

**WARNING**

**OPERATING PERSONNEL MUST NOT REMOVE INSTRUMENT COVERS. COMPONENT REPLACEMENT AND INTERNAL ADJUSTMENTS MUST BE MADE BY QUALIFIED MAINTENANCE PERSONNEL WHO HAVE RECEIVED SERVICE TRAINING FOR THE HP 4278A.**

**HOW TO USE THIS MANUAL**

This Maintenance Manual is for the HP 4278A 1kHz/1MHz Capacitance Meter. Both the Operation and the Maintenance Manuals are needed to service the HP 4278A at the assembly replacement repair level. Refer to the Operation Manual for information on operating the 4278A. This manual includes information for adjusting, and repairing the 4278A at the assembly level. The contents of this manual are described below.

**Section 1 ADJUSTMENTS**

Section 1 provides the information necessary to adjust the 4278A to meet the specifications given in Section 5 of the Operation Manual.

**Section 2 OPTION INSTALLATION/MODIFICATION**

Section 2 contains necessary information for modifying the 4278A's options.

**Section 3 REPLACABLE ASSEMBLY LIST**

Section 3 provides a list of the assemblies that can be replaced at the assembly repair level.

**Section 4 ASSEMBLY LEVEL TROUBLESHOOTING**

Section 4 provides the information necessary for assembly level repair of the 4278A.

**Appendix A MANUAL CHANGES**

Appendix A includes information for modifying this manual for instruments manufactured after the printing date of this manual.



**Agilent 4278A 1 kHz/1 MHz CAPACITANCE METER**  
**Maintenance Manual**

**SERIAL NUMBERS**

This manual applies directly to instruments with serial number prefix 2713J and with firmware version 2.00. For additional important information about serial numbers, read "INSTRUMENT COVERED BY THIS MANUAL" in Section 5 of the Operation Manual.



**Agilent Technologies**

**Agilent Part No. 04278-90100**  
**Printed in JAPAN July 2000**

## Notice

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### Hewlett-Packard to Agilent Technologies Transition

This manual may contain references to HP or Hewlett-Packard. Please note that Hewlett-Packard's former test and measurement, semiconductor products and chemical analysis businesses are now part of Agilent Technologies. To reduce potential confusion, the only change to product numbers and names has been in the company name prefix: where a product name/number was HP XXXX the current name/number is now Agilent XXXX. For example, model number HP8648 is now model number Agilent 8648.

### Contacting Agilent Sales and Service Offices

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## Manual Printing History

The manual printing date and part number indicate its current edition. The printing date changes when a new edition is printed. (Minor corrections and updates that are incorporated at reprint do not cause the date to change.) The manual part number changes when extensive technical changes are incorporated.

February 1987 ..... First Edition (part number: 04278-90100)  
July 2000..... Second Edition (part number: 04278-90100)

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## Safety Summary

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific **WARNINGS** elsewhere in this manual may impair the protection provided by the equipment. In addition it violates safety standards of design, manufacture, and intended use of the instrument.

*The Agilent Technologies assumes no liability for the customer's failure to comply with these requirements.*

### Ground The Instrument

To avoid electric shock hazard, the instrument chassis and cabinet must be connected to a safety earth ground by the supplied power cable with earth blade.

### DO NOT Operate In An Explosive Atmosphere

Do not operate the instrument in the presence of flammable gasses or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

### Keep Away From Live Circuits

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with the power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

### DO NOT Service Or Adjust Alone

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

### DO NOT Substitute Parts Or Modify Instrument

Because of the danger of introducing additional hazards, do not install substitute parts or perform unauthorized modifications to the instrument. Return the instrument to a Agilent Technologies Sales and Service Office for service and repair to ensure that safety features are maintained.

### Dangerous Procedure Warnings

**Warnings**, such as the example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed.

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#### Warning



**Dangerous voltages, capable of causing death, are present in this instrument. Use extreme caution when handling, testing, and adjusting this instrument.**

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## SAFETY SYMBOLS

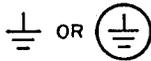
General Definitions of Safety Symbols Used On Equipment or In Manuals.



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



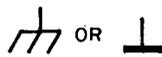
Indicates dangerous voltage (terminals fed from the interior by voltage exceeding 1000 volts must be so marked).



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



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



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



Alternating current (power line).



Direct current (power line).



Alternating or direct current (power line).

**WARNING**

A **WARNING** denotes a hazard. It calls attention to a procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in injury or death to personnel.

**CAUTION**

The **CAUTION** sign denotes a hazard. It calls attention to an operating procedure, practice, condition 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.

**Note**

A **Note** denotes important information. It calls attention to a procedure, practice, condition or the like, which is essential to highlight.

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# SECTION 1

## ADJUSTMENTS

### 1-1. INTRODUCTION

This section describes the adjustments required to ensure that the HP 4278A is within its published specifications after it has been repaired. These adjustments should be performed along with periodic maintenance to keep the HP 4278A in optimum operating condition. The recommended calibration cycle is six months. If proper performance cannot be achieved after calibration refer to the troubleshooting procedures in Section 4.

#### NOTE

To ensure proper results and correct instrument operation, Hewlett-Packard suggests a 30-minute warm-up and stabilization period before performing any of the following adjustments.

### 1-2. SAFETY CONSIDERATIONS

This manual contains **NOTES**, **CAUTIONS**, and **WARNINGS** which must be followed to ensure the safety of the operator and to keep the instrument in a safe and serviceable condition. The adjustments covered in this section must be performed by qualified service personnel.

#### **WARNING**

**ANY INTERRUPTION OF THE PROTECTIVE GROUND CONDUCTOR (INSIDE OR OUTSIDE THE INSTRUMENT) OR DISCONNECTION OF THE PROTECTIVE GROUND TERMINAL CAN MAKE THE INSTRUMENT DANGEROUS. INTENTIONAL INTERRUPTION OF THE PROTECTIVE GROUND SYSTEM FOR ANY REASON IS PROHIBITED.**

The removal or opening of covers for adjustment or removal of parts other than those which are accessible by hand will expose circuits containing dangerous voltages.

Remember that even though you may have shut the instrument off and unplugged it, the capacitors in the 4278A can remain charged for a few minutes.

**WARNING**

**THE ADJUSTMENTS DESCRIBED IN THIS SECTION ARE PERFORMED WITH POWER APPLIED AND THE PROTECTIVE COVERS REMOVED. DANGEROUS VOLTAGE LEVELS EXIST AT MANY POINTS AND CAN RESULT IN SERIOUS PERSONAL INJURY OR DEATH IF YOU COME INTO CONTACT WITH THEM.**

**1-3. TEST EQUIPMENT**

Table 1-1 lists the test equipment required to perform the adjustments described in this section. Use only calibrated test equipment when adjusting the 4278A. If the recommended test equipment is not available, equipment whose specifications are equal to or surpass those of the recommended test equipment may be used.

**1-4. ADJUSTABLE COMPONENTS**

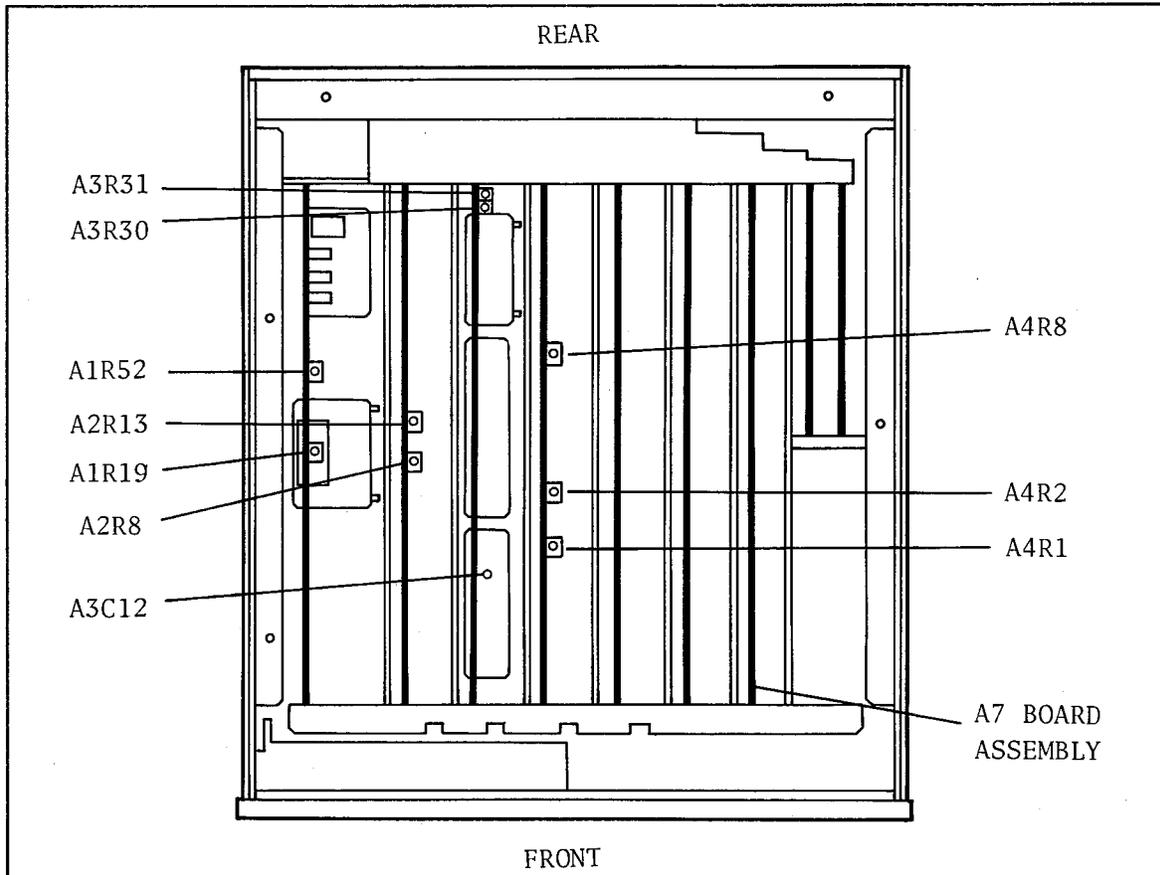
Table 1-2 lists the 4278A's adjustable components, lists the name of the adjustment related to each component, and gives a brief description of each adjustment.

**1-5. ADJUSTMENT INTERACTION**

Some of the 4278A adjustments are interactive. If you repair or replace an HP 4278A assembly, be sure to perform the related adjustment(s) in the sequence given. Table 1-3 lists the adjustments required for each assembly repaired or replaced. Ignoring or changing the adjustment sequence will make it impossible to obtain optimum performance.

## 1-6. ADJUSTMENT LOCATIONS

Figure 1-1 will help you to locate the adjustment points. Each adjustment procedure contains a figure to help you locate the test points, and to identify the required connectors and other related equipment.



## 1-7. INITIAL OPERATING PROCEDURE

Before you start, perform the BASIC OPERATING CHECK and the DISASSEMBLY procedures given in the following paragraphs to prepare the 4278A for adjustment. The 4278A must be initialized (set to its initial control settings), before each adjustment as described in Section 3 of the Operation Manual. Exceptions to these settings will be noted as they occur. After you complete an adjustment reinitialize the 4278A.

### NOTE

The 4278A is initialized, when it is turned on and when it receives an HP-IB RST command.

**OPERATIONAL VERIFICATION**

Check that the line voltage selector switch on the rear panel of the 4278A is properly set. Turn the 4278A on and let it warm-up for at least 30 minutes. After the warm up period, initialize the instrument. If the 4278A fails its self test or if you can't initialize it, refer to the troubleshooting procedures in Section 4.

**DISASSEMBLY, TOP COVER REMOVAL**

To gain access to the adjustment points, perform the following procedure.

1. Remove the two plastic instrument-feet located at the upper corners of the rear panel.
2. Fully loosen the top cover retaining screw located at the back of the top cover.
3. Slide the top cover towards the rear and lift it off.
4. Loosen the five screws that secure the right hand side top shield plate. You don't have to remove the screws.

**WARNING**

**DO NOT REMOVE THE LEFT HAND SIDE TOP SHIELD PLATE ON WHICH WARNING MESSAGE IS PRINTED.**

5. Slide the top shield plate towards the front and lift it off.

**WARNING**

**TO PROTECT AGAINST POSSIBLE ELECTRICAL SHOCK, USE INSULATED TOOLS TO MAKE ALL ADJUSTMENTS.**

Table 1-1. Recommended Test Equipment

Equipment	Critical Specification	Qty.	Recommended Model	Use
Oscilloscope	Band Width: > 10MHz Range: 10mV/div min Voltage Accuracy: < 3%	1	HP 1740A	A, T
Divider Probe	10:1, 1M $\Omega$	1	HP 10040A	A, T
RMS Voltmeter	Frequency: 1kHz to 1MHz Accuracy: < 1%	1	HP 3400A	A
Test Cable	BNC(m) to BNC(m) (30cm)	1	PN 8120-1838	A
Digital Voltmeter	Range: DC 0.1, 1.0 and 30V Sensitivity: 0.1mV min.	1	HP 3478A	A, T
Test Lead	Dual Banana Plug to Alligator Clip	1	HP 11002A	A
Standard Capacitor	Nominal C: 1pF, 10pF, 100pF, 1nF, 10nF, 100nF, 1 $\mu$ F Calibrated at 1kHz and 1MHz Four Terminal Pair		HP 16380A HP 16380C	A A
Standard Resistor	Nominal R: 10 $\Omega$ Calibrated at 1kHz supplied with 0 $\Omega$ reference Four Terminal Pair		P/O HP 16074A	A
OPEN/SHORT Reference	Four Terminal Pair		P/O HP 16074A	A
Test Leads	Length: 1m and 2m Four Terminal Pair	1 1	HP 16048A HP 16048D	A A
Extender Board	For Digital Board	1	PN 04278-66597	T
Tool	Coaxial Cable Extractor	1	PN 8710-1754	T

A: Adjustments

T: Troubleshooting

Table 1-2. Adjustable Components

Adjustable Component	Adjustment Name	Description
A1R19	FREQ-ADJ	Switching Power Supply Frequency Adjustment
A1R52	V-ADJ	Power Supply Output Voltage Adjustment
A2R8	OSC LVL 1M	1MHz Test Signal Voltage Adjustment
A2R13	OSC LVL 1k	1kHz Test Signal Voltage Adjustment
A3R30 A3R31	ORG OFS ADJ	1MHz Transducer Second Null Amplifier Offset Voltage Adjustment
A3C12	RES FREQ ADJ	1MHz Transducer First Null Amplifier Resonance Frequency Adjustment
A4R1	I/V OFFSET ADJ	1kHz Transducer I-V Converter DC Offset Voltage Adjustment
A4R2	ICH OFFSET ADJ	1kHz Transducer Current Channel DC Offset Voltage Adjustment
A4R8	VCH OFFSET ADJ	1kHz Transducer Voltage Channel DC Offset Voltage Adjustment

Table 1-3. Required Adjustments

<b>Assembly Replaced or Repaired</b>	<b>Adjustments Required (paragraph)</b>
A1 Power Supply	1-8, 1-11
A2 Signal Source	1-9, 1-10, 1-12
A3 1MHz Transducer	1-9, 1-10, 1-12
A4 1kHz Transducer	1-9, 1-11, 1-12
A5 Switching Matrix/Phase Detector	NONE
A6 A-D Converter	NONE
A7 Digital Control	1-12
A8 Input Switch	NONE
A9 Keyboard	NONE
A10 Memory Card Socket	NONE
A11 Motherboard	NONE
A13 DC-AC Converter	NONE
A20 #101 HP-IB	NONE
A30 #201 Handler Interface	NONE
A90 Keyboard/Display Control	NONE
A91 LCD Module	NONE

## 1-8. POWER SUPPLY ADJUSTMENTS

The following two part procedure adjusts the switching frequency and the output voltage of the switching power supply.

### 1-8-1. POWER SUPPLY SWITCHING FREQUENCY ADJUSTMENT

Adjusts the switching frequency of the power supply.

#### EQUIPMENT:

Oscilloscope  
10:1 Divider Probe, 1M $\Omega$

HP 1740A  
HP 10040A

#### PROCEDURE:

1. Make sure that the 4278A is turned off.
2. Loosen the two screws holding the left hand side top shield plate (the shield plate on which the **WARNING** message is printed), and remove it.

**WARNING**

**DANGEROUS VOLTAGES ARE PRESENT ON THE A1 BOARD. DON'T TOUCH ANYPLACE EXCEPT WHERE INSTRUCTED TO.**

3. Connect the 10040A to the **CHAN A INPUT** of the 1740A. Figure 1-2 shows the setup for this adjustment.

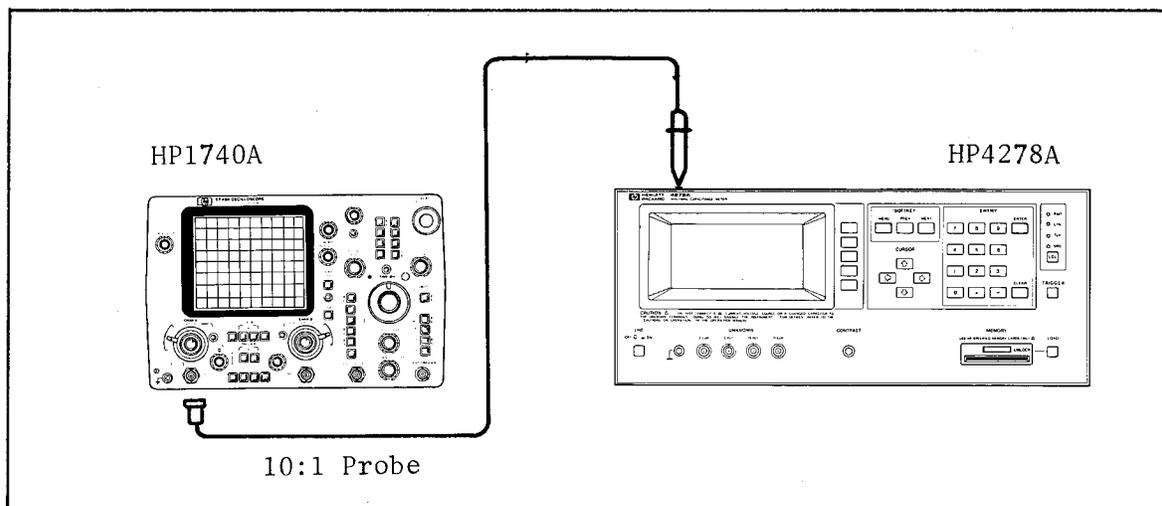


Figure 1-2. Power Supply Frequency Adjustment Setup

4. Set the 1740A's controls as follows:

INPUT A	DC, 1M $\Omega$
CHAN A Vertical	1V/DIV
TIME BASE	2 $\mu$ sec

5. Connect the probe's ground lead to A1TP12. Connect the probe tip to A1TP11. Figure 1-3 shows the access and the adjustment locations.

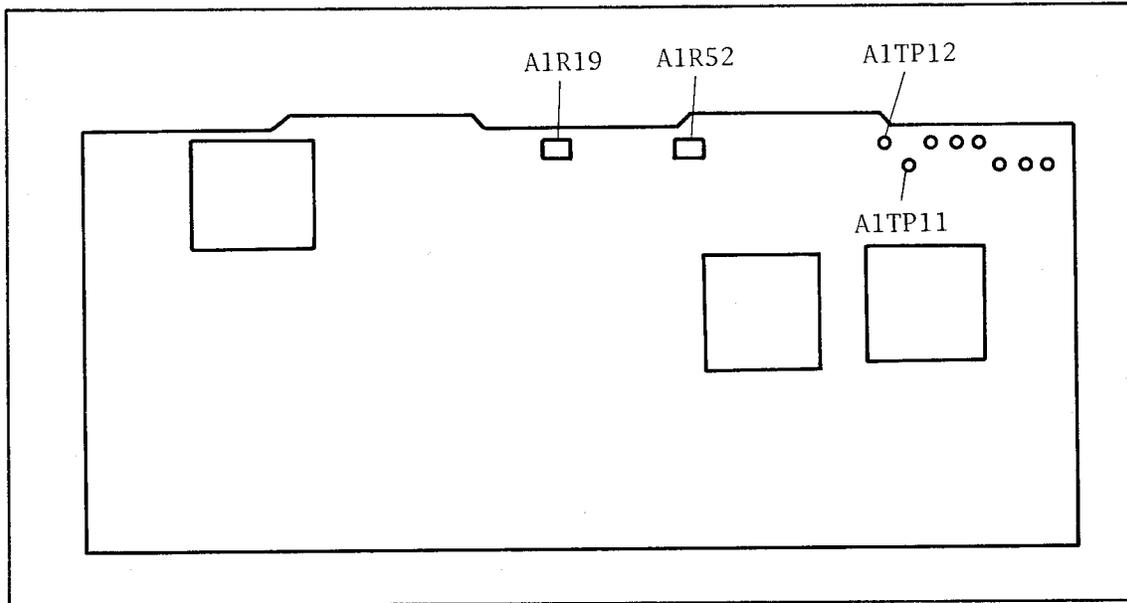


Figure 1-3. Switching Frequency Adjustment Locations

6. Turn on the 4278A.

7. Adjust A1R19 (**FREQ-ADJ**), until the period (T), of the waveform, is 12.5 $\mu$ s  $\pm$ 0.5 $\mu$ s, as shown in Figure 1-4.

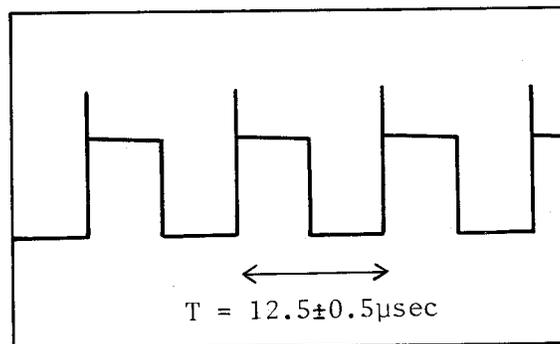


Figure 1-4. Switching Waveform

8. Disconnect the probe from the 4278A.

**1-8-2. POWER SUPPLY OUTPUT VOLTAGE ADJUSTMENT**

This adjustment sets the output voltages of the power supply.

**EQUIPMENT:**

Digital Voltmeter  
Dual Banana Plug to Alligator Clip Cable

HP 3478A  
HP 11002A

**PROCEDURE:**

1. Connect the 11002A to the 3478A's INPUT. Figure 1-5 shows the equipment setup.

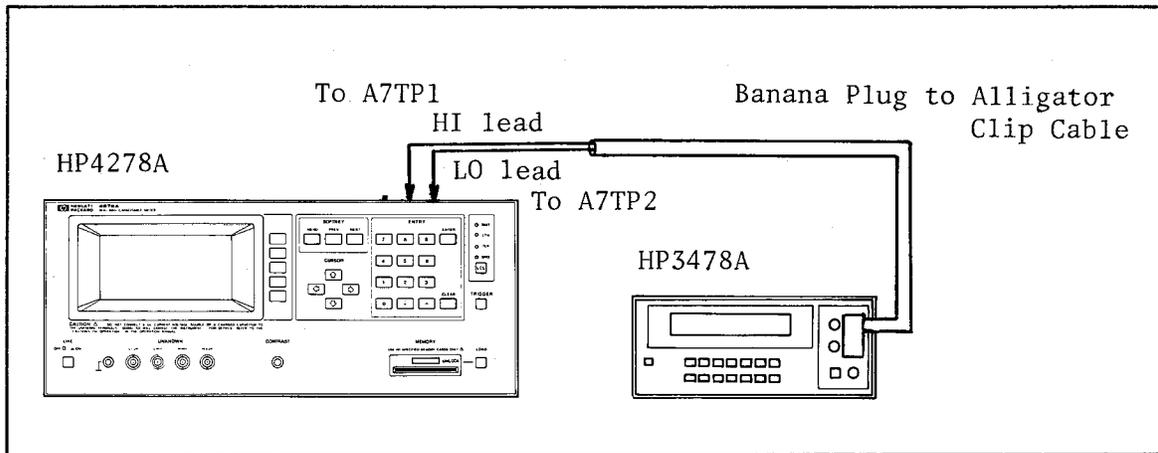


Figure 1-5. Power Supply Voltage Adjustment Setup

2. Set the 3478A's controls as follows:

FUNCTION  
RANGE

DCV  
AUTO

3. Connect the LO lead of the 3478A to A7TP2 and the HI lead to A7TP1. Figure 1-6 shows the location of test points.

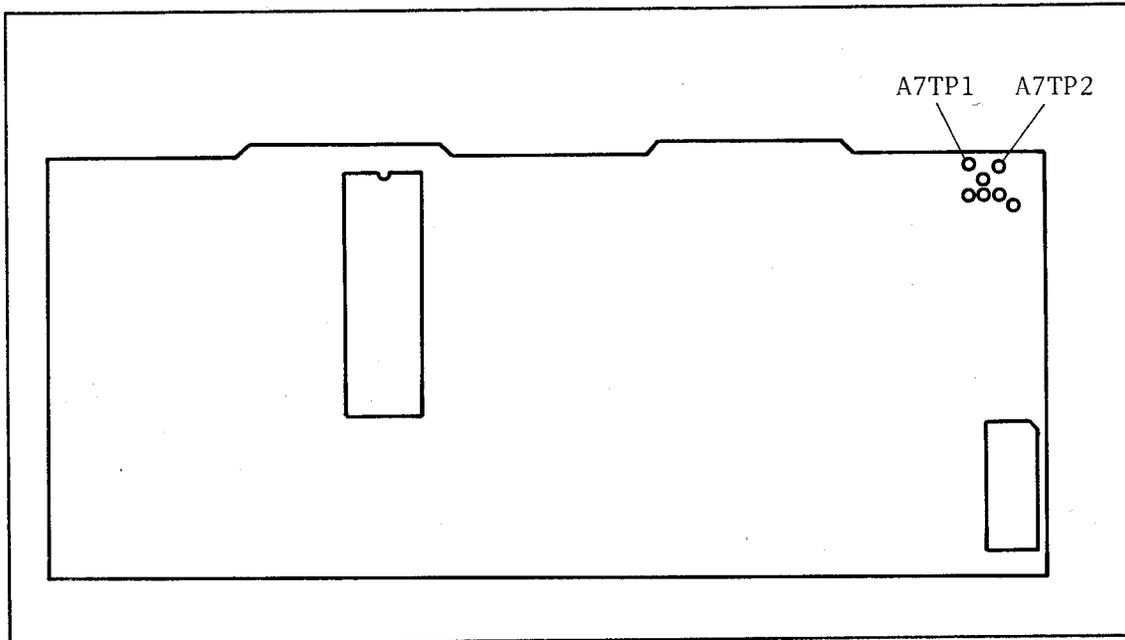


Figure 1-6. Voltage Adjustment Access Locations

4. Turn A1R52 (**V-ADJ**) fully **CCW**.
5. Adjust A1R52 until the voltage reading of the 3478A is  $5V \pm 0.05V$ .
6. Remove the test leads and turn off the 4278A.
7. Reinstall the left hand side top shield plate on the A1 board.

## 1-9. SIGNAL SOURCE ADJUSTMENTS

This is a two part adjustment. In the first part you will adjust the 1kHz test signal voltage, and in the second part you will adjust the 1MHz test signal voltage.

### EQUIPMENT:

RMS Voltmeter  
BNC(m)-to-BNC(m) Cable (30cm)

HP 3400A  
PN 8120-1838

### PROCEDURE:

1. Set the voltage range on the 3400A to 3V.
2. Connect INPUT of the 3400A and the **UNKNOWN** Hcur terminals of the 4278A using the BNC cable as shown in Figure 1-7.

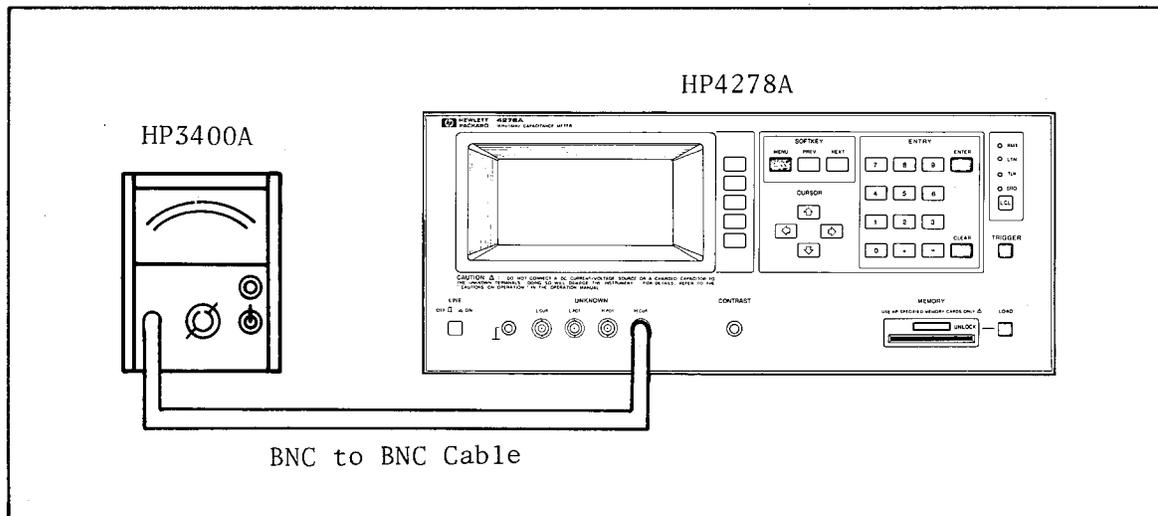


Figure 1-7. Signal Source Adjustments Setup

### NOTE

The length of the BNC cable used in this adjustment must be less than 50cm.

### NOTE

If your 4278A is equipped with Option 002 (1MHz measurement only), skip steps 3 and 4.

3. Set the 4278A's controls as follows:

FREQUENCY	1kHz
OSC LEVEL	1.0V

- Adjust A2R13 (**OSC LVL 1k**), until the voltage reading of the 3400A is 1.04Vrms  $\pm 0.01V$ . Refer to Figure 1-1 for location of A2R13.

**NOTE**

The optimum test signal voltage for making 1kHz measurements is 1.04V, which is higher than 1.00V, because the output voltage will decrease due to the load impedance.

**NOTE**

If your 4278A is equipped with Option 001 (1kHz measurement only), skip steps 5 and 6.

- Set the 4278A's controls as follows:

FREQUENCY	1MHz
OSC LEVEL	1.0V

- Set the voltage range of the 3400A to 3V and adjust A2R8 (**OSC LVL 1M**), for a coarse voltage reading of 0.7V, then change the voltage range 1V and adjust A2R8 for a voltage reading of 0.99Vrms  $\pm 0.01V$ .

**NOTE**

The optimum test signal voltage for making 1MHz measurements is 0.99V, which is less than 1.00V, because the output voltage will increase when the test leads are extended.

- Disconnect the 3400A from the 4278A.

## 1-10. 1MHz TRANSDUCER ADJUSTMENTS

This is a two step adjustment. The first step adjusts the offset voltage of the second null amplifier, and the second step adjusts the resonance frequency of the first null amplifier. These adjustments are not necessary if the 4278A has Option 001.

### 1-10-1. SECOND NULL AMPLIFIER OFFSET ADJUSTMENT

The following adjustment minimizes the offset voltage of the integrator in the second null amplifier circuit. This adjustment is performed using the 4278A's self test function.

#### EQUIPMENT:

OPEN Reference

P/O HP 16074A

#### PROCEDURE:

1. Connect the **OPEN** reference to the **UNKNOWN** terminals.
2. Press the **MENU** and **PREV** keys in sequence.
3. Press the '**SVC FNCTN**', '**SELF TEST**', and '**TEST NO**' softkeys in sequence.
4. Press the **4** and **ENTER** keys in sequence.
5. Press the '**TEST START**' softkey.
6. Adjust A3R30 and A3R31 (**ORG OFS ADJ**), alternately so that the displayed result on the LCD is less than 0.00003 and minimum.
7. Press the '**ABORT TEST**' and '**TEST MENU**' softkeys in sequence, to return to the test menu.
8. Disconnect the OPEN reference from the **UNKNOWN** terminals.

#### NOTE

Continue on to the next adjustment without resetting the 4278A.

### 1-10-2. FIRST NULL AMPLIFIER RESONANCE FREQUENCY ADJUSTMENT

Adjusts the resonance frequency of the first null amplifier. This adjustment is performed using the self test.

#### PROCEDURE:

1. Press the 'TEST NO' softkey.
2. Press 3 and ENTER in sequence.
3. Press the 'TEST START' softkey.
4. Adjust A3C12 (RES FREQ ADJ), for a maximum readout on the LCD.

#### NOTE

Confirm that the maximum value in step 4 is between 0.04 and 0.4. If the value is out of range, troubleshoot the A3 board.

### 1-11. 1kHz TRANSDUCER ADJUSTMENTS

This three part procedure is used to adjust the DC offset voltage of I-ch I-V Converter, and the DC offset voltages of the I-ch and V-ch outputs.

**EQUIPMENT:**

Digital Voltmeter	HP 3478A
Dual Banana Plug to Alligator Clip Cable	HP 11002A

#### 1-11-1. I-V CONVERTER OFFSET VOLTAGE ADJUSTMENT

This adjustment minimizes the DC offset voltage of the current to voltage Converter.

**PROCEDURE:**

1. Set the 3478A's controls as follows:

FUNCTION	DCV
RANGE	AUTO

2. Connect the **LO** lead of the 3478A to A4TP2 and the **HI** lead to A4TP1 as shown in Figure 1-8.

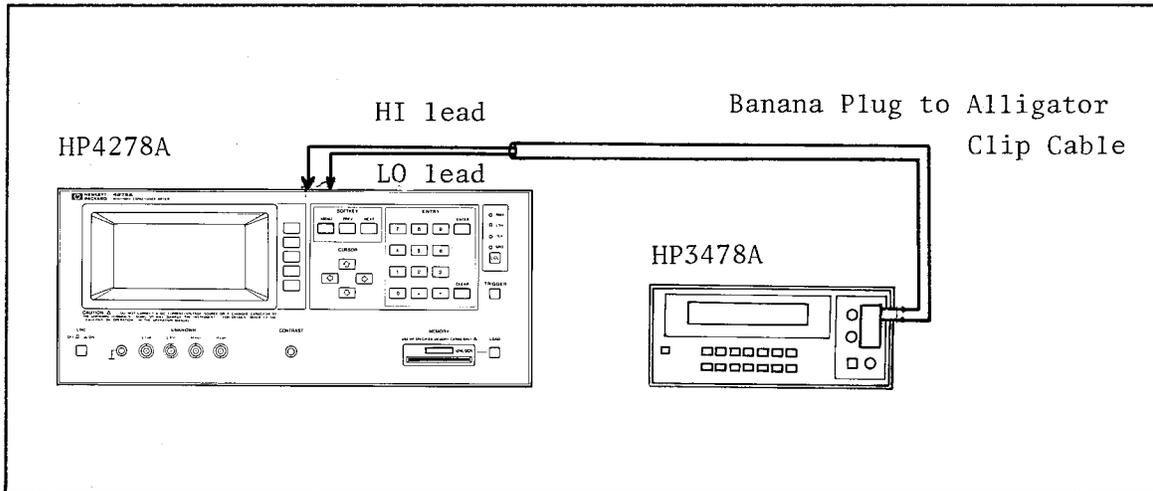


Figure 1-8. 1kHz Transducer Adjustment Setup

3. Set the 4278A's controls as follows.

FREQUENCY	1kHz
RANGE	100pF

4. Adjust A4R1 (**I/V OFFSET ADJ**), until the voltage displayed on the 3478A is  $0V \pm 3mV$ .

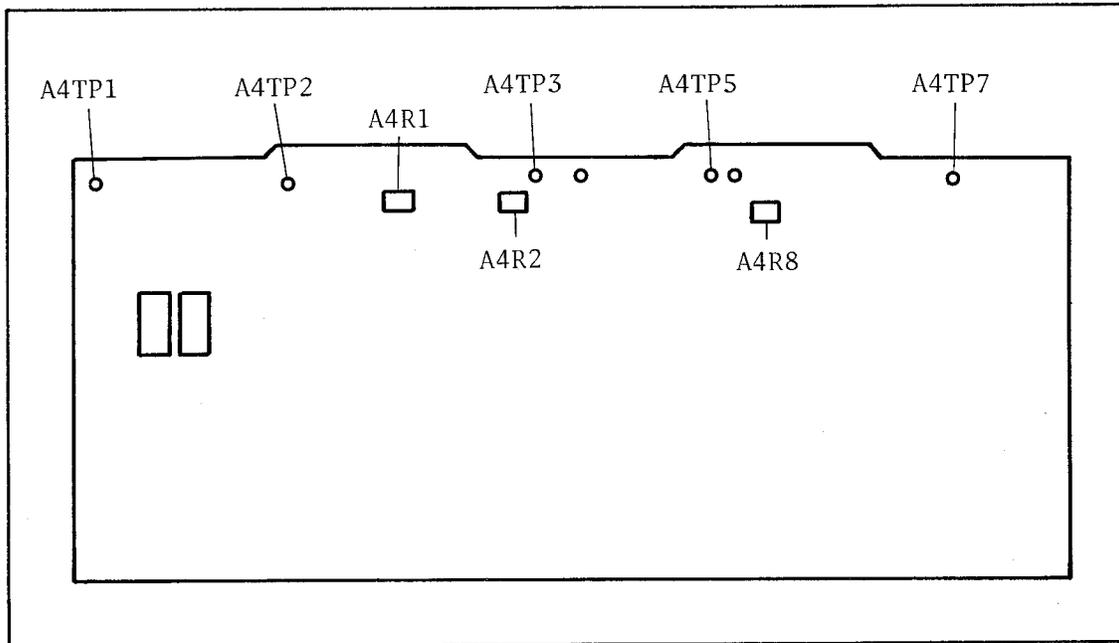


Figure 1-9. 1kHz Transducer Adjustment Locations

**NOTE**

Continue on to the next adjustment without resetting the 4278A and 3478A.

**1-11-2. CURRENT CHANNEL AMPLIFIER OFFSET VOLTAGE ADJUSTMENT**

This adjustment minimizes the DC offset voltage of the current channel output.

**PROCEDURE:**

1. Connect the **LO** lead of the 3478A to A4TP7 and the **HI** lead to A4TP3 as shown in Figure 1-8.
2. Adjust A4R2 (**ICH OFFSET ADJ**), until the voltage displayed on the 3478A is  $0V \pm 5mV$ .

**NOTE**

Continue on to the next adjustment without resetting the 4278A and 3478A.

### 1-11-3. VOLTAGE CHANNEL AMPLIFIER OFFSET VOLTAGE ADJUSTMENT

This adjustment minimizes the DC offset voltage of the voltage channel output.

#### PROCEDURE:

1. Connect the **LO** lead of the 3478A to A4TP7 and the **HI** lead to A4TP5 as Figure 1-8.
2. Adjust A4R8 (**VCH OFFSET ADJ**), until the voltage displayed on the 3478A is 0V  $\pm$ 5mV.

## 1-12. AUTO CALIBRATION

The analog calibration data is stored in the 4278A's EEPROM must be updated when any adjustments are made to the 4278A. The 4278A's calibration is performed by comparing a standards' calibration values to the raw measurement values.

Auto calibration consists of four parts. First, in paragraph 1-12-1 you will set the 4278A's EEPROM write enable and operate the keys on the front panel to open the CAL menu page. Second, in paragraph 1-12-2 you will enter your standards' calibration values into the table named STANDARD DATA TABLE in order to perform the calibration. Third, in paragraph 1-12-3 you will perform the calibration using your standards. Fourth, in paragraph 1-12-4 you will reset the 4278A's EEPROM write protect to save the calibration data memorized in EEPROM. The auto calibration procedures are performed in paragraph number sequence.

### NOTE

Perform Auto Calibration when any adjustments have been made to the 4278A or when an EEPROM is initialized.

If your 4278A does not have the 1MHz measurement function, skip paragraphs 1-12-2 (2) and 1-12-3 (2). If your 4278A does not have the 1kHz measurement function, skip paragraphs 1-12-2 (1) and 1-12-3 (1).

The equipment used during auto calibration is as follows.

### EQUIPMENT:

Standard Capacitor 1pF	P/O HP 16380A
Standard Capacitor 10pF	P/O HP 16380A
Standard Capacitor 100pF	P/O HP 16380A
Standard Capacitor 1nF	P/O HP 16380A
Standard Capacitor 10nF	P/O HP 16380C
Standard Capacitor 100nF	P/O HP 16380C
Standard Capacitor 1 $\mu$ F	P/O HP 16380C
Standard Resistor 10 $\Omega$	P/O HP 16074A
0 $\Omega$ Reference for 10 $\Omega$ Standard	P/O HP 16074A
SHORT Reference	P/O HP 16074A
OPEN Reference	P/O HP 16074A
Four-Terminal Pair Test Leads (1m)	HP 16048A <sup>1</sup>
Four-Terminal Pair Test Leads (2m)	HP 16048D <sup>1</sup>
Memory Card	P/N HP 04278-89001

<sup>1</sup> The HP16074A or D test leads must be used, do not make any substitutions.

### 1-12-1. CALIBRATION SETUP

Now you will set the 4278A's EEPROM write enable and operate the keys on the front panel to open the CAL. menu page. The following procedure is necessary when performing an auto calibration.

#### PROCEDURE:

1. Turn the 4278A off and remove the A7 board assembly.
2. Set the 4278A's EEPROM write protect jumper (**A7W2**), to the right hand side as shown in Figure 1-10.

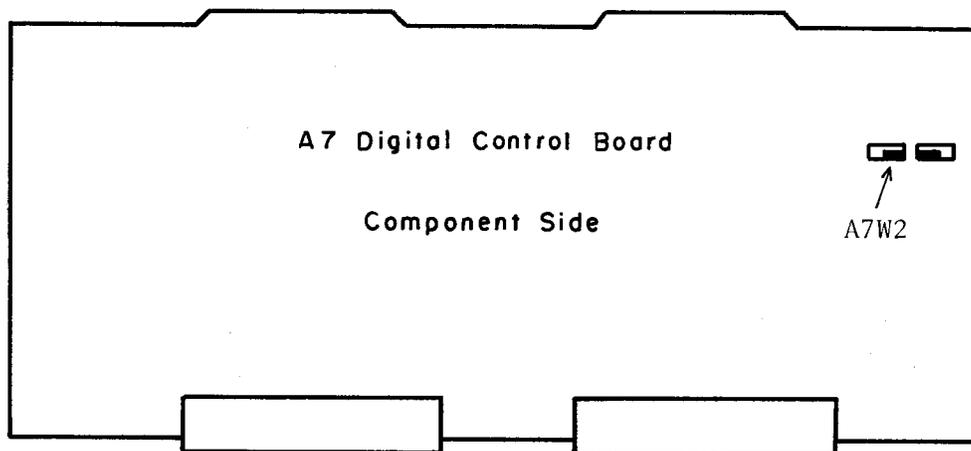


Figure 1-10. EEPROM Write Enable

3. Install the A7 board assembly into the 4278A, and replace the shield plate and top cover.
4. Turn the 4278A on.
5. Press the **MENU** and **PREV** keys on the front panel.
6. Press the '**SVC FNCTN**' and '**CAL.**' softkeys.

7. Confirm that the display is as shown in Figure 1-11.

CALIBRATION MENU	
1KHz DATA: 1kHz STD. DATA ENTRY	1kHz DATA
1MHz DATA: 1MHz STD. DATA ENTRY	1MHz DATA
1kHz CAL.: EXECUTE 1kHz CAL.	1kHz CAL.
1MHz CAL.: EXECUTE 1MHz CAL.	1MHz CAL.
	exit CAL.

Figure 1-11. Calibration Menu Page.

#### 1-12-2. STANDARD DATA TABLE ENTRY

This paragraph describes how to enter the calibration values for a standard into the **STANDARD DATA TABLE**. The calibration values for 1kHz and 1MHz are entered independently.

You can also enter a standards' calibration values using a memory card. For example, if you calibrate multiple 4278As using the same standard, you don't have to key in the standard's calibration values for each **STANDARD DATA TABLE**, you only need to press the front panel **LOAD** key to load the calibration values from the memory card.

#### NOTE

Prepare a memory card to use exclusively for storing a standard's calibration values.

The following procedure consists of three paragraphs. Paragraphs (1) and (2), gives the procedures for entering the standard's calibration values into the 1kHz, and 1MHz **STANDARD DATA TABLE**, respectively. Paragraph (3), tells how to use the memory card for storing the calibration values.

**(1) 1kHz STANDARD DATA TABLE ENTRY**

The following describes how to enter the standard's calibration values into the **1kHz STANDARD DATA TABLE**. Skip to **(2)**, if your 4278A does not have the 1kHz measurement function.

**PROCEDURE:**

1. Press the '1kHz DATA' softkey.
2. Use the numeric **ENTRY** and **ENTER** keys to enter your standard's calibration values into the **STANDARD DATA TABLE**.

**NOTE**

If you use the HP 16380A capacitors as the calibration standards, use the calibrated capacitance given in the calibration data sheet supplied with the 16380A. The dissipation factor for the 100pF and 1000pF standard capacitors can be regarded as zero.

**NOTE**

When using the HP 16380C capacitors as the calibration standards, use the calibrated capacitance given in the calibration data sheet supplied with the 16380C, determine the value for the dissipation factor by reading the supplied graph.

**NOTE**

The HP 16074A's 10 $\Omega$  standard's calibrated value (resistance and inductance) will be given as the difference between the 0 $\Omega$  and the 10 $\Omega$  standard. If you use the 0 $\Omega$  standard, enter the difference between the 10 $\Omega$  standard's values and 0 $\Omega$  standard's values.

3. Confirm that the standard's calibration values are correctly entered into the **1kHz STANDARD DATA TABLE**. (Refer Figure 1-12.)

1kHz STANDARD DATA TABLE			MEMORY STORE
STANDARD	C	D	
100pF	099.9960pF	0.000000	
1000pF	0999.980pF	0.000000	
0.01 $\mu$ F	010.0006nF	0.000100	
0.1 $\mu$ F	0100.007nF	0.000250	
1 $\mu$ F	1.000005 $\mu$ F	000.0000	
10 $\Omega$ -0 $\Omega$	09.62100 $\Omega$	000.0000nH	
	R	L	
			exit TABLE

Figure 1-12. 1kHz Standard Data Table Example

4. Press the **'exit TABLE'** softkey.

**(2) 1MHz STANDARD DATA TABLE ENTRY**

The following describes how to enter the standard's calibration values into the **1MHz STANDARD DATA TABLE**. Skip this paragraph if your 4278A does not have the 1MHz measurement function.

**PROCEDURE:**

1. Press the **'1MHz DATA'** softkey.
2. Use the numeric **ENTRY** and **ENTER** keys to enter the standard's calibration values into the **STANDARD DATA TABLE**.

**NOTE**

When you use the 16380A capacitors as the standard capacitors, use the calibrated capacitance given for the 1pF, 10pF, and 100pF standard capacitors given for 1kHz as the calibration values for 1MHz. For the 1000pF standard capacitor, multiply the value for 1kHz by 1.0003. (Refer to the 16380A Data Sheet). For the dissipation factor of the 1pF, 10pF, and 100pF standard capacitors use a value of zero, and for the 1000pF standard capacitor use a value of 0.00004.

3. Confirm that the standard's calibration values are correctly entered into the **1MHz STANDARD DATA TABLE**. (Refer Figure 1-13.)

1MHz STANDARD DATA TABLE			MEMORY STORE
STANDARD	C	D	
1pF	0.999970pF	0.000000	
10pF	0.999920pF	0.000000	
100pF	099.9960pF	0.000000	
1000pF	1000.280pF	0.000040	
			exit TABLE

Figure 1-13. 1MHz STANDARD DATA TABLE Example

4. Press the **'exit TABLE'** softkey.

### (3) USING THE MEMORY CARD FOR THE STANDARDS' CALIBRATION VALUES

The following describes how to use the memory card to store or load a standards' calibration values. The standards' calibration values entered into the **STANDARD DATA TABLE** can be loaded from a memory card. The calibration values for 1kHz and 1MHz are stored independently. Both the 1kHz and 1MHz data are loaded when you press the **LOAD** key. Press the **LOAD** key while in the **CALIBRATION MENU** page because the calibration values are load only from this menu. If you are not using a memory card, go to paragraph 1-12-3.

#### [HOW TO STORE THE STANDARDS' CALIBRATION VALUES]

##### PROCEDURE:

1. Set the CAL. menu page operating the key on the front panel.
2. Insert the memory card into the **MEMORY** card slot.
3. Press the '**1kHz DATA**' softkey.
4. Press the '**MEMORY STORE**' softkey and **ENTER** key to store the standard's calibration values into the memory card.
5. Press the '**exit TABLE**' softkey.
6. Press the '**1MHz DATA**' softkey.
7. Press the '**MEMORY STORE**' softkey and **ENTER** key to store the standards' calibration values into the memory card.
8. Press the '**exit TABLE**' softkey.

#### [HOW TO LOAD THE STANDARDS' CALIBRATION VALUES]

##### PROCEDURE:

1. Set the CAL. menu page operating the key on the front panel.
2. Press the **LOAD** key to load the calibration values from the memory card.
3. Press the '**1kHz DATA**' softkey and confirm that the data in the **1kHz STANDARD DATA TABLE** is the same as your standards' calibration values. If the data reproduced in the **1kHz STANDARD DATA TABLE** is not correct, revise the data and save to the memory card again.
4. Press the '**exit TABLE**' softkey.
5. Press the '**1MHz DATA**' softkey and confirm that the data in the **1MHz STANDARD DATA TABLE** is the same as your standards' calibration values. If the data reproduced in **1MHz STANDARD DATA TABLE** is not correct, revise the data and save to the memory card again.
6. Press the '**exit TABLE**' softkey.

### 1-12-3. CALIBRATION METHOD

#### (1) 1kHz CALIBRATION

This paragraph describes the 1kHz calibration method using the standard's calibration values stored in the **1kHz STANDARD DATA TABLE**. Skip this paragraph if your 4278A does not have the 1kHz measurement function.

**Do Not** turn off the 4278A while you are performing the following procedures, if you do, the calibration data will be lost.

#### PROCEDURE:

1. Press the '**1kHz CAL.**' softkey, the display will appear as shown in the Figure 1-14 .

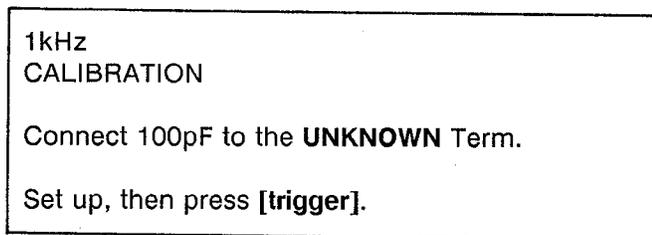


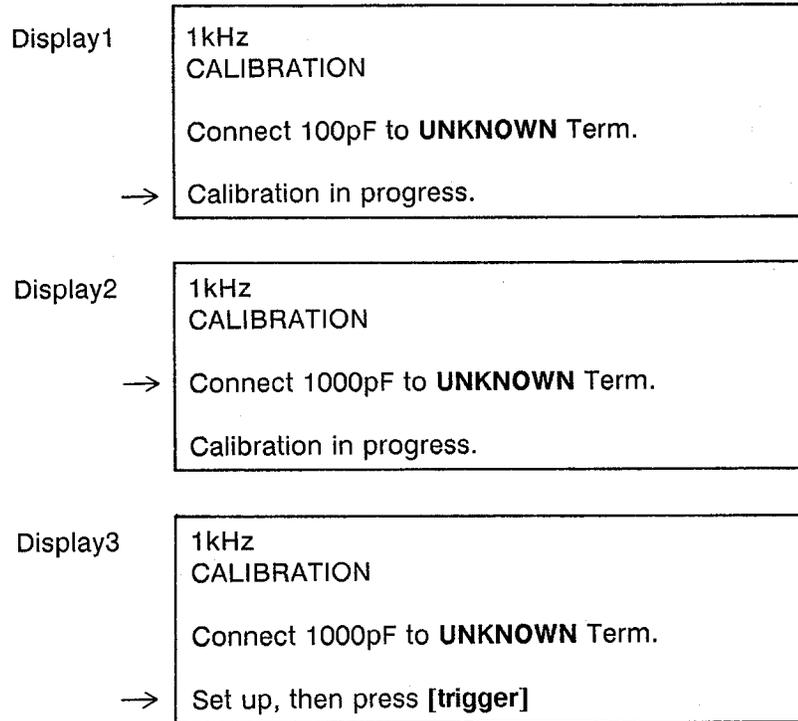
Figure 1-14. First Message at 1kHz CAL.

2. Connect the 100pF standard capacitor to the **UNKNOWN** terminals as instructed by the display message.

3. Press the **TRIGGER** key and wait.

#### NOTE

The following figures show the 4278A's transition from the time you press the '**TRIGGER**' key until the next measurement will be available.



#### [Display 1]

As soon as the 4278A starts to measure the 100pF standard capacitor, "Calibration in progress.", is displayed on the SYSTEM MESSAGE LINE as shown in the Display 1. While this message is displayed, the 4278A is measuring the 100pF standard capacitor.

#### [Display 2]

After the analog measurement is complete, "Connect 1000pF to UNKNOWN Term.", is displayed as shown in the Display2. This message means you may disconnect 100pF capacitor and connect the 1000pF capacitor. While this message is displayed, the 4278A is writing calibration data to EEPROM.

#### [Display 3]

After the 4278A has completed writing the calibration data to the EEPROM, "Set up, then press [trigger].", will be displayed on the SYSTEM MESSAGE LINE as shown in Display 3. When this message is displayed, the next measurement is available.

4. Disconnect the 100pF standard capacitor after Display 3 is displayed and connect the 1000pF standard capacitor.
5. Repeat steps 3 through 4 according to the connection order listed in Table 1-4.

**NOTE**

You can perform the calibration's procedure according to the display only.

**NOTE**

The Processing Times shown in Table 1-4 are the approximate times from when you press the '**TRIGGER**' key until the next measurement will be available.

Table 1-4. 1kHz Connection Order

Connection Order	Standard Connected	Processing Time
(1)	(100pF capacitor)	(a few seconds)
2	1000pF capacitor	a few seconds
3	0.01 $\mu$ F capacitor	a few seconds
4	0.1 $\mu$ F capacitor	a few seconds
5	1 $\mu$ F capacitor	a few seconds
6	0 $\Omega$ standard resistor	a few seconds
7	10 $\Omega$ standard resistor	about 8 sec.
8	100pF capacitor, 16048A (1m test lead)	a few seconds
9	100pF capacitor 16048D (2m test lead)	a few seconds

6. Confirm that "1kHz Calibration is Complete" is displayed.

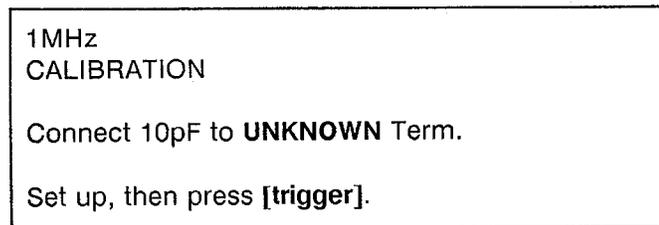
## (2) 1MHz CALIBRATION

This paragraph describes 1MHz calibration using the calibration values in the **STANDARD DATA TABLE**. Skip this paragraph if your 4278A does not have the 1MHz measurement function.

**Do Not** turn off the 4278A while you are performing the following procedure, if you do, the calibration data will be lost.

### PROCEDURE:

1. Press the '1MHz CAL.' softkey, then the display as shown in the Figure 1-15 is displayed.



1MHz  
CALIBRATION

Connect 10pF to **UNKNOWN** Term.

Set up, then press [trigger].

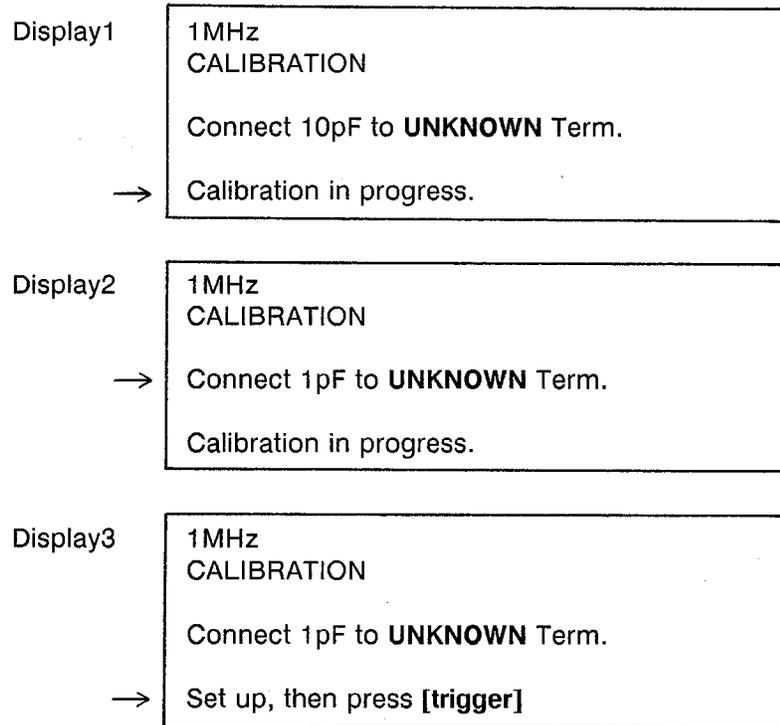
Figure 1-15. First Message at 1MHz CAL.

2. Connect 10pF standard capacitor to the **UNKNOWN** terminals as instructed by the displayed message.

3. Press the **TRIGGER** key and wait.

#### NOTE

The following figures show the 4278A's transition from the time you press the '**TRIGGER**' key until the next measurement will be available.



#### [Display 1]

As soon as the 4278A starts to measure the 10pF standard capacitor, "Calibration in progress.", is displayed on the SYSTEM MESSAGE LINE as shown in the Display 1. While this message is displayed, the 4278A is measuring the 10pF standard capacitor.

#### [Display 2]

After the analog measurement is complete, "Connect 1pF to UNKNOWN Term.", is displayed as shown in the Display2. This message means that you may disconnect the 10pF capacitor and connect the 1pF capacitor. While this message is displayed, the 4278A is writing calibration data to the EEPROM.

#### [Display 3]

After the 4278A has completed writing the calibration data to EEPROM, "Set up, then press [trigger].", is displayed on the SYSTEM MESSAGE LINE as shown in Display 3. When this message is displayed, the next measurement is available.

4. Disconnect the 10pF standard capacitor after the Display 3 is displayed and connect the 1pF standard capacitor.
5. Repeat steps 3 through 4 according to the connection order listed in Table 1-5.

**NOTE**

You can perform the calibration's procedure according to the display only.

**NOTE**

The Processing Time shown in Table 1-5 is the approximate time from when you press the **TRIGGER** key until the next measurement will be available.

Table 1-5. 1MHz Connection Order

Connection Order	Standard Connected	Processing Time
(1)	(10pF capacitor)	(about 40 sec.)
2	1pF capacitor	about 20 sec.
3	100pF capacitor	a few seconds
4	1000pF capacitor	a few seconds
5	OPEN reference	a few seconds
6	SHORT reference	about 10 sec.
7	100pF capacitor 16048A (1m test lead)	a few seconds
8	OPEN reference 16048A (1m test lead)	a few seconds
9	SHORT reference 16048A (1m test lead)	about 20 sec.
10	100pF capacitor 16048D (2m test lead)	a few seconds
11	OPEN reference 16048D (2m test lead)	a few seconds
12	SHORT reference 16048D (2m test lead)	about 20 sec.

6. Confirm that "**1MHz Calibration is Complete**" is displayed.

**1-12-4. RETURNING THE EEPROM WRITE PROTECT JUMPER**

Calibration is now complete, so perform the following steps to write protect the 4278A's EEPROM.

1. Press the **'exit CAL.'** softkey to exit the Calibration Mode.
2. Turn the 4278A off and remove the A7 board assembly.
3. Restore the 4278A's EEPROM write protect jumper (A7W2) to its Normal position (left hand side), the location of the jumper (A7W2) is shown in Figure 1-10.
4. Install the A7 board assembly.
5. Replace the shield plate and the top cover.

**SECTION 2**

**INSTALLING/MODIFYING OPTIONS**

**2-1. INTRODUCTION 2-1**

**2-2. OPTION INSTALLATION/MODIFICATION 2-1**

**2-3. ADDING 1MHz MEASUREMENT CAPABILITY TO OPTION 001 4278As 2-3**

**2-4. ADDING 1kHz MEASUREMENT CAPABILITY TO OPTION 002 4278As 2-5**

**2-5. OPTION 003 INSTALLATION 2-7**

**2-6. OPTION 101 (HP-IB INTERFACE) INSTALLATION 2-9**

**2-7. OPTION 201 (HANDLER INTERFACE) INSTALLATION 2-11**



## SECTION 2

### INSTALLING/MODIFYING OPTIONS

#### 2-1. INTRODUCTION

This section contains information about adding Options for which the 4278A was not initially equipped, and for modifying existing Options. Most of the procedures in this section include a list of Required Parts and the installation/modification procedures. Information on how to order the parts required to install or modify an Option is described in paragraph 3-3. The adjustments required in the Option installation procedure must be performed to maintain the performance of the 4278A. The adjustment procedures are described in Section 1.

#### 2-2. OPTION INSTALLATION/MODIFICATION

The Options available for the 4278A, all of which are field installable, are listed in Table 2-1. Table 2-1 lists the option numbers, gives a description of the option, and lists the paragraph number which describes the modification procedure for each option. Figure 2-1 shows the location of the board assemblies to be installed or modified, and the saddle-edge.

Table 2-1. List of 4278A Options

Option Number	Description	Modification/Installation Procedure
001	1kHz Test Frequency Only	Paragraph 2-3
002	1MHz Test Frequency Only	Paragraph 2-4
003	1% Frequency Shift	Paragraph 2-5
101	HP-IB Interface	Paragraph 2-6
201	Handler Interface	Paragraph 2-7

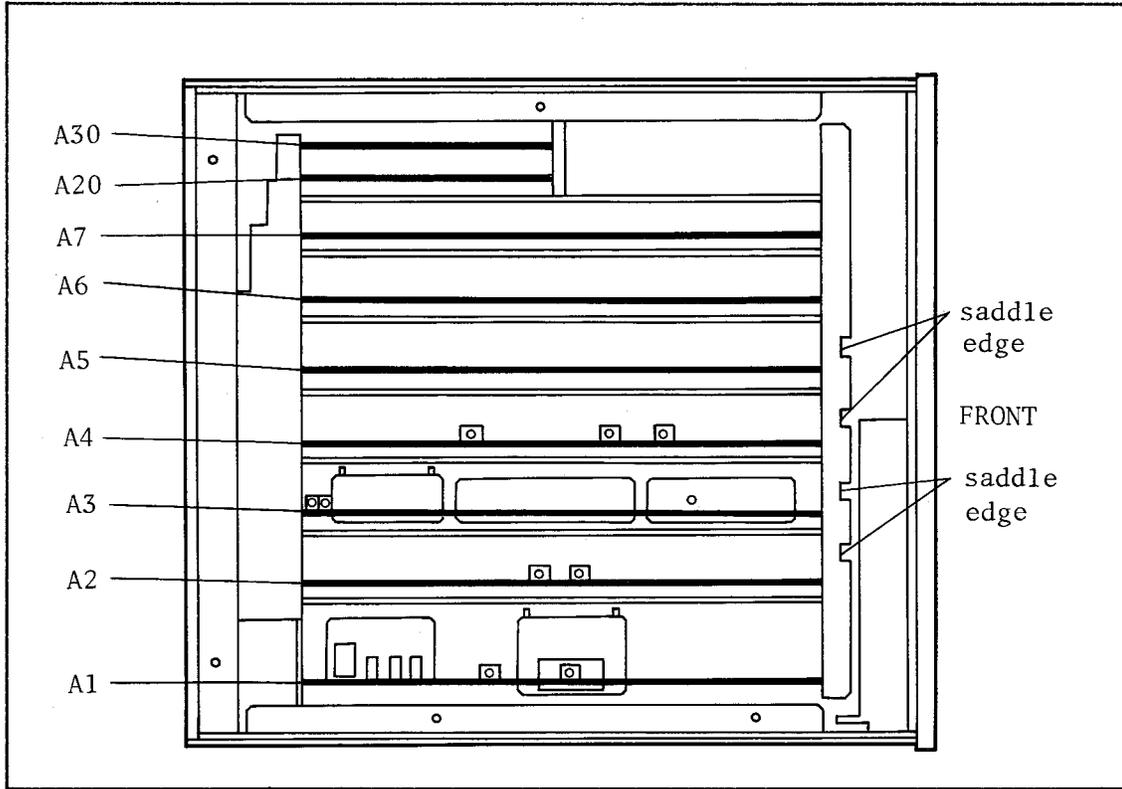


Figure 2-1. Board Locations

**2-3. ADDING 1MHz MEASUREMENT CAPABILITY TO OPTION 001 4278As**

The following procedure describes how to modify an HP 4278A with Option 001 to add 1MHz measurement capability.

**REQUIRED PARTS:**

Description	Part Number	Qty.
1MHz Transducer Board Assembly	04278-66503	1
Coaxial Cable Assembly (B)	04278-61606	1
Coaxial Cable Assembly (D)	04278-61604	1
Coaxial Cable Assembly (H)	04278-61612	1
Coaxial Cable Assembly (I)	04278-61613	1
Cable Tie	1400-1361	1

**NOTE**

The letters in parentheses are the letters on the wire markers.

**PROCEDURE:**

1. Remove the top cover and the right hand side top shield plate. Refer to paragraph 1-7 for instructions on removing the top cover and the top shield plate.
2. Connect the four coaxial cables listed in the required parts list to the four connectors on the 1MHz Transducer Board Assembly, see Figure 2-2.

**NOTE**

The letters on the cable markers should match the letters marked beside the connectors on the board.

**NOTE**

Use the special extractor tool (HP P/N 8710-1754), to prevent damaging the coaxial cables and connectors when removing them from the board.

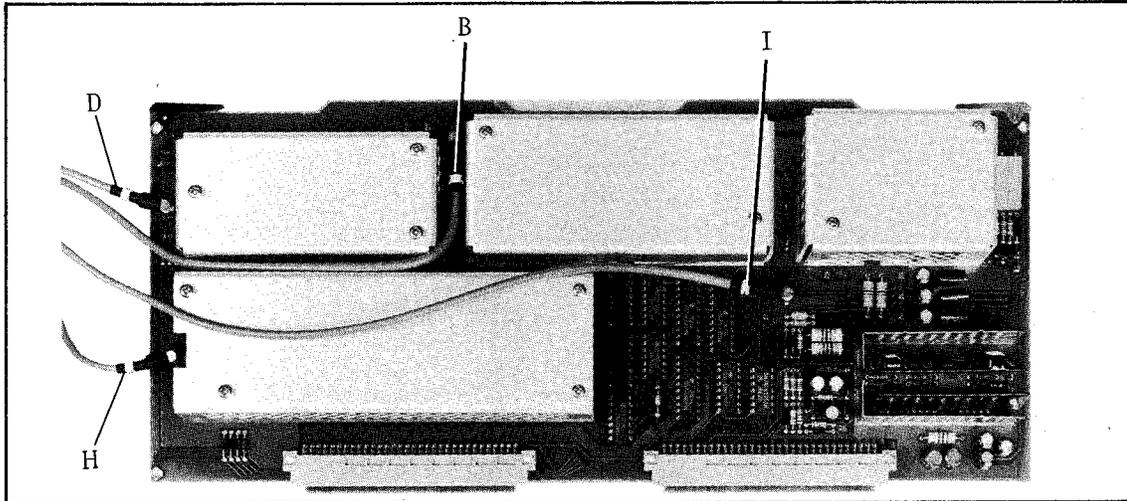


Figure 2-2. 1MHz Transducer Board

3. Install the 1MHz Transducer Board into the A3 slot, see Figure 2-1. Then place the coaxial cables on the saddle-edge (see Figure 2-1 for the location of the saddle-edge).
4. Remove the A5 Switching Matrix/Phase Detector board from 4278A, and connect coaxial connectors (H) and (I) from the A3 board to connectors (H) and (I) on the A5 board.
5. Reinstall the A5 board, then place the coaxial cables on the saddle-edge (see Figure 2-1 to locate the saddle-edge).
6. Remove the front panel assembly from the 4278A. Refer to paragraph 4-7-4 for instructions on how to remove the front panel.
7. Connect coaxial cables (B) and (D) from the A3 board to connectors (B) and (D) on the A8 board.
8. Cut the cable ties on the coaxial cables from the A8 board, then bundle and tie all of the coaxial cables together (including cables (B) and (D)), using the cable ties listed in the required parts list.
9. Reinstall the 4278A front panel assembly.
10. Perform the adjustments described in paragraphs 1-8, 1-9, 1-10 and 1-12 (1-12-1, 3, 5 and 6, in sequence).

**2-4. ADDING 1kHz MEASUREMENT CAPABILITY TO OPTION 002 HP 4278As**

The following procedure describes how to add 1kHz measurement capability to Option 002 (1MHz Test Frequency Only), HP 4278As.

**REQUIRED PARTS:**

Description	Part Number	Qty.
1kHz Transducer Board Assembly	04278-66504	1
Coaxial Cable Assembly (A)	04278-61607	1
Coaxial Cable Assembly (C)	04278-61605	1
Coaxial Cable Assembly (E)	04278-61603	1
Cable Tie	1400-1361	1

**NOTE**

The letters in parentheses are the letters on the wire markers.

**PROCEDURE:**

1. Remove the top cover and the right hand side shield plate. Refer to paragraph 1-7 for instructions on how to remove the top cover.
2. Connect the three coaxial cables listed in the required part list to the three connectors on the 1kHz Transducer Board Assembly, as shown in Figure 2-3.

**NOTE**

The letter on the cable marker should match the letter marked beside the connector on the board.

**NOTE**

Use the special extractor tool (HP P/N 8710-1754), to prevent damaging the coaxial cables and connectors when removing them from the board.

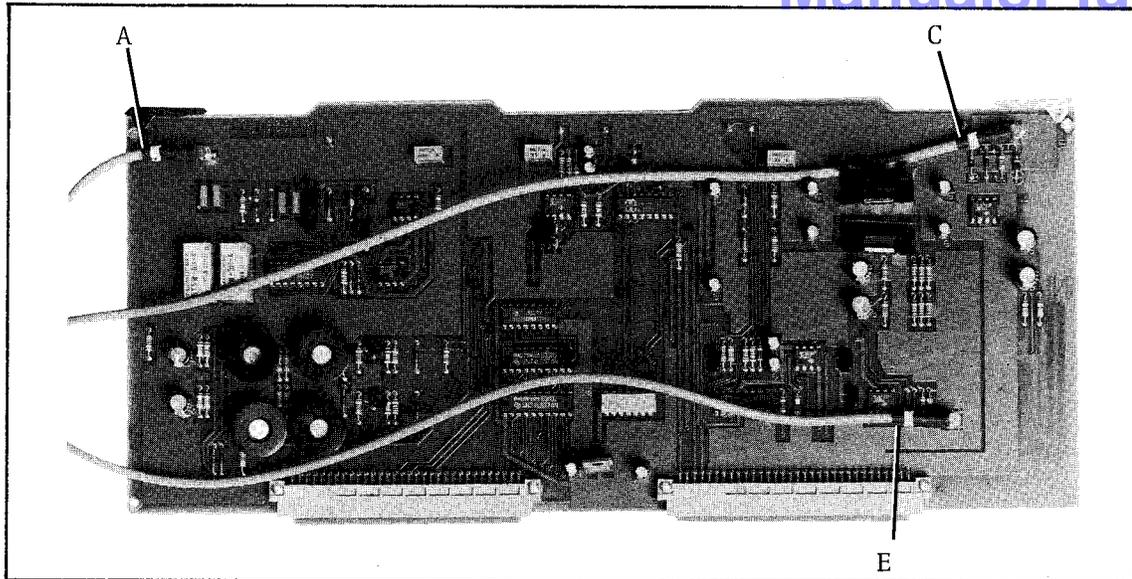


Figure 2-3. 1kHz Transducer Board

3. Install the 1kHz Transducer Board into the A4 slot, as shown in Figure 2-1. Then place the coaxial cables on the cable clamp and the saddle-edge (see Figure 2-1 for the location of the saddle-edge).
4. Remove the front panel assembly from the 4278A. Refer to paragraph 4-7-4 for instructions on how to remove the front panel.
5. Connect coaxial cables (A), (C) and (E) from the A4 board to the (A), (C) and (E) connectors on the A8 board.
6. Cut the cable ties on the coaxial cables from the A8 board, and bundle all of the coaxial cables (including the (A), (C) and (E) cables), and tie them together using the cable ties listed in the required parts list.
7. Replace the front panel assembly on the 4278A.
8. Perform the adjustments described in paragraphs 1-8, 1-9, 1-11 and 1-12 (1-12-1, 2, 4 and 6, in sequence).

## 2-5. OPTION 003 INSTALLATION

The following procedure describes how to add Option 003: Test Frequency 1% Shift (shift the test frequency of the 4278A by 1%), to the 4278A.

### NOTE

If you want to change the test frequency from the 1% shifted frequency to the standard frequency, reverse the operations in steps 3, 4 and 5 of the following procedure.

### REQUIRED PARTS:

Description	Part Number	Qty.
8.08MHz Clock Oscillator	1813-0551	1
LABEL "-66572"	5080-3152	1

### PROCEDURE:

1. Remove the top cover and the right hand side shield plate. Refer to paragraph 1-7 for instructions on how to remove the top cover.
2. Remove the A2 Signal Source board.

### NOTE

Use the special extractor tool (HP P/N 8710-1754), to prevent damaging the coaxial cables and connectors when removing them from the board.

3. Change the parts for A2U24 to the 8.08MHz Clock Oscillator (PN 1813-0551) from 8.00MHz Clock Oscillator (PN 1813-0550). Figure 2-4 shows the location of A2U24.

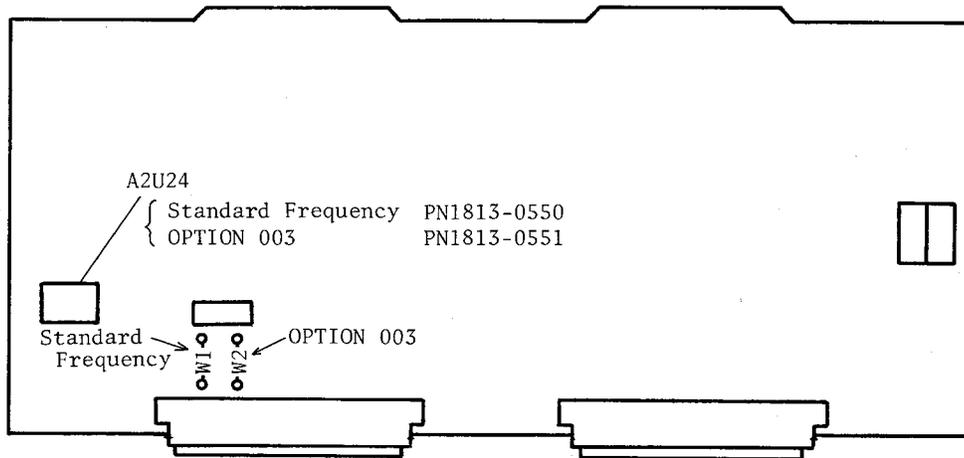


Figure 2-4. Location of A2U24

4. Disconnect the jumper soldered at position W1, and solder it to position W2 (See Figure 2-4).
5. Put the "-66572" label over the "-66502" printed on the A2 board.
6. Reinstall the A2 board. Then hang the coaxial cable on the cable clamp and the saddle-edge (Figure 2-1 shows the location of the saddle-edge).
7. Perform the adjustments described in paragraphs 1-8, 1-9, 1-10, and 1-12.

## 2-6. OPTION 101 (HP-IB INTERFACE) INSTALLATION

The following procedure describes how to install Option 101, HP-IB Interface in the 4278A.

### REQUIRED PARTS:

Description	Part Number	Qty.
#101 HP-IB Interface Board Assembly	04278-66520	1
Cable Assembly HP-IB (includes washers)	04278-61621	1
Panel HP-IB	04278-00210	1
Washer (LK HLCR)	2190-0577	2

### PROCEDURE:

1. Assemble the HP-IB Cable Assembly and HP-IB Panel as shown in Figure 2-5.

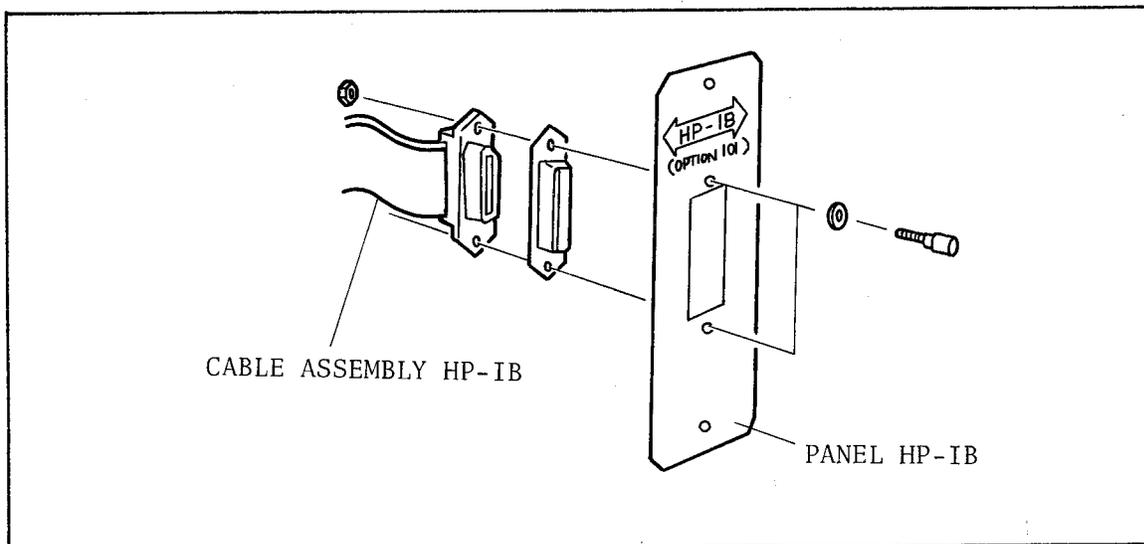


Figure 2-5. HP-IB Connector Panel Assembly

### NOTE

The "HP-IB Cable Assembly" includes a cover, and two each nuts, screws, washers. Use the washers listed in the required parts list in place of the washers included with the HP-IB cable assembly to mount the HP-IB Cable Assembly on the HP-IB.

2. Remove the top cover and the right hand side shield plate.
3. Install the #101 HP-IB Interface board in the A20 slot, as shown in Figure 2-1.

- Remove the blank panel installed over the second slot from the left on the rear panel, and install the HP-IB Panel as shown in Figure 2-6.

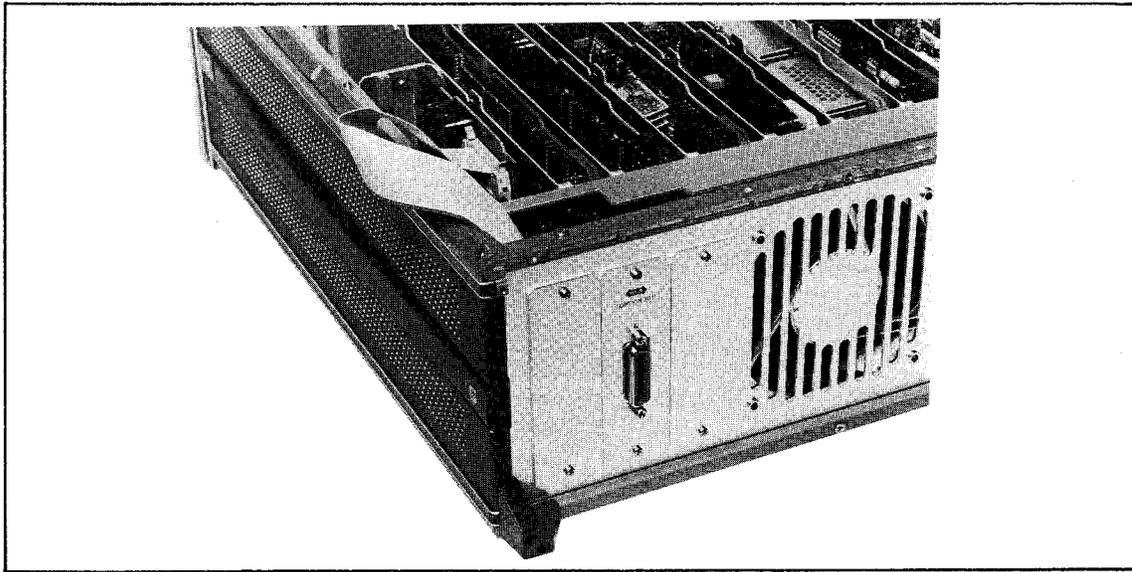


Figure 2-6. Option 101 Set Up

- Connect the HP-IB Assembly's female connector to the male connector on the HP-IB Interface board (A20J1), as shown in Figure 2-6.
- Remove the A7 board, and set bits 0 and 1 of switch A7S3 (A7S3-1 and A7S3-2), as shown in Figure 2-7.

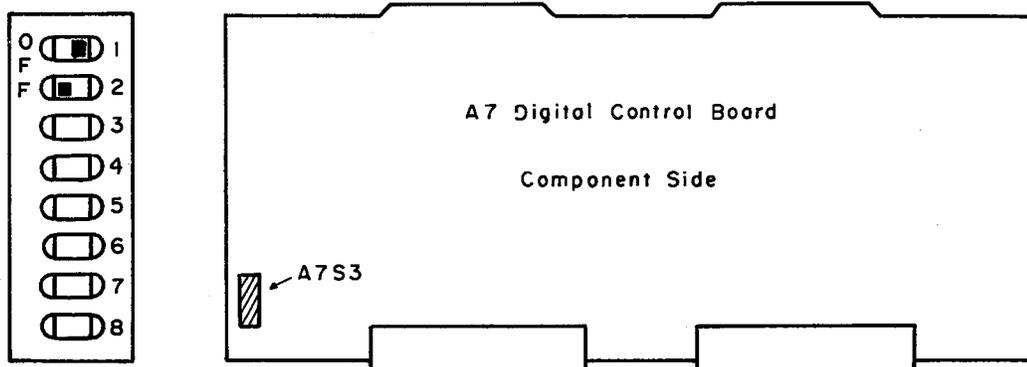


Figure 2-7. A7S3 Setting for Option 101

**NOTE**

Refer to the paragraph 4-8 for more details on the switch bit patterns.

7. Reinstall the A7 board.
8. Perform the adjustments described in paragraph 1-8.

**2-7. OPTION 201 (HANDLER INTERFACE) INSTALLATION**

The following procedure describes how to install Option 201, Handler Interface, in the 4278A.

**REQUIRED PARTS:**

Description	Part Number	Qty.
#201 Handler Interface Board Assembly	04278-66530	1
Cable Assembly I/F	04278-61622	1
Panel I/F	04278-00211	1
Screw (SCR M3-L 10 P-H)	0515-1551	2
Nut (NUT-HEX W/LOCKER)	0535-0031	2

**PROCEDURE:**

1. Mount the I/F Cable Assembly on the I/F panel using the screws and nuts listed in the required parts list.
2. Remove the top cover and the right hand side shield plate of the 4278A.
3. Install the Handler Interface board into the A30 slot, as shown in Figure 2-1.
4. Remove the left most blank panel on the rear panel, and install the I/F panel in place of the blank panel as shown in Figure 2-8.

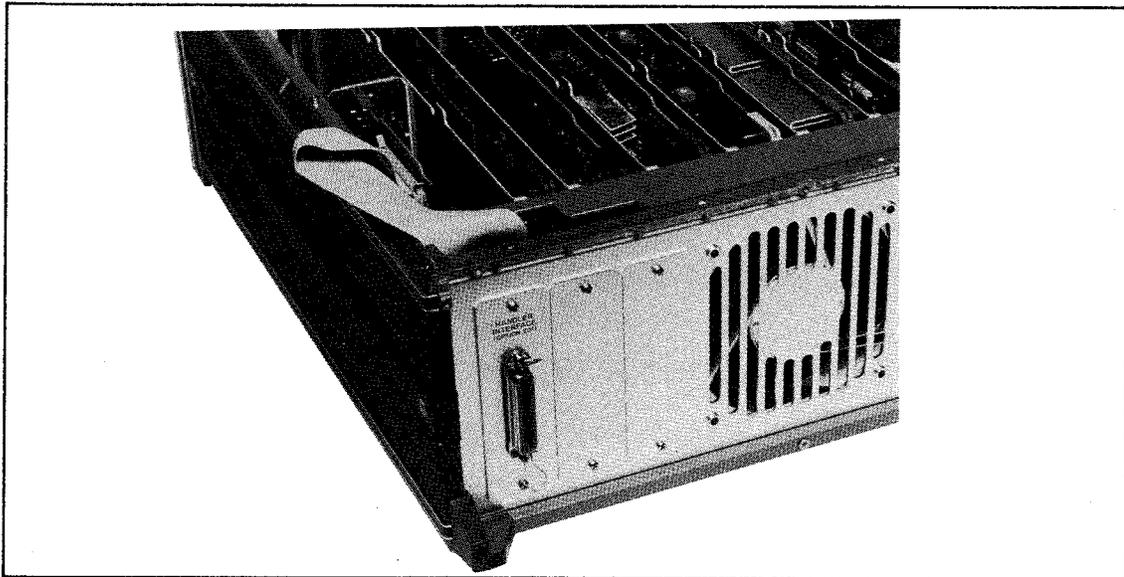


Figure 2-8. Option 201 Set Up

5. Connect the female connector of the I/F cable assembly to the male connector (A30J1) on the Handler Interface board, as shown in Figure 2-8.
6. Remove the A7 board and set bits 2 and 3 of switch A7S3 (A7S3-3 and A7S3-4) as shown in Figure 2-9.

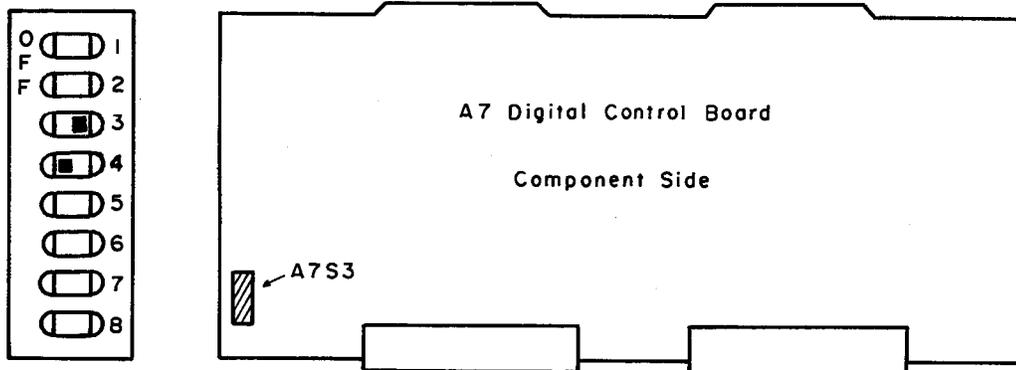


Figure 2-9. A7S3 Setting for Option 201

**NOTE**

Refer to the paragraph 4-8 for more details on the switch bit patterns.

7. Replace the A7 board.
8. Perform the adjustments described in paragraph 1-8.



**SECTION 3**

**REPLACEABLE ASSEMBLIES**

- 3-1. INTRODUCTION 3-1**
- 3-2. REPLACEABLE ASSEMBLY LIST 3-1**
- 3-3. ORDERING INFORMATION 3-1**
- 3-4. DIRECT MAIL ORDERING 3-1**



## SECTION 3

### REPLACEABLE ASSEMBLIES

#### 3-1. INTRODUCTION

This section contains information for ordering replacement assemblies. The following information is included: an explanation of the assembly lists, basic ordering information, and the procedure for mail ordering parts.

#### 3-2. REPLACEABLE ASSEMBLY LIST

Table 3-1 provides a listing of the replaceable assemblies and an exploded view of the 4278A. Tables 3-2 through 3-4 lists the internal cable assemblies of the 4278A. The following information for each cable assembly is included:

- a. The Hewlett-Packard part number.
- b. Quantity in the 4278A.
- c. A description of the assembly.

#### 3-3. ORDERING INFORMATION

When ordering a replacement assembly listed in this section, specify the HP part number, the quantity required, and send your order to the nearest HP Sales Office. When ordering an assembly not listed in this section, state the full instrument model number and serial number, describe the function of the assembly, and give the quantity required. Send your order to the nearest Hewlett-Packard Sales Office.

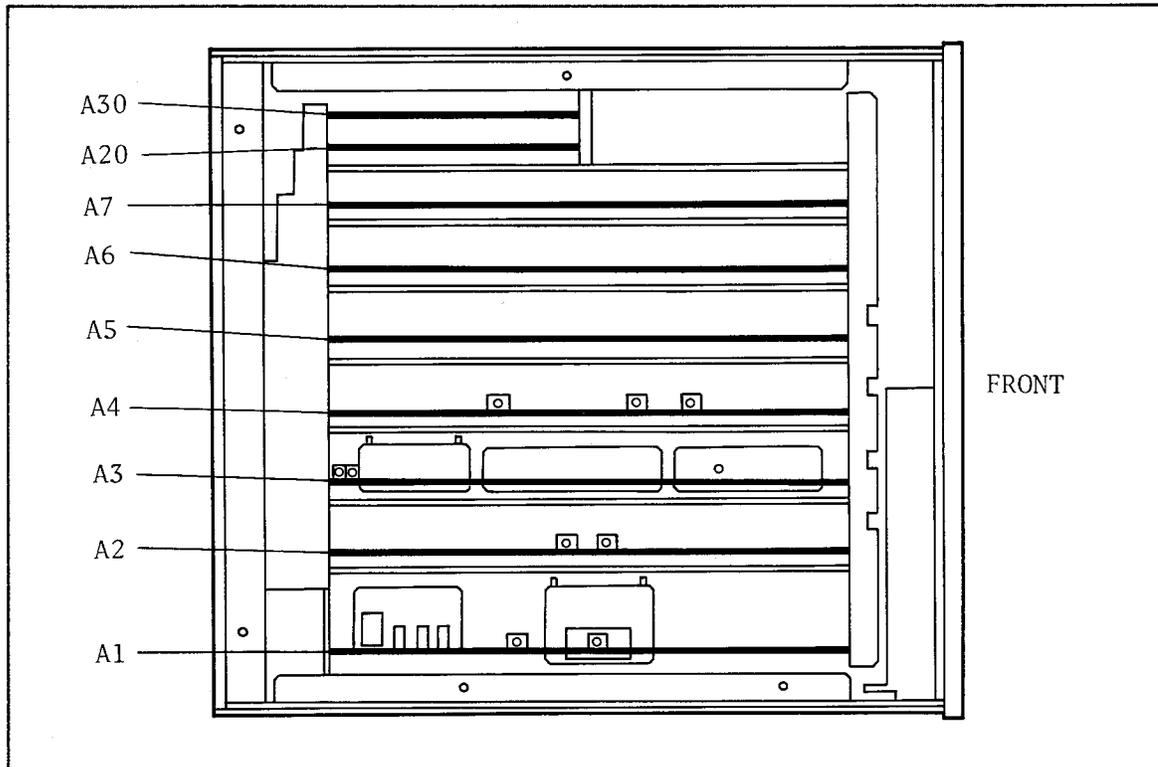
#### 3-4. DIRECT MAIL ORDERING

HP supplies parts through the direct mail order system within the United States. The advantages of using the direct mail order system are:

- a. Direct ordering and shipment from the HP Parts Center in Mountain View, California.
- b. No maximum or minimum on any mail order (there is a minimum order for parts ordered through a local HP Office if the orders require billing and invoicing).
- c. Prepaid shipping (there is a small handling charge for each order).
- d. No invoices - a check or money order must accompany each other.

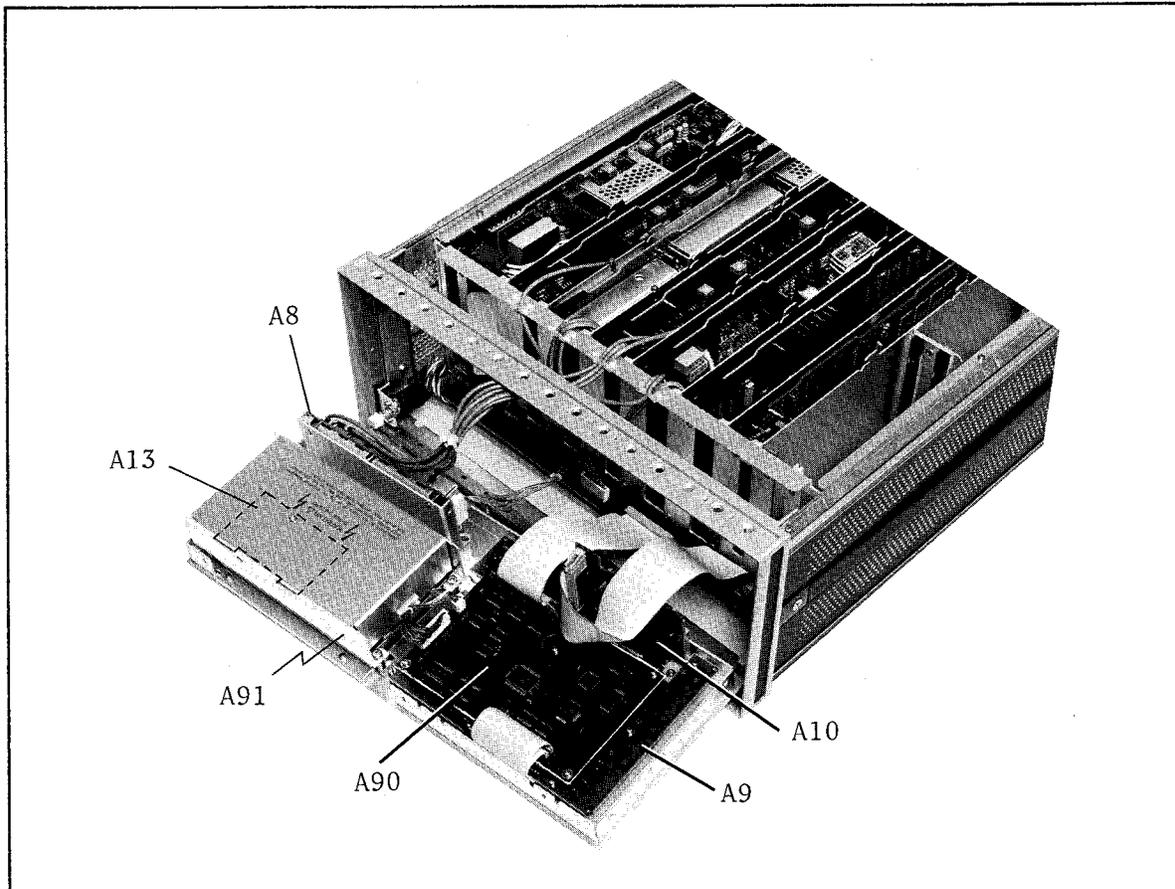
Mail order forms and specific ordering information are available through your local HP office. Addresses and telephone numbers are listed in the back of this manual.

Table 3-1. Replaceable Assembly List (1/3)



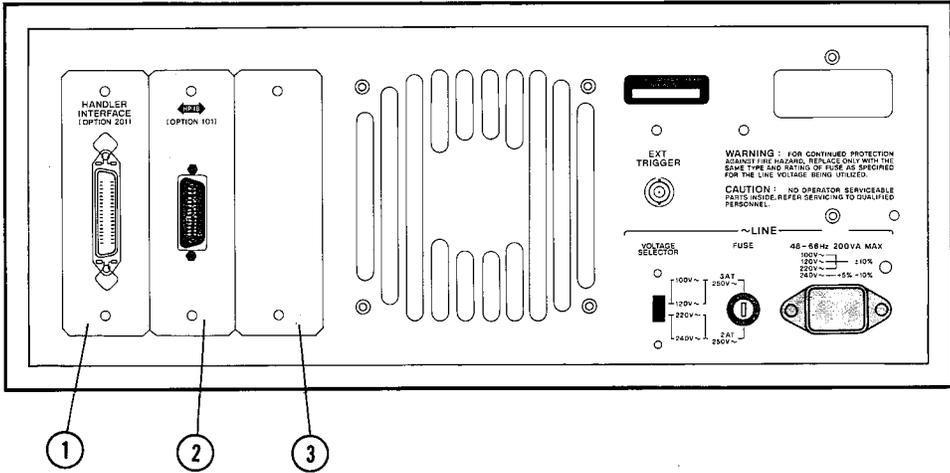
Reference Designator	Part Number	Qty.	Description
A1	04278-66501	1	Power Supply Board Assembly
A2	04278-66502	1	Signal Source Board Assembly (Standard)
A2	04278-66572	1	Signal Source Board Assembly (Option 003)
A3	04278-66503	1	1MHz Transducer Board Assembly
A4	04278-66504	1	1kHz Transducer Board Assembly
A5	04278-66505	1	Switching Matrix/Phase Detector Board Assembly
A6	04278-66506	1	A-D Converter Board Assembly
A7	04278-66607	1	Digital Control Board Assembly (without ROM)
A20	04278-66520	1	#101 HP-IB Board Assembly (Option 101 only)
A30	04278-66530	1	#201 Handler Interface Board Assembly (Option 201 only)

Table 3-1. Replaceable Assembly List (2/3)



Reference Designator	Part Number	Qty.	Description
A8	04278-66508	1	Input Switch Board Assembly (excluding the shield covers)
A9	04278-66509	1	Keyboard Assembly
A10	04278-66510	1	Memory Card Socket (excluding the bezel and knob)
A13	04278-66513	1	DC-AC Converter Board Assembly (inside of the shield cover)
A90	04278-66590	1	Keyboard/Display Control Board Assembly
A91	04278-61100	1	LCD Module (inside of the shield cover: excluding the bezel and filter)

Table 3-1. Replaceable Assembly List (3/3)



Reference Designator	Part Number	Qty.	Description
1	04278-00211	1	PANEL I/F (Option 201)
2	04278-00210	1	PANEL HP-IB (Option 101)
3	04278-00212	3	PANEL BLANK (Standard)

Table 3-2. Coaxial Cable Assembly

Marker	Part Number	Qty.	Description
A	04278-61607	1	A4J1 to A8J5
B	04278-61606	1	A3J2 to A8J6
C	04278-61605	1	A4J2 to A8J7
D	04278-61604	1	A3J1 to A8J8
E	04278-61603	1	A4J3 to A8J9
F	04278-61602	1	A5J2 to A8J10
G	04278-61601	1	A2J1 to A8J11
H	04278-61612	1	A3J3 to A5J3
I	04278-61613	1	A3J4 to A5J1

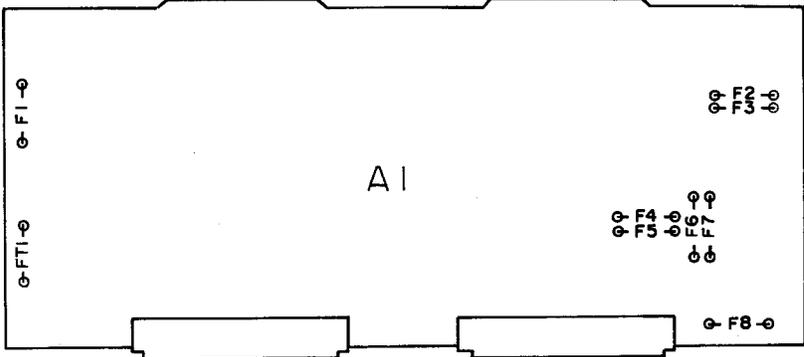
Table 3-3. Flat Cable Assembly

Part Number	Qty.	Description
04278-61621	1	CABLE ASSY HP-IB (Option 101) A20J1 to PANEL HP-IB
04278-61622	1	CABLE ASSY I/F (Option 201) A30J1 TO PANEL I/F

Table 3-4. Wire Assembly

Part Number	Qty.	Description
04278-61614	1	A8J12 to A11J3, 10 pin
04278-61615	1	A13J2 to A90J5, 3 pin
04278-61616	1	A90J4 to A91J1, 12 pin
04278-61630	1	A13J1 to A91J2, 3 pin
04278-61631	1	A9J1 to A91J3, 2 pin

Table 3-5. Replaceable Fuse List (1/2)



Reference Designator	Part Number	Qty.	Description
A1F1	2110-0014	1	FUSE 4A 250V TD 1.25X.25 UL
A1F2	2110-0746	1	FUSE 4A 125V NTD UL
A1F3	2110-0746	1	FUSE 4A 125V NTD UL
A1F4	2110-0741	1	FUSE 1A 125V NTD UL
A1F5	2110-0741	1	FUSE 1A 125V NTD UL
A1F6	2110-0743	1	FUSE 2A 125V UL
A1F7	2110-0743	1	FUSE 2A 125V UL
A1F8	2110-0743	1	FUSE 2A 125V UL
A1FT1	2110-0663	1	FUSE-THERMAL 96°C

Table 3-5. Replaceable Fuse List (2/2)

Reference Designator	Parts Number	Qty.	Description
A9F1	2110-0741	1	FUSE 1A 125V NTD UL
A20F1	2110-0742	1	FUSE 1.5A 125V NTD UL
A30F1	2110-0741	1	FUSE 1A 125V NTD UL

Table 3-6. Replaceable ROM and Fuse List

The diagram shows a circuit board layout. On the right side, there are eight ROM chips arranged in two rows of four. The top row chips are labeled 0, 2, 4, and 6. The bottom row chips are labeled 1, 3, 5, and 7. A bracket underneath the bottom row of chips is labeled 'ROM'. To the right of the ROM chips, there is a fuse labeled 'F1'. Below the ROM chips, there are two rectangular components connected by a line, likely representing other parts of the circuit.

Reference Designator	Part Number	Qty.	Description
0	04278-85501	1	ROM (Version 2.0)
1	04278-85502	1	ROM (Version 2.0)
2	04278-85503	1	ROM (Version 2.0)
3	04278-85504	1	ROM (Version 2.0)
4	04278-85505	1	ROM (Version 2.0)
5	04278-85506	1	ROM (Version 2.0)
6	04278-85507	1	ROM (Version 2.0)
7	04278-85508	1	ROM (Version 2.0)
F1	2110-0743	1	FUSE 2A 125V UL

**SECTION 4**

**ASSEMBLY LEVEL TROUBLESHOOTING**

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- 4-2. SAFETY CONSIDERATIONS 4-1**
- 4-3. RECOMMENDED TEST EQUIPMENT 4-1**
- 4-4. AFTER SERVICE PRODUCT SAFETY CHECKS 4-2**
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## SECTION 4

### ASSEMBLY LEVEL TROUBLESHOOTING

#### 4-1. INTRODUCTION

This section provides the information and instructions required for assembly level troubleshooting and repair of the HP 4278A 1kHz/1MHz Capacitance Meter. The rest of this section is divided into three parts. Part 1 contains the information you need to know before using the troubleshooting procedures. Part 2 explains the 4278A's block level circuit operation. Part 3 gives the troubleshooting procedures.

#### 4-2. SAFETY CONSIDERATIONS

This section contains **WARNINGS** and **CAUTIONS** which must be followed for your safety, and to avoid damaging the equipment. Notes are included for clarification.

**WARNING**

**MAINTENANCE DESCRIBED HEREIN IS PERFORMED WITH POWER SUPPLIED TO THE INSTRUMENT AND PROTECTIVE COVERS REMOVED. SUCH MAINTENANCE SHOULD BE PERFORMED BY TRAINED SERVICE PERSONNEL ONLY.**

#### 4-3. RECOMMENDED TEST EQUIPMENT

The test equipment required for performing the procedures given in this section are listed in Table 1-1, Section 1. The table includes the type of instrument required, critical specifications, and model numbers for the recommended equipment. If the recommended models are not available, equipment which meets or exceeds all critical specifications may be substituted.

#### 4-4. AFTER SERVICE PRODUCT SAFETY CHECKS

**WARNING**

WHENEVER IT APPEARS LIKELY THAT PROTECTIVE SAFETY PROVISIONS HAVE BEEN IMPAIRED, THE APPARATUS SHALL BE MARKED AS INOPERATIVE AND SHOULD BE SECURED AGAINST ANY UNINTENDED OPERATION. THE PROTECTION PROVISIONS WILL HAVE LIKELY BEEN COMPROMISED IF, FOR EXAMPLE:

- INSTRUMENT SHOWS VISIBLE DAMAGE.
- THE INSTRUMENT FAILS TO PERFORM THE INTENDED MEASUREMENT.
- THE UNIT HAS UNDERGONE PROLONGED STORAGE UNDER UNFAVORABLE CONDITIONS.
- THE INSTRUMENT WAS SEVERELY STRESSED IN TRANSPORT.

Perform the following five checks to verify the safety of the 4278A (these checks may also be used to check for safety after troubleshooting and repair).

1. 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 the cause and repair.
2. Use an ohmmeter capable of accurately measuring  $0.5\Omega$  to check the resistance from the instrument enclosure to the power cord's ground pin. The resistance must be less than  $0.5\Omega$ . Flex the power cord while making this measurement to determine if any intermittent discontinuities exist.
3. Check the **GUARD** terminal on front panel using the procedure outlined in step 2.
4. Disconnect the 4278A's power plug from the power source. Turn on the power switch. Tie the line and neutral pins of the power connector together and check the resistance between them and the instrument's enclosure. The minimum acceptable resistance is  $2M\Omega$ . Find and replace any component which causes the instrument to fail this test.
5. Verify that the correct fuse is installed.

## 4-5. ASSEMBLY DESIGNATIONS

Assemblies such as printed circuit boards are assigned numbers in sequence, A1, A2, etc., as shown in Table 4-1. Assembly locations are given in Section 3.

Table 4-1. Assembly Identification

Assembly Number	Assembly Name
A1	Power Supply Board Assembly
A2	Signal Source Board Assembly
A3	1MHz Transducer Board Assembly (not installed on option 001 unit)
A4	1kHz Transducer Board Assembly (not installed on option 002 unit)
A5	Switching Matrix/Phase Detector Board Assembly
A6	A-D Converter Board Assembly
A7	Digital Control Board Assembly
A8	Input Switch Board Assembly
A9	Keyboard Assembly
A10	Memory Card Socket Board Assembly
A11	Motherboard Assembly
A13	DC-AC Converter Board Assembly
A20	#101 HP-IB Board Assembly (option 101 unit only)
A30	#201 Handler Interface Board Assembly (option 201 unit only)
A90	Keyboard/Display Control Board Assembly
A91	LCD Module Assembly

## 4-6. TOOLS AND FASTENERS

The 4278A's internal coaxial cable assemblies use a new type of coaxial connector. Use the special extractor tool (PN 8710-1754), to disconnect these coaxial cables. Using your fingers or pliers to disconnect these new coaxial connectors may damage them.

The 4278A's mechanical components are secured using metric screws. Many screws in the 4278A may appear to be Phillips screws, but they are in fact, Pozidrive. Use only Pozidrive screwdrivers when removing or tightening these screws to avoid damaging them.

## 4-7. DISASSEMBLY

The disassembly procedures are described in the following paragraphs. First the top cover removal procedure is given. Then the following paragraphs give information on removing each assembly from the instrument. Refer to section 3 for the assembly locations.

### 4-7-1. TOP COVER REMOVAL

The following procedure should be performed to gain access to any of the assemblies.

1. Remove the two plastic instrument-feet located at the upper corners of the rear panel.
2. Fully loosen the top cover retaining screw located at the rear of the top cover.
3. Slide the top cover towards the rear and lift off.

### 4-7-2. A1 ASSEMBLY REMOVAL

1. Loosen two screws that secure the left hand side top shield plate. You don't have to remove the screws.

#### NOTE

There are two top shield plates. In order to gain access to the A1 assembly, remove the top shield plate on which the **WARNING** message is printed.

**WARNING**

**CAPACITORS ON THE A1 BOARD REMAIN CHARGED WITH HAZARDOUS VOLTAGES FOR A PERIOD OF TIME AFTER THE INSTRUMENT IS TURNED OFF, OR AFTER THE POWER CABLE IS DISCONNECTED. ALLOW AT LEAST ONE MINUTE FOR THE CAPACITORS TO DISCHARGE AFTER THE INSTRUMENT IS TURNED OFF OR THE POWER CABLE IS DISCONNECTED.**

2. Slide the top shield plate towards the front and lift it off.

3. Lift the black and the brown board extractors at the top corners of the A1 assembly as shown in Figure 4-1.

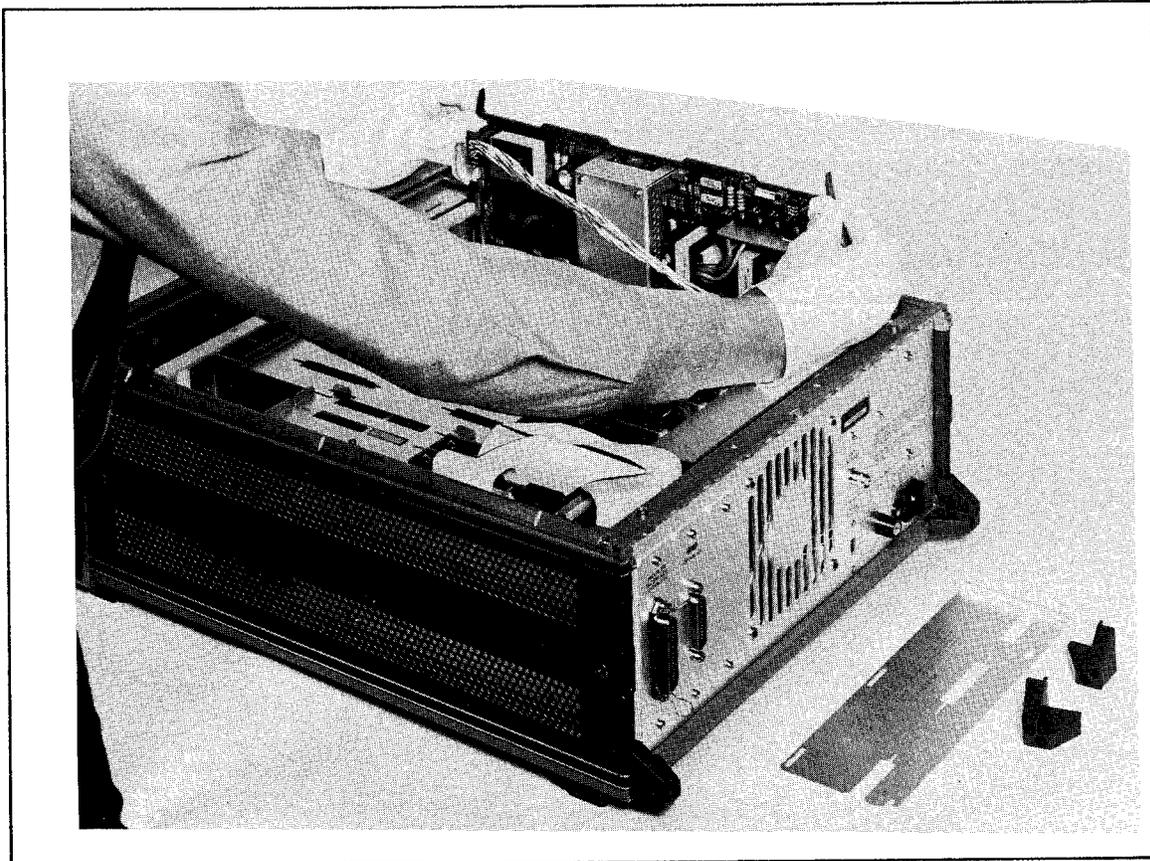


Figure 4-1. A1 Assembly Removal

4. Disconnect the cable connected to the rear panel from the A1 assembly.

#### 4-7-3. A2, A3, A4, A5, A6, A7, A20, OR A30 ASSEMBLY REMOVAL

1. Loosen the five screws that secure the right hand side top shield plate. You don't have to remove the screws.

#### NOTE

There are two top shield plates. In order to access A2, A3, A4, A5, A6, A7, A20, or A30 assembly, remove the top shield plate on which the **WARNING** message is **NOT** printed.

2. Slide the top shield plate towards the front and lift it off.

3. Lift the extractors at top corners of the board assembly that you want to remove.

#### NOTE

Use the special extractor tool to disconnect the coaxial cables from a board assembly. Refer to paragraph 4-6.

#### 4-7-4. FRONT PANEL DISASSEMBLY

This paragraph shows how to remove the front panel assembly from the 4278A. In order to remove the A8, A9, A10, A13, A90, or A91 assembly, first disassemble the front panel assembly.

1. Remove the top trim from the top of the front frame as shown in Figure 4-2.

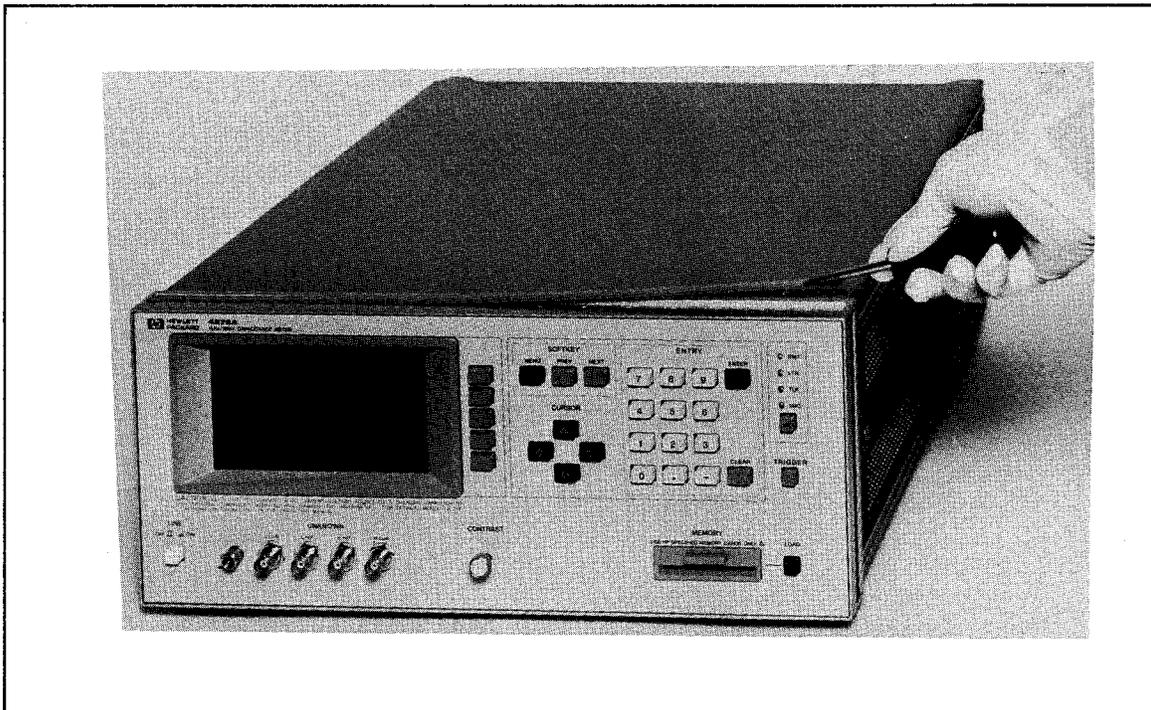


Figure 4-2. Top Trim Removal

2. Remove the two front feet from the bottom cover.
3. Remove the three screws from the bottom of the front frame.
4. Remove the three screws from the top of the front frame.
5. Carefully pull off the front panel assembly from the 4278A.

#### 4-7-5. A8 ASSEMBLY REMOVAL

Remove the front panel assembly from the 4278A as described in paragraph 4-7-4.

1. Turn the 4278A upside-down.
2. Remove the two shield cases from the A8 assembly as shown in Figure 4-3.

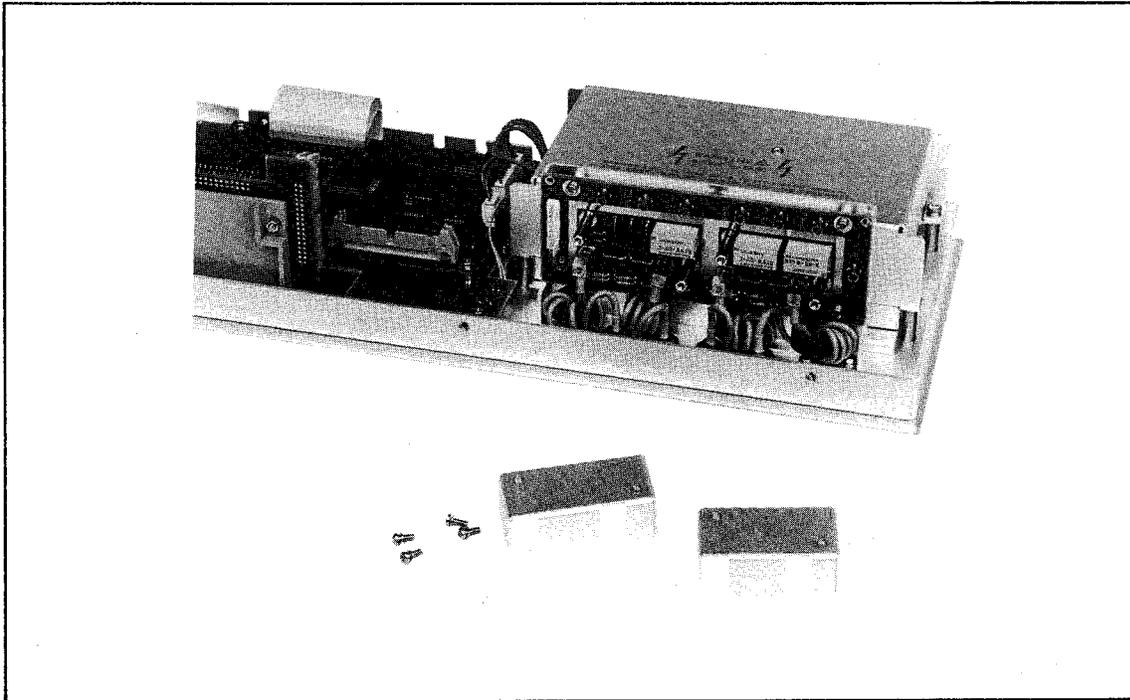


Figure 4-3. A8 Assembly Removal

3. Disconnect the four coaxial cables connected to the **UNKNOWN** connectors from the A8 assembly.
4. Disconnect the seven coaxial cables from the A8 assembly. Be sure to use the special extractor tool. Refer to paragraph 4-6.
5. Disconnect the 10 pin cable from the A8 assembly.
6. Remove the four screws that secure the A8 assembly.

#### 4-7-6. A9 OR A90 ASSEMBLY REMOVAL

First remove the front panel assembly from the 4278A as described in paragraph 4-7-4.

1. Loosen the two hex setscrews on the **CONTRAST** knob and remove it.
2. Disconnect the flatcable assembly that is connected to the motherboard from the A90 assembly as shown in Figure 4-4.
3. Disconnect the 3 and 12 pin cables from the A90 assembly.
4. Remove the eight screws that secure the A9 assembly.
5. Remove the four screws that secure the A90 assembly to the A9 assembly and slide the A90 assembly.
6. Disconnect the 2 pin cable from the A9 assembly.
7. Disconnect the wires that connect the A90 assembly and the A9 assembly.

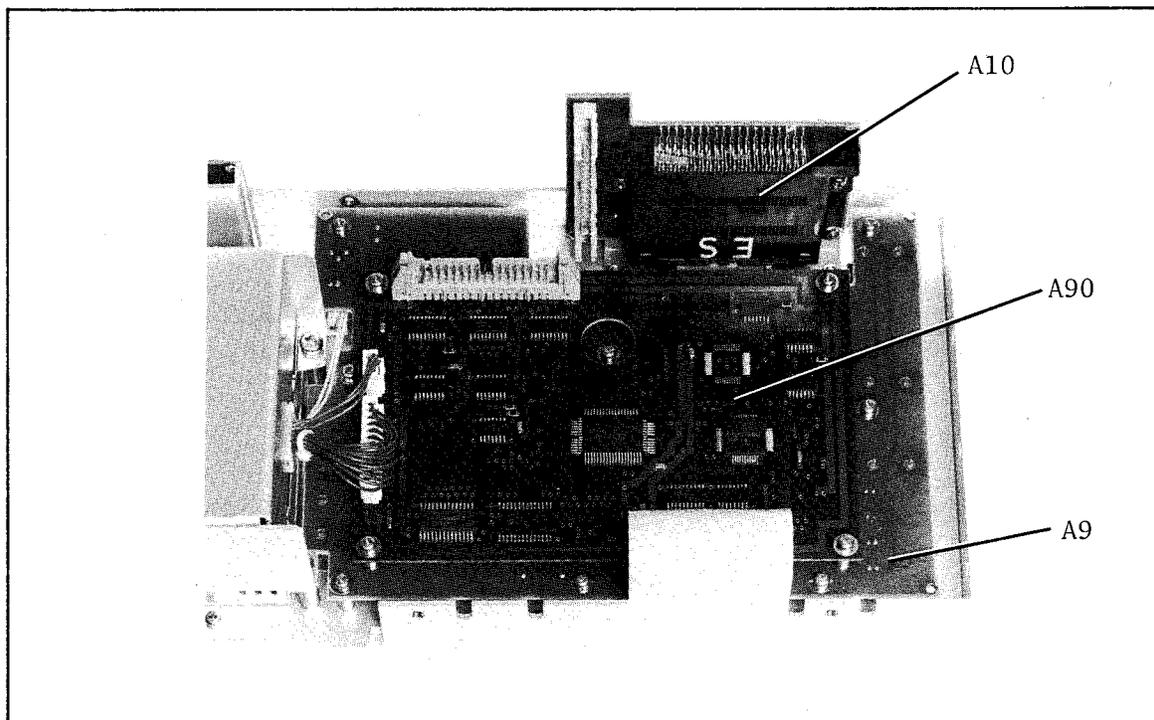


Figure 4-4. A9, A90, and A10 Assembly Removal

#### 4-7-7. A10 ASSEMBLY REMOVAL

First remove the front panel assembly from the 4278A as described in paragraph 4-7-4.

1. Disconnect the flatcable assembly that is connected to the motherboard from the A10 assembly as shown in Figure 4-4.
2. Remove the two screws, nuts, and washers that secure the A10 assembly to the MEMORY card bezel.

#### 4-7-8. A13 ASSEMBLY REMOVAL

First remove the front panel assembly from the 4278A as described in paragraph 4-7-4.

1. Remove four screws that secure the shield case on which the **WARNING** is printed as shown in Figure 4-5.
2. Remove the screw that secures the A13 assembly to the back of the shield case.
3. Disconnect the 3 pin cables from the A 90 assembly.
4. Disconnect the 3 pin cables from the A 91 assembly.

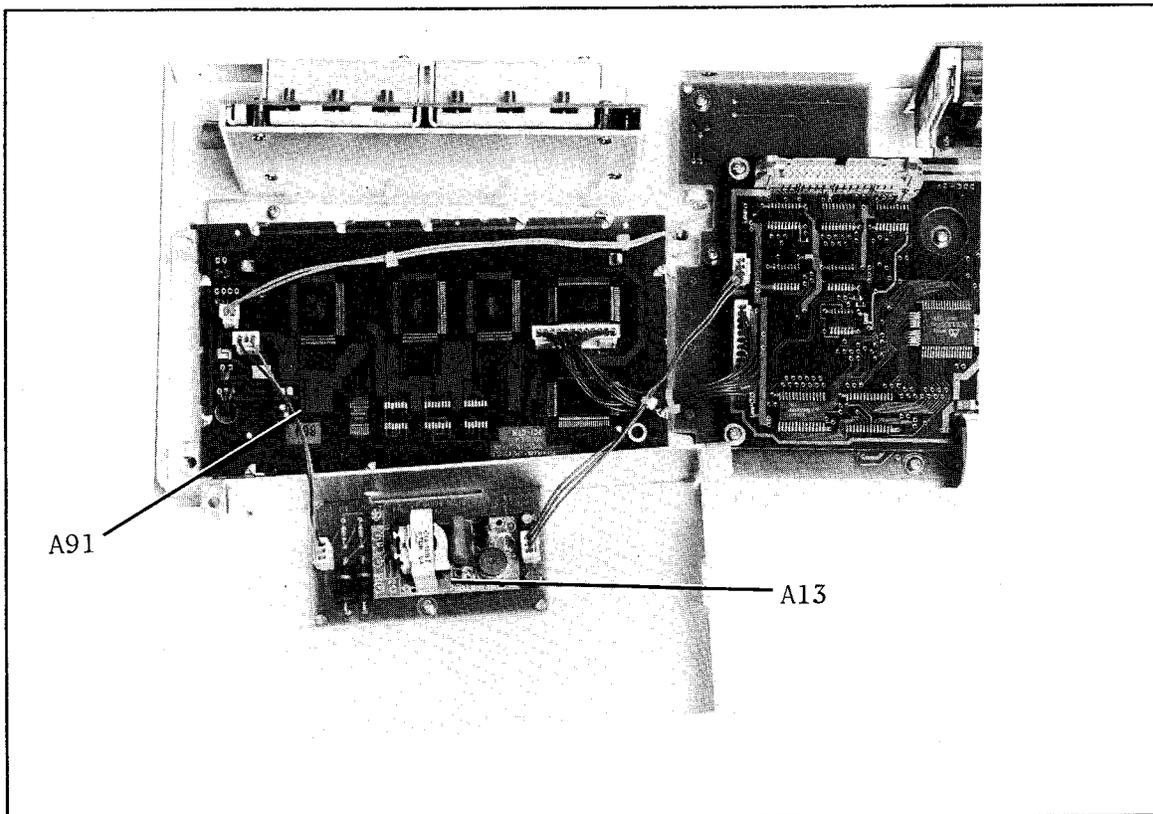


Figure 4-5. A13 and A91 Assembly Removal

#### 4-7-9. A91 ASSEMBLY REMOVAL

First remove the front panel assembly from the 4278A as described in paragraph 4-7-4.

1. Remove the four screws that secure the shield case on which the **WARNING** is printed as shown in Figure 4-5.
2. Remove the 3 pin cables connected to the A13 assembly from the A90 and A91 assemblies.
3. Remove the 12 pin cable connected to the A90 assembly from the A91 assembly.
4. Remove the 2 pin cable connected to the A9 assembly from the A91 assembly.

#### NOTE

The A91 assembly consists of the LCD panel and the control circuit. Do not disassemble the LCD module, the LCD panel and the circuit board must remain together as a unit.

## 4-8. BLOCK DIAGRAM DISCUSSION

Figure 4-6 shows the 4278A's analog circuit block diagram. Knowing the function of every board will help you to isolate and troubleshoot the faulty assembly.

The A1 board is the switching power supply and supplies DC voltages to all assemblies, and to the cooling fan on the rear panel. The output voltages are +5V,  $\pm 12V$ , +8V,  $\pm 15V$ ,  $\pm 48V$  and -20V for the electronic circuits, and  $\pm 12V$  for the cooling fan.

The test signals are generated on the A2 board. The test signal source is the 8.00MHz clock generator (8.08MHz on Option 003 units). The A2 board supplies the test signal and digital clocking signals to synchronize the analog measurement circuit. The differences between the A2 boards for 8.00MHz version and for 8.08MHz version are the crystal oscillator module and the ID jumper wire setting to be identified by the digital circuit.

The A3 board is the 1MHz transducer (not installed on option 001 4278As). The A3 board outputs a 1MHz signal whose amplitude and phase are proportional to the current flowing through the capacitor under test. This circuit should be thought of as a current-to-voltage-phase converter.

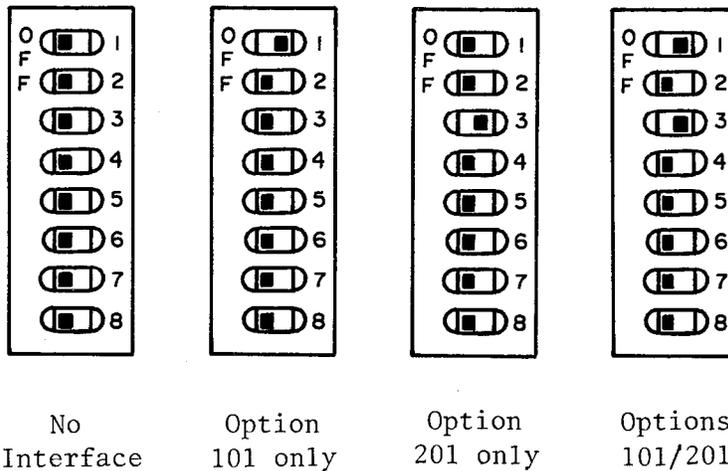
The A4 board is the 1kHz transducer (not installed on Option 002 4278As). The A4 board outputs two 1kHz signals -- one whose amplitude and phase are proportional to the current flowing through the capacitor under test, and the other is the buffered voltage applied to the capacitor under test.

The A5 board contains the switching matrix and phase detectors. There are four inputs to the A5 board -- the voltage across the capacitor under test for the 1kHz and 1MHz measurements, and the voltage proportional to the current flowing through the capacitor under test for 1kHz and 1MHz measurements. There are four phase detectors to detect the  $0^\circ$  and  $90^\circ$  components of the voltage proportional to the current flowing through the capacitor under test and the voltage applied to the capacitor under test. The switching matrix routes the signals between the inputs and the phase detectors.

The A6 board contains the four multi-slope A-D converters used to digitize the four output voltages from the A5 board.

The A7 board is the digital control board. This board controls all measurement circuits and interfaces. The clock frequency is 7.92MHz. There are two EEPROMs on the A7 board. One is usually write-protected and has the analog circuit's calibration data stored in it, and the other is not write-protected and the instrument's back-up data (compensation data etc.), is stored in it.

The A7 board determines which Options are installed in the 4278A by reading the ID signal bus and the settings of the A7S3 switches. The ID signal bus gives the information of which version A2 board is installed (8.00MHz or 8.08MHz (Option 003)), whether or not the A3 board is installed (Option 001), and whether or not the A4 board is installed (Option 002). The information on whether the 4278A is configured as option 101 or not, and whether the 4278A is configured as Option 201 or not is determined by reading the settings of the A7S3 switches.



The A8 board is the input switch and is located just behind the **UNKNOWN** terminals. The A8 board outputs the test signal from the A2 board to the  $H_{CUR}$  terminal. The  $H_{POT}$ ,  $L_{POT}$ , and  $L_{CUR}$  signals are connected to the A3 (A5), board or to the A4 board depending on the test frequency selected.

The A9 board is the front panel keyboard. Key switches, LED indicators and the CONTRAST adjustment potentiometer are located on the A9 board.

The A10 board is the memory card socket board. The only component on this board is the memory card connector.

The A13 board is the DC-to-AC converter which supplies approx. 600 Vac to backlight the LCD.

The A20 and the A30 boards are the HP-IB and the Handler interfaces, respectively.

The A90 board is the display and the keyboard control circuit. This interfaces the digital control circuit on the A7 board to the LCD module and the switches and indicators on the A9 board.

The A91 assembly is the LCD module. This includes the digital control and driver circuits for the LCD and the LCD panel.

ANALOG SECTION BLOCK DIAGRAM

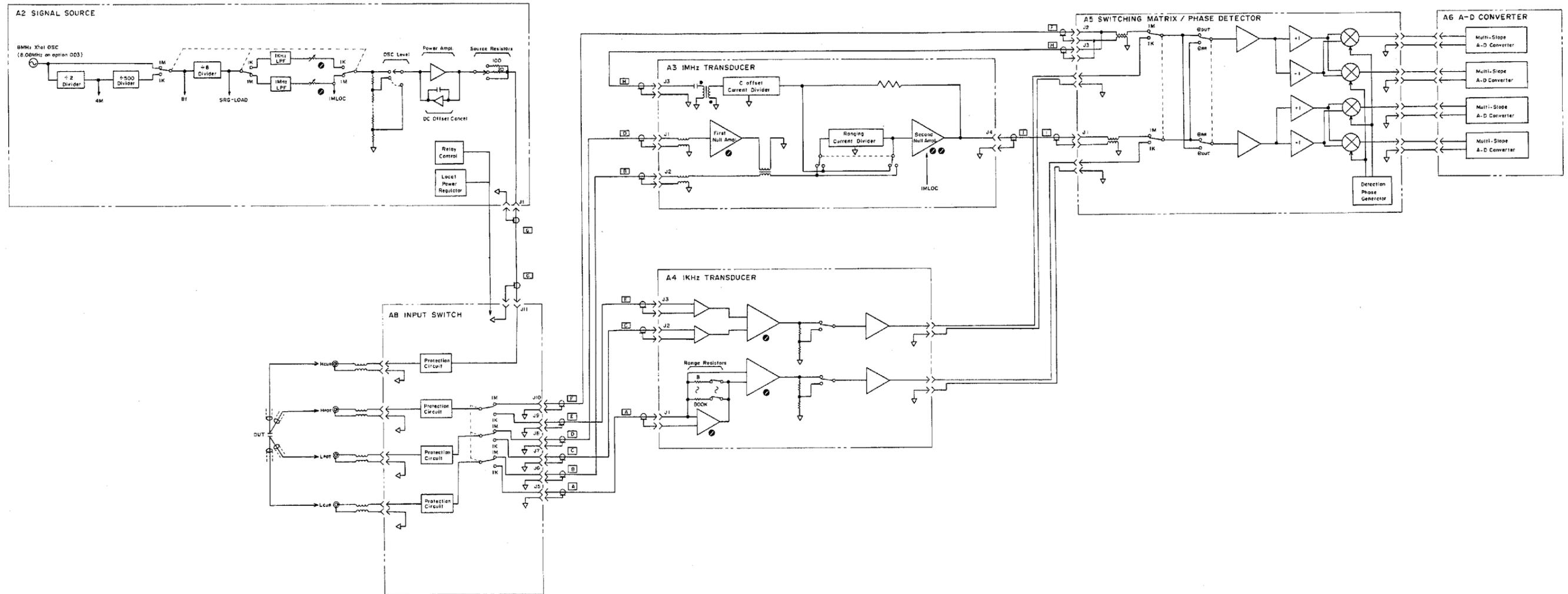


Figure 4-6. Analog Circuit Block Diagram

## 4-9. TROUBLESHOOTING

Paragraph 4-9-1 describes the 4278A's Self Tests. Paragraph 4-9-2 describes the troubleshooting procedure of using flow charts to isolate the faulty board.

### 4-9-1. SELF TEST

The 4278A's self tests can be categorized into the following three types: Power on self test, Softkey selected self test, and Hardware selected (bit switch selected), self test.

#### 1. Power on self test

Every time the 4278A is turned on it performs a power on self test during the power on sequence. When the power on sequence halts because of a failure, the LED indicators on the A7 board indicate which power on sequence step was being performed at the time of the failure. Use this information as a troubleshooting aid to localize the problem. The following chart shows the power on sequence and the LED indication pattern. LED numbers are designated by their top to bottom position on the A7 board.

LED Pattern ( 1 = ON 0 = OFF )								Task
Upper				Under				
1	2	3	4	5	6	7	8	
x	x	x	x	x	x	x	x	Clears memory card read/write flip-flop
x	x	x	x	x	x	x	x	Turns off memory card power supply
1	1	1	1	1	1	1	1	LED test
1	0	0	0	0	0	0	0	LED test
0	1	0	0	0	0	0	0	LED test
0	0	1	0	0	0	0	0	LED test
0	0	0	1	0	0	0	0	LED test
0	0	0	0	1	0	0	0	LED test
0	0	0	0	0	1	0	0	LED test
0	0	0	0	0	0	1	0	LED test
0	0	0	0	0	0	0	1	LED test
0	0	0	0	0	0	0	0	LED test
1	0	0	0	0	0	0	0	Initializes LCD controller <sup>1</sup>
0	1	0	0	0	0	0	0	Initializes timer on A7 <sup>1</sup>
1	1	0	0	0	0	0	0	Initializes timer on A90 <sup>1</sup>
0	0	1	0	0	0	0	0	Initializes A90 <sup>1</sup>
1	0	1	0	0	0	0	0	Initializes timers for A-D Converters <sup>1</sup>
0	1	1	0	0	0	0	0	Initializes HP-IB chip on A20 <sup>2</sup>
1	1	1	0	0	0	0	0	Initializes PIA chip on A30 <sup>3</sup>
0	0	0	1	0	0	0	0	Clears all interrupt signal
1	0	0	0	0	0	0	0	RAM read/write test
1	0	0	0	0	0	0	0	Displays "Copyright" message
1	0	0	0	0	0	0	0	ROM check sum test
1	0	0	0	0	0	0	0	EEPROM #0 check sum test
1	0	0	0	0	0	0	0	EEPROM #1 check sum test
1	0	0	0	0	0	0	0	Analog test (1kHz)
1	0	0	0	0	0	0	0	Analog test (1MHz)
1	0	0	0	0	0	0	0	Starts measurements

- <sup>1</sup> If the power on test stops here, A7 data acknowledgement circuit is faulty.
- <sup>2</sup> If the power-on test stops here, the A20 is faulty.
- <sup>3</sup> If the power-on test stops here, A30 is faulty.

One of the error messages listed in Table 4-2 will be displayed when the 4278A fails the power-on self test,

Table 4-2. Error Message

Error Message	Meaning
RAM TEST ERROR	This message is displayed when the RAM read/write test fails.
ROM CHECK SUM ERROR NO=xx	This message is displayed when the check sum of any of the programmed ROMs is incorrect. The ROM number with this message is given in Figure 3-6.
EEPROM CSUM ERROR NO=0	This message is displayed when the check sum of EEPROM (0) is incorrect. The calibration data in the EEPROM is lost, thus auto calibration (refer to the paragraph 1-12. AUTO CALIBRATION) must be performed.
EEPROM CSUM ERROR NO=1	This message is displayed when the EEPROM #1 check sum is incorrect. The back-up data (compensation data etc.) in the EEPROM is lost.
A6 B'd is not working	This message is displayed when the A-D converter's End Of Conversion signal from the A6 board is not output.
ANALOG TEST (1kHz) FAILED	This message is displayed when the boards used for the 1kHz measurement have failed.
ANALOG TEST (1MHz) FAILED	This message is displayed when the boards used for the 1MHz measurement have failed.

## 2. Self Tests Selected by Softkeys

The following self tests can be performed using softkey operations. The self tests are performed as follows.

1. Press the **MENU**, and **PREV** keys and the '**SVC FNCTN**' softkey.
2. Press the '**SELF TEST**' softkey to display the Test Menu Page listed in Table 4-3 (there are two pages in the the Test Menu Page). Press the '**other menu**' softkey to swap Test Menu Pages.
3. Press the '**TEST NO.=**' softkey.
4. Enter the desired test number and press the **ENTER** key.
5. Press the '**TEST START**' softkey to start the selected test.
6. Press the '**TEST ABORT**' softkey to stop the test in progress.

7. Press the '**TEST MENU**' softkey to select another test.
8. When the self tests are completed, press the '**exit TEST**' softkey.

Table 4-3. Test Menu Page

PAGE 1		PAGE 2	
NO.	SELF TEST MENU 1/2	NO.	SELF TEST MENU 2/2
1:	A3 1MHz TRD-C offset div test	10:	ROM check sum display
2:	A3 1MHz TRD-Range div test	11:	Memory card R/W test
3:	A3 1MHz TRD-1st null amp test	12:	LED display test
4:	A3 1MHz TRD-2nd null amp test	13:	LCD display test
5:	A4 1kHz TRD test	14:	Handler I/F test
6:	A5 1kHz SWM/PHD test		
7:	A5 1MHz SWM/PHD test		
8:	A6 ADC test		

**NOTE**

Perform the analog circuit self-tests (NO. 1 to NO. 8), in the following order.

NO.8, NO.7, NO.6, NO.5, NO.4, NO.3, NO.1, and NO.2.

The softkey selected self tests are described by self-test number as follows.

### 1. A3 1MHz TRD-C offset div test

Checks the C-offset current divider on the A3 board used for 1MHz high accuracy measurements. Perform this test after confirming the A2, A5, and A6 boards used in this test are working properly.

In this test, the 4278A's setup is different from the typical measurement setup in order to check the C-offset current divider, as shown in the Figure 4-7.

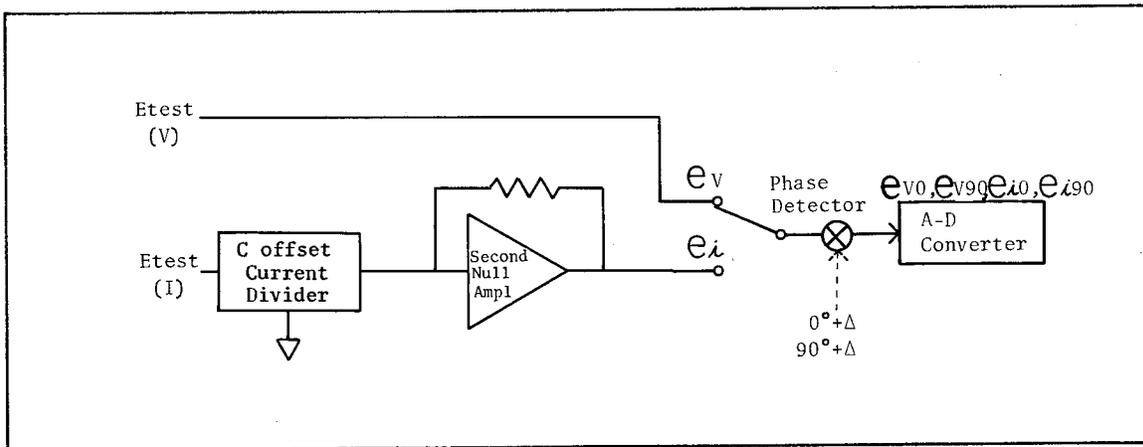


Figure 4-7. C-offset Current Divider

During this test, internal test current ( $E_{TEST-I}$ ), is applied to the C-offset current divider, and the divided current is converted into voltage signal  $e_I$ , by the second null amplifier.  $e_I$  is phase detected on the A5 board and the detected  $e_I$  is converted to a digital value on the A6 board. The internal test voltage ( $E_{TEST-V}$ ), is applied directly to the A5 board as  $e_V$ .  $e_V$  is phase detected on the A5 board, and the detected  $e_V$  is converted to a digital value on the A6 board.

The digital values of  $e_I$  and  $e_V$  are used to calculate the ratio ( $|e_I/e_V|$ ). The 4278A changes only the setting of the C-offset current divider and repeats the measurement again and calculates the ratio ( $|e_I/e_V|$ ). Finally the two calculated ratios are used to calculate the setting error ratio of the C-offset current divider, and then the result is displayed.

This test will pass when the calculated result is within the limits as follows.

$$\text{RESULT} < 0.5$$

## 2. A3 1MHz TRD-Range Div Test

This test checks the ranging current divider used for 1MHz measurements on the A3 board. Perform this test after you confirm the A2, A5, and A6 boards used in this test are working properly.

In this test, the 4278A's setup is different from the typical setup in order to check the ranging current divider, as shown in the Figure 4-8.

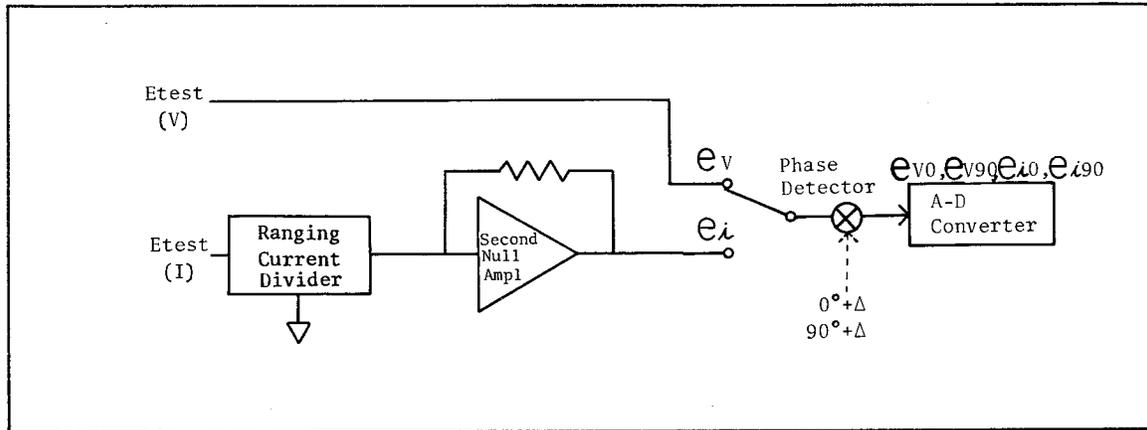


Figure 4-8. Ranging Current Divider

When this test is performed, the internal test current signal ( $E_{\text{TEST-I}}$ ), is applied to the ranging current divider which is set to the 16pF measurement range, and the divided current signal is converted to the voltage  $e_I$  by the second null amplifier. The converted  $e_I$  is phase detected on the A5 board, and the detected  $e_I$  is converted to a digital value on the A6 board.

The internal test voltage signal ( $E_{\text{TEST-V}}$ ), is input directly to the A5 board as  $e_V$ .  $e_V$  is phase detected on the A5 board, and the detected  $e_V$  is converted to a digital value on the A6 board. Then the  $e_I$  and  $e_V$  digital converted values are used to calculate the ratio  $|e_I/e_V|$ .

The 4278A sets the ranging current divider to the 8pF measurement range and repeats the preceding procedure again to calculate the ratio  $|e_I/e_V|$ . Then, using the two calculated ratios, the setting error ratio of the ranging current divider is calculated, and that result is displayed (RESULT 1).

Similarly by changing the setting of the Range Current Divider to each range (32pF range for RESULT 2, 64pF range for RESULT 3, 128pF range for RESULT 4, 256pF range for RESULT 5, 512pF range for RESULT 6, and 1024pF range for RESULT 7), the ratio  $|e_I/e_V|$ , for each range is calculated. By using the calculated ratio for each range and the ratio of 16pF range setting as a reference, the setting errors of the ranging current divider are calculated and the results are displayed.

This test will pass when all results are within the following listed limits.

**Limit Values**

RESULT 1	<	0.02
RESULT 2	<	0.02
RESULT 3	<	0.03
RESULT 4	<	0.07
RESULT 5	<	0.1
RESULT 6	<	0.2
RESULT 7	<	0.4

### 3. A3 1MHz TRD-1st Null Amp Test

This test checks the first null amplifier on the A3 board used for 1MHz measurements. This test is also used for performing the adjustment given in paragraph 1-10-2. Perform this test after you confirm that the A2, A5, and A6 boards used in this test are working properly.

In this test, the 4278A's setup is different from the typical measurement setup in order to check the first null amplifier, as shown in the Figure 4-9.

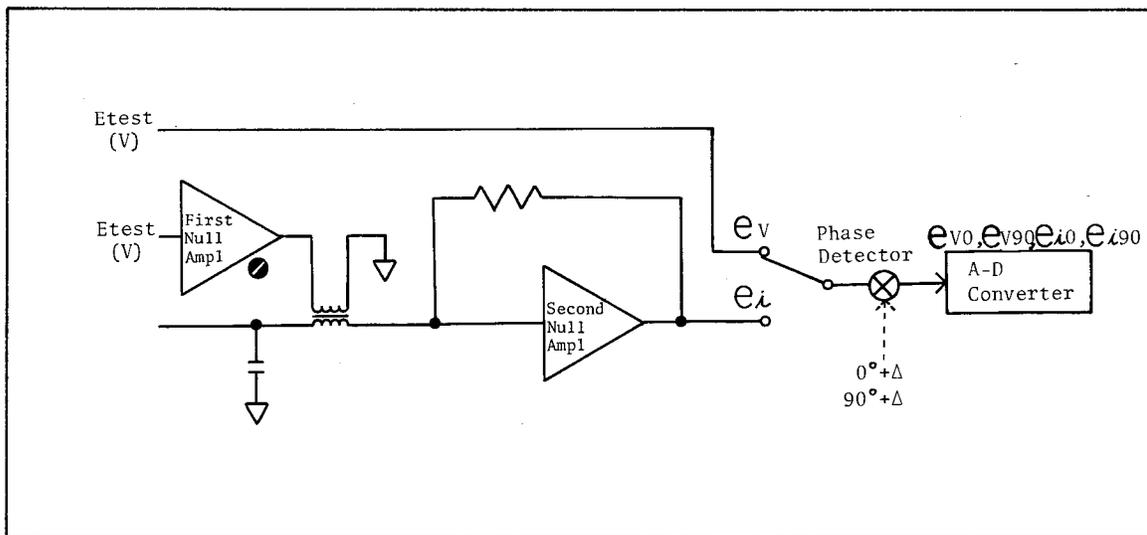


Figure 4-9. First Null Amplifier

When this test is performed, the internal test voltage ( $E_{TEST}-V$ ), is applied to the first null amplifier. The output current signal from the first null amplifier is checked as follows.

The output current signal is converted into voltage signal ( $e_I$ ), by the second null amplifier.  $e_I$  is phase detected on the A5 board and the detected  $e_I$  is converted to a digital value on the A6 board.

The internal test voltage  $E_{TEST}-V$ , is input directly to the A5 board as  $e_V$ .  $e_V$  is phase detected on the A5 board and the detected  $e_V$  is converted to a digital value on the A6 board. The digital values of  $e_I$  and  $e_V$  are used to calculate the ratio  $|e_I/e_V|$ , which is then displayed.

This test will pass when the calculated result is within the limit listed as follows.

#### Limit Values

$$0.04 < \text{RESULT} < 0.4$$

#### 4. A3 1MHz TRD-2nd Null Amp Test

This test checks the second null amplifier on the A3 board which is used for making 1MHz measurements. This test is also used for performing the adjustment given in paragraph 1-10-1. Perform this test after you confirm the A2, A5, and A6 used in this test are working properly. This test must be performed while connecting the **OPEN** standard to the **UNKNOWN** terminals, or making connects between the  $H_{CUR}$  and  $H_{POT}$  terminals, and between the  $L_{CUR}$  and  $L_{POT}$  terminals by using the two BNC cable which are as short as possible.

The 4278A is setup as follows for this test. Refer Figure 4-10.

Measurement Frequency	1MHz (normal mode)
Measurement Range	16pF
OSC. Level	1Vrms

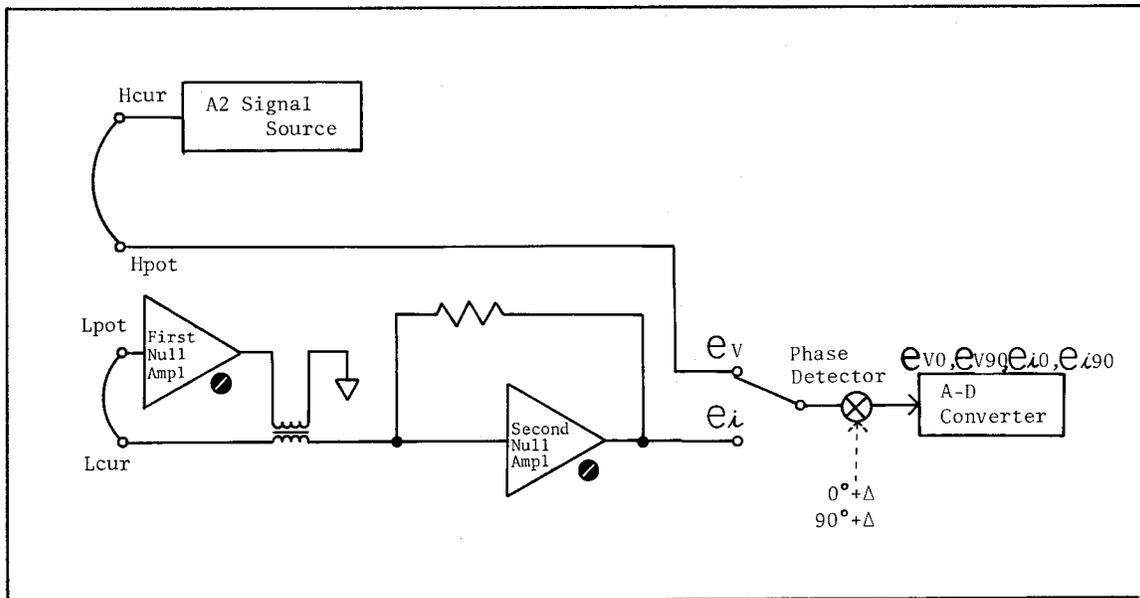


Figure 4-10. Second Null Amplifier

The 1Vrms signal from the A2 board is input directly to the A5 board as  $e_v$ .  $e_v$  is phase detected on the A5 board and the phase detected  $e_v$  is converted to a digital value on the A6 board. The second null amplifier converts the noise current flowing through the first null amplifier is converted to voltage  $e_i$ .  $e_i$  is phase detected on the A5 board and the phase detected  $e_v$  is converted to a digital value on the A6 board. The digital values of  $e_i$  and  $e_v$  are used to calculate the ratio  $|e_i/e_v|$ , and the result is displayed.

This test will pass when the calculated result is within the limit listed as follows.

#### Limit Values

RESULT < 0.0003

## 5. A4 1kHz TRD Test

This test checks the operation of the transducer circuit on the A4 board. Perform this test after you confirm the A2, A5, and A6 boards used in this test are working properly.

The 4278A's setup in this test is different from the typical measurement setup in order to check the 1kHz transducer circuit, as shown in the Figure 4-11.

There are two attenuators on the A4 board, one for the I-channel and one for the V-channel. Each attenuator has two settings, ON and OFF. The ON setting of the attenuator (Low Gain), is used when the OSC level is from 0.4Vrms to 1.0Vrms, and the OFF setting of the attenuator (High Gain), is used when the OSC level is from 0.1Vrms to 0.3Vrms. This test uses both attenuator settings to check the transducer circuit.

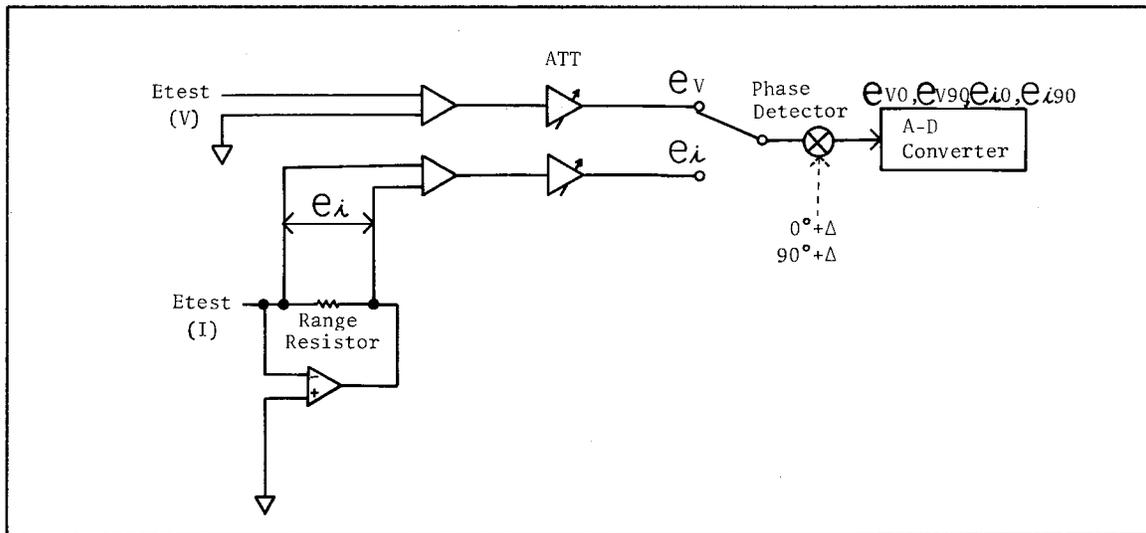


Figure 4-11. 1kHz Transducer

During this test the internal test voltage signal ( $E_{\text{TEST}}-V$ ), is applied to the differential amplifier, and the output signal from of the differential amplifier passes through the attenuator (ON), and is input to the A5 board as  $e_v$ .  $e_v$  is phase detected on the A5 board, and the phase detected  $e_v$  is converted to a digital value on the A6 board.

The internal test current ( $E_{\text{TEST}}-I$ ), is applied to the I-V converter and converted. The output from the I-V converter passes through the attenuator (ON), and is input to the A5 board as  $e_i$ .  $e_i$  is phase detected on the A5 board, and the detected  $e_i$  is converted to a digital value on the A6 board. The amplitude values (ABS(I)), of  $e_i$ , the ratio (ABS(I/V)), of  $e_i$  and  $e_v$ , and the phase difference (TANGENT), of  $e_i$  and  $e_v$  are calculated using both  $e_i$  and  $e_v$  digital values. The calculated values are displayed. The 4278A changes the attenuator's setting (OFF) and repeats the preceding procedure.

This test will pass when the calculated results are within the limits listed as follows.

#### Limit Values

##### OSC LVL=1.0V (low gain)

22100	≤	ABS(I)	≤	30800
0.96420	≤	ABS(I/V)	≤	0.9935
-0.03842	≤	TANGENT	≤	0.0

##### OSC LVL=0.3V (high gain)

73800	≤	ABS(I)	≤	102500
0.96420	≤	ABS(I/V)	≤	0.9935
-0.03842	≤	TANGENT	≤	0.0

## 6. A5 1kHz SWM/PHD Test

This test checks the switching matrix and the phase detector used for the 1kHz measurement function on the A5 board. Perform this test after you confirm the A2 and A6 boards used in this test are working properly.

In this test the 4278A setup is different from the typical measurement setup to check the switching matrix and phase detector, as shown in the Figure 4-12.

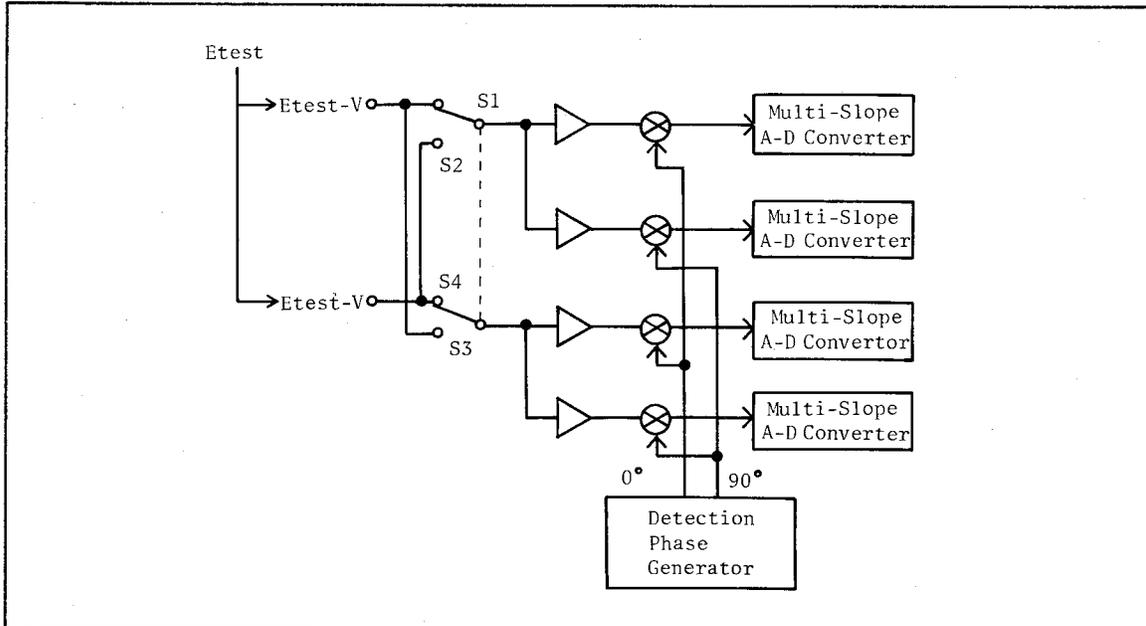


Figure 4-12. 1kHz Switching Matrix and Phase Detector

During this test internal test voltage signal ( $E_{TEST-V}$ ), is input to the switching matrix and the 4278A sets only S1 of the switching matrix to ON. The applied test signal ( $e_I = E_{TEST-V}$ ), is phase detected on the A5 board, and the detected  $e_I$  is converted to a digital value on the A6 board. The amplitude values ( $I_A$ ), are calculated using these digital values.

The 4278A repeats the preceding procedure, changing only the switching matrix switch which is ON from S2 to S4. Each amplitude value ( $V_a$ ), is calculated when the 4278A sets only S2 ON, ( $I_B$ ), with only S3 ON, and ( $V_B$ ), with only S4 ON.

This test will pass when all calculated results are within the limits listed as follows.

### Limit Values

164100	≤	$I_A$	≤	226700
164100	≤	$V_A$	≤	226700
164100	≤	$I_B$	≤	226700
164100	≤	$V_B$	≤	222670

## 7. A5 1MHz SWM/PHD Test

This test checks the switching matrix and phase detector used for the 1MHz measurement function on the A5 board. Perform this test after you confirm the A2 and A6 boards used in this test are working properly.

In this test the 4278A's setup is different from the typical measurement setup in order to check the switching matrix and phase detector, as shown in the Figure 4-13.

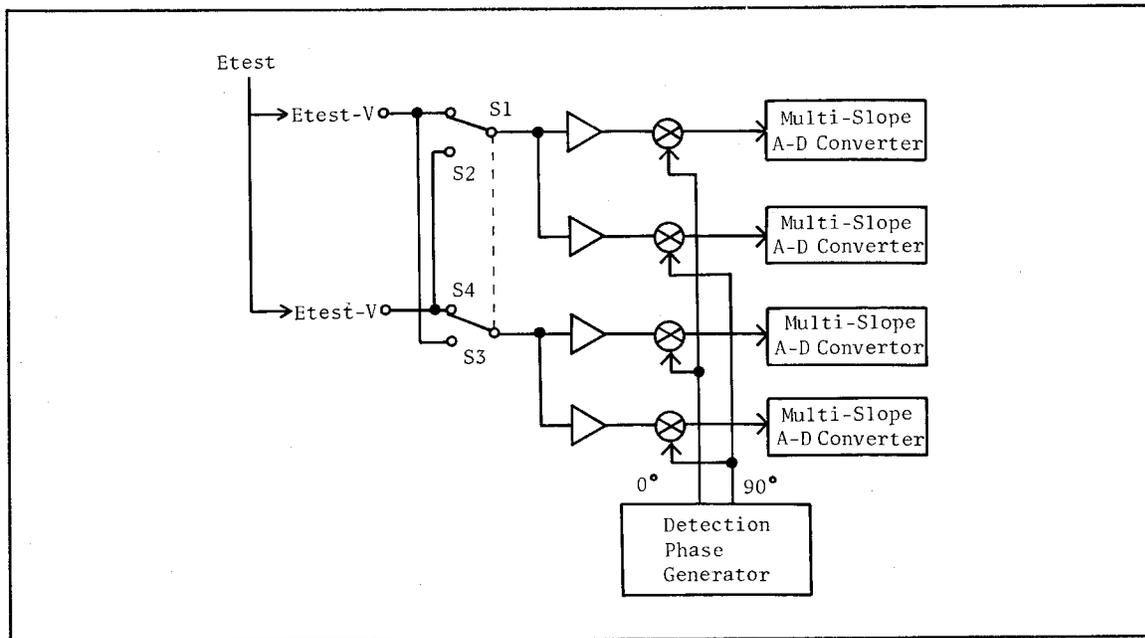


Figure 4-13. 1MHz Switching Matrix and Phase Detector

When this test is performed, the internal test voltage signal ( $E_{TEST-V}$ ), is input to the switching matrix, and the 4278A sets S1 only of the switching matrix to ON. The detected  $e_I = E_{TEST-V}$  is phase detected on the A5 board and the detected  $e_I$  is converted to a digital value by the A6 board. The amplitude value (IA), is calculated using the these digital values.

The 4278A repeats the preceding procedure, changing only the ON switching matrix switch from S2 to S4. Each amplitude value is calculated as (VA), when the 4278A sets only S2 to ON, (IB), with only S3 ON, and (VB), with only S4 ON.

This test will pass when the all calculated results are within the limits listed as follows.

### Limit Values

156300	≤	IA	≤	234500
156300	≤	VA	≤	234500
156300	≤	IB	≤	234500
156300	≤	VB	≤	234500

**8. A6 ADC Test**

This test checks the four analog-to-digital converters (A-D converters), on the A6 board.

In this test the 4278A's setup is different from the typical measurement setup to check the A-D converters. The four A-D converters each have their own offset circuit and offset value. When this test is performed, the offset value for each A-D converter is used when that converter is under test. The A-D converter test values are displayed as ADC1, ADC2, ADC3, and ADC4.

This test will pass when the test values of the four multislope A-D converters are within the following limits.

**Limit Values**

197000	≤	ADC1	≤	240000
197000	≤	ADC2	≤	240000
197000	≤	ADC3	≤	240000
197000	≤	ADC4	≤	240000

**10. ROM Check Sum Display**

This test lists the check sum of all programmed ROMs. If any of check sums are incorrect, the 4278A will stop during the power on self test, therefore you normally won't need to perform this self test.

**11. Memory Card R/W Test**

This test performs a read/write test of the memory card. This test will overwrite any test data on the memory card, thus destroying the stored data.

**12. LED Display Test**

This test repeatedly turns the LED indicators on the front panel ON and OFF.

**13. LCD Display Test**

This test repeatedly reverses all dots on the LCD panel, except for the dots for the lines that partition the softkey labels which will remain on.

**14. Handler I/F Test**

This test sequentially activates all of the handler interface output pins.

3) Self Tests Selected Using the Bit Switch

Following self tests can be performed by setting the A7S3 bit switch. Table 4-4 shows the A7S3 bit switch setting patterns and their description.

Table 4-4. Bit Switch Location and Patterns (1/2)

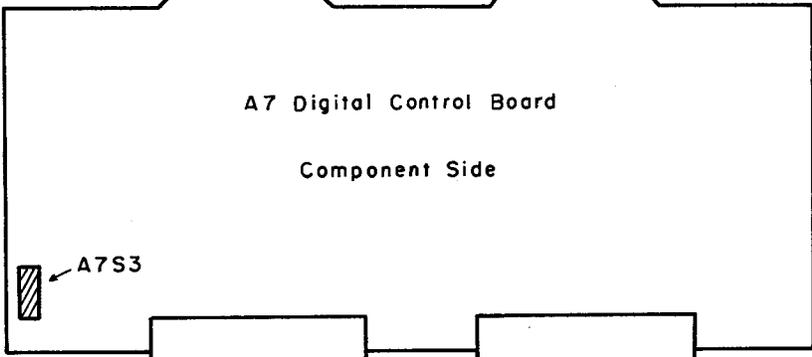
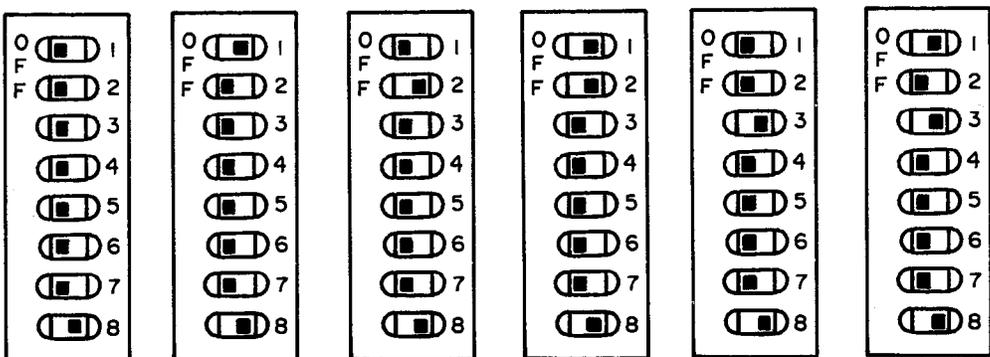
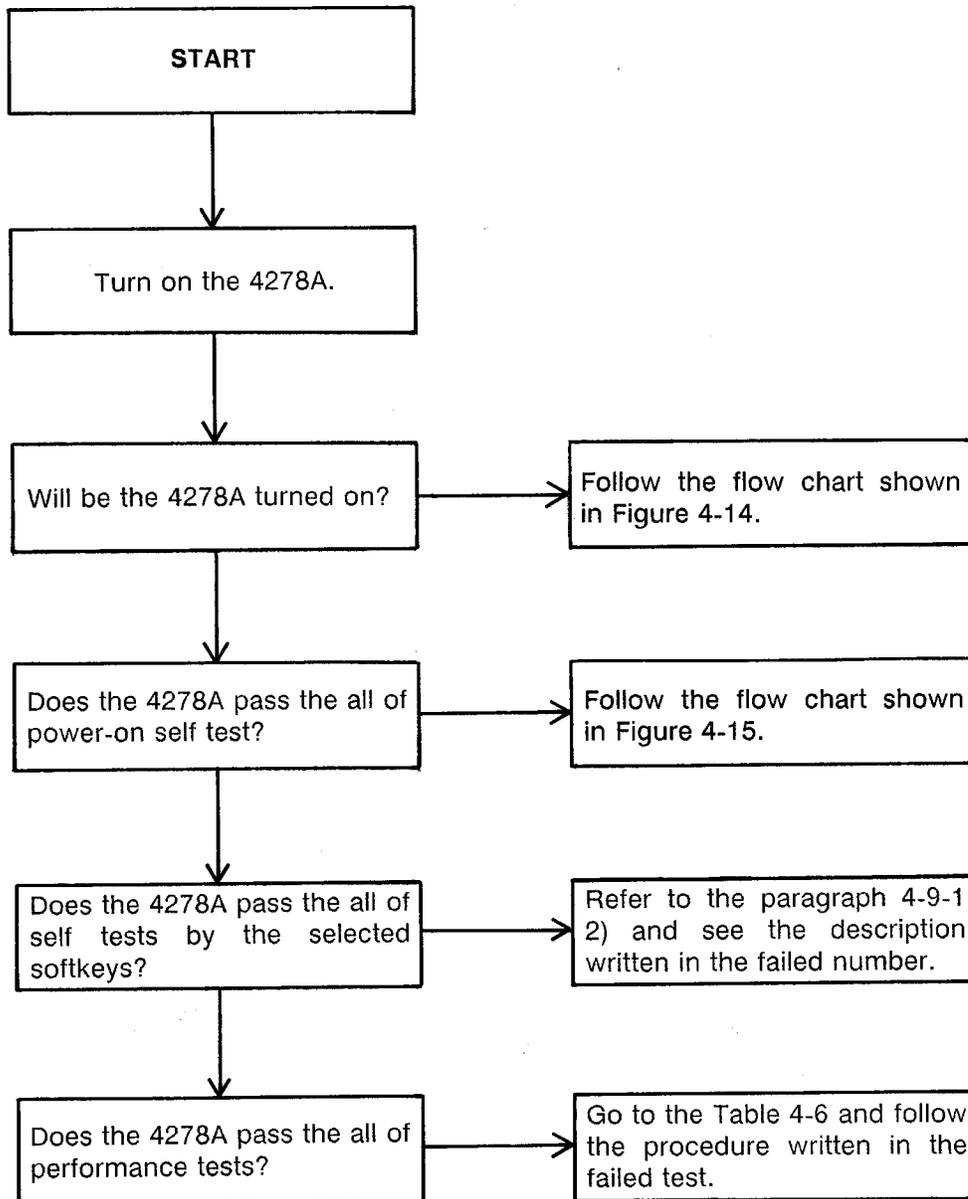
 <p style="text-align: center;">A7 Digital Control Board Component Side</p> <p style="text-align: center;">A7S3</p>	
 <p style="text-align: center;">No. 0      No. 1      No. 2      No. 3      No. 4      No. 5</p>	
Bit Switch Setting Number	Description
0	ROM checksum display.
1	RAM read/write test.
2	The EEPROM for back-up read/write test. By performing this test, back-up data (compensation data etc.) in the EEPROM will be lost.

Table 4-4. Bit Switch Location and Patterns (2/2)

Bit Switch Setting Number	Description
3	The front panel keyboard test. The code of the key pressed and its abbreviated name will be displayed.
4	<b>EEPROM initialization. This test will clear all the calibration data. Do not perform this, except when replacing the EEPROM. The EEPROM calibration described in paragraph 1-12 must be performed, after this test is performed.</b>
5	LCD test. All dots on the LCD are repeatedly turned ON and OFF.

**4-9-2. TROUBLESHOOTING PROCEDURE**

This paragraph consists primarily of the following flow chart. If you think the problem or trouble is in the 4278A, use the this flow chart to identify which board is faulty.



The 4278A is ON, but the LCD display back light is not ON. For this problem, refer to Figure 4-18.





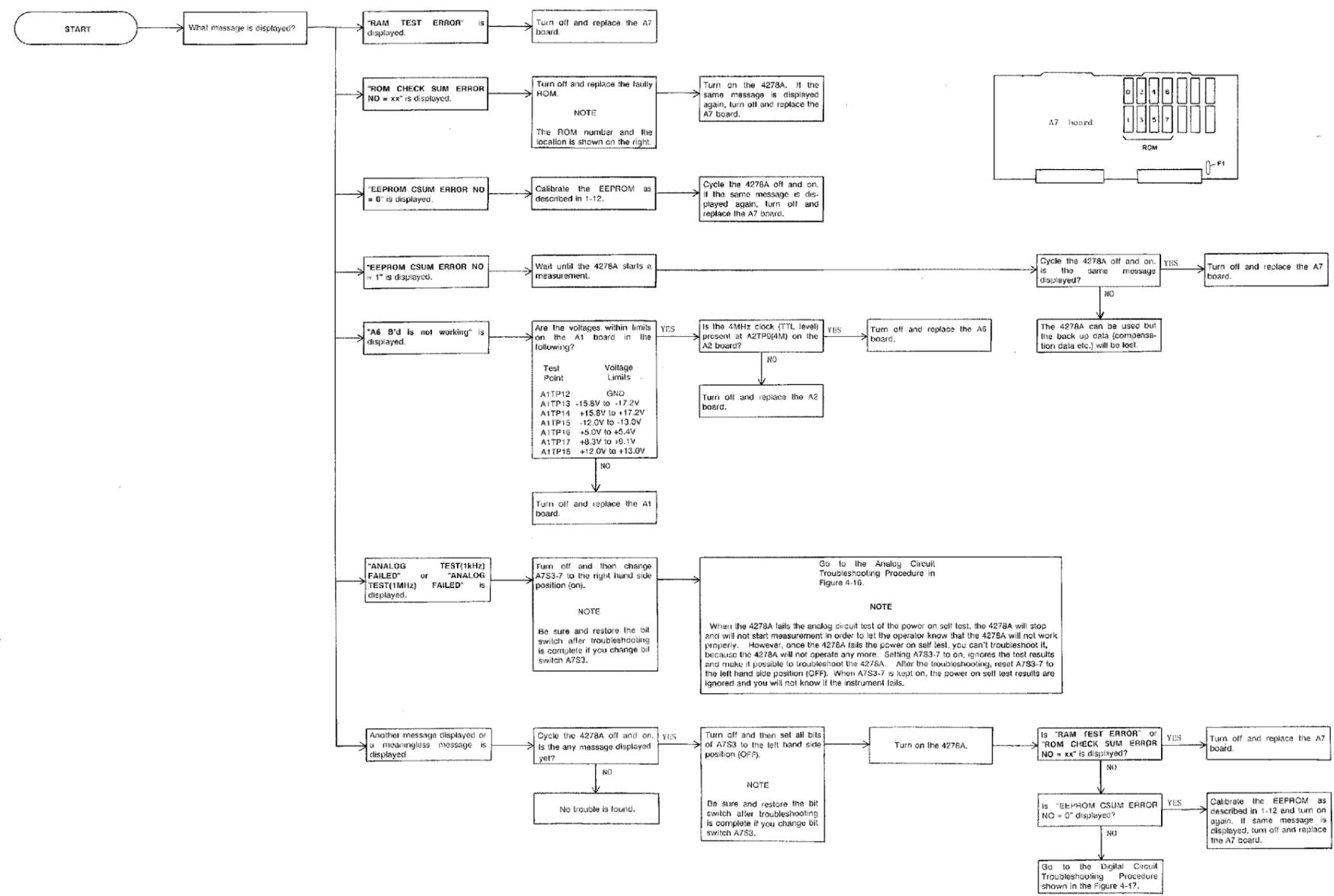


Figure 4-15. When The 4278A Fails The Power-On Self Test.

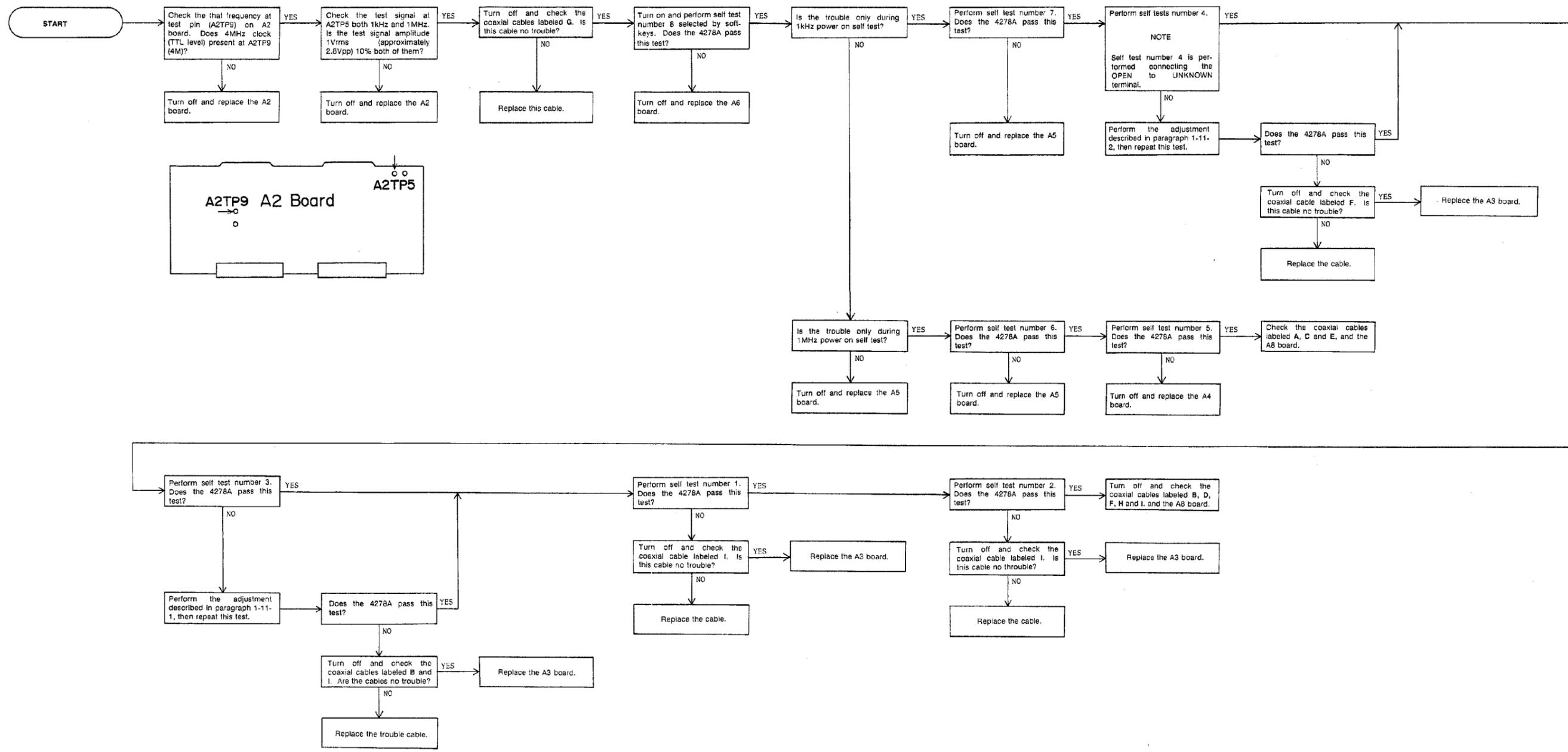


Figure 4-16. Analog Circuit Troubleshooting Procedure.

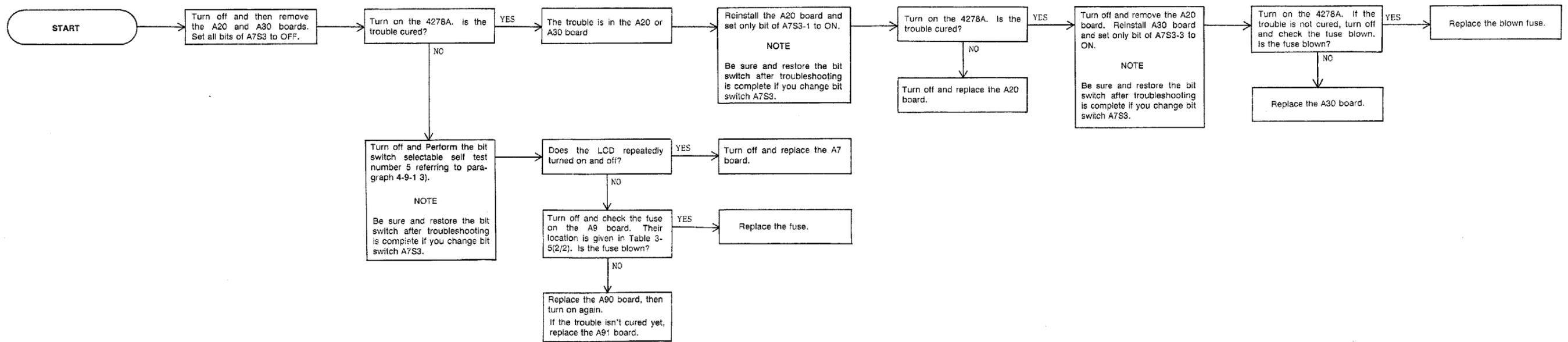


Figure 4-17. Digital Circuit Troubleshooting Procedure.

Table 4-5 gives troubleshooting information based on Performance Test failures.

Table 4-5. When the Performance Tests Fail (1/2)

Test Failed	Checked Board and Coaxial Cable	Verification Method
Test frequency accuracy	A2, A8, G	Check the test signal at A2TP5 (EOSC). If the test signal is approximately 1Vrms (approximately 2.8Vpp) but not present at A2TP5, replace the A2 board, otherwise check the coaxial cable labeled G and the A8 board.
Test signal level accuracy	A2, A8, G	Check the test signal at A2TP5 (EOSC). If the test signal is approximately 1Vrms (approximately 2.8Vpp) but is not present at A2TP5, replace the A2 board, otherwise check the coaxial cable labeled G and the A8 board.
1kHz capacitance accuracy	A8, A, C, E	Check the coaxial cable labeled A, C, and E, and the A8 board.
1MHz capacitance accuracy	A8, B, D, F, H, I	Check the coaxial cable labeled B, D, F, H, and I, and the A8 board.
1kHz/1MHz fluctuation	A3, A4, A5	If the 4278A fails the 1kHz fluctuation check only, replace the A4 board. If it fails only the 1MHz fluctuation check only, replace the A3 board. If both 1kHz and 1MHz fluctuation checks fail, replace the A5 board.
Store and load function	A10	Perform the test using another memory card. If the test still fails, replace the A10 board.

Table 4-5. When the Performance Tests Fail (2/2)

HP-IB interface function	A20	Check the HP-IB connector on the rear panel and the flatcable connected to it. If the trouble is not on the connector and cable, replace the A20 board.
Handler interface function	A30	Check the handler interface connector on the rear panel and the flatcable connected to it. If the trouble is not on the connector and cable, replace the A30 board.

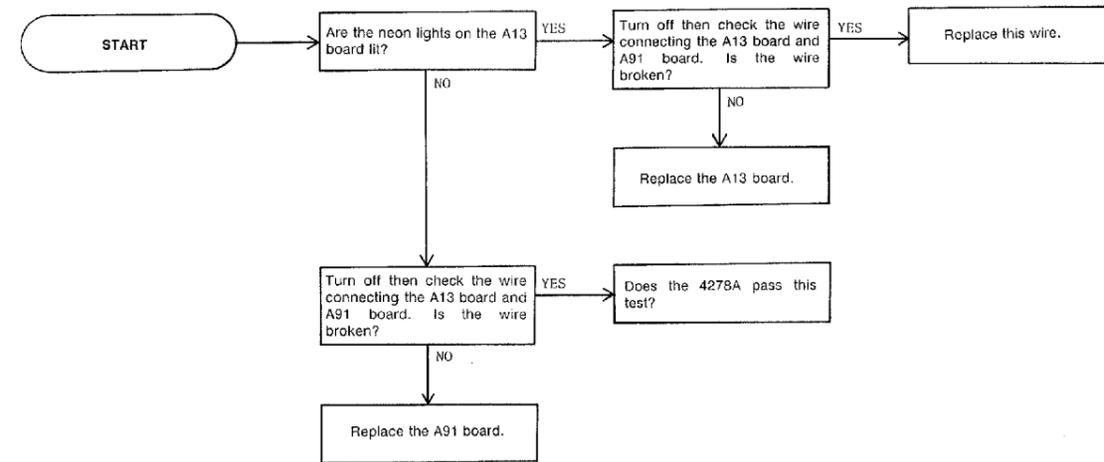


Figure 4-18. The Back Light On The Display Is Not Lighting.

**APPENDICES**

**APPENDIX A.    MANUAL CHANGES**

A-1



**MANUAL CHANGES  
A****APPENDIX**

Appendix A contains information for 4278A's to which the content of this manual does not directly apply.

To adapt this manual to your instrument, refer to Table A and make all of the manual changes listed opposite of the serial number group in which the serial number of your 4278A belongs.

If your instrument serial number is not listed on the title page of this manual or in Table A, it may be documented in the yellow MANUAL CHANGES supplement. For additional information on serial number coverage, refer to **INSTRUMENTS COVERED BY MANUAL** in **SECTION 5** of the **Operation Manual**.

Table A. Manual Changes by Serial Number

Serial Prefix or Number	Make Manual Changes



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