRQ) to the A4 Microprocessor Assembly. The AVAIL signal also goes to the A4 microprocessor through buffer U25(10) as the L\_KB\_DAVL signal. The microprocessor uses the L\_KB\_DAVL signal to detect a key being held down for repeating. Buffers U25(12) and U25(10) block noise on the AVAIL line which may cause spurious keyboard interrupts. The 5-line output of the U23 key encoder goes to three-state inverting octal buffer U22, and then to the A4 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 U24 flip-flop.

A unity gain impedance converter consisting of Q6 and Q9 feeds a two stage amplifier and a trigger circuit consisting of U6B, U6A, and U6C, respectively. U6 is a triple differential line receiver with positive feedback around the last stage to form the trigger circuit. The output of the trigger circuit 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 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 Multiple Register Counter (MRC) on the A3 Counter Assembly.

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.

The 10 MHz-525 MHz amplifier chain consists of three 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.

Figure 8-14. A2 Block Diagram



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. 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" (or open) the front panel fuse (J2F1).

The limiter consisting of CR1, CR2, CR3, and CR5 provides 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.

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 effects.

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 502 operation and is LOW for all other functions.

### 8-166. A3 Counter Assembly

The A3 Counter Assembly, as shown in Figure 8-15, 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.

The operation of the A3 Assembly centers around the Multiple Register Counter (MRC), 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.

The MRC has three frequency input channels (A,B, and C) a gate signal input (EXT), and a timebase input (REF). Outputs include four data lines (D4-D7), 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.

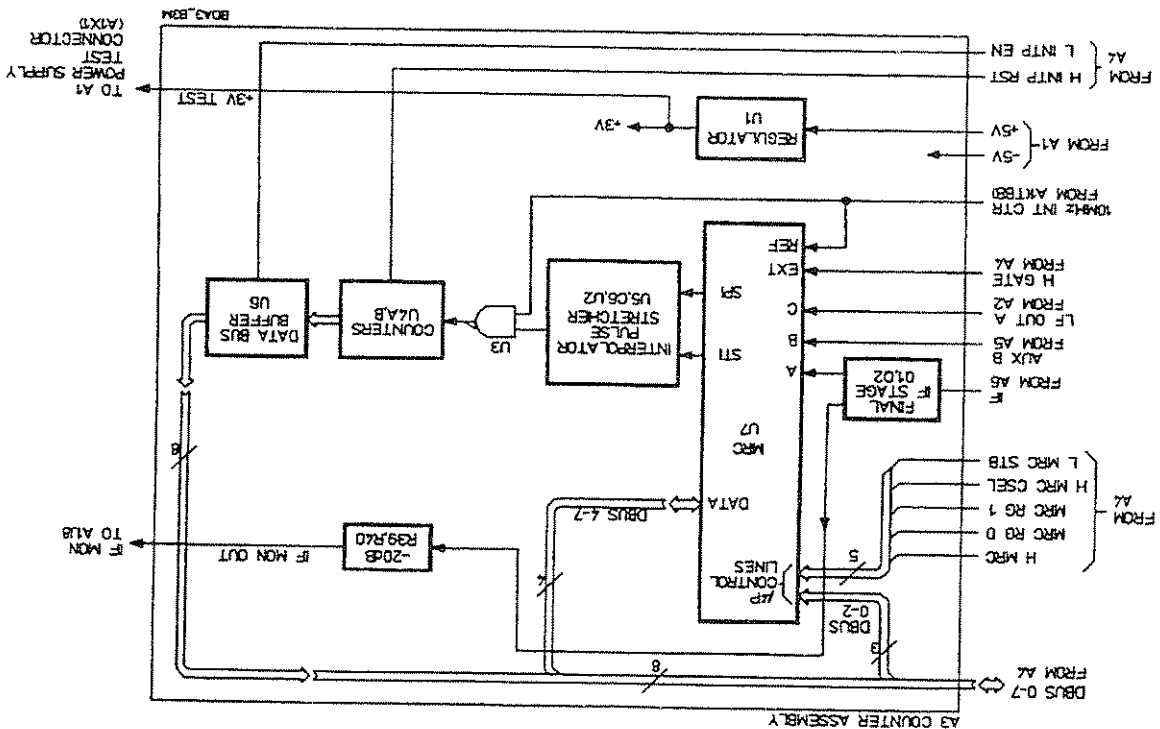
The IF signal from the A6 assembly is amplified by the final IF stage before entering Channel A of the MRC. The final IF stage consists of differential pair Q1 and Q2 driven single-ended, and has a frequency range of 35 MHz to 105 MHz. The collector of Q1 drives the Channel A input at U7(30), while the 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.

The test signal from the A5 Synthesizer Assembly enters the A3 Assembly as the 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.

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 MRF input. The LF OUT B line is terminated by R32.

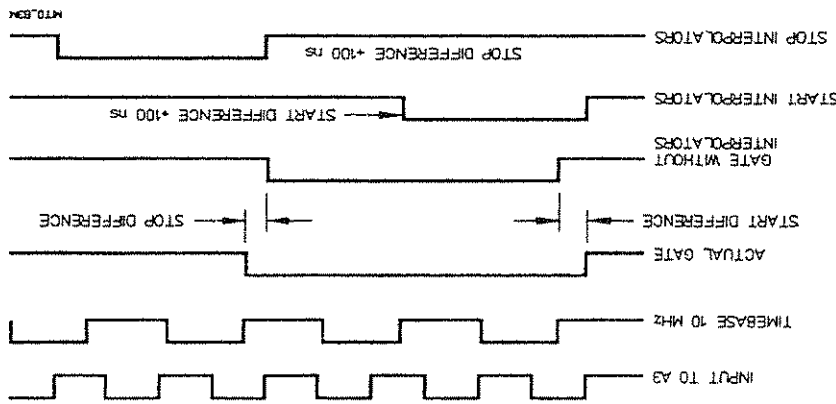
The H GATE signal is controlled by the A4 microprocessor, and is level-shifted from TTL levels by CR2, R19, and R20, to the level required by the EXT input at U7(17).

Figure 8-15. A3 Block Diagram



The MRC detects the error between event counts and the signal gate, and provides start and stop interpolator pulses representing this time difference. 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 to the interpolators. Because the Start and Stop Interpolators operate serially, the interpolator outputs are wire-ORed at the collectors of U5B and U5C. The following interpolator circuit description will discuss only the start pulse interpolation, as the stop pulse interpolation is identical.

Figure 8-16. Interpolator Timing Diagram

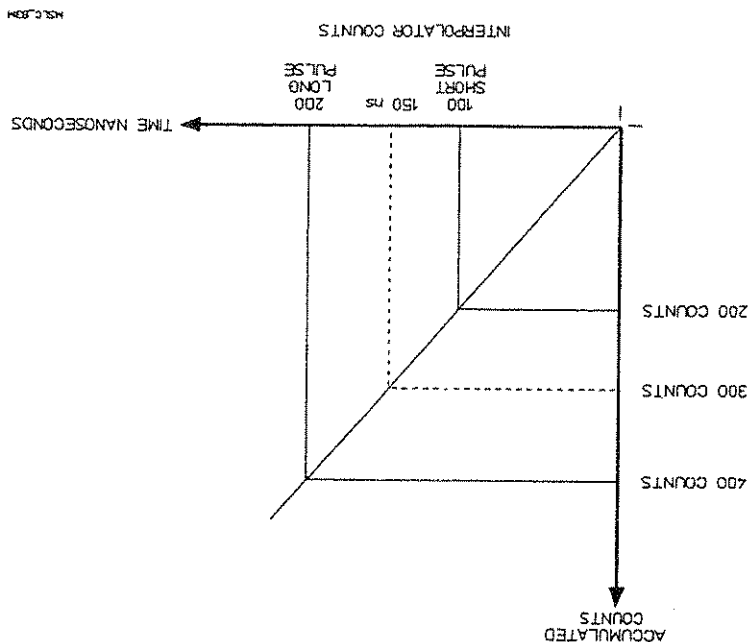


INTERPOLATORS. When measuring a frequency with the MRC, there is an inherent  $\pm 1$  count uncertainty. An interpolator circuit is used to reduce this uncertainty. The gate signal during a measurement is normally synchronous with the main clock (timebase). If the measurement gate does not open and close at the same time an event occurs (N number of events later), the time difference between the gating and the events produces 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 time (required for N events to occur) calculating the input frequency, thus eliminating the  $\pm 1$  count uncertainty. By using interpolation, resolution of the actual time can be improved to about 1 ns as shown in Figure 8-16.

Regulator U1 provides a +3 volt supply (derived from the +5 volt line) to the MRC, the final IF Supply Test connector, A1X1(7), on the A1 Motherboard Assembly.

The 10MHZ INT CTR signal from the Timebase circuit on the A1 Assembly drives the RHF input at U7(21). The 10 MHz signal also branches to NAND gate U3 to be used as part of the interpolator circuit.

Figure 8-17. Short and Long Calibration Pulses Example



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 interval) would indicate an error factor of 150 ns as shown in Figure 8-17. 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 example below.)

The integrated waveshape at the C6 node is detected by comparator U2, when the voltage reaches 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 INTF EN line, and resets the U4 counters via the H INTF RST line after the data is sent.

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.

- Microprocessor Logic (U8)
- 32K byte Read-Only Memory (ROM), U14
- 8K Byte Random-Access Memory (RAM), U15
- Input Buffers (U1, U2)
- Output buffers (U4, U5, U9, U10, U11)
- Address Buffer (U3)
- Data Buffer (U12)
- Decoding and Dual-Port RAM Decoding (U16 through U22)
- Dual-Port RAM Buffers (U6, U7, U13)
- Clock Delay (U18C, U18E, U21B)

As shown *Figure 8-18*, the A4 Assembly consists of the following main circuits:

The A4 Microprocessor 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, counter circuitry, and power meter circuitry.

### 8-167. A4 Microprocessor Assembly

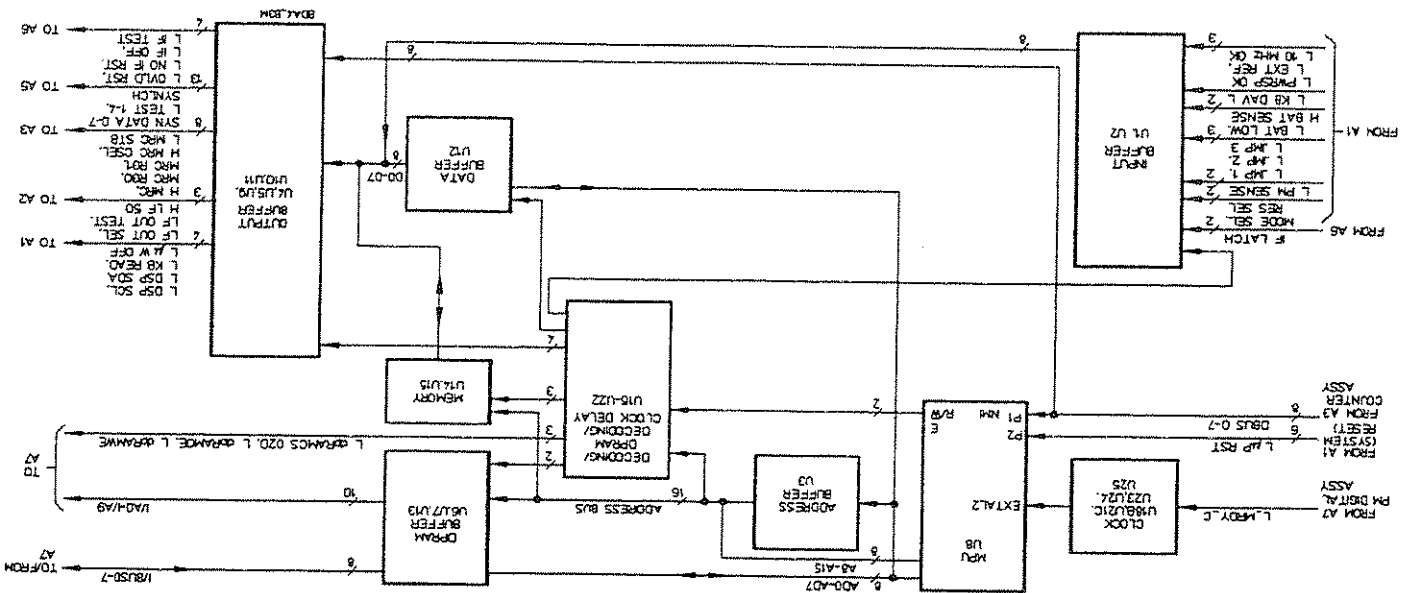
The general measurement program routine carried out by the microprocessor is to make a measurement, read the MRC registers, read the interpolator counter, perform the calculations, and display the results. Between measurements, the MRC registers and the interpolator counter are reset. For an INPUT 2 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.

All control functions are performed by the NMOS 6803 microprocessor (U8). The processor contains an 8-bit CPU, 128 bytes of on-board 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 eight 8-bit ports, a 5-bit port, and a 10-bit port for on the A4 Assembly for communication with other circuit assemblies. Three latched 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 (Port 1) and a 4-bit Data Port (Port 2) are used for bidirectional data transfer between other assemblies and the microprocessor. An 8-bit data buffer and 10-bit address buffer (the DPRAM Buffers) are used to interface with the power meter circuits on the A7 Power Meter Digital Assembly.

- 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
- Read and write from the Dual-Port RAM Buffers.

GENERAL. The main tasks the microprocessor executes are as follows:

Figure 8-18. A4 Block Diagram





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<sub>UP</sub>RST line, U8(6). The L<sub>UP</sub>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 microprocessor U8 to stabilize.

At power-up, the microprocessor is latched into its proper operating mode by the setup conditions at U8(10-12). The latching of the operating mode is explained in more detail in the paragraph titled "Latching the Operating Mode", but for now it is only necessary to know that once the operating mode is set, the processor reads from a preset ROM address (OFFFE,OFFFF). The addressed memory location contains the starting address of the operating program.

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. Refer to the schematic diagram in *Figure 8-41*.

**ADDRESSING AND DATA TRANSFER.** Microprocessor U8 uses an 8-bit multiplexed address/data port (A/D 0 to A/D 7). This port is demultiplexed by latch U3 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 U8(22-29). The required address lines are applied directly to ROM U14 and RAM U15 (lines A0-A14 for ROM, lines A0-A10 for RAM). The lower 8 bits of the address are latched by U3 on the falling edge of the strobing pulse from U8(39), causing the address to be applied to the ROM and RAM ICs for the rest of the memory access cycle.

The multiplexed address/data lines are buffered by bidirectional transceiver U12 to provide the on-board 8-bit data bus (D0-D7). The level at the EN1 input at U12(1) determines the direction of the data transfer. The U12 outputs are enabled by the rising edge of a delayed and inverted system clock signal ( $\sim\emptyset D$ ), so that the U12 outputs are three-stated during the address portion of the multiplexed bus cycle.

**READ FROM ROM.** ROM U14 is a NMOS 32K byte device. The ROM has an enable line, 15 address lines, and 8 three-state data lines. The ROM is enabled when the  $\sim\emptyset E$  input at pin 22 is a logic LOW. The  $\sim\emptyset 2D$  enable signal goes HIGH to turn off RAM U15 during the address portion of the multiplexed data bus cycle, reducing overall power consumption. The  $\sim\emptyset E$  line is the logical AND result (active LOW) of two of the read address decoder outputs from U17 (9,10,11) or U22 (1,2,4,5).

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 U8(22,23,24) are used to select 8K byte memory blocks. The  $\sim R/W$  signal is inverted by U18A to make an active LOW signal on read ( $\sim R/W$ ); this signal to U22(10) makes U22(8), the RAM WE (Write Enable) line, HIGH to ensure that the RAM is not enabled during the address portion of the multiplexed bus cycle.

When the  $\sim\emptyset E$  ROM, U8(22), enabling line is active LOW, the data at the addressed location appears at the data lines. The data is held until the enable line goes HIGH. The microprocessor 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 three-stated, the ROMs go into its standby low power dissipation state.

**RAM READ AND WRITE.** U15 is an 8K byte CMOS static RAM device. U15 has four enable lines, 11 address lines, and 8 bidirectional data lines. The CS2 (Chip Select 2) input at U15(26) is tied to +5V, whereas the ~CS1 (Chip Select 1) input at U15(20) is active LOW, and goes HIGH during the address part of the multiplexed bus cycle, saving power. The ~OE (Output Enable) input at U15(22) is always HIGH during a write, and will be discussed later. The /WE (Write Enable) signal at U15(27) is active LOW during a write. The /WE signal comes from NAND gate U22(8), the inputs to which are the ~R/W line (active HIGH during a write), the system clock,  $\emptyset$ 2 (active HIGH when data valid), and the write decoder select output lines from U20(13) (active HIGH during a write), and address line A13 from the microprocessor (active HIGH during a write). Once RAM U15 is enabled, data on the I/O lines at U15(11-13, 15-19) are stored into memory on the rising edge of the /WE signal. This completes the write cycle to RAM.

The read from RAM cycle is identical to the read from ROM cycle, but with a different address sent to the U22B, resulting in an enabling output from U22(8). The /RAMWE line is held HIGH during the read operation, and the /RAMOE line at U15(22) is active LOW. The ~OE input comes from NAND gate U22(6), the inputs to which are the R/~W line (active HIGH during a read) from U8(38), a delayed version of the system clock ( $\emptyset$ 2D), and the enabling signal from U20(13).

**READ FROM INPUT PORT.** Status condition signals from other circuits are received at the S1PRT1 and S1PRT2 input ports, using 8-bit latches with three-state outputs, U1 and U2, as input buffers. Reading from an input port is similar to reading from ROM. The enable signal for each input buffer is at pin 1. Decoder U16 read/write output is selected based on address range. When the enable signal is LOW, data at the buffer inputs, U1(2-9) and U2(2-9), is transferred onto the data bus (D0-D1). The microprocessor reads this data, via Data Bus Buffer U12, on the falling edge of the system clock ( $\emptyset$ 2), and decoder U16 disables the input buffers before the next bus cycle begins.

**WRITE TO OUTPUT PORT.** Control signals to other circuits are sent through buffer U4 and transferred via the S1PRT1, S1PRT2, and S1PRT3 output ports, using 8-bit flip-flop ICs U9, U10, and U11, as output buffers. Writing to an output port is similar to writing to RAM. The inverted system clock,  $\sim\emptyset$ 2, at pin 1 of U9, U10, and U11, is used to latch the data on the output lines (SOBUS0-SOBUS7) of U4 to the outputs of the buffers. Data transfer through each buffer is enabled only when the corresponding enable signal from read/write decoder U16 (pin 13, 14, or 15) is active LOW and the  $\emptyset$ 2 line makes the low-to-high transition. The outputs of U9, U10, and U11 are totem pole outputs, and thus are always active.

**DATA PORT READ AND WRITE.** Microprocessor U8 uses two of its ports as static data buses for data transfer to and from other assemblies. Data Port 1 (pins 13 through 20) 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 4-bit Data Port 2 (pins 10 through 12) are used for handshaking with the HP-IB processor on the A11 HP-IB Interface Assembly (Option 011). These three handshake lines (IB DVAL, IB DREC, IB DDIR) provide synchronization between the two asynchronous processors. The fourth Data Port 2 line (L KB IRQ) is used to detect an interrupt caused by a front panel key being pressed. The fifth of Data Port 2 line is not used.

The pins of the Data Port 1 (DPR1) and Data Port 2 (DPR2) 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 resistor networks R2 and R1, makes the DPR1 and DPR2 lines high level when configured as inputs. When configured as outputs, DPR1 and DPR2 lines are totem pole outputs. A read to, or write from, these ports is controlled entirely within microprocessor U8.

**WRITE TO SYNTHESIZER ASSEMBLY.** The A5 Synthesizer Assembly is programmed via a separate 8-bit latch, U5, in order to isolate the A5 Assembly from microprocessor noise. A write to the synthesizer is similar to writing to one of the SOPT outputs, except the latching signal (SYNLCH) comes from out buffer U9(9). The U5 output latch is always enabled by a ground connection at U5(1).

**INTERFACE BUFFERS READ AND WRITE TO POWER METER.** The addressing and data transferring of data from the counter to the power meter is manipulated by the Microprocessor (U8), the Decoding, the DPRAM Decoding, and the Dual-Port RAM Buffers circuits. The following paragraphs describe the Decoding, DPRAM Decoding, and Dual-Port RAM Buffers circuits.

**Decoding.** The Decoding circuit provides the enable signals for the Data Bus Buffer, U12(3), the Output Enable signal for the EPROM, U14(22), the Output Enable, the Write Enable, and the Chip Select signals for the RAM, U15 (22,27,26), the enable signals for the Output Buffers, U9, U10, U11(1), and the enable signals for the Input Buffers, U1(1), U2(1). Logic gates U18A(2), U17C(8), U22A(6), U22B(8), and 3-to-8 line Decoder/Demultiplexer U16 are the outputs of the Decoding circuit.

**Dual-Port RAM Decoding.** The Dual-Port Ram (DPRAM) Decoding circuit provides three lines to control the Counter side of the Dual-Port RAM (A7U18) located on the A7 Power Meter Digital Assembly; these lines are the chip select line (L\_dprAMCS\_Ø2D), the output enable line (L\_dprAMOE), and the write enable line (L\_dprAMWE). NAND gates U21A, U17A, and U17B inputs are control by the H\_dprAMCS and Ø2D lines. The H\_dprAMCS line enables the DPRAM Decoding gates outputs to drop LOW to select and enable the DPRAM Buffers (U6, U7, U13), and enables Data Bus Buffer U12 to latch the data to the DPRAM Buffers. The Ø2D clock terminates the read from DPRAM A7U18.

OR gate U20B and NAND gate U21D controls when data is latch from Data Bus Buffer U12 to DPRAM Buffer U13; this circuit is controlled by the H\_dprAMCS line. When H\_dprAMCS line is HIGH, data to be sent to the DPRAM Buffers is latched through Data Bus Buffer U12.

**Dual-Port RAM Buffers.** This circuit consists of two types of buffers: Interface Data Buffer (U13) and Interface Address Buffers (U6,U7). This circuit provides the necessary buffering for the DPRAM Interface Data Bus (I/DBUS) and the Interface Address Bus (I/A). Selection of any Power Meter function via the front panel keyboard or HP-IB signals Microprocessor U8 to transfer the keyboard or HP-IB data through the co-processor interface. Microprocessor U8 uses 8 bits (A0-A7) to send address codes, which represents the selected function, through the Interface Address Buffers (U7, U6), and 8 bits (A/D0-A/D7) to send/receive data through the Interface Data Buffer (U13). The output of these buffers are routed to Dual-Port RAM MPU Interface U18 of the A7 Power Meter Digital Assembly. The inverted R/W signal U18A(2)

enables the data at U13 to be sent (or written) to U18 of the A7 assembly when U21A(3) is active LOW.

**CLOCK DELAY.** Microprocessor U8 provides a single system clock output ( $\emptyset 2$ ) at U8(40). A number of delayed and/or inverted clock signals are derived from this single clock by NAND gate U21B, inverters U18C and U18E. The  $\emptyset 2$  system clock at U8(40) is a 2 MHz square wave which is active HIGH for data valid, and active LOW for address valid. Individual devices on the A4 assembly are enabled based on two things: the Decoder U16, and a precisely timed edge of the system clock. The decoding outputs of U16 have many propagation delays, and are used only for device selection, not device deselection. The  $\sim R/W$  line is also used in some of the decoding; it is not used for device de-selection.

The delayed clock signals are used for deselection of devices. The  $\emptyset 2$  signal is used to terminate the write to RAM U15, so that the cycle ends before the outputs of the processor go to their three-state mode and write erroneous information to the RAM U15. The inverted clock,  $\sim \emptyset 2$ , is used to terminate the write to the output buffers (U9, U10, U11), for the same reason.

A delayed version of the noninverted clock,  $\emptyset 2D$ , is provided by an inversion of  $\sim \emptyset 2$  by U18C. The  $\emptyset 2D$  signal is used to terminate the read from RAM U15 so that the U15 holds its data for 10 ns after Microprocessor U8 reads.

The  $\sim \emptyset 2D$  signal produced by inverted U18F is used to enable the Decoder (U16), the RAM (U15), and the DPRAM Decoding circuits.

This completes the explanations of the basic tasks performed by A4 Microprocessor Assembly. The following paragraphs describe auxiliary circuits of A4 Assembly; such as, the clock circuit, 6803 Microprocessor operating mode latching, interrupts, and power supply decoupling circuitry.

**CLOCK (CRYSTAL).** Microprocessor U8 has an internal clock generating circuit which requires only an external 4 MHz clock. Crystal oscillator U25 supplies a 16 MHz crystal frequency that is divided by 16 to give a system clock frequency of 1 MHz. JK flip-flop U24 and RS Latch U23 combination comprise a divide-by 16 circuit.

**INTERRUPTS.** Two interrupt inputs to the processor are available in addition to the  $L_{UP\_RST}$  input: the  $L_{KB\_IRQ}$  and the  $IB\_DDIR$  inputs.

The  $IRQ1$  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  $IRQ1$  input at U8(5). When the processor is interrupted, it scans the DPR12 lines to determine whether the  $L_{KB\_IRQ}$  line at U8(8), or the  $IB\_DDIR$  line at U8(12) has gone low, and executes the appropriate program based on which interrupt occurred.

To aid in troubleshooting, a red LED indicator at the top of the board lights when the synthesizer is not phaselocked. Note that all three ECL ICs on the A5 board (U7, U8, U10) operate on the +5V supply (instead of the usual -5V), to allow easier interfacing of dc coupled control signals from CMOS and TTL devices operating on the +5V supply.

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.

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.

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 phase-lock 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.

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 phase-lock loop (PLL), which gives the high frequency wideband tunable 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 8-19*), followed by a detailed circuit description.

### 8-168. A5 Synthesizer Assembly

**POWER SUPPLY DECOUPLING.** The +5V supply from the A1 Motherboard supplies Vcc for all the A4 circuitry except the memory devices. In order to keep power dissipation low, the memory devices (U14, U15) are turned ON and OFF at a 1 MHz rate (ON when data valid). This generates system noise, so L2 and C3 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.

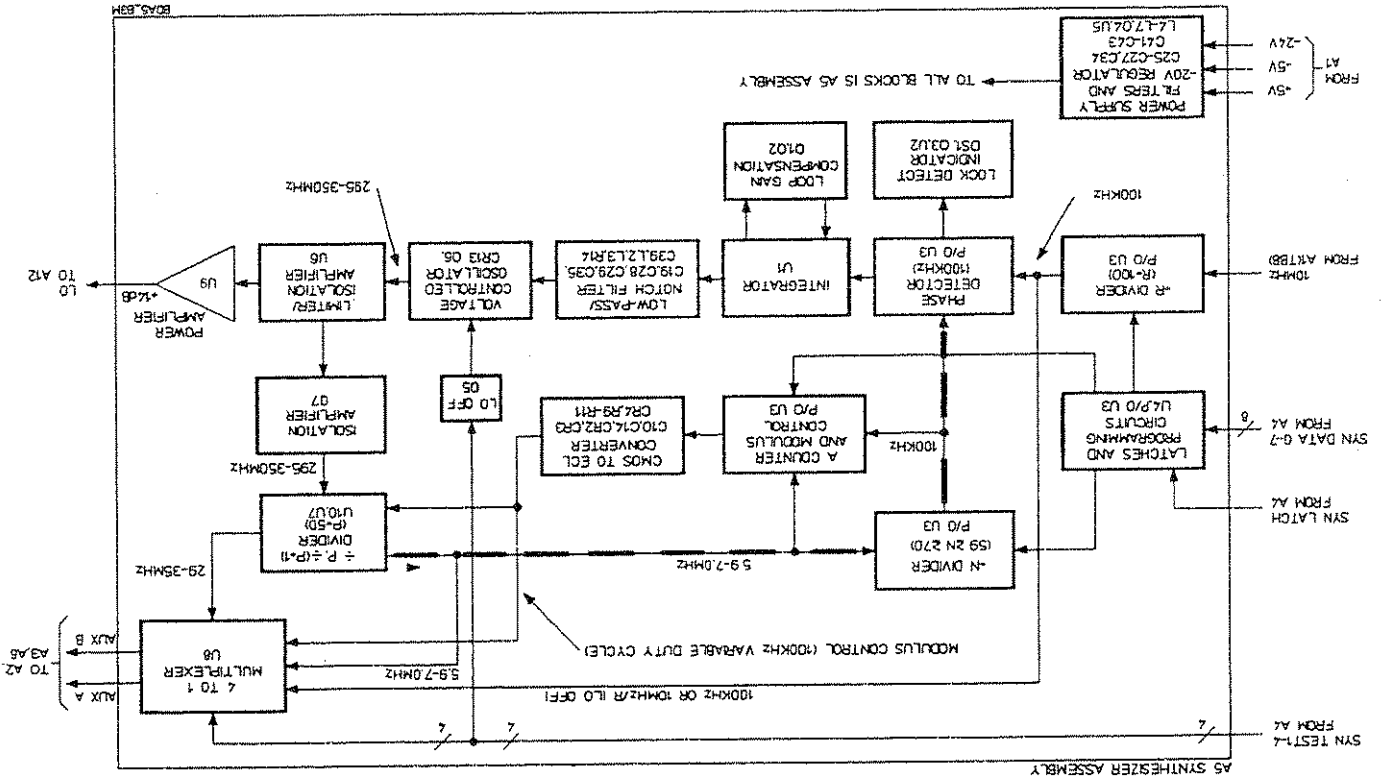
**LATCHING THE OPERATING MODE.** The 6803 (Microprocessor U8) is basically a 6801 single-chip microcomputer operating in Mode 2. U8 operating mode is established on the rising edge of the L\_UP\_RST signal from the A1 Assembly. When L\_UP\_RST signal goes LOW the cathodes of diodes CR1 and CR2 are LOW; thus, U8(8 and 9) are pulled LOW. The microprocessor U8 reads DPR2 at U8(8,9,10) for the operating mode. The levels read by the processor are 010 (binary 2), which is operating mode 2. After the L\_UP\_RST line goes HIGH, CR1 and CR2 have no effect and DPR2 operates as a bidirectional data port.

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 required synthesizer functions.

**DATA LATCH.** The programmable frequency dividers of U3 are controlled by 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.

The programming data is transferred to U3 as a series of 4-bit parallel inputs to D0-D3 at U3(2,12,0,19), 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 8-19. A5 Block Diagram



**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.

**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 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.

The +R counter inside U3 divides the 10MHZ INT SYN signal by 100 to obtain the 100 kHz reference frequency for the phase-lock loop. The value of R is always programmed to 100. **Two Modulus Counter.** Two-modulus ECL counter U10 divides the LO frequency at its Fin 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. Refer to Figure 8-20.

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.

The % 2 flip-flop in U7 does not divide the frequency, but instead provides an output which satisfies the input requirements of the Fin 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 Q0 outputs at U7(15,14) have the same frequency as the Q3 and 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 cycle.

**Low Frequency Programmable Divider (+N).** The Fin input (CMOS) at U3(3), which is ac coupled from the Q0 output at U7(14), is biased at about +2.4 V by R37 and R38. The Fin 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 Fin frequency down to 100 kHz (when phase-locked). N is an integer between 59 and 70 for LO frequencies in the 295 to 350 MHz range.

**Modulus Control (A/MC).** The Fin 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 Fin, 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  $N_t = (A \cdot 51) + [(N - A) \cdot 50] = (N \cdot 50) + A$ .



When phaselocked, the LO frequency will be  $N_t \cdot 100 \text{ kHz}$ , that is,  $f_{LO} = [(N \cdot 50) + A] \cdot 100 \text{ kHz} = (N \cdot 5 \text{ MHz}) + (A \cdot 100 \text{ kHz})$ . 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.

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,  $N_t$ , is always a whole number.

CMOS-to-ECL Converter. CR2, CR3, CR4, CR10, 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).

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.

PHASE DETECTOR. The phase detector inside U3 compares the 100 kHz signal from the reference divider, FR, with the signal from the internal  $\%N$  divider, FV (100 kHz when phaselocked). The phase detector output (PD) is normally high impedance, but it pulses high or low at a 100kHz 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 FV leads FR and high if FV lags FR, and the pulse width is proportional to the phase difference between FV and FR. The phase-lock 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.

If the phase-lock loop is not phaselocked (FV not 100 kHz), the phase detector (PD) output of U3 will be pulsing high if the LO frequency is too low (FV > 100 kHz) or pulsing low if the LO frequency is too high (FV < 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 FV and FR. The dc component will tend to drive the phase-lock loop toward the locked state.

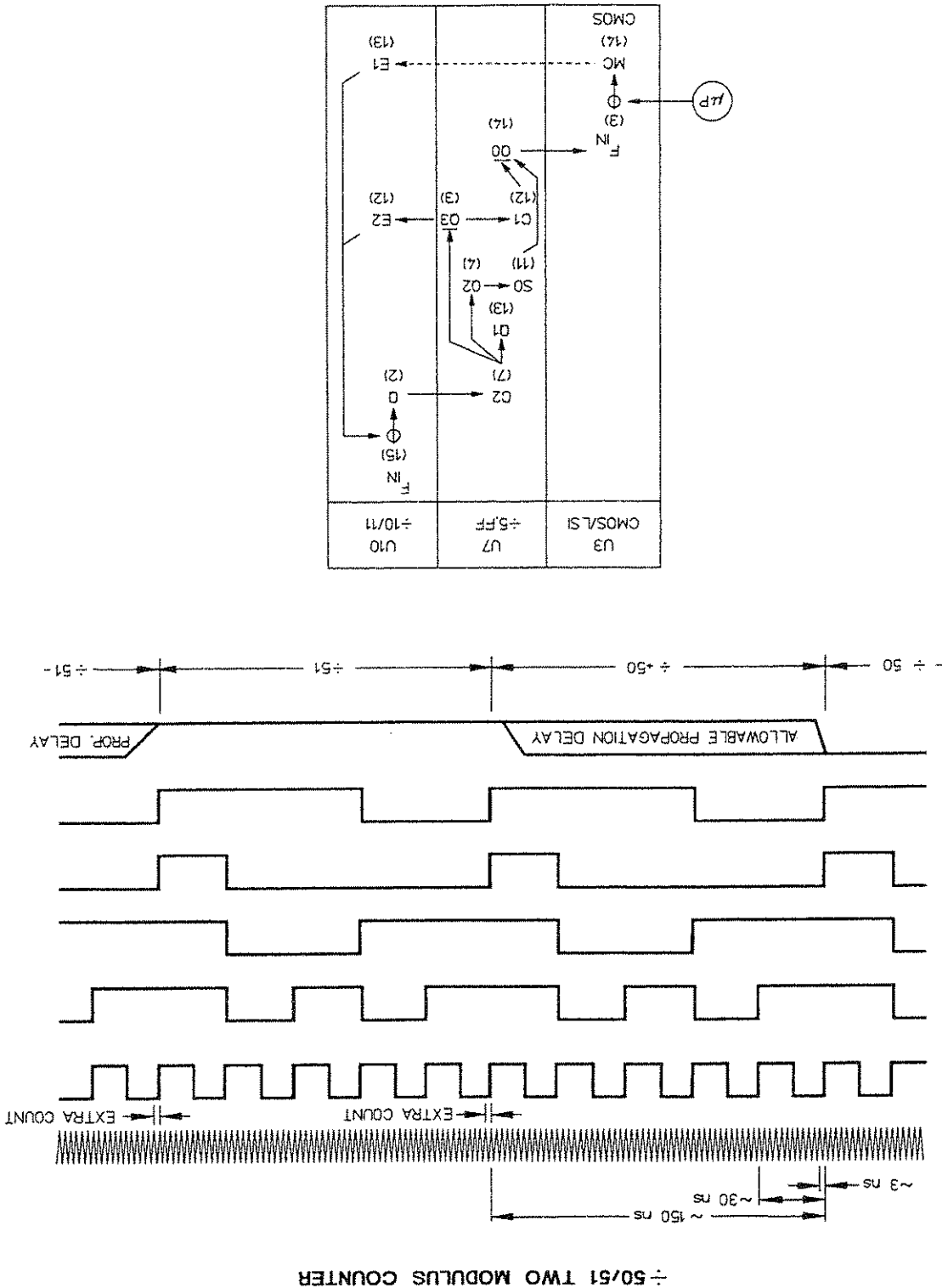
PHASELOCK INDICATOR. A red LED indicator at the top of the A5 board lights when the synthesizer is not phaselocked. The LED flashes at a rapid rate (it may appear to be just dimly lit) during the signal acquisition sweep in Auto mode. The lock indicator is derived from the phase detector.

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.

**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 to change 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.

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 8-20. Two-Modulus Counter (divide-by 50/divide-by 51) Timing Diagram



The noninverting input at U1(3) is biased at about +2.35V dc by R8B, R4, and R8A. When the synthesizer is phase-locked, 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 phase-locked, the PD output of U3 will have narrow low pulses (20-100 ns).

When the synthesizer is not phase-locked, 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.

**LOOP GAIN COMPENSATION.** The phase-lock 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 phase-lock loop stable.

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 phase-lock loop gain. 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.

**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.

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 phase-lock loop can be monitored or influenced through the PLL OUT and PLL IN connector pins.

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.

**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 firmware control.

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.

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 and 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.

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.

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 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.

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.

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.

U6 is a monolithic differential pair of transistors (and three 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 peak-to-peak near-square wave of current. The small inductance of jumper W2 in series with the output to the main LO power amplifier improves the bandwidth.

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. Q7 also transforms the near-square wave of current from one output of limiter/isolation amplifier U6 into a near-sine wave of voltage at the clock (Fin) input of digital divider U10. The signal at the collector of Q7 is ac coupled to the clock (Fin) input of divider U10 and to R36. R36 is the main load on the isolation amplifier and also biases the Fin input at U10(15) from the Vbb output at U10(14). The fundamental frequency voltage amplitude at U10(15) is typically about 1 Vp-p.

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.

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 1M $\Omega$  and 50 $\Omega$  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.

The AUX multiplexer circuit consists of U8, resistor network R32, and power supply bypass capacitors C48 and C49. U8 is an ECL IC which has four 3-input OR gates whose outputs feed an internal 4-input 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.

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:  $3 < R < 4096$ )

\* L TEST 4 also turns off the VCO

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.

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.

U5 is a three-terminal adjustable voltage regulator that maintains a -1.25V difference between its output (Vout) 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.

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 -1.35 volts, 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.

### 8-169. A6 IF Amplifier/Detector Assembly

The A6 IF Amplifier/Detector Assembly, shown in Figure 8-21, amplifies the IF signal from the A12 Microwave Assembly, and converts it into an amplitude limited waveshape for the A3 Counter Assembly. 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.

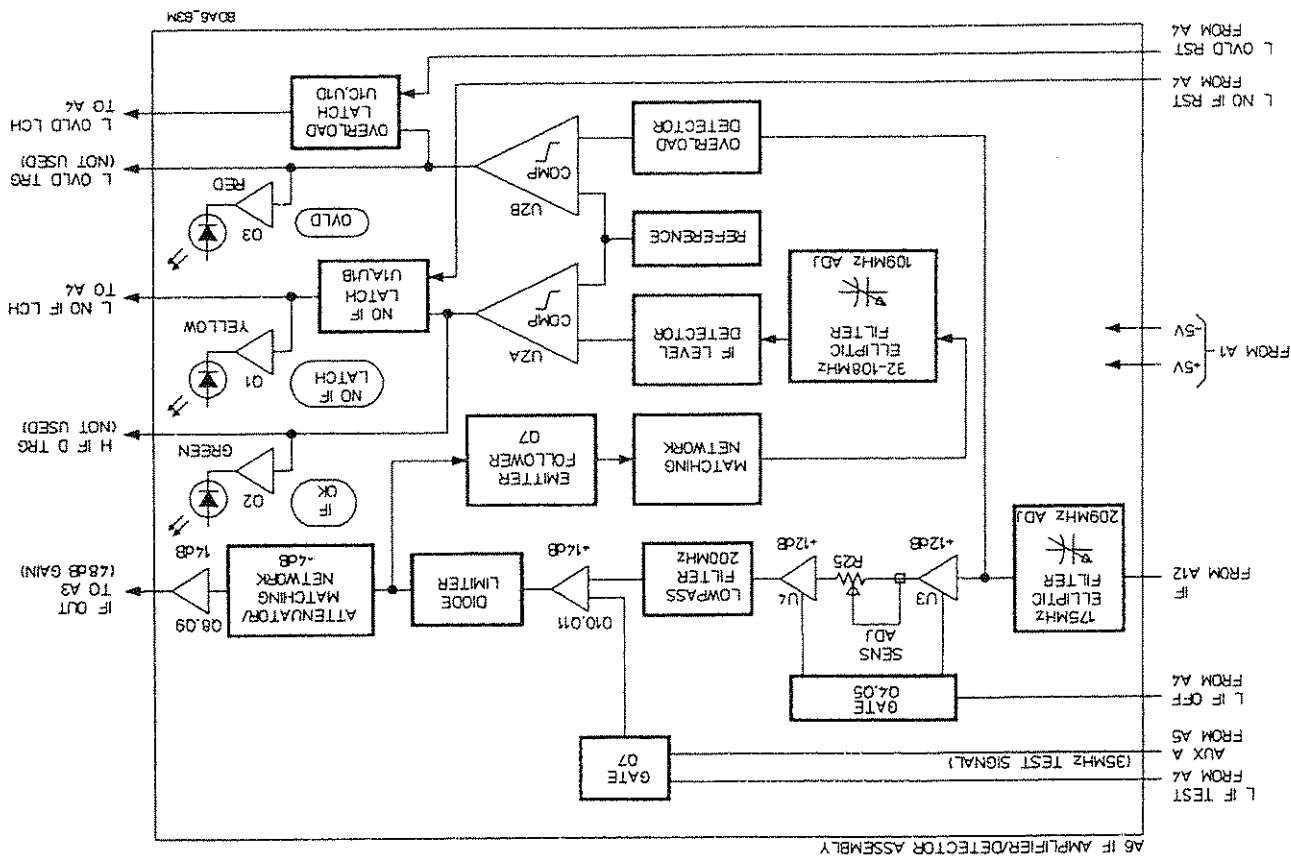


Figure 8-21. A6 Block Diagram

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.

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.

There are several networks cascaded with the main signal path. The first is the 175 MHz low pass 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.

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.

**OVERLOAD DETECTION.** An overload condition is sensed at the output of the 175 MHz 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 DSI red LED (OVL D). The latch output (L OVL D LCH) is checked by the A4 microprocessor at the end of the count. The latch is then reset via the L OVL D RST line.

**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.

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.

**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 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.

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.

## 8-170. A7 Power Meter Digital Assembly

The A7 Power Meter Digital Assembly is a microprocessor based interface board that contains the firmware (ROM) that controls the overall operation of the Power Meter functions of the HP 5347A/48A. A combination of the ROMs, CPU, and interfacing circuits of the A7 Power Meter Digital and the A4 Microprocessor assemblies enable power measurement of an input signal received by A8 Power Meter Analog Assembly.

A7 Digital and A8 Analog assemblies work together to convert the analog power measurements to a digital value - the digitized data is in Programmable Timer Module (PTM) U8 and Analog Ramp Counter U9. Upon selection of any of the Power Meter's functions via front panel keyboard or the HP-IB program codes, data is sent to A4 microprocessor, which sends the control data to Dual-Port RAM U18 on A7 Digital Assembly. U18 reads the control data from A4 microprocessor and then writes the control data to A7 microprocessor (U13), causing the digitized power measurement to be read, manipulated, and then displayed in units of dbm or watts.

As shown in Figure 8-22, the A7 Power Meter Digital Assembly consists of the following circuits:

- Central Processing Unit, CPU, (U13)
- 1 ms Interrupt (U2B)
- Timer (U2, U3E, U1, U4, U5)
- Address Decoding and Control (U3C, U3D, U6A, U10, U14)
- Memory (U16, U17)
- Counter to Power Meter Interface (U18)
- Input/Output (I/O) Interface (U12, U11)
- Analog-to-Digital (A/D) Interface (U6B, U3A, U9, U8, U7)

Refer to Figure 8-44, A7 Power Meter Digital Assembly Schematic Diagram, to help understand the following paragraphs.

CPU. Microprocessor U13 is the Power Meter's CPU. U13 is an 8-bit 63B09E CMOS Microprocessor (which is part of the 6800 microprocessor family) that controls all of the Power Meter functions. U13 has 16 address outputs (PA0 - PA15), and 8 data pins (PD0 - PD7). The data pins are bidirectional. (The data bus lines are pulled up to +5V by pull-up resistor pack R12). U13 outputs the R/~W (HIGH READ/LOW WRITE) control signals that coordinate the movement of data on the data bus.

U13(37) RESET input is used to initialize the microprocessor internal circuitry and is controlled by the System Power-Up Reset circuit of A1 Motherboard Power Supply Block Assembly.

1 ms INTERRUPT. The 1 ms interrupt JK flip-flop U2.2 receives at U2(13) a 1 ms clock pulse from PTM, U8(3), which is part of the Analog-to-Digital (A/D) Interface circuit. With the J input, U2(11), tied to ground, and the K input, U2(12), tied to +5V, the positive-going edge of the 1 ms clock signal causes U12(9) the IRQ input to the microprocessor, U13(39), to drop to a LOW level, resulting in an interrupt. In response, the microprocessor enters an "interrupt acknowledged" state. In the interrupt acknowledged state the microprocessor sets the Bus Available (BA) signal LOW, and the Bus Status (BS) signal HIGH. These signals lines are tied to U14, the Address and Control Decoder.

Address and Control Decoder U14 (PAL) is programmed such that with BA LOW, BS HIGH, and E LOW (output of the Timer), the output signal (L IRQ RST) at U14(14) becomes LOW. The L IRQ RST signal is tied to the S (set) input of JK flip-flop, U2(10). When L IRQ RST is LOW, U2(9), the input to the microprocessor U13(3) is reset to a HIGH state, and will not drop LOW again until the next 1 ms clock pulse from U8(3) occurs, which will cause the next 1 ms interrupt to the microprocessor.



**TIMER.** The Timer section has a 16 MHz input from a crystal clock oscillator, Y1. JK flip-flop U2 divides this 16 MHz signal by two resulting in an 8 MHz signal from U2(5), which is used to drive the remainder of the clock circuitry and the Analog Ramp Counter, U9. The remainder of the clock circuitry consists of two more JK flip-flops, U4A and U4B, and clock "stretching" circuitry (U3E, U1A, and U5A). The two JK flip-flops of U4 provide a divide-by-four function, resulting in outputs Q (-STRETCH signal) and E (Enable clock), which provide the 2 MHz clock signals required by the Microprocessor U13.

The function of the clock stretching circuitry is to inhibit further microprocessor clock cycles. When the ~BUSY signal goes LOW, the U5(5) output drops LOW, causing E, U4B(9), to essentially "freeze" at a HIGH level, and Q, U4A(5), to freeze at a LOW level. The ~BUSY signal will be LOW whenever the Power Meter CPU (U13) and the Counter CPU on A4 Microprocessor Assembly try to access the same memory location in Dual-Port RAM, U18. The Dual-Port RAM serves as the interface between the two processor boards.

**ADDRESS DECODING AND CONTROL.** Based on instructions from the microprocessor U13, the Programmable Array Logic (PAL), U14, performs the majority of the memory decoding by providing and controlling Chip Select lines to the ROM (U16), the RAM (U17), the Dual Port RAM (U18), the PIA or Analog I/O Buffer (U7), and the PTM (U8); also, U14 provides and controls Enable lines to the Memory Data Bus Buffer (U15), the I/O Data Bus Buffer (U12), and the Data Input Port Buffer (U11).

PAL U14, also generates a signal (L IRQ RST) that presets the 1 ms interrupt flip-flop, U22; thus, the HIGH state input into U13(3) takes the microprocessor out of the interrupt acknowledge state.

The Read/Write (R/W) Gate logic circuit (U3C, U3D, U6A, U6D) and Address and Control Buffer (U10) control reading and writing of data from and to the RAM (U17), all the data buffers (U12, U15, U11), and the PTM (U8) and PIA (U7). U10 provides necessary delay for the L<sub>E</sub>, L<sub>RD</sub>, and R/L<sub>WR2</sub> output signals. The memory read and write functions are discussed in the following paragraphs.

**MEMORY.** As stated previously, the majority of the memory decoding is performed by PAL U14.

The R/W Gate circuit and Address and Control Buffer U10 provide additional memory enabling signals L<sub>WE</sub>, L<sub>E</sub>, L<sub>RD</sub>, and R/L<sub>WR2</sub>. These signals are used as follows:

- L<sub>WE</sub> is used to latch data into RAM U17 and DPRAM U18 at the end of a memory write cycle. It is connected to the Write Enable (WE) inputs of those IC's.
- L<sub>E</sub> is connected to the Output Enable (OE) input of ROM U16 providing a delayed, inverted E clock signal. This holds valid data on the data bus for the time required by microprocessor U13.
- L<sub>RD</sub> is connected to the OE inputs of the RAM and DPRAM. L<sub>RD</sub> also delays the E clock signal to these OE inputs, NAND'ed with the R/W signal so that data from these RAMs stays on the data bus for the required time.

- R/L\_WR2 is connected to the direction control pin of Memory Data Bus Buffer U15, and to the R/W pins of Programmable Timer Module (PTM) U8, and Peripheral Interface Adapter (PIA) U7. Thus, R/L\_WR2, controls the direction in which data is passed through U15, and the time at which the direction changes.

**COUNTER TO POWER METER INTERFACE.** Dual-Port RAM (DPRAM) U18 provides the interface between the Counter and the Power Meter circuits, U18 has two separate and independent I/O ports, and read/write control lines.

Data is passed from one microprocessor to the other through the DPRAM. When it is necessary for one microprocessor to talk to the other, the first will write data into the DPRAM, and the second will then read the data. The firmware (ROMs) of both microprocessors controls the handshaking that is necessary to make sure valid data is passed.

The data passed between the two microprocessors includes power meter configuration, power meter measurement, HP-IB, diagnostic and error messages, a frequency value (used for choosing a sensor calibration factor), and status byte data.

The firmware divides U18 into two halves, each half serves for data transfer in one direction; that is, counter-to-power meter or power meter-to-counter.

Transferring data via the Counter half (right side) of the DPRAM is controlled by L\_dpramOE, L\_dpintR\_C, L\_MRDY\_C, L\_dpramWE, and L\_dpram\_CS\_02 control signals. The firmware handshaking logic is controlled by data status bytes and flag bytes. The data from the Counter microprocessor is passed through the data transfer buffer (pins 25 through 32) of U18. This data is then acknowledge by the Power Meter microprocessor (U13), which is always scanning its I/O port for new or updated data.

The Power Meter half of the DPRAM control lines, status bytes, and data transfer lines are configured identically to the Counter half of the DPRAM; except, all control lines, status bytes, and data transfer information is from the Power Meter CPU. The data passed through the data transfer buffer U18 (pins 16 through 23) to the counter section is power measurement and power configuration data, instead of counter data. The Counter microprocessor (U8) is also always scanning its I/O port for new or updated data.

**I/O INTERFACE.** Input/Output Data Buffers U12 and U11 comprise the I/O Interface circuit of A7 Power Meter Digital Assembly.

To avoid contention on the data bus, all data to and from the A8 Analog Assembly is first routed to buffer U12 and held there until the CPU is ready to use the data. When the L\_IO\_EN input signal to U12(19) becomes LOW, and R/L\_WR2 control line, U10(5), becomes HIGH the data is transferred to the microprocessor (U13) for manipulation. When the both L\_IO\_EN and R/L\_WR2 lines are LOW, data is transferred from the microprocessor (U13) to the A/D Interface circuitry, and then to the A8 Analog Assembly. Buffer U12 ensures the correct logic drive level is restored to the data bus, and eliminates contention problems on the DIP data bus.

Data Input Port Buffer U11 lines are connected to the rear panel DIP switch. The MODE\_SEL input to U11(18) is controlled manually via the Mode select switch of the rear panel DIP switch. The MODE\_SEL input tells the CPU what mode to operate. When the DIP switch is set to the NORMAL position, the MODE\_SEL line will be LOW, and when the switch is set to the DIAGNOSTICS position, the MODE\_SEL line will be HIGH.

**ANALOG-TO-DIGITAL INTERFACE.** This circuit works together with the A/D Conversion circuit of the A8 Analog Assembly to convert the measured analog power to a digital value. As shown in the block diagram of Figure 8-23, the Analog-to-Digital (A/D) Interface circuit receives control signals from the Address Decoding and Control circuit, A8 Analog Assembly, and the CPU circuit. The A/D interface also receives data from the CPU circuit. The A/D Interface sends data and control information to the analog assembly, and sends the pulse signal to the 1 ms Interrupt circuit. Clock signals are received from the Timer circuit.

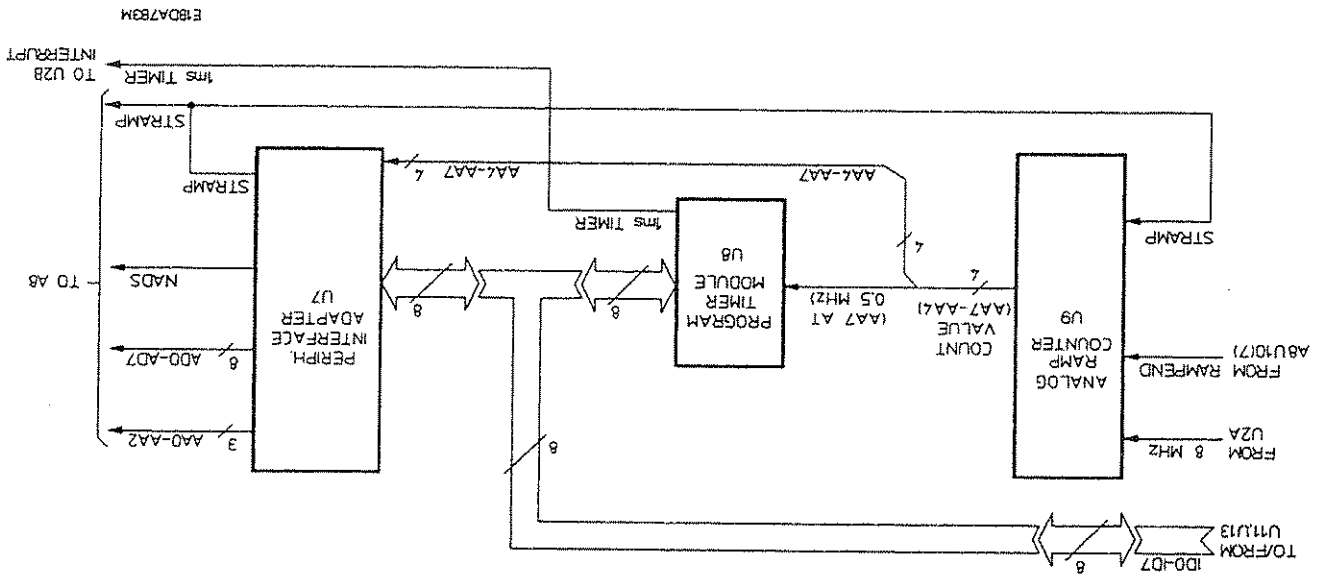


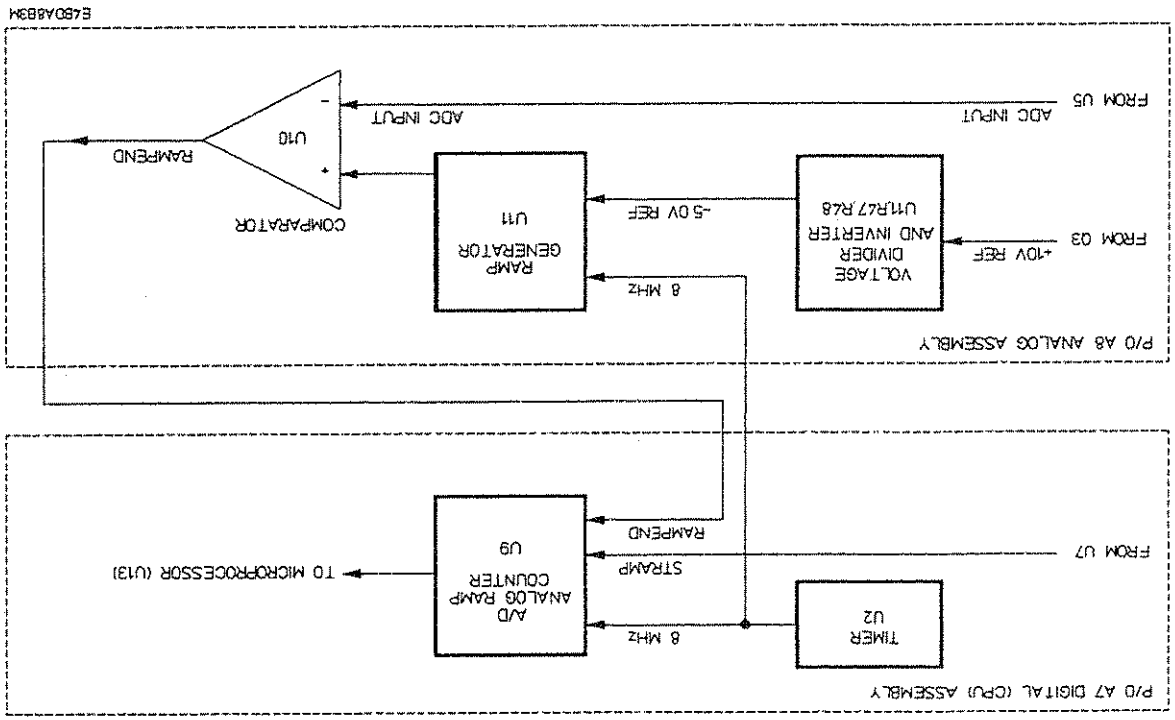
Figure 8-23. A7 A/D Interface Simplified Block Diagram

1. Generates the 1 ms interrupt pulse.
2. Selects input for A/D Conversion.

The A/D Interface circuit performs the following nine tasks:

The actual A/D Conversion is performed by the ramp generator and comparator on A8 Analog Assembly, and the Analog Ramp Counter and Programmable Timer Module (PTM) on A7 Digital Assembly. The A/D Conversion is initiated by the STRAMP signal and terminated by the RAMPEND signal.

Figure 8-24. Simplified Block of the A/D Conversion

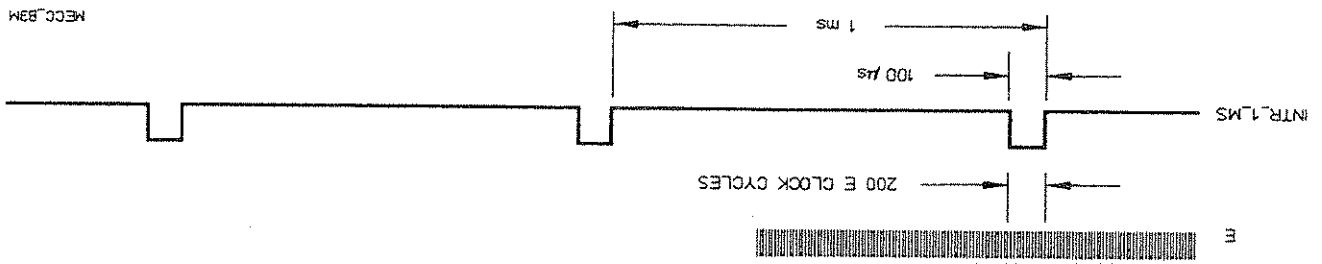


The A/D Interface section of the Power Meter Digital Assembly can be further broken down into the following block diagram, Figure 8-24.

- a. Address Lines AA0 - AA2 are used to address particular sections within the Analog assembly.
- b. Data Lines AD0 - AD7 are used as DAC inputs, and as enable lines.
- c. STRAMP is used as a start/reset signal for A/D Conversion (Starts the ramp generator).
- d. NADS (Negative Address Signal) is used to Latch the input data from A7 Digital Assembly to A8 Analog Assembly.

The data and control signals sent from the A/D Interface circuit of the A7 Digital Assembly to the A8 Analog Assembly are used by the Analog assembly as follows:

Figure 8-25. E Clock Cycles



The following paragraphs discuss tasks 1 through 4 in detail. For details of tasks 5 through 9, see the A8 Power Meter Analog Assembly circuit description.

1 ms Interrupt Pulse Generation. The 1 ms interrupt signal is generated by the PTM (U8). The PTM is programmed by the firmware of ROM U16 so that Timer 2 section of the PTM runs in a continuous wave synthesis mode. The PTM runs in a count down fashion, decrementing the count buffers by 1 with each clock cycle.

Timer 2 of the PTM is configured by the firmware so that the count buffers are decremented with each E (Enable) clock cycle, and the resulting waveform is a 100 μs duration pulse which occurs every 1 ms as shown in Figure 8-25. This pulse occurring every 1 ms is required by the Power Meter firmware for a 1 ms time line function.

3. Starts and resets A/D Conversion.
4. Performs A/D Conversion.
5. Selects slow or fast low pass filter.
6. Sets gain of variable gain amplifier.
7. Selects range attenuators.
8. Turns reference oscillator on or off.
9. Sets input of Auto-Zero DAC.



**A/D Input Selection.** There are five possible inputs for A/D Conversion, which are selected separately based on the values sent on the address and data lines to A8 Analog Assembly (AA0 - AA2 and AD0 - AD7, respectively). The five inputs are the sensor signal, the B-ground, the 2.5 V reference voltage, the sensor I.D. resistor, and the output voltage from the Auto-Zero DAC (refer to A8 Power Meter Analog Assembly schematic diagram).

**Start and Reset A/D Conversion.** The STRAMP signal starts and resets the A/D Conversion process. When STRAMP is HIGH, the ramp generator on A8 Analog Assembly is ON, the Analog Ramp Counter is enabled and the PTM Timer 1 circuitry is gated ON. When STRAMP is LOW, the ramp generator is reset, the Analog Ramp Counter is disabled, and the PTM Timer circuitry is gated OFF. The STRAMP signal is generated by the Power Meter firmware (U16) via the Peripheral Interface Adapter.

The actual A/D Conversion process consists of determining the time it takes for the ramp generator on A8 Analog Assembly to reach the same voltage as the selected input. This time duration is measured by the Analog Ramp Counter and the PTM, with the result being a 2 byte digital count value. The PTM Timer 1 is configured as a single shot count down counter. The all lines of the count down buffers of Timer 1 are initialized HIGH (to 64K), and decremented by each clock pulse. The clock for the PTM Timer 1 is the MSB (Most Significant Bit) output of the Analog Ramp Counter, AA7, which runs at a frequency of 0.5 MHz. The Analog Ramp Counter runs as a continuous count up counter. The resulting count value in the PTM Timer 1 count buffers at the end of the A/D Conversion process are "complemented" (1's complements), so that the count value in the PTM and the count value on the Analog Ramp Generator outputs are in the same format.

The A/D Conversion process proceeds as follows: the Power Meter firmware selects the desired A/D input via Peripheral Interface Adapter U7. Analog Ramp Counter U9 is reset, and the PTM Timer 1 buffers are initialized to 64K. The ramp generator, the Analog Ramp Counter, and the PTM are started with the STRAMP signal. When the ramp voltage equals the A/D input voltage, the comparator on A8 Analog Assembly sets the KAMPEND signal HIGH. This stops the Analog Ramp Counter, and the PTM Timer 1 circuitry. The count values in the PTM Timer 1 buffers, and on the outputs of the Analog Ramp Counter are analyzed by the Power Meter firmware to determine the value of the A/D input voltage.

## 8-171. A8 Power Meter Analog Assembly

As shown in *Figure 8-45*, the A8 Power Meter Analog circuit consists of the connected Power Sensor (refer to the Power Sensor Operating and Service Manual for circuit information) and six functional sections on the Power Meter Analog board. The six functional sections are as follows:

- Power Sensor and Input Amplifier circuits
- Microprocessor Control and Autozero Digital-to-Analog Converter (DAC) circuits
- Attenuator, Variable Gain Amplifier, Detector, and Filter circuits
- Analog-to-Digital (A/D) Conversion circuits
- 1 mW 50 MHz Power Reference circuits
- Voltage References and Power Supply Decoupling circuits

**POWER SENSOR AND INPUT AMPLIFIER.** The Power Sensor (HP 8481A, HP 8484A, or HP 8485A) determines the frequency range, dynamic range, and measurement accuracy of the combined Power Sensor and Power Meter. The basic operation of the Power Sensor and Input Amplifier is described in the following paragraphs.

The Power Sensor absorbs RF input power in a 50 $\Omega$  impedance and generates a dc voltage proportional to the RF input power level. The HP 848XA series Power Sensors have thermocouple sensing elements with an output of approximately 160  $\mu$ V/mW. For a power measurement range of -30 to +20 dbm the thermocouple voltage can range from 0.160  $\mu$ V to 16.0 mV. To avoid measurement inaccuracies caused by unintentional thermocouple junctions or amplifier dc drifts, it is necessary to chop this small signal prior to subsequent amplification and transmission down the sensor cable.

**Input Amplifier.** Amplification of the chopped sensor signal is accomplished partly in the Power Sensor itself and partly in the Power Meter's Input Amplifier. A simplified block diagram of the interconnection between the Power Sensor and the Input Amplifier is shown in *Figure 8-26*. The overall amplifier circuit has a voltage gain of 600. Voltage gain is determined by a circuit consisting of R4, R5, and R7 in the Input Amplifier and two resistors in the Power Sensor.

The shaping feedback circuit reduces the gain of the Input Amplifier on the full-scale power ranges of +10 dbm (Range 4) and +20 dbm (Range 5). This reduction in gain is required to offset the improved efficiency of thermocouple sensing elements at high power levels. Resistor R6, Potentiometer R111, and limiting diodes CR1 and CR2 comprise the part of the shaping feedback circuit that limits the Input Amplifier's gain when the +10 dbm power range of the sensor is required for a measurement. Resistors R12, R14, R15, Potentiometer R112, and zener diodes VR1 and VR2 comprise the circuit that limits the gain when the +20 dbm power range of the sensor is required for a measurement.

**A-Ground (A-GND) Source.** Operational amplifier U9, transistors Q1 and Q2, resistors R56, R9, R10, and R11 comprise the A-GND source circuit. To prevent large signal currents from flowing in the SENSOR GROUND REF (not a true ground), the A-GND source circuit recreates this "ground" at Q2 where it can be used for the analog circuits on the A8 Analog Assembly. This circuit is a high gain voltage feedback circuit that keeps the input voltage at U9(6) equal to the input voltage at U9(5); thus, keeping the SENSOR GROUND REF equal to

AGND (TP14). If the input voltage at U9(6) goes above the SENSOR GROUND REF, a proportionally negative voltage at U9(7) is output. Similarly, if the input voltage at U9(6) goes below the SENSOR GROUND REF, a proportionally positive voltage at U9(7) is output. Transistors Q1 and Q2 provide good sourcing and sinking capability for their respective current on the A-GND bus.

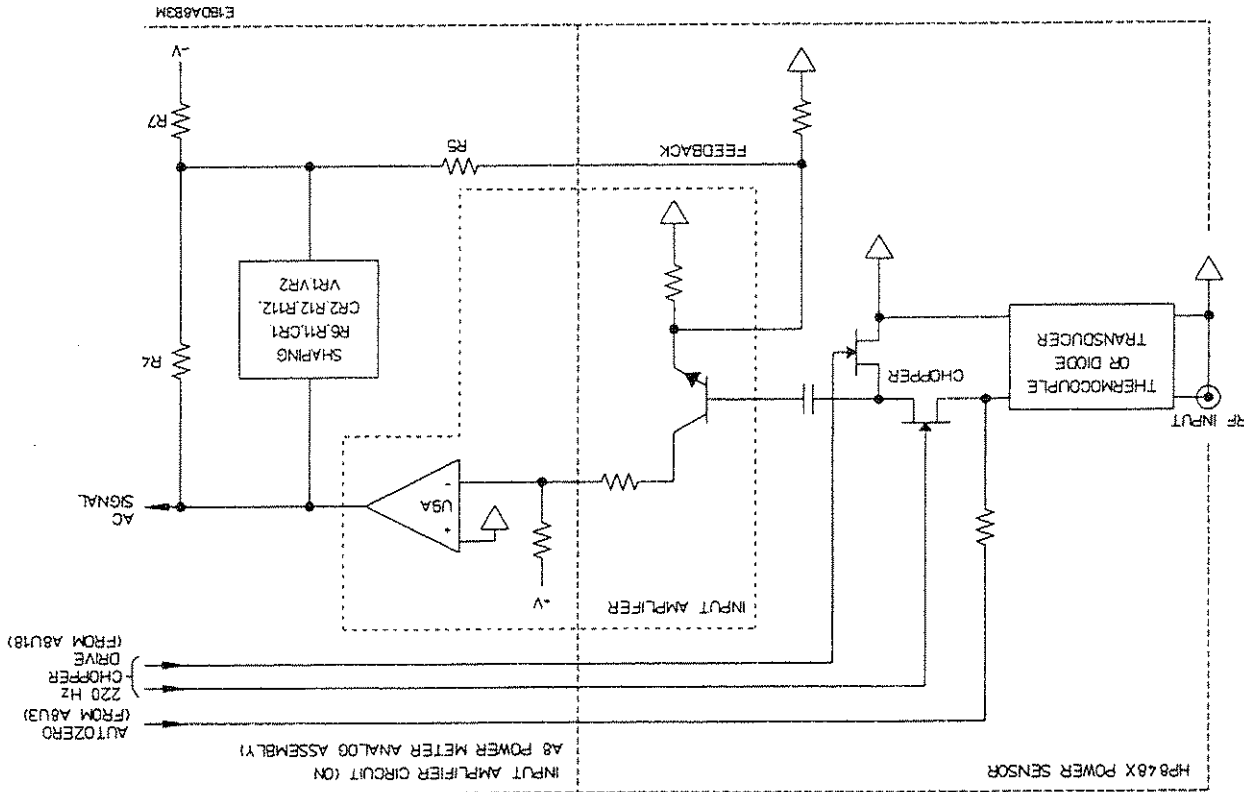


Figure 8-26. Simplified Power Sensor and Input Amplifier Circuit

The purpose of this circuit, which consists of multiple transistor IC (U18), transistor Q9, and the other associated discrete components, is to provide the 220 Hz drive signals (CHOPPER Ø1 and Ø2) to the Power Sensor to gate the thermocouple dc voltage ON and OFF. These drive signals enable the sensor to output a 220 Hz square wave that is proportional to the RF input power level and in phase with the 220 Hz reference signal applied to Synchronous Phase Detector U15.

U18's dual PNP transistor, U18(5,6,7) and U18(8,9,10), is the chopper multivibrator which produces the 220 Hz square wave signals. U18's dual NPN transistor, U18(1,2,3) and U18(12,13,14), is the differential amplifier whose current source is transistor Q9. The multivibrator switches the current between the two halves of the differential amplifier. The half of the multivibrator that is conducting turns ON the appropriate transistor of the differential amplifier, causing the output (collector) of the transistor to be about -10.5V. The other half of the differential amplifier is turned OFF, and the collector of the transistor is 0V. The outputs of the multivibrator are reduced by voltage dividers R60, R61 and R64, R65 and drive the bases U18(2) or U18(13) of the differential amplifier more positive than the emitters U18(3) or U18(12), causing conduction. Potentiometer R87 adjusts the frequency of the chopper multivibrator so that it is centered in the bandpass filter response.

**Sensor Resistor Input.** This sensor identification circuit is used by the CPU to determine which model Power Sensor is connected to the Input Amplifier. The power sensors contain internal resistors that identify the power range for which the sensor is specified. The controller will not be able to distinguish between the 8481A and 8485A sensors because both are specified for the -30 to +20 dBm range. The Sensor Resistor Input circuit consists of resistors R95, R94, and capacitor C45. When a power sensor is connected to the Input Amplifier, the power sensor internal identification resistor and R94 form a voltage divider that divides the +2.5V REF that is tied to one side of R94. This divided voltage will be greater or lesser, depending on which sensor is used, at ADC Multiplexer U5(12). Then the ADC reads the voltage out at U5(8) to determine which sensor is attached. R95 and C45 filter any noise that might occur.

**MICROPROCESSOR CONTROL AND AUTO-ZERO DAC.** The Microprocessor Control and Auto-Zero DAC circuits interpret the control signals from the microprocessor of A7 Power Meter Digital Assembly (Central Processing Unit, CPU) and set various functional blocks on the A8 Analog Assembly to the correct configuration to perform the required measurement. Programming instructions are sent from the CPU via data and address buses, and the control lines to perform the following activities.

1. Set amplitude of Auto-Zero DAC output voltage.
2. Turn the 1 mW 50 MHz Reference Oscillator on or off.
3. Set Range Attenuators.
4. Set gain of Variable Gain Amplifier.
5. Select Fast/Slow Low Pass Filter.
6. Select appropriate input for Analog-to-Digital (A/D) Conversion.
7. Start/terminate A/D Conversion.

**Microprocessor Control.** As shown in Figure 8-45, the address bus (AA0-AA2) is decoded in Program Address Decoder U1. U1 outputs are used to enable specific functional blocks to receive data bus (AD0-AD7) information. The NADS (Negative Address Signal) control line from the CPU enables decoder U1. Program Data Latch U2 uses the data bus information to make select choices at other functional blocks.

**Auto-Zero DAC.** Figure 8-27, is a simplified block diagram of the zeroing loop. When the front panel Zero key is pressed, the firmware zeroing routine is initiated. Auto-Zero DAC U3(14) output is used to zero the output from the Low Pass Filter (LPF) circuit when no RF signal is applied at the sensor input. The Auto-Zero output compensates for any pre-chopping or post-detection dc voltage offsets. This includes offsets contributed by the Power Sensor, the Synchronous Phase Detector, and the LPF. (The Input Amplifier, Range Attenuators, Variable Gain Amplifier, and Bandpass Filter Amplifier are ac-coupled, and therefore cannot contribute.) Auto-Zero DAC U3(14) output is applied to the Power Sensor, where it is attenuated, summed at the thermocouple sensing element, gets chopped, and then sent through the Power Meter amplifier chain.

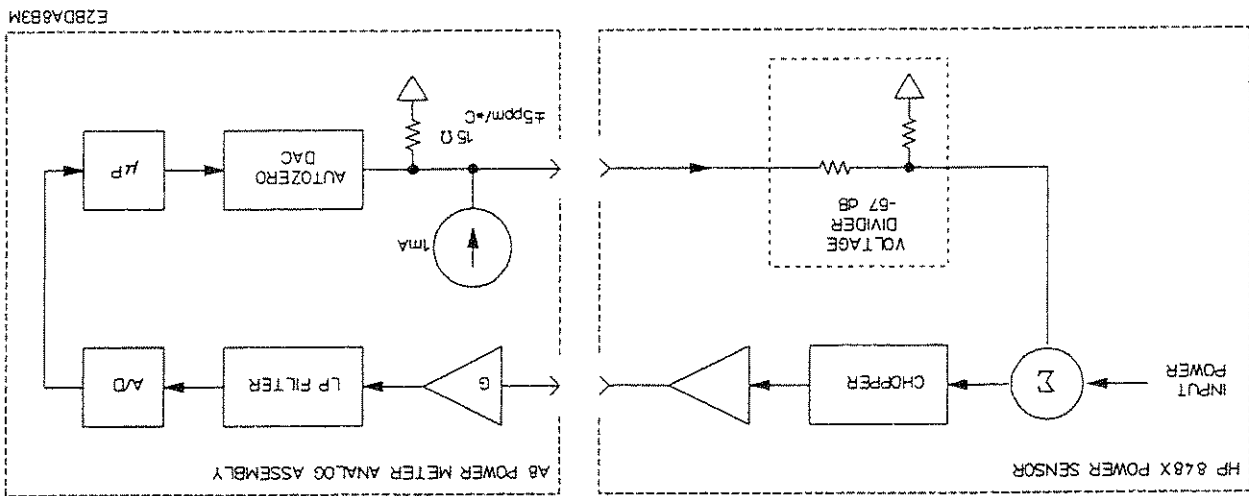
Range Attenuator 1 circuit consists of coupling capacitor C5, voltage divider R16 and R17, and SPST CMOS analog switches (U12A,U14B). C5 blocks any dc or low frequencies that might be present at the input of Attenuator 1. The 220 Hz signal is coupled to U12(2). To select X1 attenuation, the Power Meter's CPU pulls the AD0 line LOW and the ATTEN line HIGH, which connects the input to output U12(3); this output becomes the input to the Variable Gain Amplifier circuit. To select X100 attenuation, the CPU pulls the AD2 line LOW, enabling the Program Data Latch U2 to pull its ATTEN line U2(6) LOW. This LOW at the input U14(16)

Range Attenuator 1 and 2. The Range Attenuators provide amplitude reduction in decade factors from 1 to 100,000 in order to make the full-scale sensor voltage to the Comparator of the Analog-to-Digital Converter circuit, which is derived from ADC Input Multiplexer U5(8), the same for all selected power ranges. The Power Meter's CPU commands Attenuator 1 to divide by 1 or 100, and it commands Attenuator 2 to divide by 1, 10, or 100. The Range Attenuators are basically voltage dividers consisting of very accurate, low temperature coefficient resistors and single-pole, single-throw (SPST) CMOS analog switches. Two Range Attenuator circuits are needed to cover the entire dynamic range of the power sensors.

The CPU sets the output of the Auto-Zero DAC to make the Low Pass Filter output as close to zero as possible. Residual voltages at the Low Pass Filter output are used to compute the pre-chopping and post-detection offsets. These offsets in conjunction with the DAC setting are used to determine the zero level for all input signals until the meter is zeroed again.

ATTENUATOR, VARIABLE GAIN AMPLIFIER, DETECTOR, AND FILTER. The combination of these circuits comprise the amplifier gain-chain. Each circuit is described in the following paragraphs.

Figure 8-27. Simplified Zeroing Block Diagram



causes the input signal to pass to U14(14) after voltage divider resistors R17 and R16 divide the voltage by 100. The Range Attenuator 2 circuit operates similar to the Range Attenuator 1 circuit; except, it can also divide by 10, and it provides the input signal for the 220Hz Bandpass Filter circuit. The CPU uses the AD1, AD2, and AD3 lines to control the X1, X10, and X100 attenuation, respectively.

**Variable Gain Amplifier (VGA).** This circuit allows channel gain adjustment during the zeroing or calibration routines for the combination of any Power Sensor and Power Meter. It is programmed by the CPU to provide a full-scale output to the A/D Comparator for any power range. Typical gain is 37 dB and increments are 0.15 dB. The VGA consists of a multiplying D/A converter, U13, used in an amplifier configuration.

The CPU on A7 assembly programs the gain of the measured power input via inputs (AD0-AD7) of the 8-bit Multiplying DAC U13. Non-inverting op amp U8A receives the 220 Hz square wave input at U18(3). Output resistor R19 and feedback input resistor R18 cause U8A to amplify the input by 101. This amplified output at U18(1) becomes the reference voltage of DAC, U13, at U13(15). An analog current is produced at U8(1) that is proportional to the binary binary value number programmed by the CPU. It is fed to op amp U8B, which converts it to a proportional output voltage. The output square wave is routed to Range Attenuator 2 where it is attenuated as necessary; then, it is routed to the input of the 220 Hz Bandpass Filter circuit.

**220 Hz Bandpass Filter.** This circuit is used to eliminate harmonics of 220 Hz, high-frequency chopping spikes, and to minimize noise. The Bandpass Filter circuit consists of several active filter stages consisting of amplifiers U15A, U15D, and U15C and their associated RC networks. As the sensor signal progresses through the amplifier, it is changed from a 220 Hz square wave to a sine wave. The voltage gain is approximately 48 dB, and the bandpass response broadly peaks at 220 to 235 Hz with 0 degrees of phase shift.

**Synchronous Phase Detector.** This circuit rectifies the output from Bandpass Filter amplifier circuit. It is basically a unity-gain amplifier whose polarity is switched in synchronism with the output of the 220 Hz input signal (and whose output amplitude is proportional, of course, to the RF power applied to the Power Sensor). The output also contains 440 Hz (the doubled chopper frequency) and its harmonics.

Operational amplifier U15, and FET switch Q6, diode CR4, and the other associated discrete components comprise the Synchronous Phase Detector circuit. As stated previously, U15, R34, R35, R36, and C14 circuit form a unity-gain amplifier. The amplifier polarity is positive when the 220 Hz at the cathode of CR4 is HIGH. When the 220 Hz CHOPPED  $\emptyset$  signal and the cathode of CR4 goes LOW, CR4 conducts and turns on Q6, which now turns the U15 and its associated components into an inverting amplifier; thus, the negative-half cycles of the Bandpass Filter input are converted to positive-half cycles at U15(7). The frequency out at U15(7) is now a 440 Hz half-wave rectified signal with positive-half cycles only. Bypass capacitor C14 filters out any high frequencies or noise to the input of U15.

**Low Pass Filters (LPF).** This circuit that follows the phase detector takes out the 440 Hz fundamental and harmonic frequencies and also further reduce noise accompanying the signal. There is a programmed choice of "fast" or "slow" LPFs depending on the power range selected (the five power ranges are listed in *Table 8-12*). The two most sensitive power ranges (Range 1 and 2) require the use of the "slow" (1.24 Hz bandwidth) LPF to minimize noise,

- The dc measurement voltage from the LFF.
- The sensor ID voltage.
- The B-Ground (low-current analog ground).
- The Precise +2.500 Vdc from the Voltage Reference for self-check purposes.
- The Auto-Zero DAC output voltage.

ADC Input Multiplexer. The ADC Input Multiplexer (MUX) selects any one of the following signals as the ADC input to comparator U10.

ANALOG-TO-DIGITAL CONVERSION. The Analog-to-Digital Conversion block consists of an Input Multiplexer circuit and the actual Analog-to-Digital Converter (ADC) circuit as shown in Figure 8-45.

Figure 8-46 shows that the Low Pass Filter circuit consists of three main parts: the Slow Filter, the Fast Filter, and the Filter Output Selection. Operational amplifiers U16B and U16C with their appropriate RC network perform the filtering and amplification of the 440 Hz input to produce a representative dc voltage. The Power Meter's CPU, via Program Data Latch U2, selects the resultant dc voltage of the slow or fast filter circuit by pulling switch U14(8) or U14(9) LOW. The selected dc voltage is then routed to U16(3) where it is amplified to be a dc voltage, which is proportional to the measured power input signal, at U16(1). This output is then fed to the ADC circuit where it can be digitized. Circuits on the A7 Power Meter Digital Assembly complete the digitizing of the measured power and transfer power data to the main CPU (A4 Microprocessor) for display.

Range	Fullscale Power Ranges (dBm)	Meter Noise 2 Sigma, %FS	Setting Time 0 to 99% (Sec) (-10 dB step)	Filter	Number of Averages
Range 5	+20	0.0002	0.25	Fast	4
Range 4	+10	0.002	0.25	Fast	4
Range 3	0	0.018	0.25	Fast	4
Range 2	-10	0.09	1.0	Slow	8
Range 1	-20	0.3	6.9	Slow	128

Table 8-12. Noise and Step Response of Power Meter

whereas the other ranges can use the "fast" (15.6 Hz bandwidth) LFF. Naturally, there is a performance trade-off in that use of the "slow" filter increases the Power Meter's response time to changes in Rf power amplitude. (In addition to slow filtering, good signal-to-noise ratios are obtained on the sensitive power ranges by taking multiple measurements and averaging them in software.) Table 8-12 shows meter noise, settling time, hardware filtering, and software filtering (i.e., averaging) for the different power ranges.

CMOS Analog Multiplexer U8 is configured to connect to one of the five analog inputs, listed above, to a common output, U5(8), as determined by 3-bit binary address (MUX1, MUX2, MUX3). The MUX1, MUX2, and MUX3 lines (U5 pins 1,16,15, respectively) are programmed, by Program Data Latch U2 of the Microprocessor Control circuit, to select the particular input to U5. The CPU of A7 assembly tells U2 which input to select and output at U5(8). This output signal then becomes the input to comparator U10(3) of the Analog-to-Digital Converter circuit.

Analog-to-Digital Converter. The ADC consists of the following three parts:

1. The Ramp Generator and Comparator circuits on the Power Meter analog board.

2. The Analog Ramp Counter and software interrupt circuit on the A7 Power Meter Digital Assembly (CPU).

3. The software routine that controls these circuits.

Figure 8-28 shows the relationship between the CPU and the circuits on the Power Meter Analog board. The method of digitizing the input signal is identical for all input signals. The sequence is as follows:

1. The selected signal from the ADC Input MUX is applied to the ADC input of the Comparator.
2. The CPU generates the start ramp signal "STRAMP". This signal is applied simultaneously to the Analog Ramp Counter in the CPU and the Ramp Generator on the analog board.
3. The Analog Ramp Counter starts counting at an 8 MHz rate.
4. Using a -5.000 Vdc reference input (derived from the +10.000 Vdc Voltage Reference), the Ramp Generator produces a linear positive ramp.
5. When the ramp voltage equals the ADC input voltage, the ADC Comparator sends the ramp end signal "RAMPEND" to the Analog Ramp Counter in the CPU. The counter is stopped at the count that represents the value of the ADC input signal. This information is used by the microprocessor to compute the measurement value. This value can then be used in any other computations required to obtain the final displayed information.

The precision Voltage Reference supplies reference voltages at either +2.500 Vdc or +10.000 Vdc to the Sensor ID Circuit, the ADC Select MUX, and the ADC Ramp Generator.



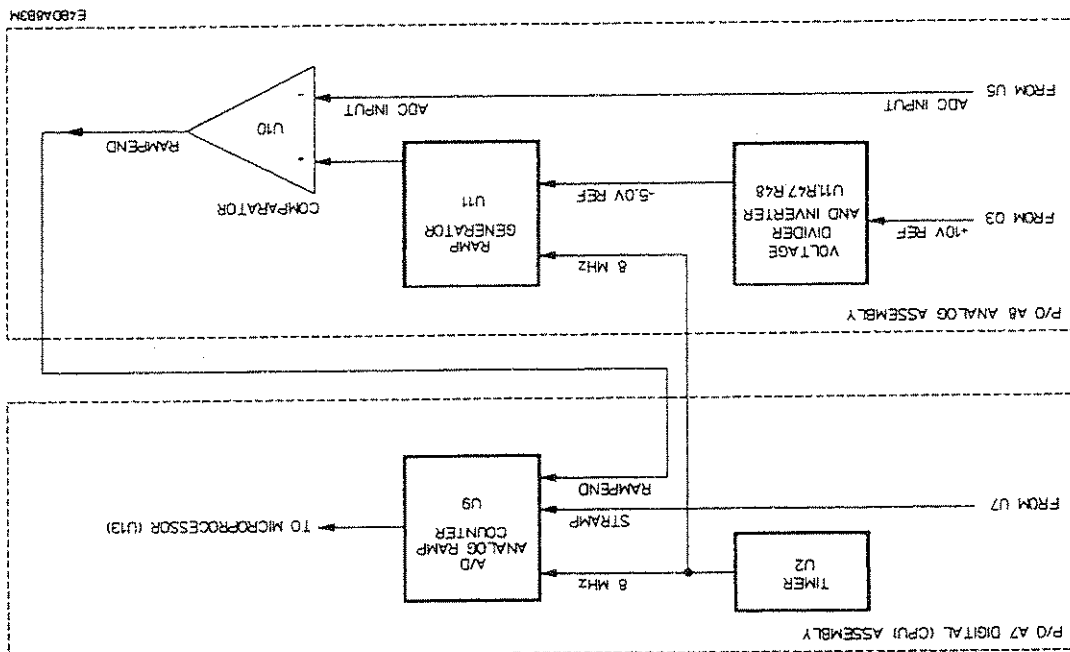
Therefore, the selected input from the ADC Input Multiplexer is applied to U10(3). The CPU then generates the STRAMP signal, which is applied simultaneously to the Analog Ramp Counter on A7 Digital Assembly, and to U14(1). (The STRAMP signal is a logic HIGH during the A/D conversion, and remains HIGH until disabled by the ramp stop, RAMPEND, signal.)

When STRAMP goes HIGH the Analog Ramp Counter (A7U9) starts counting at an 8 MHz rate. The normally closed switch in U14 is opened to allowed the -5.000V reference voltage (derived from the precision +10V reference and divided and inverted by op amp U11A) to enable integrator U11B to produce a linear positive ramp. When the ramp input at U10(2) equals the ADC input at U10(3), comparator U10.1 is triggered, producing a RAMPEND signal that goes to a logic HIGH. This stops the A/D Analog Ramp Counter on A7 and also resets STRAMP LOW. U14A conducts and discharges integrator capacitor C23 so that the U11(7) output is -0.7 Vdc.

1 mW 50 MHz POWER REFERENCE. The Power Reference section generates the 1mW 50 MHz power reference signal that is used to calibrate the individual Power Sensors used with the Power Meter. The circuits that comprise this section are the Power Reference Switch and 50 MHz Reference Oscillator. These circuits are described in the following paragraphs.

Power Reference Switch. This circuit cuts the 50 MHz Reference Oscillator on or off. The CALOSC logic input to transistor Q8 controls the circuit. When the calibration routine is running CALOSC line is HIGH; thus, it turns on Q8. Q8 turns on transistor Q7, which then switches the -15V to its collector, supplying the -15V to the 50 MHz Power Reference circuit. Inductor L2 acts as a filter choke. When the calibration routine stops the CALOSC line goes LOW and cuts off transistors Q8 and Q7; thus, the -15V supply is disconnected from Power Reference circuit, cutting it off.

Figure 8-28. Simplified Analog-to-Digital (A/D) Converter Block Diagram



50 MHz Reference Oscillator. The Reference Oscillator provides a  $50.0 \pm 0.5$  MHz output at 1.0 mW  $\pm 0.7\%$ . This output is used to calibrate the individual Power Sensors used with the Power Meter. It can also be used with the instrument's diagnostic routines as a signal source. The Reference Oscillator may be turned on and off by programming the oscillator's Power Reference Switch circuit. The Power Reference Switch controls the  $-15\text{V}\phi$  supply voltage to the oscillator, as described in the paragraph titled "Power Reference Switch".

The 50 MHz Reference Oscillator circuit can be broken into four sections: Voltage Reference, DC Reference Level Control, Automatic Level Control (ALC), and 50 MHz Oscillator. Zener diode VR3, transistor Q4, and precision zener diode VR4 comprise the Voltage Reference section. When  $-15\text{V}\phi$  is supplied to enable the 50 MHz Reference Oscillator circuit, VR3 conducts and determines the current in the current source transistor Q4. The current at the collector of Q4 flows through VR4 and produces a precise  $-6.2\text{V}$  reference voltage that is used to drive the DC Reference Level Control.

Potentiometer R114 and op amp U17B are the main components for the DC Reference Level Control section. R114, resistors R72 and R74, determine the gain of U17B, which is an inverting amplifier. The  $-6.2\text{Vdc}$  at the collector of Q4 is amplified to a very stable  $+4.5 \pm 1\text{V}$  at U17(7). This stable voltage becomes the reference voltage input for the Automatic Level Control (ALC) section. (The actual value of this voltage is determined when a level adjustment is performed to obtain 1.00 mW at the Reference Output.)

The ALC section consists of comparator U17A, detector diode CR6, and their associated components. The ALC keeps the 50 MHz Oscillator's output amplitude at a precise 1 mW. CR6 and RC network R77 and C33 convert the ac (oscillating) feedback signal to a dc equivalent. If the feedback voltage to U17(3) is lower than the reference voltage at U17(2) (that is, output power  $> 1.00\text{ mW}$ ), U17A produces a more negative voltage at the anode of varactor CR7. This reduces the capacitance of CR7 and increases the fraction of the oscillator signal sent from the collector of Q5 to its base via capacitive voltage divider C34 and CR7. This causes the oscillator circuit to oscillate harder. Likewise, if the feedback voltage to U17(3) is greater than the reference voltage (that is, output power  $> 1.00\text{ mW}$ ), feedback action reduces the oscillator amplitude.

The main components of the 50 MHz Oscillator circuit are transistor Q5, varactor CR7, and the CLC network (L5, L10, C37, C38 and C39). Bias resistors R83 and R84 set up the current in Q5. Resistor R85 and inductor L6 are for 50 $\Omega$  matching. Capacitors C38 and C39 buffer the oscillator feedback circuit from the connected power sensor. L5, L10, C37, and C38 and C39 (CLC network) provide the necessary phase shift in the feedback circuit to cause oscillation. Capacitor C34 and varactor CR7 make up a capacitive voltage divider so that CR7 can control the amount of feedback to Q5.

## VOLTAGE REFERENCES AND POWER SUPPLY DECOUPLING. These circuits are described in the following paragraphs.

**Voltage References.** This circuit supplies a precision +10 volts to the Auto-Zero DAC (U3) and the ADC Input Multiplexer (U5) circuits. It also supplies a precision +2.5 volts reference to the ADC Input Multiplexer (U5) and the Sensor Resistor Input circuits.

From the +15V supply, voltage regulator U7 generates a precise +10 volt. Voltage divider resistors R115 and R116 divides the +10 volts by a factor of 4 to provide a precision +2.5 volts at op amp U11(10). U11C functions as a non-inverting high impedance buffer amplifier; thus, maintaining a precise +2.5V reference voltage. The non-inverting buffer amplifier U11D, transistor Q3, and resistor R118, produce a precision +10 volts for driving the ramp generator of Analog-to-Digital Converter circuit. Transistor Q3 provides greater current drive capability.

**Power Supply Decoupling.** Refer to *Figure 8-46*. Because of the high precision requirements, A8 Power Meter Analog Assembly uses a variety of digital and analog grounds. Below is a list with descriptions, of the different grounds used in the assembly to isolate the different circuits.

- AGND - Sensor reference ground
- DGND - Digital ground
- BGND - Low level analog ground
- CGND - High level analog ground
- RGND - Reference oscillator ground.

The inductor and capacitor combinations in these decoupling circuits are bypass filters that prevent unwanted interaction between the analog and digital circuits that operate from the +15V, +5V, and -15V supplies.

## 8-172. A11 HP-IB Interface Assembly (Option 011)

The HP-IB Assembly, shown in *Figure 8-29*, controls all HP-IB interfacing between the HP 5347A/48A 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.

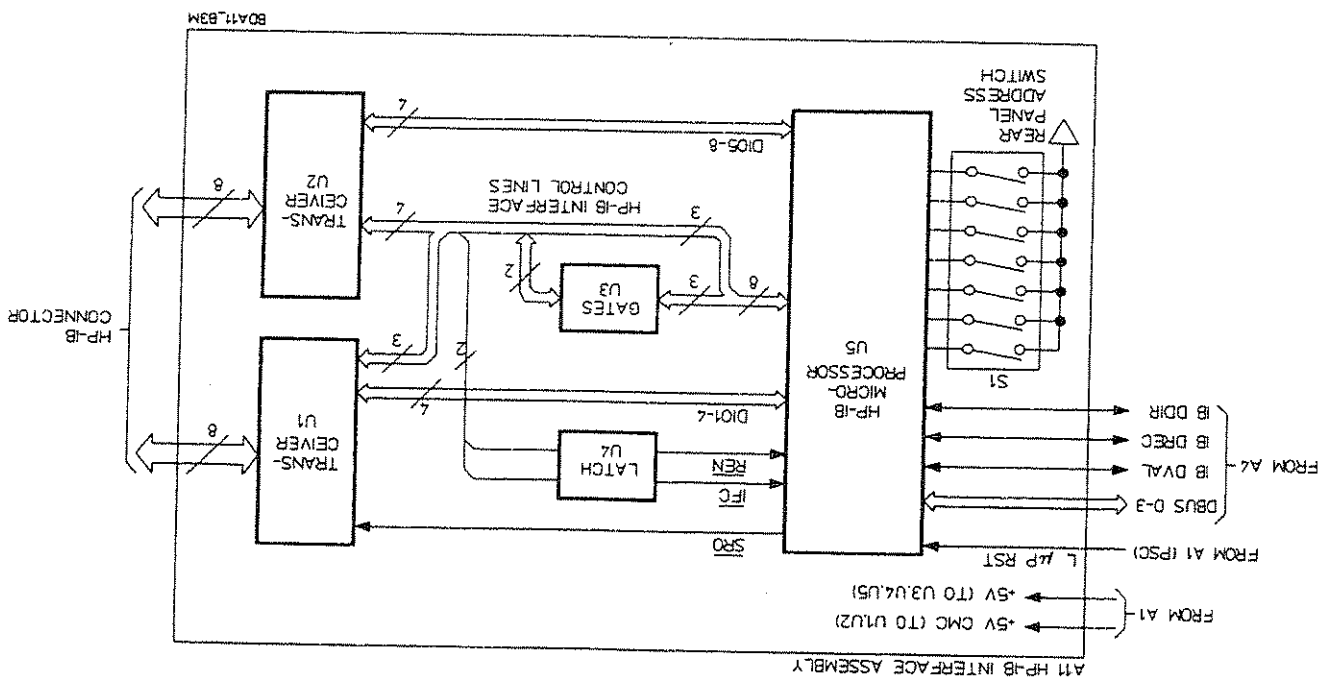
Major components of the HP-IB board are the HP-IB processor (U5), two TTL logic IC's (U3,U4), and two transceiver IC's (U1,U2). The HP-IB processor U5 is internally programmed to control all HP-IB Interface functions and overall operation of the HP-IB board. Quad NAND gate U3 and quad S-R latch U4 are used to speed the detection and response of the HP 5347A/48A 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.

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 UP 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 key is set to ON.

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 ATN line is set to a permanent Receive mode due to their respective Send/Receive inputs being tied to +5V. The IFC and 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 the external controller via U3 and U4.

NAND gate U3A also pulls the NDAC line low to start the handshake for the information which is sent from the controller. The other two handshake lines, DAV and NFRD, are driven directly by the HP-IB processor.

Figure 8-29. A11 Block Diagram



Quad latch U4 speeds the HP 5347A/48A response by latching in the REMOTE ENABLE (REN) and INTERFACE CLEAR (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 ATTENTION (ATN) signal. When ATN goes LOW, the interface immediately releases control of the HP-IB data lines and goes into the acceptor handshake mode. When IFC goes LOW, control of the data and the handshake lines is relinquished.

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 Vcc 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 Vcc for all other IC's on the A11 Assembly.

### 8-173. A12 Microwave Module (A12 Microwave Assembly/U1 Sampler)

The basic function of the A12 Microwave Module, shown in Figure 8-30, in the HP 5347A/48A is to down-convert microwave signals in the 500 MHz to 26.5 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.

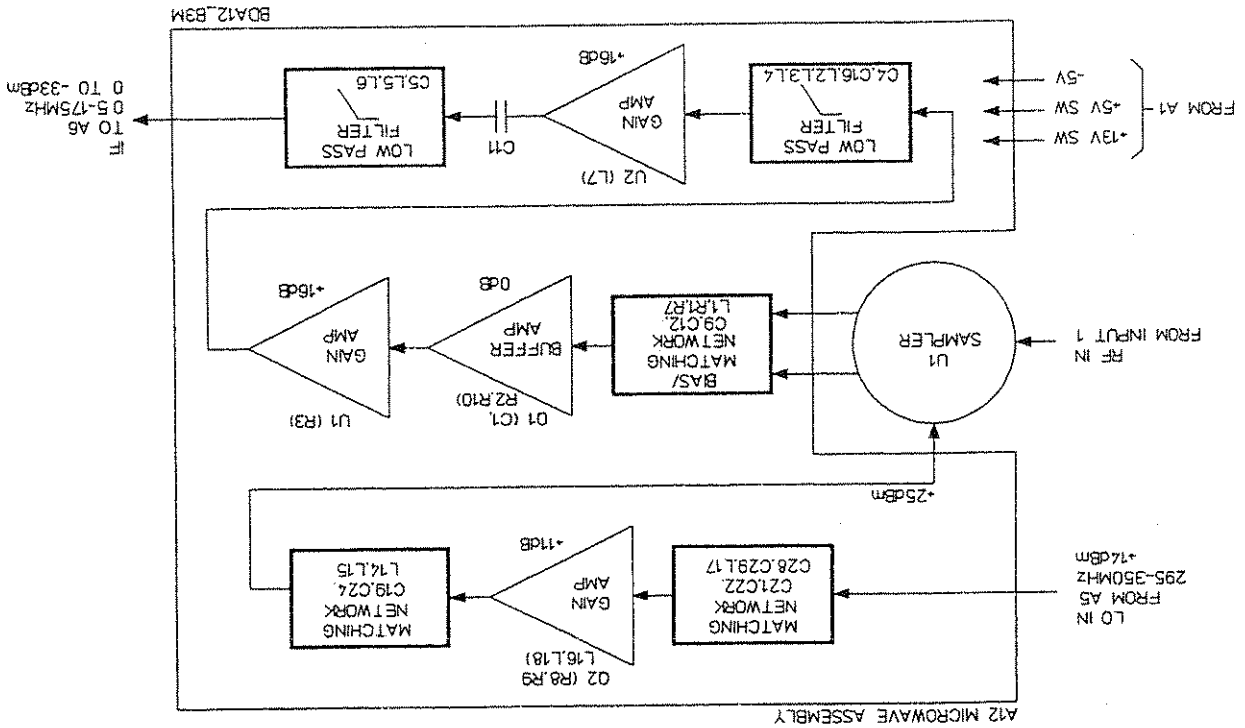


Figure 8-30. A12 Block Diagram

To perform the down-conversion, the module receives a medium power local oscillator (LO) signal from the A5 Synthesizer board, as well as dc power (+13V, +5V, -5V) from the power supply circuit. The microwave module can be divided into three sections: the sampler driver, sampler, and the IF preamplifier.

**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.

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.

**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 1MHz 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 50 $\Omega$  source impedance, and isolating the residual LO feedthrough signal and its harmonics from the IF signal. The IF preamplifier consists of eight stages: a bias/matching network, a buffer amplifier, two gain amplifiers, two low-pass filters, a PI (the Greek letter  $\pi$ ) attenuator, and a frequency compensation network.

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. Emitter follower transistor Q1 translates the 1.5 K $\Omega$  sampler impedance to approximately 50 $\Omega$  to match the input impedance of the following stages.

The IF signal is ac coupled to the first gain stage, U1. Amplifier U1 provides 16 dB of gain, set by bias resistor R3. Resistors R3, R5, and R6 form a PI attenuator network that controls the overall gain of the microwave module. Coupling capacitor C10 prevents R5 and R6 from affecting the bias current supplied to U1 by R3. The IF signal is then connected 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.

Amplifier U2 provides another 16 dB of gain. The bias current for the amplifier is supplied through inductor L7.

Capacitor C11 ac couples the signal to the second low-pass filter/matching network consisting of L5, C5, and L6.

Two of the power supplies for the A12 Assembly are switched supplies, +13 SW and +5V SW. The two supplies are turned off by the A4 microprocessor, via a microwave turn off circuit on the A1 Motherboard, when INPUT 2 is selected or when the "SLEEP" mode has been turned on via the HP-IB.

**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.

### 8-174. Schematic Diagrams

The following pages contain front and rear panel views, top and bottom internal views, an overall block diagram, followed by a schematic diagram for each of the circuit-board assemblies in the HP 5347A/48A. Each schematic diagram includes a component locator for each field repairable assembly. Where applicable, test and troubleshooting waveforms are placed adjacent to the schematic. The schematic diagrams are arranged in order by assembly number.

Figure 8-31. Front Panel View (HP 5348A shown)

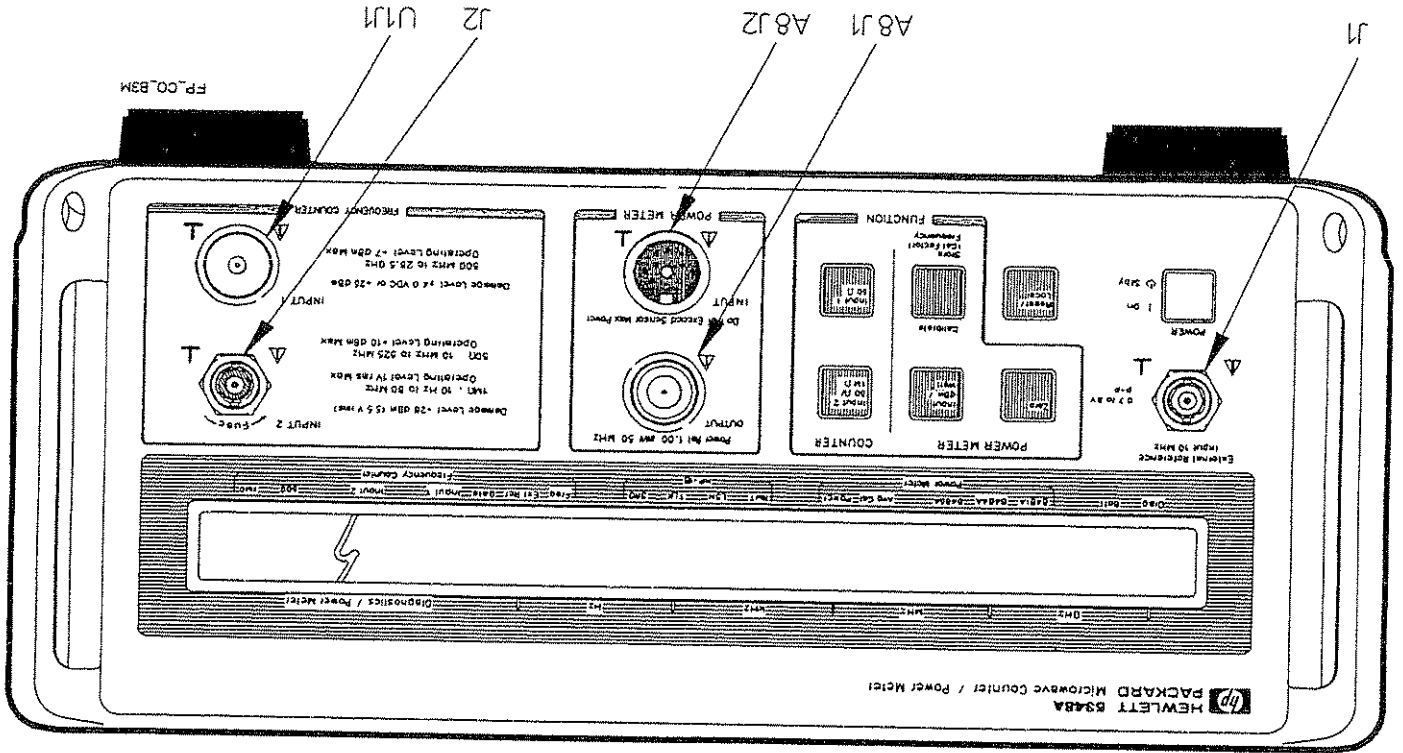






Figure 8-33. Top Internal View

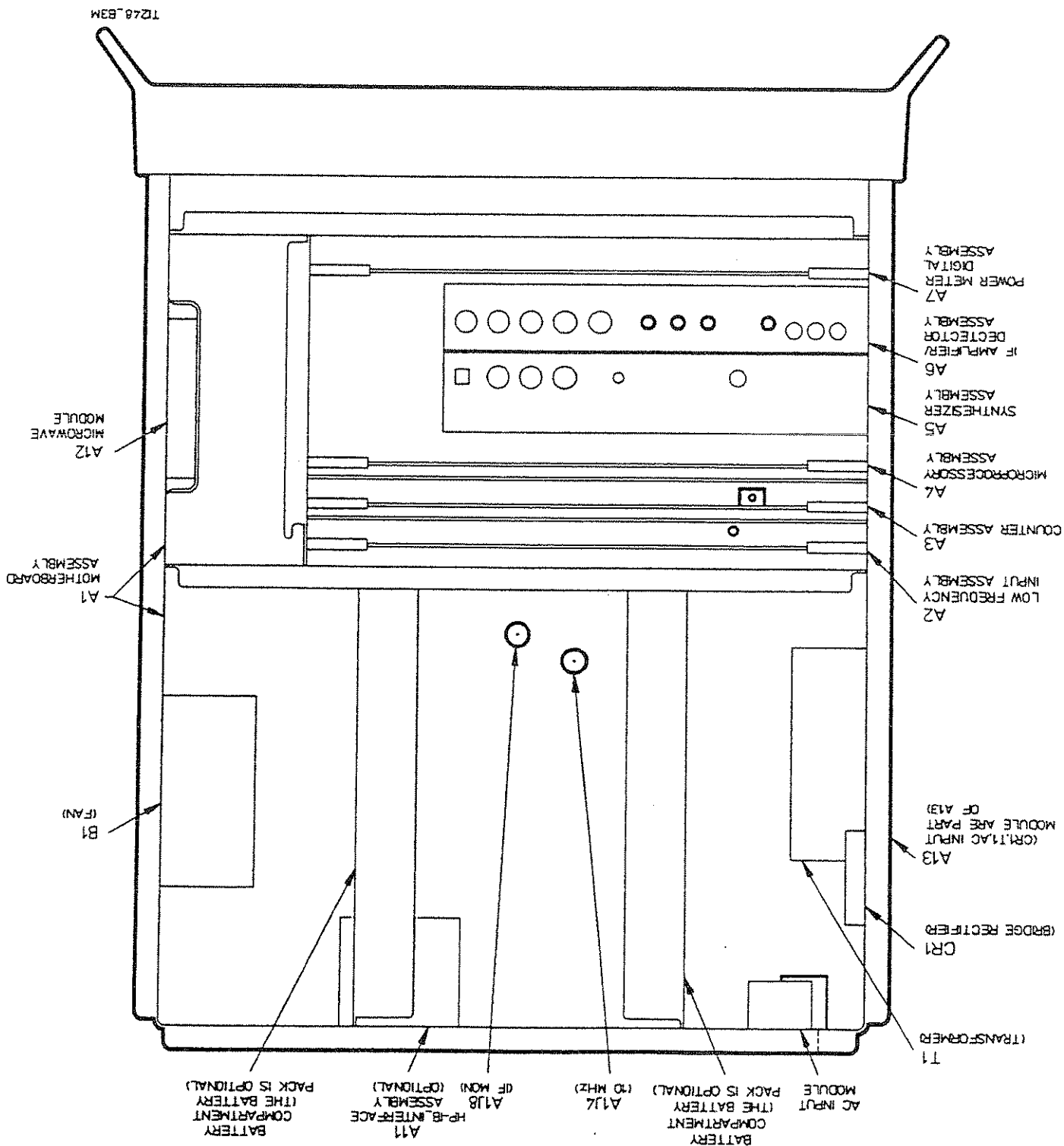
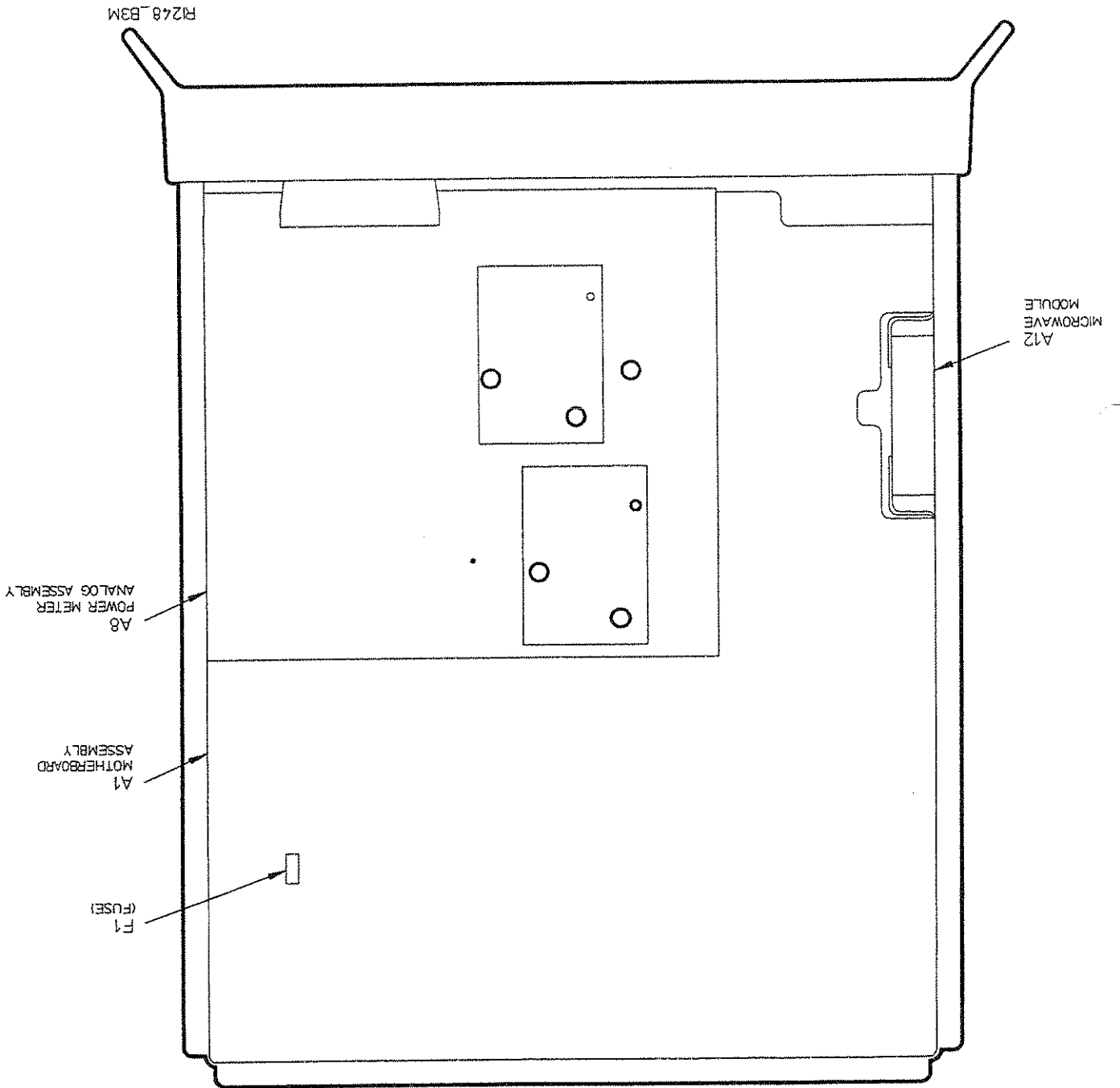


Figure 8-34. Bottom Internal View









A1 INTERCONNECTIONS

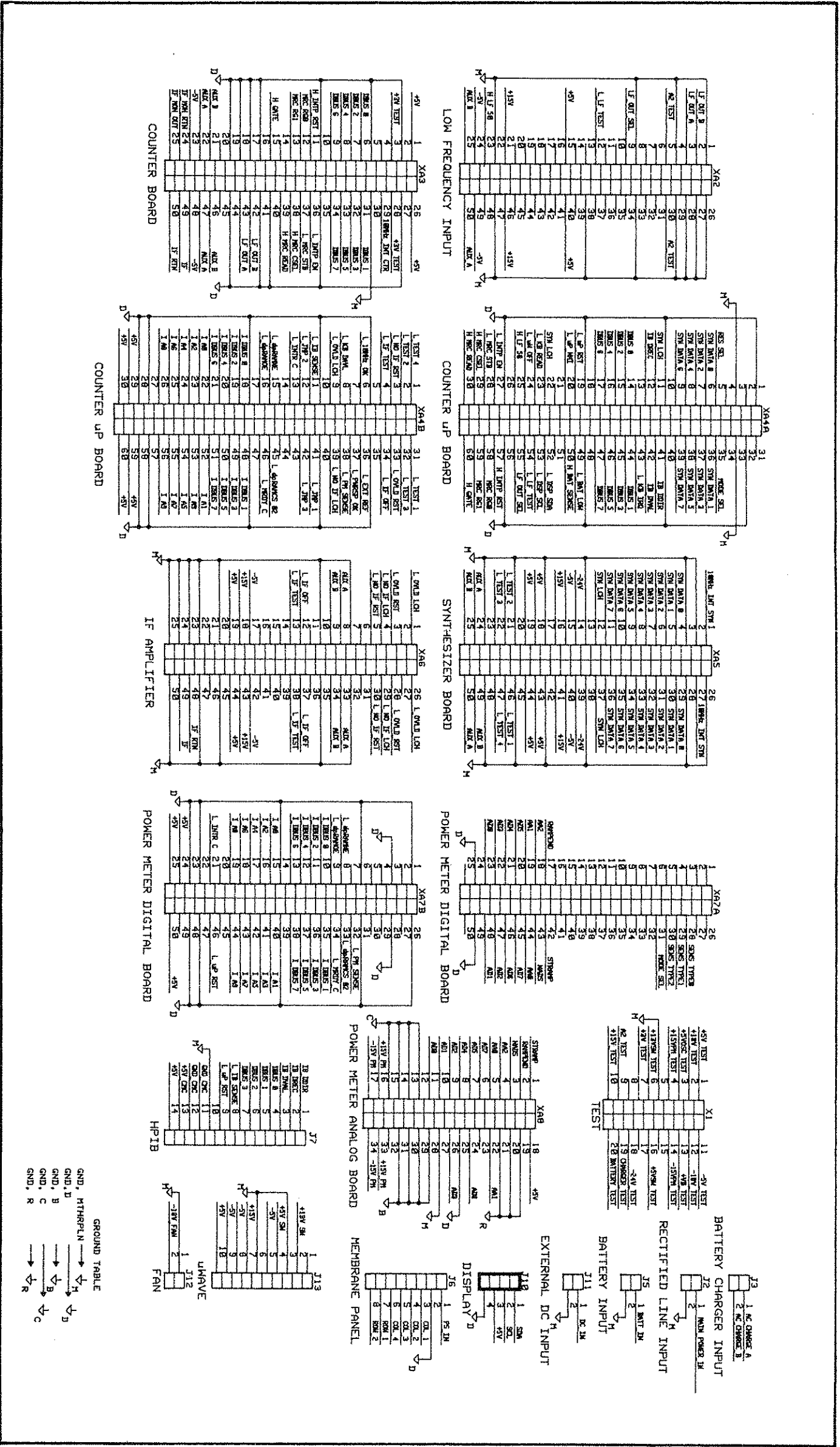


Figure 8-36. A1 Interconnections Drawing

*Figure 8-36*  
**A1 INTERCONNECTIONS DRAWING**

(See Page 8-217)





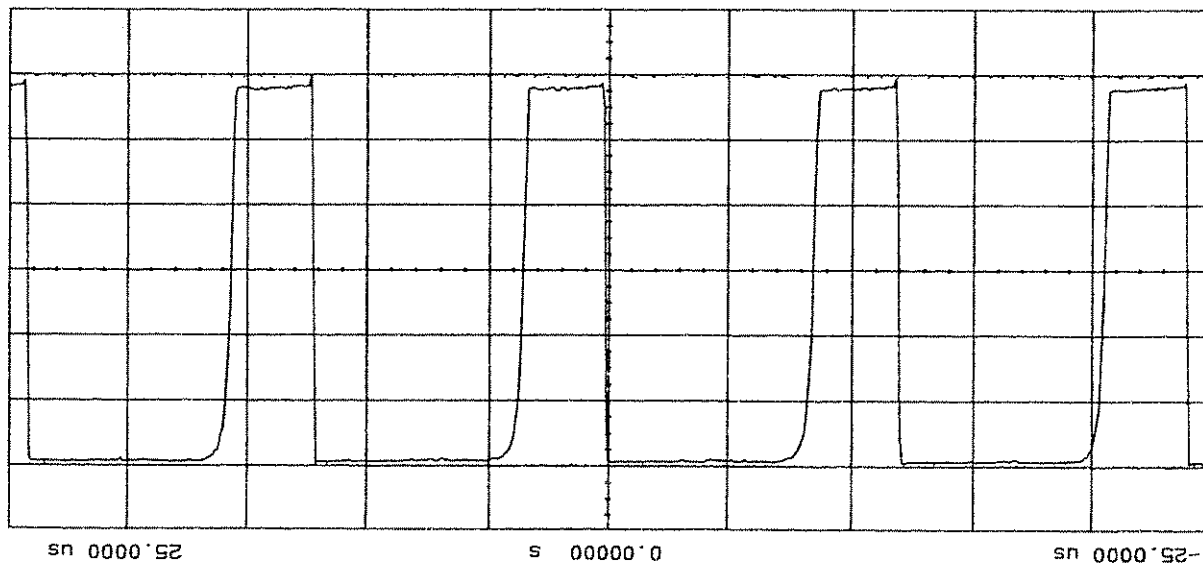
*Figure 8-37*  
**A1 MOTHERBOARD POWER SUPPLY  
OVERALL BLOCK DIAGRAM**

(See Page 8-219)

P/O Figure 8-38. A1 Waveforms

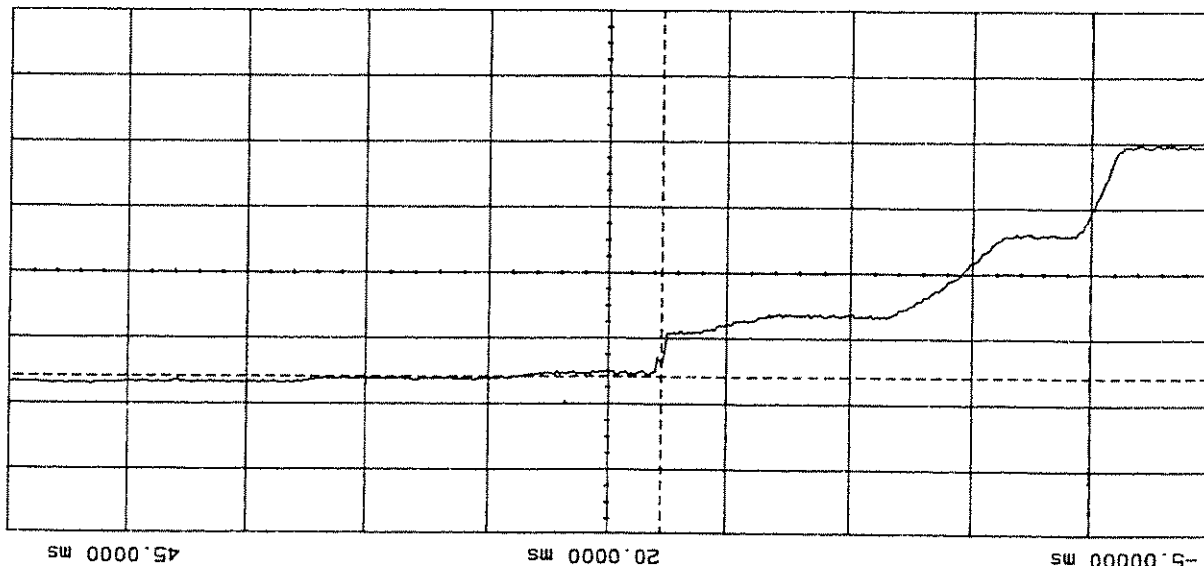
NAME OF WAVEFORM: **B**  
 POINT PROBED: A1P9--DC COUPLED  
 CONDITIONS: JUMPER A1W2 IN PLACE, +VB = 16V

Ch. 1  
 = 2.000 volts/div  
 Timebase = 5.00 us/div  
 Ch. 1 Parameters  
 = 8.51039 us  
 + Width  
 = 82.8506 KHZ  
 Freq.  
 = 11.84 volts  
 P-P Volts  
 = 0.0000 s  
 Delay  
 = 12.0397 us  
 Period  
 = 70.68 %  
 Duty Cycle  
 = 6.080 volts  
 Offset



NAME OF WAVEFORM: **A**  
 POINT PROBED: A1P4, ALSO CALLED SYSTEM POWER  
 CONDITIONS: SIGNAL OBTAINED AT LINE CORD PLUG-IN, WITH INSTRUMENT PREVIOUSLY POWERED OFF FROM FRONT PANEL

Ch. 1  
 = 5.000 volts/div  
 Timebase = 5.00 ms/div  
 Start = 0.0000 s  
 Marker 1 = 0.000 volts  
 Stop = 17.7000 ms  
 Marker 2 = 18.00 volts  
 Delta V = 18.00 volts  
 Delta T = 17.7000 ms  
 Delay = -5.0000 ms  
 Offset = 10.00 volts

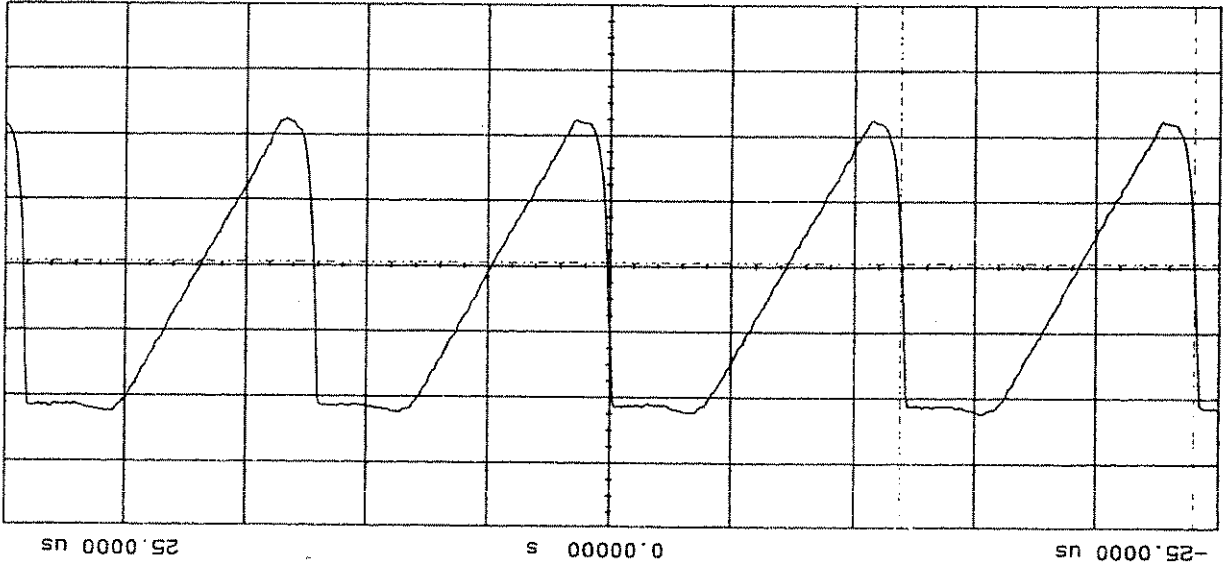


P/O Figure 8-38. A1 Waveforms

NAME OF WAVEFORM: D  
 POINT PROBED: A1U16 PIN 13—DC COUPLED  
 CONDITIONS: +VB = 16V

Ch. 1 Parameters  
 Timebase = 5.00 us/div  
 = 1.000 volts/div

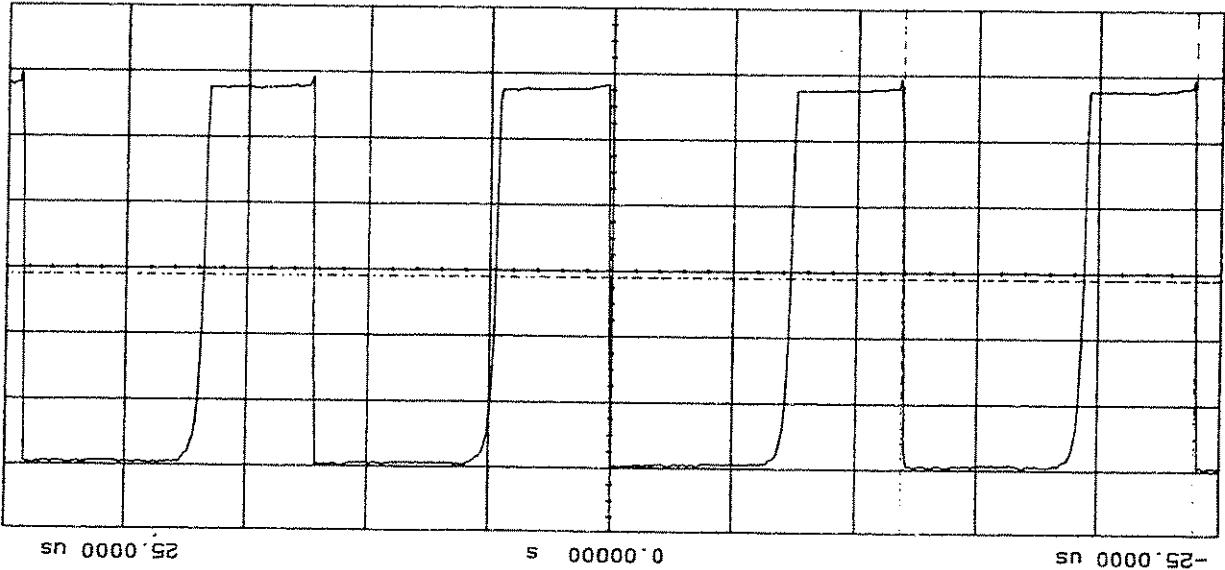
Offset = 3.780 volts  
 Delay = 0.0000 s  
 P-P Volts = 4.500 volts  
 Freq. = 83.0575 KHZ



NAME OF WAVEFORM: C  
 POINT PROBED: A1P9—DC COUPLED  
 CONDITIONS: JUMPER A1W2 REMOVED, +VB = 18V

Ch. 1 Parameters  
 Timebase = 5.00 us/div  
 = 2.000 volts/div

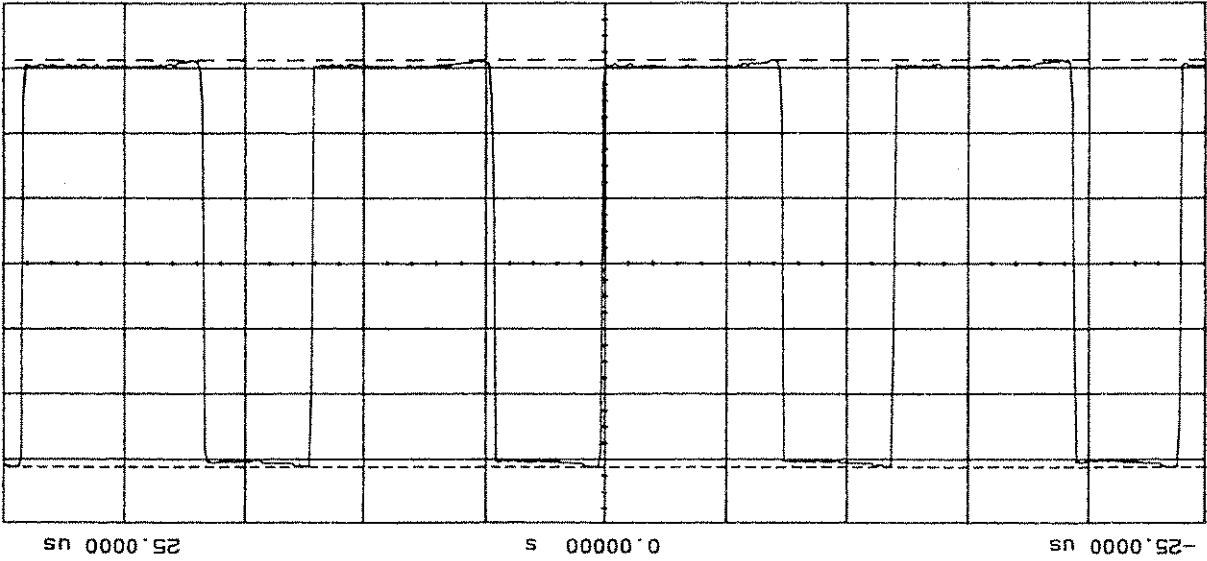
Offset = 6.000 volts  
 Delay = 0.0000 s  
 Period = 12.0826 us  
 Duty Cycle = 61.60 %  
 P-P Volts = 11.92 volts  
 Freq. = 83.0226 KHZ



P/O Figure 8-38. AI Waveforms

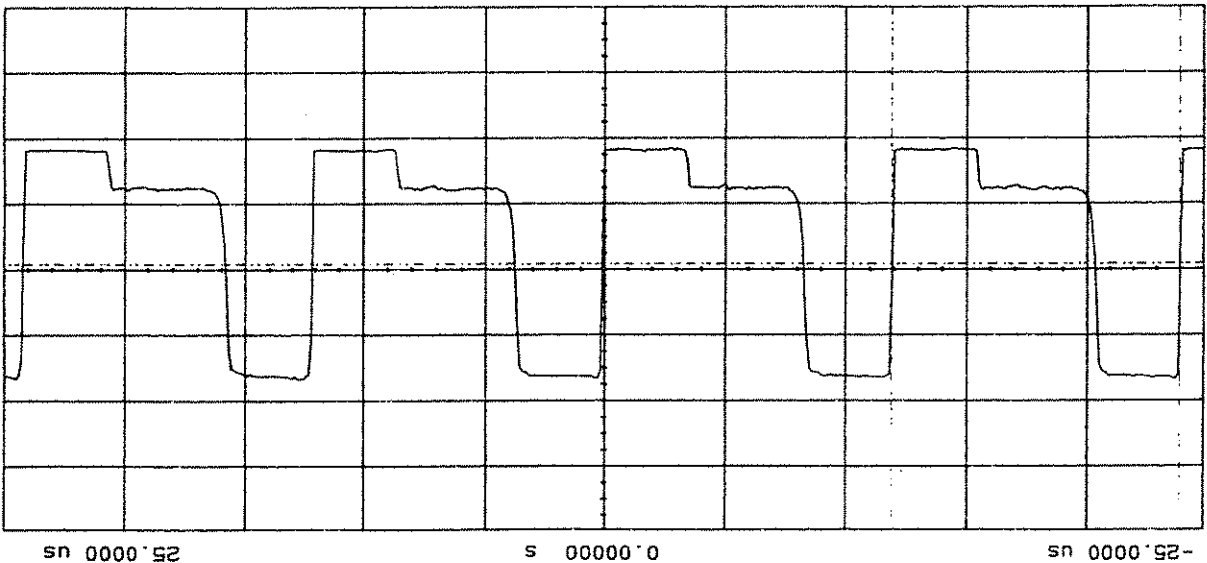
NAME OF WAVEFORM: F  
 POINT PROBED: JUNCTION OF A1R46 AND A1R47 - DC COUPLED  
 CONDITIONS: JUMPER A1W2 REMOVED, +VB = 18V

Ch. 1 Parameters  
 Timebase = 5.00 us/div  
 Ch. 1 = 2.000 volts/div  
 Offset = 5.800 volts  
 Delay = 0.00000 s  
 P-P Volts = 12.48 volts  
 Freq. = 83.2322 KHZ



NAME OF WAVEFORM: E  
 POINT PROBED: A1U16 PIN 6, 2A  
 CONDITIONS: +VB = 16V

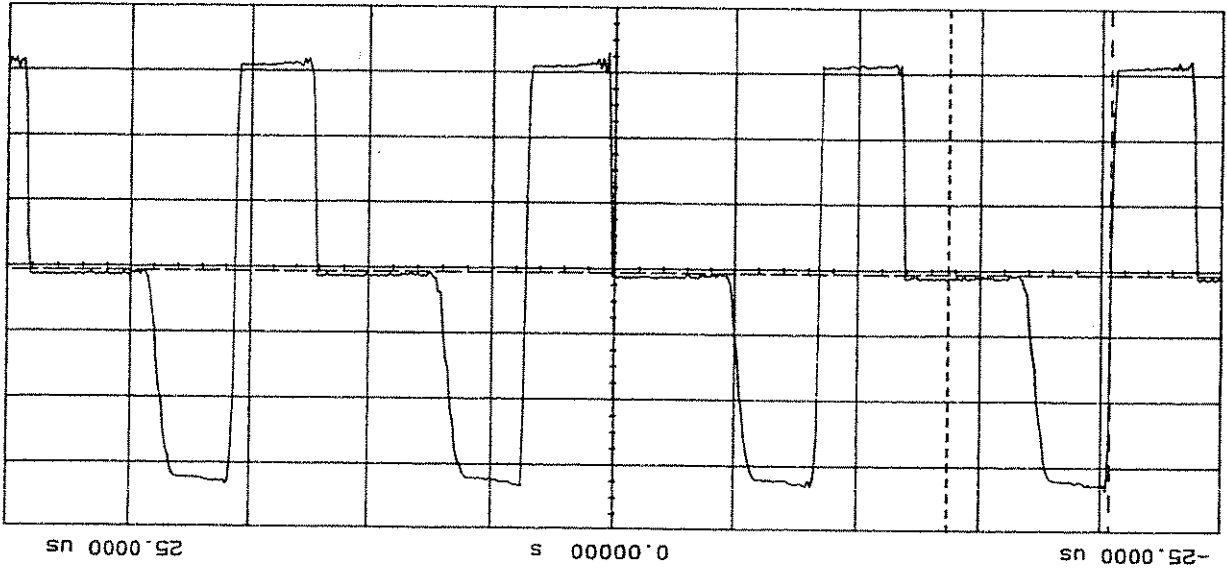
Ch. 1 Parameters  
 Timebase = 5.00 us/div  
 Ch. 1 = 1.000 volts/div  
 Offset = 1.340 volts  
 Delay = 0.00000 s  
 P-P Volts = 3.520 volts  
 Freq. = 82.8546 KHZ



P/O Figure 8-38. AI Waveforms

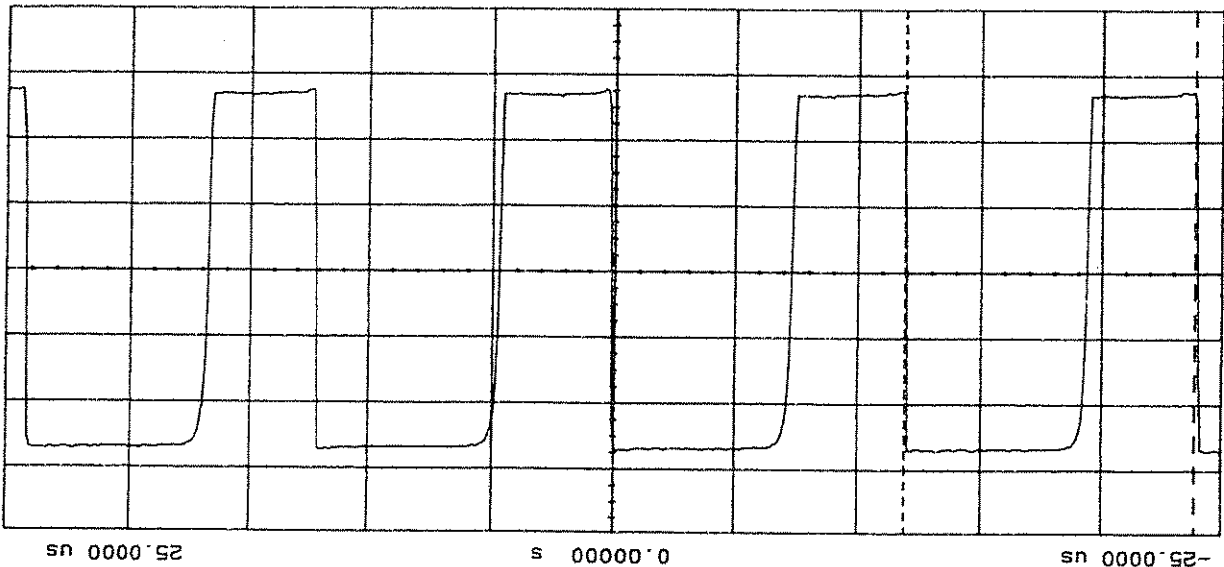
NAME OF WAVEFORM: H  
 POINT PROBED: A17P11 — DC COUPLED  
 CONDITIONS: JUMPER A1W2 IN PLACE, +VB = 16V

Ch. 1 Parameters  
 Timebase = 5.00 us/div  
 P-P Volts = 33.50 volts  
 Ch. 1 Parameters  
 Period = 11.9955 us  
 Duty Cycle = 55.80 %  
 Offset = 16.10 volts  
 Delay = 0.0000 s  
 + Width = 6.69396 us



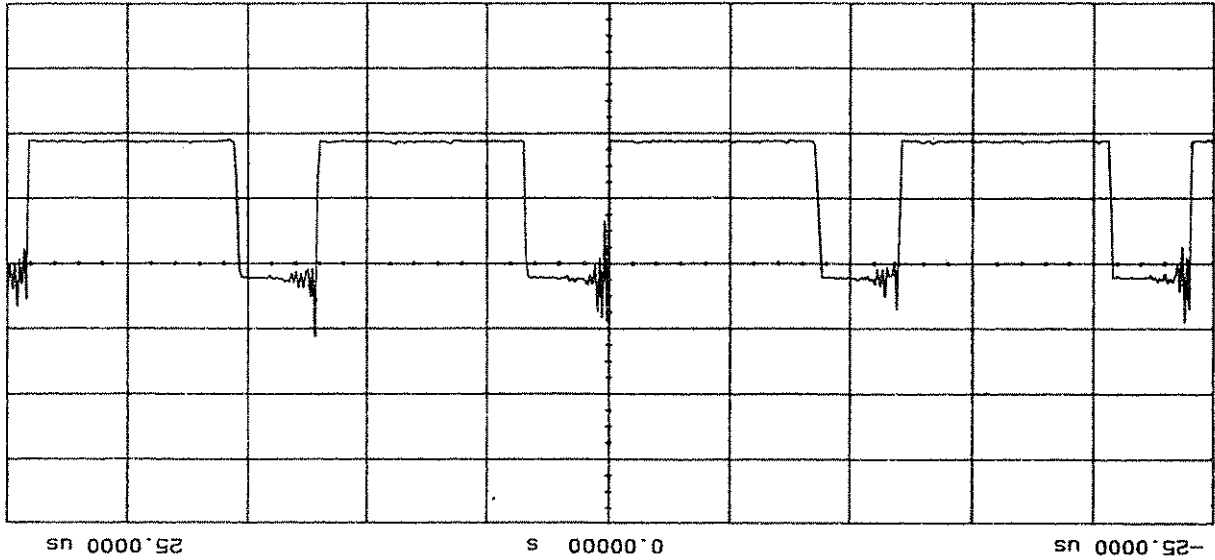
NAME OF WAVEFORM: G  
 POINT PROBED: A1Q7 EMITTER — DC COUPLED  
 CONDITIONS: JUMPER A1W2 REMOVED, +VB = 18V

Ch. 1 Parameters  
 Timebase = 5.00 us/div  
 P-P Volts = 10.96 volts  
 Ch. 1 Parameters  
 Freq. = 83.1488 KHz  
 Offset = 6.000 volts  
 Delay = 0.00000 s

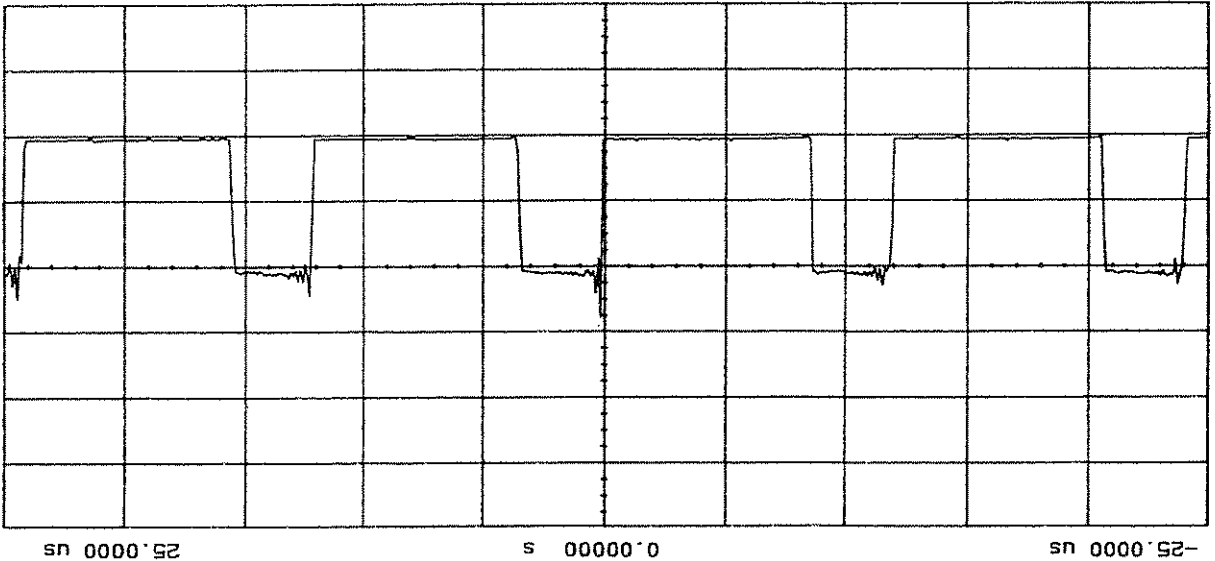


P/O Figure 8-38. AI Waveforms

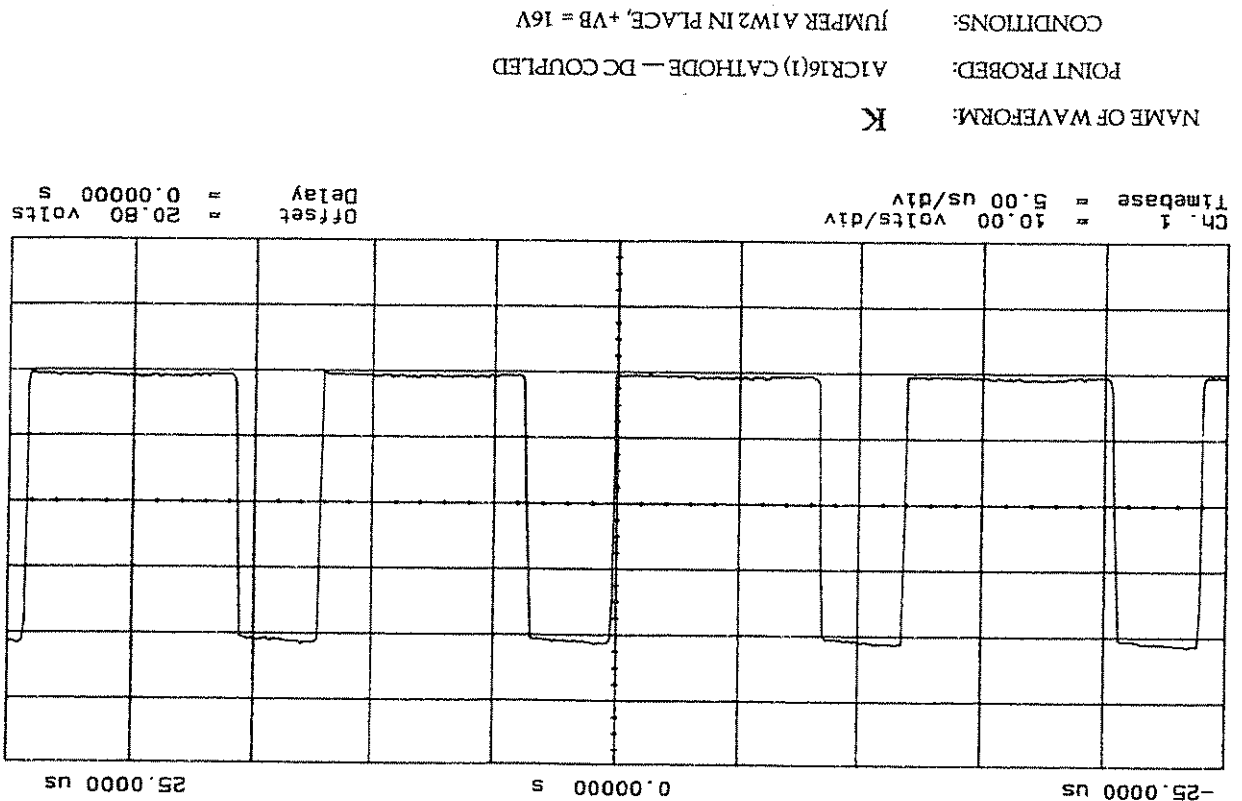
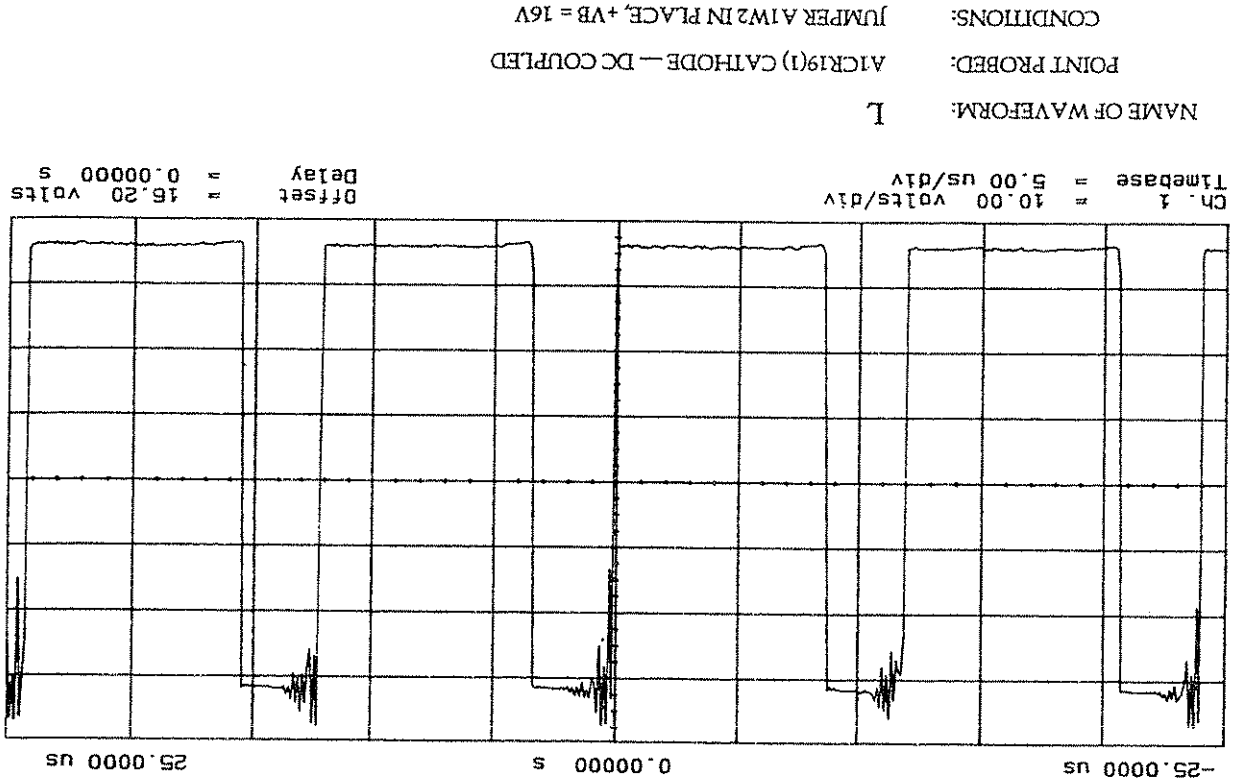
NAME OF WAVEFORM: J  
POINT PROBED: A1CR14 PIN 2 - DC COUPLED  
CONDITIONS: JUMPER A1W2 IN PLACE, +VB = 16V  
Ch. 1 = 10.00 volts/div  
Timebase = 5.00 us/div  
Offset = 12.20 volts  
Delay = 0.0000 s



NAME OF WAVEFORM: I  
POINT PROBED: A1CR15 PIN 2 - DC COUPLED  
CONDITIONS: JUMPER A1W2 IN PLACE, +VB = 16V  
Ch. 1 = 10.00 volts/div  
Timebase = 5.00 us/div  
Offset = 18.00 volts  
Delay = 0.00000 s

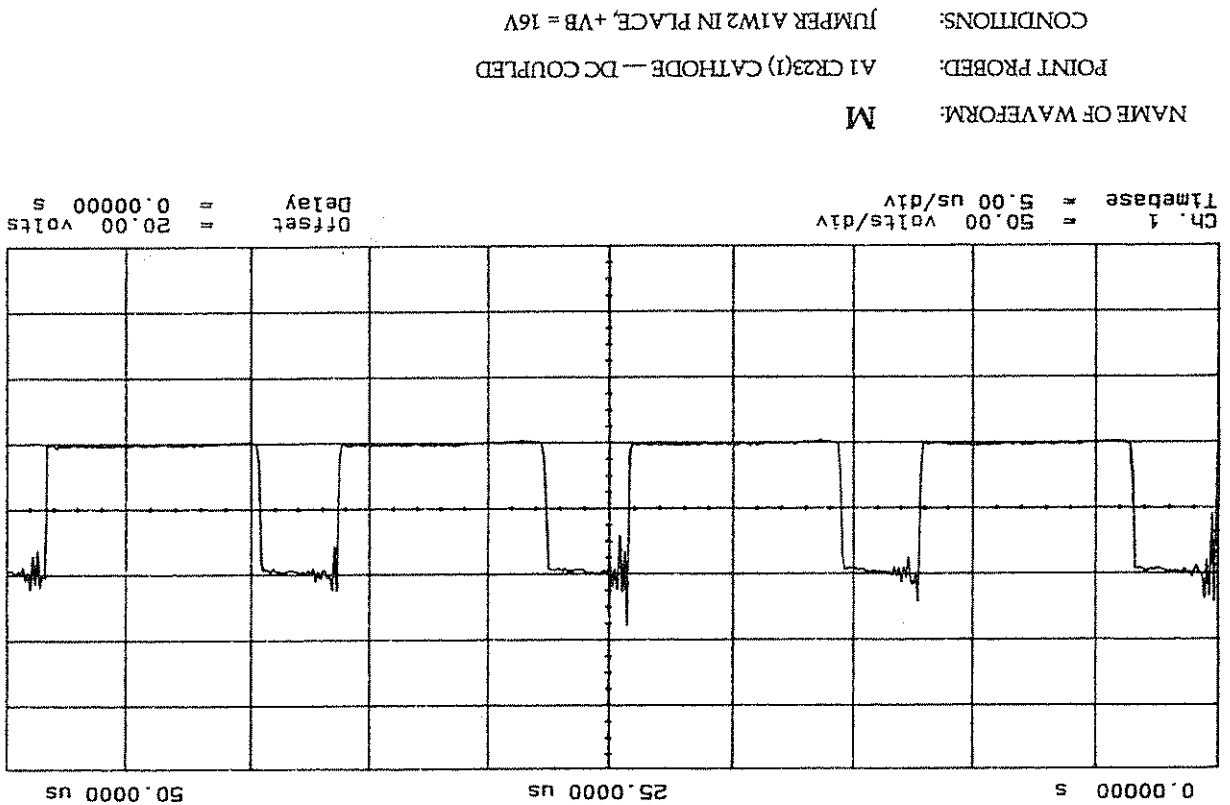


P/O Figure 8-38. A1 Waveforms





P/O Figure 8-38. A1 Waveforms





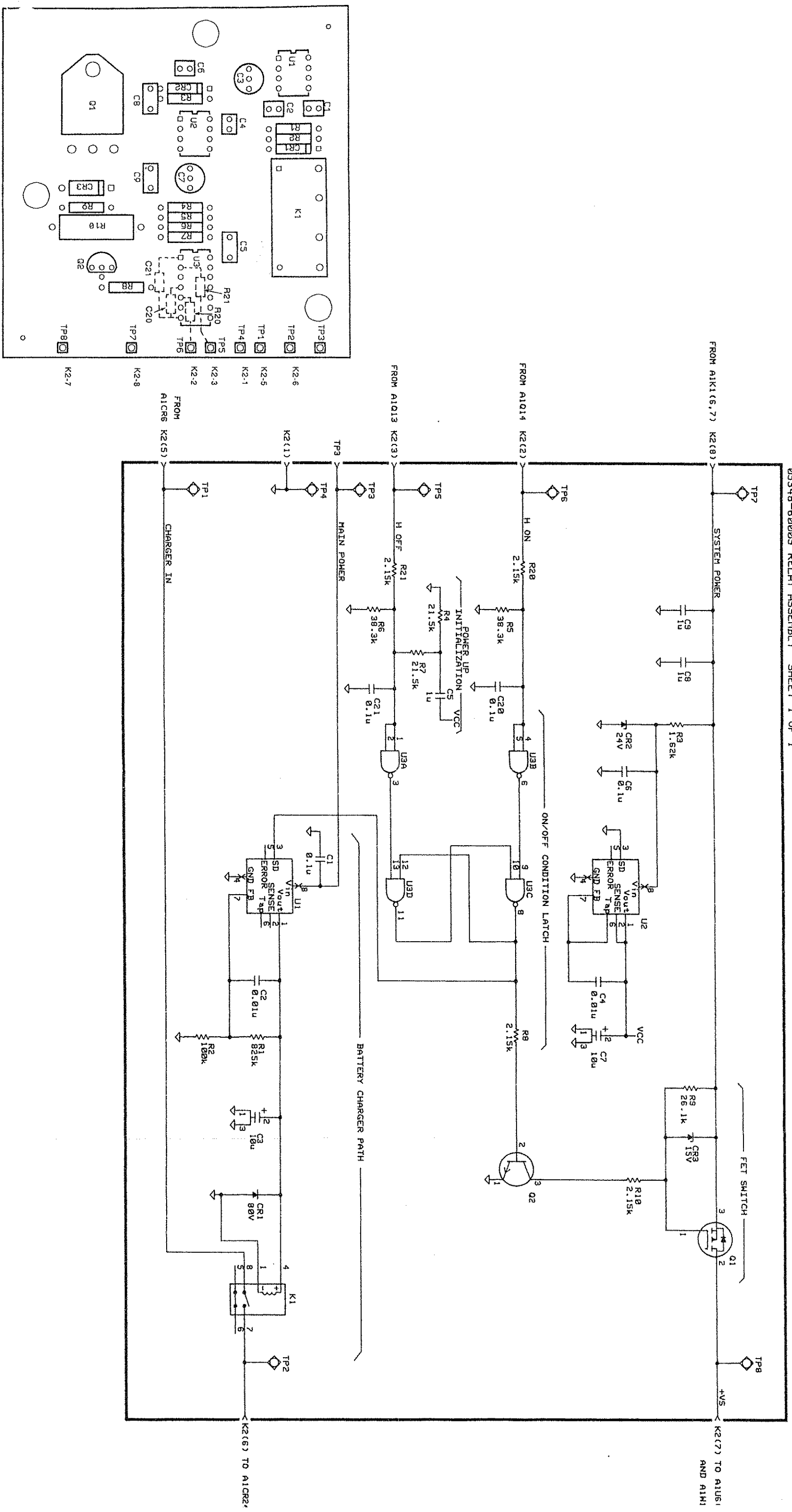
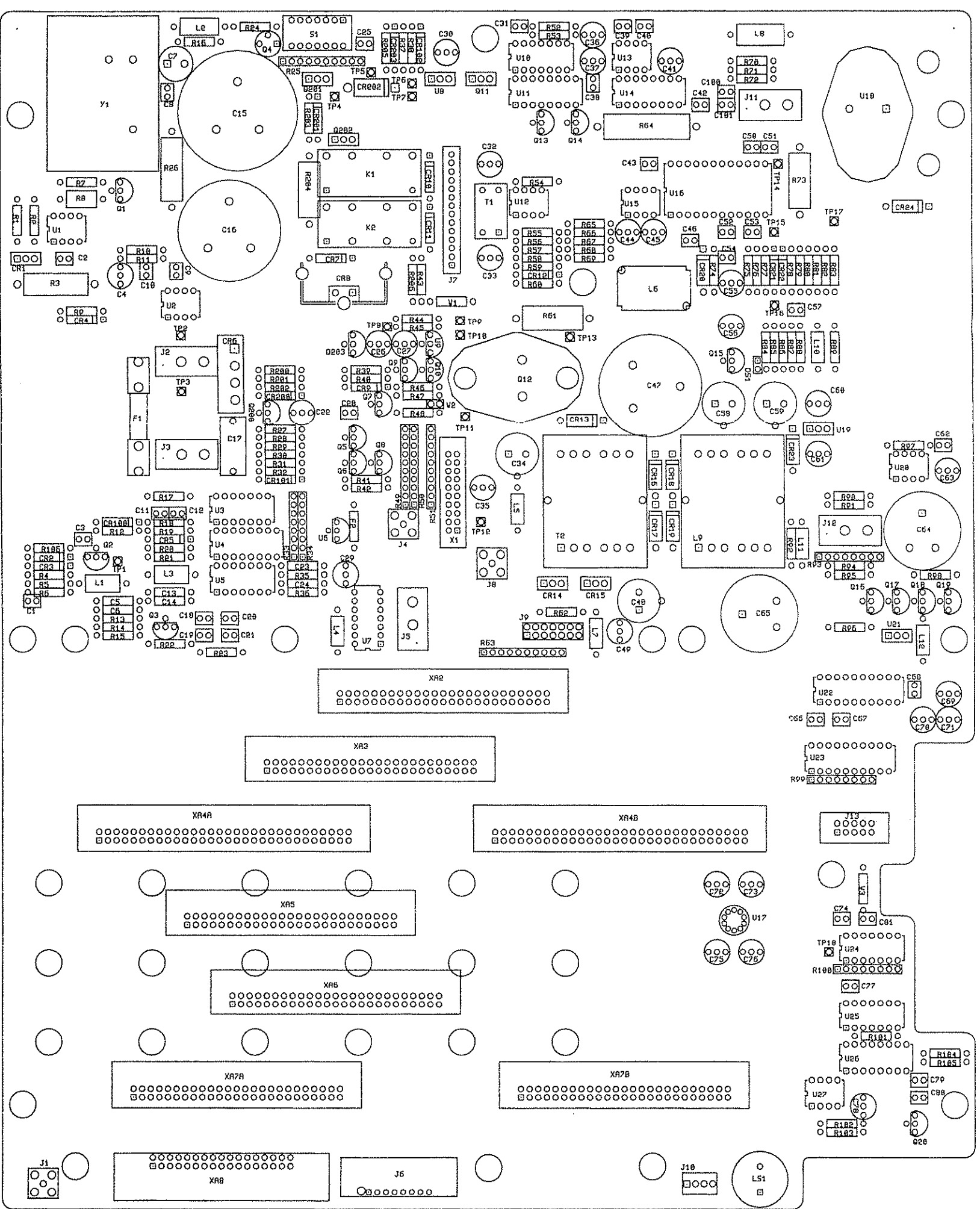


Figure 8-38A. Relay Assembly Component Locator/Schematic Diagram

*Figure 8-38A*  
RELAY ASSEMBLY COMPONENT LOCATOR/SCHEMATIC DIAGRAM

(See Page 8-227A)



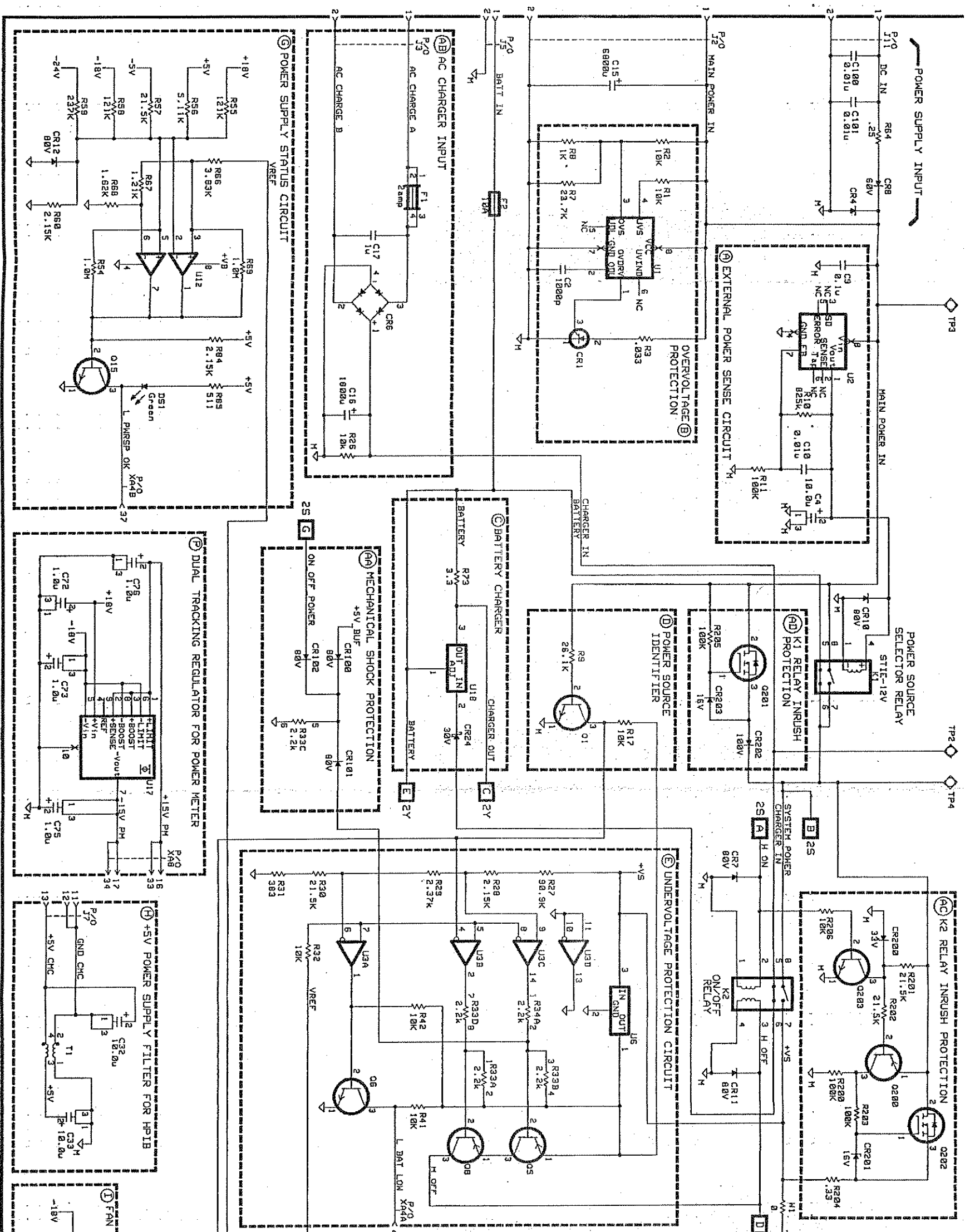
P/O Figure 8-38. A1 Component Locator

*P/O Figure 8-38*  
**A1 COMPONENT LOCATOR**

(See Page 8-229)

A1 SCHEMATIC DIAGRAM NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD A1 ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.
2. UNLESS OTHERWISE INDICATED: RESISTANCE IN OHMS, CAPACITANCE IN FARADS, INDUCTANCE IN HENRIES.
3. ASTERISK (\*) INDICATES FACTORY SELECTED COMPONENT. AVERAGE VALUE SHOWN.
4. A TILDE (~) PRECEDING A SIGNAL INDICATES A NEGATIVE-TRUE SIGNAL.







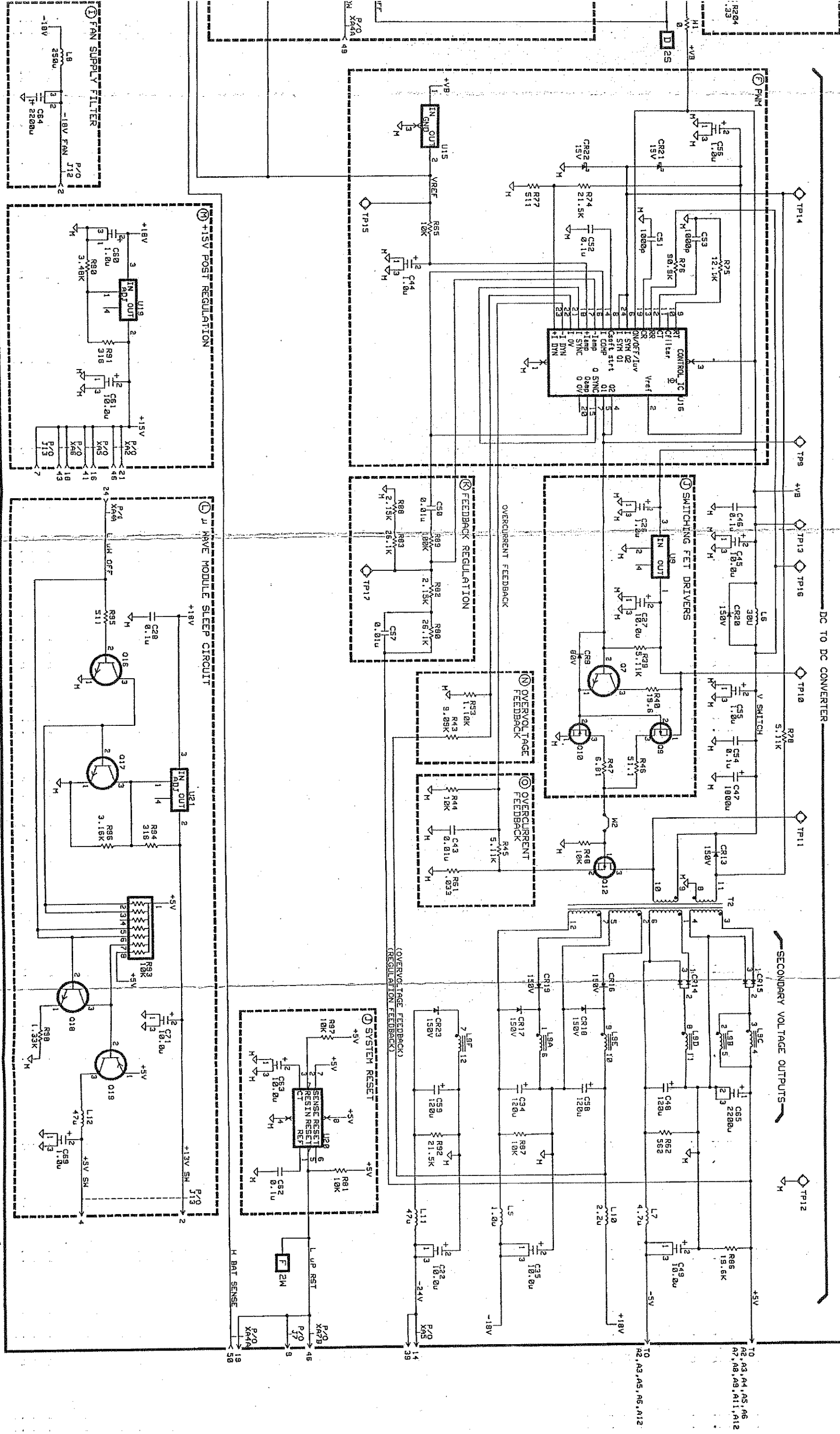
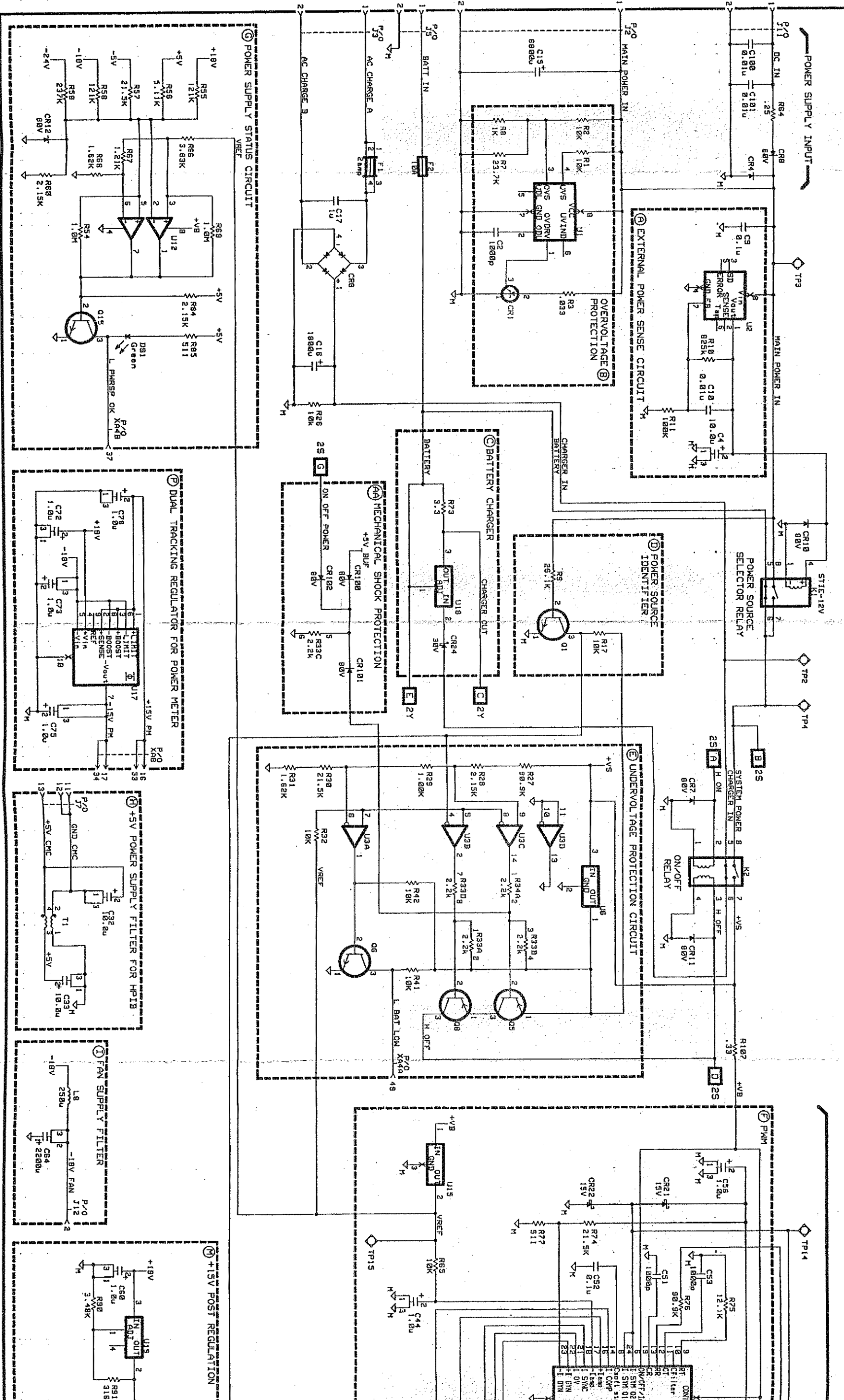


Figure 8-38. AI Motherboard Assembly  
Schematic Diagram (Sheet 1 of 2)







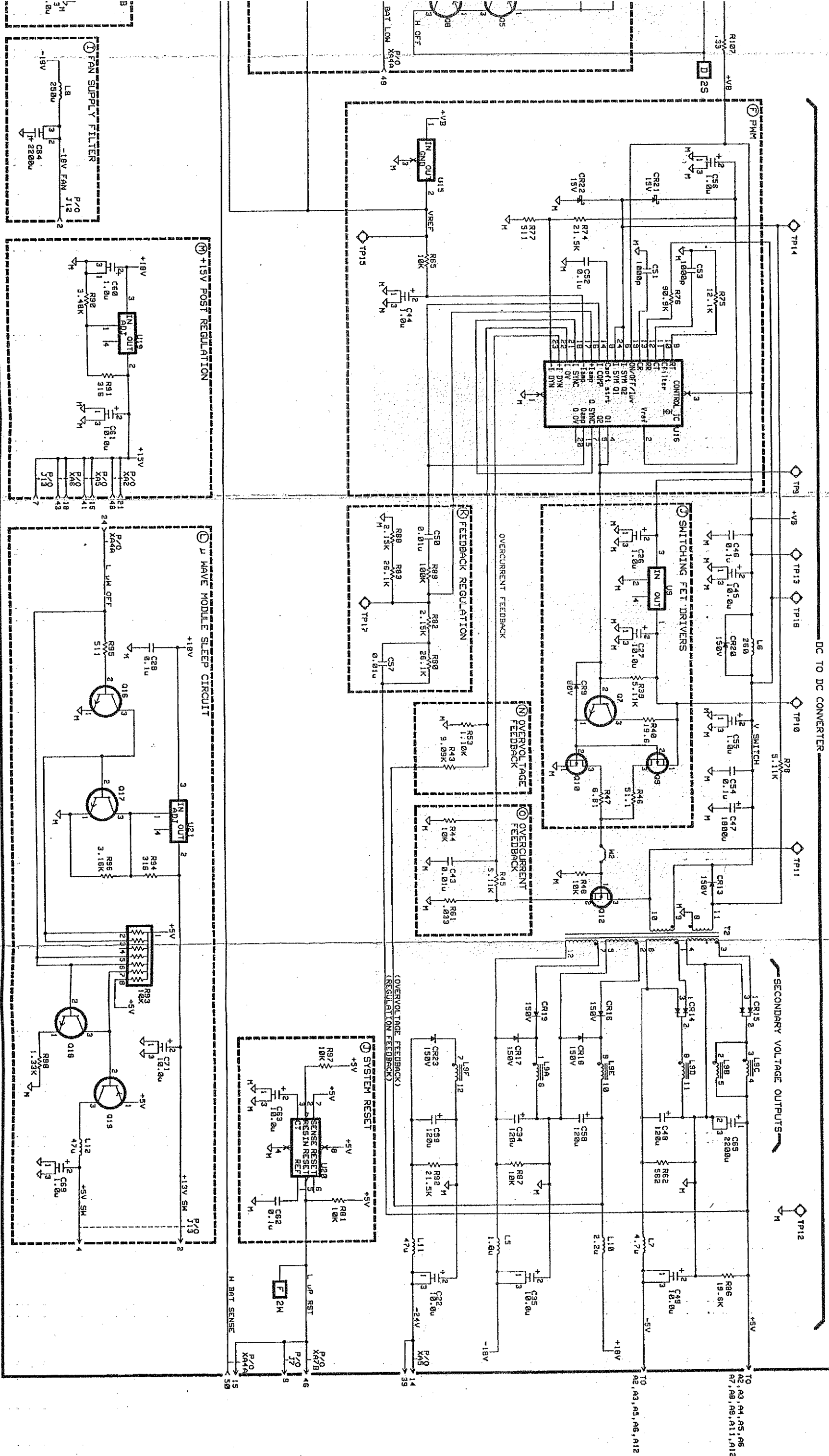
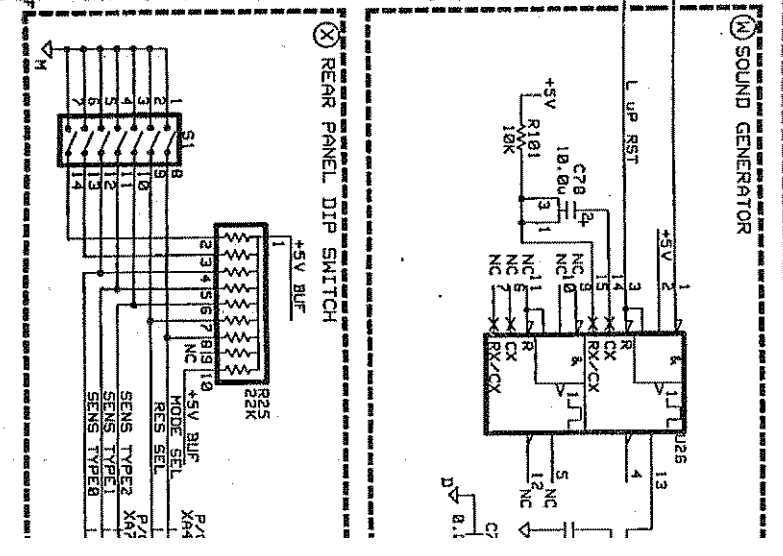
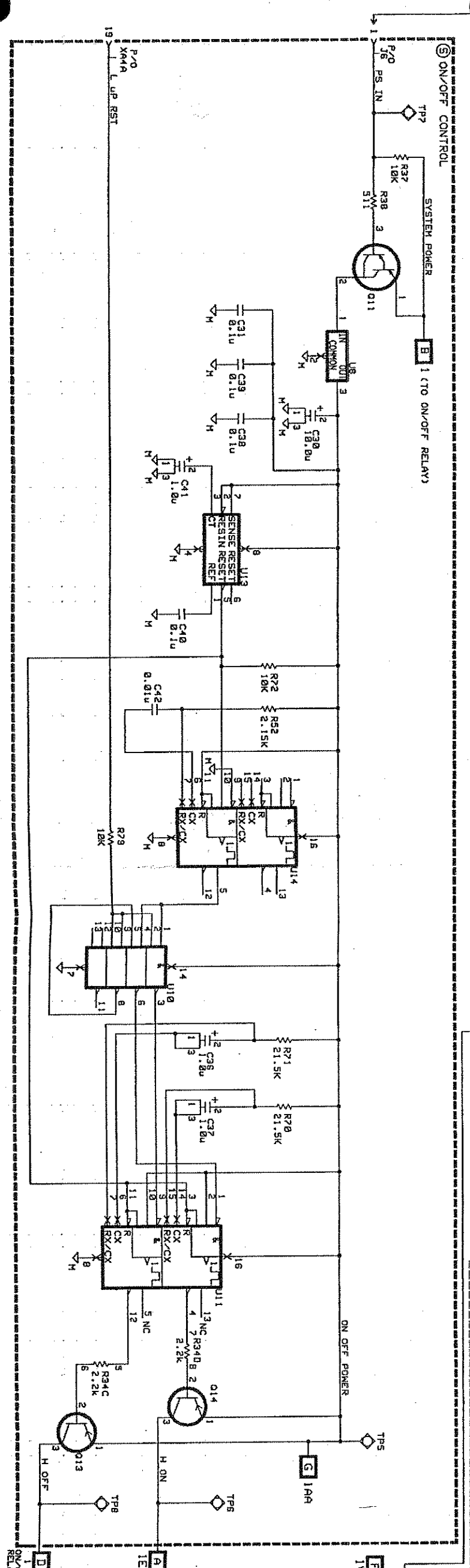
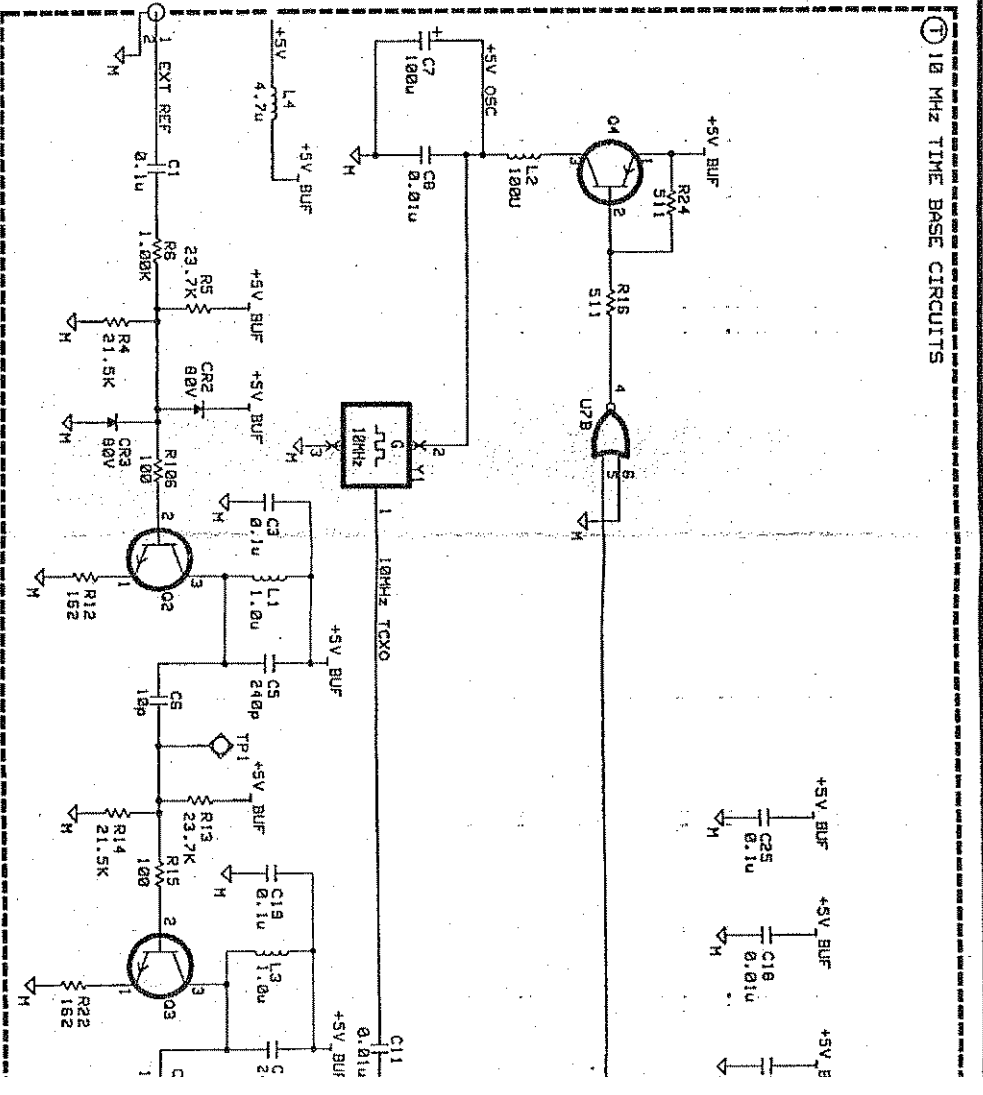
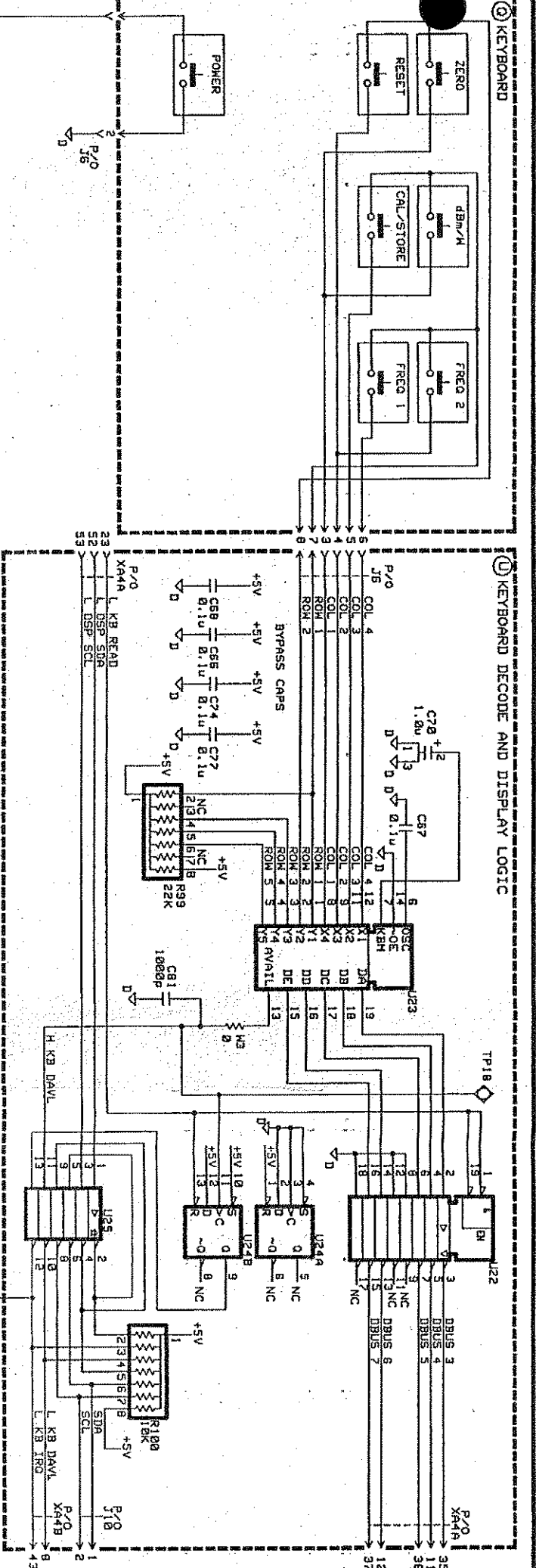


Figure 8-38B. A1 Motherboard Assembly (Rev. B)  
 Schematic Diagram (Sheet 1 of 2)









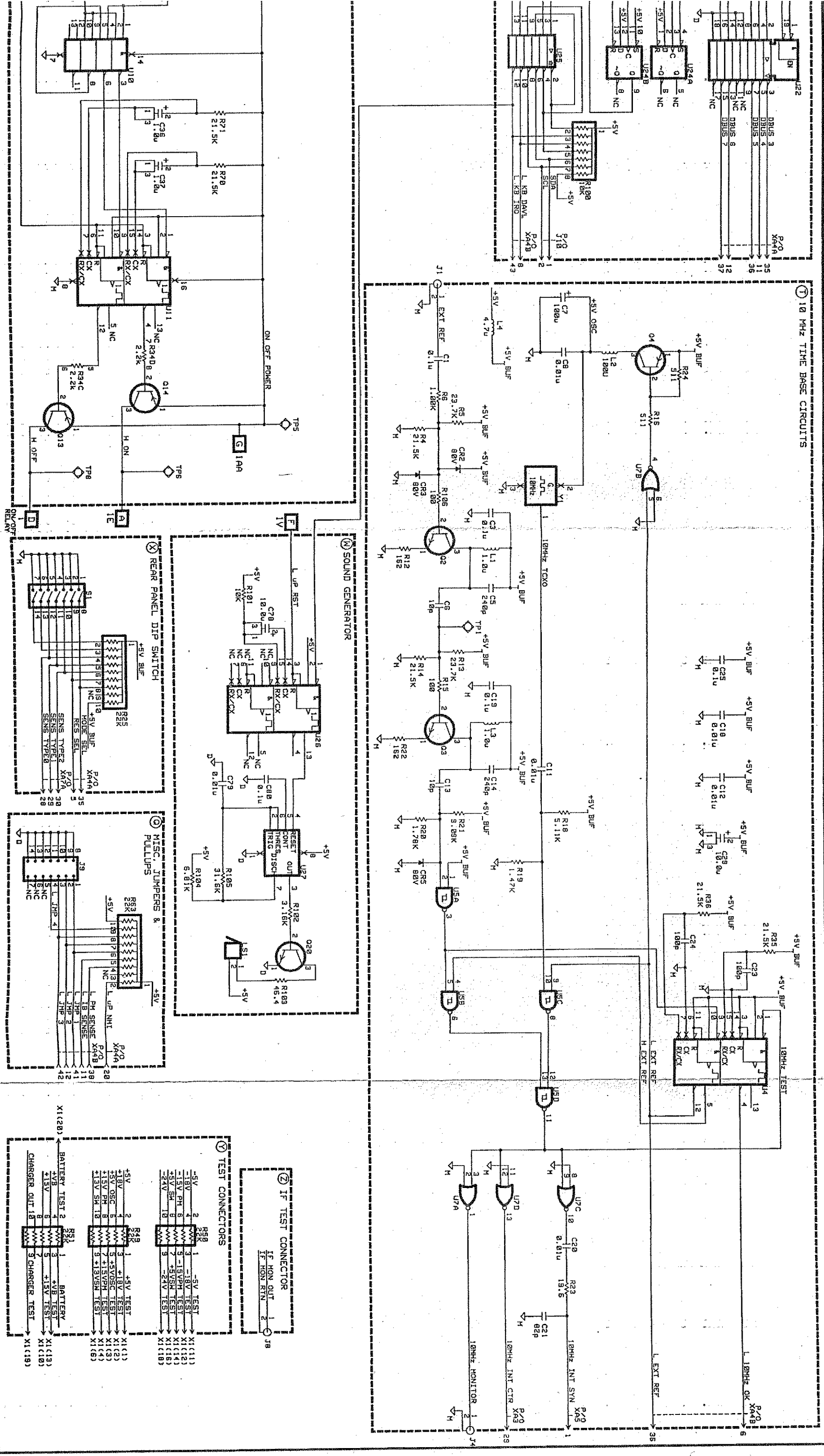
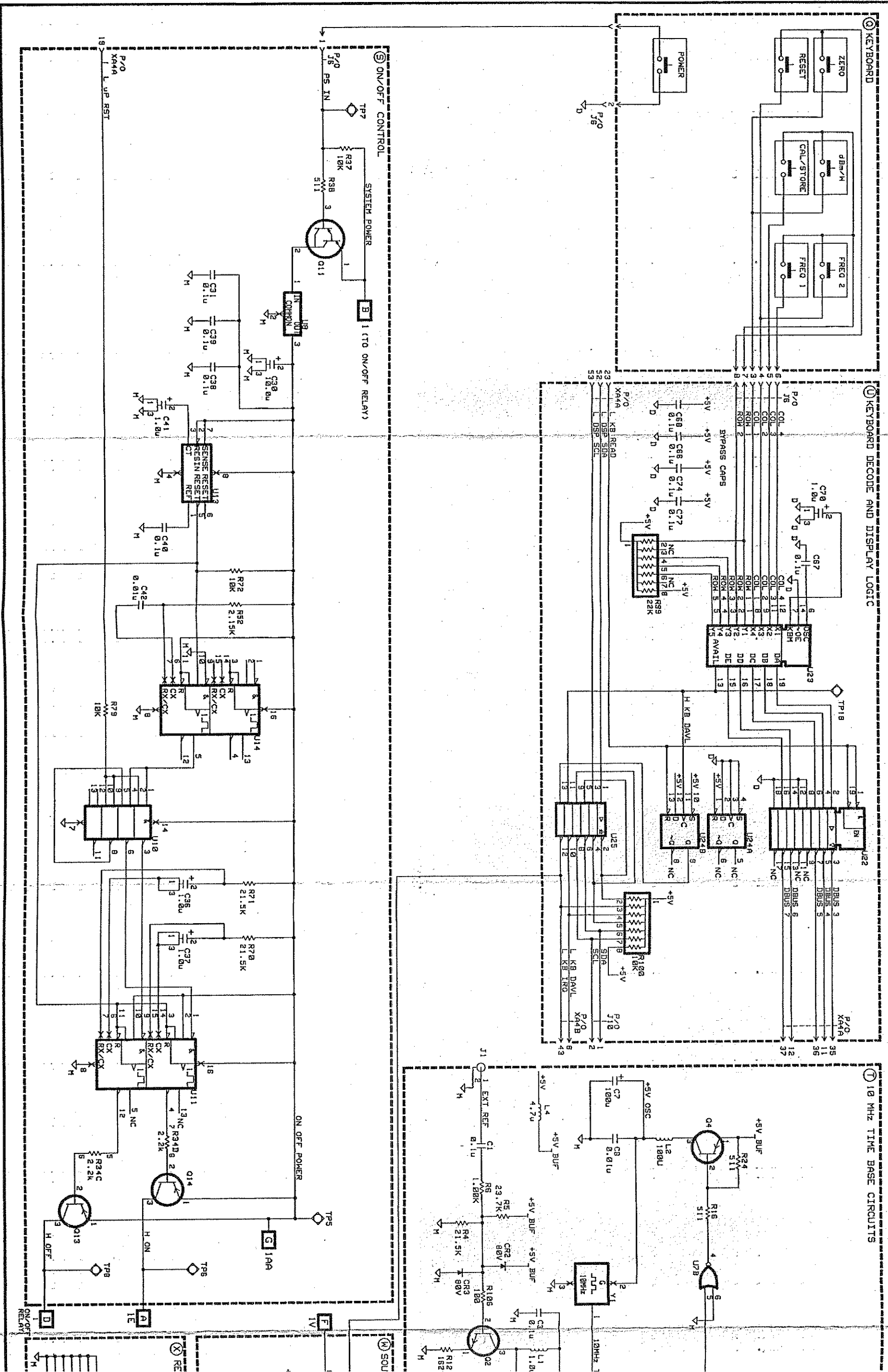


Figure 8-38. AI Motherboard Assembly Schematic Diagram (Sheet 2 of 2)







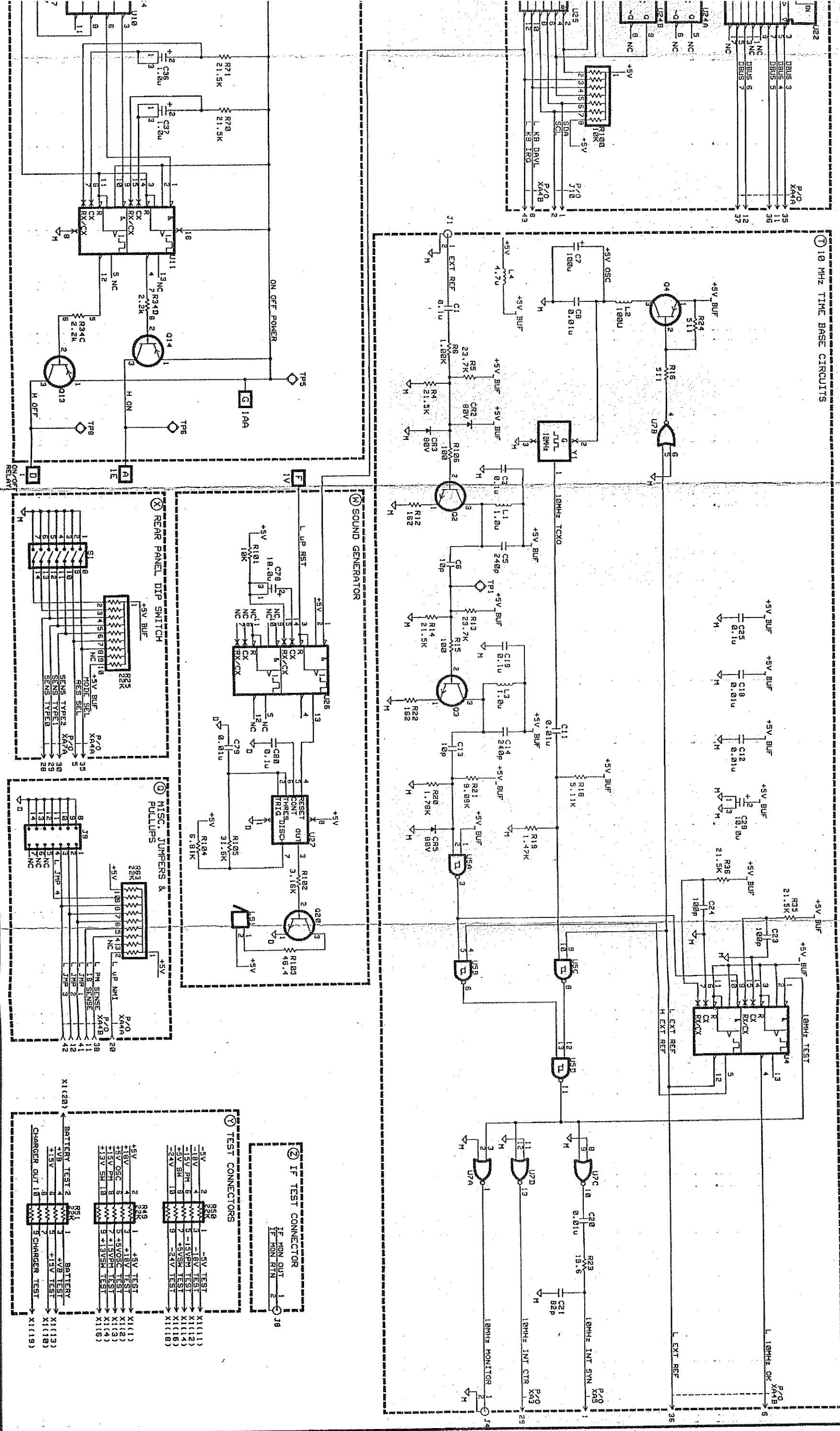
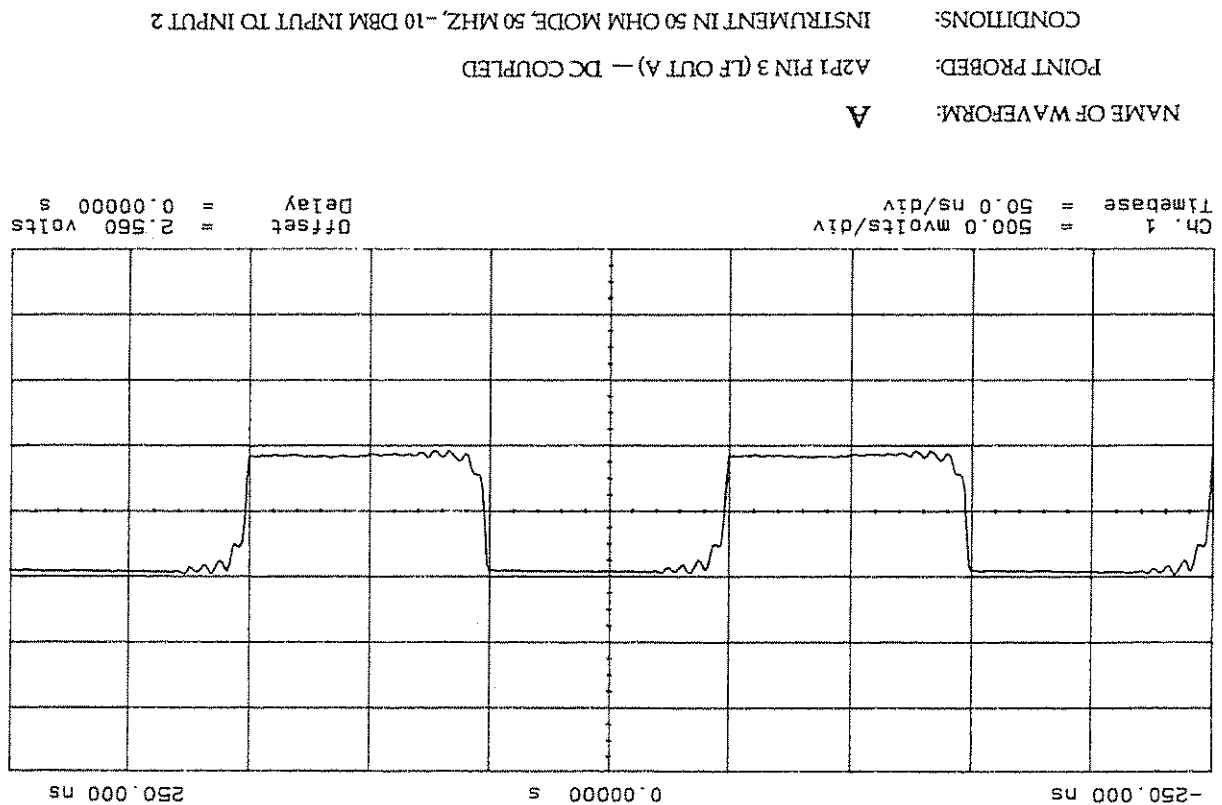
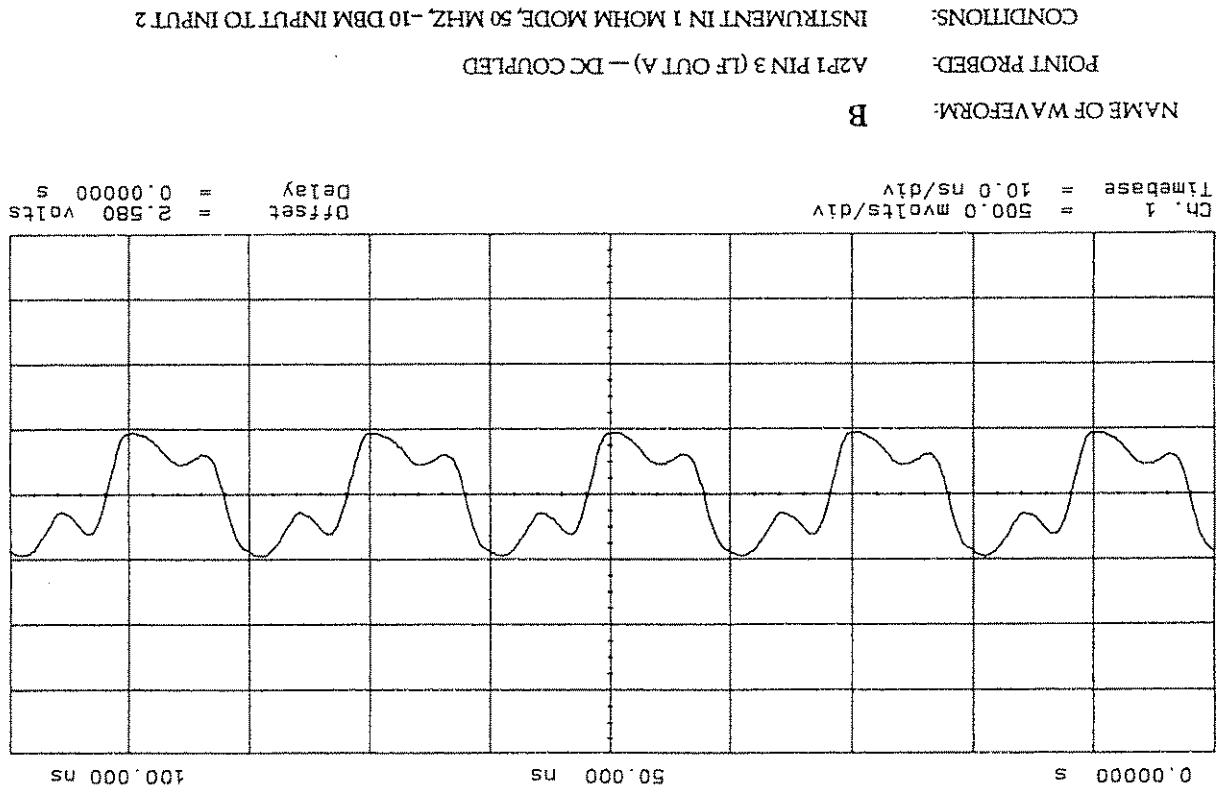


Figure 8-38B. A1 Motherboard Assembly (Rev. B)  
Schematic Diagram (Sheet 2 of 2)



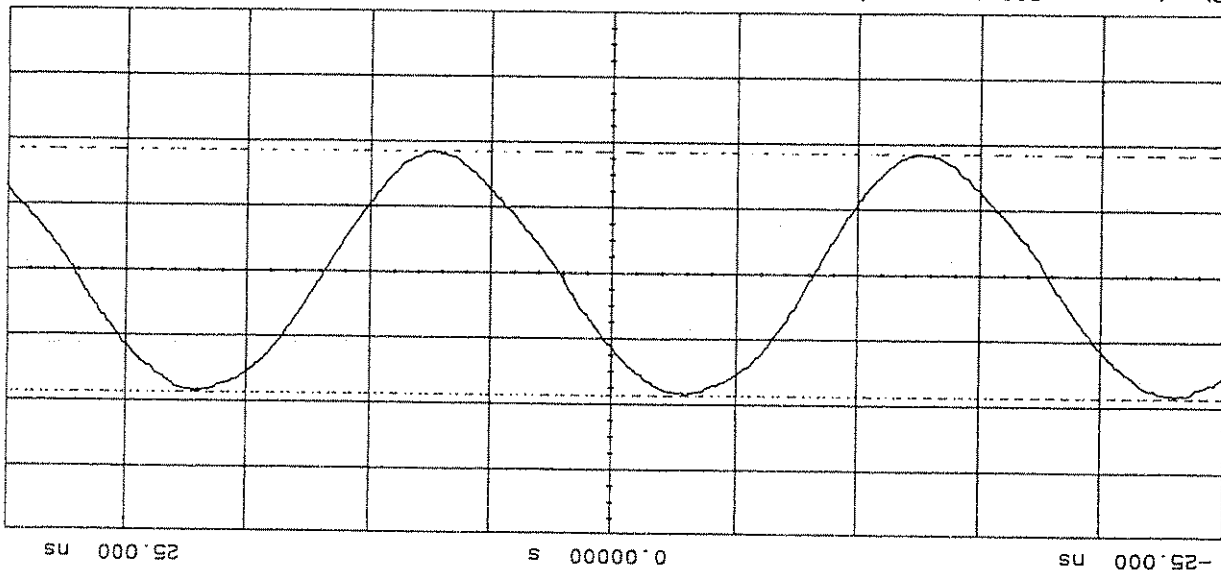
P/O Figure 8-39. A2 Waveforms



P/O Figure 8-39. A2 Waveforms

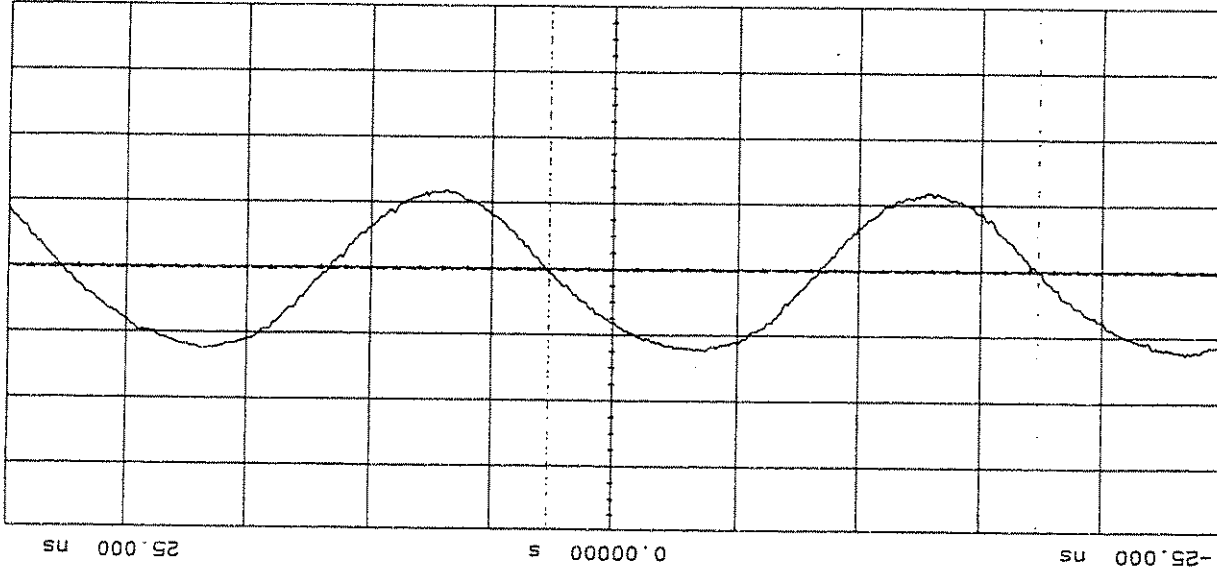
NAME OF WAVEFORM: D  
 POINT PROBED: A2U5 PIN 2 - AC COUPLED  
 CONDITIONS: INSTRUMENT IN 50 OHM MODE, 50 MHZ, 100MV P-P INPUT TO INPUT 2

Ch. 1 Parameters  
 Timebase = 5.00 ns/div  
 = 200.0 mvolts/div  
 Ch. 1 Parameters  
 P-P Volts = 744.0 mvolts  
 RMS Volts = 257.3 mvolts  
 Delay = 0.0000 s  
 Offset = -8.000 mvolts



NAME OF WAVEFORM: C  
 POINT PROBED: A2U7 PIN 2 - AC COUPLED  
 CONDITIONS: INSTRUMENT IN 50 OHM MODE, 50 MHZ, 100MV P-P INPUT TO INPUT 2

Ch. 1 Parameters  
 Timebase = 5.00 ns/div  
 = 100.0 mvolts/div  
 Ch. 1 Parameters  
 P-P Volts = 246.0 mvolts  
 RMS Volts = 85.00 mvolts  
 Delay = 0.0000 s  
 Offset = -4.000 mvolts

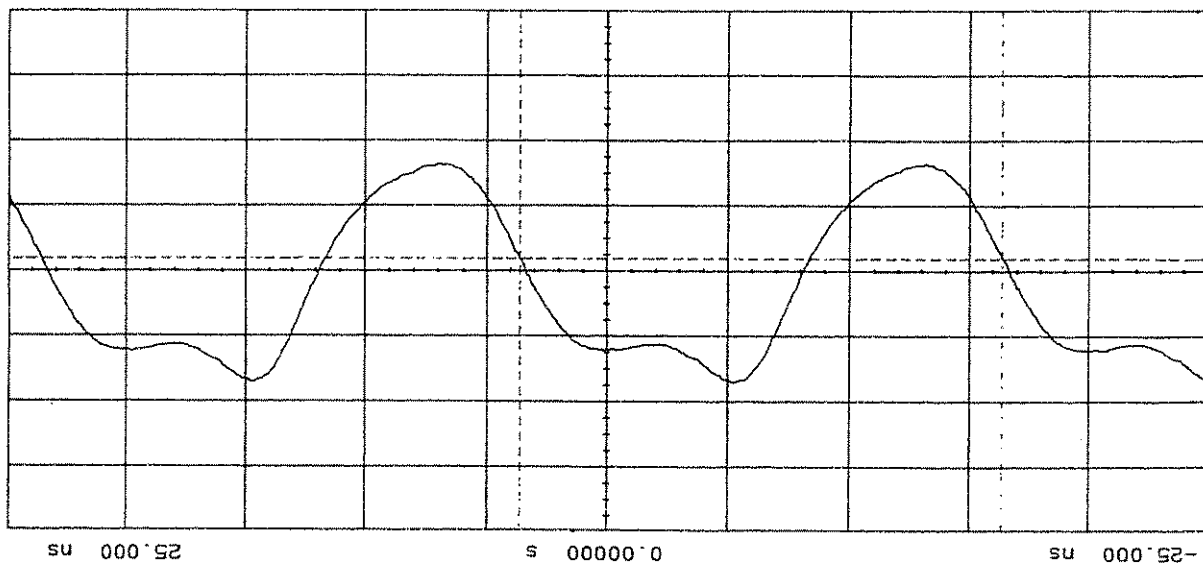




P/O Figure 8-39. A2 Waveforms

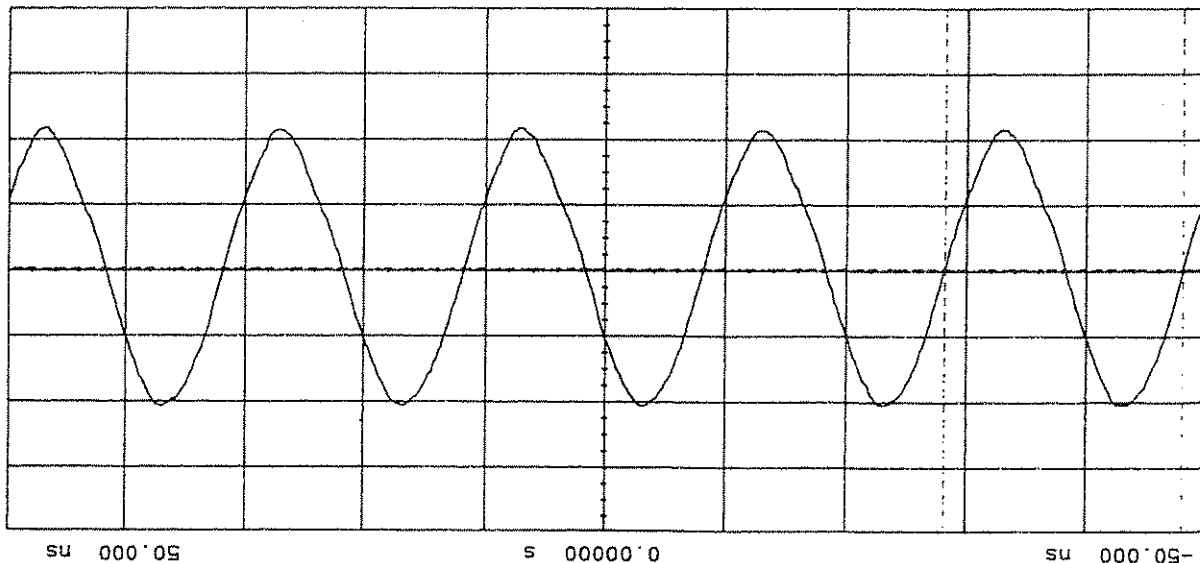
NAME OF WAVEFORM: F  
 POINT PROBED: A2U4 PIN 2 — AC COUPLED  
 CONDITIONS: INSTRUMENT IN 50 OHM MODE, 50 MHZ, 100 MV P-P INPUT TO INPUT 2

Ch. 1 Parameters  
 Timebase = 500.0 mvolts/div  
 P-P Volts = 1.670 volts  
 RMS Volts = 580.3 mvolts  
 Delay = 0.0000 s  
 Offset = -80.00 mvolts



NAME OF WAVEFORM: E  
 POINT PROBED: SOURCE OF A2Q9 — AC COUPLED  
 CONDITIONS: INSTRUMENT IN 1 MOHM MODE, 50 MHZ, -10 DBM INPUT TO INPUT 2

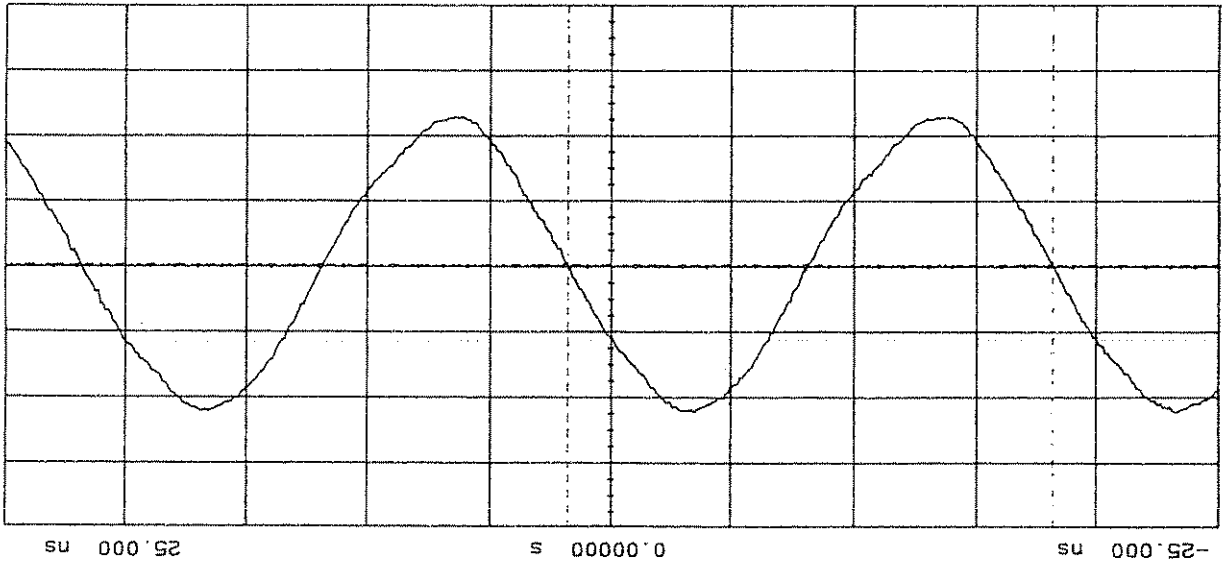
Ch. 1 Parameters  
 Timebase = 10.0 ns/div  
 P-P Volts = 422.0 mvolts  
 RMS Volts = 143.9 mvolts  
 Delay = 0.0000 s  
 Offset = 10.00 mvolts



P/O Figure 8-39. A2 Waveforms

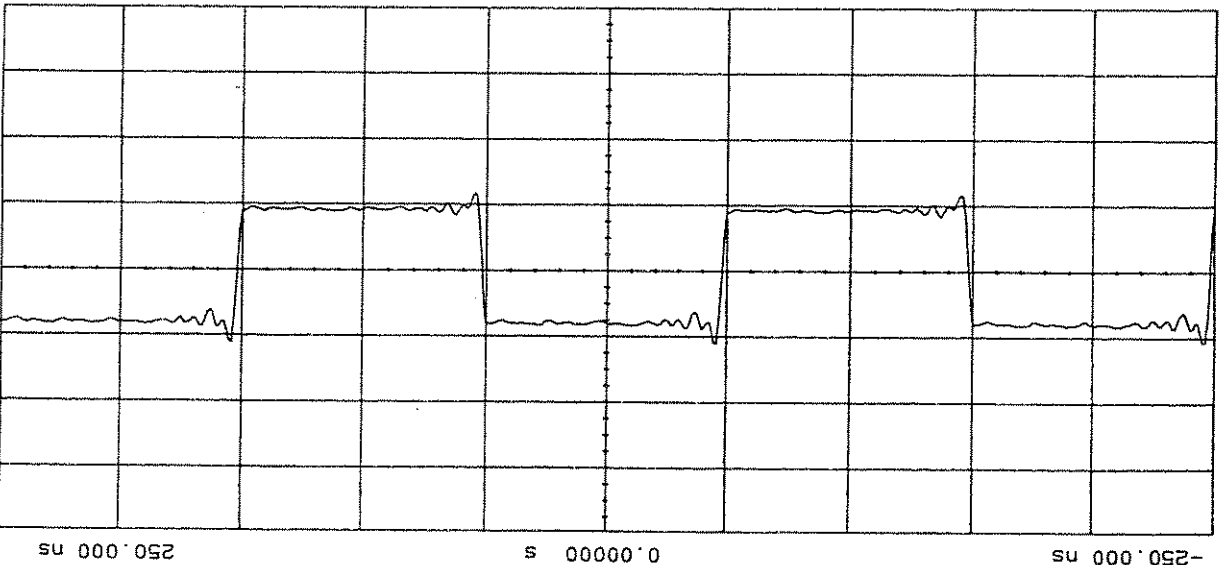
NAME OF WAVEFORM: H  
 POINT PROBED: A2 U6 PIN 7 - AC COUPLED  
 CONDITIONS: INSTRUMENT IN 1 MOHM MODE, 50 MHZ, 100 MV P-P AT U6 PIN 10

Ch. 1 Parameters  
 Timebase = 5.00 ns/div  
 = 100.0 mvolts/div  
 P-P Volts = 454.0 mvolts  
 RMS Volts = 154.3 mvolts  
 Delay = 0.0000 s  
 Offset = 10.00 mvolts



NAME OF WAVEFORM: G  
 POINT PROBED: A2 U1 PIN 8 - DC COUPLED  
 CONDITIONS: INSTRUMENT IN 50 OHM MODE, 50 MHZ, -10 DBM INPUT TO INPUT 2

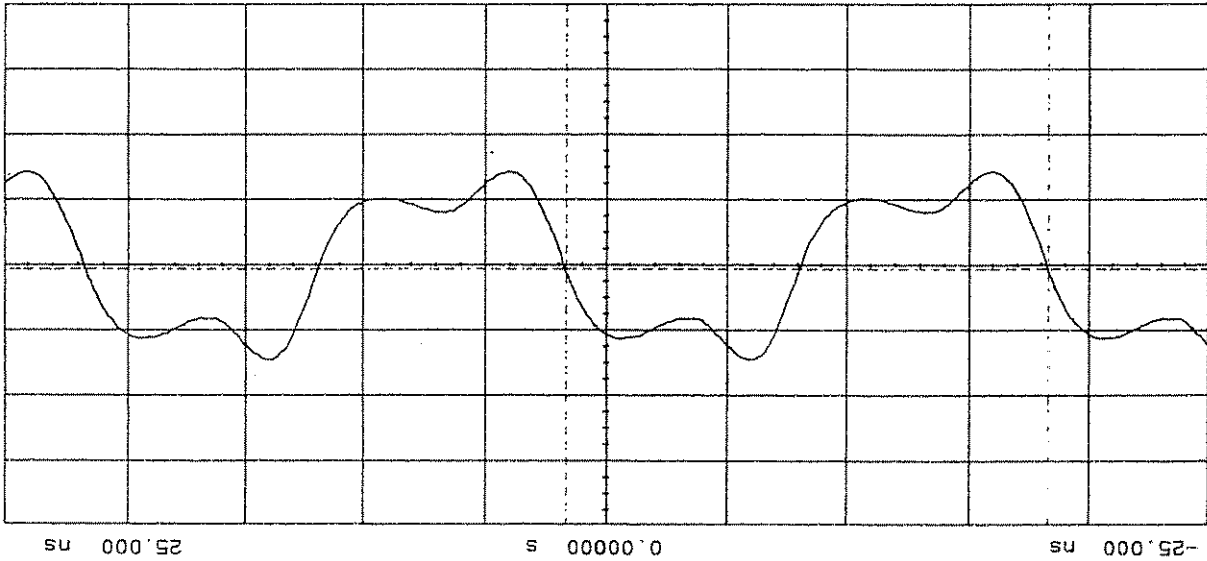
Ch. 1 Parameters  
 Timebase = 50.0 ns/div  
 = 500.0 mvolts/div  
 Offset = 3.750 volts  
 Delay = 0.0000 s



P/O Figure 8-39. A2 Waveforms

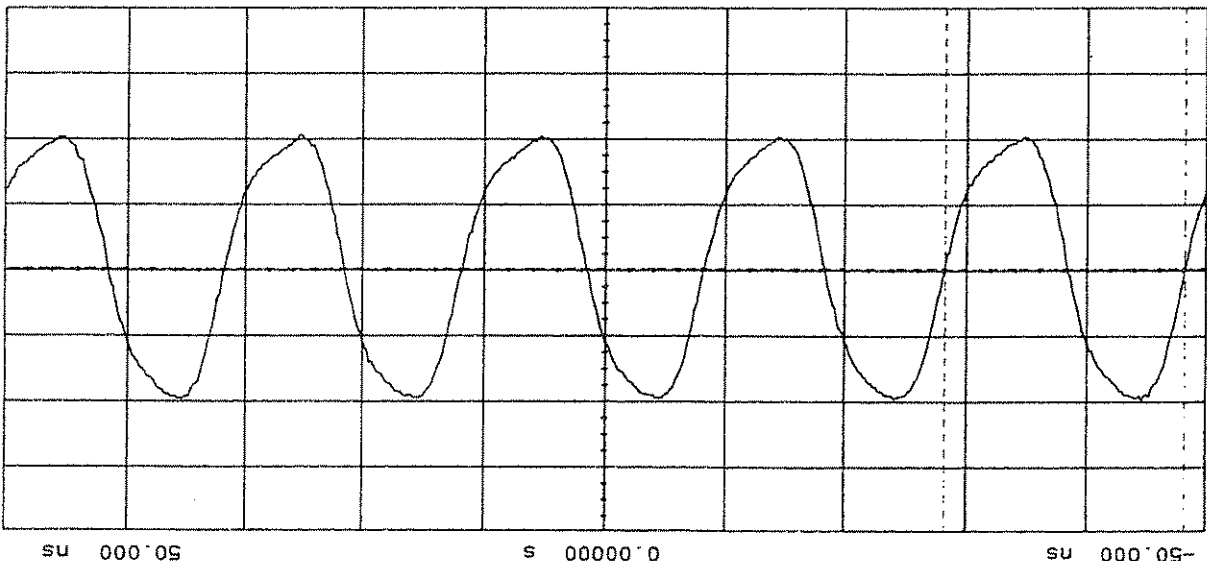
NAME OF WAVEFORM: J  
 POINT PROBED: A2U6 PIN 15 — DC COUPLED  
 CONDITIONS: INSTRUMENT IN 1 MOHM MODE, 50 MHZ, -20 DBM IN TO INPUT 2

Ch. 1 Parameters  
 = 500.0 mvolts/div  
 Timebase = 5.00 ns/div  
 P-P Volts = 1.450 volts  
 RMS Volts = 3.729 volts  
 Delay = 0.00000 s  
 Offset = 3.690 volts

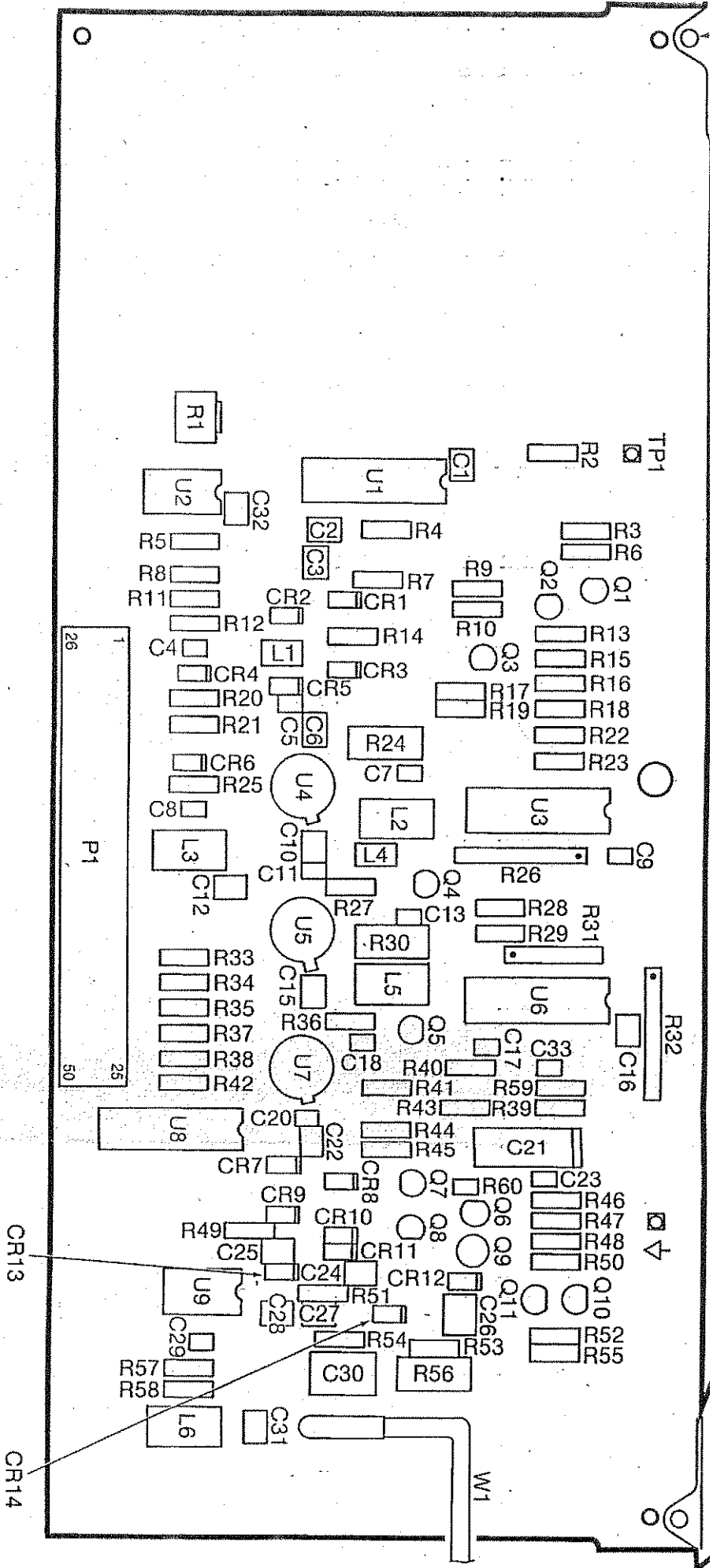


NAME OF WAVEFORM: I  
 POINT PROBED: A2U6 PIN 2 — AC COUPLED  
 CONDITIONS: INSTRUMENT IN 1 MOHM MODE, 50 MHZ, 100 MV P-P AT U6 PIN 5

Ch. 1 Parameters  
 = 200.0 mvolts/div  
 Timebase = 10.0 ns/div  
 P-P Volts = 800.0 mvolts  
 RMS Volts = 295.0 mvolts  
 Delay = 0.00000 s  
 Offset = 12.00 mvolts

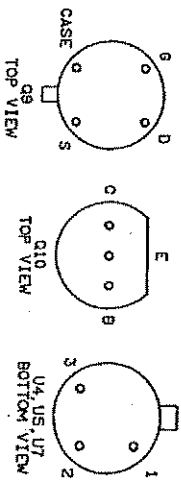




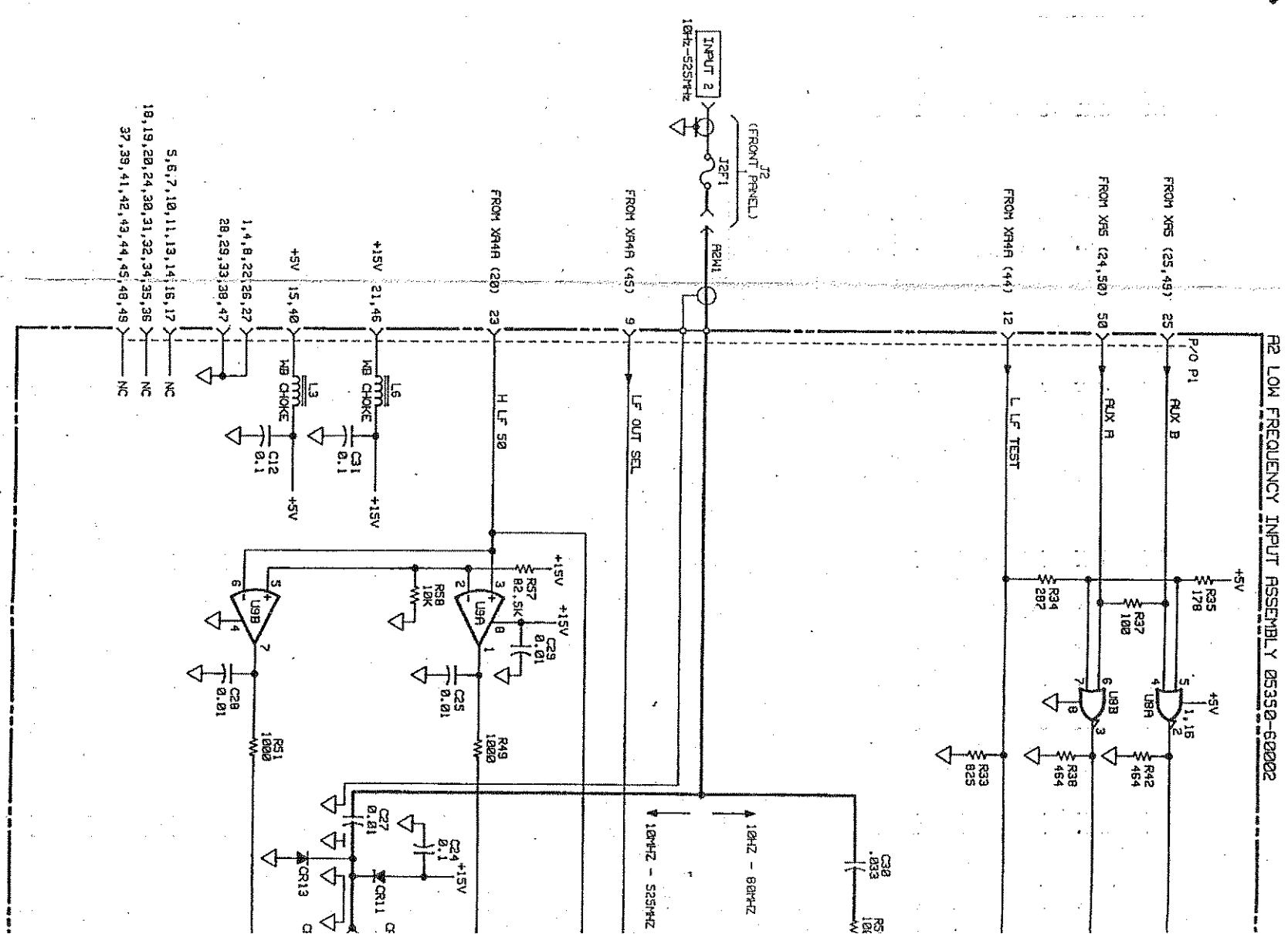


**A2 SCHEMATIC DIAGRAM NOTES**

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD A2 ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.
2. UNLESS OTHERWISE INDICATED: RESISTANCE IN OHMS, CAPACITANCE IN MICROFARADS, INDUCTANCE IN MICROHENRIES.
3. ASTERISK (\*) INDICATES FACTORY SELECTED COMPONENT. AVERAGE VALUE SHOWN.
4. A TILDE (~) PRECEDING A SIGNAL INDICATES A NEGATIVE-TRUE SIGNAL.



P/O Figure 8-39. A2 Component Locator





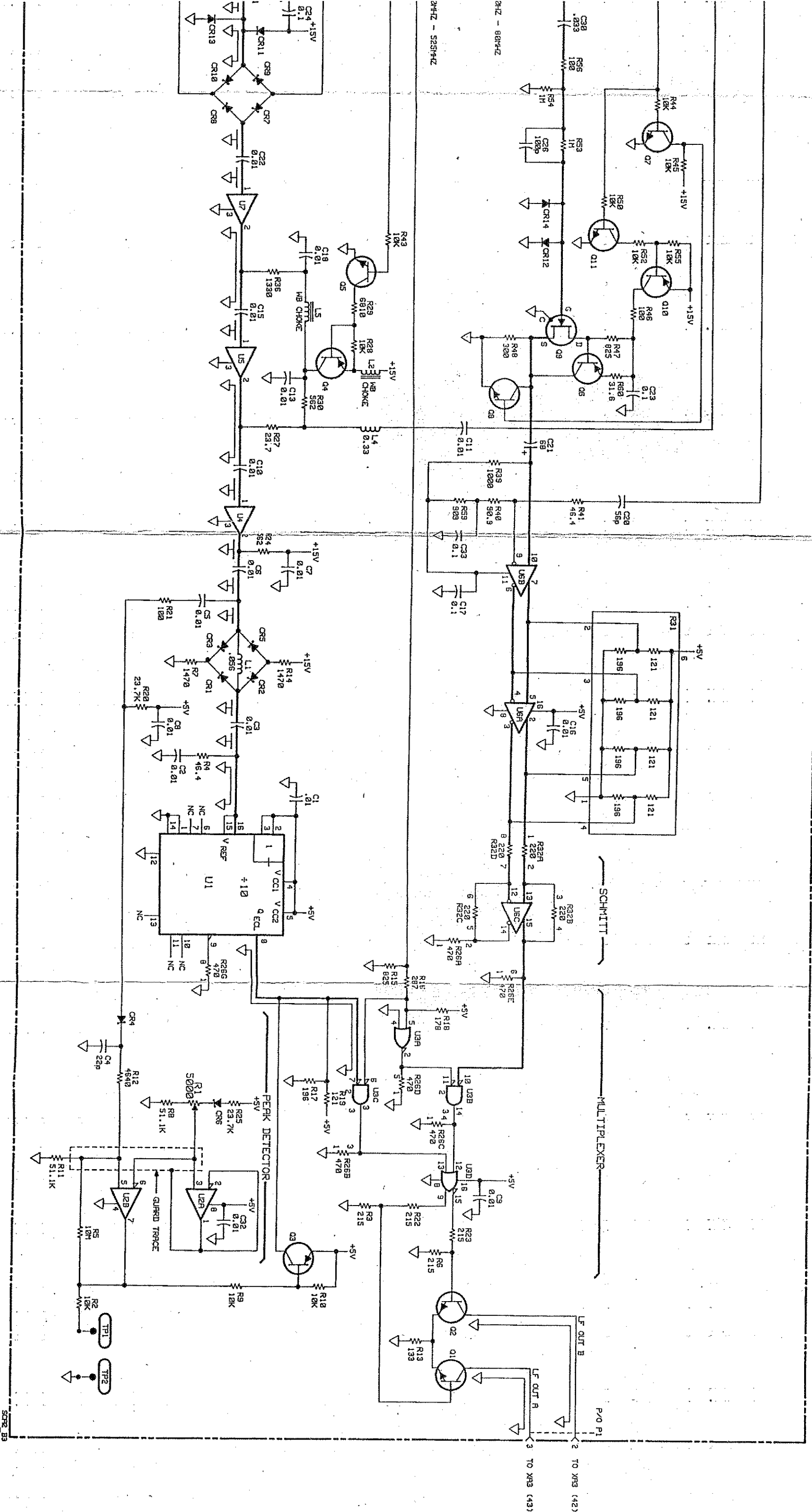


Figure 8-39. A2 Low Frequency Input Assembly Schematic Diagram

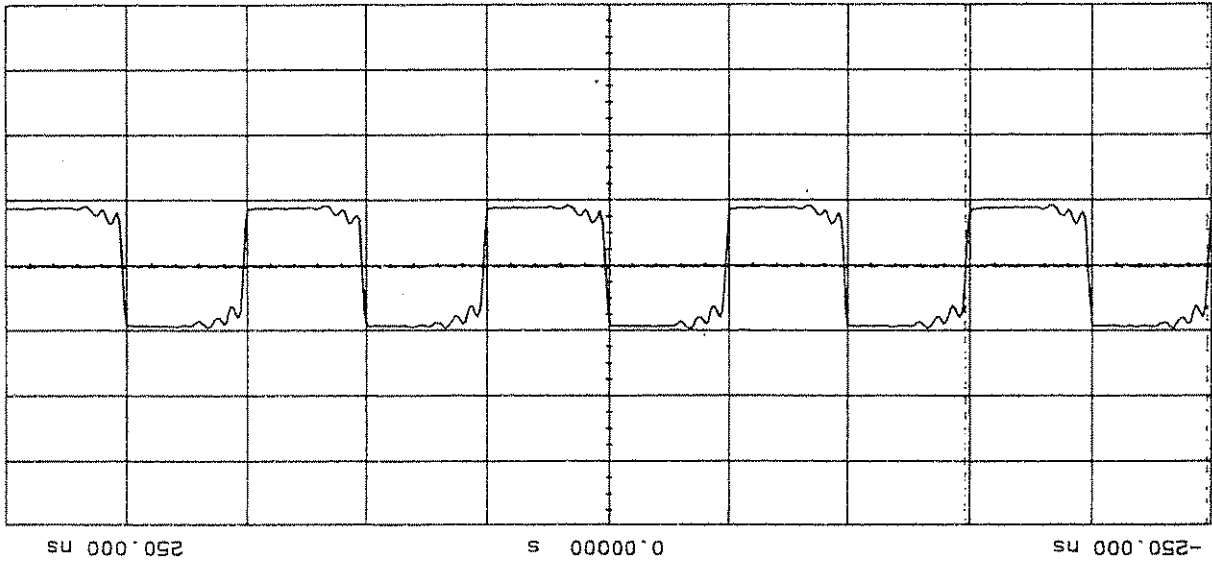




P/O Figure 8-40. A3 Waveforms

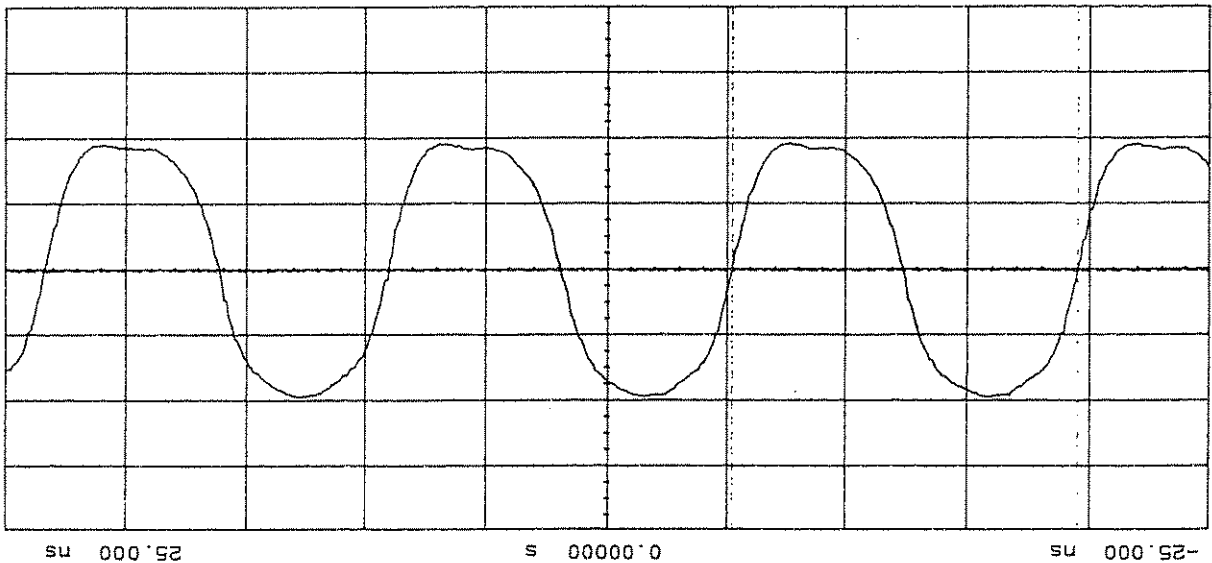
NAME OF WAVEFORM: B  
 POINT PROBED: A3U7 PIN 26 — DC COUPLED  
 CONDITIONS: INSTRUMENT IN 1 MOHM MODE, -20 DBM INPUT TO INPUT 2

Ch. 1 = 500.0 mvolts/div  
 Timebase = 50.0 ns/div  
 Ch. 1 Parameters  
 RMS Volts = 2.600 volts  
 Freq. = 10.0070 MHz  
 P-P Volts = 950.0 mvolts  
 Delay = 0.0000 s  
 Offset = 2.550 volts



NAME OF WAVEFORM: A  
 POINT PROBED: A3Q2 BASE, 70 MHZ IF — AC COUPLED  
 CONDITIONS: INSTRUMENT IN INPUT 1, MANUAL MODE, CF = 1GHZ 1GHZ, -20 DBM INPUT TO INPUT 1

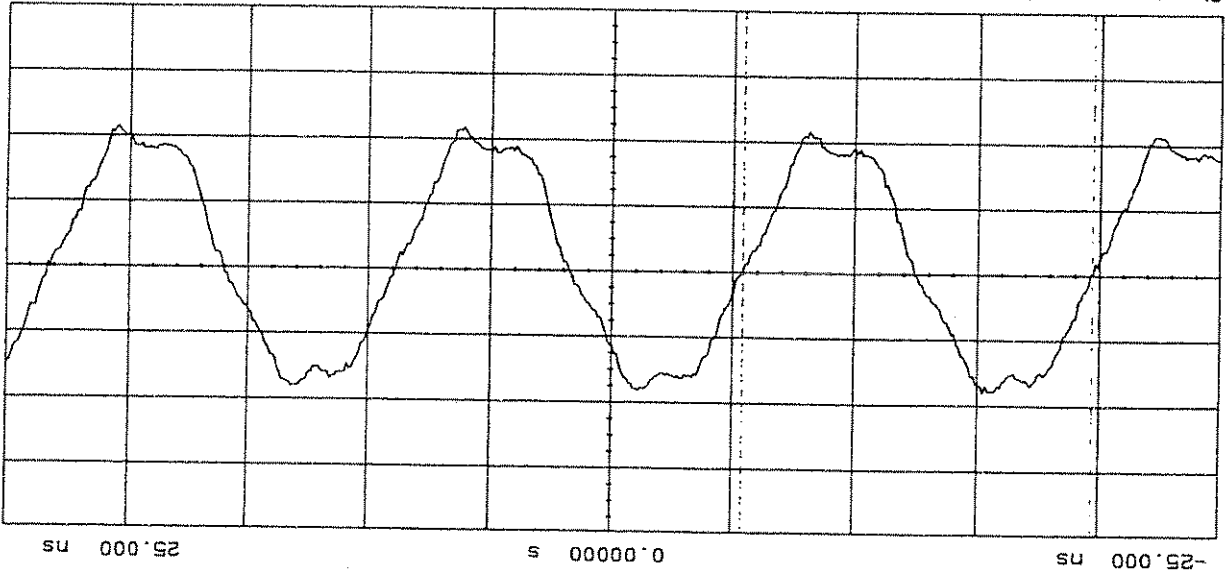
Ch. 1 = 200.0 mvolts/div  
 Timebase = 5.00 ns/div  
 Ch. 1 Parameters  
 RMS Volts = 307.5 mvolts  
 Freq. = 70.0280 MHz  
 P-P Volts = 780.0 mvolts  
 Delay = 0.0000 s  
 Offset = 12.00 mvolts



P/O Figure 8-40. A3 Waveforms

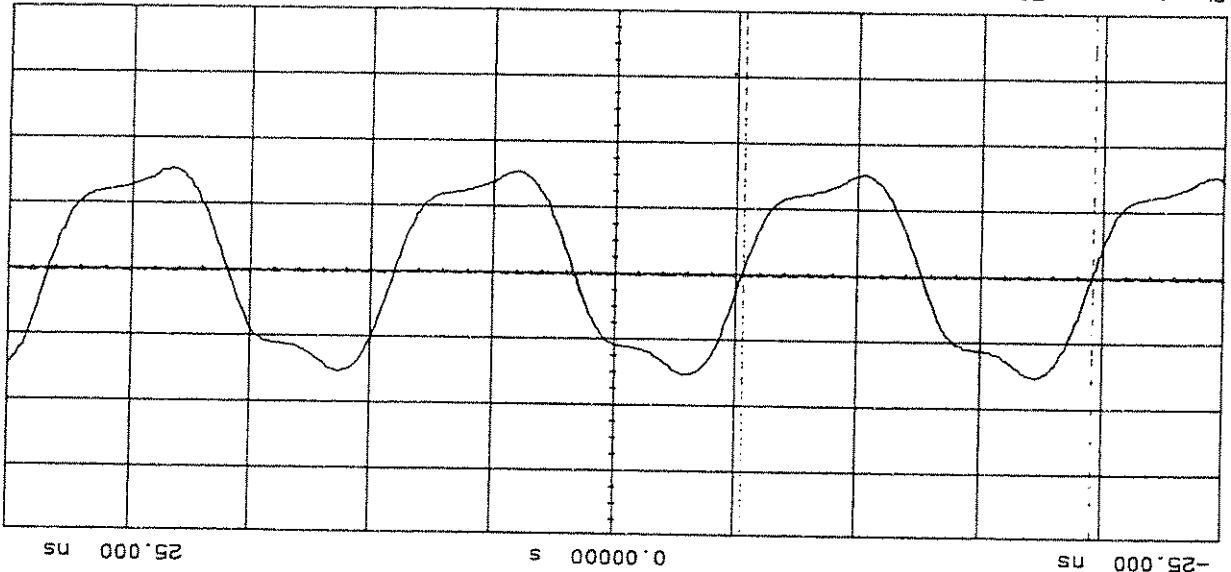
NAME OF WAVEFORM: D  
 POINT PROBED: IF MON CONNECTOR (A1)S ON A1 BOARD, 70 MHZ IF OUT DIRECT INPUT VIA ADAPTER CABLE AND BNC CABLE  
 CONDITIONS: INSTRUMENT IN INPUT 1, MANUAL MODE, CF = 1GHZ, -20 DBM INPUT TO INPUT 1

Ch. 1 = 50.00 mvolts/div  
 Timebase = 5.00 ns/div  
 Ch. 1 Parameters = 68.41 mvolts  
 RMS Volts = 68.41 mvolts  
 Freq. = 69.9301 MHz  
 P-P Volts = 197.0 mvolts  
 Delay = 0.0000 s  
 Offset = 8.000 mvolts

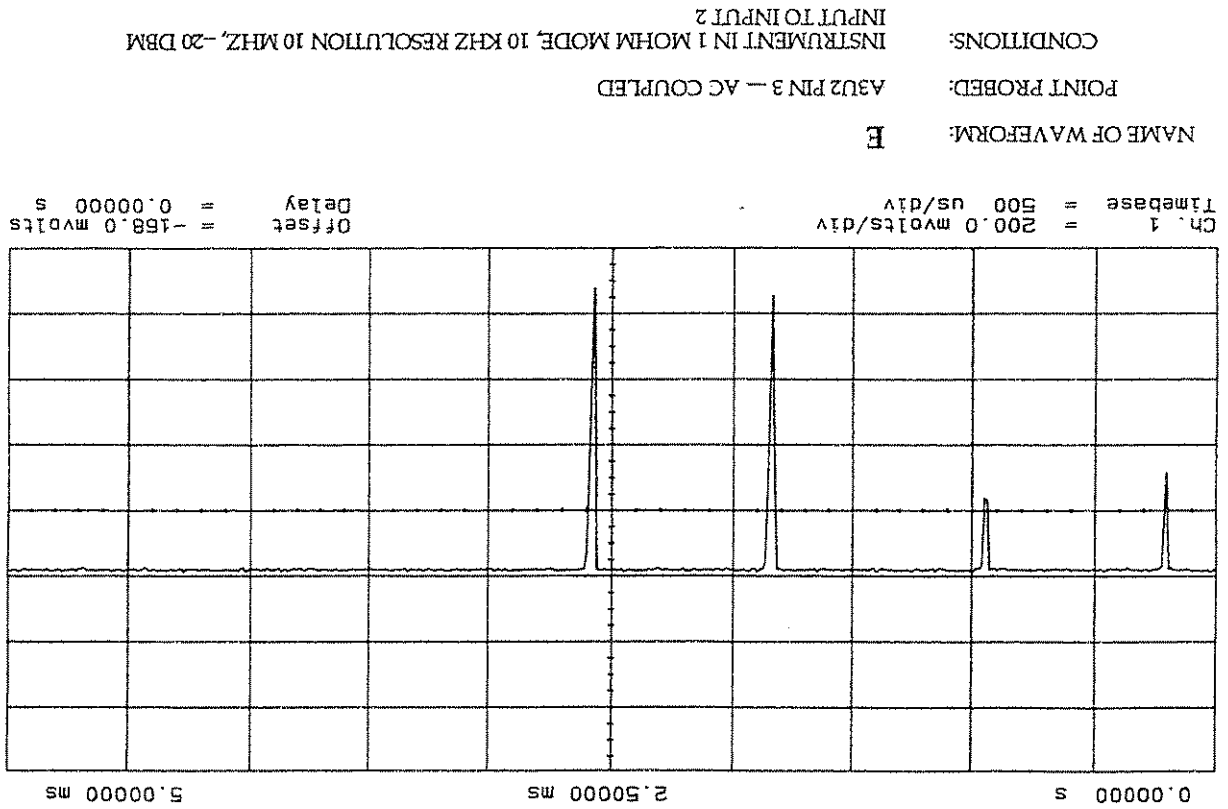


NAME OF WAVEFORM: C  
 POINT PROBED: A3U7 PIN 30, 70 MHZ IF -- DC COUPLED  
 CONDITIONS: INSTRUMENT IN INPUT 1, MANUAL MODE, CF = 1GHZ 1GHZ, -20 DBM INPUT TO INPUT 1

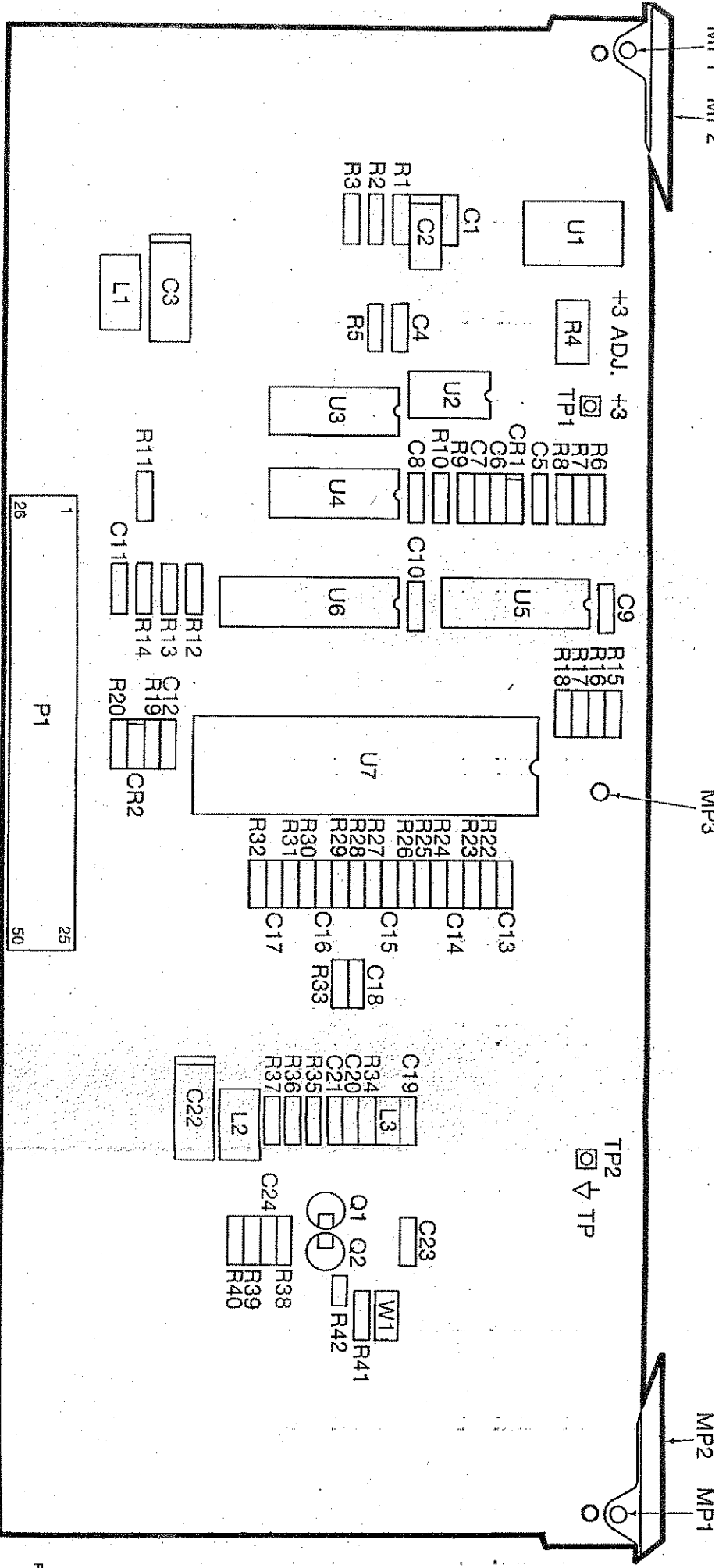
Ch. 1 = 500.0 mvolts/div  
 Timebase = 5.00 ns/div  
 Ch. 1 Parameters = 2.715 volts  
 RMS Volts = 2.715 volts  
 Freq. = 69.8812 MHz  
 P-P Volts = 1.560 volts  
 Delay = 0.0000 s  
 Offset = 2.670 volts



P/O Figure 8-40. A3 Waveforms

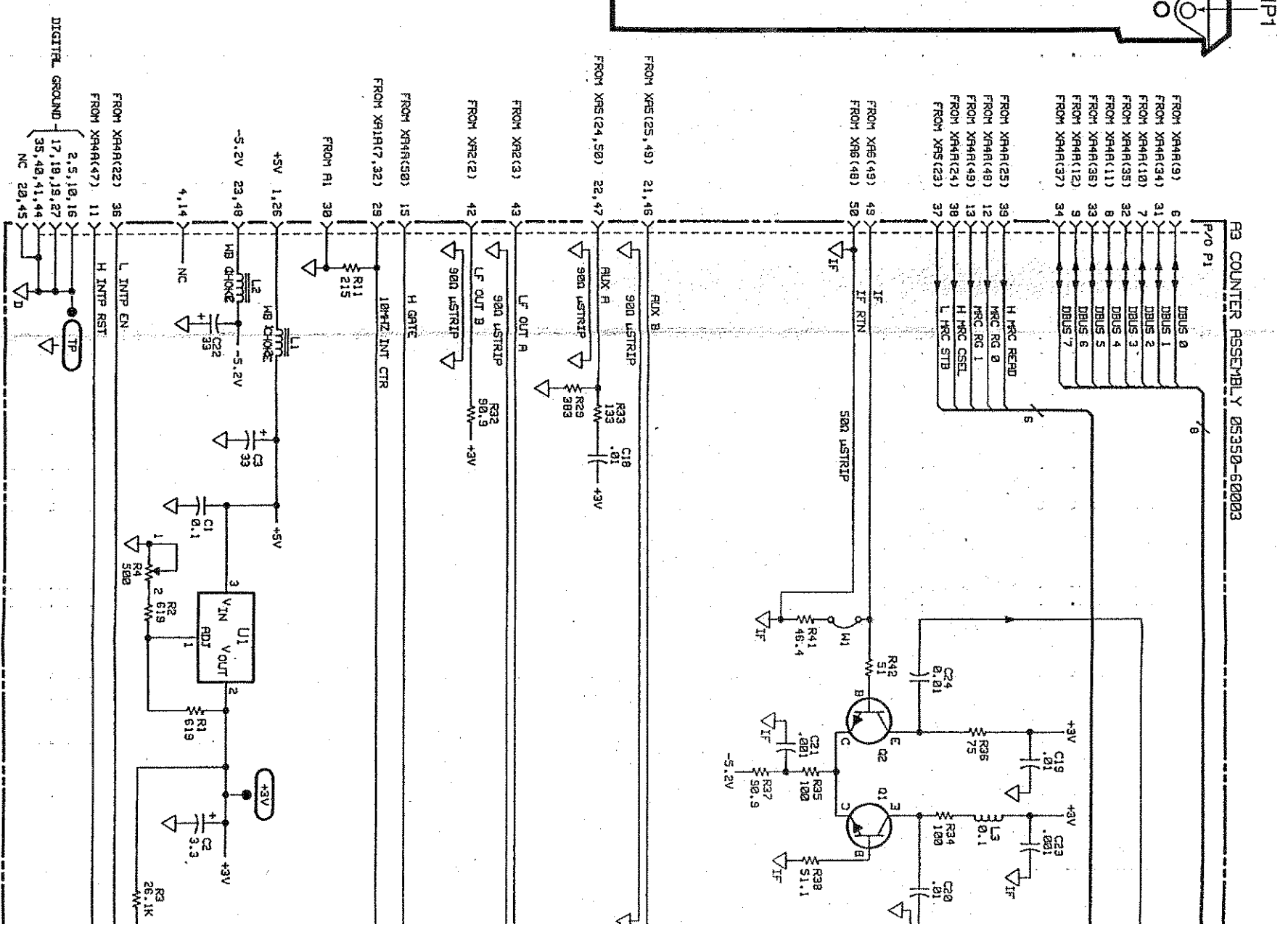






**A3 SCHEMATIC DIAGRAM NOTES**

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.
2. UNLESS OTHERWISE INDICATED, RESISTANCE IN OHMS, CAPACITANCE IN MICROFARADS, INDUCTANCE IN MICROHENRIES.
3. ASTERISK (\*) INDICATES FACTORY SELECTED COMPONENT. AVERAGE VALUE SHOWN.
4. A TILDE (~) PRECEDING A SIGNAL INDICATES A NEGATIVE-TRUE SIGNAL.



P/O Figure 8-40. A3 Component Locator



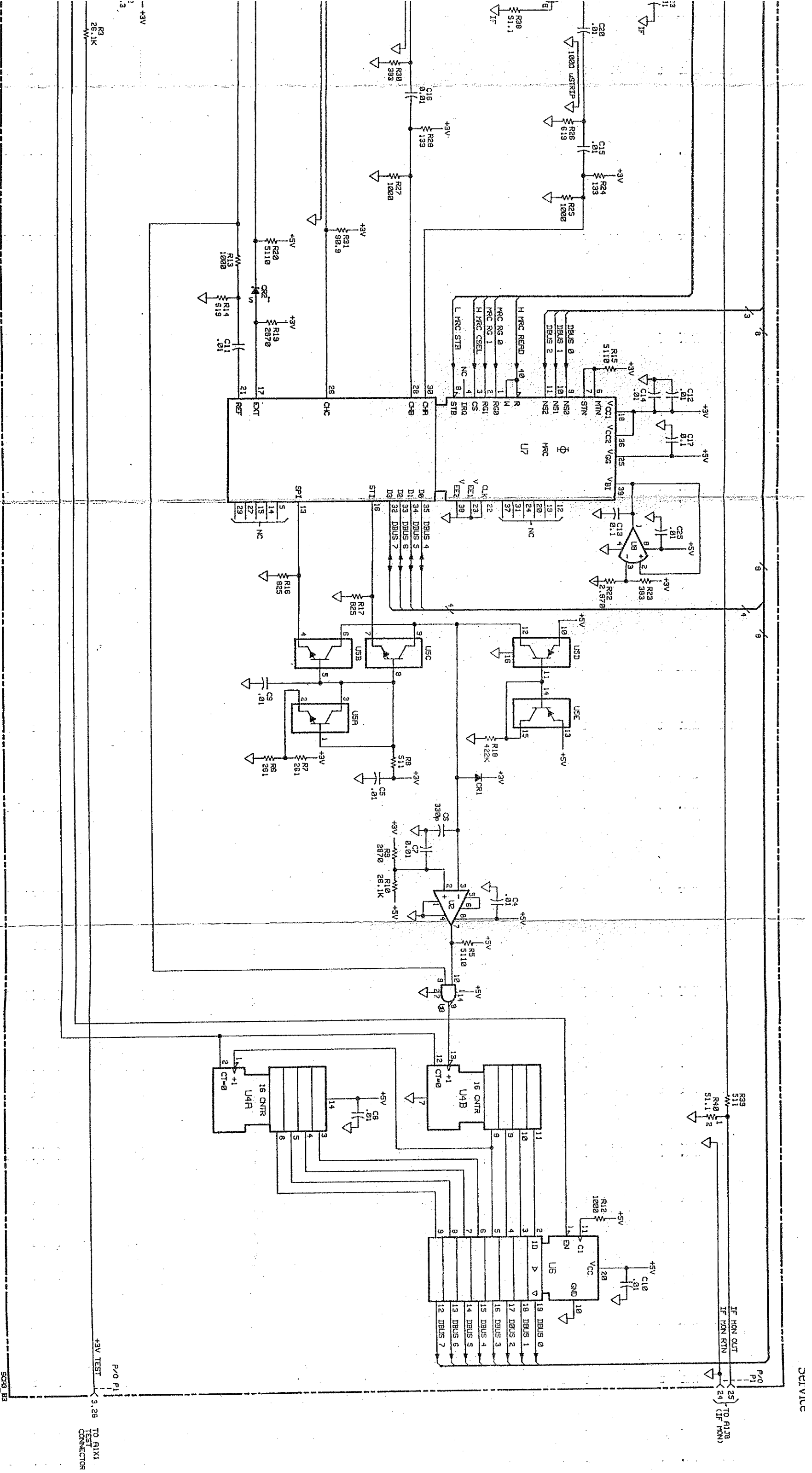


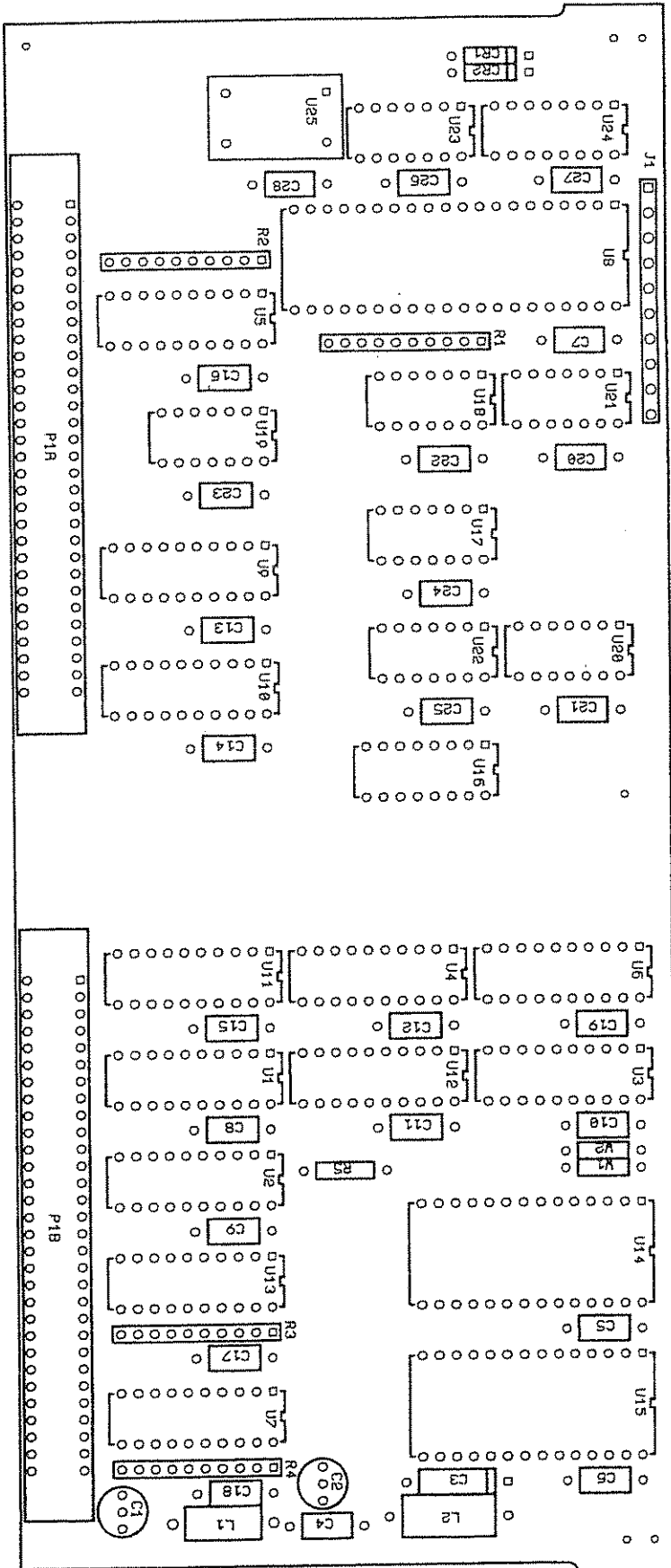
Figure 8-40. A3 Counter Assembly Schematic Diagram

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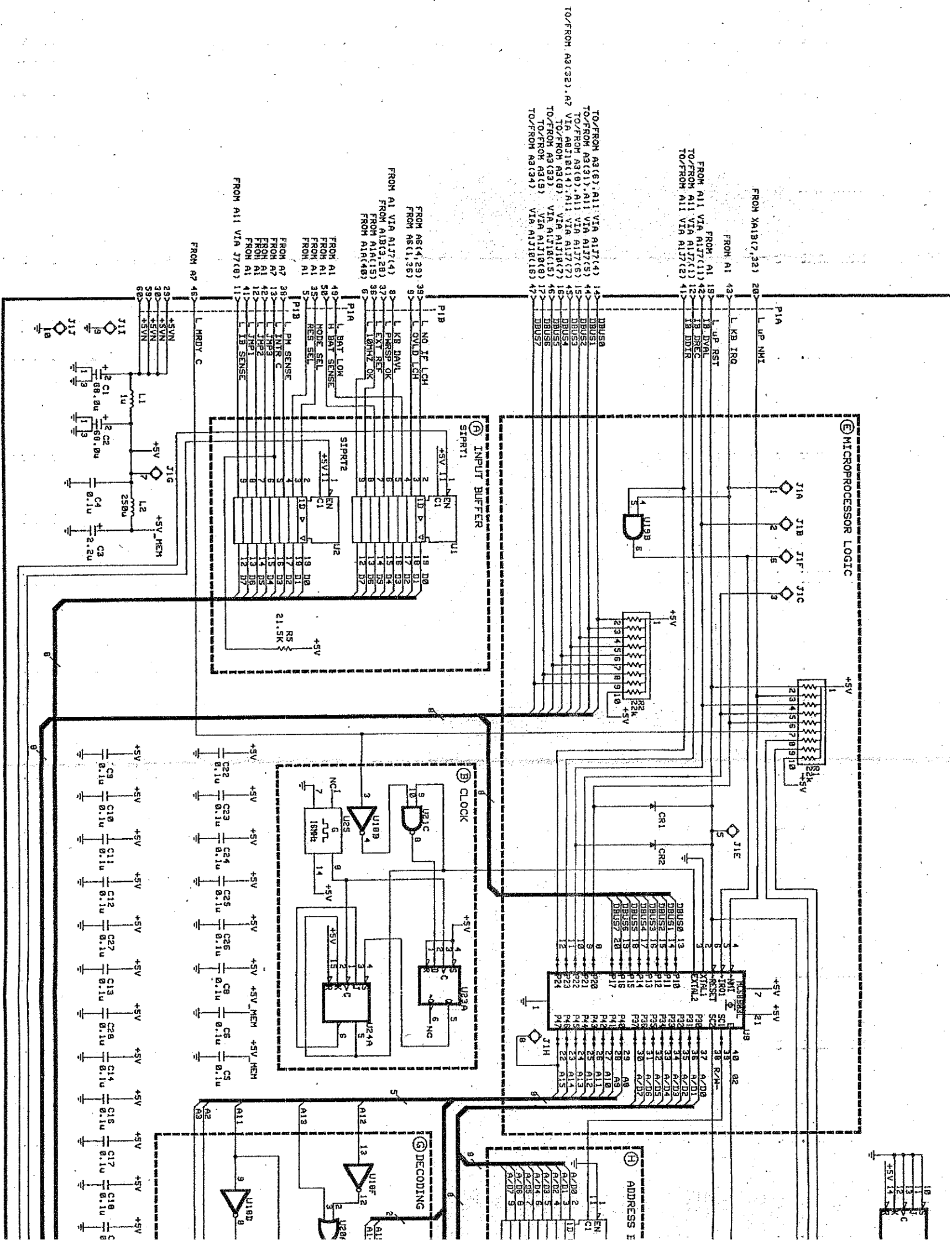
P/O Figure 8-41. A4 Microprocessor Assembly Component Locator





A4 SCHEMATIC DIAGRAM NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD A4 ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.
2. UNLESS OTHERWISE INDICATED: RESISTANCE IN OHMS, CAPACITANCE IN FARADS, INDUCTANCE IN HENRIES.
3. ASTERISK (\*) INDICATES FACTORY SELECTED COMPONENT. AVERAGE VALUE SHOWN.
4. A TILDE (~) PRECEDING A SIGNAL INDICATES A NEGATIVE-TYPE SIGNAL.





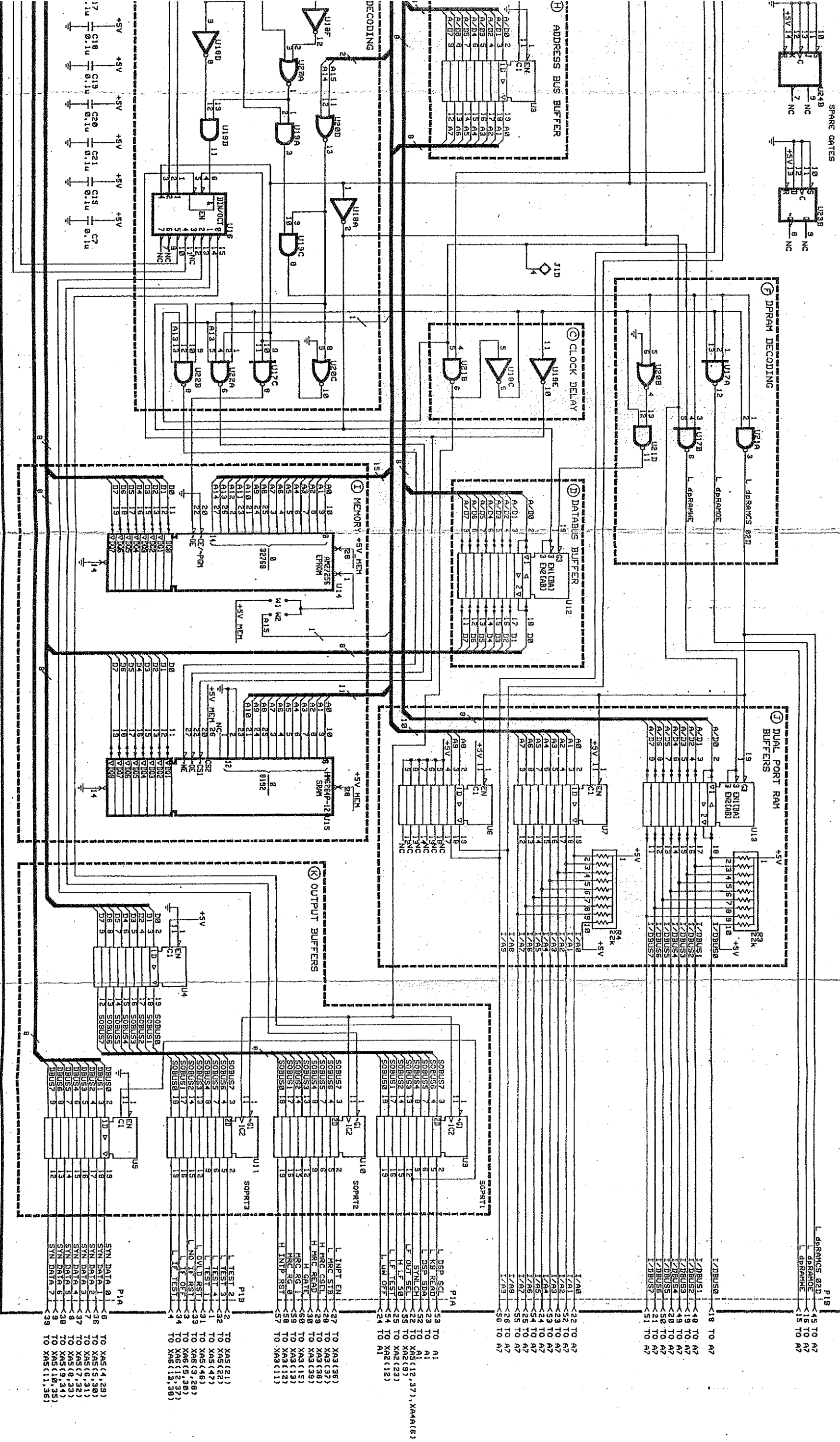


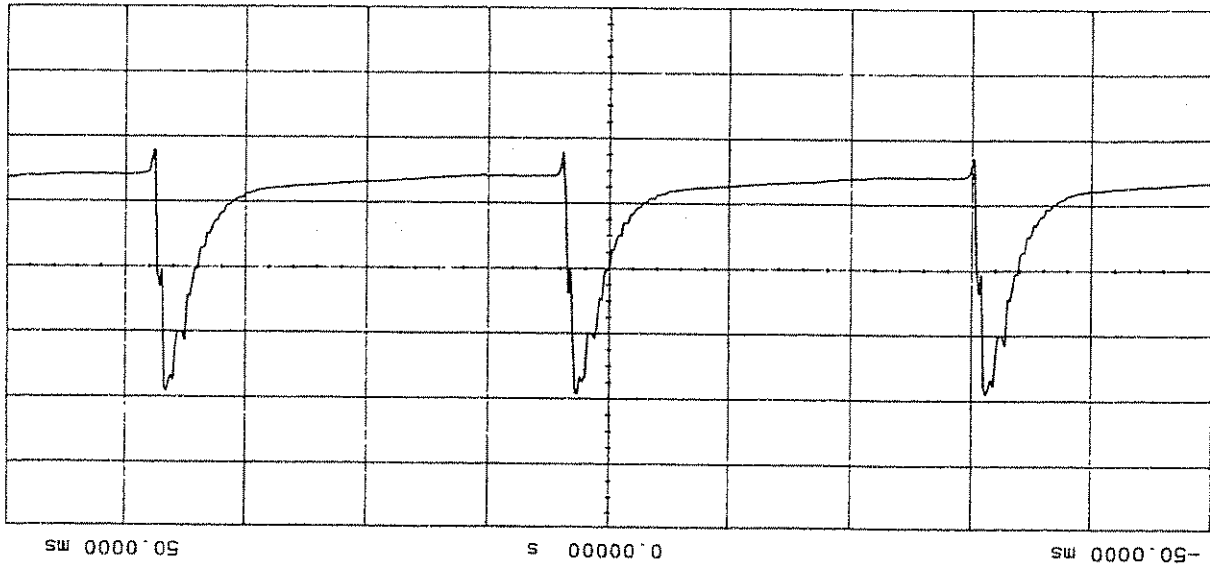
Figure 8-41. A4 Microprocessor Assembly Schematic Diagram



P/O Figure 8-42. A5 Waveforms

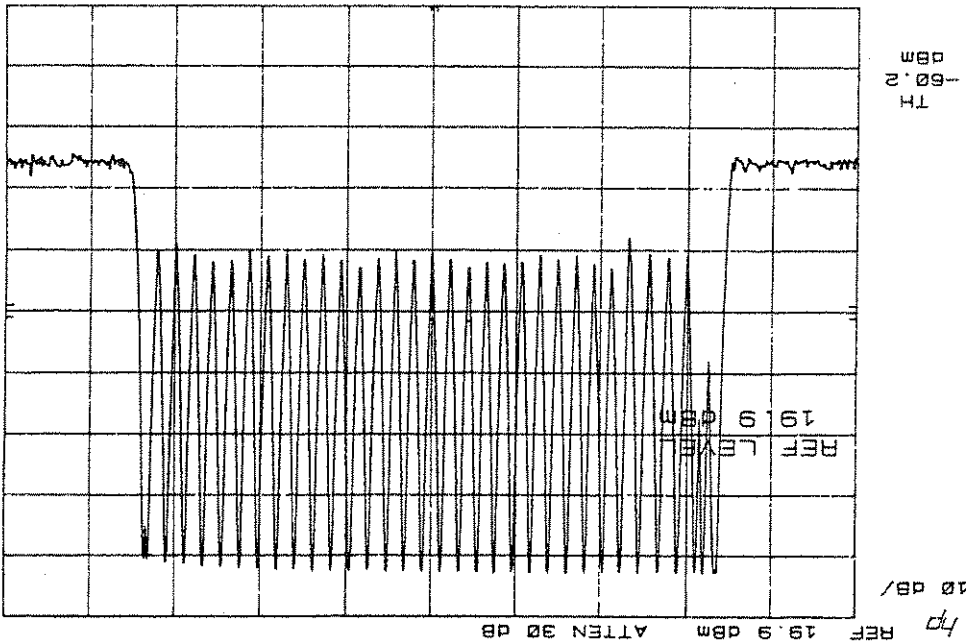
NAME OF WAVEFORM: B  
 POINT PROBED: ASU1 PIN 6 — DC COUPLED  
 CONDITIONS: INSTRUMENT IN AUTO MODE, NO INPUT

Ch. 1 = 2.000 volts/div  
 Timebase = 10.0 ms/div  
 Offset = -6.240 volts  
 Delay = 0.00000 s

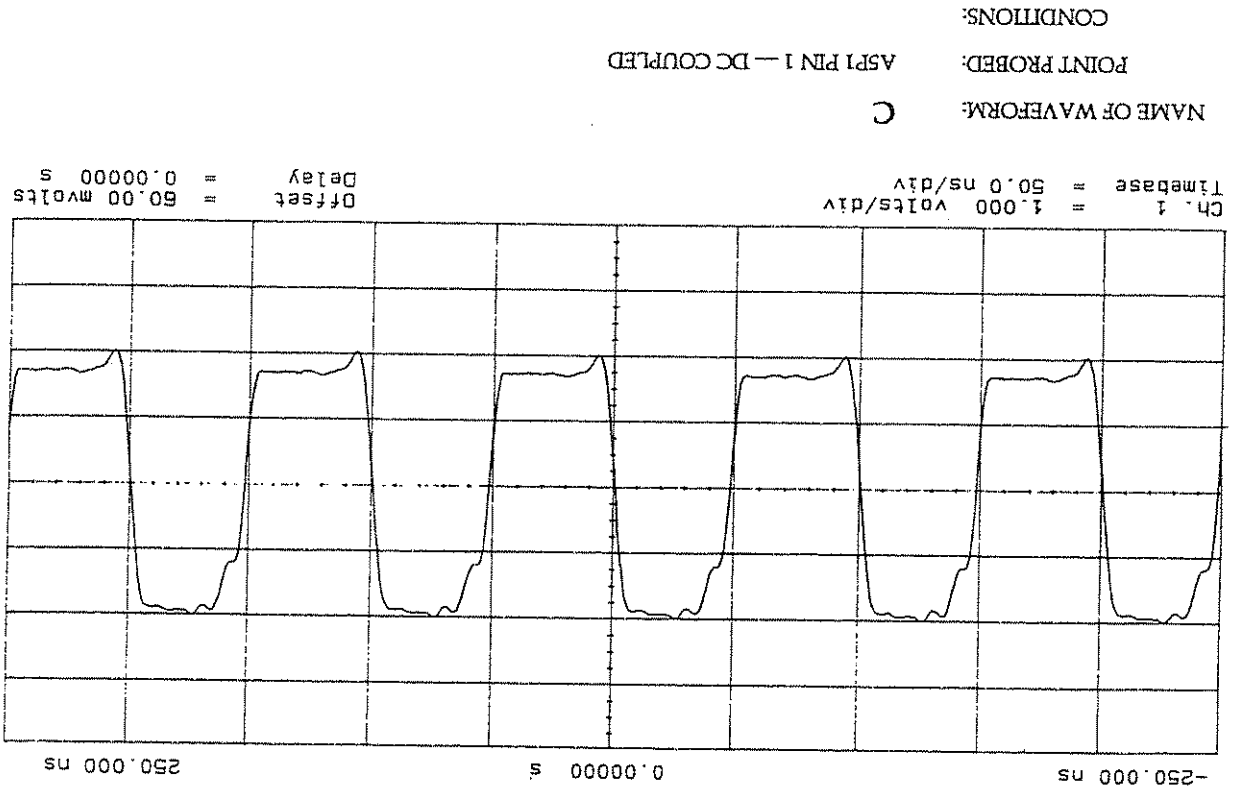
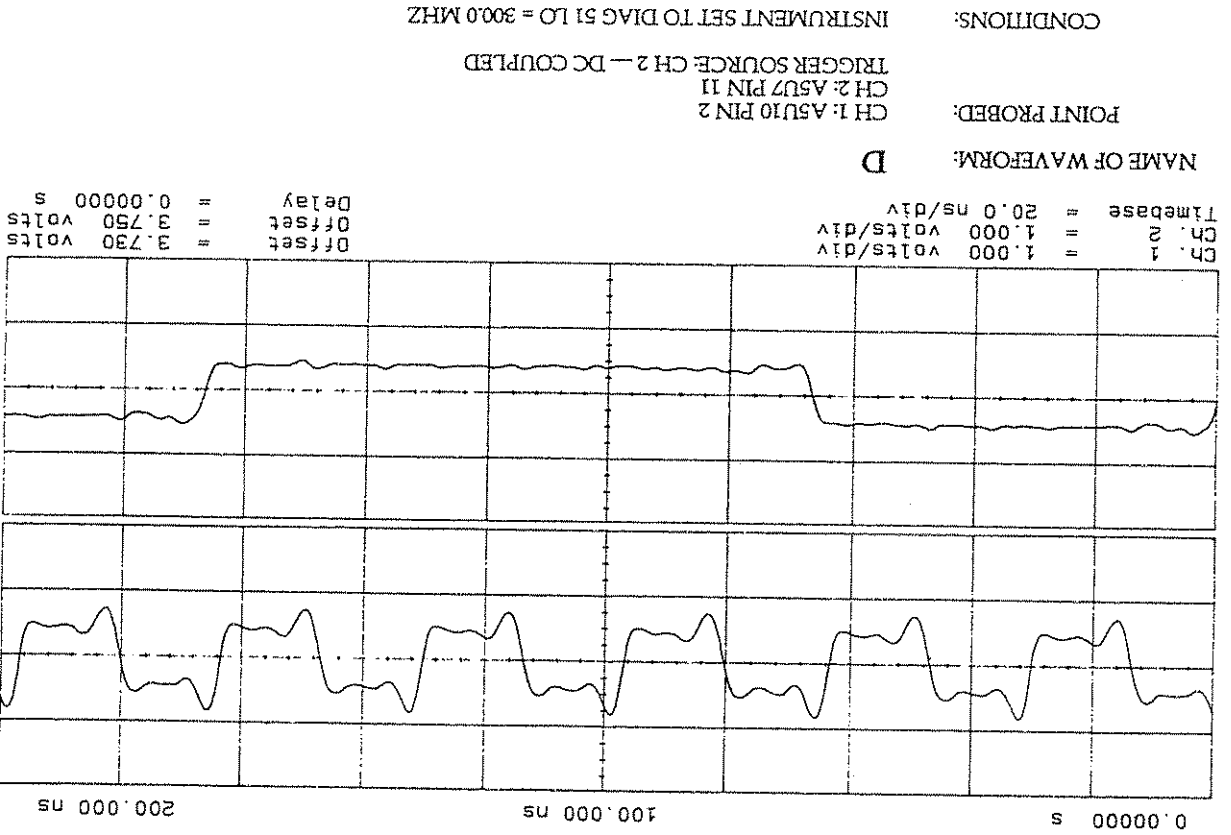


NAME OF WAVEFORM: A  
 POINT PROBED: TO OUTPUT — DC COUPLED  
 CONDITIONS: INSTRUMENT SET TO DAIG 52 (LO SWEEP) SPECTRUM ANALYSER  
 SET TO 325 MHZ CF, 150 MHZ SPAN

CENTER 325 MHZ  
 RES BW 300 KHZ  
 VBW 1 MHZ  
 SWP 20.0 msec  
 SPAN 150 MHZ

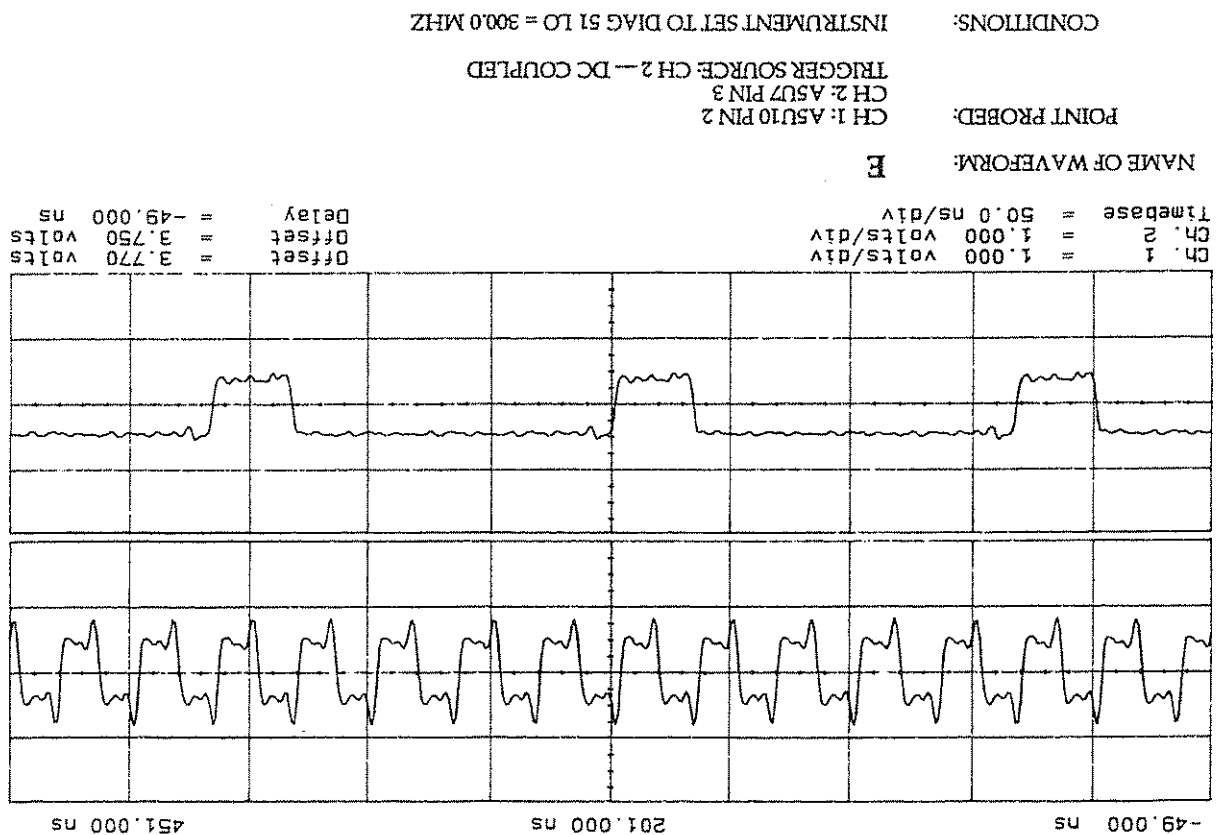
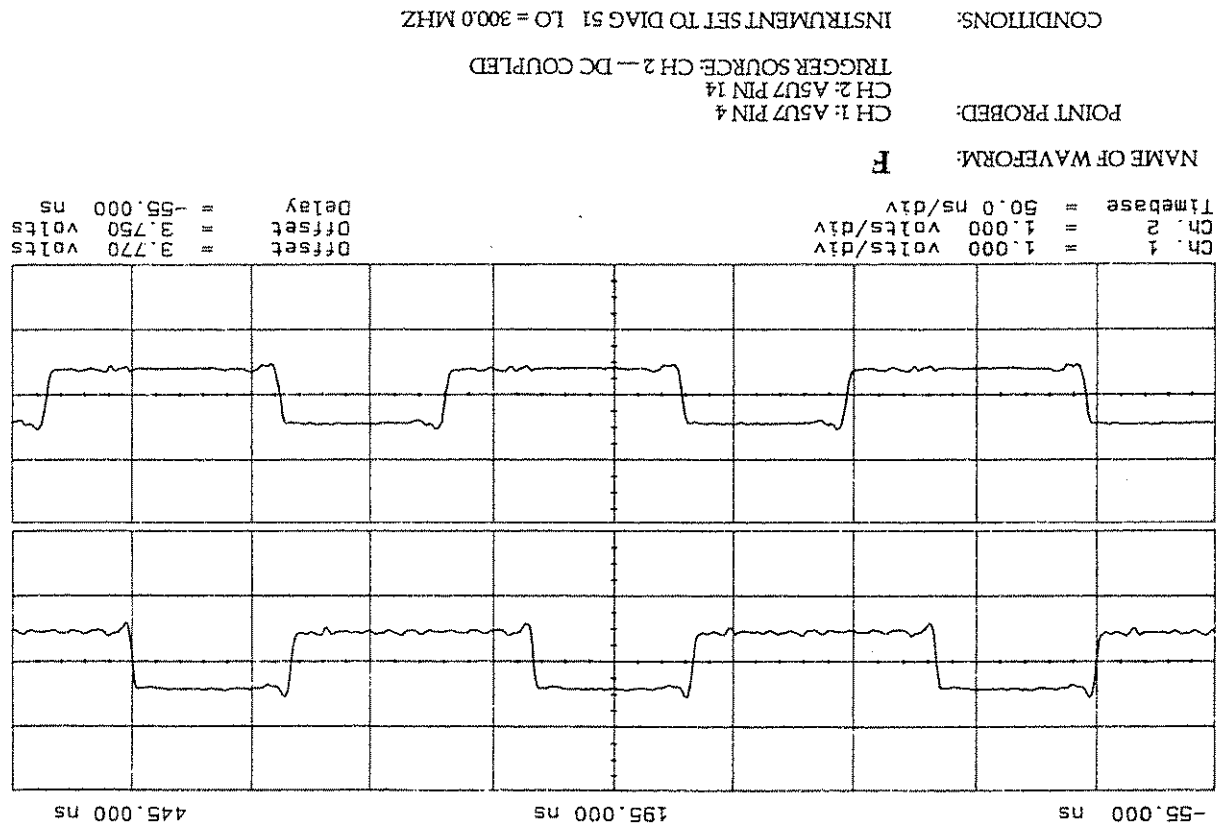


P/O Figure 8-42. A5 Waveforms

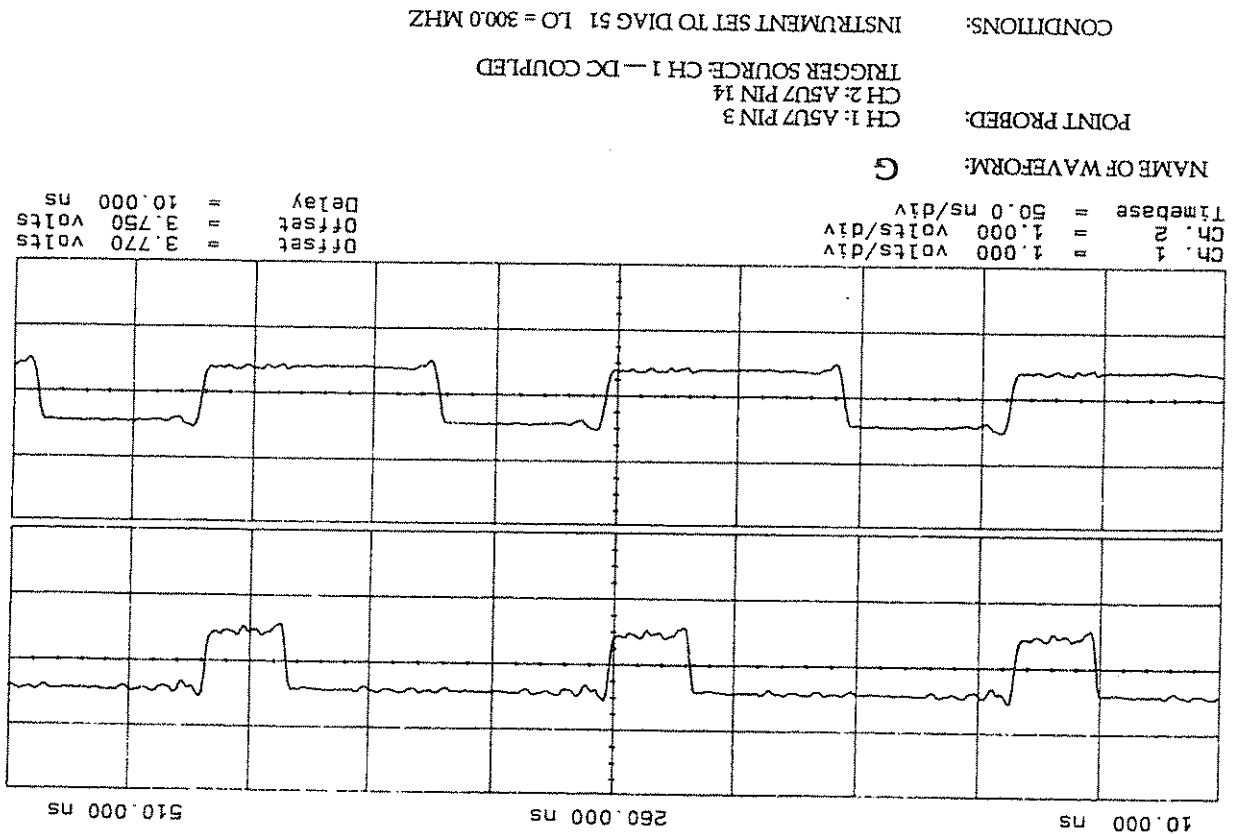
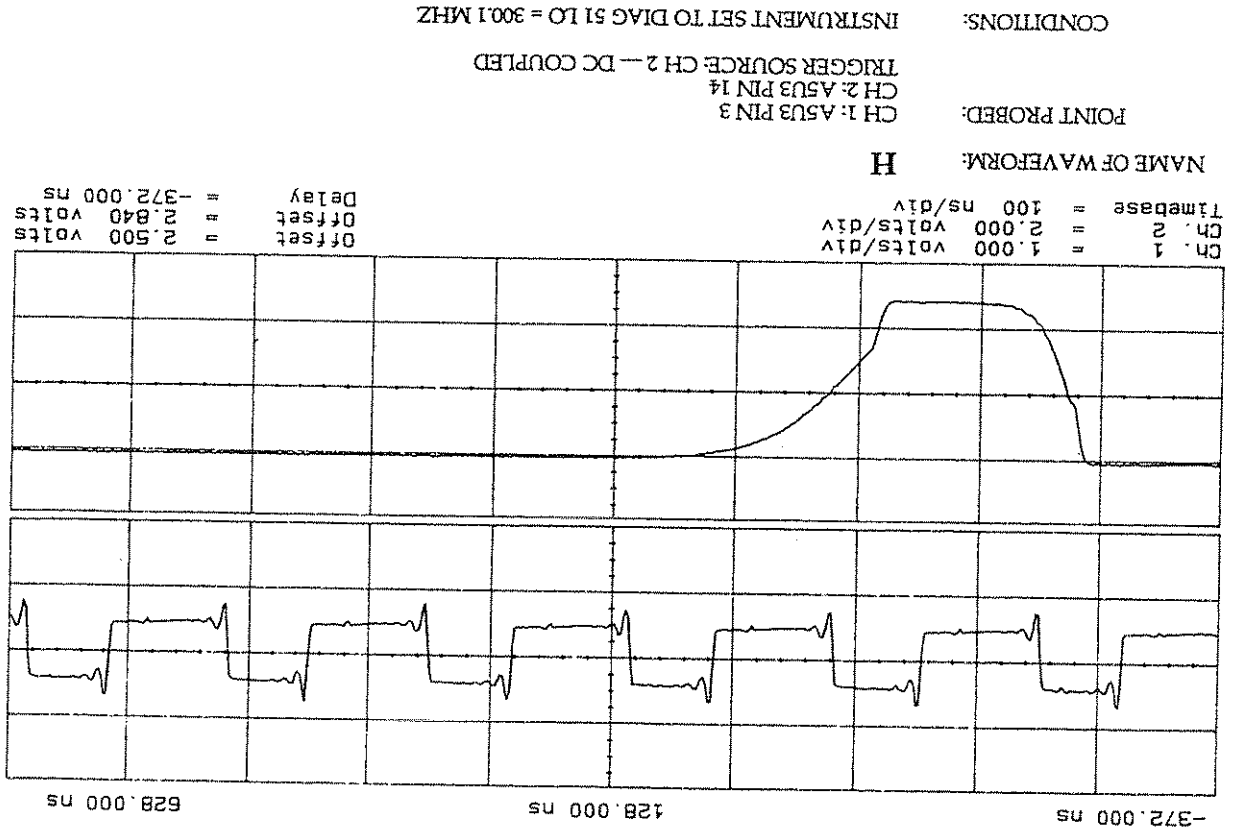




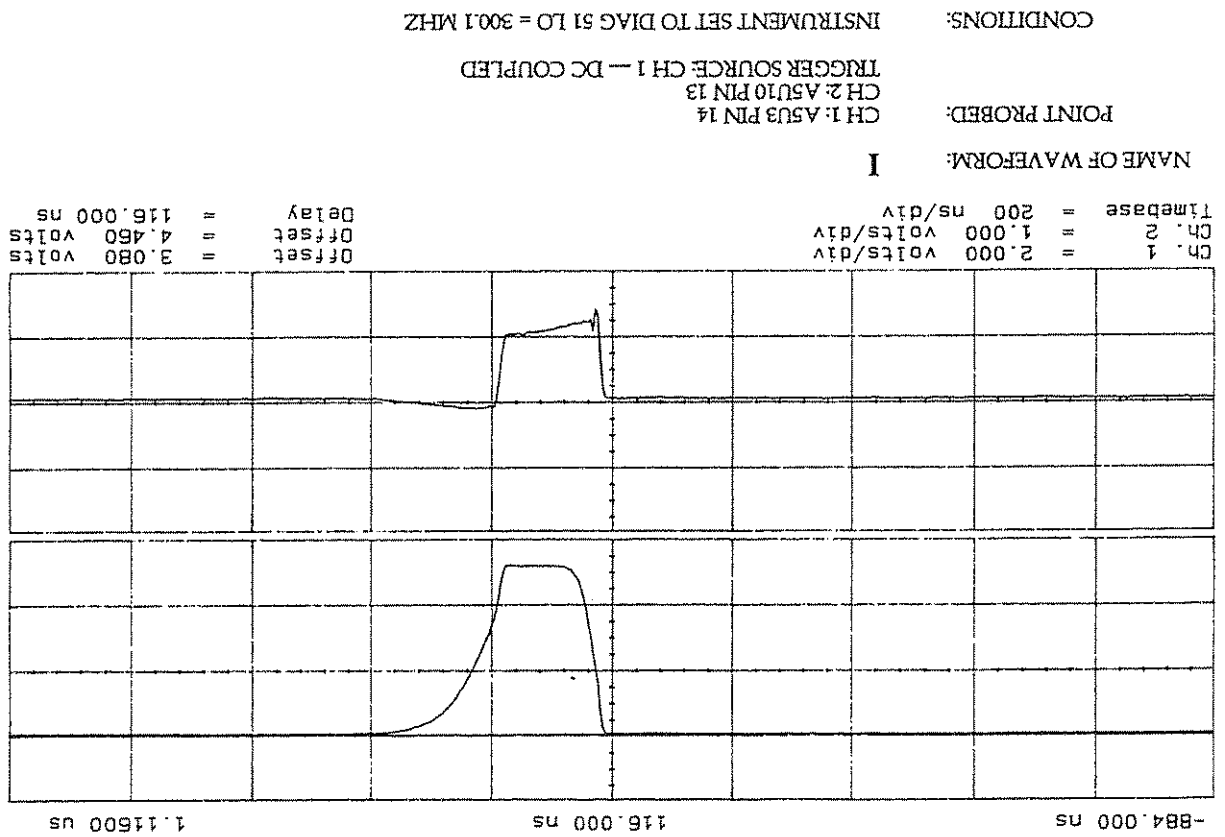
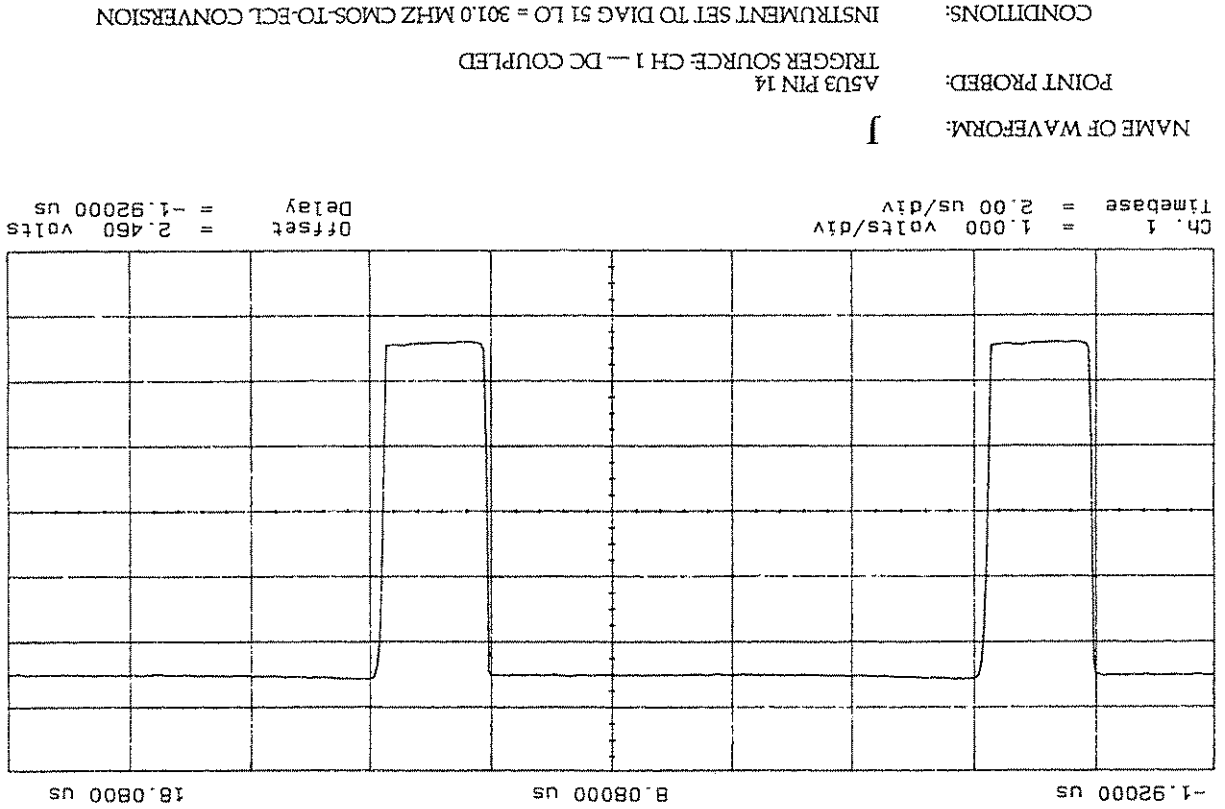
P/O Figure 8-42. A5 Waveforms



P/O Figure 8-42. A5 Waveforms



P/O Figure 8-42. A5 Waveforms









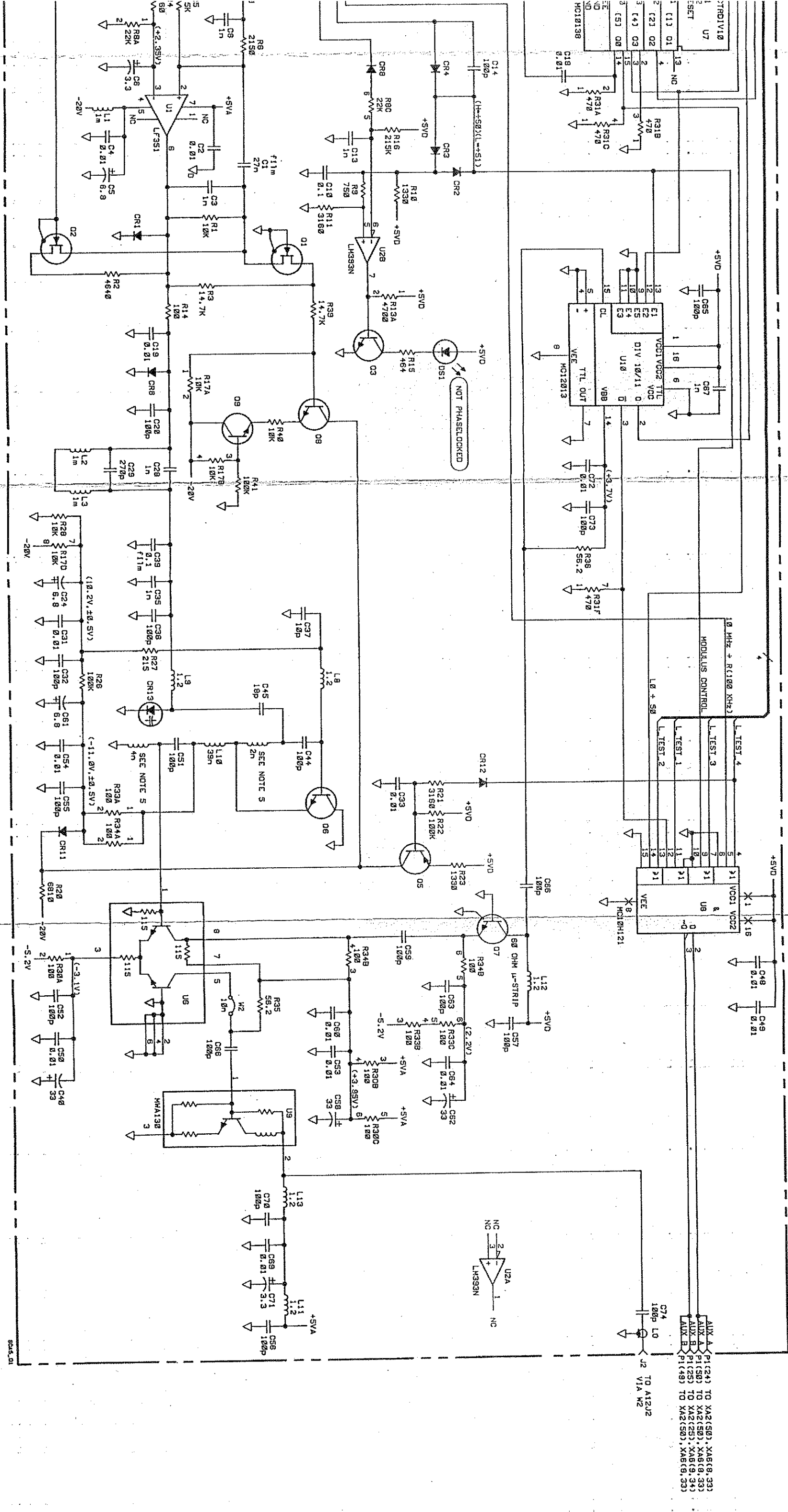
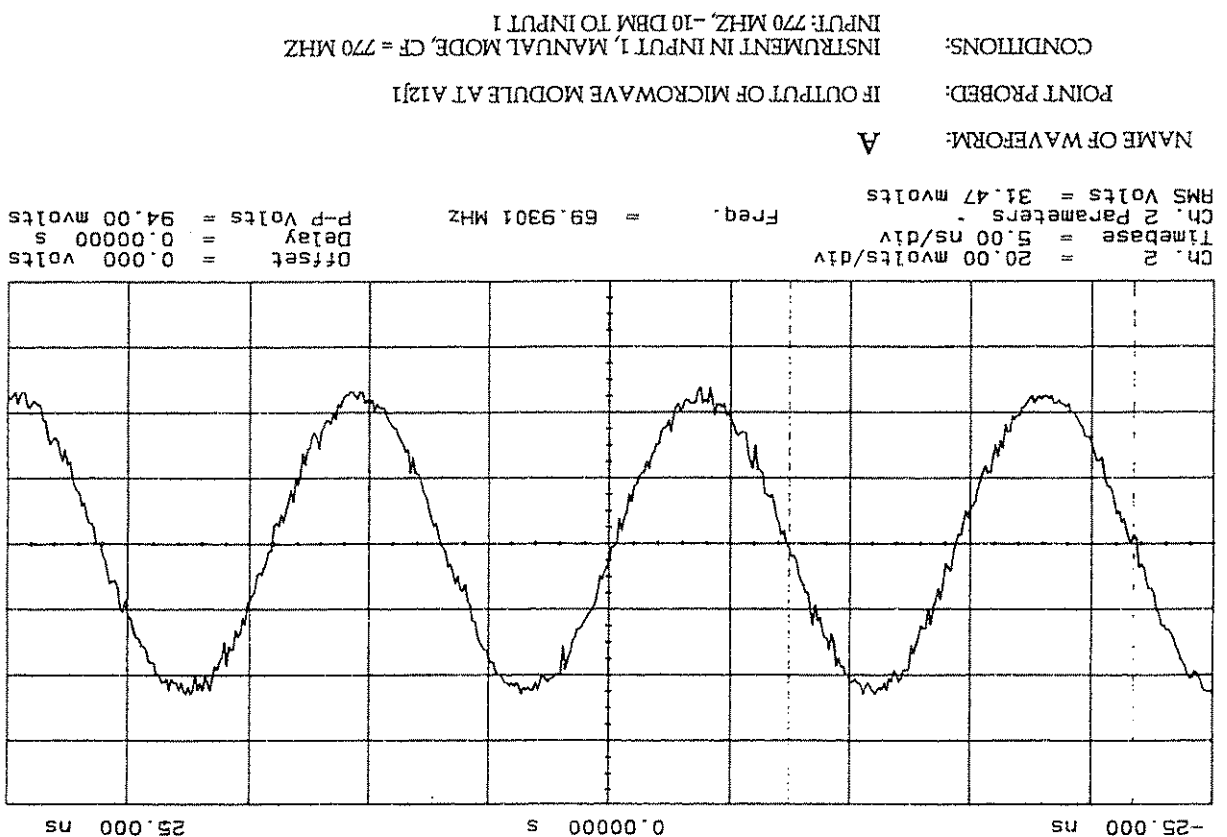
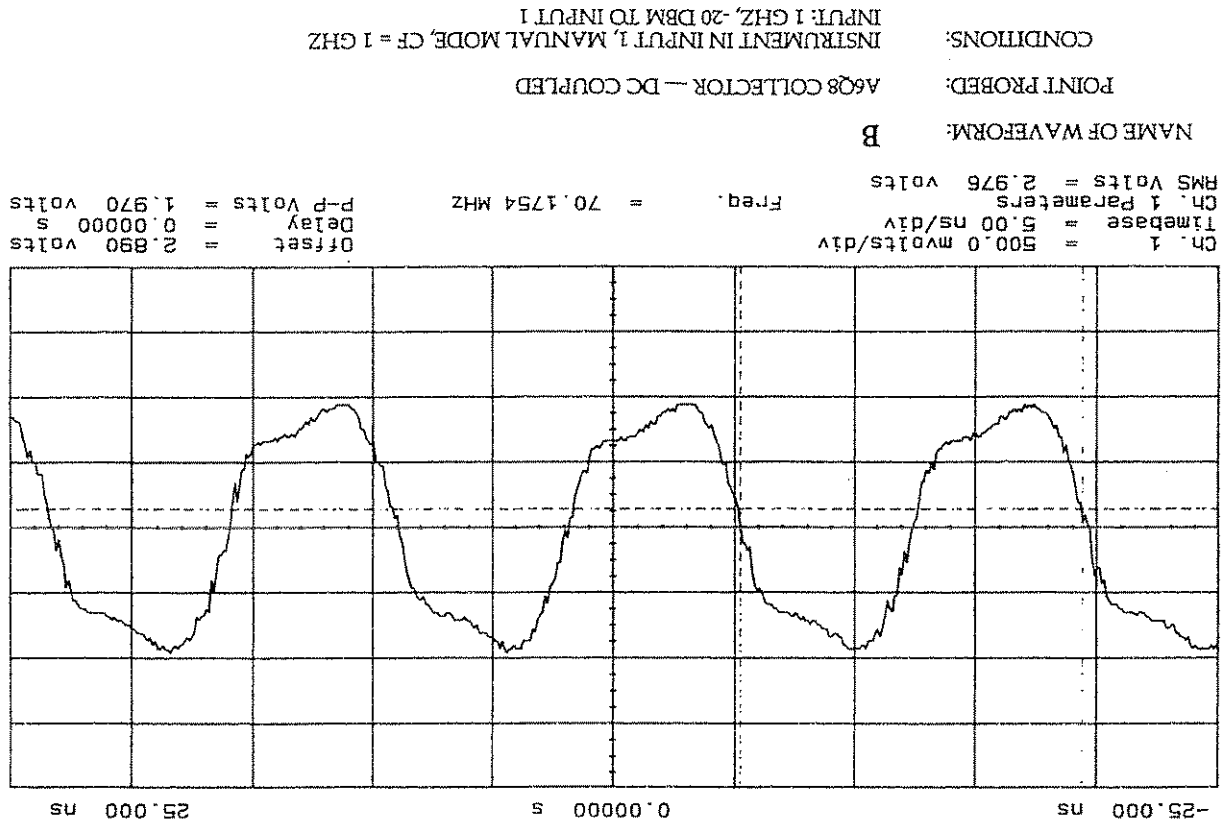


Figure 8-42. A5 Synthesizer Assembly Schematic Diagram





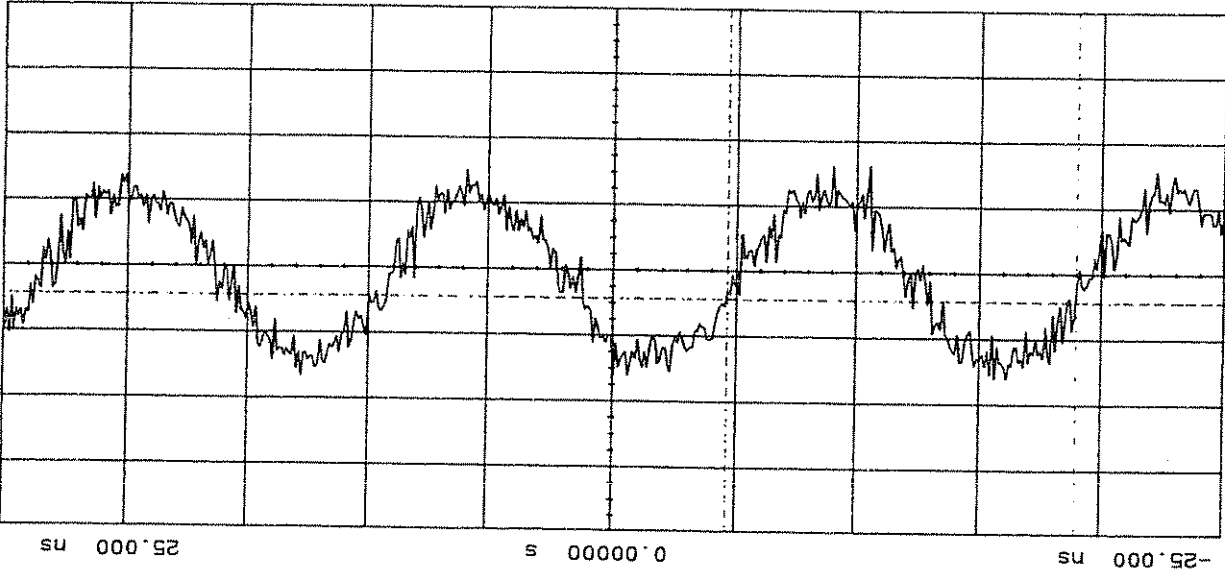
P/O Figure 8-43. A6 Waveforms



P/O Figure 8-43. A6 Waveforms

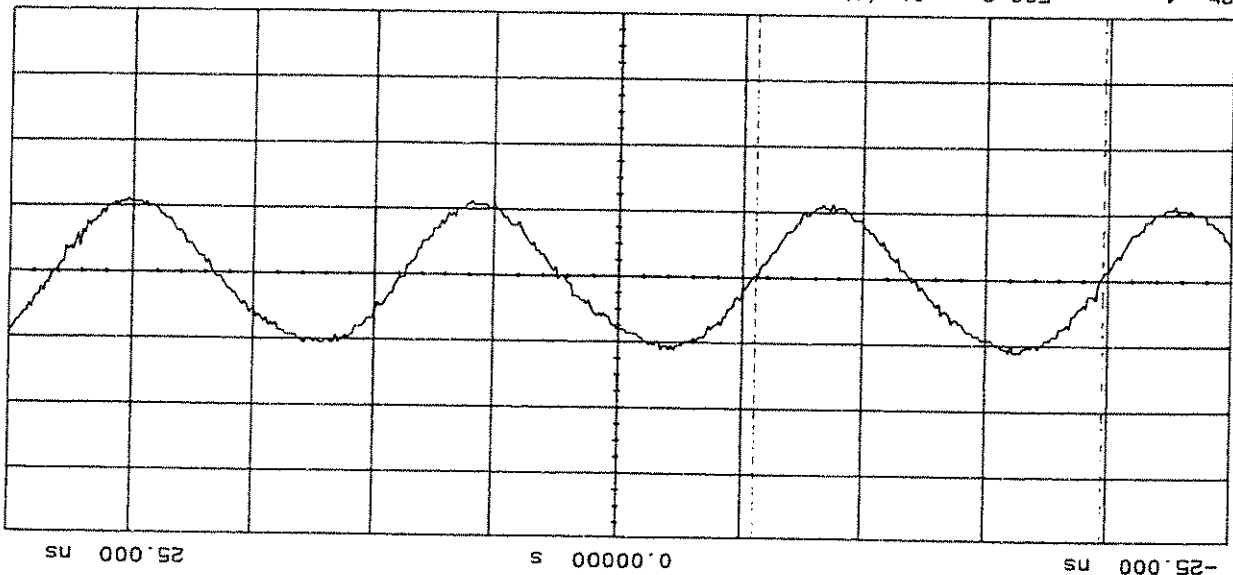
NAME OF WAVEFORM: **D**  
 POINT PROBED: A6U4 PIN 2 -- AC COUPLED  
 CONDITIONS: INSTRUMENT IN INPUT 1, MANUAL MODE, CF = 1 GHZ  
 INPUT: 1 GHZ APPLIED TO INPUT 1, 100 MV P-P MEASURED AT U4 PIN 1

Ch. 1  
 = 100.0 mvolts/div  
 Timebase = 5.00 ns/div  
 Ch. 1 Parameters  
 RMS Volts = 97.85 mvolts  
 Delay = 0.0000 s  
 P-P Volts = 344.0 mvolts  
 Offset = -4.000 mvolts  
 Freq. = 69.5410 MHz



NAME OF WAVEFORM: **C**  
 POINT PROBED: A6U3 PIN 2 -- AC COUPLED  
 CONDITIONS: INSTRUMENT IN INPUT 1, MANUAL MODE, CF = 1 GHZ  
 INPUT: 1 GHZ APPLIED TO INPUT 1, 100 MV P-P MEASURED AT U3 PIN 1

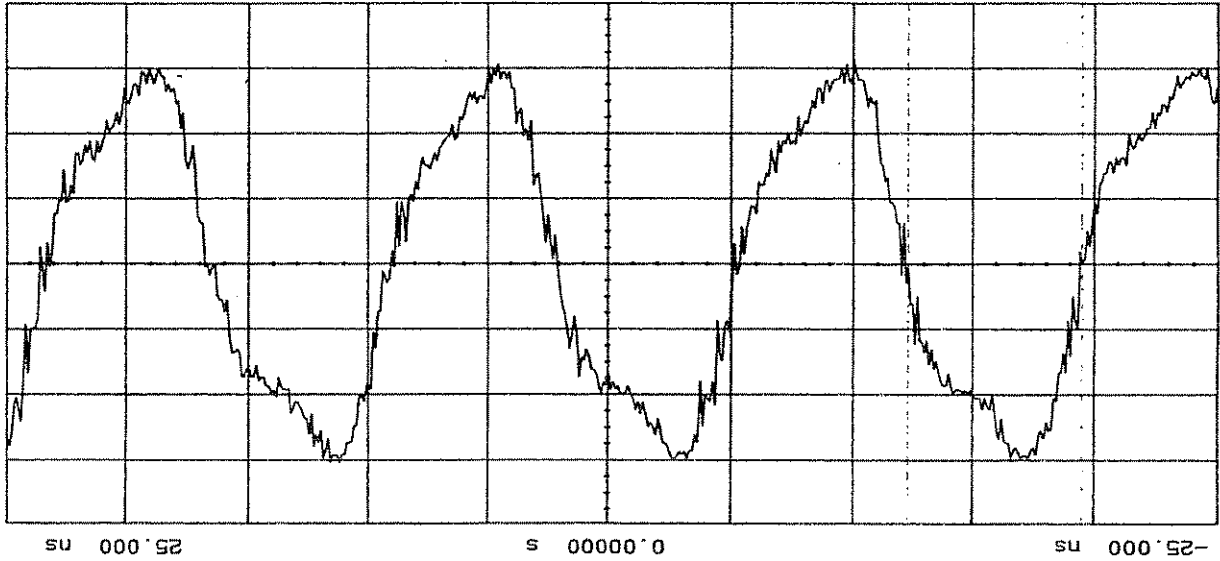
Ch. 1  
 = 500.0 mvolts/div  
 Timebase = 5.00 ns/div  
 Ch. 1 Parameters  
 RMS Volts = 3.050 volts  
 Delay = 0.0000 s  
 P-P Volts = 1.150 volts  
 Offset = 3.000 volts  
 Freq. = 69.9790 MHz



P/O Figure 8-43. A6 Waveforms

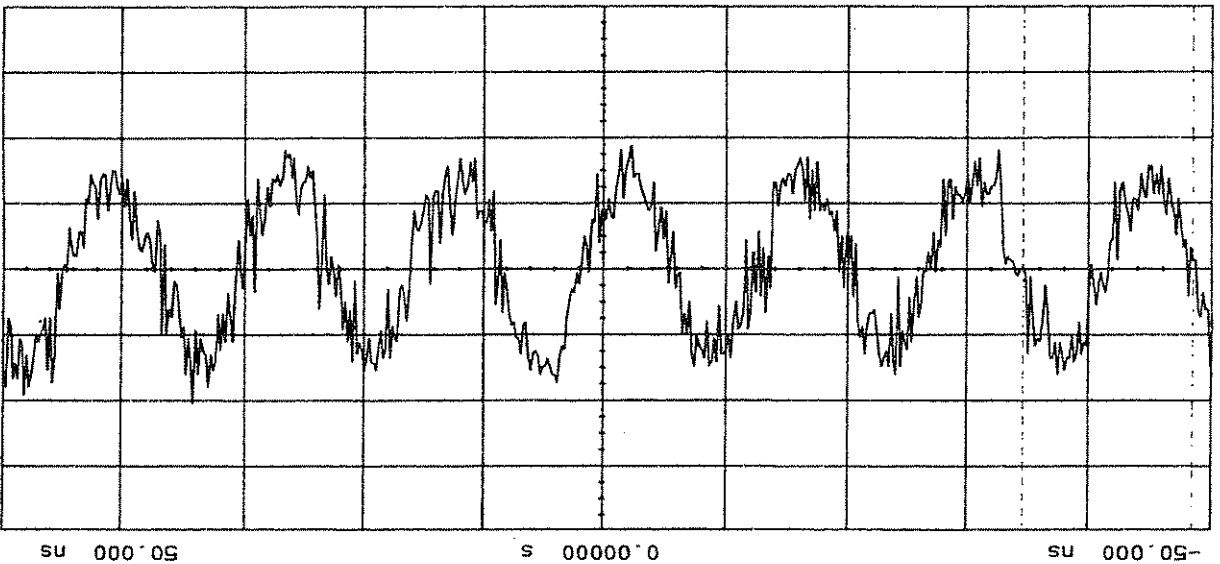
NAME OF WAVEFORM: F  
 POINT PROBED: A6Q7 EMITTER  
 CONDITIONS: INSTRUMENT IN INPUT 1, MANUAL MODE, CF = 1 GHZ  
 INPUT: 1 GHZ, -30 DBM APPLIED TO INPUT 1

Ch. 1 Parameters  
 Timebase = 200.0 mvolts/div  
 Delay = 5.00 ns/div  
 RMS Volts = 400.4 mvolts  
 Freq. = 69.5894 MHz  
 P-P Volts = 1.236 volts  
 Delay = 0.0000 s  
 Offset = -12.00 mvolts

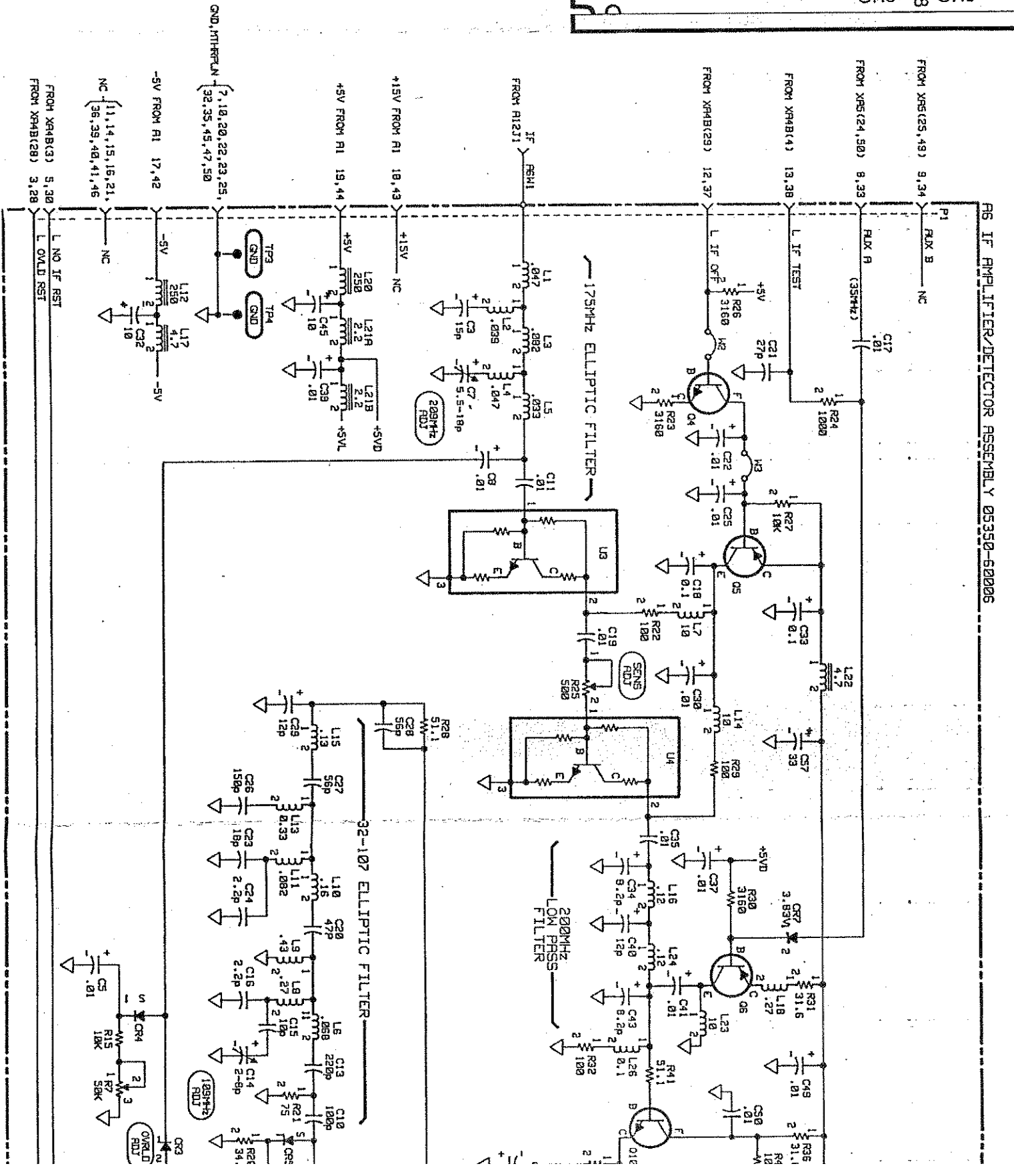
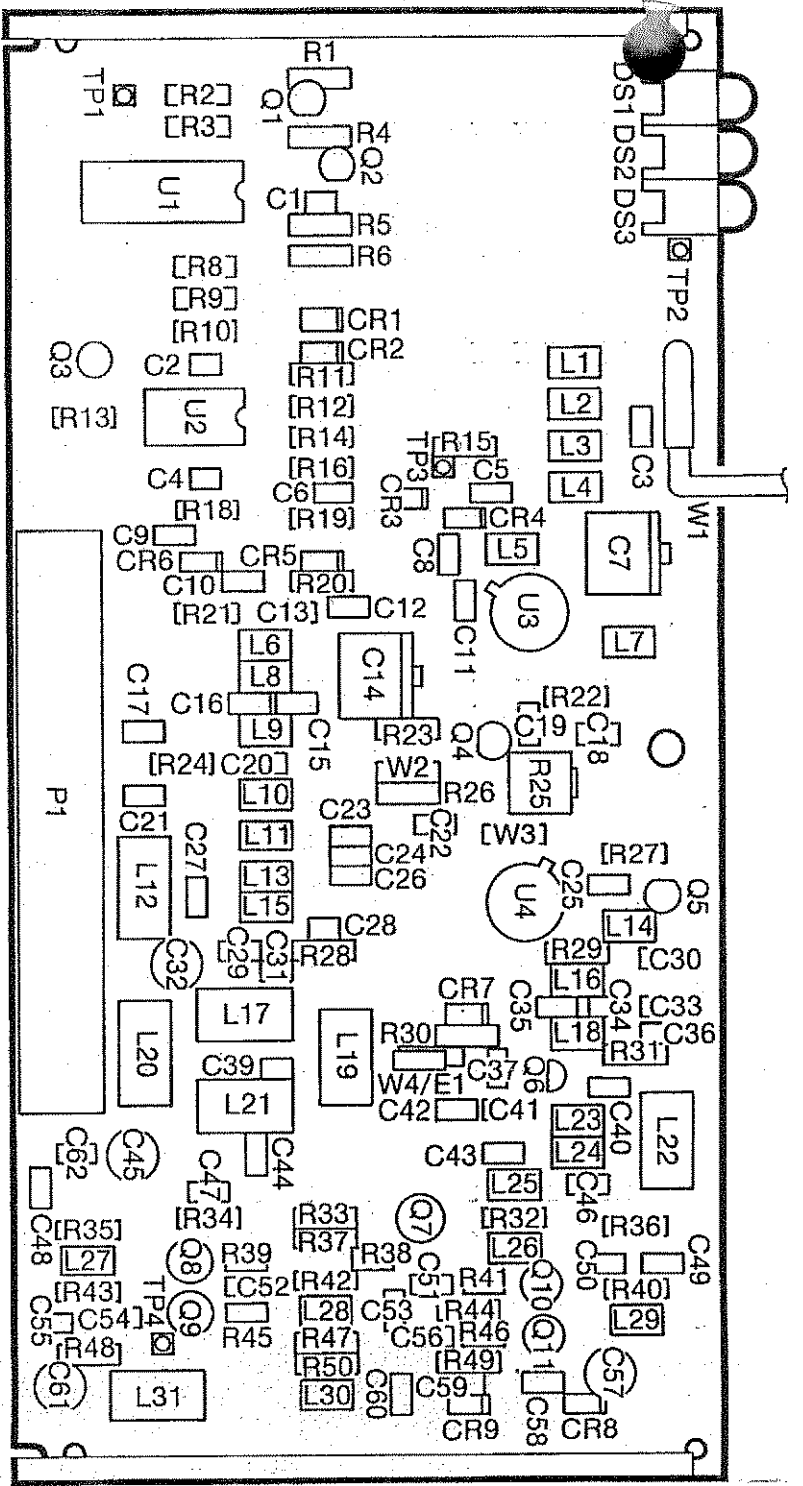


NAME OF WAVEFORM: E  
 POINT PROBED: A6Q11 COLLECTOR - AC COUPLED  
 CONDITIONS: INSTRUMENT IN INPUT 1, MANUAL MODE, CF = 1 GHZ  
 INPUT: 1 GHZ APPLIED TO INPUT 1 100 MV P-P MEASURED AT Q10 BASE

Ch. 1 Parameters  
 Timebase = 10.0 ns/div  
 Delay = 10.0 ns/div  
 RMS Volts = 70.92 mvolts  
 Freq. = 71.7875 MHz  
 P-P Volts = 824.0 mvolts  
 Delay = 0.0000 s  
 Offset = 12.00 mvolts







P/O Figure 8-43. A6 Component Locator



A6 IF AMPLIFIER/DETECTOR ASSEMBLY 05350-60005

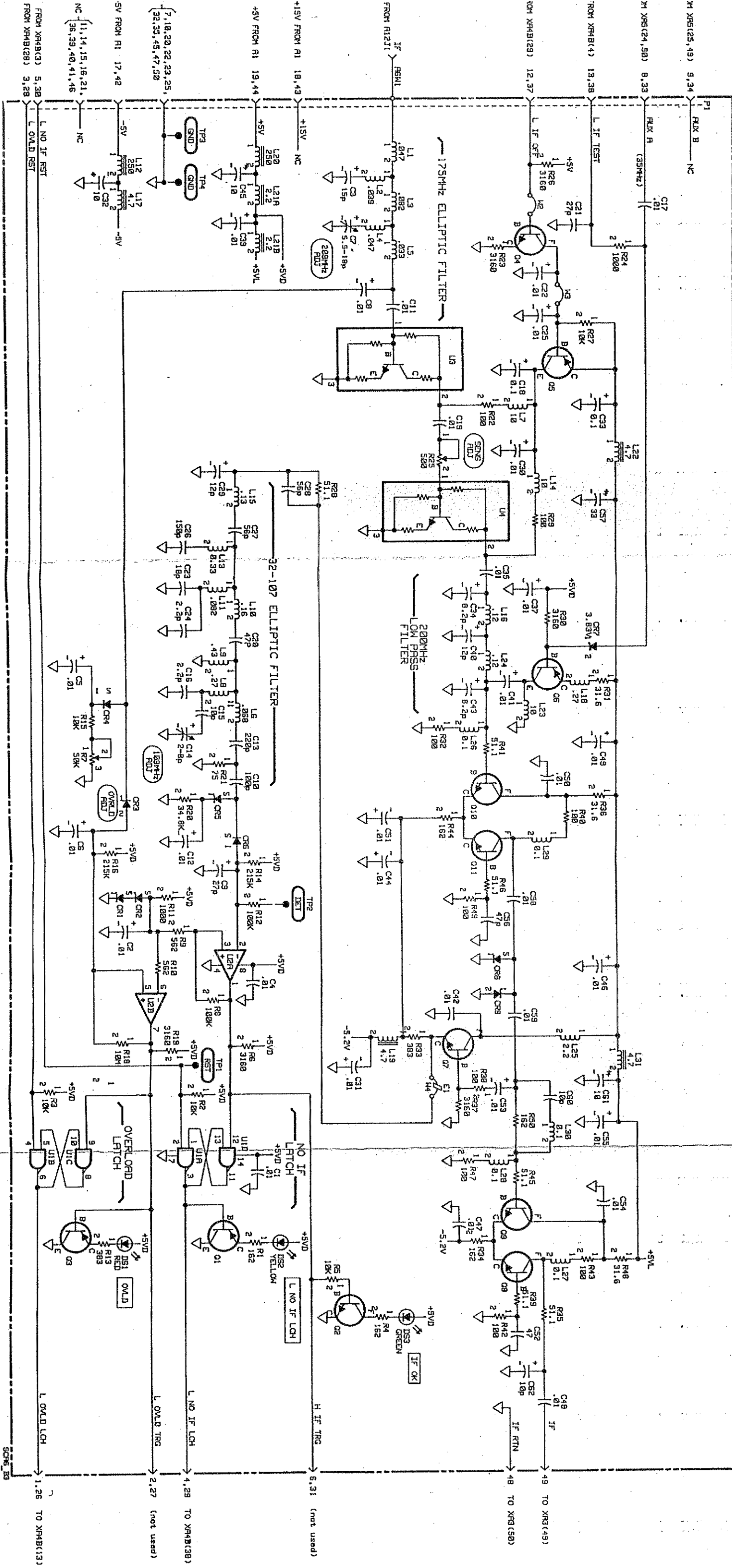
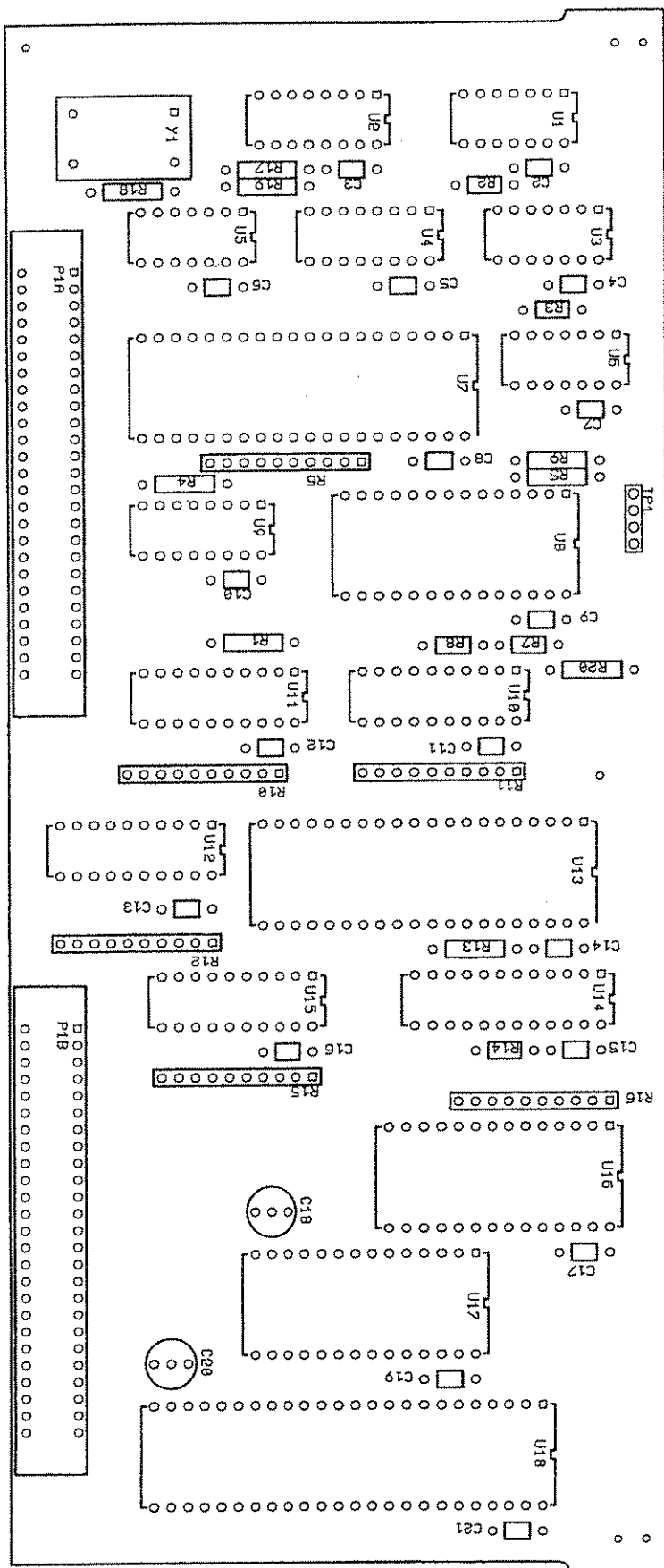


Figure 8-43. A6 Amplifier/Detector Assembly Schematic Diagram





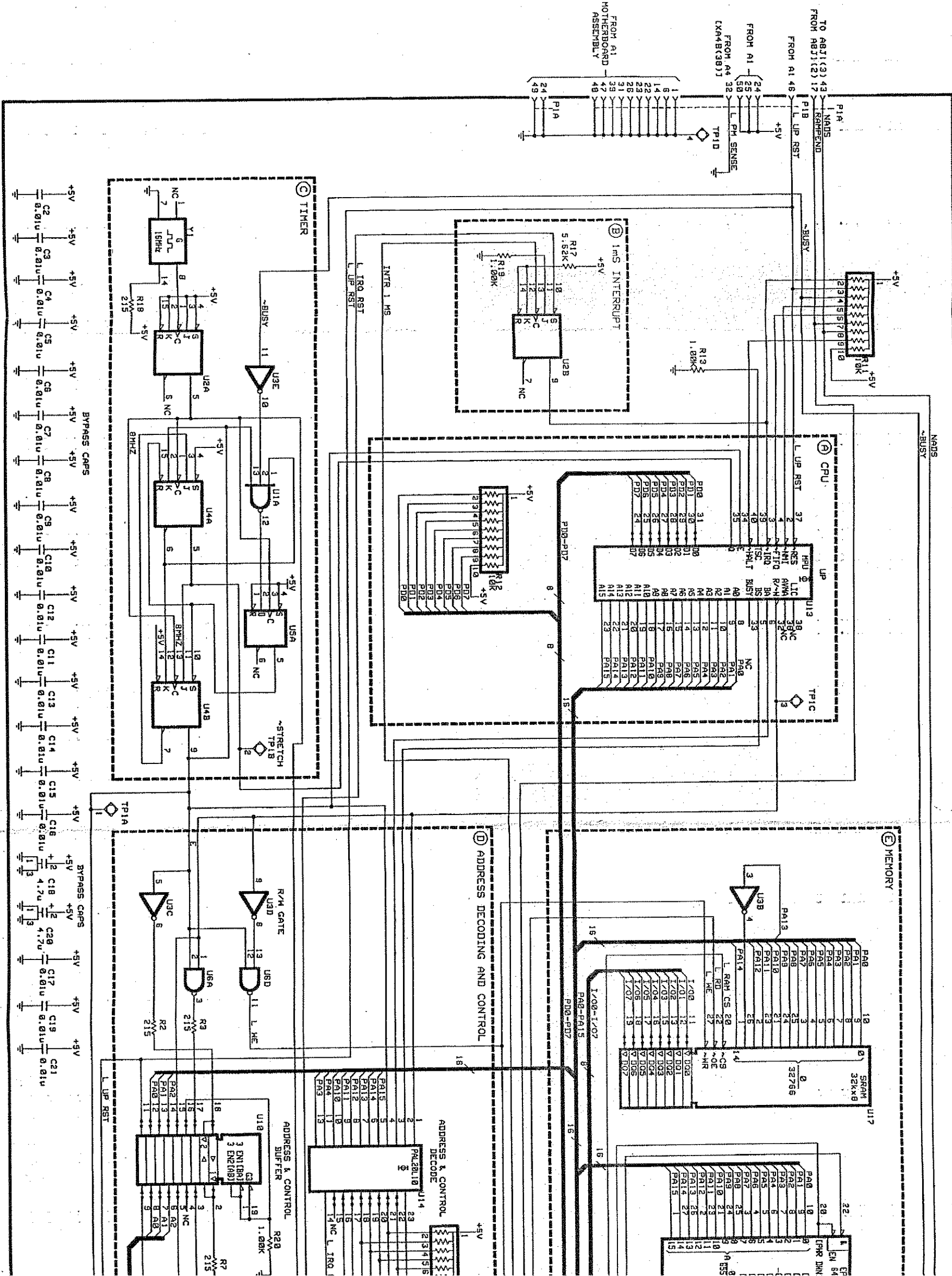
P/O Figure 8-44. A7 Power Meter Digital Assembly Component Locator





A7 SCHEMATIC DIAGRAM NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD A7 ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.
2. UNLESS OTHERWISE INDICATED, RESISTANCE IN OHMS, CAPACITANCE IN FARADS, INDUCTANCE IN HENRIES.
3. ASTERISK (\*) INDICATES FACTORY SELECTED COMPONENT. AVERAGE VALUE SHOWN.
4. A TILDE (~) PRECEDING A SIGNAL INDICATES A NEGATIVE-TRUE SIGNAL.





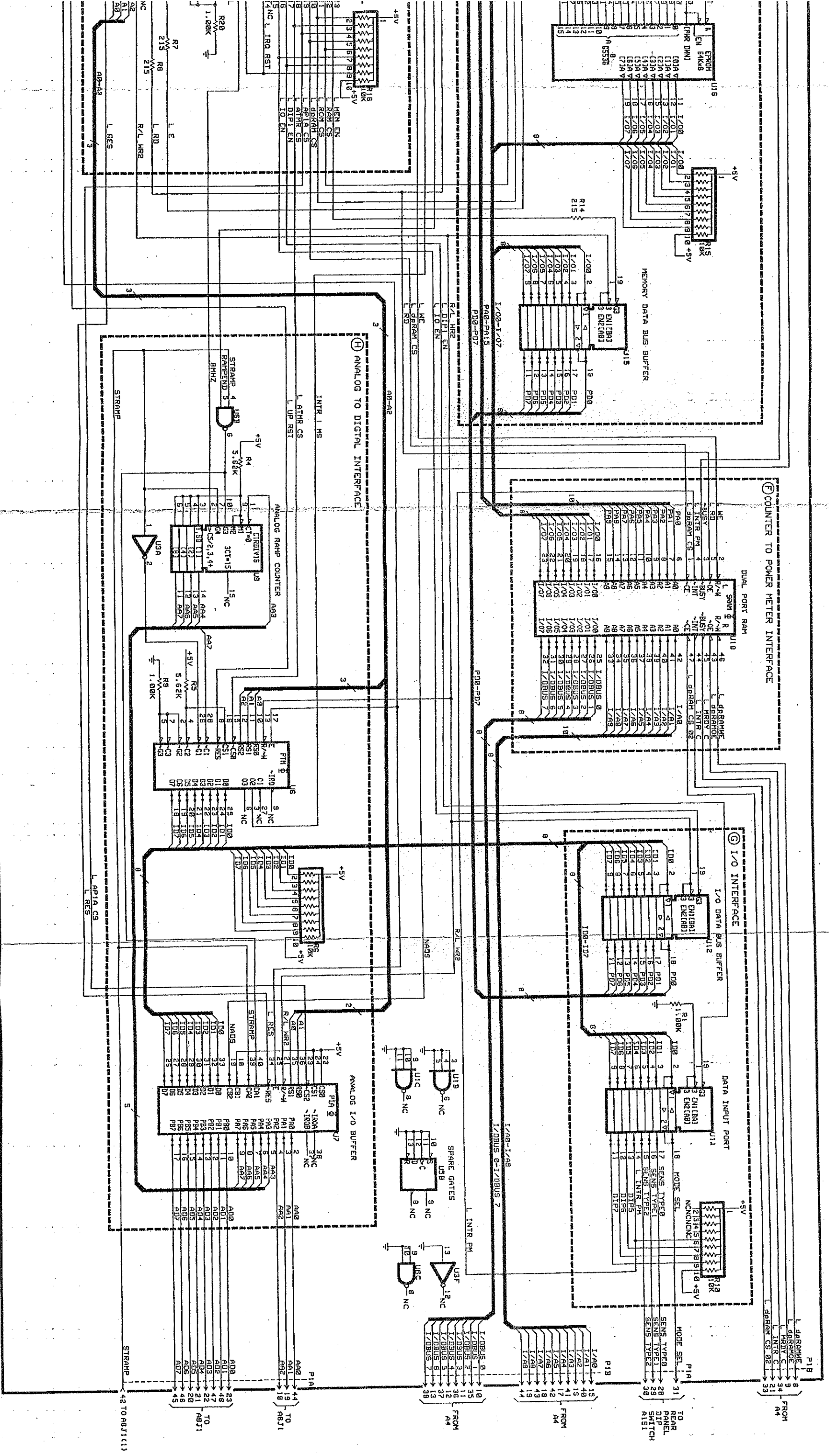


Figure 8-44. A7 Power Meter Digital Assembly Schematic Diagram



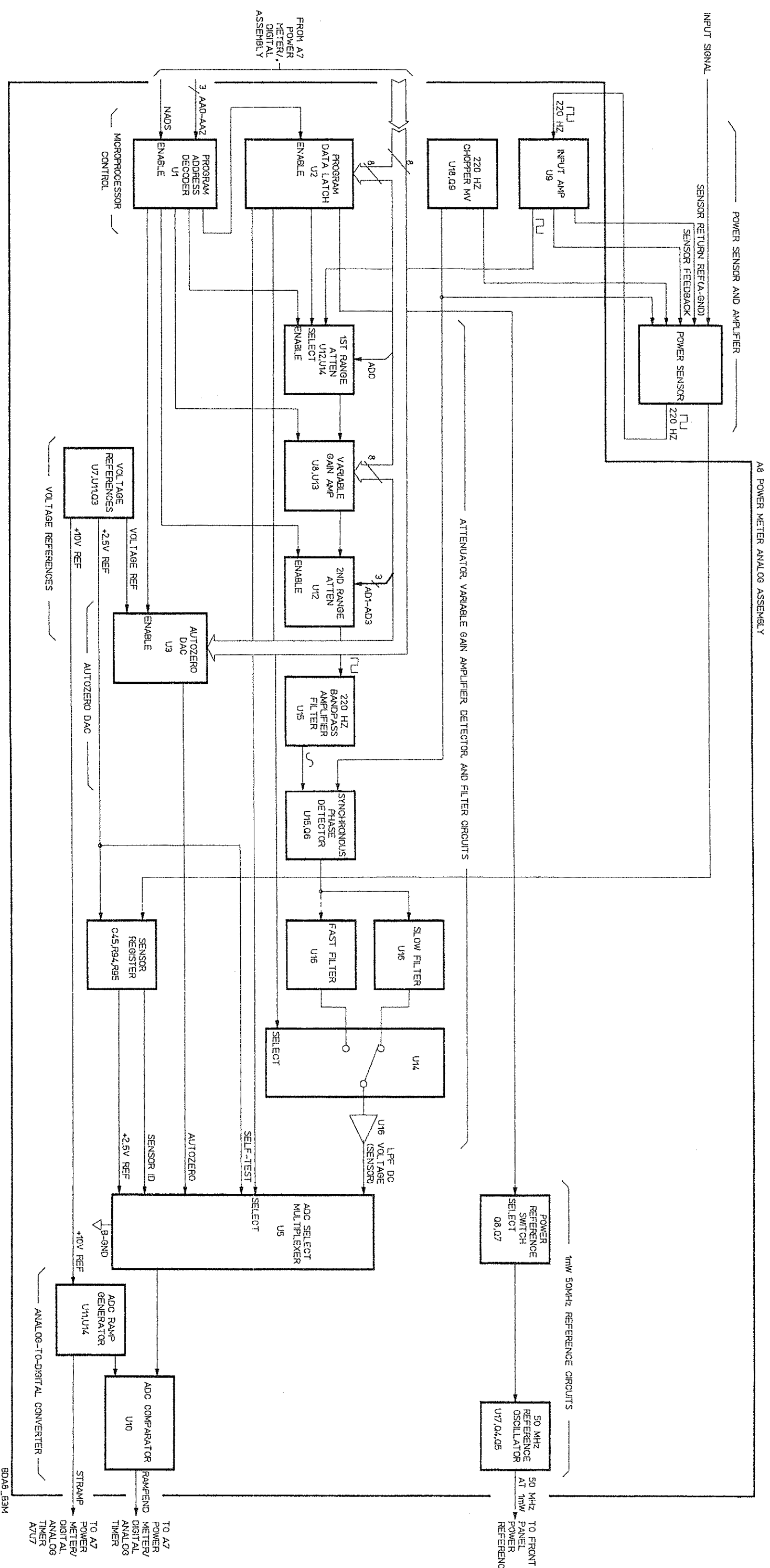


Figure 8-45. A8 Power Meter Analog Assembly Block Diagram

**AS POWER METER ANALOG ASSEMBLY BLOCK DIAGRAM**

*Figure 8-45*

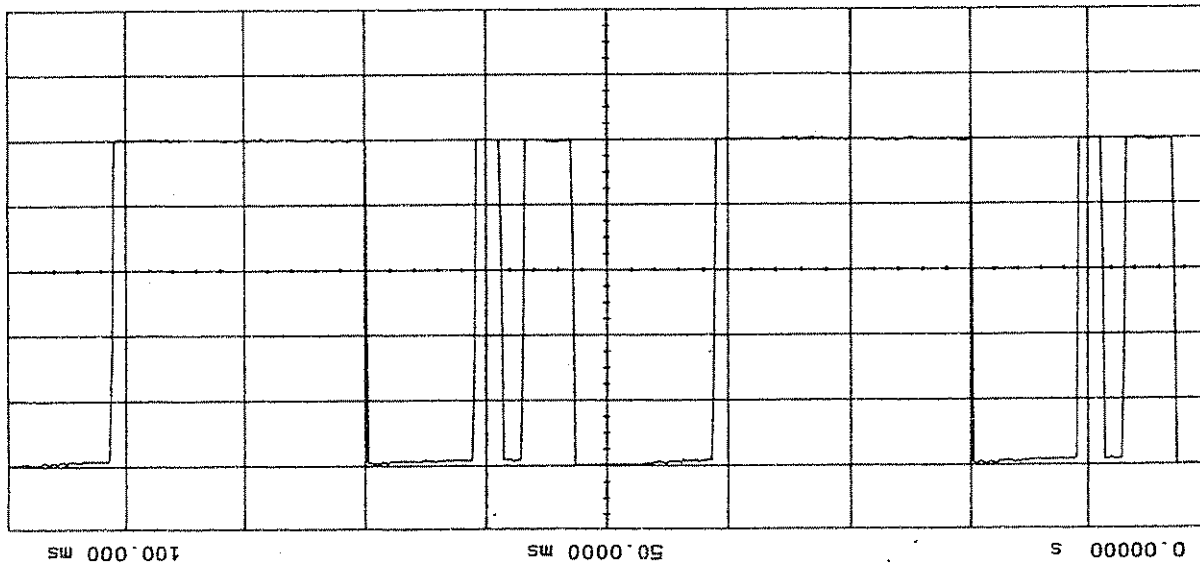
(See Page 8-271)



P/O Figure 8-46. A8 Waveforms

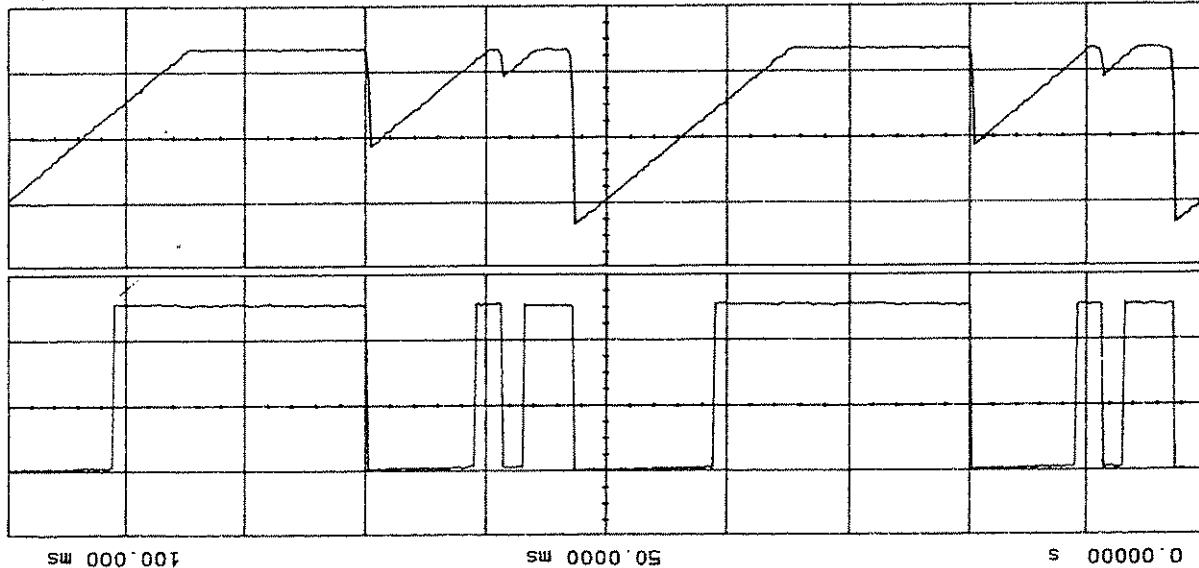
NAME OF WAVEFORM: B  
 POINT PROBED: A8TP6 RAMPEND  
 CONDITIONS: 1 MW INPUT FROM RANGE CALIBRATOR POWER METER ZEROED AND CALIBRATED

Ch. 1 = 1.000 volts/div  
 Timebase = 10.0 ms/div  
 Offset = 2.080 volts  
 Delay = 0.00000 s



NAME OF WAVEFORM: A  
 POINT PROBED: CH 1: A8TP6 RAMPEND  
 CH 2: A8TP7 RAMP  
 TRIGGER SOURCE: CH 2  
 CONDITIONS: 1 MW INPUT FROM RANGE CALIBRATOR POWER METER ZEROED AND CALIBRATED

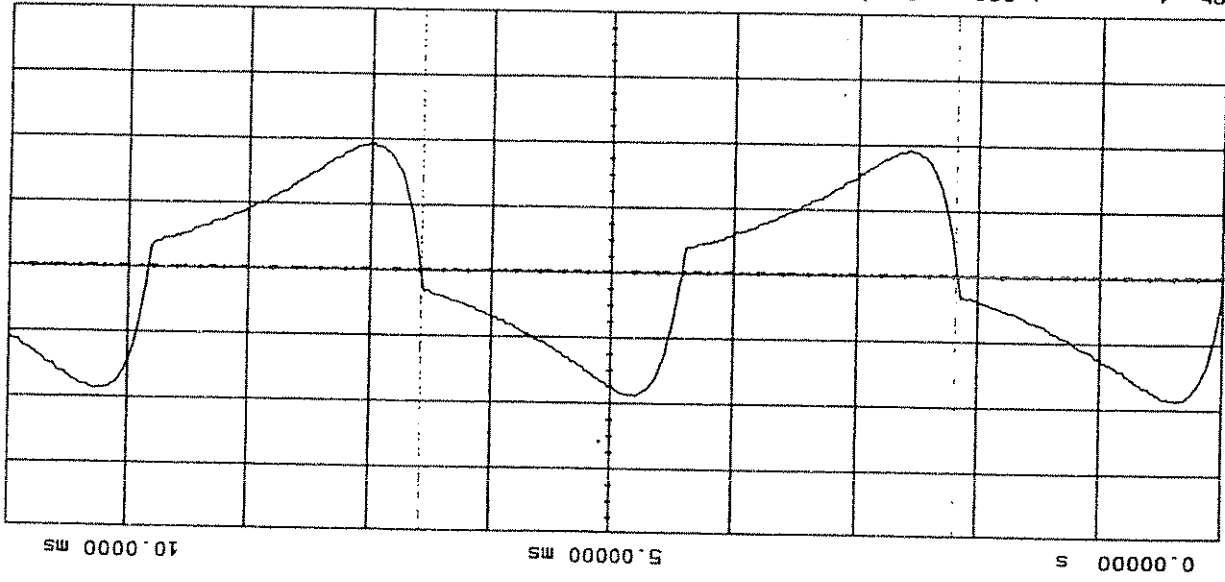
Ch. 1 = 2.000 volts/div  
 Ch. 2 = 4.000 volts/div  
 Timebase = 10.0 ms/div  
 Offset = 3.100 volts  
 Offset = 4.560 volts  
 Delay = 0.00000 s



P/O Figure 8-46. A8 Waveforms

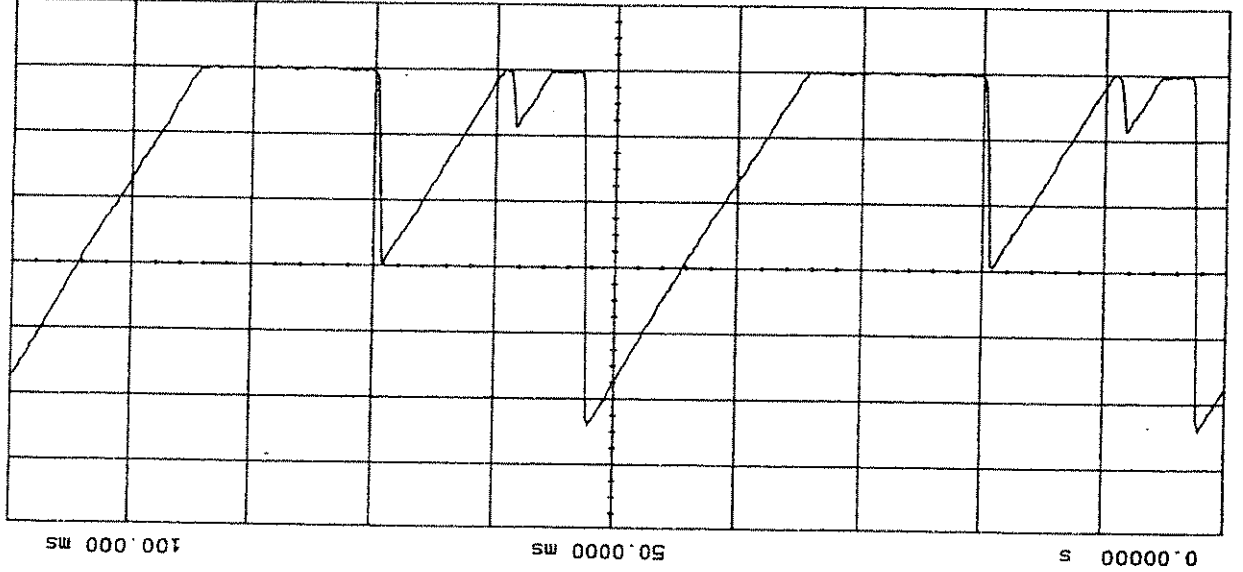
NAME OF WAVEFORM: D  
 POINT PROBED: A8T73 VAR GAIN  
 CONDITIONS: 1 MW INPUT FROM RANGE CALIBRATOR POWER METER ZEROED AND CALIBRATED

Ch. 1 = 1.000 volts/div  
 Timebase = 1.00 ms/div  
 Ch. 1 Parameters  
 RMS Volts = 1.215 volts  
 Freq. = 226.190 Hz  
 P-P Volts = 3.840 volts  
 Delay = 0.0000 s  
 Offset = 40.00 mvolts



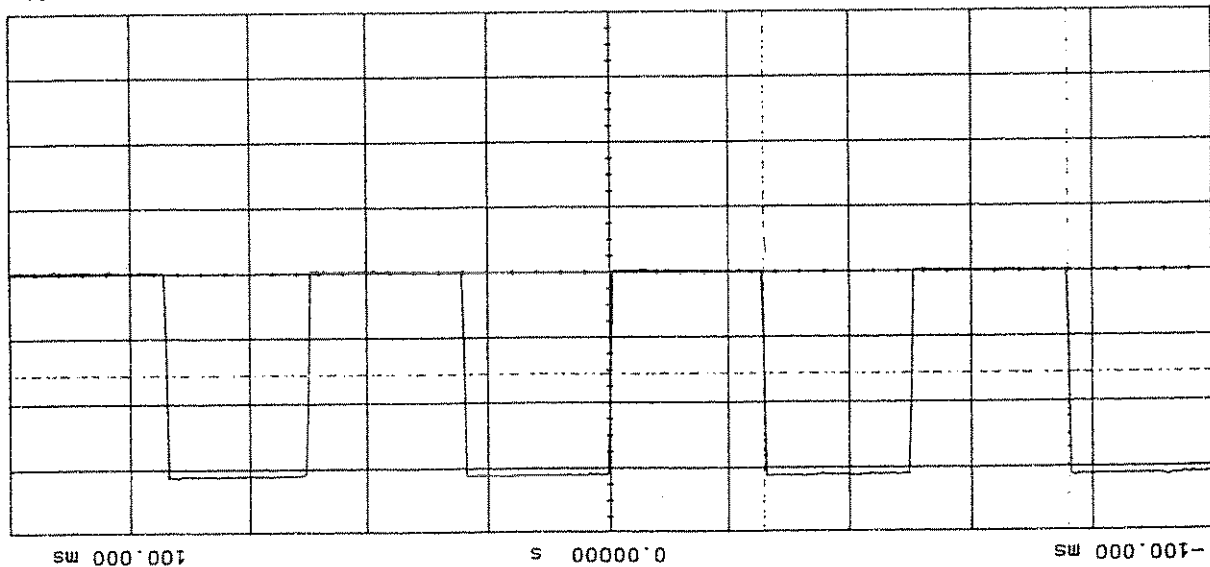
NAME OF WAVEFORM: C  
 POINT PROBED: A8T7 RAMP  
 CONDITIONS: 1 MW INPUT FROM RANGE CALIBRATOR POWER METER ZEROED AND CALIBRATED

Ch. 1 = 2.000 volts/div  
 Timebase = 10.0 ms/div  
 Offset = 5.000 volts  
 Delay = 0.00000 s

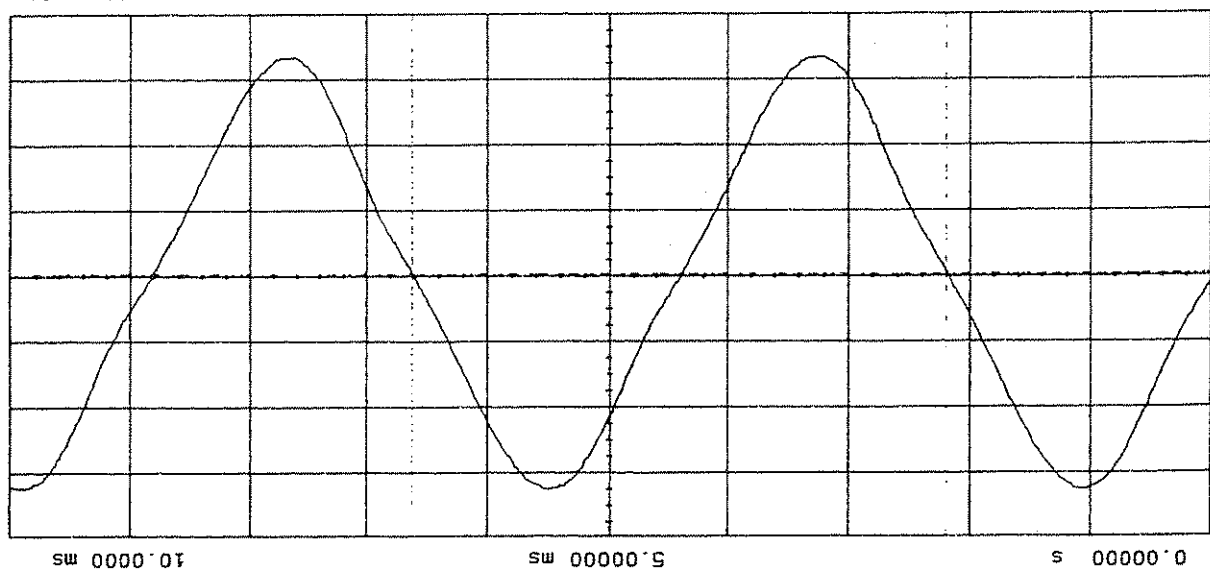


P/O Figure 8-46. A8 Waveforms

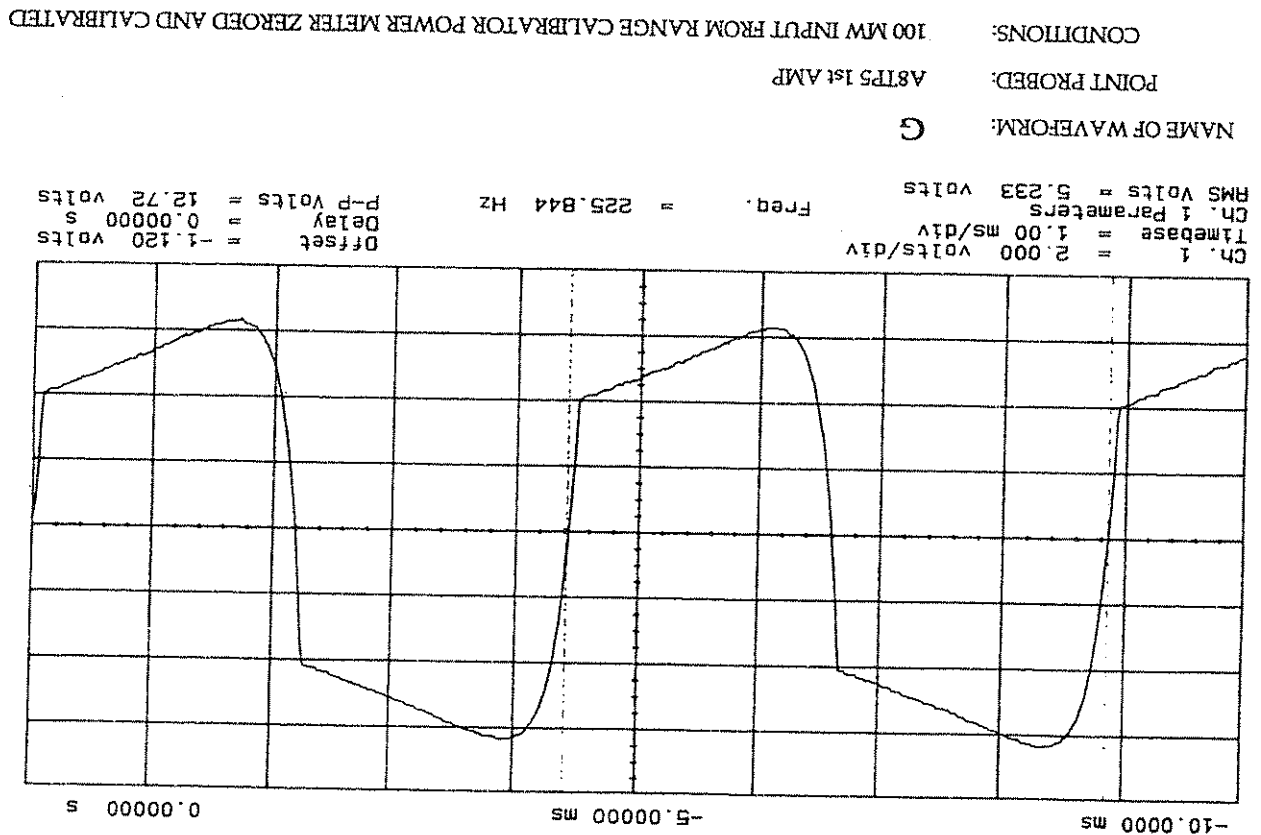
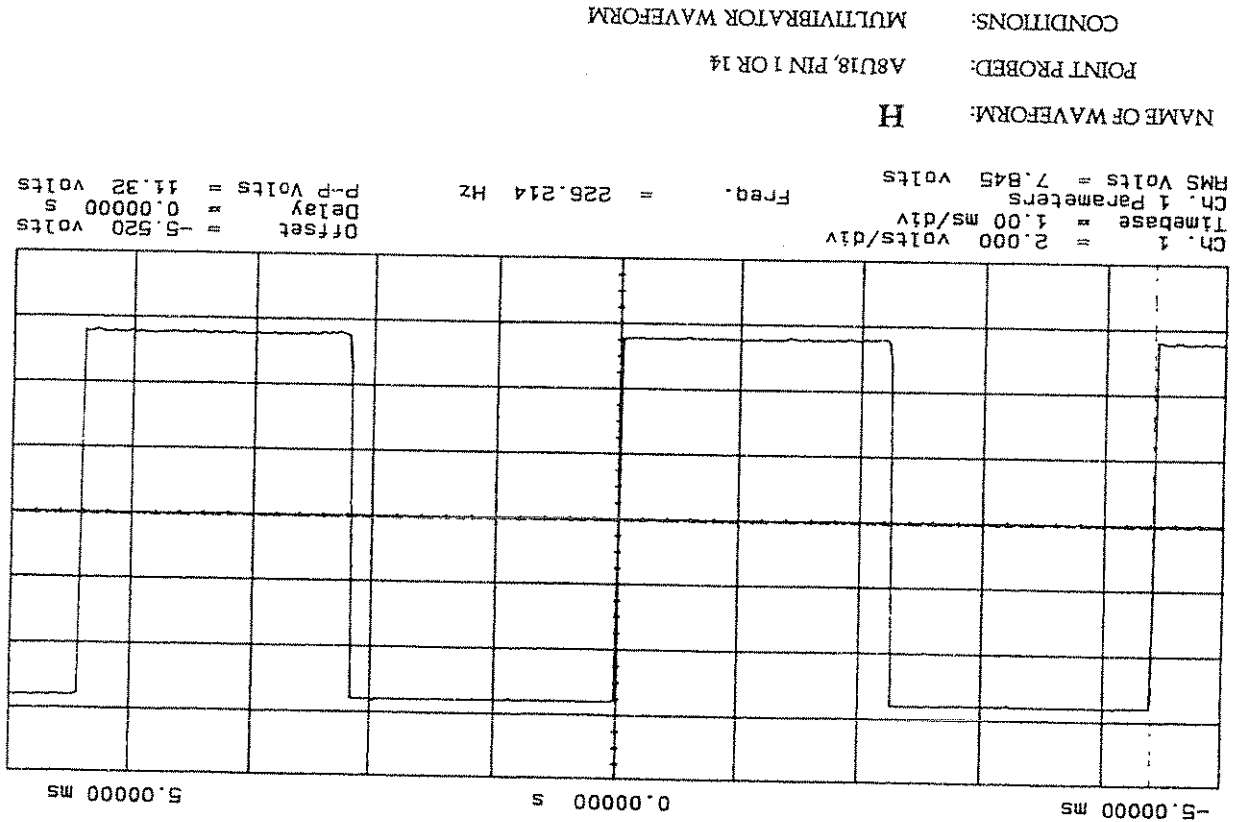
CONDITIONS: 1 MW INPUT FROM RANGE CALIBRATOR POWER METER ZEROED AND CALIBRATED  
 POINT PROBE: A8TP2 ADC IN  
 NAME OF WAVEFORM: F  
 Ch. 1 Parameters  
 Timebase = 20.0 ms/div  
 RMS Volts = 2.149 volts  
 Freq. = 20.0032 Hz  
 P-P Volts = 3.220 volts  
 Delay = 0.0000 s  
 Offset = 0.000 volts



CONDITIONS: 1 MW INPUT FROM RANGE CALIBRATOR POWER METER ZEROED AND CALIBRATED  
 POINT PROBE: A8TP16 BPF OUT  
 NAME OF WAVEFORM: E  
 Ch. 1 Parameters  
 Timebase = 1.00 ms/div  
 RMS Volts = 2.166 volts  
 Freq. = 225.701 Hz  
 P-P Volts = 6.620 volts  
 Delay = 0.0000 s  
 Offset = 0.000 volts



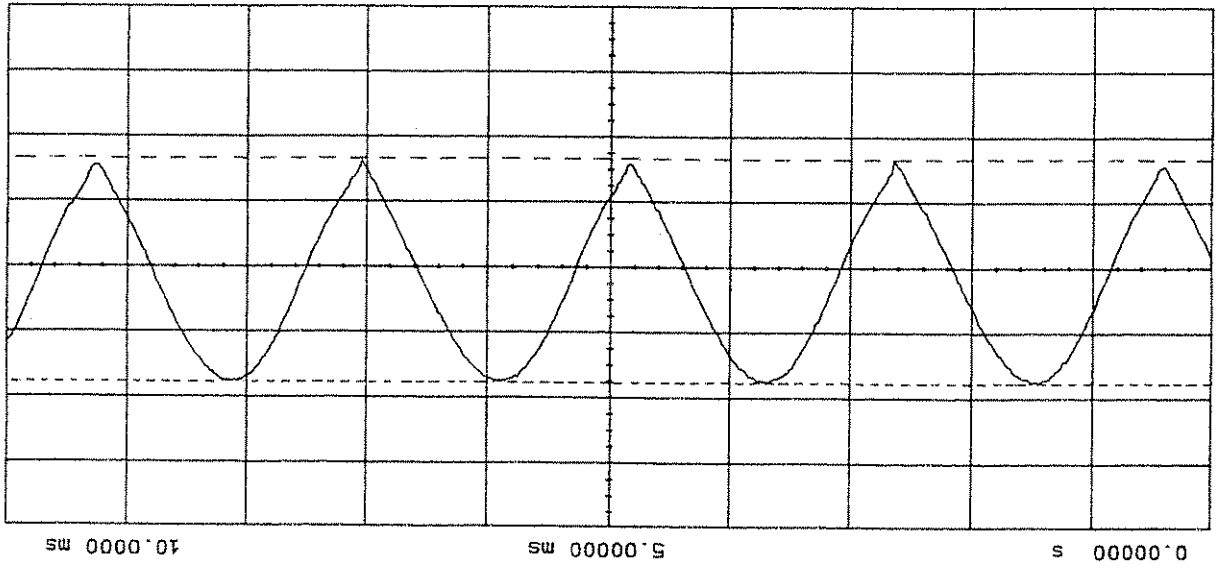
P/O Figure 8-46. A8 Waveforms



P/O Figure 8-46. A8 Waveforms

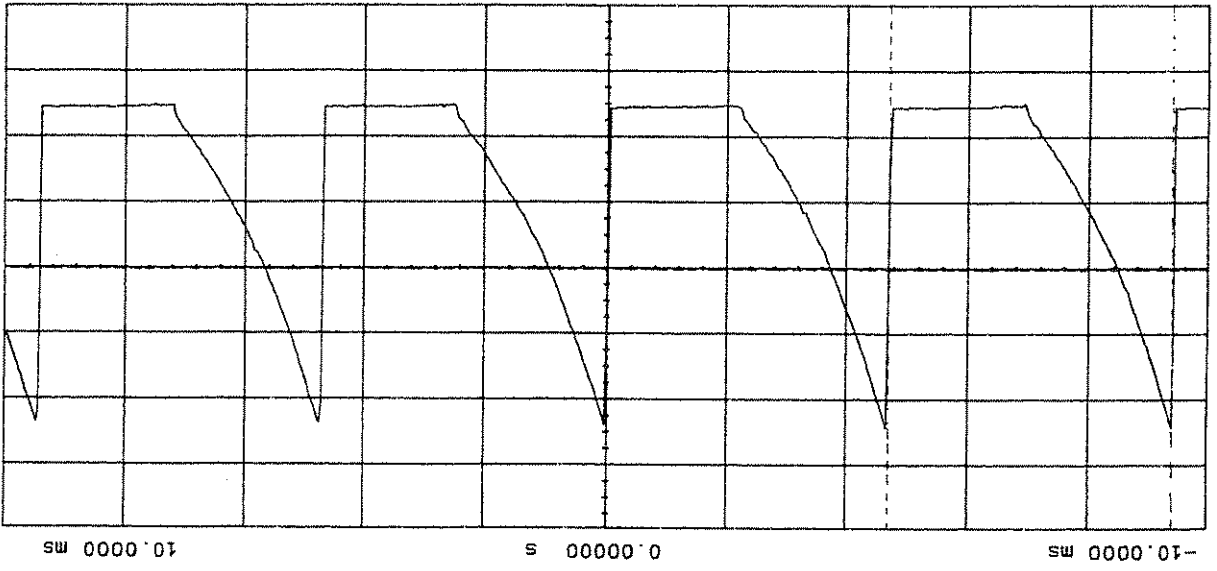
NAME OF WAVEFORM: J  
 POINT PROBED: A8T15 PHS DET  
 CONDITIONS: 1 MW INPUT FROM RANGE CALIBRATOR POWER METER ZEROED AND CALIBRATED

Ch. 1 Parameters  
 Timebase = 1.00 ms/div  
 Offset = 1.530 volts  
 Delay = 0.00000 s  
 P-P Volts = 3.440 volts  
 Freq. = 457.120 Hz



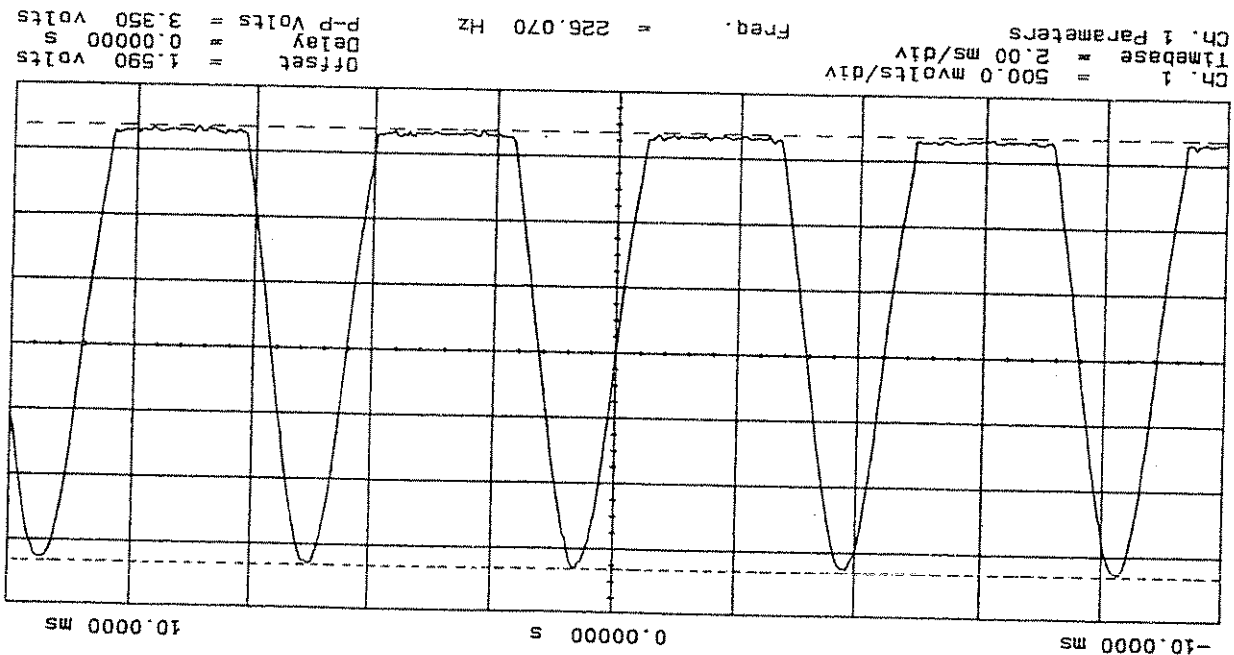
NAME OF WAVEFORM: I  
 POINT PROBED: A8U18, PIN 6 OR 9  
 CONDITIONS: MULTIVIBRATOR WAVEFORM

Ch. 1 Parameters  
 Timebase = 2.00 ms/div  
 Offset = -8.600 volts  
 Delay = 0.00000 s  
 P-P Volts = 4.960 volts  
 Freq. = 212.043 Hz

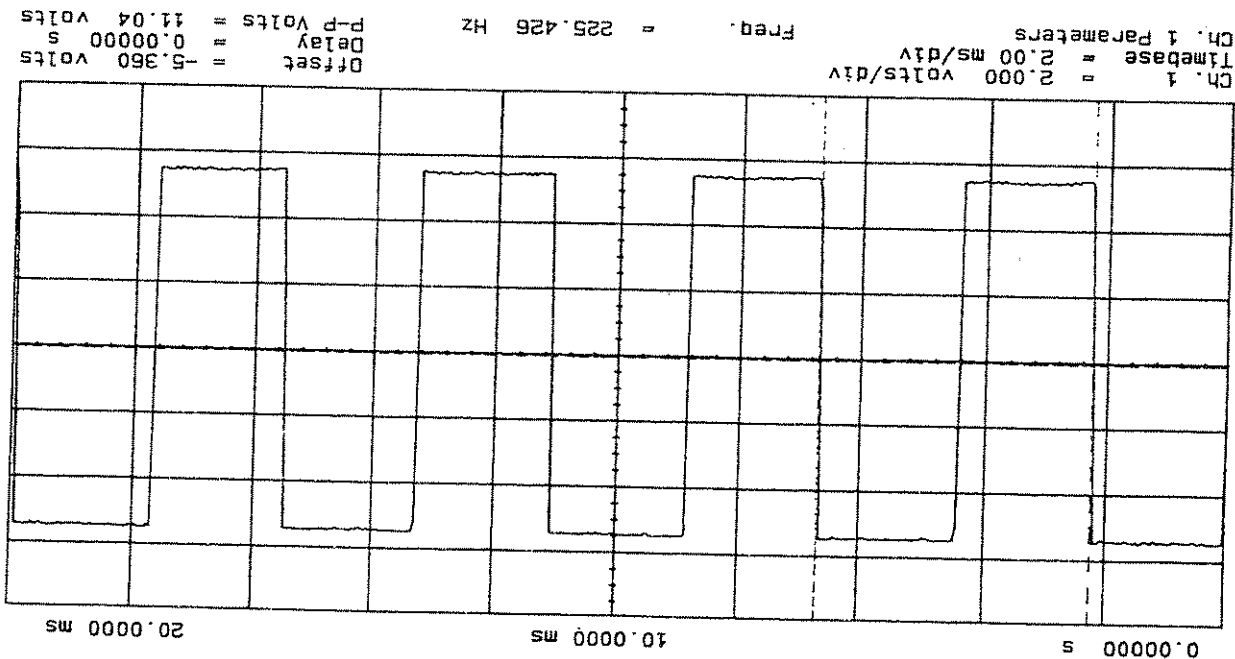


P/O Figure 8-46. A8 Waveforms

NAME OF WAVEFORM: **L**  
 POINT PROBED: A8U15 PIN 5 PHASE DETECTOR CONTROL  
 CONDITIONS: 1 MW INPUT FROM RANGE CALIBRATOR POWER METER ZEROED AND CALIBRATED



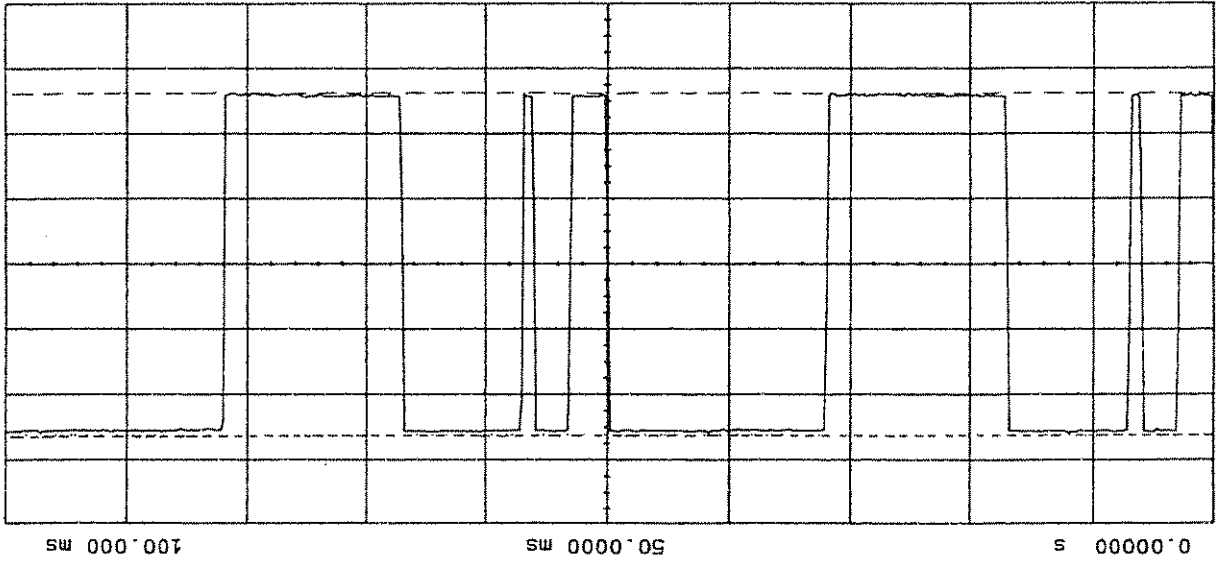
NAME OF WAVEFORM: **K**  
 POINT PROBED: A8TP18 220 HZ  
 CONDITIONS: MULTIVIBRATOR OUTPUT



P/O Figure 8-46. A8 Waveforms

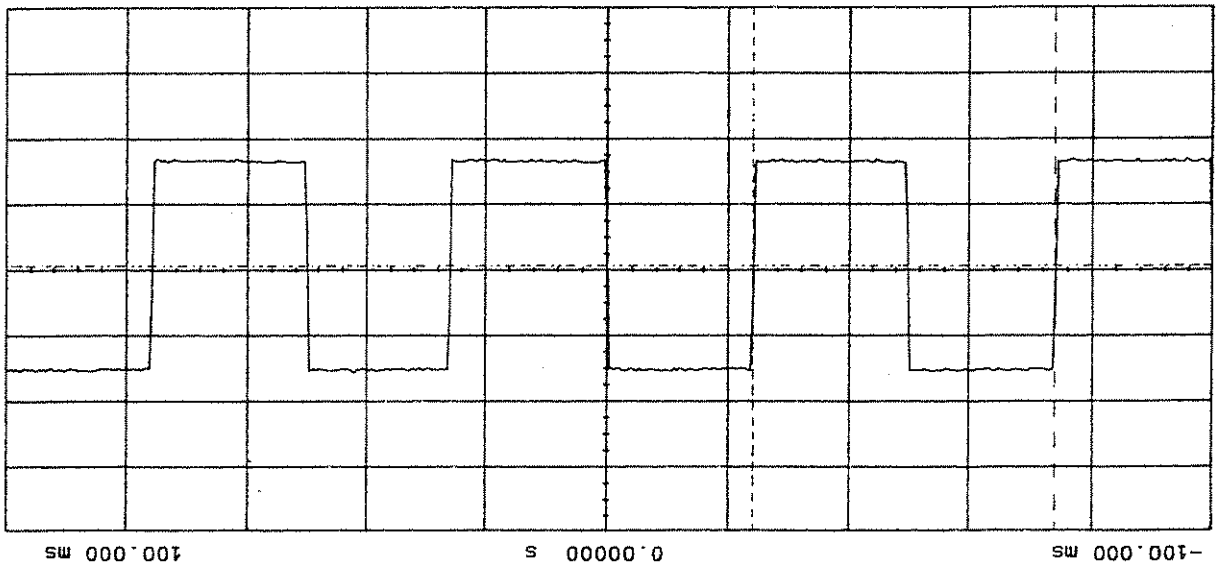
CONDITIONS: 1 MW INPUT FROM RANGE CALIBRATOR POWER METER ZEROED AND CALIBRATED  
 POINT PROBED: A8U14 PIN 1 RAMP GEN GATE  
 NAME OF WAVEFORM: N

Ch. 1 Parameters  
 Timebase = 10.0 ms/div  
 Ch. 1 = 1.000 volts/div  
 Offset = 2.500 volts  
 Delay = 0.00000 s  
 P-P Volts = 5.240 volts



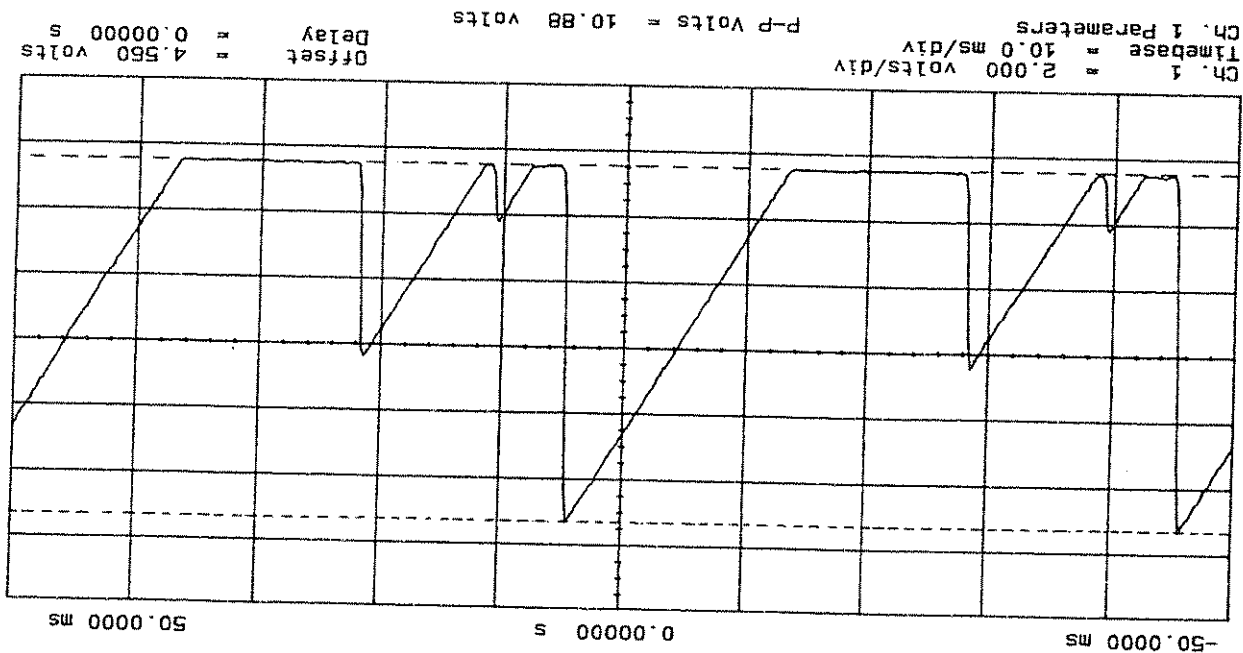
CONDITIONS: 1 MW INPUT FROM RANGE CALIBRATOR POWER METER ZEROED AND CALIBRATED  
 POINT PROBED: A8TR2 ADC IN  
 NAME OF WAVEFORM: M

Ch. 1 Parameters  
 Timebase = 20.0 ms/div  
 Ch. 1 = 1.000 volts/div  
 Offset = 1.590 volts  
 Delay = 0.00000 s  
 P-P Volts = 3.260 volts  
 Freq. = 19.9991 Hz

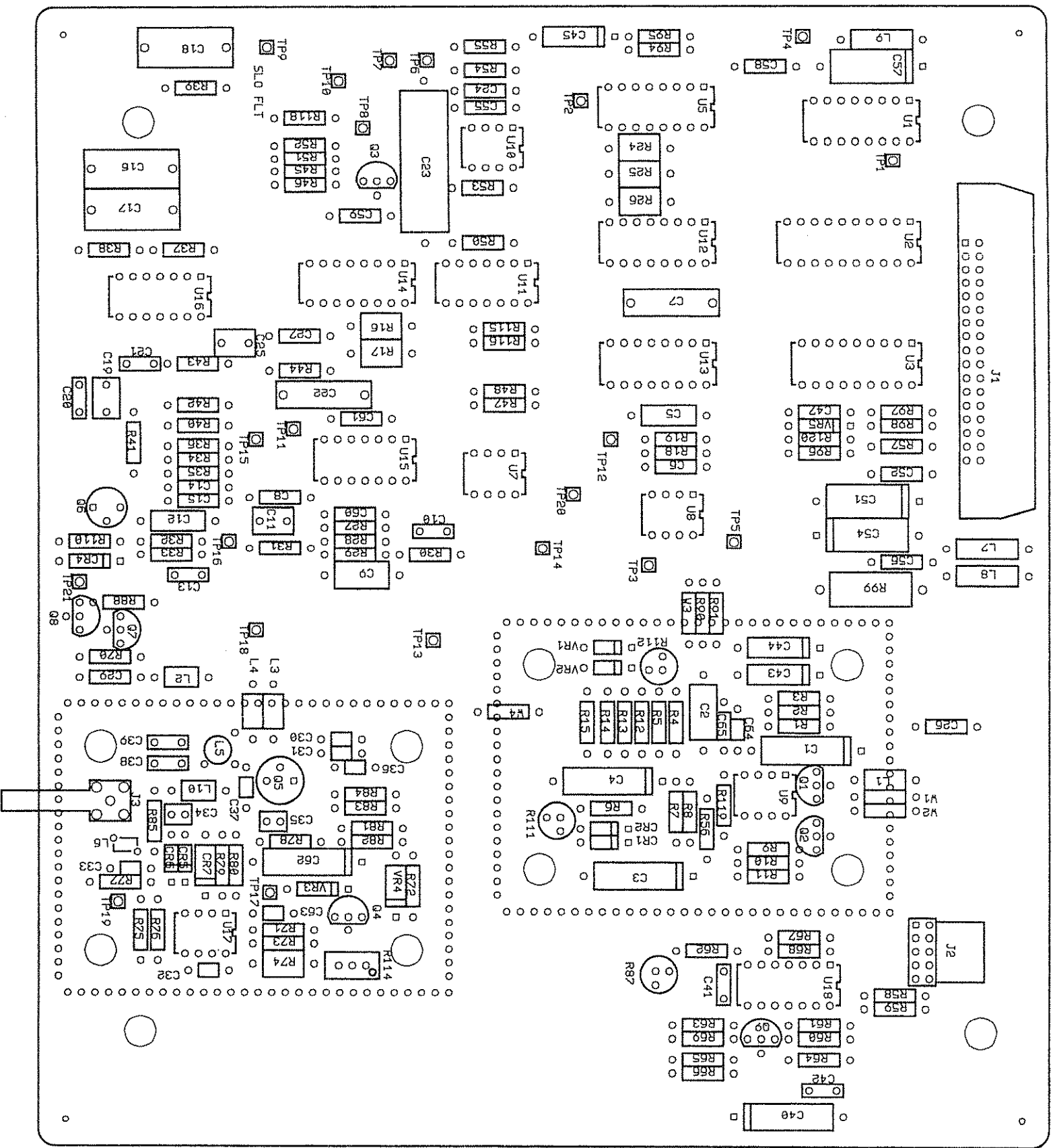


P/O Figure 8-46. A8 Waveforms

NAME OF WAVEFORM:    
 POINT PROBED: A817 A/D CONVERTER RAMP   
 CONDITIONS: 1 MW INPUT FROM RANGE CALIBRATOR POWER METER ZEROED AND CALIBRATED







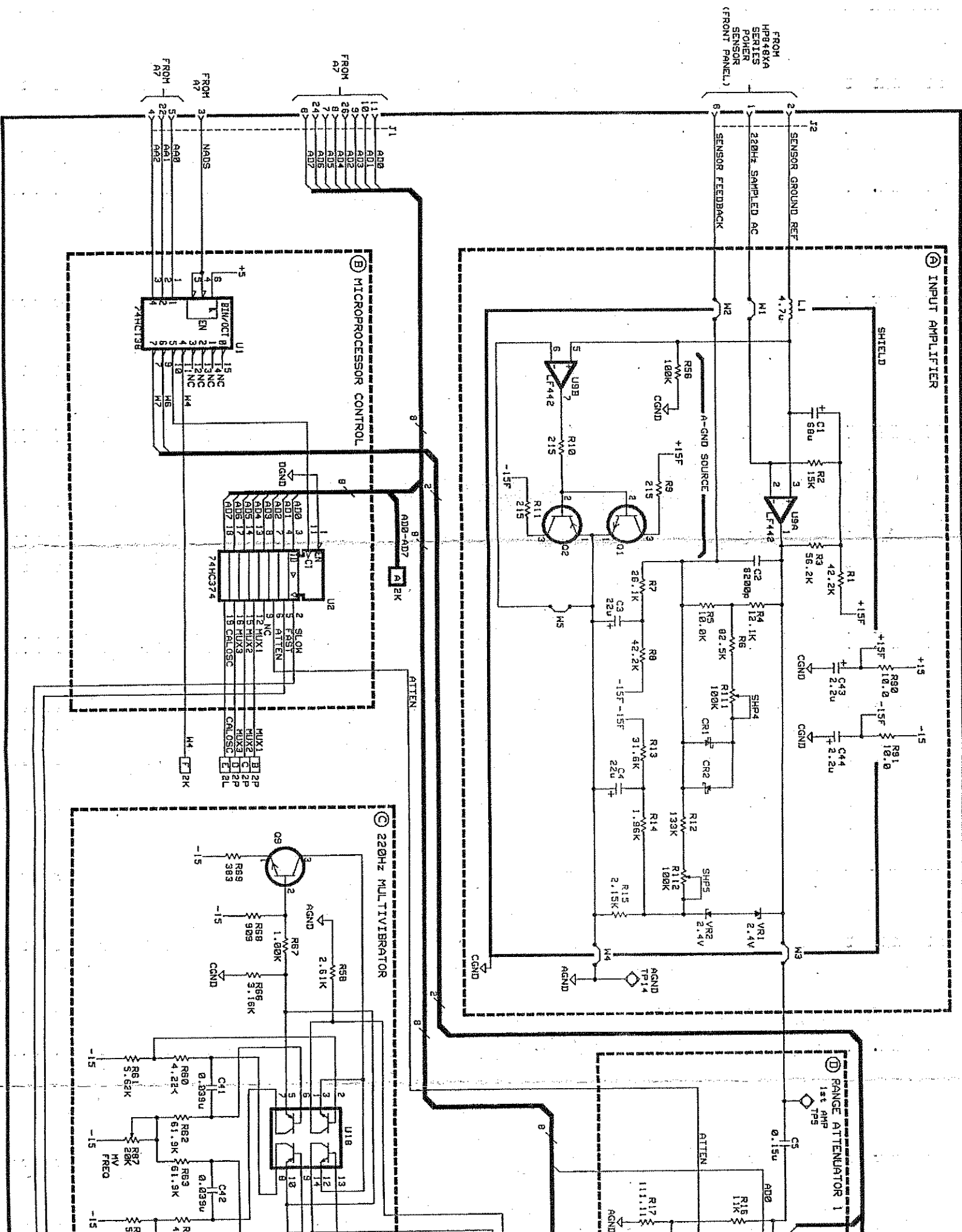
P/O Figure 8-46. A8 Power Meter Analog Assembly Component Locator

*P/O Figure 8-46*  
**A8 POWER METER ANALOG ASSEMBLY COMPONENT LOCATOR**

(See Page 8-281)

A8 SCHEMATIC DIAGRAM NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD A8 ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.
2. UNLESS OTHERWISE INDICATED, RESISTANCE IN OHMS, CAPACITANCE IN FARADS, INDUCTANCE IN HENRIES.
3. ASTERISK (\*) INDICATES FACTORY SELECTED COMPONENT. AVERAGE VALUE SHOWN.
4. A TILDE (~) PRECEDING A SIGNAL INDICATES A NEGATIVE-TYPE SIGNAL





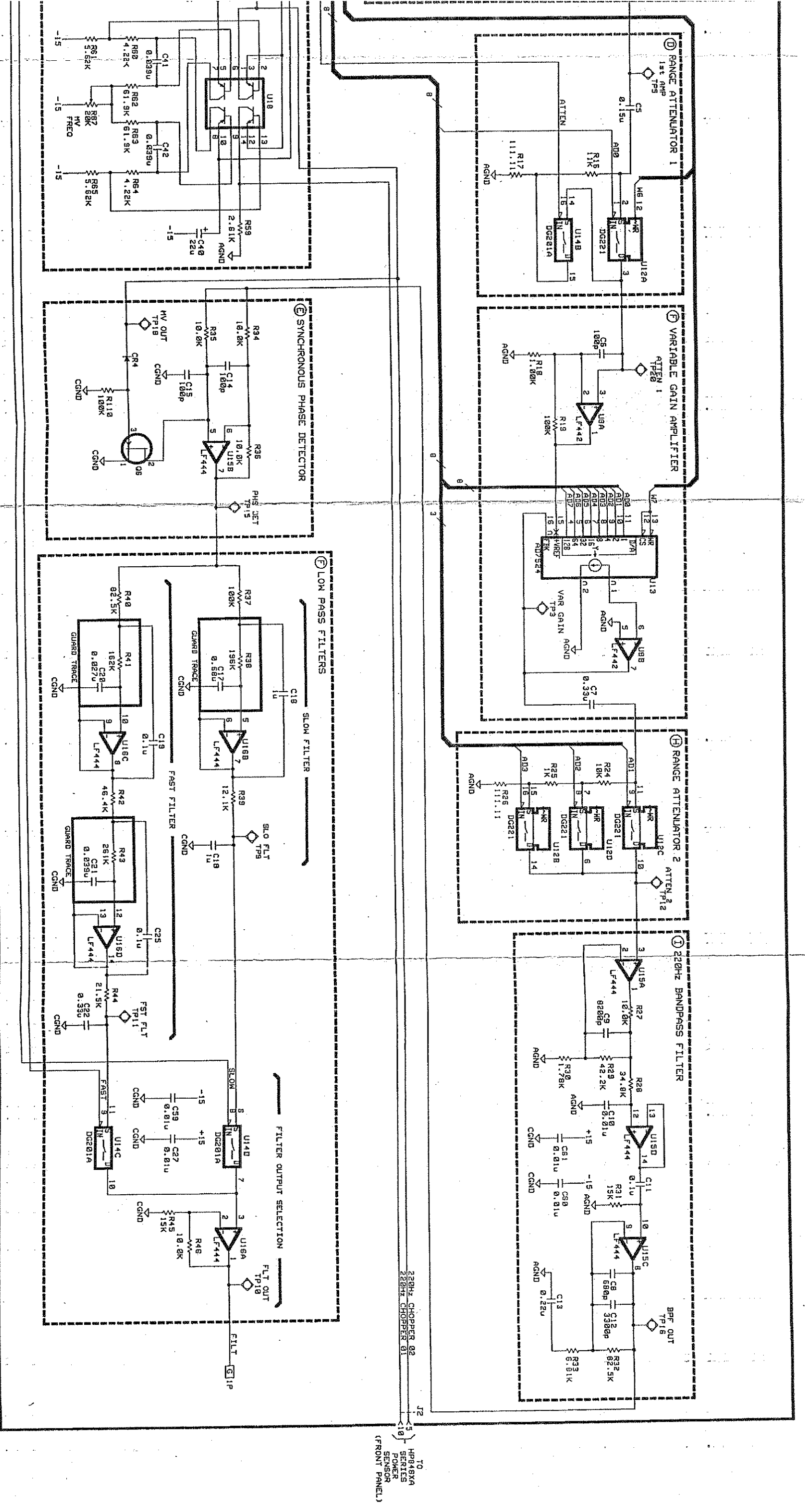
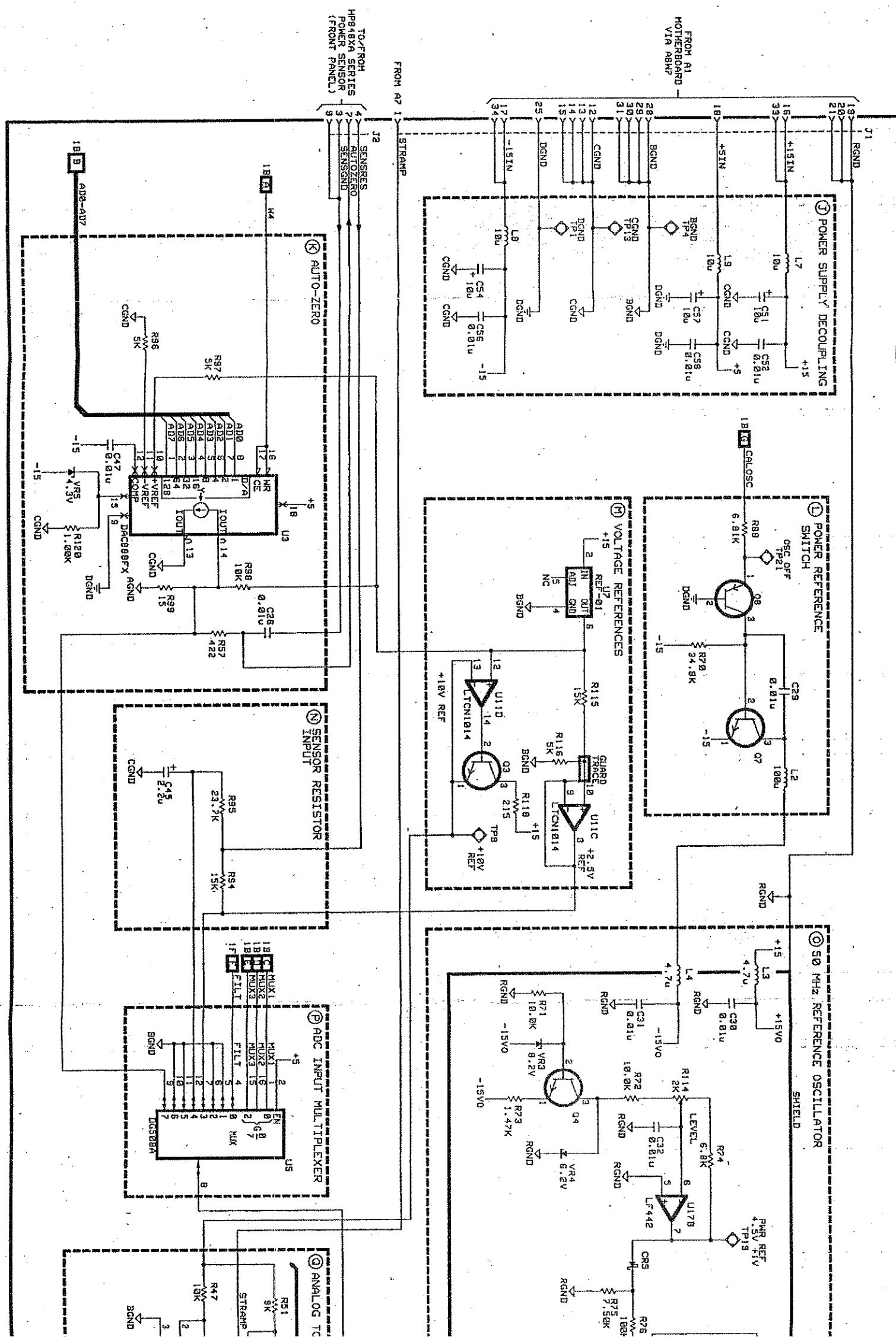


Figure 8-46. A8 Power Meter Analog Assembly Schematic Diagram (Sheet 1 of 2)









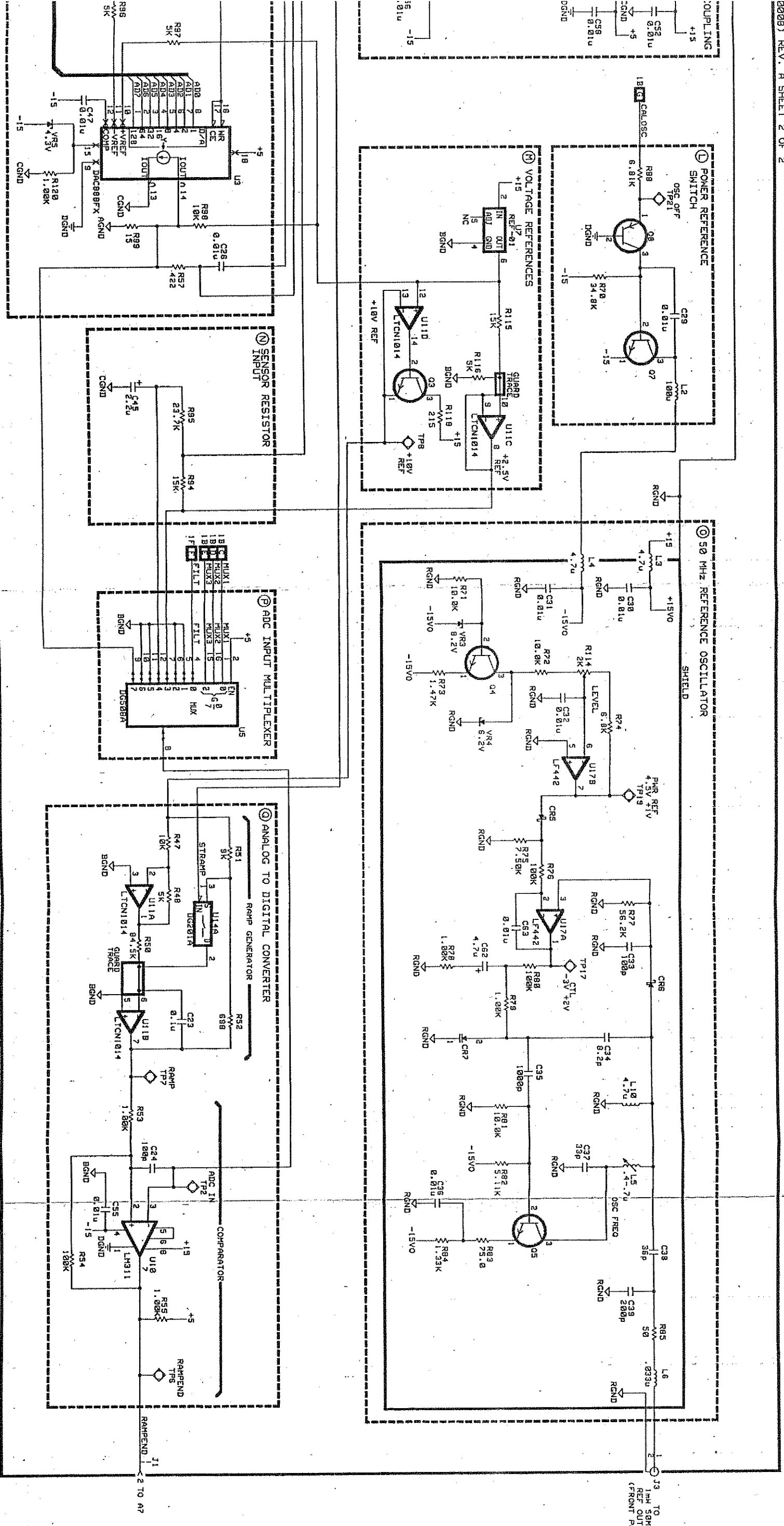


Figure 8-46. A8 Power Meter Analog Assembly Schematic Diagram (Sheet 2 of 2)

8-285



- A9 SCHEMATIC DIAGRAM NOTES**
1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD A9 ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.
  2. UNLESS OTHERWISE INDICATED, RESISTANCE IN OHMS, CAPACITANCE IN FARADS, INDUCTANCE IN HENRIES.
  3. ASTERISK (\*) INDICATES FACTORY SELECTED COMPONENT, AVERAGE VALUE SHOWN.
  4. A TILDE (~) PRECEDING A SIGNAL INDICATES A NEGATIVE-TRUE SIGNAL.

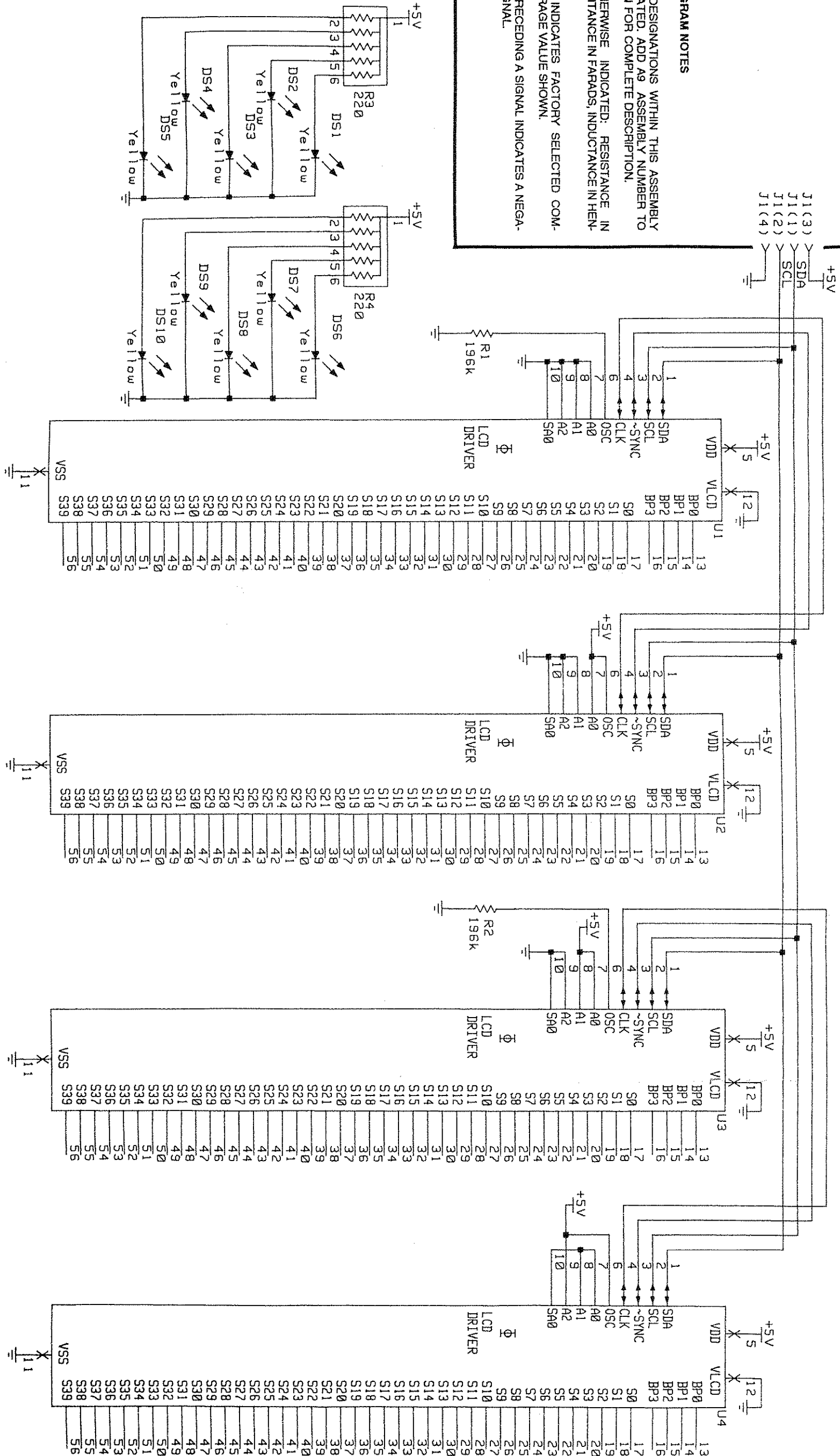
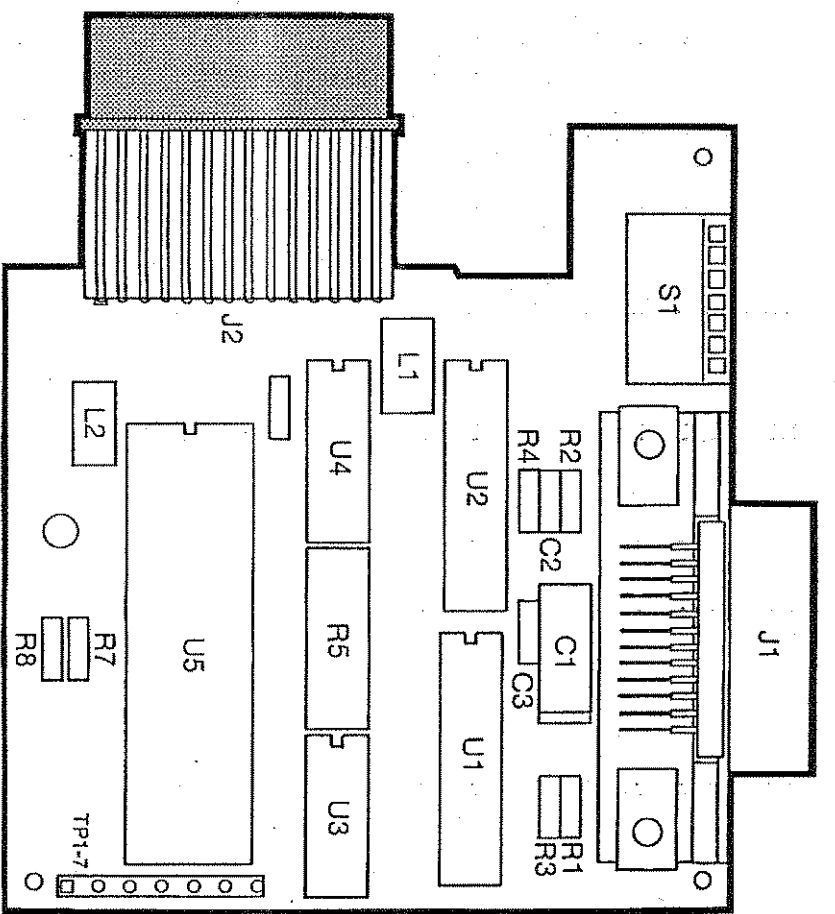


Figure 8-47. A9 Display/Driver Assembly Schematic Diagram

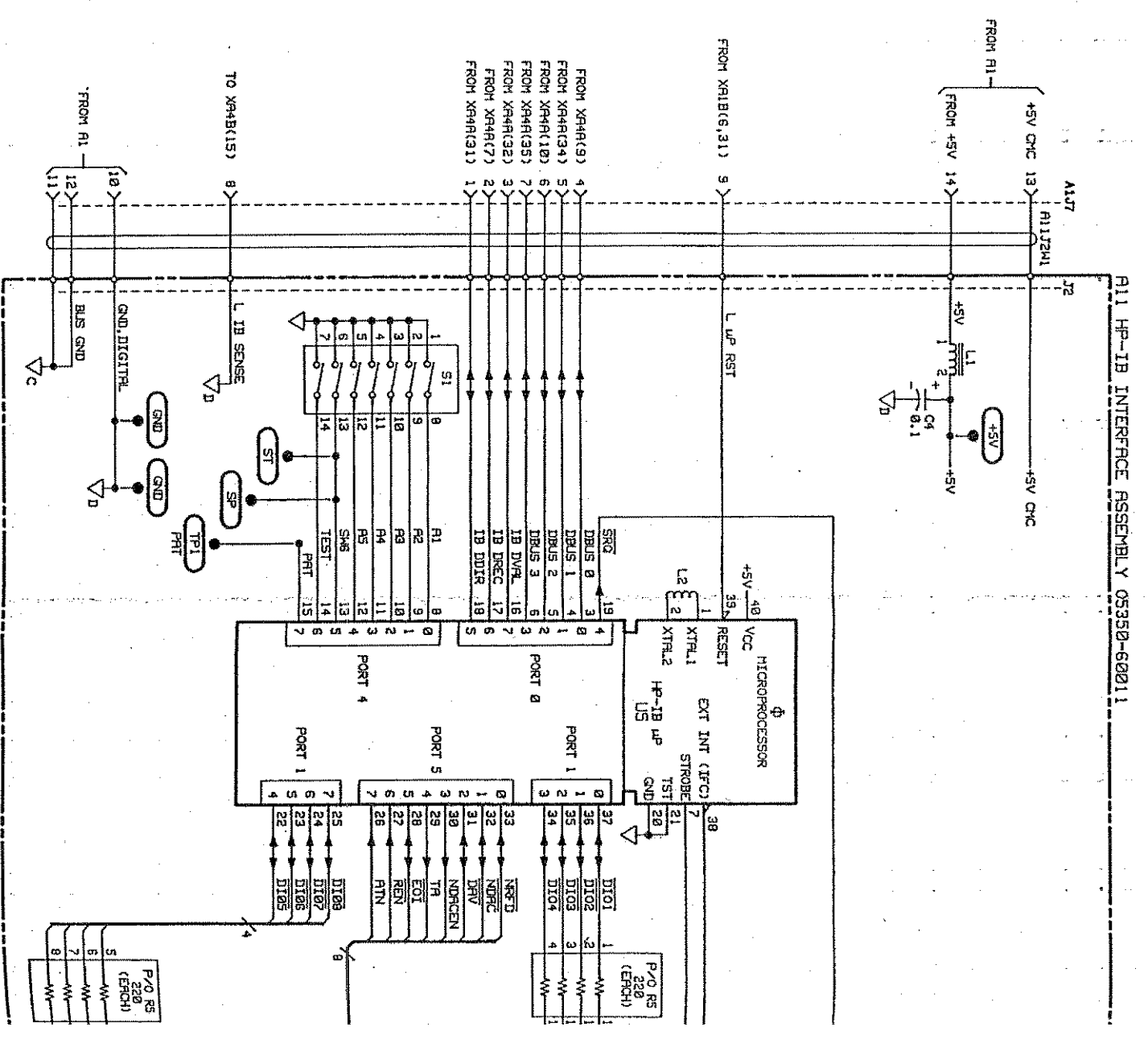
*Figure 8-47*  
**A9 DISPLAY/DRIVER ASSEMBLY SCHEMATIC DIAGRAM**

(See Page 8-287)



**A11 SCHEMATIC DIAGRAM NOTES**

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD A11 ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.
2. UNLESS OTHERWISE INDICATED: RESISTANCE IN OHMS, CAPACITANCE IN MICROFARADS, INDUCTANCE IN MICROHENRIES.
3. ASTERISK (\*) INDICATES FACTORY SELECTED COMPONENT. AVERAGE VALUE SHOWN.
4. A TILDE (~) PRECEDING A SIGNAL INDICATES A NEGATIVE TRUE SIGNAL.



P/O Figure 8-48. A11 Component Locator



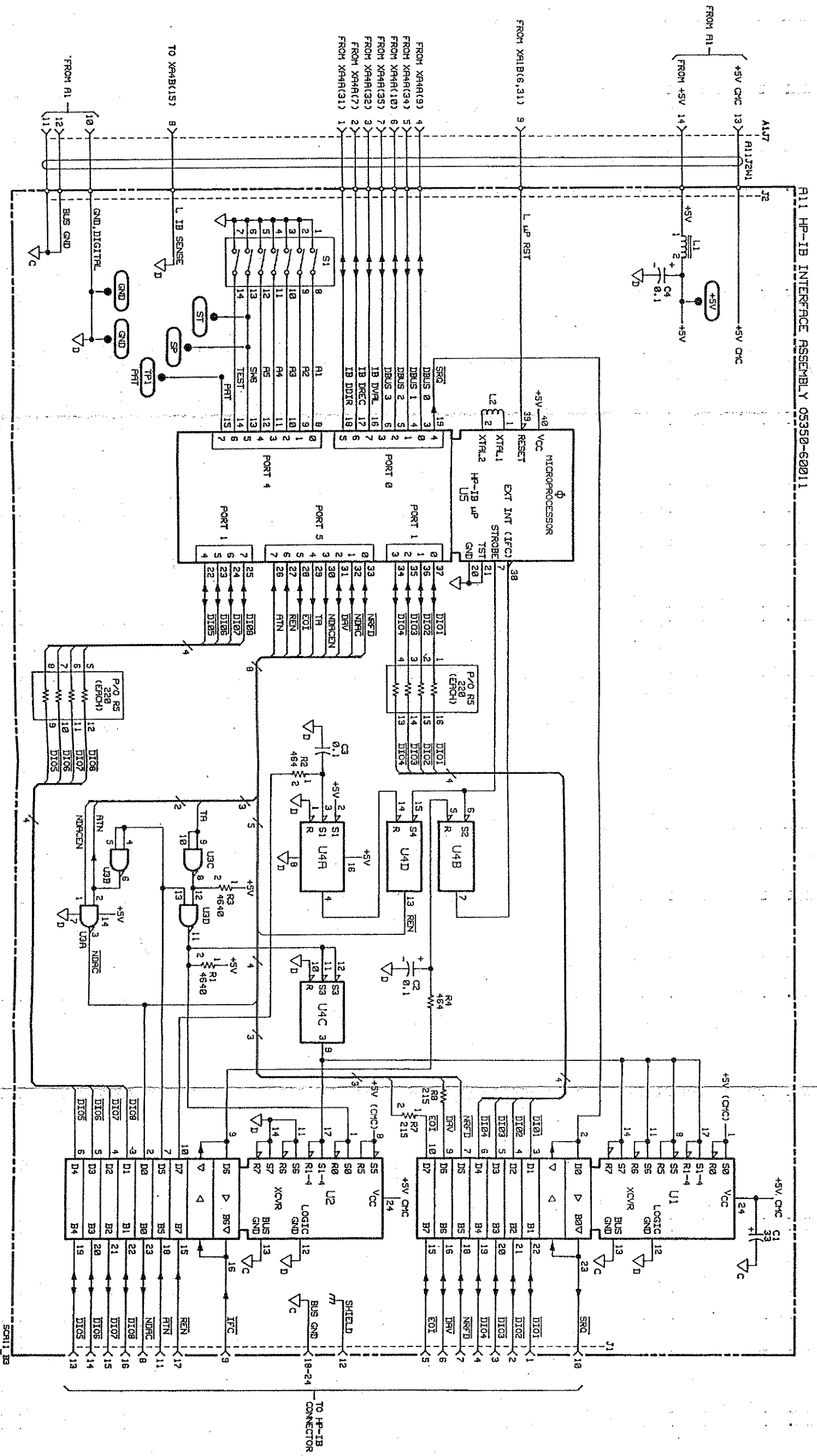
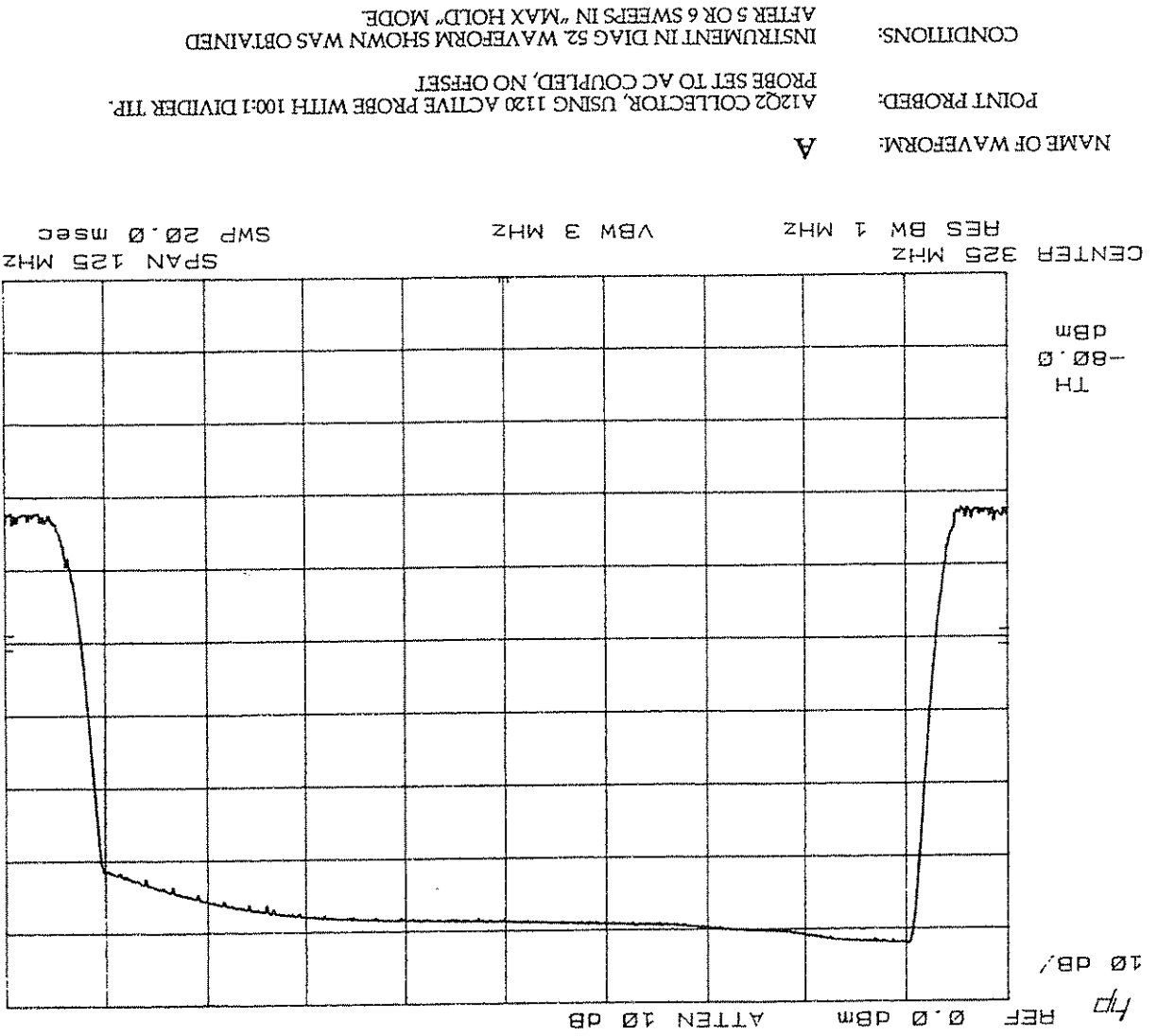


Figure 8-48. A11 HP-IB Interface Assembly Schematic Diagram

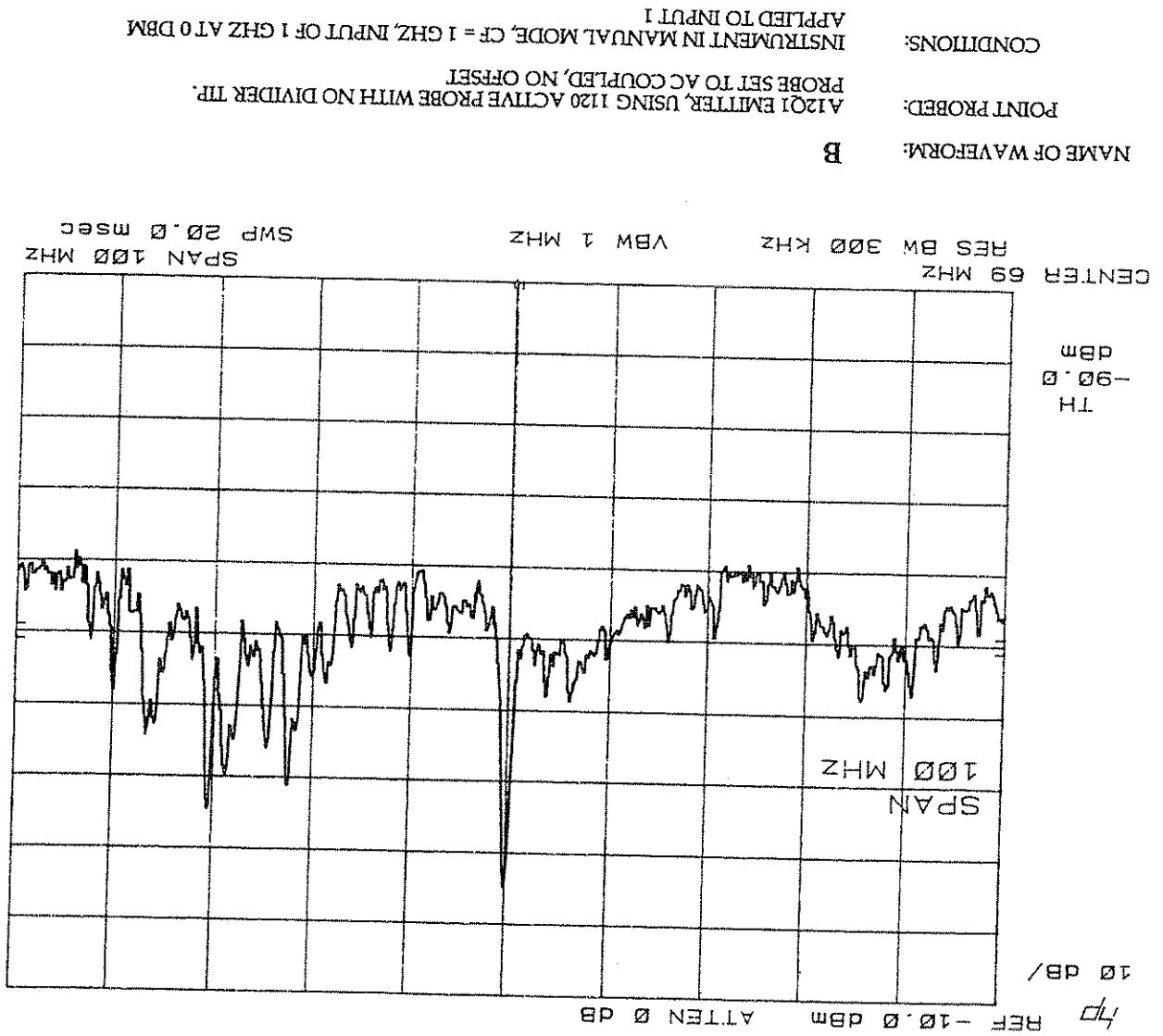




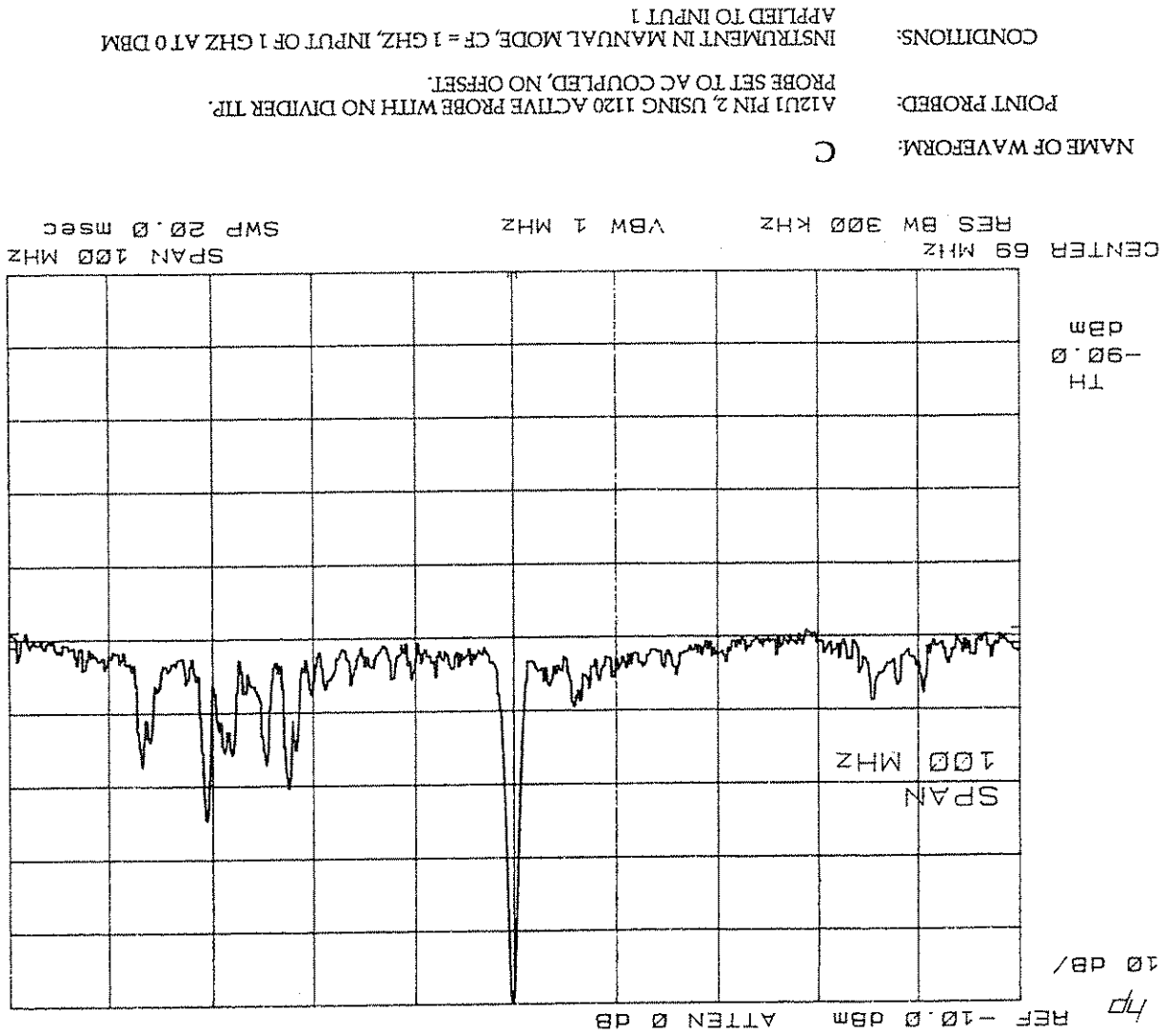
P/O Figure 8-49. A12 Waveforms



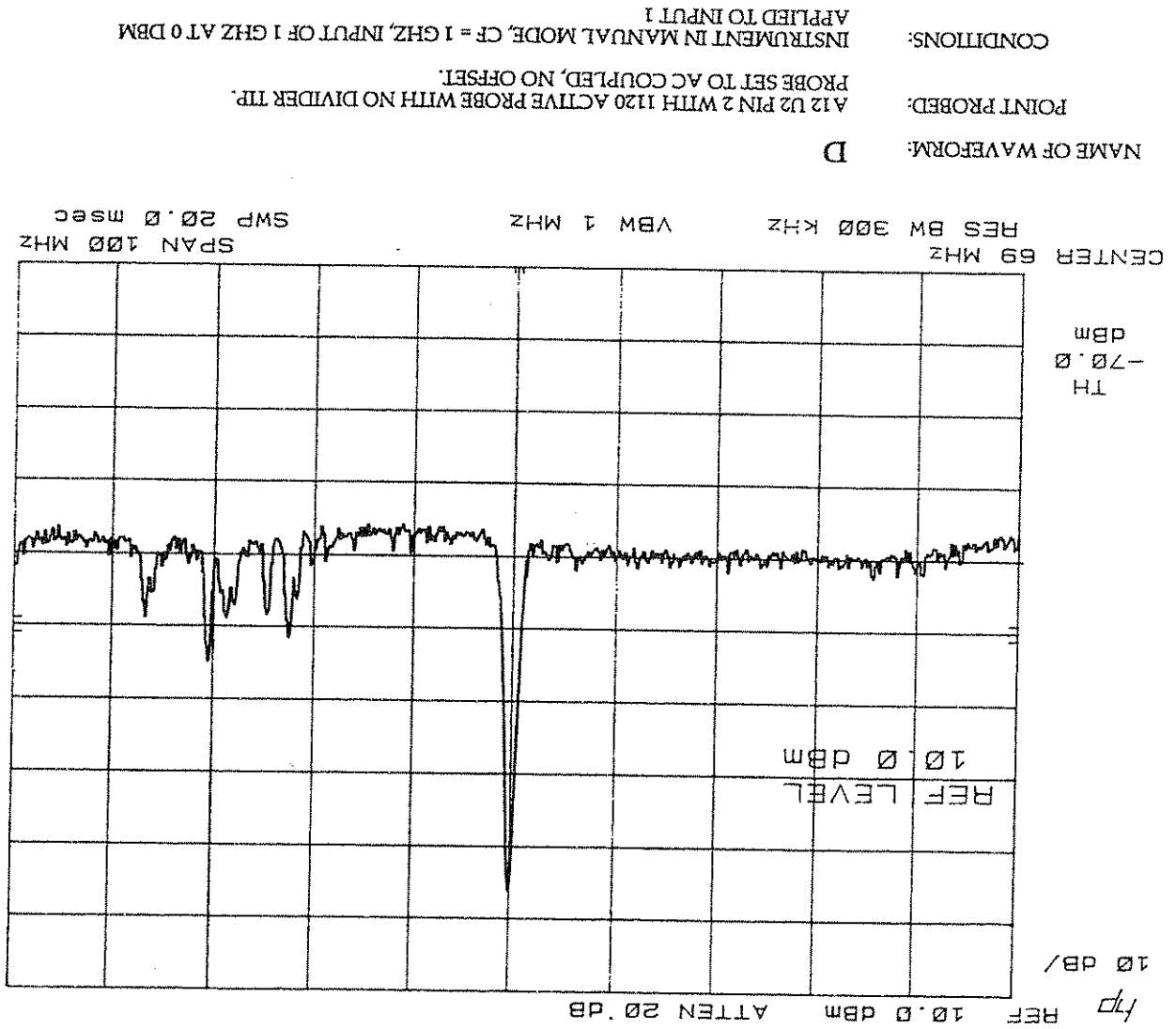
P/O Figure 8-49. A12 Waveforms



P/O Figure 8-49. A12 Waveforms



P/O Figure 8-49. A12 Waveforms







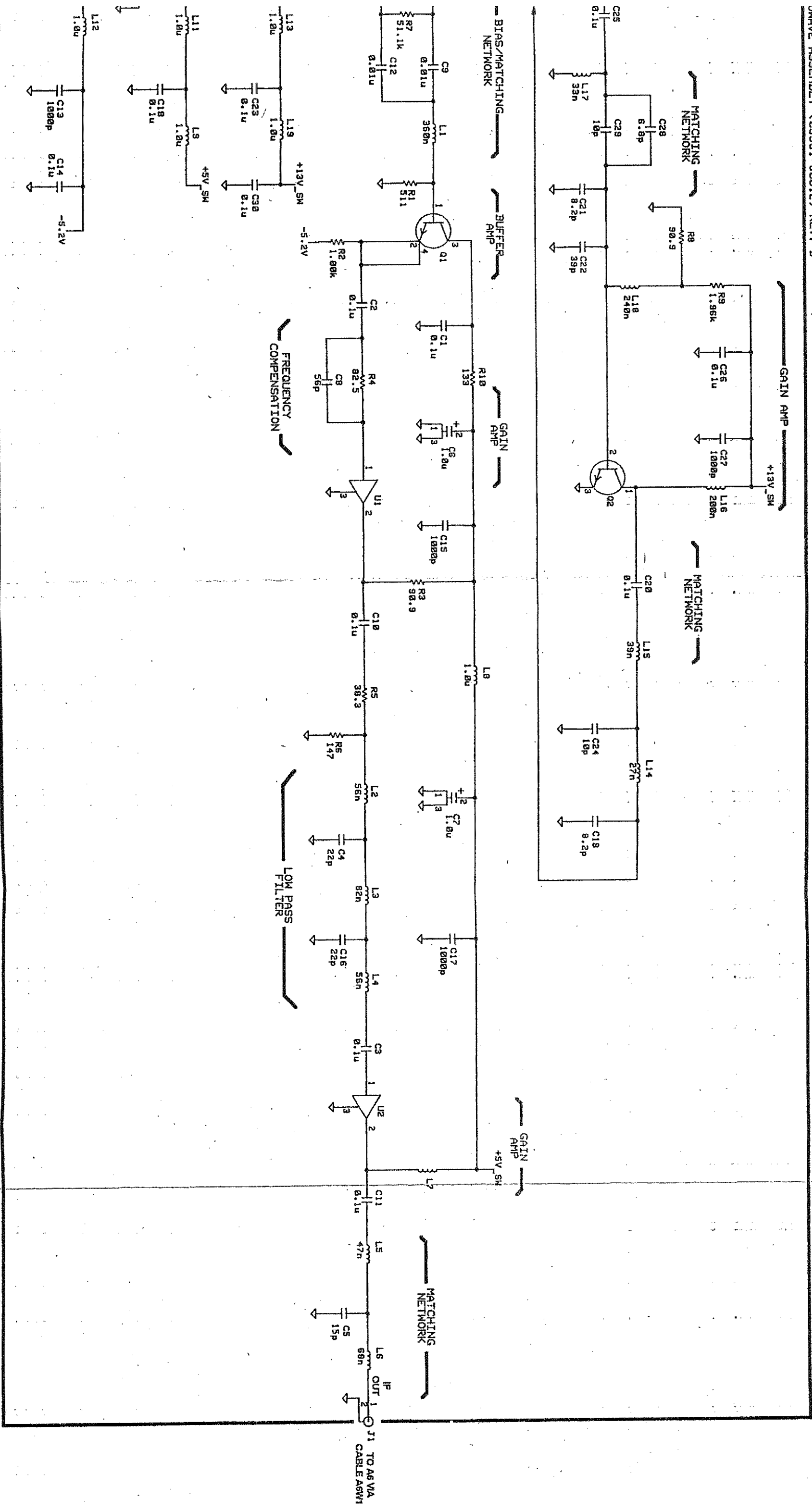
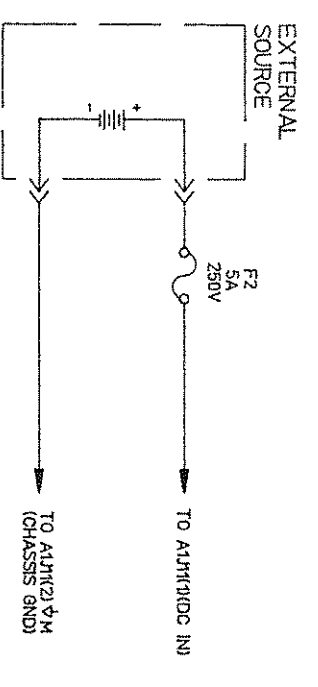


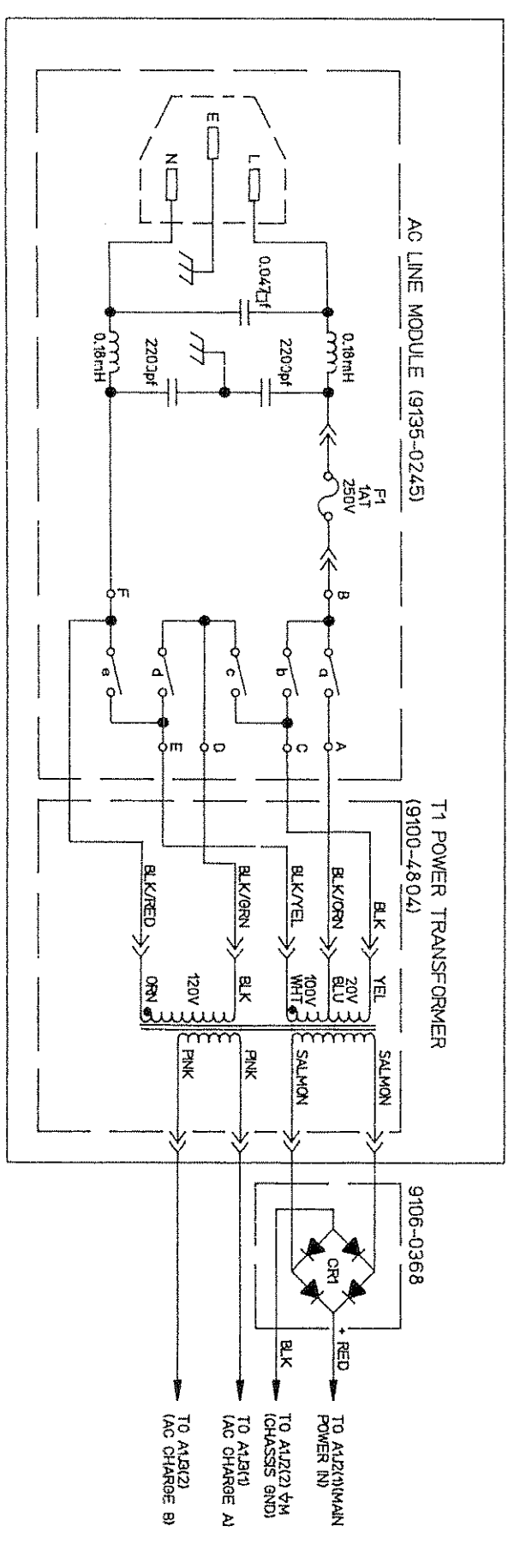
Figure 8-49. A12 Microwave Module Schematic Diagram







A13 POWER TRANSFORMER PRIMARY ASSEMBLY 05348-60207



VOL TAGE	CONTACTS	CONTACTS
	CLOSED	
100V	a,c,e	
120V	b,c,e	
220V	d,d	
240V	b,d	

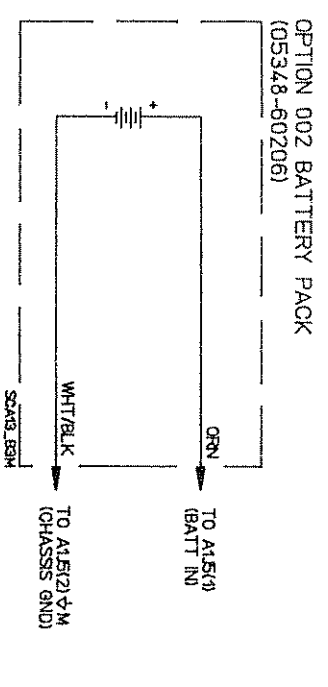


Figure 8-50. A13 Power Transformer Primary Assembly/  
External DC and Battery Input Supplies

*Figure 8-50*  
A13 POWER TRANSFORMER PRIMARY ASSEMBLY/  
EXTERNAL DC AND BATTERY INPUT SUPPLIES

(See Page 8-297)



# SPECIFICATIONS

## A-1. INTRODUCTION

The specifications for the HP 5347A/48A Microwave Counter/Power Meter are shown in Table A-1.

Table A-1. HP 5347A/48A Specifications

Counter Specifications			
SPECIFICATIONS describe the instrument's warranted performance over the 0° to 55°C temperature range. SUPPLEMENTAL CHARACTERISTICS are intended to provide information useful in applying the instrument by giving typical, but nonwarranted, performance standards.			
INPUT 1	HP 5347A	HP 5348A	OPTIONAL INCREASED DAMAGE LEVEL OPTION 006
Frequency Range:	500 MHz - 20.0 GHz	500 MHz - 26.5 GHz	
Sensitivity:	500 MHz - 12.4 GHz -32 dBm (-35 dBm typical) 12.4 GHz - 20.0 GHz -27 dBm (-32 dBm typical) 20.0 GHz - 26.5 GHz N/A	-32 dBm (-35 dBm typical) -27 dBm (-32 dBm typical) -20 dBm (-27 dBm typical)	5 dB 4 dB 3 dB Sensitivity is reduced by:
Impedance:	50 Ohms nominal	50 Ohms nominal	
Damage Level:	+25 dbm, peak	+25 dbm peak	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)
Connector:	N(f)	APC 3.5(m)	
SWR:	500 MHz - 10.0 GHz <2:1 typical 10 GHz - 20 GHz <3:1 typical 20 GHz - 26.5 GHz N/A	<2:1 typical <3:1 typical <3:1 typical	<2.5:1 typical <3.5:1 typical <3.5:1 typical
Coupling:		ac	
Accuracy:	± 1 LSD rms ± time base error × frequency		
Residual Stability:	When counter and source use common 10 MHz time base or counter uses external higher stability time base, 1 LSD rms typical for 1 Hz resolution at 25°C.		
Resolution:	1 Hz or 10 KHz, selectable		
Note: a) Accuracy specification applies from 0° to 50°C when using internal time base, 0° to 55°C with external time base.			

Table A-1. HP 5347A/48A Specifications (Continued)

Counter Specifications (Continued):

HP 5347A	HP 5348A
<b>INPUT 1</b> Gate Time: For 1 Hz resolution	
500 MHz - 5.7 GHz	200 ms
5.7 GHz - 11.3 GHz	400 ms
11.3 GHz - 16.9 GHz	600 ms
16.9 GHz - 22.5 GHz	800 ms
>22.5 GHz	1000ms

INPUT 2	
HP 5347A/5348A	
Frequency Range:	10 Hz - 525 MHz
Sensitivity:	25 mV ms (15 mV ms typical)
Impedance:	1 MΩ nominal shunted by <70 pF (10 Hz to 80 MHz)
Maximum Input:	+10 dBm (50Ω input), 1 V ms (1MΩ input)
Damage Level:	50Ω or 1 MΩ, dc - 5 kHz: 250V (dc + ac peak); >5 kHz: 5.5V ms (+28 dBm) + 1.25 × 10 <sup>6</sup> V ms/FREQ
Connector:	BNC (f)
Coupling:	ac
Accuracy:	± 1 LSD ± [(1.4 × Trigger Error/Gate Time) ± Time Base Error] × frequency
Resolution:	1 Hz or 10 kHz, selectable
Gate Time:	1/Resolution 1 ms minimum

NOTES:  
b) Trigger Error:

$$\sqrt{e_1^2 + e_n^2}$$

Input Slew Rate in V/s at Trigger point  
ms

Where  $e_1$  = Effective rms noise of counter's input channel. (100 μV typical)  
 $e_n$  = rms noise of the input signal for a 500 MHz bandwidth.

c) Manual Mode is only accessible via HP-IB.

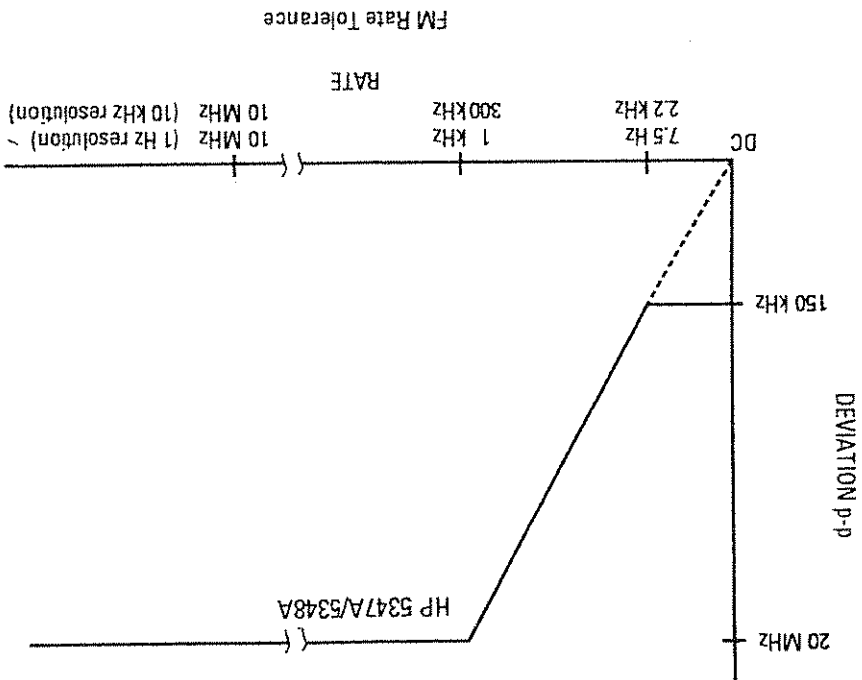
**Tracking Speed:**  
 Resolution = 1 Hz, Speed = 1 MHz/sec  
 Resolution + 10 kHz, Time = <60 ms

**Acquisition Time:**  
 Resolution = 1 Hz, Time <126 ms  
 Resolution = 10 kHz, Time = <60 ms

**AM Tolerance:**  
 Any modulation index provided the minimum signal level is not less than the sensitivity specification  
 Maximum FM Rate: 10 MHz

Table A-1. HP 5347A/48A Specifications (Continued)

Counter Specifications (Continued):



TCXO Time Base

Crystal Frequency: 10 MHz

Stability:

Aging Rate:  $< 1 \times 10^{-7}$  per month

Short Term:

Temperature:  $< 1 \times 10^{-8}$  for 1 s averaging time

Line Variation:  $< 1 \times 10^{-6}$ , 0 - 50° C, if referenced to +25° C and set to the offset

frequency:

Line Variation:  $< 1 \times 10^{-7}$  for 10 % change from nominal

nominal

External Time Base:

10 MHz, 0.7 V min. to 8 V max p-p  
 sine wave or square wave into  
 $> 1 \text{ K}\Omega$  shunted by  $< 30 \text{ pF}$ , via front  
 panel BNC connector.

**Power Meter Specifications**

**Frequency Range:** 10 MHz to 26.5 GHz, sensor dependent

**Power Range:** -70 to +20 dBm (100 pW to 100 mW), sensor dependent

**Power Sensors:** HP 8481A, HP 8481D<sup>4</sup>, HP 8484A, HP 8485A

**Dynamic Range:** 50 dB in 10 dB steps

**Display Units:** Watts, dBm

**Resolution:** 0.01 dB in logarithmic mode, 0.1% of full scale in linear mode

**Accuracy:** Instrumentation:<sup>a</sup> ±0.02 dB or ±0.5%  
Zero Set (digital settable to zero):<sup>b</sup> ±0.5% of full scale on most sensitive range. Decrease percentage by a factor of 10 for each higher range, ±1 display count.

Range	# of Avg	Accuracy
5	4	±0.02 dB or ±0.5%
4	4	±0.02 dB or ±0.5%
3	4	±0.02 dB or ±0.5%
2	8	±0.02 dB or ±0.5%
1	128	±0.02 dB or ±0.5%

**Auto Filter:** The meter automatically selects the required number of averages for the selected range.

**Power Meter Supplemental Characteristics**

Table 1  
Uncertainties in Power Measurements

Source of Error	Typical Value	Reduce To	Reduce Error by
Mismatch	1.8 %	<±0.1 %	Tuning at each frequency
Calibration Factor Uncertainty	1.5 % - 4.2%	N/A	
Power Reference Uncertainty	1.2 %	<0.7 %	Special calibration by standards lab
HP 11708A Calibration Pad (HP 8484A)	1.1 %	<0.5 %	"
Instrumentation Uncertainty*	0.5 %	N/A	N/A
Zero Set	0.2 %	N/A	N/A
Noise	0.2 %	<0.1 %	Average several readings
Power Reference Mismatch	0.2 %	<0.2 %	Tuning

\* Add sensor power linearity error (see sensor specification) on top range only.

**Notes:**

d) The HP 8481D sensor is a direct replacement for the HP 8484A.

e) When operating on power measurement Range 4 and 5, add the power linearity percentages found in the Power Sensor Matrix on page 6.

f) If using the HP 8484A Power Sensor ±2% of full scale.

Table A-1. HP 5347A/48A Specifications (Continued)

Meter Noise:	
(% of full scale, constant temperature, range 1, measured over one minute interval, two standard deviations).	
HP 8481A, HP 8485A Sensors	
Range	Noise (%)
1	0.3
2	0.09
3	0.02
4	0.002
5	0.0002
HP 8484A Sensor: multiply noise levels by 4	
Range 1 is the lowest power measurement, range 5 is the highest.	
Range	Setting Time
1	<7.0 s
2	<1.0 s
3-5	<250 ms
Zero Drift of sensors:	
(% of full scale, 1 hour, at constant temperature after 24-hour warm-up). Decrease noise by a factor of 10 for each higher range. HP 8481A, HP 8485A: <0.1% of full scale on range 1. HP 8484A: <2.0% of full scale on range 1.	
Setting Time:	
(0 to 99% settled readings over the bus). 10 dB decreasing power step.	

**Power Reference Specifications**

**Power Output:** 1.00 mW. Factory set to  $\pm 0.7\%$  traceable to U.S. National Institute of Standards.  
**Accuracy:**  $\pm 1.2\%$  worst case ( $\pm 0.9\%$  RSS) for one year.  
**Front Panel Connector:** N (f)

**Power Reference Supplemental Characteristics**

**Frequency:** 50 MHz nominal  
**SWR:** 1.05 maximum

Table A-1. HP 5347A/48A Specifications (Continued)

Sensor Specifications

Model	HP 8487A	HP 8484A	HP 8485A
Power Range	100 pW to 100 mW -30 dBm to +20 dBm	100 pW to 10 μW -70 dBm to -20 dBm	1 μW to 100 mW -30 dBm to +20 dBm
Frequency Range	10 MHz - 18 GHz	10 MHz - 18 GHz	50 MHz - 26.5 GHz
Maximum SWR	10 MHz - 30 MHz : 1.40 30 MHz - 50 MHz : 1.18 50 MHz - 2 GHz : 1.10	10 MHz - 30 MHz : 1.40 30 MHz - 4 GHz : 1.15 4 GHz - 10 GHz : 1.20	50 MHz - 100 MHz : 1.15 100 MHz - 2 GHz : 1.10 2 GHz - 12.4 GHz : 1.15 12.4 GHz - 18 GHz : 1.20 18 GHz - 26.5 GHz : 1.25
Power Linearity <sup>h)</sup>	+10 to +20 dBm +2, -4%	-30 dBm to -20 dBm ±1%	+10 to +20 dBm +2, -4%
Maximum Power	300 mW avg, 15W peak	200 mW average	300 mW avg, 15W peak 30W μs per pulse
Connector	N (m)	N (m)	APC 3.5 (m)

The HP 8481D Power sensor is a direct replacement for the 8484A.

General

Diagnostics

Rear panel or HP-IB selectable, service diagnostics and user information.

Data Output:

90 meas/sec, counter - varies with frequency (10 kHz resolution, "DUMP MODE") 18 meas/sec, power meter.

Overload Indication:

"OVERLOAD" A user message; External pad or signal attenuation should be used to avoid damage.

Sleep Mode:

Counter input 1 conducted emissions are reduced to <-70 dBm (typical) when sleep mode, input 2, or power meter is selected.

HP-IB:

Functions and diagnostics are program-mable; Default switches on rear panel; IEEE 488 compatible command structure; Function subset SH1, AH1, T5, L4, SR1, RL1, DC1, DT1, E1.

Operating Temperature: 0° to 55°C

Weight: 9.1 kg, 20 lbs (10.4 kg, 23 lbs with battery)

Dimensions:

144 mm H x 325 mm W x 456 mm D  
5.66" H x 12.8" W x 18.0" D

Accessories Supplied:

Power cord, Operating/Programming manual, power sensor cable (HP 11730A)

Battery (Option 002):

1 to 2 hours operation (typical)  
12 hours to charge (typical)

External DC:

12 to 26 VDC, 40W, Binding Post

Line Select:

100V (90 - 105 VAC rms; 47.5 - 440 Hz)  
115V/120V (104 - 126 VAC rms; 47.5 - 440 Hz)  
220V (198 - 231 VAC rms; 47.5 - 66 Hz)  
230/240V (207 - 252 VAC rms; 47.5 - 66 Hz)

Power Requirements: 50 VA maximum

Notes:

- (g) Includes Hp 11708A 30 dBm attenuator for calibrating against a 0 dBm, 50 MHz power reference. HP 11708A is factory set to 30 dB ± 0.5 dB at 50 MHz, traceable to NIS. SWR < 1.05 at 50 MHz.
- (h) Negligible deviation except for those power ranges noted.





# RECOMMENDED TEST EQUIPMENT

## A-1. INTRODUCTION

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

*Table B-1. Recommended Test Equipment*

RECOMMENDED MODEL	USE*	REQUIRED CHARACTERISTICS
HP 1725A HP 54111D	T, A	Oscilloscope 275 MHz bandwidth, delayed sweep or 250 MHz Digital Oscilloscope
HP 10017A or HP 10432A	T, A	Oscilloscope Probe High impedance (10:1), minimal capacitance (8-10 pF), compensate 10-16 pF scope input
HP 10431A	T, A	Oscilloscope Probe for HP 54111D High impedance (10:1), compensate 6-9 pF
HP 1120A	T	Active Probe >350 MHz, 100:1 divide
HP 10014A	T	High Impedance Oscilloscope Probe 10 megohm or greater
HP 1744A HP 54111D	T	Storage Oscilloscope 100 MHz bandwidth, storage or 250 MHz Digital Oscilloscope
HP 8350A HP 83595A	OV, P	Sweep Oscillator .01-26.5 GHz with FM modulation capability, 14 MHz p-p at 1 KHz modulating frequency

\*T = Troubleshooting  
A = Adjustment

OV = Operational Verification  
P = Performance Tests

Table B-1. Recommended Test Equipment (Continued)

RECOMMENDED MODEL	USE*	REQUIRED CHARACTERISTICS	INSTRUMENT
HP 8660C/ HP 86603A/ HP 86632B or HP 8663A or HP 8642A	T, A	10 MHz - 2.6 GHz 5% AM, 200 KHz FM p-p, -40 dbm to + 10 dbm	Synthesized Signal Generator
HP 8780A	P	1 GHz with FM modulation capability of 20 MHz p-p at 1 KHz modulating frequency	Vector Signal Generator
HP 8673B or HP 8340B	P	2 GHz to 26.5 GHz	Synthesizer
HP 3325A	OV, P	10 Hz to 10 MHz, -20 dbm to +5 dbm	Synthesizer
HP 8565A or HP 8566B or HP 8568B or HP 8590A	T, P, A	RF inputs from 1 MHz to 500 MHz	Spectrum Analyzer
HP 3466A or HP 3456A or HP 3458A	T, A	4 1/2-digit AC/DC	Digital Voltmeter (Multimeter)
Allied Electronics 927-6010 (120V) 927-6120 (240V)	T	120V/240V	Variable Transformer
HP 436A or HP 437B or HP 8902A	A, OV, P	50 MHz to 26.5 GHz	Power Meter
HP 8485A	A, OV, P	50 MHz to 26.5 GHz	Power Sensor
HP 5384A	A	9-digit resolution	Frequency Counter
HP 6216A	T	20V @ 480 ma	Power Supply
HP 3406A or HP 3458A	T	~3% accuracy @ 10 MHz	Sampling Voltmeter
HP 11667B	OV, P	DC to 26.5 GHz	Power Splitter
HP 909D	P	DC to 26.5 GHz	50Ω Termination
HP 10100C	OV, P	BNC male to BNC female	50Ω Feedthrough Termination
HP 8495D	OV, P	DC to 26.5 GHz 0 to 70 dB in 10 dB steps	Step Attenuator

\*T = Troubleshooting  
A = Adjustment  
OV = Operational Verification  
P = Performance Tests

\*\*HP 478A-H75 calibrated at NBS.  
 HP 478-H76 calibrated at Hewlett-Packard to ~0.58% at 50 MHz (traceable to NBS).

\*T = Troubleshooting  
 A = Adjustment  
 OV = Operational Verification  
 P = Performance Tests

RECOMMENDED MODEL	USE*	REQUIRED CHARACTERISTICS	INSTRUMENT
HP 8491A	A	20 dB attenuation	Fixed Attenuator
HP 6024A HP 6291A	A, T	12-30 V, 1.5-3 amps	Power Supply
HP 11683A	P, A, T	Calibration uncertainty ~0.25%	Range Calibrator
HP 432A	P, A, T	Range: 1 mw Transfer accuracy: 0.2% (input to output)	Power Meter
HP 478A-H75 HP 478A-H76	P, A	SWR: 1.05 at 50 MHz Accuracy: ~0.5% at 50 MHz**	Thermistor Mount
05348-67001	P, A, T	Contents of kit are listed in Table 8-2.	Service Accessories Kit

Table B-1. Recommended Test Equipment (Continued)



For more information, call your local HP sales office listed in your telephone directory or an HP regional office listed below for the location of your nearest sales office.

**United States of America:**

I (800)452-4844

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(301) 258 2000

Rolling Meadows, IL

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Fullerton, CA

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Atlanta, GA

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**Brazil:**

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**Australia/New Zealand:**

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**Asia Pacific:**

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**Korea:**

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**Israel:**

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**Netherlands:**

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**Norway:**

(22) 73 56 00

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International Sales Europe

Geneva, Switzerland

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Fax: +41-22-780-4770

(0344) 366 666

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**Turkey:**

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**Switzerland:**

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**Sweden:**

900 123 123

**Spain:**

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**South Africa:**

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