Agilent 4288A 1kHz/1MHz Capacitance Meter

Service Manual

Second Edition

FIRMWARE REVISIONS/SERIAL NUMBERS

This manual applies directly to instruments which has
the firmware revision A.01.10 and the serial number prefix JP1KH.
For additional important information about firmware revisions and serial numbers, see Appendix A.

Agilent Technologies

Manufacturing No. 04288-90200

July 2007

Notices

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Manual Printing History

The manual's 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.

April 2001	First Edition (part number: 04288-90100)
July 2007	Second Edition (part number: 04288-90200)

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.

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

NOTE 4288A comply with INSTALLATION CATEGORY II and POLLUTION DEGREE 2 in IEC61010-1. 4288A are INDOOR USE product.

NOTE LEDs in 4288A are Class 1 in accordance with IEC60825-1.
CLASS 1 LED PRODUCT

- 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.

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

Safety Symbol

General definitions of safety symbols used on the instrument or in manuals are listed below.


Instruction Manual symbol: the product is marked with this symbol when it is necessary for the user to refer to the instrument manual.

Alternating current.

Direct current.

On (Supply).


Off (Supply).


In position of push-button switch.


Out position of push-button switch.


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

WARNING **This warning sign 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 This Caution sign 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 damage to or destruction of part or all of the product.

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

Certification

Agilent Technologies certifies that this product met its published specifications at the time of shipment from the factory. Agilent Technologies further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology, to the extent allowed by the Institution’s calibration facility, or to the calibration facilities of other International Standards Organization members.

Warranty

This Agilent Technologies instrument product is warranted against defects in material and workmanship for a period corresponding to the individual warranty periods of its component products. Instruments are warranted for a period of one year. Fixtures and adapters are warranted for a period of 90 days. During the warranty period, Agilent Technologies Company will, at its option, either repair or replace products that prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by Agilent Technologies. Buyer shall prepay shipping charges to Agilent Technologies and Agilent Technologies shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to Agilent Technologies from another country.

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

Limitation of Warranty

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside the environmental specifications for the product, or improper site preparation or maintenance.

IMPORTANT

No other warranty is expressed or implied. Agilent Technologies specifically disclaims the implied warranties of merchantability and fitness for a particular purpose.

Exclusive Remedies

The remedies provided herein are buyer’s sole and exclusive remedies. Agilent Technologies shall not be liable for any direct, indirect, special, incidental, or consequential damages, whether based on contract, tort, or any other legal theory.

Assistance

Product maintenance agreements and other customer assistance agreements are available for Agilent Technologies products.

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

Typeface Conventions

Bold	Boldface type is used when a term is defined. For example: **icons** are symbols.
Italic	Italic type is used for emphasis and for titles of manuals and other publications.
[Hardkey]	Indicates a hardkey labeled “Hardkey.”
Softkey	Indicates a softkey labeled “Softkey.”
[Hardkey] - **Softkey1** - **Softkey2**	Indicates keystrokes **[Hardkey]** - **Softkey1** - **Softkey2**.

4288A Documentation Map

The following manuals are available for the 4288A.

- **Operation Manual (Agilent P/N: 04288-900x0)**

  Most of basic information necessary for using 4288A is described in this manual. It includes the way of installation, preparation, measurement operation including calibration, performances (specifications), key definitions, and error messages. For GPIB programming, see the *Programming Manual* together with “*HP Instrument BASIC User's Handbook*”.

- **Programming Manual (Agilent P/N: 04288-900x1)**

  The Programming Manual shows how to write and use BASIC program to control the 4288A and describes how HP Instrument BASIC works with the analyzer.

- **Service Manual (Agilent P/N: 04288-90x00, Supplied as a service part)**

  This manual describes how to adjust and repair the 4288A, and how to carry out performance tests. This manual is supplied as a service part.

NOTE The number position shown by “x” in the part numbers above indicates the edition number.

Contents

Contents

Contents

1 General Information

This *Service Manual* is a guide to servicing the 4288A 1kHz/1MHz Capacitance Meter. The *Service Manual* provides information about performance test, adjustment, troubleshooting, and repairing the 4288A.

Organization of Service Manual

This manual consists of the major chapters listed below. This section describes the names of the chapters and the content of each chapter.

- “Performance Test” provides procedures for executing performance test and function test for 4288A.
- “Adjustment” provides procedures for adjusting the 4288A after repair or replacement of an assembly. All adjustments update the correction constants stored in the EEPROM on the A1 Main board.
- “Troubleshooting” provides troubleshooting procedures to isolate faulty assembly. This chapter also contains the theory of operation and explanation of service functions.
- “Theory of Operation” describes the general overall operation of the 4288A and the operation of each assembly.
- “Assembly Replacement” provides part numbers and illustrations of the replaceable assemblies and miscellaneous chassis parts. This chapter also contains procedures to disassemble portions of the 4288A when certain assemblies have to be replaced.

Instruments Covered by This Manual

Agilent Technologies uses a two-part, ten-character serial number label (See Figure 1-1) attached to the instrument's rear panel. The first five characters are the serial prefix and the last five digits are the suffix.

Figure 1-1 **Serial Number Label**

An instrument manufactured after the printing date of this manual may have serial number prefix that is not listed on the title page. This unlisted serial number prefix indicates the instrument is different from those described in this manual. The manual for this new instrument may be accompanied by a yellow *Manual Changes* supplement or have a different manual part number. This sheet contains "change information" that explains how to adapt the manual to the newer instrument.

In addition to change information, the supplement may contain information for correcting errors (Errata) in the manual. To keep this manual as current and accurate as possible, Agilent Technologies recommends that you periodically request the latest *Manual Changes* supplement. The supplement for this manual is identified by this manual's printing data and is available from Agilent Technologies. If the serial prefix or number of an instrument is lower than that on the title page of this manual, see *Appendix A, Manual Changes*. For information concerning, a serial number prefix that is not listed on the title page or in the *Manual Changes* supplement, contact the nearest Agilent Technologies office.

Required Equipment

Table 1-1 lists the recommended equipment for performance test, adjustment and troubleshooting for 4288A.

Table 1-1 Recommended Test Equipment

Equipment	Critical Specifications	Recommended Model	Qty.	Use*1
Frequency Counter	Frequency Range: 1 kHz, 1 MHz Time Base Error < 50 ppm/year	5334B, 53131/2A or 53181A	1	P
Multimeter	No Substitute	3458A	1	P
Standard Capacitor Set	No Substitute	16380A	1	P,A
Standard Capacitor Set	No Substitute	16380C with #001	1	P,A
4TP Open Termination	No Substitute	42090A	1	P,A,T
Test Leads 1 m	No Substitute	16048A	1	P
Test Leads 2 m	No Substitute	16048D	1	P
Handler & Scanner Interface Tester	No Substitute	04288-65001 or (04278-65001 and 04278-65301)*2	1	P
Interface Box	No Substitute	04284-65007	1	P
Cables	BNC(m)-BNC(m) Cable, 61 cm	p/n 8120-1839	1	P
Adapter	BNC(f)-BNC(f) Adapter	p/n 1250-1830	4	P
	Dual Banana-BNC(f) Adapter	p/n 1251-2277	1	P

*1. P:Performance Test A:Adjustment T:Troubleshooting
*2. Both instruments are required for an alternative to 04288-65001.

2 Performance Test

This chapter provides the procedure of the performance test and the function test for 4288A 1 kHz/1 MHz Capacitance Meter. These tests are used to verify that the 4288A's performance meets its specifications.

Test Equipment

Table 1-1 on page 14 lists the recommended equipment for Performance Test and Function Test.

Performance Test

Introduction

This section provides the test procedures used to verify that the 4288A's specifications are met. The performance tests can also be used for incoming inspection, and for verification after troubleshooting or adjustment. If the performance tests indicate that the 4288A is *NOT* operating within the specified limits, check your test setup, then proceed with troubleshooting if necessary.

Warm Up Time

Allow the 4288A to warm up for at least 30 minutes before you execute any of the performance tests

Ambient Conditions

Perform all performance tests in ambient conditions of 23 °C ± 5 °C, ≤ 70% RH.

Performance Test Interval

The performance test should be performed periodically. The recommended test interval is 12 months.

NOTE The test interval depends on maintenance of use and the environmental conditions under which the instrument is used. You may find that the test interval could be shortened or lengthened; however, such a decision should be based on substantial quantitative data.

Performance Test Record and Calculation Sheet

Performance test record lists all test points, acceptable test limits, test result entry columns, and measurement uncertainties. The listed measurement uncertainties are valid only when the recommended test equipment is used.

The calculation sheet is used as an aid for recording raw measurement data, and for calculating the performance test results.

The procedure for using the calculation sheet and performance test record is;

1. Photo copy the calculation sheet.
2. Follow the performance test procedure and record the measurement values, the 4288A's reading, etc., into the specified column on the calculation sheet.
3. Calculate the test result using the appropriate equation given on the calculation sheet, and record the test result into the Test Result column of the performance test record.

Frequency Accuracy Test

The 4288A's frequency is measured with a frequency counter

Specification

Frequency Accuracy: ±0.02 %

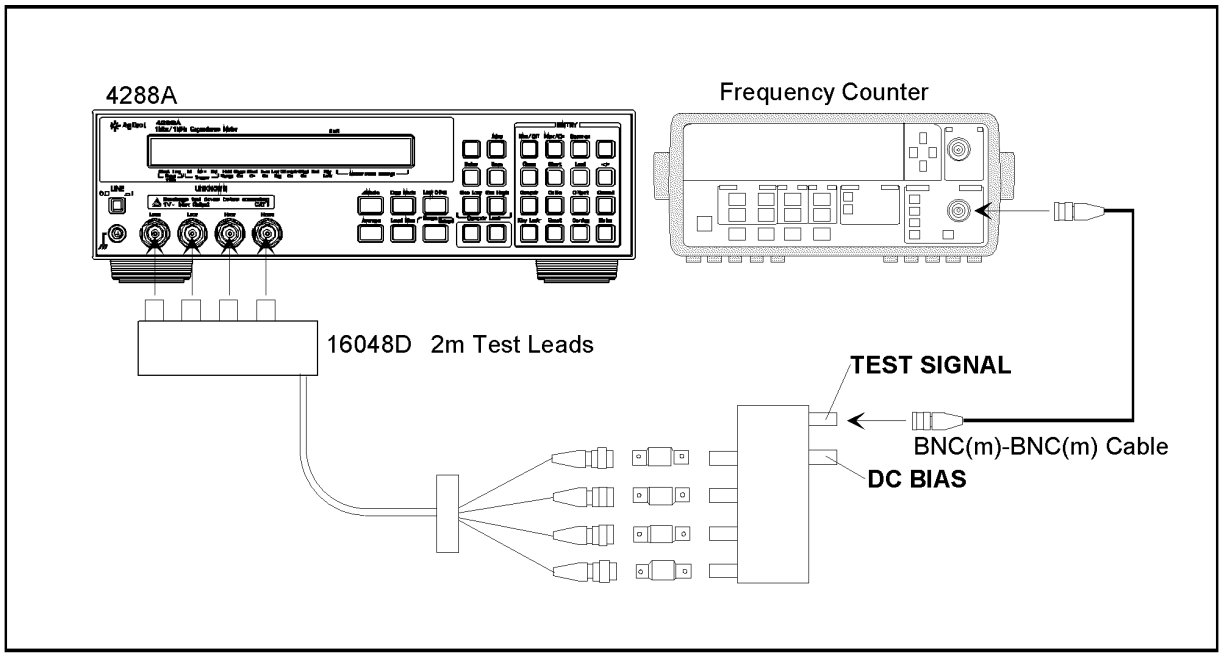
Test Equipment

Description	Recommended Model
Test Leads, 2 m	16048D
Frequency Counter	53131A, 53132A, 53181A or 5334B
Interface Box	p/n 04284-65007
BNC(f)-BNC(f) Adapter	p/n 1250-1830, 4ea
BNC(m)-BNC(m) Cable, 61 cm	p/n 8120-1839

Procedure

Step 1. Setup the instrument as shown in Figure 2-1.

Figure 2-1 **Frequency Accuracy Test**



4288ase002

Step 2. Press blue-**[.]-[↑→]-[Enter]** to reset the 4288A.

Step 3. Set the 4288A measurement condition as follows.

NOTE The selection menu appears after the following operations. Choose the proper setting with **[←↓]** or **[↑→]** key and press **[Enter]** key.

Conditions	**Operation**
Cable Length: 2 m	blue-**[2]**
Frequency: 1 kHz	**[Freq]**
Frequency Shift: 0 %	blue-**[–]-[↑→]-[Enter]**

Step 4. Record the frequency counter's reading to the calculation sheet.

Step 5. Calculate the test result according to the calculation sheet, then record it into the performance test record.

Step 6. Repeat Step 4 and 5 under the following setting.

Frequency	**Frequency Shift**
1 kHz	0 %
1 MHz	0 %
	–1 %
	+1 %
	+2 %

Signal Level Accuracy Test

The 4288A's signal level is measured with a digital multimeter.

Specification

Signal Level Accuracy: ±5 %

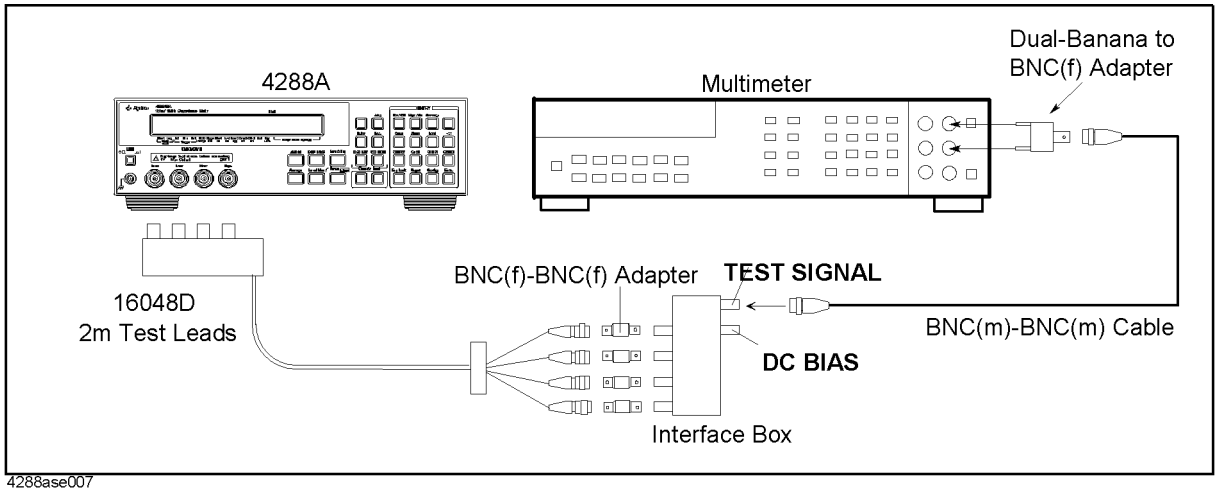
Test Equipment

Description	Recommended Model
Test Leads, 2 m	16048D
Multimeter	3458A
Interface Box	p/n 04284-65007
BNC(m)-BNC(m) Cable, 61 cm	p/n 8120-1839
BNC(f)-BNC(f) Adapter	p/n 1250-1830, 4ea
BNC(f)-Dual Banana Plug	p/n 1251-2277

Procedure

Step 1. Setup the instrument as shown in Figure 2-2.

Figure 2-2 Signal Level Accuracy Test



Step 2. Press blue-**[.]**-**[↑→]**-**[Enter]** to reset the 4288A.

Step 3. Set the 4288A measurement condition as follows.

NOTE The selection menu appears after the following operations. Choose the proper setting with **[←↓]** or **[↑→]** key and press **[Enter]** key.

Conditions	**Operation**
Cable Length: 2 m	blue-**[2]**
Frequency: 1 kHz	**[Freq]**
Frequency Shift: 0 %	blue-**[–]-[↑→]-[Enter]**
Level: 1000 mV	**[Level]**

Step 4. Set the 3458A Multimeter to the Synchronously Sub-sample AC voltage measurement mode using the following procedure:

1. Press **[ACV]** key to set the measurement mode to AC voltage.
2. Press **S**(blue-**[N Rdgs/Trig]**)-**[↓]-[↓]-[↓]** to display SETACV.
3. Press **[→]-[↓]-[↓]-[↓]** to display SYNC, then press **[Enter]**.

Step 5. Record the multimeter reading to the calculation sheet.

Step 6. Calculate the test result according to the calculation sheet, and record the result into the performance test record.

Step 7. Repeat Step 5 and 6 under the following setting.

Frequency	Frequency Shift	Level
1 kHz	0 %	1000 mV
		500 mV
		300 mV
		100 mV
1 MHz	0 %	1000 mV
		500 mV
		300 mV
		100 mV
	–1 %	1000 mV
		500 mV
		300 mV
		100 mV
	+1 %	1000 mV
		500 mV
		300 mV
		100 mV
	+2 %	1000 mV
		500 mV
		300 mV
		100 mV

Capacitance Measurement Accuracy Test

The 4288A measures the calibrated standard capacitors at the 4288A's front panel, and the measured values are compared with the standards' listed values.

Specifications

Basic Measurement Accuracy: ±0.07 % (Capacitance)

±0.0005 (Dissipation Factor)

NOTE See the *Specifications and Supplemental Informations* on the *Operation Manual* for details.

Test Equipment

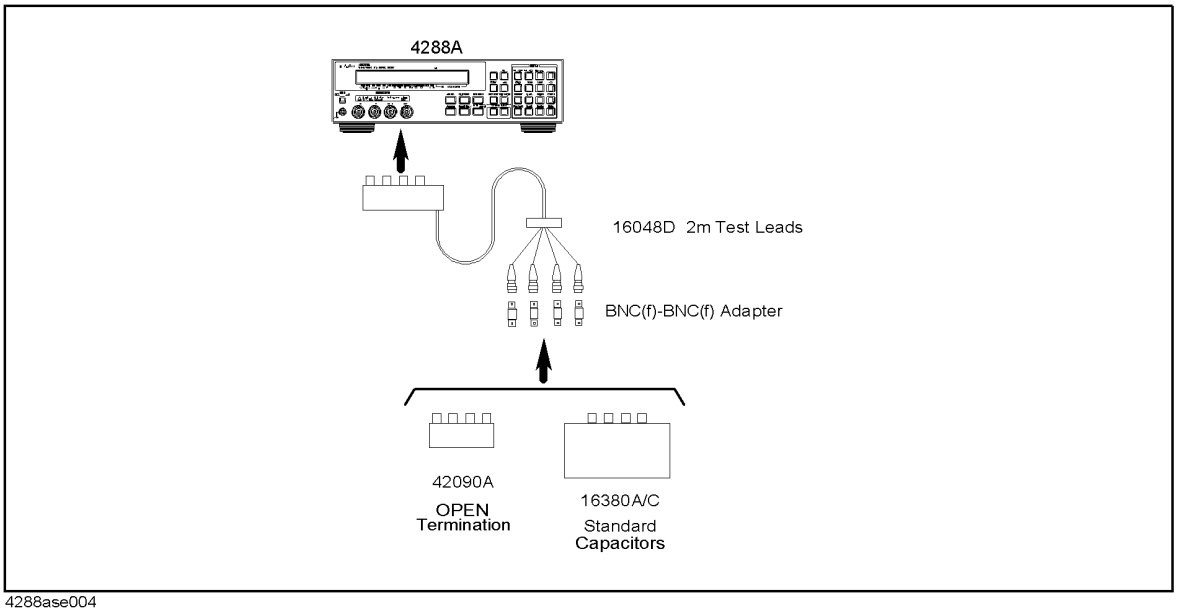
Description	Recommended Model
Test Leads, 1 m	16048A
Test Leads, 2 m	16048D
Standard Capacitor Set	16380A
Standard Capacitor Set	16380C
4TP Open Termination	42090A
BNC(f)-BNC(f) Adapter	p/n 1250-1830, 4ea

Procedure

Step 1. Record the 16380A and 16380C calibration values into the calculation sheet.

Step 2. Setup the instrument as shown in Figure 2-3.

Figure 2-3 Capacitance Measurement Accuracy Test



4288ase004

Step 3. Press blue-**[.]-[↑→]-[Enter]** to reset the 4288A.

Step 4. Connect the OPEN termination to the 2 m Test Leads.

Step 5. Press the blue-**[4]-[↑→]-[↑→]-[Enter]** to execute the OPEN compensation.

Step 6. Connect the 1 pF standard capacitor to the 2 m Test Leads.

Step 7. Set the 4288A measurement condition as follows.

NOTE The selection menu appears after the following operations. Choose the proper setting with **[←↓]** or **[↑→]** key and press **[Enter]** key.

Conditions	Operation
Cable Length: 2 m	blue-**[2]**
Frequency: 1 MHz	**[Freq]**
Frequency Shift: 0 %	blue-**[–]-[↑→]-[Enter]**
Level: 1000 mV	**[Level]**
Meas. Parameter: Pri:Cp Sec:D	**[Meas Prmtr]**
Range: 1 pF	blue-**[Auto/Hold]**
Trigger Mode: manual	**[Trig Mode]**
Meas. Time: Long	**[Meas Time]**
Averaging: 1	blue-**[Meas Time]**

Step 8. Press **[Trig]** to start measurement.

Step 9. Record the 4288A reading in the calculation sheet.

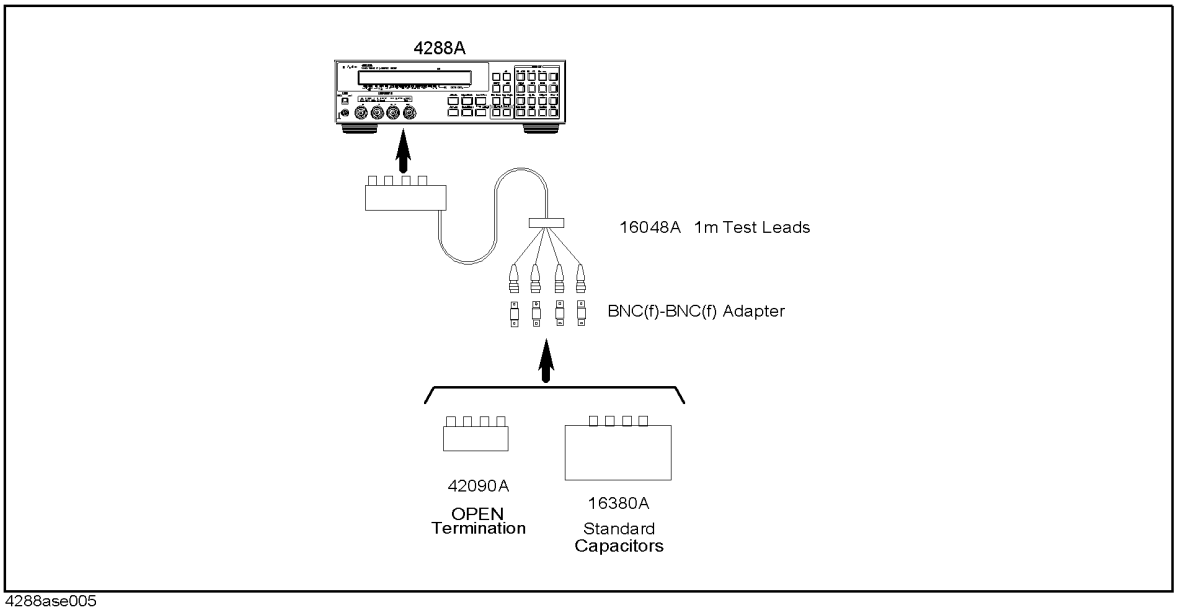
Step 10. Calculate the capacitance measurement accuracy according to calculation sheet, then record it into the test record.

Step 11. Perform Step 8 and 10 for all setting in the following table.

Standard Capacitor	Frequency	Level	Meas. Time	Range	Averaging	Frequency Shift
1 pF	1 MHz	1000 mV	Long	1 pF	1	0 %
						–1 %
						+1 %
						+2 %
10 pF	1 MHz	1000 mV	Long	10 pF	1	0 %
						–1 %
						+1 %
						+2 %
100 pF	1 kHz	1000 mV	Long	100 pF	1	0 %
	1 MHz	1000 mV	Long	100 pF	1	0 %
		100 mV				
		1000 mV				–1 %
						+1 %
						+2 %
				220 pF	5	0 %
						–1 %
						+1 %
						+2 %
				470 pF	22	0 %
						–1 %
						+1 %
						+2 %
			Short	100 pF	1	0 %
1000 pF	1 kHz	1000 mV	Long	1000 pF	1	0 %
	1 MHz	1000 mV	Long	1000 pF	1	0 %
						–1 %
						+1 %
						+2 %
0.01 µF	1 kHz	1000 mV	Long	10 nF	1	0 %
0.1 µF	1 kHz	1000 mV	Long	100 nF	1	0 %
		100 mV				
		1000 mV		220 nF	5	
				470 nF	22	
			Short	100 nF	1	
1 µF	1 kHz	1000 mV	Long	1 µF	1	0 %
10 µF	1 kHz	1000 mV	Long	10 µF	1	0 %

Step 12. Setup the instrument as shown in Figure 2-4.

Figure 2-4 Capacitance Measurement Setup



4288ase005

Step 13. Connect the OPEN termination to the 1 m Test Leads.

Step 14. Press the blue-**[4]-[↑→]-[↑→]-[Enter]** to execute the OPEN compensation.

Step 15. Connect the 100 pF standard capacitor to the 2 m Test Leads.

Step 16. Set the 4288A measurement condition as follows.

Conditions	**Operation**
Cable Length: 1 m	blue-**[.]**
Frequency: 1 MHz	**[Freq]**
Frequency Shift: 0 %	blue-**[–]-[↑→]-[Enter]**
Range: 100 pF	blue-**[Auto/Hold]**

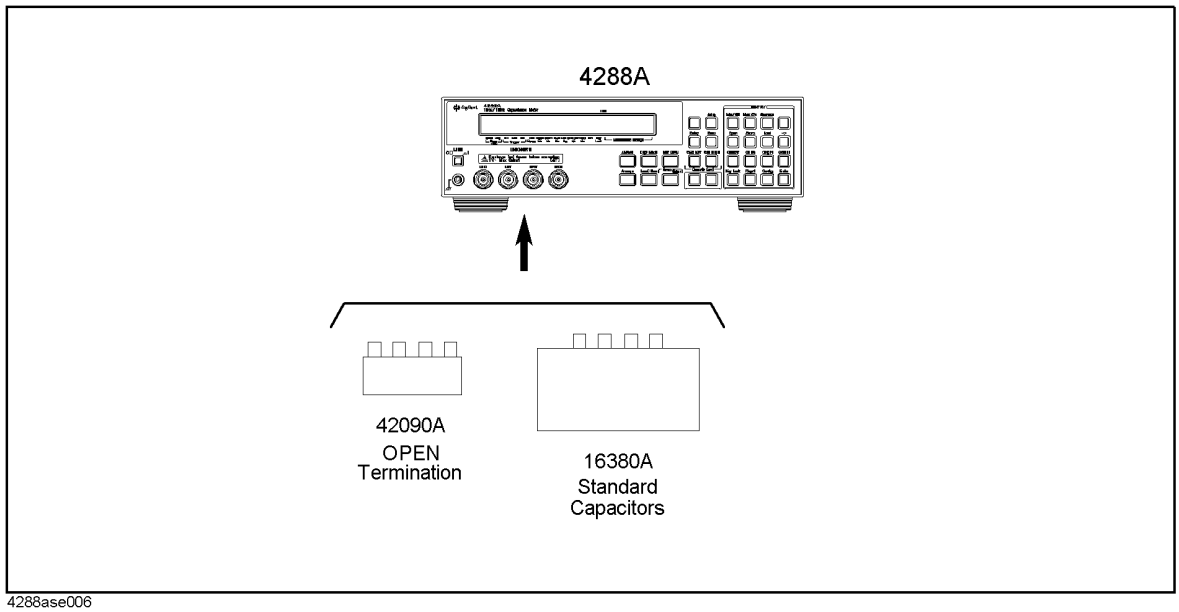
Step 17. Press **[Trig]** to start measurement.

Step 18. Record the 4288A reading in the calculation sheet.

Step 19. Calculate the capacitance measurement accuracy according to calculation sheet, then record it in the test record.

Step 20. Setup the instrument as shown in Figure 2-5.

Figure 2-5 Capacitance Measurement Setup



4288ase006

Step 21. Connect the OPEN termination to 4288A UNKNOWN terminal.

Step 22. Press the blue-**[4]-[↑→]-[↑→]-[Enter]** to execute the OPEN compensation.

Step 23. Connect the 100 pF standard capacitor to 4288A UNKNOWN terminal.

Step 24. Set the 4288A measurement condition as follows.

Conditions	**Operation**
Cable Length: 0 m	blue-**[2]**
Frequency: 1 MHz	**[Freq]**
Frequency Shift: 0 %	blue-**[–]-[↑→]-[Enter]**
Range: 100 pF	blue-**[Auto/Hold]**

Step 25. Press **[Trig]** to start measurement.

Step 26. Record the 4288A reading in the calculation sheet.

Step 27. Calculate the capacitance measurement accuracy according to calculation sheet, then record it in the test record.

Function Test

Signal Level Monitor Accuracy Test

The 4288A's signal level monitor accuracy is verified by comparing readings of the multimeter and the level monitor.

Specification

Signal Level Monitor Accuracy: ± (3 % + 1 mV)

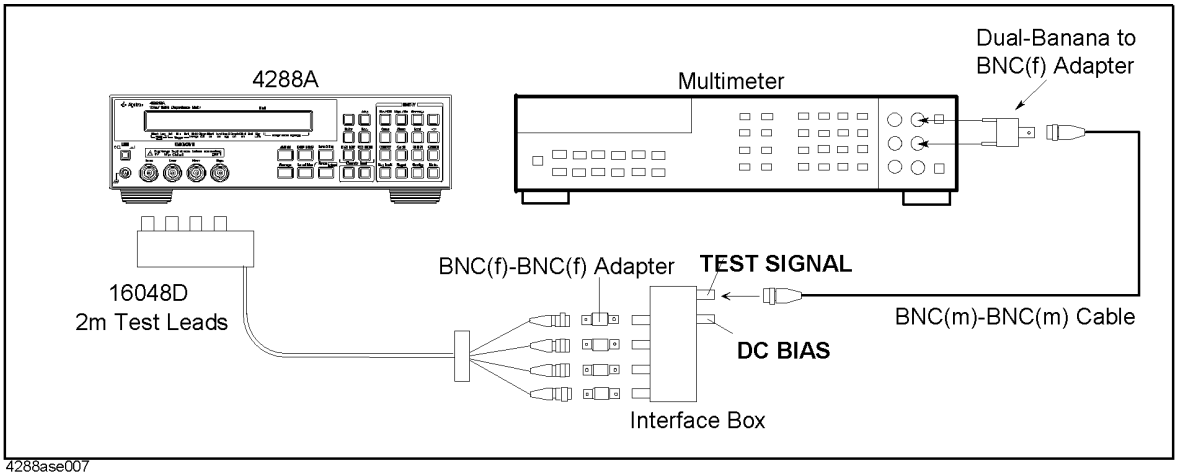
Test Equipment

Description	Recommended Model
Test Leads, 2 m	16048D
Multimeter	3458A
Interface Box	p/n 04284-65007
BNC(m)-BNC(m) Cable, 61 cm	p/n 8120-1839
BNC(f)-BNC(f) Adapter	p/n 1250-1830, 4ea
BNC(f)-Dual Banana Plug	p/n 1251-2277

Procedure

Step 1. Setup the instrument as shown in Figure 2-6.

Figure 2-6 Signal Level Monitor Accuracy Test



Step 2. Press blue-**[.]-[↑→]-[Enter]** to reset the 4288A.

Step 3. Set the 4288A measurement condition as follows.

NOTE The selection menu appears after the following operations. Choose the proper setting with **[←↓]** or **[↑→]** key and press **[Enter]** key.

Conditions	Operation
Cable Length: 2 m	blue-**[2]**
Frequency: 1 kHz	**[Freq]**
Frequency Shift: 0 %	blue-**[–]-[↑→]-[Enter]**
Level: 1000 mV	**[Level]**
Trigger Mode: manual	**[Trig Mode]**
Level Monitor: V	blue-**[Show Setting]-[↑→]-[Enter]**

Step 4. Set the 3458A Multimeter to the Synchronously Sub-sample AC voltage measurement mode using the following procedure:

1. Press **[ACV]** key to set the measurement mode to AC voltage.
2. Press **S**(blue-**[N Rdgs/Trig]**)-**[↓]-[↓]-[↓]** to display SETACV.
3. Press **[→]-[↓]-[↓]-[↓]** to display SYNC, then press **[Enter]**.

Step 5. Record the Multimeter reading in the calculation sheet.

Step 6. Press **[Trig]** key to start measurement.

Step 7. Record the 4288A reading of the voltage monitor in the calculation sheet.

Step 8. Calculate the signal level monitor accuracy according to calculation sheet.

Step 9. Perform the step 5 to 8 for all setting in the following table

Frequency	Frequency Shift	Level
1 kHz	0 %	1000 mV
1 MHz	0 %	1000 mV
	–1 %	1000 mV
	+1 %	1000 mV
	+2 %	1000 mV

Handler Interface and Scanner Interface Test

The 4288A's handler interface function and scanner interface function are tested using the built-in self-test and the handler and scanner interface tester.

Test Equipment

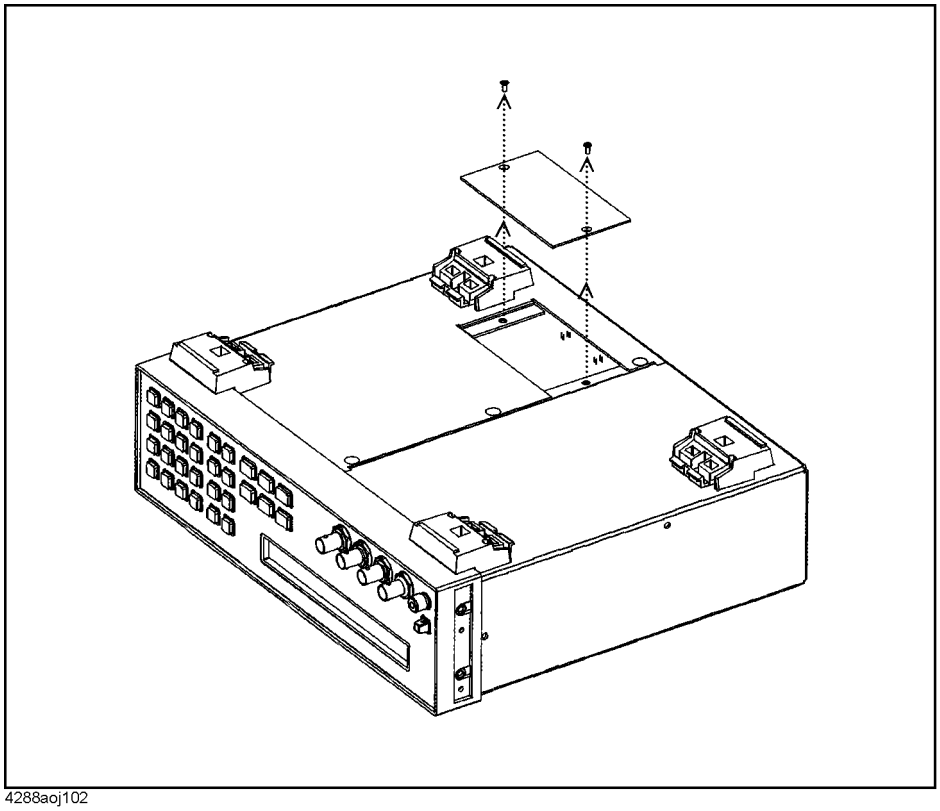
Description	Recommended Model
Handler & Scanner I/F Tester	p/n 04288-65001*1

*1. Handler Interface Simulator (04278-65001) and Scanner Interface Simulator (04278-65301) can be used for substitute,

Procedure with 04288-65001

Step 1. Turn off the 4288A, then remove the screws from the bottom side as shown in Figure 2-7.

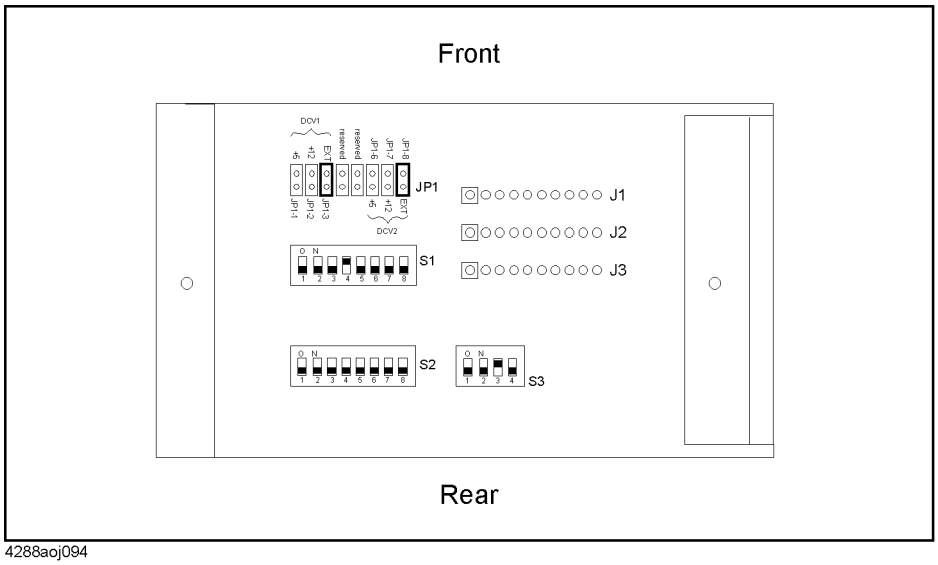
Figure 2-7 **Removing the screws from the bottom side.**



Step 2. Memorize the settings of the jumper(JP1), the bit switchs(S1,S2 and S3) and the networking resitors(J1,J2,J3).

Step 3. Set these setting to the factory setting as shown in Figure 2-8.

Figure 2-8 **Factory Setting of the jumper, the bit switches and the networking resistors**

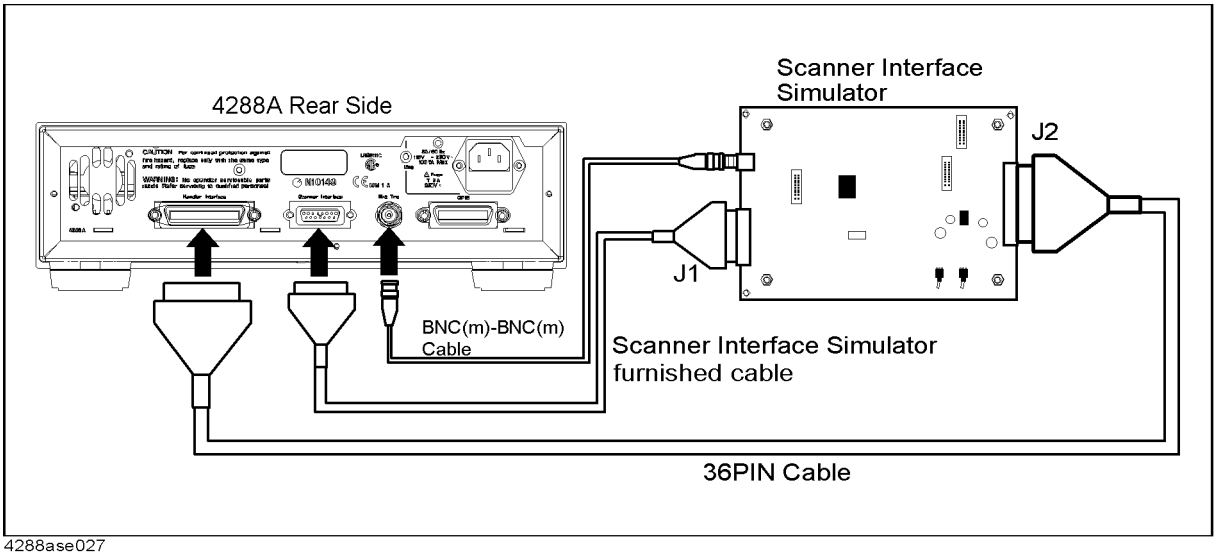


4288aoj094

Step 4. Re-assemble the plate removed in Step 1.

Step 5. Setup the instrument as shown in Figure 2-9.

Figure 2-9 **Handler Interface and Scanner Interface Test setup**



4288ase027

Step 6. Turn on the 4288A.

Step 7. Press blue-**[.]-[↑→]-[Enter]** to reset the 4288A.

Step 8. Reset the handler & Scanner I/F Tester to change the reset switch on the tester SET→RESET→SET.

Step 9. Press blue-**[-]** to show the configuration menu.

Step 10. Choose Svc with **[←↓]** and **[↑→]** key, then Press **[Enter]**.

Step 11. Choose `I/F` with **[←↓]** and **[↑→]** key, then Press **[Enter]** to start the test.

Step 12. If the 4288A pass the test, “I/F TEST: PASS” is shown in upside the LCD.

Step 13. Set the KEYLOCK switch on the tester to ON. Confirm that the 4288A refuse the operation from the front panel.

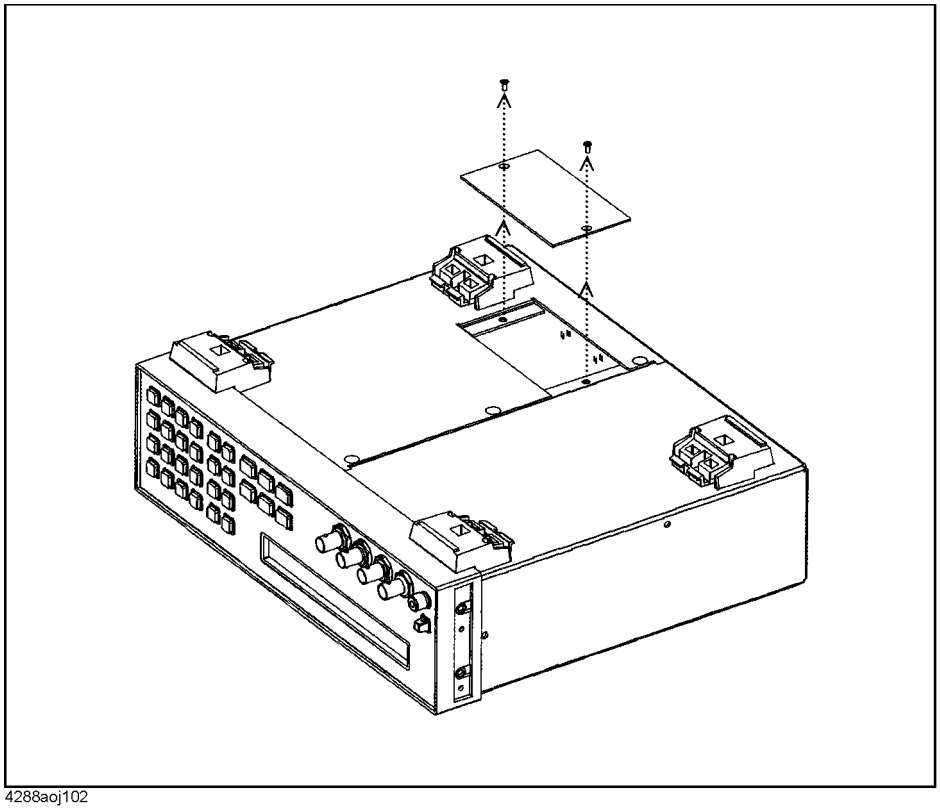
Step 14. Record the result in the test record.

Step 15. Restore the setting of the jumper, the bit switch and the network resistor.

Procedure with 04278-65001&04278-65301

Step 1. Turn off the 4288A, then remove the screws from the bottom side as shown in Figure 2-7.

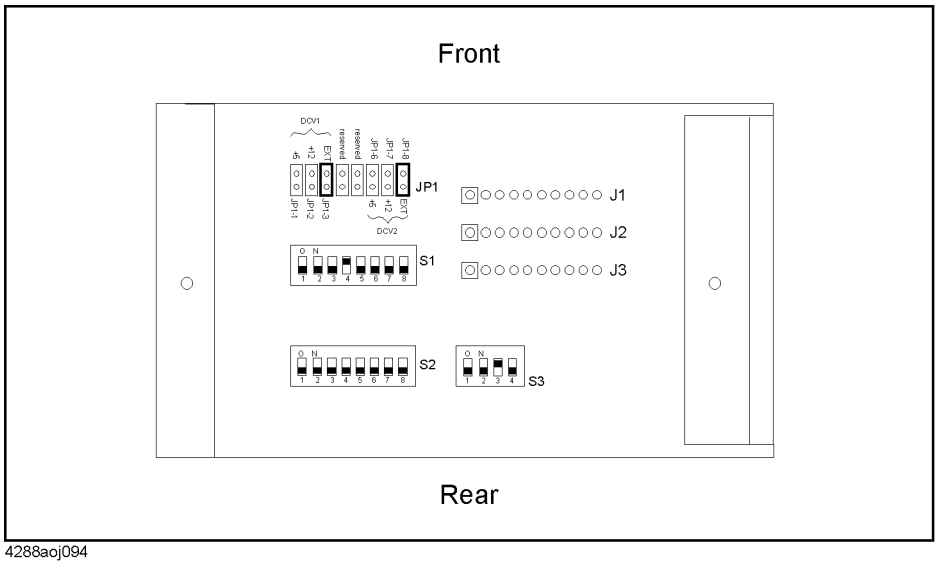
Figure 2-10 **Removing the screws from the bottom side.**



Step 2. Memorize the settings of the jumper(JP1), the bit switchs(S1,S2 and S3) and the networking resitors(J1,J2,J3).

Step 3. Set these setting to the factory setting as shown in Figure 2-8.

Figure 2-11 **Factory Setting of the jumper, the bit switches and the networking resistors**



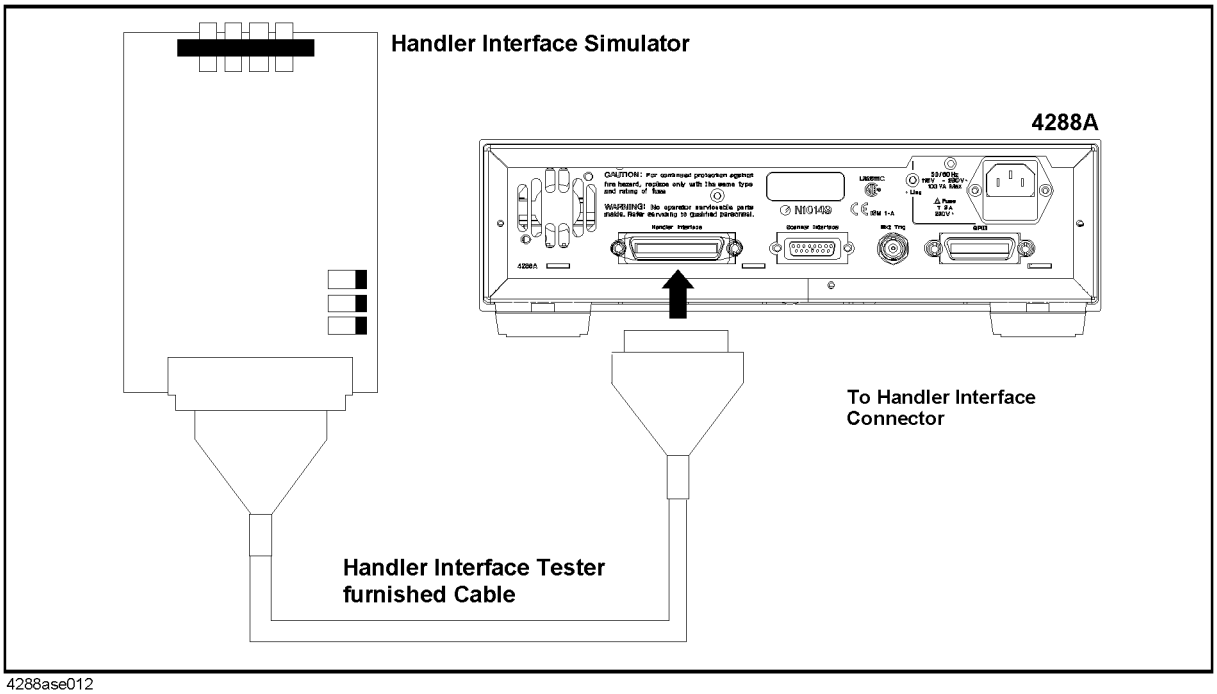
4288aoj094

Step 4. Re-assemble the plate removed in Step 1.

Step 5. Confirm the LEDs on the handler interface simulator as shown in Figure 2-14 on page 35 is mounted. If all LEDs is not mounted, add LEDs(Agilent P/N 1990-0486).

Step 6. Setup the instrument as shown in Figure 2-12.

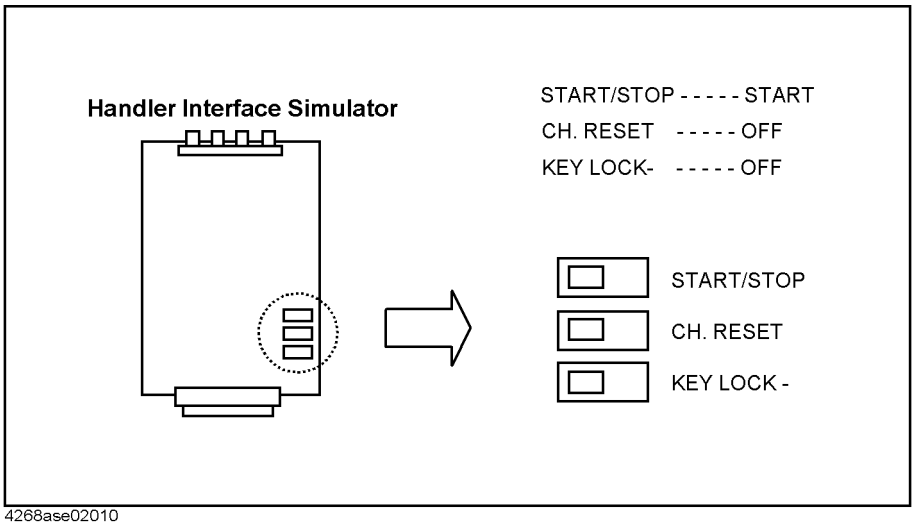
Figure 2-12 **Handler Interface Simulator Setup**



4288ase012

Step 7. Set START/STOP, CH.RESET, KEYLOCK Switches as shown in Figure 2-13

Figure 2-13 **Handler Interface Simulator Setting**



Step 8. Turn on the 4288A.

Step 9. Press blue-**[.]-[↑→]-[Enter]** to reset the 4288A.

Step 10. Confirm EOM,INDEX and CH2 light. The location are shown in Figure 2-14 on page 35.

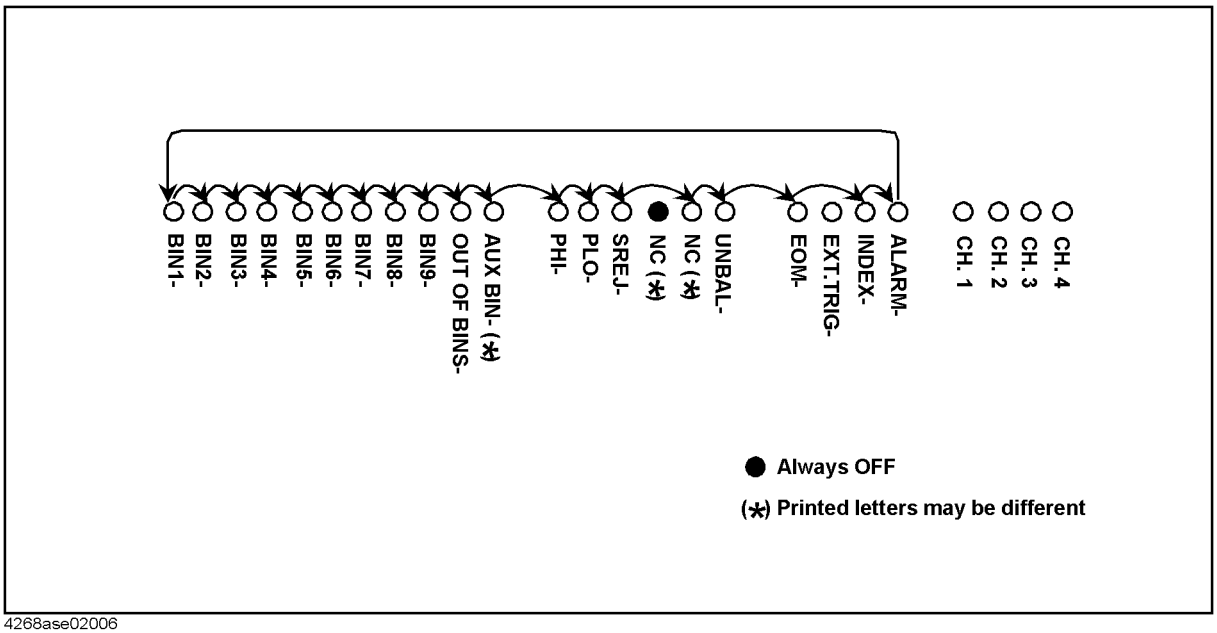
Step 11. Press blue-**[-]** to show the configuration menu.

Step 12. Choose Svc with **[←↓]** and **[↑→]** key, then Press **[Enter]**.

Step 13. Choose HNDL with **[←↓]** and **[↑→]** key, then Press **[Enter]** to start the test.

Step 14. Confirm that the LEDs on the handler interface simulator light in the order shown in Figure 2-14.

Figure 2-14 Order of LEDs lightning



4268ase02006

Step 15. Exit from the test mode by Pressing **[Enter]**, then press **[Enter]** twice to exit the configuration mode.

Step 16. Press the **[Trig Mode]** key several times until the ▼ symbol is displayed above Man.

Step 17. Set the KEYLOCK switch on the handler interface simulator to ON.

Step 18. Confirm that the all keys on the 4288A front panel are locked out.

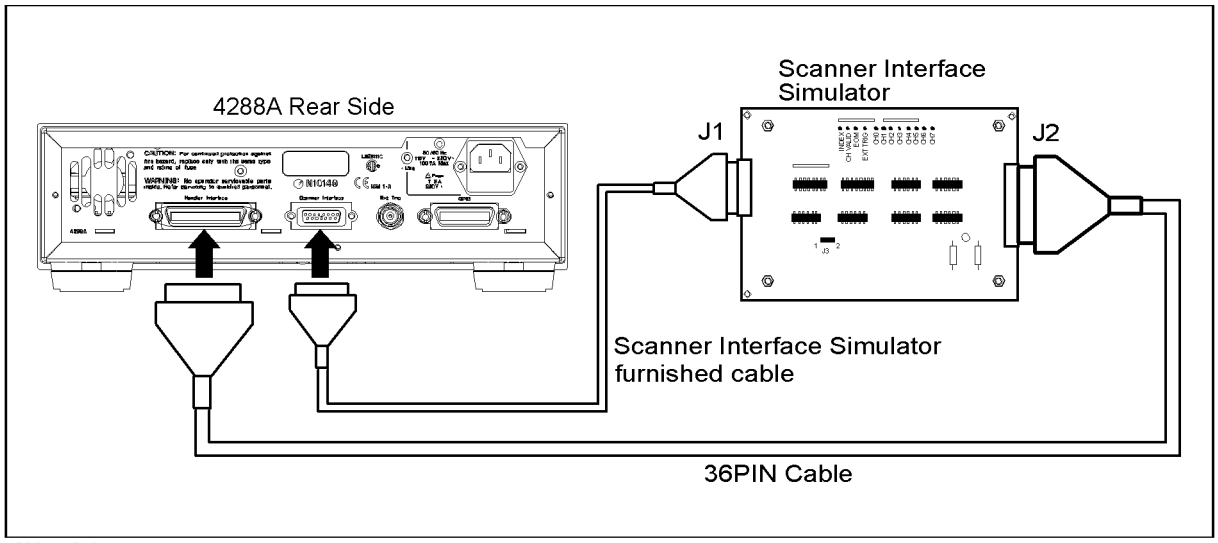
Step 19. Seth the KEYLOCK switch to OFF.

Step 20. Turn off the 4288A

Step 21. Disconnect the handler interface simulator from the 4288A.

Step 22. Setup the equipment as shown in Figure 2-15.

Figure 2-15 **Scanner Interface Simulator Setup**

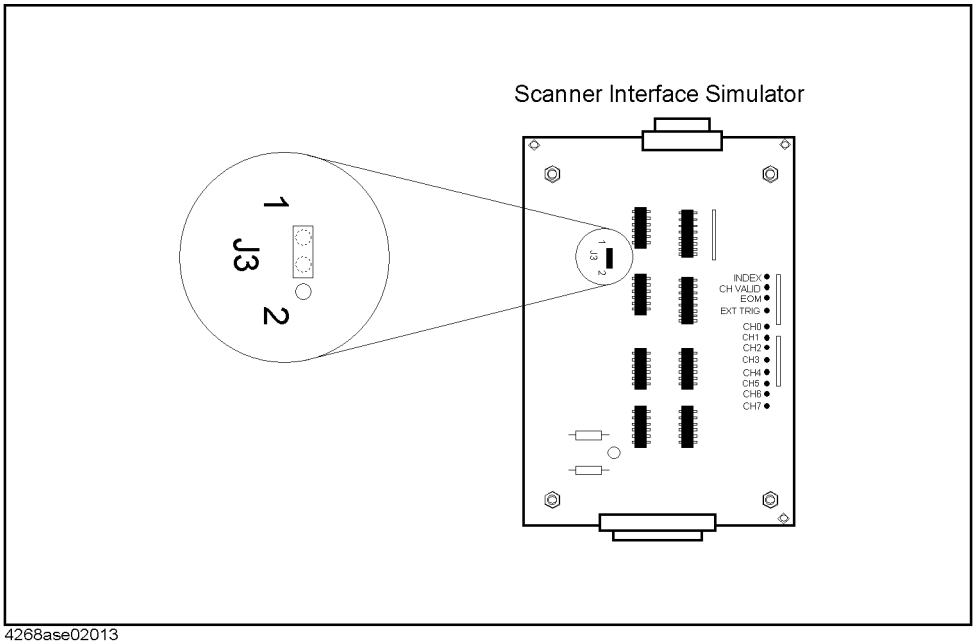


4288ase013

Step 23. Turn on the 4288A.

Step 24. Set the jumper on the scanner interface simulator to 1 as shown in Figure 2-16.

Figure 2-16 **Jumper Setting**



4268ase02013

Step 25. Press blue-**[-]** to show the configuration menu.

Step 26. Choose SVC with **[←↓]** and **[↑→]** key, then Press **[Enter]**.

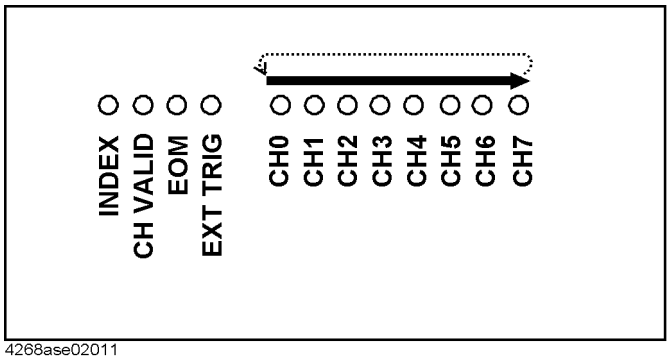
Step 27. Choose SCNR with **[←↓]** and **[↑→]** key, then Press **[Enter]** to start the test.

Step 28. Confirm that the LEDs on the scanner interface simulator light in the order shown in Figure

2-17, in accordance with the 4288A display.

NOTE Generally the CH*n* LED light, "CH 2^n" is displayed on the 4288A display. However, "CH 0" is displayed when CH6 or CH7 LED light.

Figure 2-17 Scanner Interface Output Order



Step 29. If all tests work correctly, check pass into the function test record.

Calculation Sheet

Performance Test

Frequency Accuracy Test

Frequency	Frequency Shift	Counter Reading [a]	Test Result Equation
1 kHz	0 %	kHz	(a – 1) × 1000 Hz
1 MHz	0 %	MHz	(a – 1) × 10^6 Hz
	–1 %	MHz	(a – 0.99) × 10^6 Hz
	+1 %	MHz	(a – 1.01) × 10^6 Hz
	+2 %	MHz	(a – 1.02) × 10^6 Hz

Signal Level Accuracy Test

Frequency	Frequency Shift	Signal Level	Multimeter Reading [a]	Test Result Equation
1 kHz	0 %	1000 mV	V	(a - 1) × 1000 mV
		500 mV	V	(a - 0.5) × 1000 mV
		300 mV	V	(a - 0.3) × 1000 mV
		100 mV	V	(a - 0.1) × 1000 mV
1 MHz	0 %	1000 mV	V	(a - 1) × 1000 mV
		500 mV	V	(a - 0.5) × 1000 mV
		300 mV	V	(a - 0.3) × 1000 mV
		100 mV	V	(a - 0.1) × 1000 mV
	–1 %	1000 mV	V	(a - 1) × 1000 mV
		500 mV	V	(a - 0.5) × 1000 mV
		300 mV	V	(a - 0.3) × 1000 mV
		100 mV	V	(a - 0.1) × 1000 mV
	+1 %	1000 mV	V	(a - 1) × 1000 mV
		500 mV	V	(a - 0.5) × 1000 mV
		300 mV	V	(a - 0.3) × 1000 mV
		100 mV	V	(a - 0.1) × 1000 mV
	+2 %	1000 mV	V	(a - 1) × 1000 mV
		500 mV	V	(a - 0.5) × 1000 mV
		300 mV	V	(a - 0.3) × 1000 mV
		100 mV	V	(a - 0.1) × 1000 mV

Capacitance Measurement Accuracy Test

DUT	Frequency	Parameter	Calibration Value [a]	Reference Designation
1 pF	1 MHz	Cp	pF	CV1
		D		CV2
10 pF	1 MHz	Cp	pF	CV3
		D		CV4
100 pF	1 kHz	Cp	pF	CV5
		D		CV6
	1 MHz	Cp	pF	CV7
		D		CV8
1000 pF	1 kHz	Cp	pF	CV9
		D		CV10
	1 MHz	Cp	pF	CV11
		D		CV12
0.01 µF	1 kHz	Cp	nF	CV13
		D		CV14
0.1 µF	1 kHz	Cp	nF	CV15
		D		CV16
1 µF	1 kHz	Cp	µF	CV17
		D		CV18
10 µF	1 kHz	Cp	µF	CV19
		D		CV20

Cable Length: 2m
DUT: 1 pF
Range: 1 pF (Averaging: 1)
Meas. Time: Long

Frequency	Frequency Shift	Signal Level	Parameter	4288A Reading [a]	Test Result Equation
1 MHz	0 %	1000 mV	Cp	pF	a – CV1
			D		a – CV2
	–1 %	1000 mV	Cp	pF	a – CV1
			D		a – CV2
	+1 %	1000 mV	Cp	pF	a – CV1
			D		a – CV2
	+2 %	1000 mV	Cp	pF	a – CV1
			D		a – CV2

Cable Length: 2m
DUT: 10 pF
Range: 10 pF (Averaging: 1)
Meas. Time: Long

Frequency	Frequency Shift	Signal Level	Parameter	4288A Reading [a]	Test Result Equation
1 MHz	0 %	1000 mV	Cp	pF	a – CV3
			D		a – CV4
	–1 %	1000 mV	Cp	pF	a – CV3
			D		a – CV4
	+1 %	1000 mV	Cp	pF	a – CV3
			D		a – CV4
	+2 %	1000 mV	Cp	pF	a – CV3
			D		a – CV4

Cable Length: 2m
DUT: 100 pF
Range: 100 pF (Averaging: 1)
Meas. Time: Long

Frequency	Frequency Shift	Signal Level	Parameter	4288A Reading [a]	Test Result Equation
1 kHz	0 %	1000 mV	Cp	pF	a – CV5
			D		a – CV6
1 MHz	0 %	1000 mV	Cp	pF	a – CV7
			D		a – CV8
		100 mV	Cp	pF	a – CV7
			D		a – CV8
	–1 %	1000 mV	Cp	pF	a – CV7
			D		a – CV8
	+1 %	1000 mV	Cp	pF	a – CV7
			D		a – CV8
	+2 %	1000 mV	Cp	pF	a – CV7
			D		a – CV8

Cable Length: 2m
DUT: 100 pF
Range: 220 pF (Averaging: 1)
Meas. Time: Long

Frequency	Frequency Shift	Signal Level	Parameter	4288A Reading [a]	Test Result Equation
1 MHz	0 %	1000 mV	Cp	pF	a – CV7
			D		a – CV8
	–1 %	1000 mV	Cp	pF	a – CV7
			D		a – CV8
	+1 %	1000 mV	Cp	pF	a – CV7
			D		a – CV8
	+2 %	1000 mV	Cp	pF	a – CV7
			D		a – CV8

Cable Length: 2m
DUT: 100 pF
Range: 470 pF (Averaging: 1)
Meas. Time: Long

Frequency	Frequency Shift	Signal Level	Parameter	4288A Reading [a]	Test Result Equation
1 MHz	0 %	1000 mV	Cp	pF	a – CV7
			D		a – CV8
	–1 %	1000 mV	Cp	pF	a – CV7
			D		a – CV8
	+1 %	1000 mV	Cp	pF	a – CV7
			D		a – CV8
	+2 %	1000 mV	Cp	pF	a – CV7
			D		a – CV8

Cable Length: 2m
DUT: 100 pF
Range: 100 pF (Averaging: 1)
Meas. Time: Short

Frequency	Frequency Shift	Signal Level	Parameter	4288A Reading [a]	Test Result Equation
1 MHz	0 %	1000 mV	Cp	pF	a – CV7
			D		a – CV8

Cable Length: 2m
DUT: 1000 pF
Range: 1 nF(Averaging: 1)
Meas. Time: Long

Frequency	Frequency Shift	Signal Level	Parameter	4288A Reading [a]	Test Result Equation
1 kHz	0 %	1000 mV	Cp	nF	a / 1000 – CV9
			D		a / 1000– CV10
1 MHz	0 %	1000 mV	Cp	nF	a / 1000 – CV11
			D		a / 1000 – CV12
	–1 %	1000 mV	Cp	nF	a / 1000 – CV11
			D		a / 1000 – CV12
	+1 %	1000 mV	Cp	nF	a / 1000 – CV11
			D		a / 1000 – CV12
	+2 %	1000 mV	Cp	nF	a / 1000 – CV11
			D		a / 1000 – CV12

Cable Length: 2m
DUT: 0.01 µF
Range: 10 nF(Averaging: 1)
Meas. Time: Long

Frequency	Frequency Shift	Signal Level	Parameter	4288A Reading [a]	Test Result Equation
1 kHz	0 %	1000 mV	Cp	nF	a – CV13
			D		a – CV14

Cable Length: 2m
DUT: 0.1 µF
Range: 100 nF(Averaging: 1)
Meas. Time: Long

Frequency	Frequency Shift	Signal Level	Parameter	4288A Reading [a]	Test Result Equation
1 kHz	0 %	1000 mV	Cp	nF	a – CV15
			D		a – CV16
		100 mV	Cp	nF	a – CV15
			D		a – CV16

Cable Length: 2m
DUT: 0.1 µF
Range: 220 nF(Averaging: 1)
Meas. Time: Long

Frequency	Frequency Shift	Signal Level	Parameter	4288A Reading [a]	Test Result Equation
1 kHz	0 %	1000 mV	Cp	nF	a – CV15
			D		a – CV16

Cable Length: 2m
DUT: 0.1 µF
Range: 470 nF(Averaging: 1)
Meas. Time: Long

Frequency	Frequency Shift	Signal Level	Parameter	4288A Reading [a]	Test Result Equation
1 kHz	0 %	1000 mV	Cp	nF	a – CV15
			D		a – CV16

Cable Length: 2m
DUT: 0.1 µF
Range: 100 nF(Averaging: 1)
Meas. Time: Short

Frequency	Frequency Shift	Signal Level	Parameter	4288A Reading [a]	Test Result Equation
1 kHz	0 %	1000 mV	Cp	nF	a – CV15
			D		a – CV16

Cable Length: 2m
DUT: 1 µF
Range: 1 µF (Averaging: 1)
Meas. Time: Long

Frequency	Frequency Shift	Signal Level	Parameter	4288A Reading [a]	Test Result Equation
1 kHz	0 %	1000 mV	Cp	nF	a – CV17
			D		a – CV18

Cable Length: 2m
DUT: 10 µF
Range: 10 µF (Averaging: 1)
Meas. Time: Long

Frequency	Frequency Shift	Signal Level	Parameter	4288A Reading [a]	Test Result Equation
1 kHz	0 %	1000 mV	Cp	nF	a – CV19
			D		a – CV20

Cable Length: 1 m
DUT: 100 pF
Range: 100 pF (Averaging: 1)
Meas. Time: Long

Frequency	Frequency Shift	Signal Level	Parameter	4288A Reading [a]	Test Result Equation
1 MHz	0 %	1000 mV	Cp	pF	a – CV7
			D		a – CV8
	–1 %	1000 mV	Cp	pF	a – CV7
			D		a – CV8
	+1 %	1000 mV	Cp	pF	a – CV7
			D		a – CV8
	+2 %	1000 mV	Cp	pF	a – CV7
			D		a – CV8

Cable Length: 0 m
DUT: 100 pF
Range: 100 pF (Averaging: 1)
Meas. Time: Long

Frequency	Frequency Shift	Signal Level	Parameter	4288A Reading [a]	Test Result Equation
1 MHz	0 %	1000 mV	Cp	pF	a – CV7
			D		a – CV8
	–1 %	1000 mV	Cp	pF	a – CV7
			D		a – CV8
	+1 %	1000 mV	Cp	pF	a – CV7
			D		a – CV8
	+2 %	1000 mV	Cp	pF	a – CV7
			D		a – CV8

Function Test

Signal Level Monitor Accuracy Test

Frequency	Frequency Shift	Multimeter Reading [a]	Level Monitor Reading [b]	Test Result [1000×a–b]	Test Limit
1 kHz	0 %	V	mV	mV	±4 mV
1 MHz	0 %	V	mV	mV	±4 mV
	–1 %	V	mV	mV	±4 mV
	+1 %	V	mV	mV	±4 mV
	+2 %	V	mV	mV	±4 mV

Test Record

Agilent Technologies 4288A 1 kHz/1 MHz Capacitance Meter

Serial Number			
Temperature:		Date:	
Humidity:		Tested by:	

Performance Test Record

Frequency Accuracy Test

Cable Length 2m

Frequency	Frequency Shift	Test Limit	Test Result	Measurement Uncertainty
1 kHz	0 %	±0.20 Hz	Hz	±0.0100 Hz
1 MHz	0 %	±200 Hz	Hz	±10.0 Hz
	–1 %	±198 Hz	Hz	±9.9 Hz
	+1 %	±202 Hz	Hz	±10.1 Hz
	+2 %	±204 Hz	Hz	±10.2 Hz

Signal Level Accuracy Test

Cable Length: 2m

Frequency	Frequency Shift	Signal Level	Test Limit	Test Result	Measurement Uncertainty
1 kHz	0 %	1000 mV	±50 mV	mV	±0.26 mV
		500 mV	±25 mV	mV	±0.14 mV
		300 mV	±15 mV	mV	±0.096 mV
		100 mV	±5.0 mV	mV	±0.025 mV
1 MHz	0 %	1000 mV	±50 mV	mV	±12 mV
		500 mV	±25 mV	mV	±6.0 mV
		300 mV	±15 mV	mV	±3.7 mV
		100 mV	±5.0 mV	mV	±1.2 mV
	–1 %	1000 mV	±50 mV	mV	±12 mV
		500 mV	±25 mV	mV	±6.0 mV
		300 mV	±15 mV	mV	±3.7 mV
		100 mV	±5.0 mV	mV	±1.2 mV
	+1 %	1000 mV	±50 mV	mV	±12 mV
		500 mV	±25 mV	mV	±6.0 mV
		300 mV	±15 mV	mV	±3.7 mV
		100 mV	±5.0 mV	mV	±1.2 mV
	+2 %	1000 mV	±50 mV	mV	±12 mV
		500 mV	±25 mV	mV	±6.0 mV
		300 mV	±15 mV	mV	±3.7 mV
		100 mV	±5.0 mV	mV	±1.2 mV

Capacitance Measurement Accuracy Test

Cable Length: 2m
DUT: 1 pF
Range: 1 pF (Averaging: 1)
Meas. Time: Long

Frequency	Frequency Shift	Signal Level	Parameter	Test Limit	Test Result	Measurement Uncertainty
1 MHz	0 %	1000 mV	Cp	±0.00085 pF	pF	±0.00024 pF
			D	±0.00065		±0.00010
	–1 %	1000 mV	Cp	±0.00085 pF	pF	±0.00024 pF
			D	±0.00065		±0.00010
	+1 %	1000 mV	Cp	±0.00085 pF	pF	±0.00024 pF
			D	±0.00065		±0.00010
	+2 %	1000 mV	Cp	±0.00085 pF	pF	±0.00024 pF
			D	±0.00065		±0.00010

Cable Length: 2m
DUT: 10 pF
Range: 10 pF (Averaging: 1)
Meas. Time: Long

Frequency	Frequency Shift	Signal Level	Parameter	Test Limit	Test Result	Measurement Uncertainty
1 MHz	0 %	1000 mV	Cp	±0.0070 pF	pF	±0.0017 pF
			D	±0.00050		±0.00008
	–1 %	1000 mV	Cp	±0.0070 pF	pF	±0.0017 pF
			D	±0.00050		±0.00008
	+1 %	1000 mV	Cp	±0.0070 pF	pF	±0.0017 pF
			D	±0.00050		±0.00008
	+2 %	1000 mV	Cp	±0.0070 pF	pF	±0.0017 pF
			D	±0.00050		±0.00008

Cable Length: 2m
DUT: 100 pF
Range: 100 pF (Averaging: 1)
Meas. Time: Long

Frequency	Frequency Shift	Signal Level	Parameter	Test Limit	Test Result	Measurement Uncertainty
1 kHz	0 %	1000 mV	Cp	±0.085 pF	pF	±0.020 pF
			D	±0.00065		±0.00006
1 MHz	0 %	1000 mV	Cp	±0.070 pF	pF	±0.020 pF
			D	±0.00050		±0.00009
		100 mV	Cp	±0.205 pF	pF	±0.020 pF
			D	±0.00185		±0.00009
	–1 %	1000 mV	Cp	±0.070 pF	pF	±0.020 pF
			D	±0.00050		±0.00009
	+1 %	1000 mV	Cp	±0.070 pF	pF	±0.020 pF
			D	±0.00050		±0.00009
	+2 %	1000 mV	Cp	±0.070 pF	pF	±0.020 pF
			D	±0.00050		±0.00009

Cable Length: 2m
DUT: 100 pF
Range: 220 pF (Averaging: 1)
Meas. Time: Long

Frequency	Frequency Shift	Signal Level	Parameter	Test Limit	Test Result	Measurement Uncertainty
1 MHz	0 %	1000 mV	Cp	±0.088 pF	pF	±0.020 pF
			D	±0.00068		±0.00009
	–1 %	1000 mV	Cp	±0.088 pF	pF	±0.020 pF
			D	±0.00068		±0.00009
	+1 %	1000 mV	Cp	±0.088 pF	pF	±0.020 pF
			D	±0.00068		±0.00009
	+2 %	1000 mV	Cp	±0.088 pF	pF	±0.020 pF
			D	±0.00068		±0.00009

Cable Length: 2m
DUT: 100 pF
Range: 470 pF (Averaging: 1)
Meas. Time: Long

Frequency	Frequency Shift	Signal Level	Parameter	Test Limit	Test Result	Measurement Uncertainty
1 MHz	0 %	1000 mV	Cp	±0.125 pF	pF	±0.020 pF
			D	±0.00105		±0.00009
	–1 %	1000 mV	Cp	±0.125 pF	pF	±0.020 pF
			D	±0.00105		±0.00009
	+1 %	1000 mV	Cp	±0.125 pF	pF	±0.020 pF
			D	±0.00105		±0.00009
	+2 %	1000 mV	Cp	±0.125 pF	pF	±0.020 pF
			D	±0.00105		±0.00009

Cable Length: 2m
DUT: 100 pF
Range: 100 pF (Averaging: 1)
Meas. Time: Short

Frequency	Frequency Shift	Signal Level	Parameter	Test Limit	Test Result	Measurement Uncertainty
1 MHz	0 %	1000 mV	Cp	±0.085 pF	pF	±0.020 pF
			D	±0.00065		±0.00009

Cable Length: 2m
DUT: 1000 pF
Range: 1 nF(Averaging: 1)
Meas. Time: Long

Frequency	Frequency Shift	Signal Level	Parameter	Test Limit	Test Result	Measurement Uncertainty
1 kHz	0 %	1000 mV	Cp	±0.70 pF	pF	±0.20 pF
			D	±0.00050		±0.00007
1 MHz	0 %	1000 mV	Cp	±0.70 pF	pF	±0.21 pF
			D	±0.00050		±0.00009
	–1 %	1000 mV	Cp	±0.70 pF	pF	±0.21 pF
			D	±0.00050		±0.00009
	+1 %	1000 mV	Cp	±0.70 pF	pF	±0.21 pF
			D	±0.00050		±0.00009
	+2 %	1000 mV	Cp	±0.70 pF	pF	±0.21 pF
			D	±0.00050		±0.00009

Cable Length: 2m
DUT: 0.01 µF
Range: 10 nF(Averaging: 1)
Meas. Time: Long

Frequency	Frequency Shift	Signal Level	Parameter	Test Limit	Test Result	Measurement Uncertainty
1 kHz	0 %	1000 mV	Cp	±0.0070 nF	nF	±0.0018 nF
			D	±0.00050		±0.00003

Cable Length: 2m
DUT: 0.1 µF
Range: 100 nF(Averaging: 1)
Meas. Time: Long

Frequency	Frequency Shift	Signal Level	Parameter	Test Limit	Test Result	Measurement Uncertainty
1 kHz	0 %	1000 mV	Cp	±0.070 nF	nF	±0.018 nF
			D	±0.00050		±0.00003
		100 mV	Cp	±0.205 nF	nF	±0.018 nF
			D	±0.00185		±0.00003

Cable Length: 2m
DUT: 0.1 µF
Range: 220 nF(Averaging: 1)
Meas. Time: Long

Frequency	Frequency Shift	Signal Level	Parameter	Test Limit	Test Result	Measurement Uncertainty
1 kHz	0 %	1000 mV	Cp	±0.088 nF	nF	±0.018 nF
			D	±0.00068		±0.00003

Cable Length: 2m
DUT: 0.1 µF
Range: 470 nF(Averaging: 1)
Meas. Time: Long

Frequency	Frequency Shift	Signal Level	Parameter	Test Limit	Test Result	Measurement Uncertainty
1 kHz	0 %	1000 mV	Cp	±0.125 nF	nF	±0.018 nF
			D	±0.00105		±0.00003

Cable Length: 2m
DUT: 0.1 µF
Range: 100 nF(Averaging: 1)
Meas. Time: Short

Frequency	Frequency Shift	Signal Level	Parameter	Test Limit	Test Result	Measurement Uncertainty
1 kHz	0 %	1000 mV	Cp	±0.085 nF	nF	±0.005 nF
			D	±0.00065		±0.00003

Cable Length: 2m
DUT: 1 µF
Range: 1 µF (Averaging: 1)
Meas. Time: Long

Frequency	Frequency Shift	Signal Level	Parameter	Test Limit	Test Result	Measurement Uncertainty
1 kHz	0 %	1000 mV	Cp	±0.00070 µF	µF	±0.00018 µF
			D	±0.00050		±0.00005

Cable Length: 2m
DUT: 10 µF
Range: 10 µF (Averaging: 1)
Meas. Time: Long

Frequency	Frequency Shift	Signal Level	Parameter	Test Limit	Test Result	Measurement Uncertainty
1 kHz	0 %	1000 mV	Cp	±0.0070 µF	µF	±0.0020 µF
			D	±0.00050		±0.00008

Cable Length: 1 m
DUT: 100 pF
Range: 100 pF (Averaging: 1)
Meas. Time: Long

Frequency	Frequency Shift	Signal Level	Parameter	Test Limit	Test Result	Measurement Uncertainty
1 MHz	0 %	1000 mV	Cp	±0.070 pF	pF	±0.020 pF
			D	±0.00050		±0.00009
	–1 %	1000 mV	Cp	±0.070 pF	pF	±0.020 pF
			D	±0.00050		±0.00009
	+1 %	1000 mV	Cp	±0.070 pF	pF	±0.020 pF
			D	±0.00050		±0.00009
	+2 %	1000 mV	Cp	±0.070 pF	pF	±0.020 pF
			D	±0.00050		±0.00009

Cable Length: 0 m
DUT: 100 pF
Range: 100 pF (Averaging: 1)
Meas. Time: Long

Frequency	Frequency Shift	Signal Level	Parameter	Test Limit	Test Result	Measurement Uncertainty
1 MHz	0 %	1000 mV	Cp	±0.070 pF	pF	±0.020 pF
			D	±0.00050		±0.00009
	–1 %	1000 mV	Cp	±0.070 pF	pF	±0.020 pF
			D	±0.00050		±0.00009
	+1 %	1000 mV	Cp	±0.070 pF	pF	±0.020 pF
			D	±0.00050		±0.00009
	+2 %	1000 mV	Cp	±0.070 pF	pF	±0.020 pF
			D	±0.00050		±0.00009

Function Test Record

Signal Level Monitor Test

Pass	Fail
[ ]	[ ]

Handler Interface & Scanner Interface Test

Pass	Fail
[ ]	[ ]

3 Adjustment

This Chapter provides the adjustment procedures required to ensure that the 4288A 1kHz/1MHz Capacitance Meter is within its published specifications after it has been repaired, or when it fails the performance tests..

Safety Considerations

This manual contains NOTEs, CAUTIONs, and WARNINGs that must be followed to ensure the safety of the operator and to keep the instrument in a safe and serviceable condition. The Adjustment must be performed by qualified service personnel.

WARNING **Any interruption of the protective ground conductor (inside or outside the meter) or disconnection of the protective ground terminal can make the instrument dangerous. Intentional interruption of the protective ground system for any reason is prohibited.**

Required Controller

The following controller system is required to run the adjustment program.

Windows PC	PC-AT Compatible, RAM:≥64MBytes, CPU Pentium 200 MHz or faster
OS	Microsoft® Windows 2000®
Software	Agilent VEE (5.0 or 6.2)
GPIB Card	Agilent 82350A, 82341C/D

Required Equipment

Table 1-1 on page 14 lists the equipment required to perform the Adjustment procedures described in this chapter. Use only calibrated test equipment when adjusting the 4288A.

Warm-up for Adjustment

Warm-up the 4288A for at least 30 minute before performing any of the following Adjustment procedures to ensure procedures to ensure proper results and correct instrument operation.

Order of Adjustment

When performing more than one adjustment, perform them in the order they appear in this chapter. The procedures are presented in the following order.

Preparation for using the Adjustment Program

To use the Adjustment Program, some preparation is required. This section describes its procedure.

Installing an GPIB Card (82340, 82341 or 82350)

Install an GPIB Card into your computer (see the GPIB Card manual). The select code of the GPIB Card should be set to “7”.

Installing Agilent VEE for Personal Computer

Install the Agilent VEE into your computer (see the Agilent VEE for Windows®).

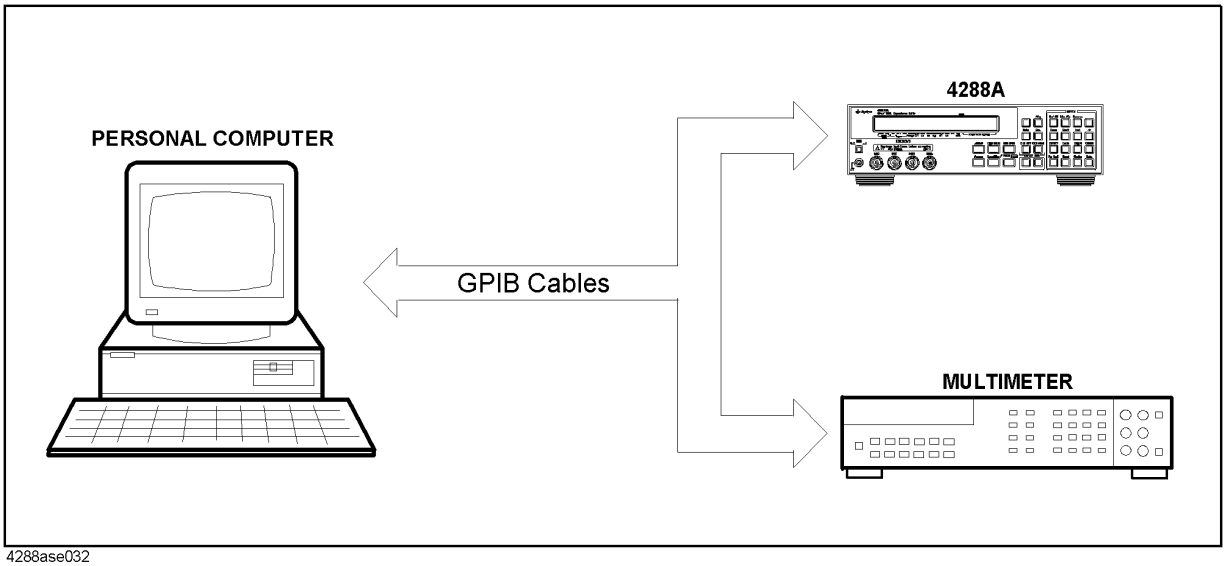
Installing Adjustment Program into Your PC

1. Make a copy of the 4288Aadjustment program named `ADJ4288A.EXE` in a directory of your harddisk drive.
2. Double-click the filename on the Windows’Explorer to start extracting the self-extracting archive.
3. You will be prompted to enter directory name for installing the program files. Input the destination directory, then Click `Unzip`. The default is `C:\ADJ4288A`.
4. Confirm the message that you successfully extract the files and click `OK` and `Close`.

Equipment Setup

Performing adjustments requires the system described in this section. The Hardware Setup is shown in Figure 3-1.

Figure 3-1 Adjustment Hardware Setup



4288ase032

Running the Adjustment Program

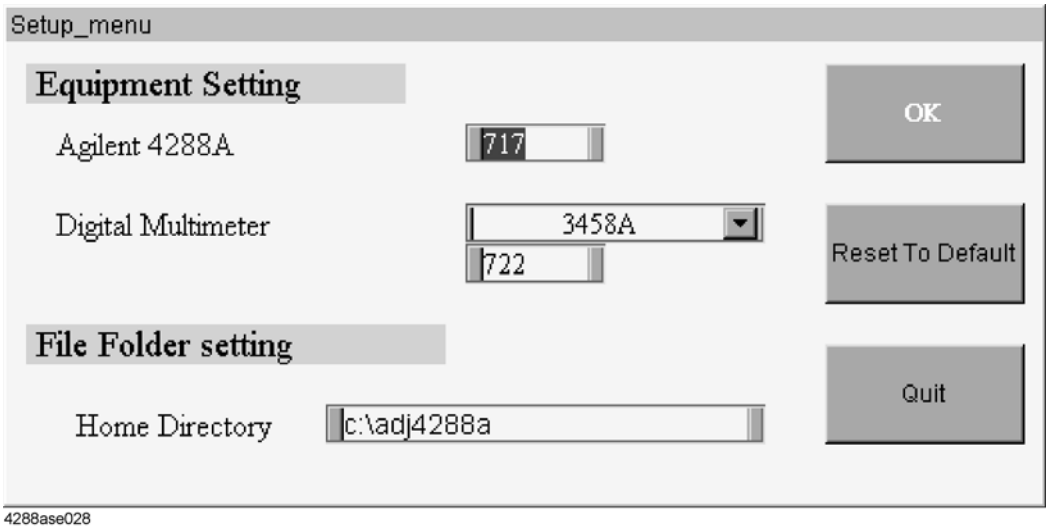
1. Start the Agilent VEE.
2. Load the adjustment program file into the Agilent VEE as follows.
   a. Pull down the `File` menu from the Agilent VEE window and select `Open`.
   b. Select the file `ADJ4288A.VEE` in the target directory at Step 3 in "Installing Adjustment Program into Your PC" on page 62, then click `Open`.
3. You may be asked to add drivers for the equipment during the program loading. Click OK and enter the GPIB address for each equipment. Enter 0 as the address for the equipment which are not used for the adjustment. (Refer to Table 3-1)

Table 3-1 Device Name and GPIB Address Example

Device Name	Equipment	GPIB Address
4288A	4288A	717
3458A	3458A	722

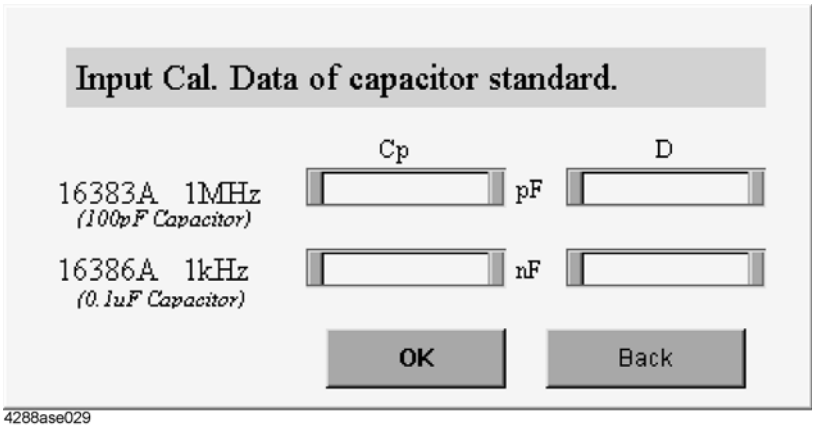
4. Click `START` button on the VEE Screen.
5. The program ask to input the home directory and the GPIB addresses of the equipment as shown in Figure 3-2. The home directory is the directory where `ADJ4288A.VEE` is stored.

Figure 3-2 Environment setting window



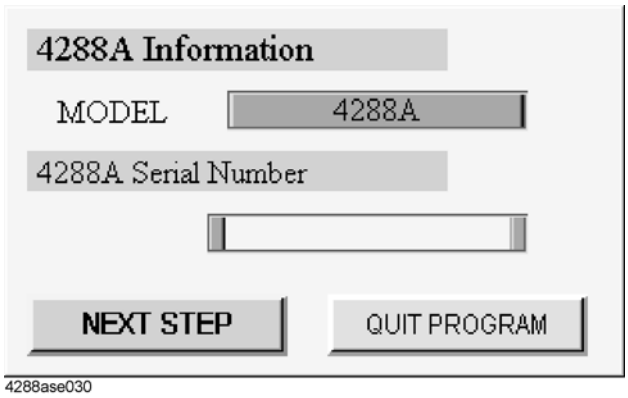
6. The program ask to input calibration data of the 100 pF and the 0.1 µF standard capacitor as shown in Figure 3-3.

Figure 3-3 Calibrating data input window



7. The Serial Number input window as

Figure 3-4 Serial Number input window



8. The main menu widow appears as Figure 3-5. Choose the proper menu. The description of each menu is as follows.

   - All Adjustment

     Perform the all adjustments.

   - Partial Adjustment

     Perform some continued adjustments.

   - Spot Adjustment

     Perform an adjustment.

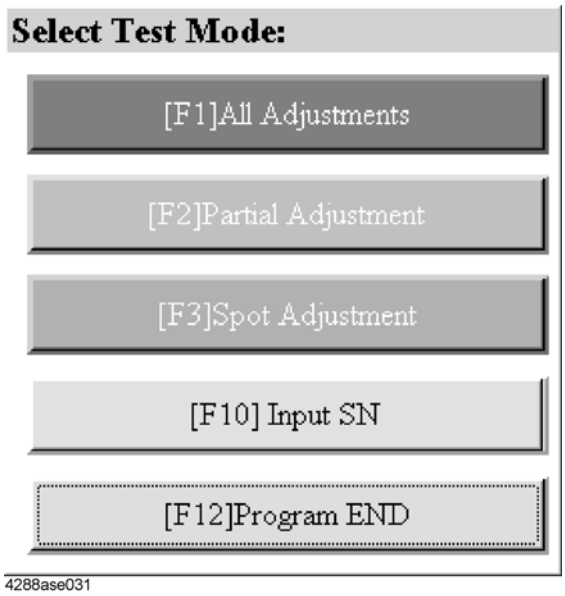
   - Input SN

     Input SN when adjusting another 4288A.

   - Program END

     Stop the adjustment program.

Figure 3-5 **Main menu window**



Correction Constant Initialization

The purpose of this procedure is to initialize correction constants and write the default data to the EEPROM.

Required Equipment

None

Procedure

Step 1. Run the adjustment program.

Step 2. Choose `InitCal`.

Step 3. Confirm nothing is connected to the 4288A UNKNOWN terminal.

Step 4. Follow the adjustment program instruction to initialize the correction constants.

Voltage Monitor Correction Constants

This adjustment calibrate the Voltage Monitor's absolute measurement accuracy. The calibration data in the form of correction constants is stored in the EEPROM.

Required Equipment

Description	Recommended Model
Multimeter	3458A
Interface Box	p/n 04284-65007
BNC(m)-BNC(m) Cable, 61 cm	p/n 8120-1839
BNC(f)-Dual Banana Plug	p/n 1251-2277

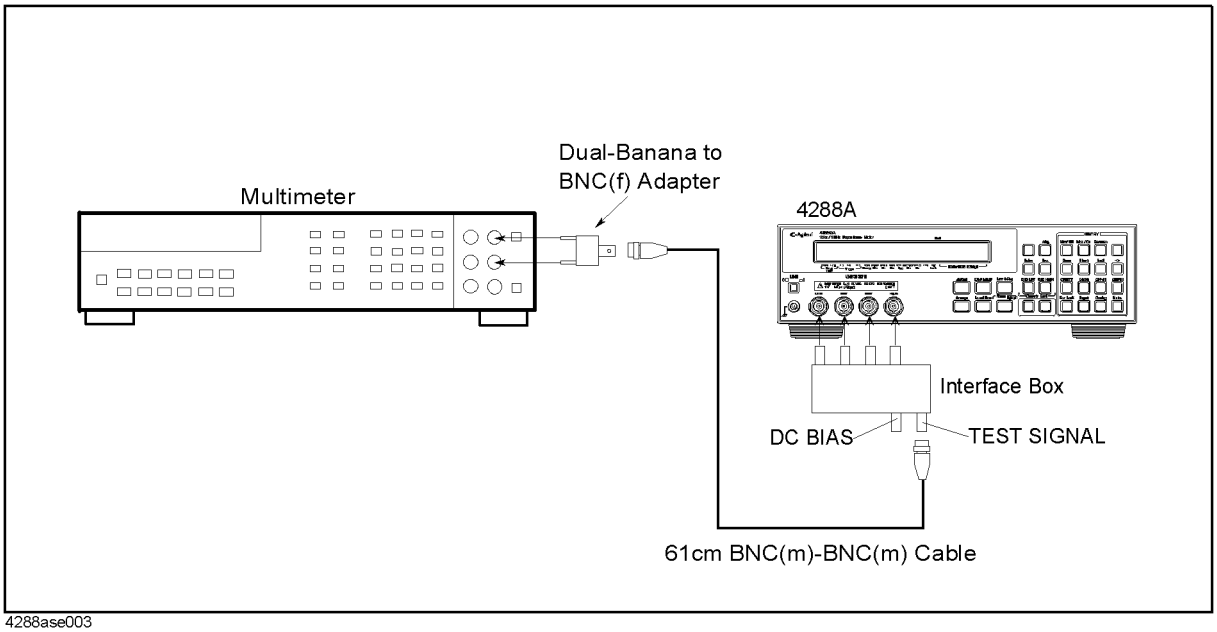
Procedure

Step 1. Run the adjustment program.

Step 2. Choose `AdjVMon`.

Step 3. Connect the equipment as shown in Figure 3-6.

Figure 3-6 Voltage Monitor Adjustment Setup



4288ase003

Step 4. Follow the adjustment program instruction to update the correction constants.

Source DC offset Correction Constants

This adjustment calibrate DAC value to prevent DC voltage from outputting from Hcur connector. The calibration data in the form of correction constants is stored in the EEPROM.

Required Equipment

Description	Recommended Model
Open Termination	42090A

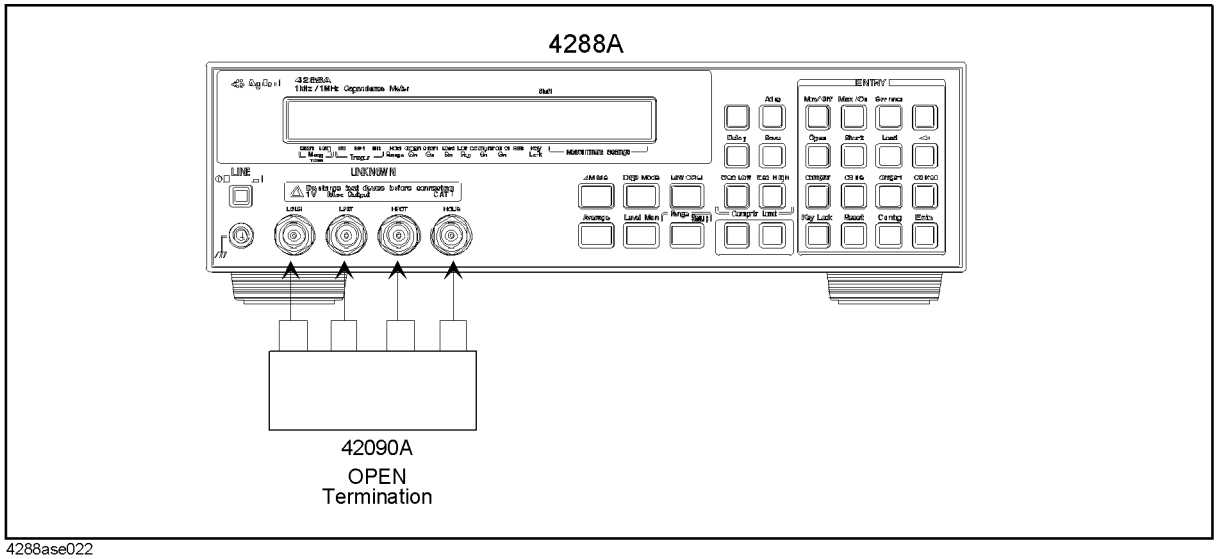
Procedure

Step 1. Run the adjustment program.

Step 2. Choose `AdjDCoffs`.

Step 3. Connect the open termination to the 4288A UNKNOWN terminal as shown in Figure 3-7.

Figure 3-7 Source DC Offset Correction Constants Setup



4288ase022

Step 4. Follow the adjustment program instruction to update the correction constants.

Source Level Correction Constants

This adjustment calibrate the source level. The calibration data in the form of correction constants is stored in the EEPROM.

Required Equipment

Description	Recommended Model
Open Termination	42090A

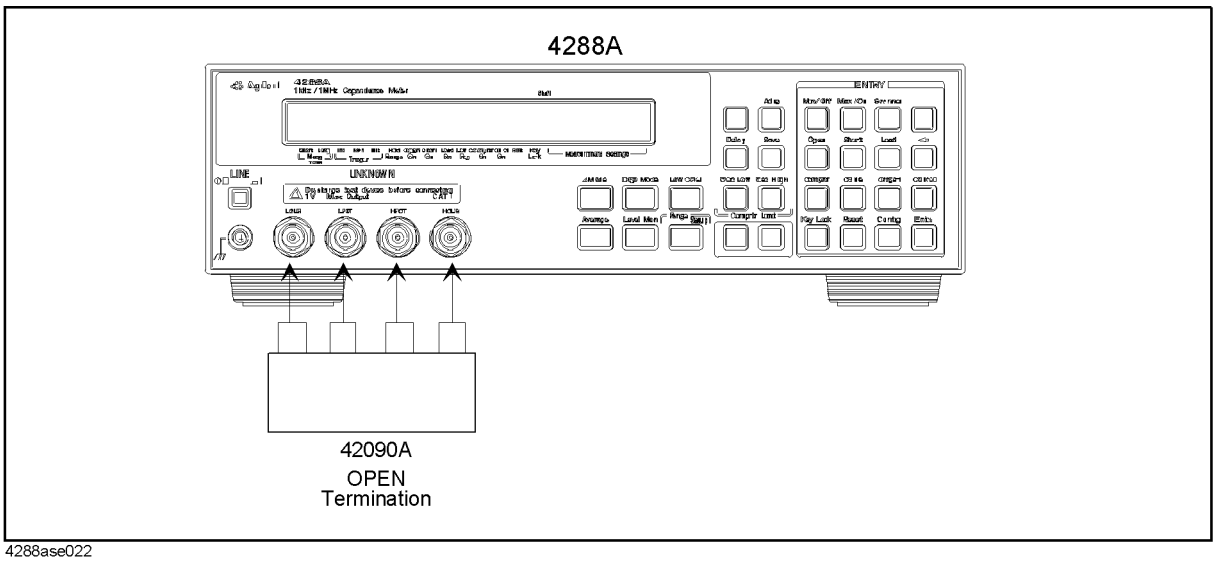
Procedure

Step 1. Run the adjustment program.

Step 2. Choose `AdjsrcLvl`.

Step 3. Connect the open termination to the 4288A UNKNOWN terminal as shown in Figure 3-8.

Figure 3-8 Source Level Correction Constants Setup



4288ase022

Step 4. Follow the adjustment program instruction to update the correction constants.

Current Sense Offset Correction Constants

This correction constants calibrate the DAC in the Lc amp to cancel the DC voltage at the input to the ADC. The calibration data in the form of correction constants is stored in the EEPROM.

Required Equipment

Description	Recommended Model
Open Termination	42090A

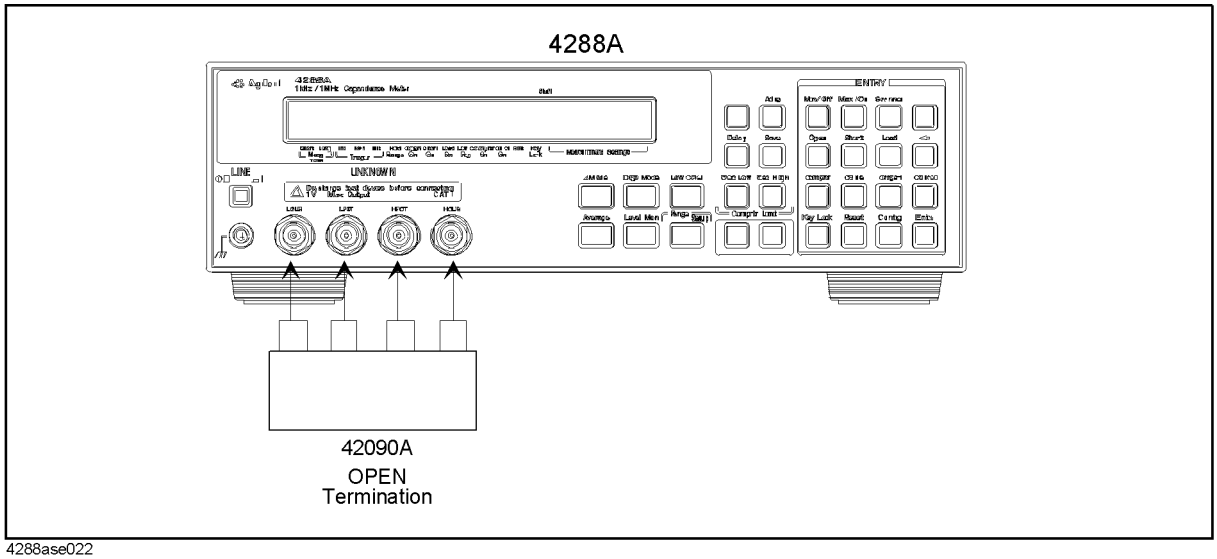
Procedure

Step 1. Run the adjustment program.

Step 2. Choose `AdjISense`.

Step 3. Connect the open termination to the 4288A UNKNOWN terminal as shown in Figure 3-9.

Figure 3-9 Current Sense Offset Correction Constants Setup



4288ase022

Step 4. Follow the adjustment program instruction to update the correction constants.

Modem Offset Correction Constants

The correction constants calibrate the DAC in the MODEM to cancel the output current of the MODEM on the OPEN measurement. The calibration data in the form of correction constants is stored in the EEPROM.

Required Equipment

Description	Recommended Model
Open Termination	42090A

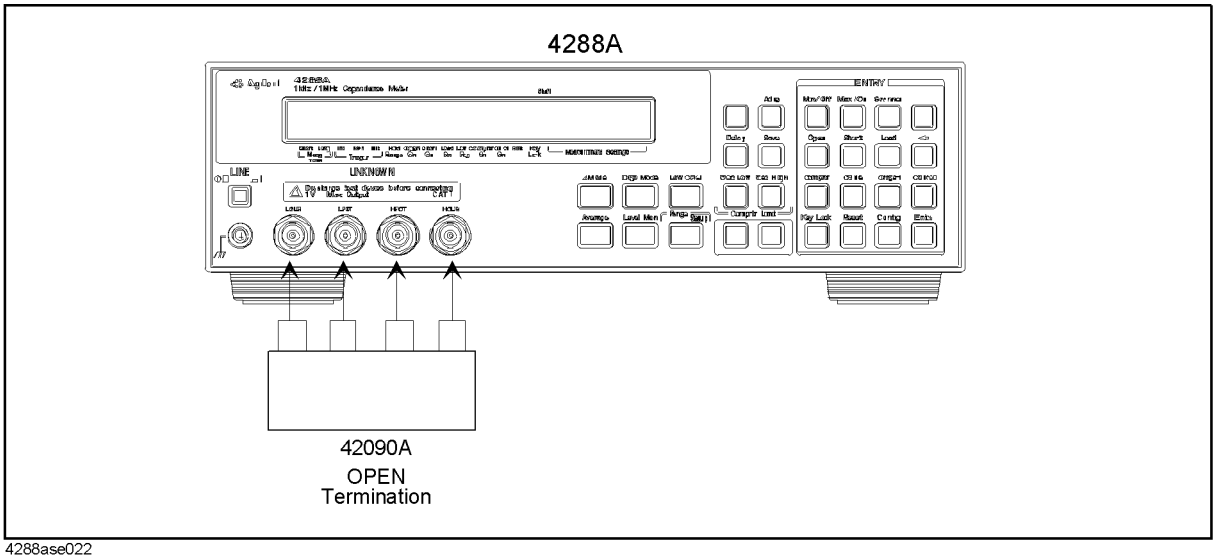
Procedure

Step 1. Run the adjustment program.

Step 2. Choose `AdjModem`.

Step 3. Connect the open termination to the 4288A UNKNOWN terminal as shown in Figure 3-10.

Figure 3-10 Modem Offset Correction Constants Setup



4288ase022

Step 4. Follow the adjustment program instruction to update the correction constants.

Linearity Correction Constants

The adjustment calibrate the linearity of the voltage meter and the current meter. The calibration data in the form of correction constants is stored in the EEPROM.

Required Equipment

Description	Recommended Model
Open Termination	42090A

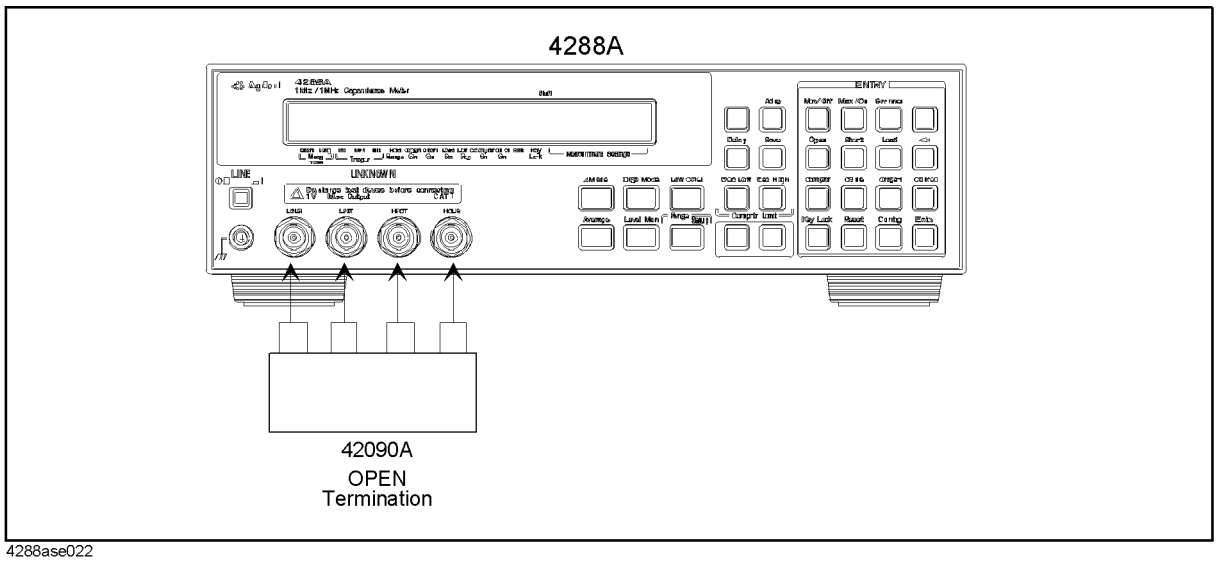
Procedure

Step 1. Run the adjustment program.

Step 2. Choose `AdjLinear`.

Step 3. Connect the open termination to the 4288A UNKNOWN terminal as shown in Figure 3-11.

Figure 3-11 Linearity Correction Constants Setup



4288ase022

Step 4. Follow the adjustment program instruction to update the correction constants.

VRD Gain Correction Constants

The adjustment calibrate the amplifiers' gain and phase shift. The calibration data in the form of correction constants is stored in the EEPROM.

Required Equipment

Description	Recommended Model
Open Termination	42090A

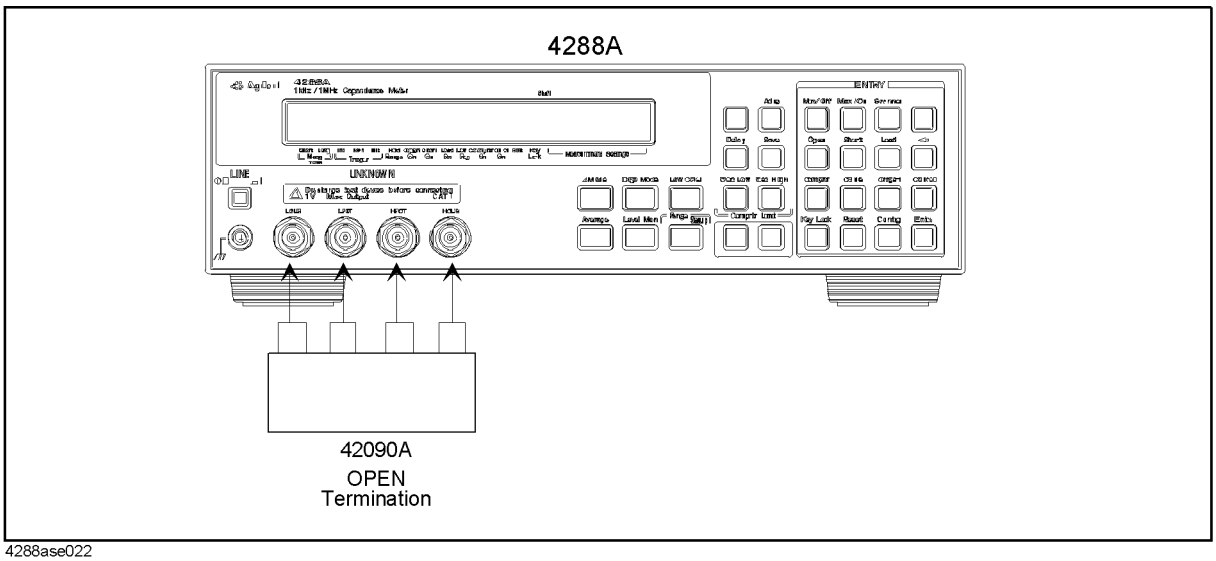
Procedure

Step 1. Run the adjustment program.

Step 2. Choose `AdjVRDGain`.

Step 3. Connect the open termination to the 4288A UNKNOWN terminal as shown in Figure 3-12.

Figure 3-12 VRD Gain Correction Constants Setup



4288ase022

Step 4. Follow the adjustment program instruction to update the correction constants.

TRD Range Resistors Correction Constants

The adjustment calibrate the resistance ratio between the neighbor range resistor. The calibration data in the form of correction constants is stored in the EEPROM.

Required Equipment

Description	Recommended Model
Open Termination	42090A

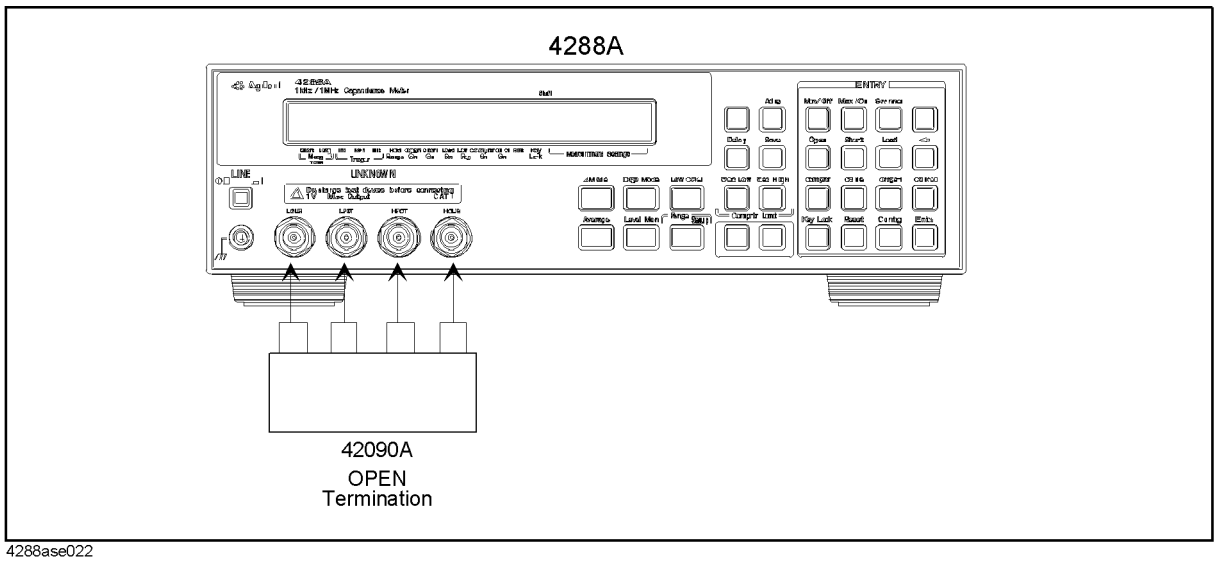
Procedure

Step 1. Run the adjustment program.

Step 2. Choose `AdjTRDRr`.

Step 3. Connect the open termination to the 4288A UNKNOWN terminal as shown in Figure 3-13.

Figure 3-13 TRD Range Resistors Correction Constants Setup



4288ase022

Step 4. Follow the adjustment program instruction to update the correction constants.

Impedance Correction Constants

The adjustment calibrate the capacitance measurement accuracy to measure the standard capacitor as a reference. The calibration data in the form of correction constants is stored in the EEPROM.

Required Equipment

Description	Recommended Model
Standard Capacitor Set	16380A
Standard Capacitor Set	16380C #001
Test Leads, 1 m	16048A
Test Leads, 2 m	16048D

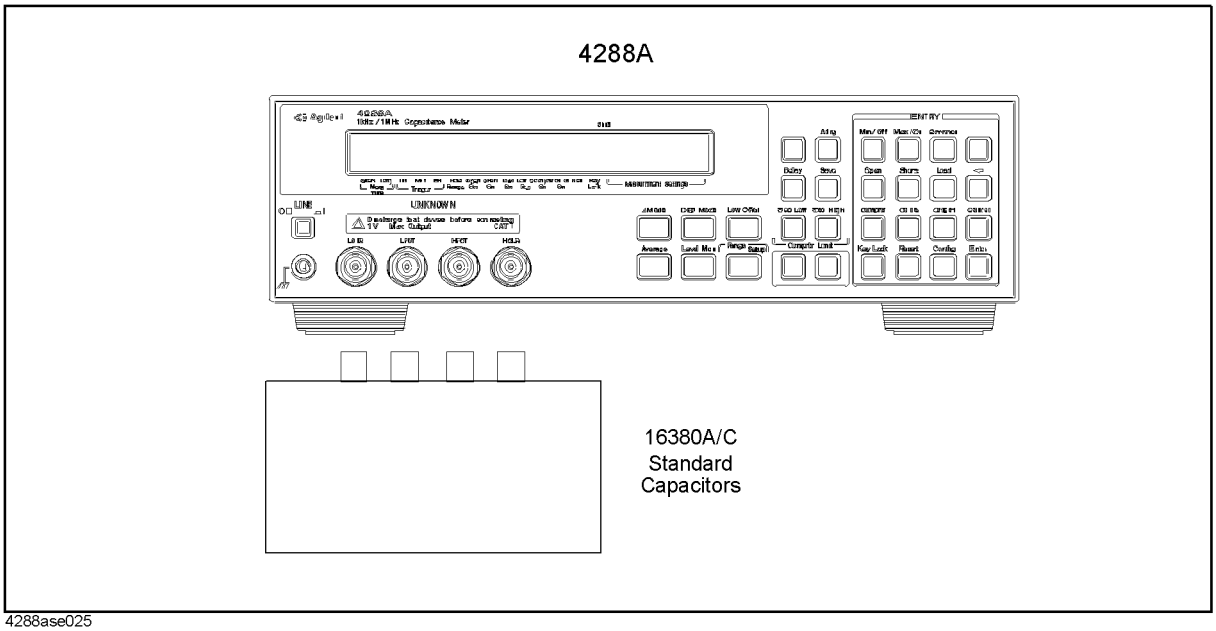
Procedure

Step 1. Run the adjustment program.

Step 2. Choose `AdjImp`.

Step 3. Connect the equipment to the 4288A UNKNOWN terminal as shown in Figure 3-14.

Figure 3-14 Impedance Correction Constants Setup 1

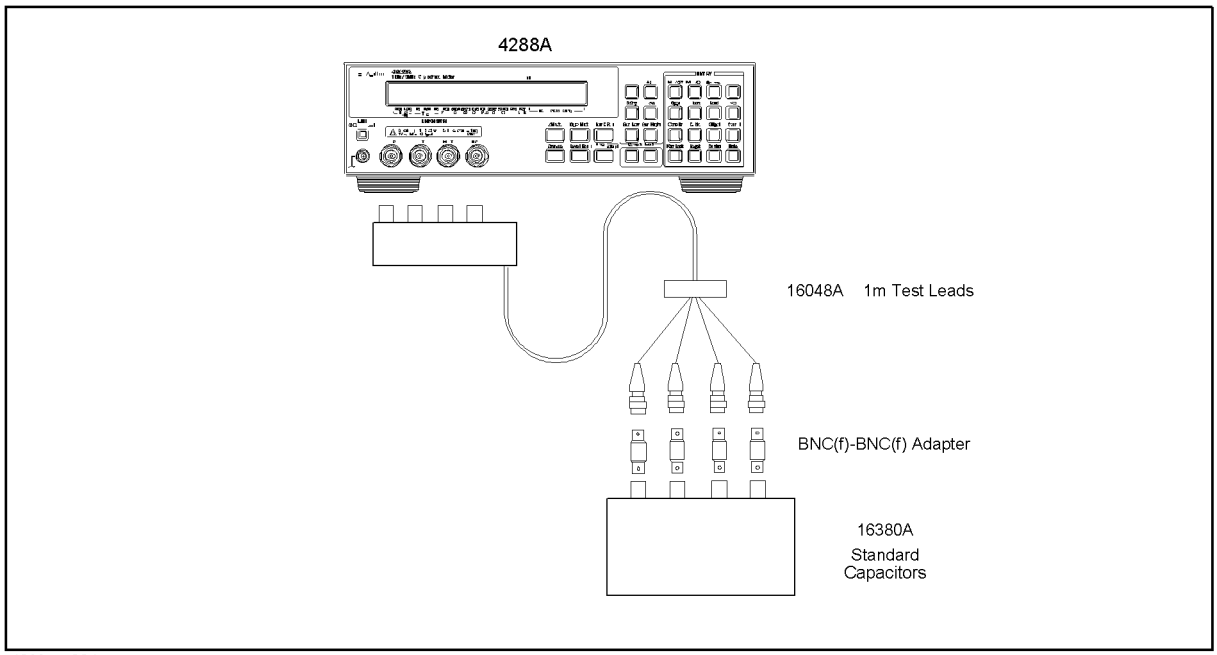


4288ase025

Step 4. Follow the adjustment program instruction to update the correction constants.

Step 5. Connect the equipment to the 4288A UNKNOWN terminal as shown in Figure 3-15.

Figure 3-15 Impedance Correction Constants Setup 2

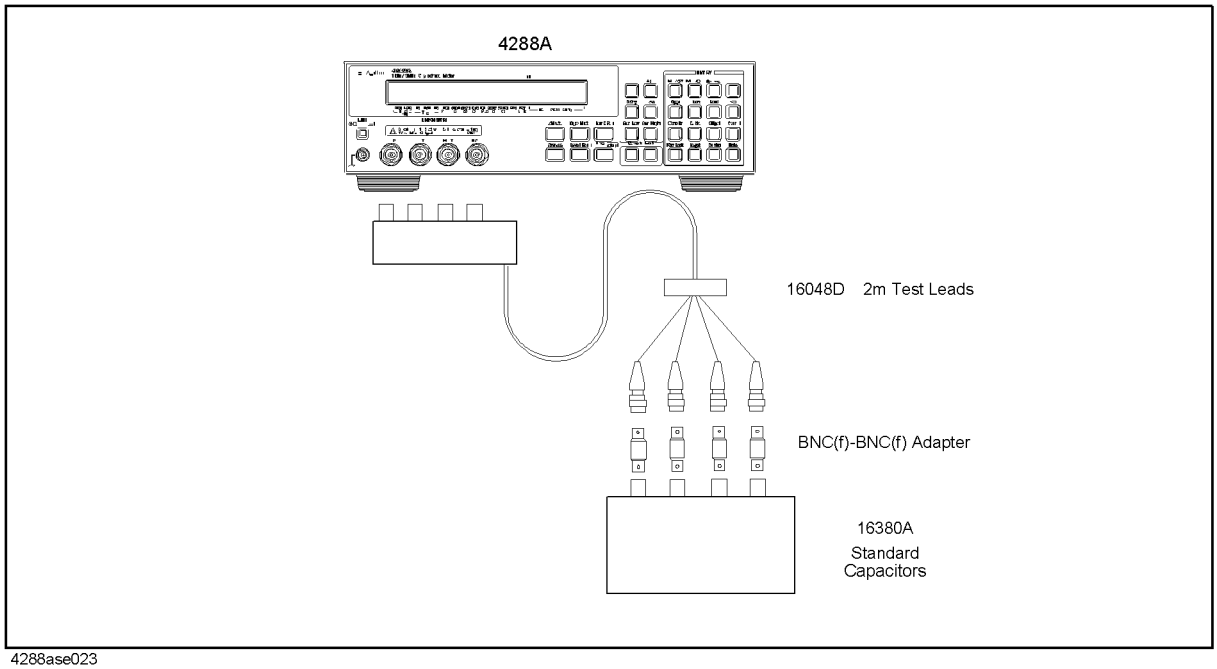


4288ase024

Step 6. Follow the adjustment program instruction to update the correction constants.

Step 7. Connect the equipment to the 4288A UNKNOWN terminal as shown in Figure 3-16.

Figure 3-16 Impedance Correction Constants Setup 3



4288ase023

Step 8. Follow the adjustment program instruction to update the correction constants.

After Adjustment

The purpose of this procedure is to write a back-up date in the EEPROM.

Required Equipment

Nothing

Procedure

Step 1. Run the adjustment program.

Step 2. Choose `AfterAdj`.

Step 3. Follow the adjustment program instruction to update the correction constants.

4 Troubleshooting

This chapter describes troubleshooting flow and provides the procedure to determine which group or assembly is faulty and should be checked.

Introduction

Safety

Read the safety summary at the front of this manual before servicing the instrument.

WARNING **The servicing procedure described here are performed when power is supplied to the instrument and its protective covers are removed. This type of servicing must be performed only by service trained personnel who are aware of the hazards involved (for example, fire and electrical shock). When servicing can be performed without power applied to the instrument, remove power from the instrument. Before any repair is completed, ensure that all safety features and functioning, and that all necessary parts are properly connected to the protective grounding system.**

ESD Precautions

When using any of the procedures in this chapter, you should use proper ESD precautions. As a minimum you should place the instrument on a properly grounded ESD mat and wear a properly grounded ESD wrist strap.

Required Equipment

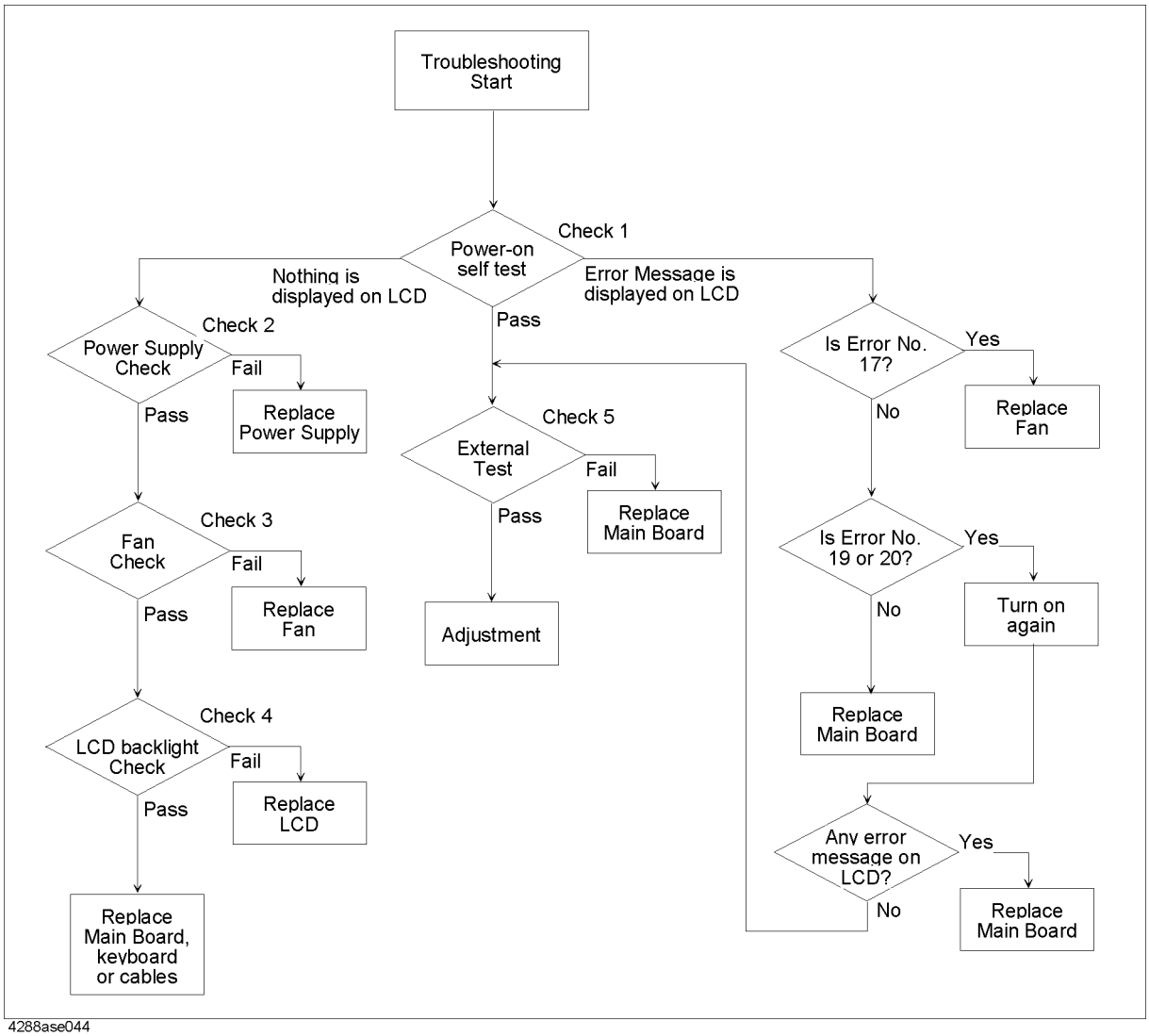
The required equipment for troubleshooting is list on Table 1-1 on page 14.

Trouble Isolation

Trouble Isolation Flowchart

Figure 4-1 shows the trouble isolation flowchart to isolate a defect assembly. Follow the flowchart.for trouble isolation.

Figure 4-1 Trouble Isolation Flowchart



Check 1: Power on self-test

Step 1. Turn off the 4288A, then turn on while watching the LCD.

Step 2. Check for a beep sound for a moment and if you see anything is displayed on the LCD.

Step 3. If nothing is shown in the LCD, proceed to “Check 2: Power Supply Check.”

Step 4. If an error message is displayed on the LCD, the power supply works properly. Proceed to “Check 6: Digital Trouble Isolation.”

Step 5. If no error message is displayed on the LCD, the power supply and the digital control circuit works properly. Proceed to “Check 5: External Test.”

Check 2: Power Supply Check

Step 1. Remove the cover as described in “Cover Removal” on page 114.

Step 2. Turn on the 4288A.

Step 3. Check the fuse in the AC inlet on the rear panel. If the fuse is defect, replace the fuse.

Step 4. Check the voltage between ground and each test pin with the multimeter. If the voltages are between the test limit as shown in Table 4-1, proceed to Table , “Check 3: Fan Check.” If all the voltages are not between the limit, the power supply or the Main Board.

Figure 4-2 **Test Point**

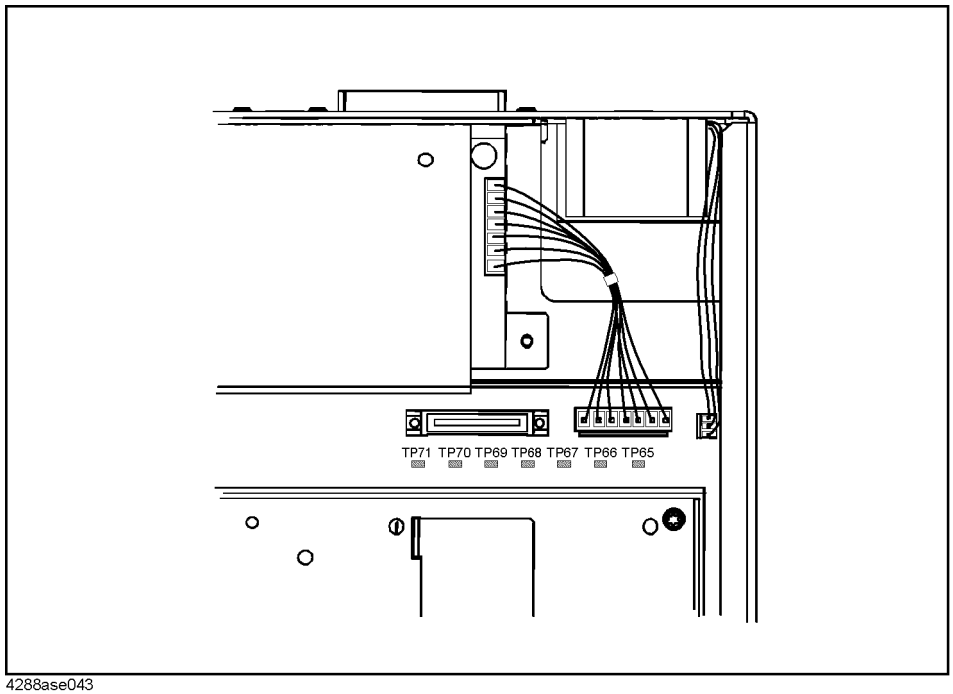


Table 4-1 **Power Supply Check Limit**

Cable Color	Test Limit	Original Voltage from Power Supply
TP65	3.3 V ± 0.16 V	5 V
TP66	5 V ± 0.25 V	12 V
TP67	10.5 V ± 0.5 V	
TP68	–5 V ± 0.25 V	–12 V
TP69	–10.5 V ± 0.5 V	
TP70	Ground	Ground
TP71	5 V ± 0.25V	5 V

Check 3: Fan Check

Step 1. Turn on the 4288A.

Step 2. Confirm that the fan is rotating. If the fan works properly, proceed to “Check 4: LCD backlight.” If the fan is not rotating, replace the fan.

Check 4: LCD backlight

Step 1. Turn on the 4288A.

Step 2. Remove the cable connected to LCD backlight from the keyboard.

Step 3. Measure the voltage between the connector electrodes in the keyboard. If the voltage is between 5 V ± 0.5 V, replace the LCD. If not, replace the A1 main board, the keyboard or the flat cable connecting between the A1 board and the keyboard.

Check 5: External Test

Step 1. Turn on the 4288A.

Step 2. Execute the external test as described in “External test” on page 86. If the test fails, replace the A1 main board.

Check 6: Digital Trouble Isolation

Step 1. If the error number is 17, replace the fan.

Step 2. If the error number is 19 or 20, turn off the 4288A then turn on again. If the same error number is displayed again, replace the main board.

Step 3. If another error number is displayed, replace the main board.

Service Functions

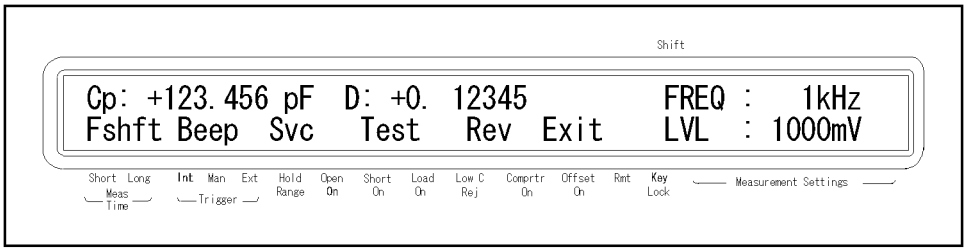
The service functions are used to test, verify, control, and troubleshoot

Firmware Revision Confirmation

The firmware revision can be confirmed with either of the following procedure.

- Turn the 4288A off, then turn it on again. (Immediately after turning on, the firmware revision and the serial number appear in the LCD.)
- Press blue-**[-]** to show the configuration menu as Figure 4-3. Use the **[←↓]** or **[↑→]** to blink `Rev`, then press the **[Enter]** key.

Figure 4-3 **Configuration menu**



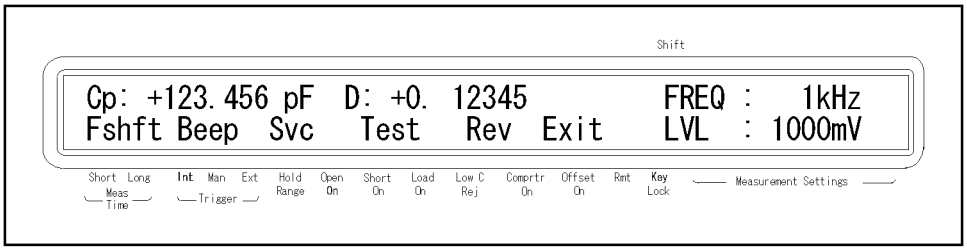
4288aoj006

Internal Test

The 4288A provides a self-test function. The self-test performs brief check of the operation of digital parts including memory.

Step 1. Press blue-**[-]** to show the configuration menu as Figure 4-4.

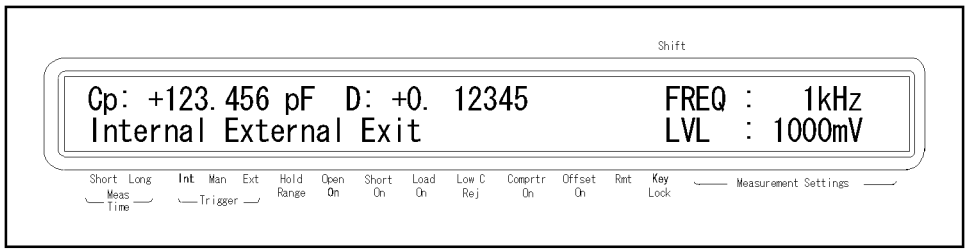
Figure 4-4 **Configuration menu**



4288aoj006

Step 2. Use the **[↑→]** key to blink `Test` and then press **[Enter]**. The test menu appears as shown in Figure 4-5.

Figure 4-5 **Test menu**



4288aoj122

Step 3. Use the **[↑→]** key to blink `Internal` and then press **[Enter]**. The “SELF TESTING” message appears and the self-test is executed.

Step 4. When the test is completed, “SELF TEST: PASS” is displayed for approximately 1 second (if an error occurs, its error number is displayed. For details on displayed error number, refer to Table 4-2) and then the menu in Step 1 appears,. Check that `Exit` is blinking (if not, operate keys to blink `Exit`) and then press the **[Enter]** key to exit from the menu.

Table 4-2 **Self-Test Items**

Test item	Test description	Error code
RAM	Verifies that the RAM data bus is connected correctly and there is no faulty memory cell.	1
Boot ROM	Verifies that the check sum of Boot ROM is correct.	2
Flash ROM	Verifies that the check sum of Flash ROM is correct.	4
Calibration data	Verifies that the check sum of the adjustment data in the EEPROM is correct.	8
User correction data	Verifies that the checksum of the OPEN/SHORT/LOAD correction data in the EEPROM is correct. Even if the test fails, the correction data is not initialized.	16
A/D converter	Verifies that the A/D converter operates normally.	32
Backup RAM	Verifies that the instrument setting value in the backup memory(RAM) is correct. Even if the test fails, the instrument setting value is not initialized.	64

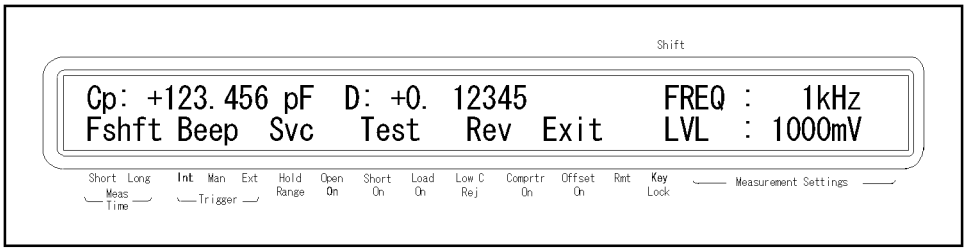
External test

The external test performs a simple operational testing on the analog circuitry using the internal calibration resistors.

Procedure from the front panel

Step 1. Press the blue-**[-]** key. The configuration menu screen as shown in Figure 4-6 appears.

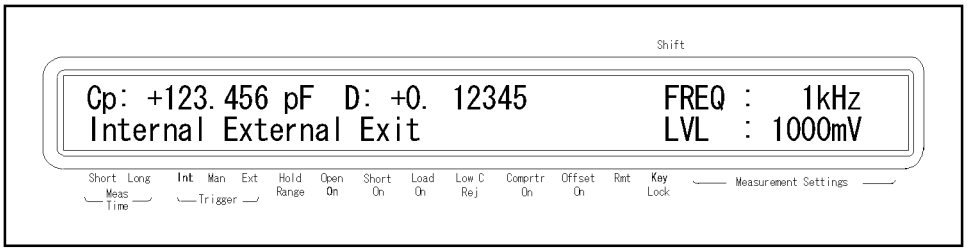
Figure 4-6 **The configuration menu**



4288aoj006

Step 2. Use the **[↑→]** and other necessary keys to blink `Test` and press the **[Enter]** key. Test menu screen as shown in Figure 4-7 appears.

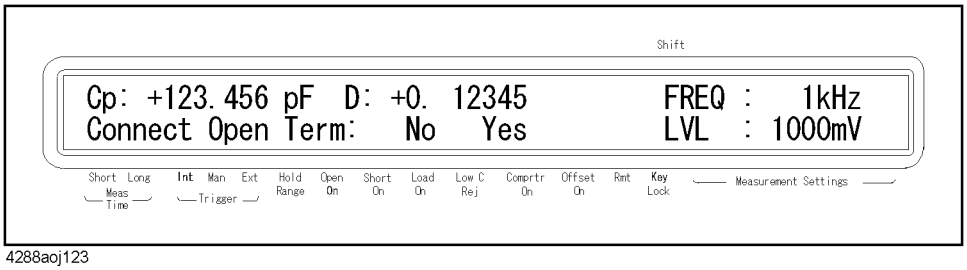
Figure 4-7 **Test menu screen**



4288aoj122

Step 3. Use the **[↑→]** and other necessary keys to blink `External` and press the **[Enter]** key. The screen as shown in Figure 4-8 appears.

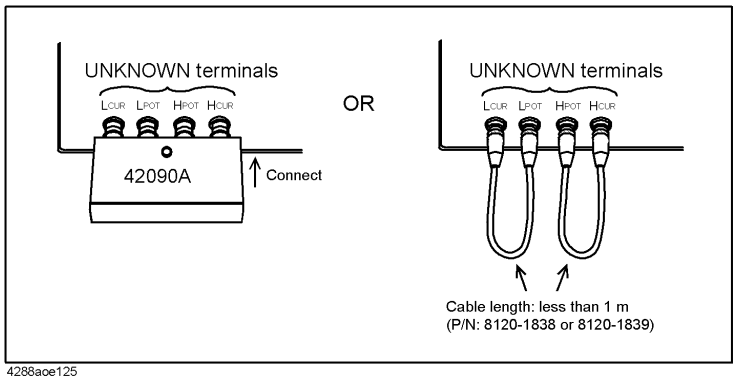
Figure 4-8 **External test execution wait screen**



4288aoj123

Step 4. As shown in Figure 4-9, connect the 42090A to the UNKNOWN terminal of the 4288A (or directly connect between L_{CUR} and L_{POT} and between H_{CUR} and H_{POT} with BNC cables).

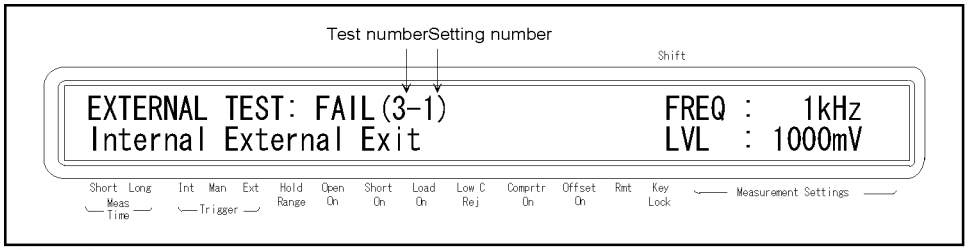
Figure 4-9 **Preparation for external test**



4288aoe125

Step 5. Use the **[↑→]** and other necessary keys to blink `Yes` and press the **[Enter]**. The external test is performed in the order of test number. When the test completes, test result (PASS or FAIL) is displayed to the right of EXTERNAL TEST: as shown in Figure 4-10 and the test menu is brought back. When the test result is FAIL, failed test numbers and setting numbers are additionally displayed (see Table 4-3 and Table 4-4). Replace the A1 main board if this test fails.

Figure 4-10 **Test result display screen (when setup 1 of measurement part test failed)**



4288aoe124

Table 4-3 **External test items**

Test number	Test item	Description
1	Entire analog circuitry	Check the 4288A which setting is after reset by “*RST” command.
2	Signal part (signal level)	Check set the signal level properly.
3	Signal part (frequency)	Check set the frequency properly.
4	Measurement part	Check set the measurement range properly.

Table 4-4 External Test Setting

Test Number	Setting Number	Frequency	Frequency Shift	Signal Level	Range	Calibration Resistor	Service Mode
1	1	1 kHz	0 %	1000 mV	100 pF	100 kΩ	OFF
2	1	1 kHz	0 %	1000 mV	100 nF	1 kΩ	OFF
	2	1 kHz	0 %	500 mV	100 nF	1 kΩ	OFF
	3	1 kHz	0 %	100 mV	100 nF	1 kΩ	OFF
	4	1 MHz	0 %	1000 mV	100 pF	1 kΩ	OFF
	5	1 MHz	0 %	500 mV	100 pF	1 kΩ	OFF
	6	1 MHz	0 %	100 mV	100 pF	1 kΩ	OFF
3	1	1 kHz	0 %	1000 mV	100 nF	1 kΩ	OFF
	2	1 MHz	0 %	1000 mV	100 pF	1 kΩ	OFF
	3	1 MHz	+1 %	1000 mV	100 pF	1 kΩ	OFF
	4	1 MHz	–1 %	1000 mV	100 pF	1 kΩ	OFF
	5	1 MHz	+2 %	1000 mV	100 pF	1 kΩ	OFF
4	1	1 kHz	0 %	1000 mV	1 nF	100 kΩ	OFF
	2	1 kHz	0 %	1000 mV	10 nF	10 kΩ	OFF
	3	1 kHz	0 %	1000 mV	100 nF	1 kΩ	OFF
	4	1 kHz	0 %	1000 mV	1 µF	100 Ω	OFF
	5	1 kHz	0 %	1000 mV	10 µF	100 Ω	OFF
	6	1 MHz	0 %	1000 mV	10 pF	100 kΩ	OFF
	7	1 MHz	0 %	1000 mV	100 pF	100 kΩ	OFF
	8	1 MHz	0 %	1000 mV	1 nF	100 kΩ	OFF
	9	1 kHz	0 %	1000 mV	100 nF	1 kΩ	ON
	10	1 kHz	0 %	1000 mV	100 nF	1 kΩ	OFF

Procedure with GPIB command

The external test can be executed by sending the GPIB command ":STSTEM:TEST?"

The following the command reference.

Syntax :SYSTEM:TEST?

Description Executing this command perform the external test for the 4288A. To perform the external test, you need to connect the equipment as shown in Figure 4-9.

Query response {numeric 1},{numeric 2},{numeric 3},{numeric 4},{numeric 5}<newline><^END>

NOTE "SYSTEM:TEST?" returns "0,0,0,0,0<newline>" when the external test passes.

{numeric 1}: Test number in Table 4-4

{numeric 2}: Setting number in Table 4-4

{numeric 3}: Failed measurement parameter 1:Impedance 2:V monitor 3:I monitor

{numeric 4}: The expected value of the failed measurement parameter

{numeric 5}: The measurement value of the failed measurement parameter. The return value −1 means that the overload is detected.

NOTE The external test fails when the measurement value is out of the following test limit

Parameter	Test limit
Impedance	Expected Value ±5 %
V monitor	Expected Value ±20 %
I monitor	Expected Value ±20 %

Power On Self-test

This test is executed when the 4288A is turned on. This test performs the following brief checks of the operation of the including memory. This test is executed at power-on.

- RAM test failed

  The RAM data bus or the address bus in NOT connected correctly. Replace A1 board.

- Boot ROM test failed

  The Boot ROM check sum is invalid. If only the Boot ROM is failed, replace the A1 Board.

- Flash ROM test failed

  The Flash ROM check sum is invalid. Install firmware to the Flash ROM. If the 4288A still fails, replace the A1 board.

- EEPROM test failed

  Read/Writing EEPROM is not performing correctly. If only the EEPROM test failed, replace A1 board.

- A1 board test failed

  The A/D converter is not working properly. Replace the A1 board.

- Calibration memory lost

  The Factory Calibration Data in the EEPROM has been lost. Perform the adjustment.

- User data lost

  The User Correction Data in the EEPROM has been lost. The correction data is initialized to the factory setting.

- Previous setting lost

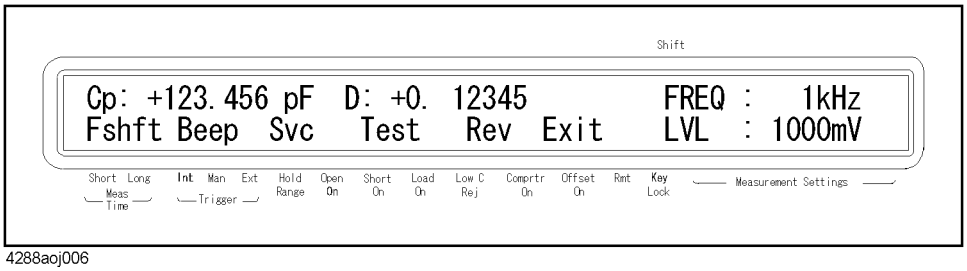
  The instrument setting values in the backup memory have been lost. These value is initialized to the factory setting. Possible cause include a lapse of 72 hours after power-off.

Front Panel Key Test

This test verifies that the front panel keys work correctly.

Step 1. Press the **[Config]**(**[Blue]** - **[–]**) key. The configuration menu screen as shown in Figure 4-6 appears.

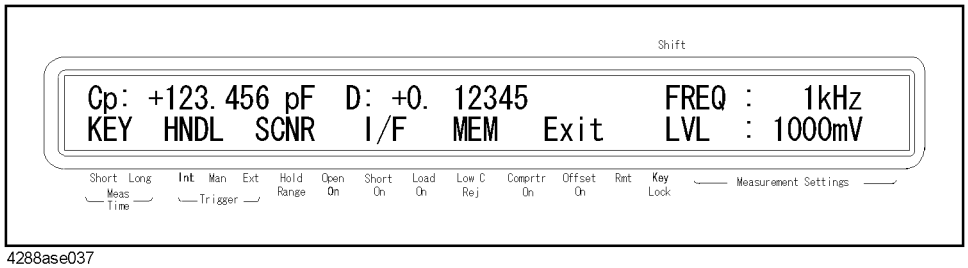
Figure 4-11 The configuration menu



4288aoj006

Step 2. Use the **[↑→]** and other necessary keys to blink “Key” and press the **[Enter]** key. Test menu screen as shown in Figure 4-7 appears.

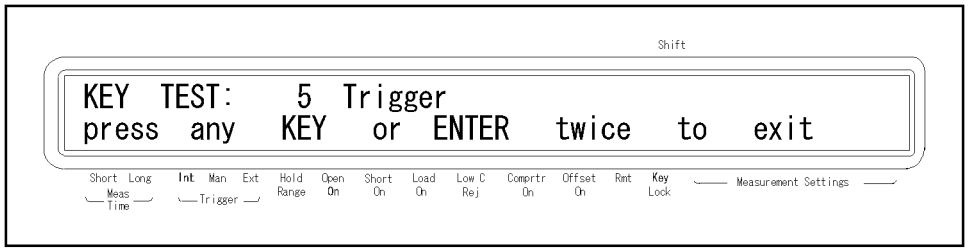
Figure 4-12 **Service function menu screen**



4288ase037

Step 3. Press a key that you test. The name of the pressed key is displayed next to “KEY TEST:“ in the upper line of the display. Figure 4-13 shows an example when **Trig** key is pressed.

Figure 4-13 **Front Panel Key Test screen**



4288ase038

Step 4. If you want to finish the test, press **[Enter]** key twice.

Interface Test

Verify the handler interface and the scanner interface function with the Handler & Scanner Interface Tester(04288-65001). For detail, refer to “Handler Interface and Scanner Interface Test” on page 30.

Handler Interface Test

Verify the handler interface with the Handler Simulator(04288-65001). For detail, refer to “Handler Interface and Scanner Interface Test” on page 30.

Scanner Interface Test

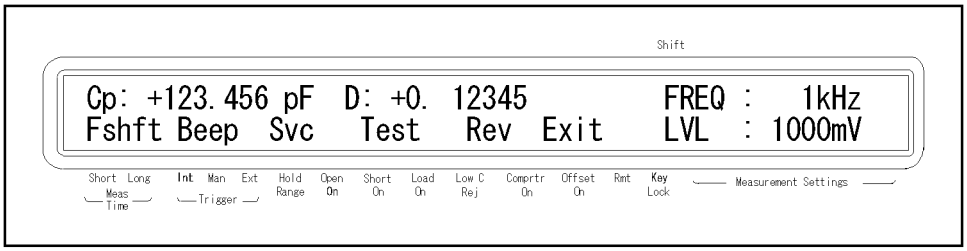
Verify the handler interface with the Scanner Simulator(04278-65301). For detail, refer to “Handler Interface and Scanner Interface Test” on page 30.

Memory Test

Verify the Boot ROM, the Flash ROM and the RAM.

Step 1. Press the **[Config]**(**[Blue]** - **[–]**) key. The configuration menu screen as shown in Figure 4-6 appears.

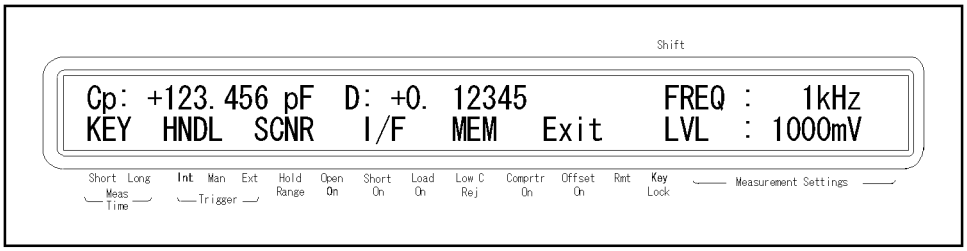
Figure 4-14 **The configuration menu**



4288aoj006

Step 2. Use the **[↑→]** and other necessary keys to blink “MEM” and press the **[Enter]** key. Test menu screen as shown in Figure 4-7 appears.

Figure 4-15 **Service function menu screen**



4288ase037

Step 3. “PASS” or “FAIL” is displayed next to “BOOT TEST:”, “FLASH TEST:” and “RAM TEST:” in the upper line of the display.

5 Theory of Operation

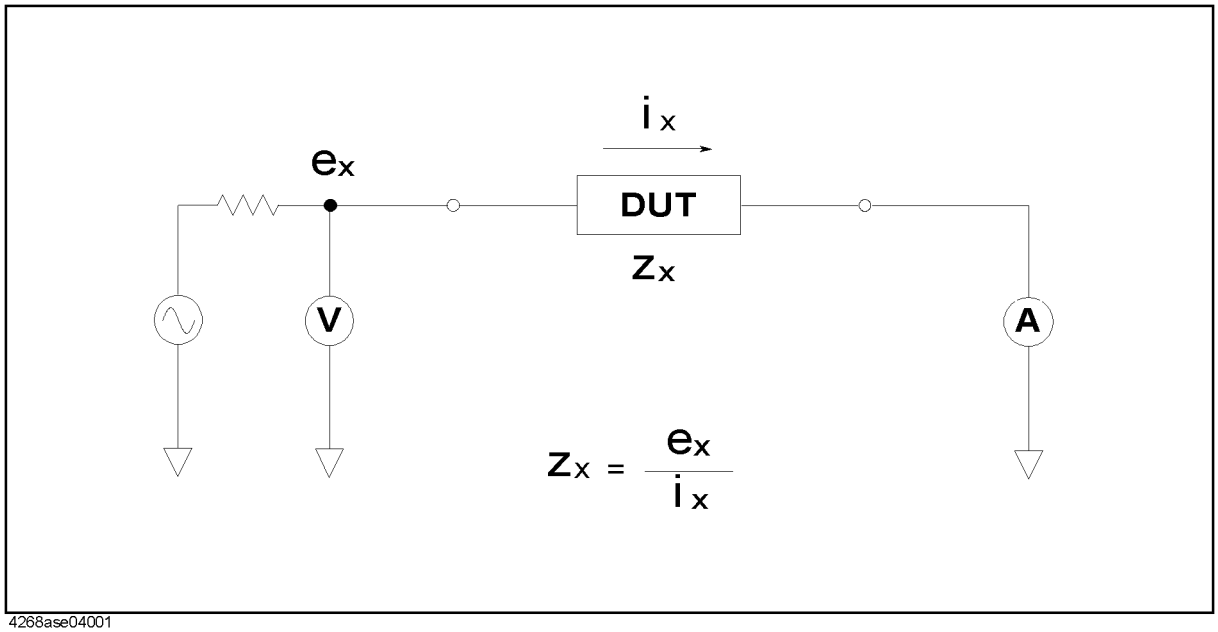
This chapter describes the general overall operation of the 4288A and the operation of each assembly.

Overall Operation

Overall Operation

The 4288A measures the impedance of the Device Under Test (DUT) by measuring vector voltage to current ratio. A vector is a value which consists of a magnitude and a phase. The impedance of the DUT is determined by the vector ratio bet ween the voltage across the DUT and the current passing through it. The 4288A essentially consists of a signal source, a vector voltmeter, and a vector current meter.

Figure 5-1 Measurement Principle



4268ase04001

In Figure 5-1, a DUT connected in series, a DUT connected in series with a test voltage source (including an output resistance), voltmeter V, and ammeter, A. If the ammeter measures i_x ampere when the source voltage is e_x, the DUT's impedance Z_x is expressed by the following equation.

$$Z_x = \frac{e_x}{i_x}$$

Function Groups

The 4288A consists of three main functional groups: a power supply, a digital control and an analog circuit. The analog circuit contains a source, a transducer and vector ratio detector. A power supply function is consist of pre-regulator. A digital control function consists of several assemblies and a part of the A1 Main Board. The analog circuit are mounted on the A1 Main board.

Power Supply Circuit

The power supply functional group consists of the pre-regulator. It supplies power to the other assemblies in the 4288A.

Digital Control

The digital control block group consists of the keyboard, the LCD and a part of the A1 Main board. This function control the 4288A.

Analog Circuit

The 4288A analog circuit consists of three main functions, the source, the transducer and the vector ratio detector.

The source function is mounted on the A1 Main Board. These source generates all analog signals in the 4288A, a phase locked test signal to the device under test.

The transducer function is mounted on the A1 main board. This function balances the range resistor current with the DUT current to maintain the zero potential at the low terminal(Lp) and transforms the DUT impedance, or admittance, into two AC signals

The vector ratio detector (VRD) functions is mounted on the A1 Main board. The vector ratio detector converts the two AC signals from the transducer function into digital data.

Power Supply Operation

The power supply functional group consists of the following assemblies.

Line Power Module

The line power module includes the main fuse. The main fuse, which protects the input side of the pre-regulator from drawing too much line current, is also accessible at thee rear panel. See Appendix B, “Power Requirement,” on page 127 for the fuse replacement and other power considerations.

Pre-regulator

The pre-regulator contains a rectifier and a switching regulator, converts the line voltage to +5 V and ±12 V.

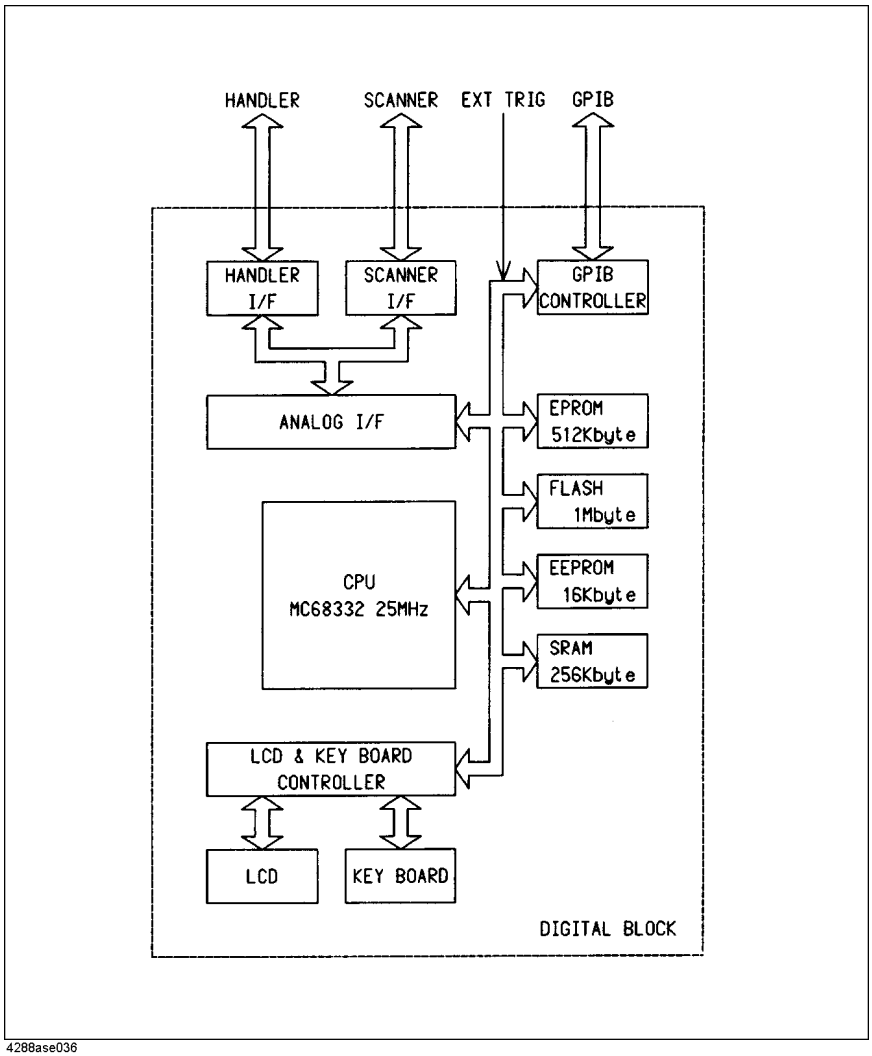
Digital Control Operation

The digital control functional group consists of the following assemblies:

- A part of the A1 main board
- Front keyboard
- LCD

These assemblies combine to provide digital control for the 4288A. They provide math processing functions, as well as communications between the 4288A and an external controller and/or peripherals.

Figure 5-2 **Digital control Group Simplified Block Diagram**



A1 Main Board

The digital control section in the A1 main board consists of the following circuits and

parts.

CPU	central processing unit that controls the analyzer.
Memory storages	consists of the boot ROMs, Flash memory, EEPROM, Backup SRAM.
Analog Interface	interfaces between the CPU and analog function.
Keyboard & LCD Control	controls the front-panel keyboard
Handler interface	control the external handler.
Scanner interface	control the scanner
GPIB Control	communicates with the external GPIB devices through the GPIB connector.

Front Keyboard

The front keyboard assembly detects your inputs form the front panel of the 4288A, and transmits them to the keyboard controller on the keyboard control in the A1 main board.

LCD

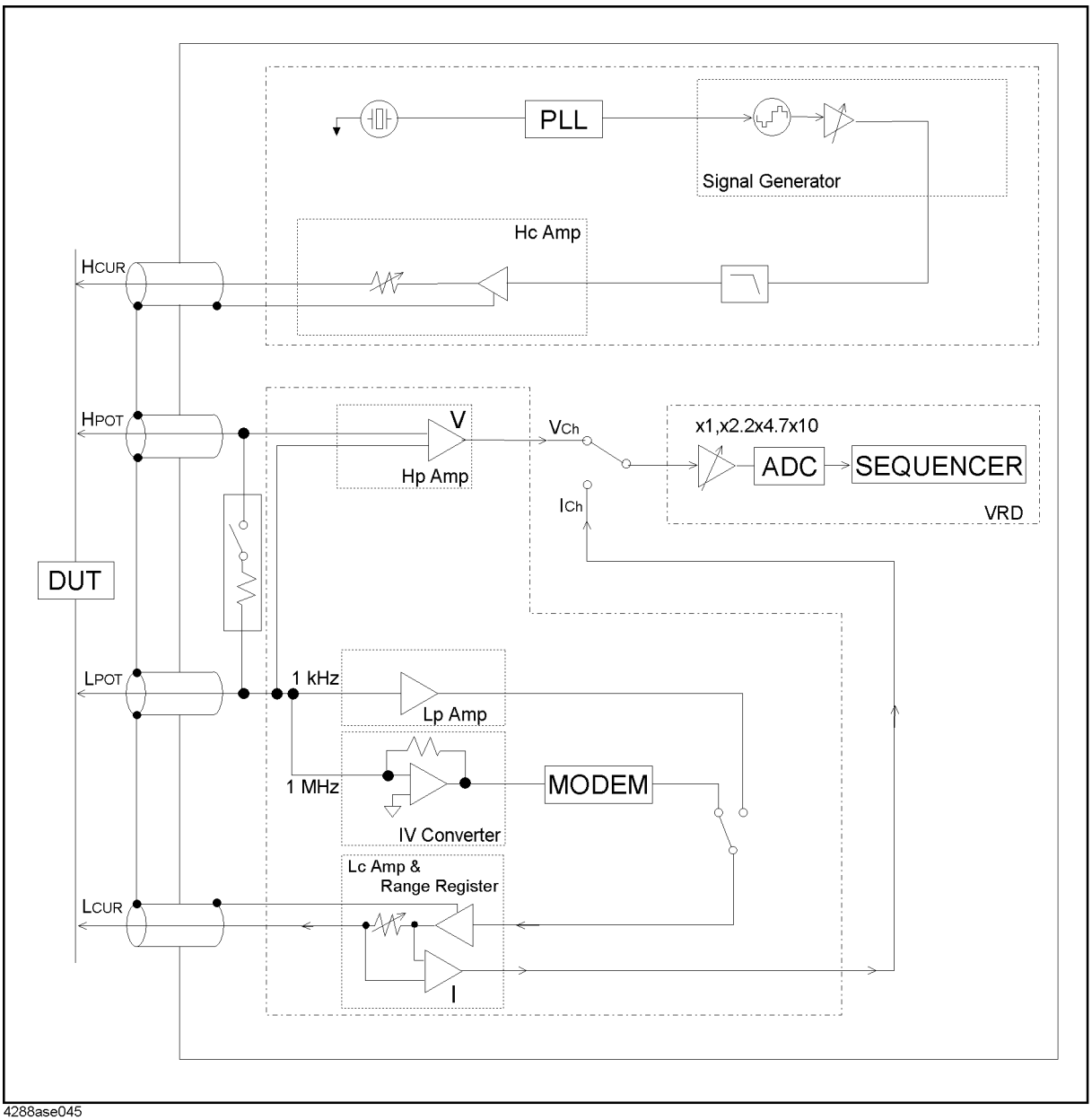
The LCD is receives a high voltage from the Inverter as backlight power and the digital horizontal and the vertical signals from the GSP.

Analog Circuit Operation

Figure 5-3 is the analog circuit block diagram. The analog circuit consists of the following three functions.

- Source
- Transducer
- Vector Ratio Detector (VRD)

Figure 5-3 Analog Circuit Block Diagram

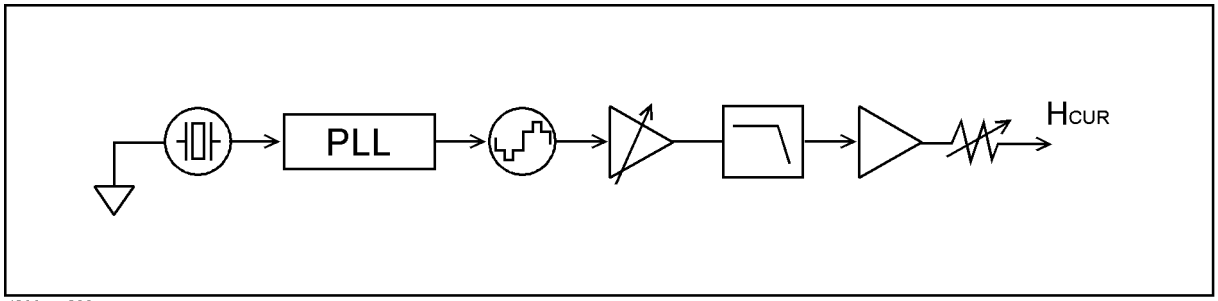


4288ase045

Source Theory

The source group generates all analog signals in the 4288A, a phase-locked test signal to the device under test, the reference signals for the transducer group and the vector ratio detector.

Figure 5-4 Source Function Simplified Block Diagram



The all analog signals derived from the PLL. The reference signals generated by the crystal oscillator is transferred to the PLL. The 4288A shift the test signal frequency by changing the dividing ratio in the PLL. The output signal of PLL is transferred to the signal generator.

The signal from the PLL is converted to the simulated sinusoidal wave and transfer it to the low-pass filter. The signal level is set by the DA converter.

The Hc Amp. produce signal voltage up to 1 V, and current up to 125 mA. The output resistor is selected in accordance with the magnitude of the DUT impedance.

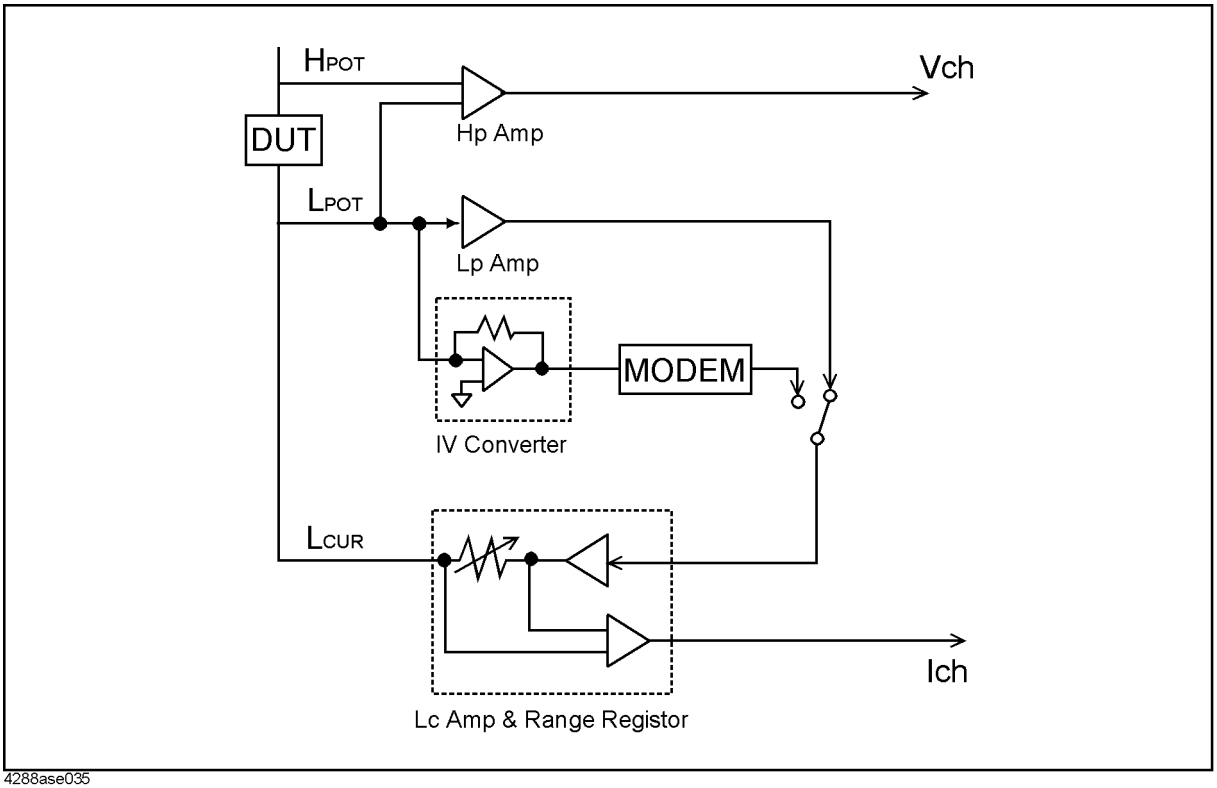
Transducer Theory

The transducer group balances the range resistor current with the DUT current to maintain a zero potential at the low terminal(Lp) and transforms the DUT impedance into two AC signals.

The transducer consists of the following assemblies:

- Lp Amp.
- Hp Amp.
- Lc Amp. and Range Resistor
- IV Converter
- MODEM

Figure 5-5 Transducer Block Diagram



Lp Amp.

The Lp Amp. amplify the input signal from Lp terminal to keep the very high gain.

Hp Amp.

The Hp Amp. detect the voltage across the DUT by measuring the voltage between the L_{POT} Terminal and the H_{POT} terminal.

Lc Amp. & Range Resistor

The Lc Amp. detect the current flowing through the range resistor with the differential

amplifier. The range resistors consists of 8, 100 Ω and 1, 10, 100 kΩ.

IV Converter

The IV Converter detect the difference between the DUT and the feedback resistor, and outputs this difference as a proportional error voltage.

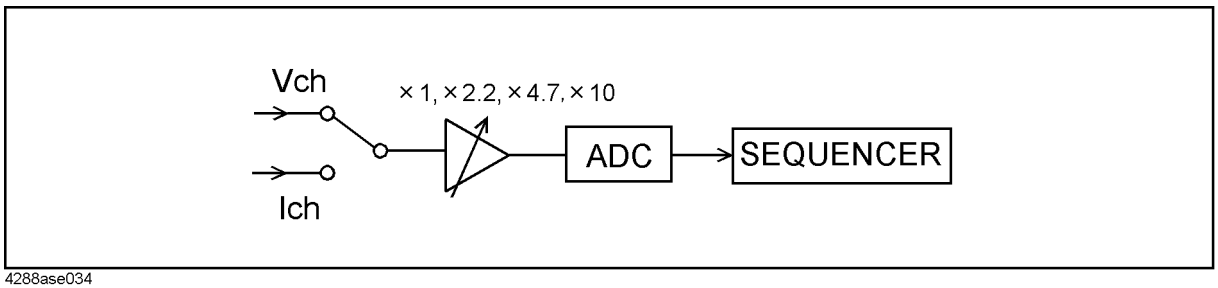
MODEM

The MODEM block generates the signal to balance the tranducer loop.

Vector Ratio Detector

The vector ratio detector converts the signal from transducer section into the digital data.

Figure 5-6 Vector Ratio Detector Block Diagram



The variable gain amplifier amplify the input signal 1, 2.2, 4.7 or 10 times in accordance with the measurement range. The amplified signal is converted to the digital data by A-D Converter.

6 Assembly Replacement

This chapter contains the list of the 4288A replaceable parts and the procedure to replace its major assemblies.

Safety

Read the safety summary at the front of this manual before servicing the instrument.

WARNING

The servicing procedures described herein are performed when power is supplied to the instrument and its protective covers are removed. This type of servicing must be performed only by service trained personnel who are aware of the hazards involved (for example, fire, and electrical shock). When serving can be performed without power applied to the instrument, remove power from the instrument. Before any repair is completed, ensure that all safety features are intact and functioning, and that all necessary parts are properly connected to the protective grounding system.

ESD Precautions

When using any of the procedures in this chapter, you should use proper ESD precautions. As a minimum you should place the instrument on a properly grounded ESD mat and wear a properly grounded ESD wrist strap.

Ordering Information

To order part listed in the replaceable part lists, quote the Agilent Technologies part number (with a check digit), indicate the quantity required, and address the order to the nearest Agilent Technologies office. The check digit will ensure accurate and timely processing of the order.

To order a part not listed in the replaceable part table, include the instrument model number, the description and function of the part, and the quantity of parts required. Address the order to the nearest Agilent Technologies office.

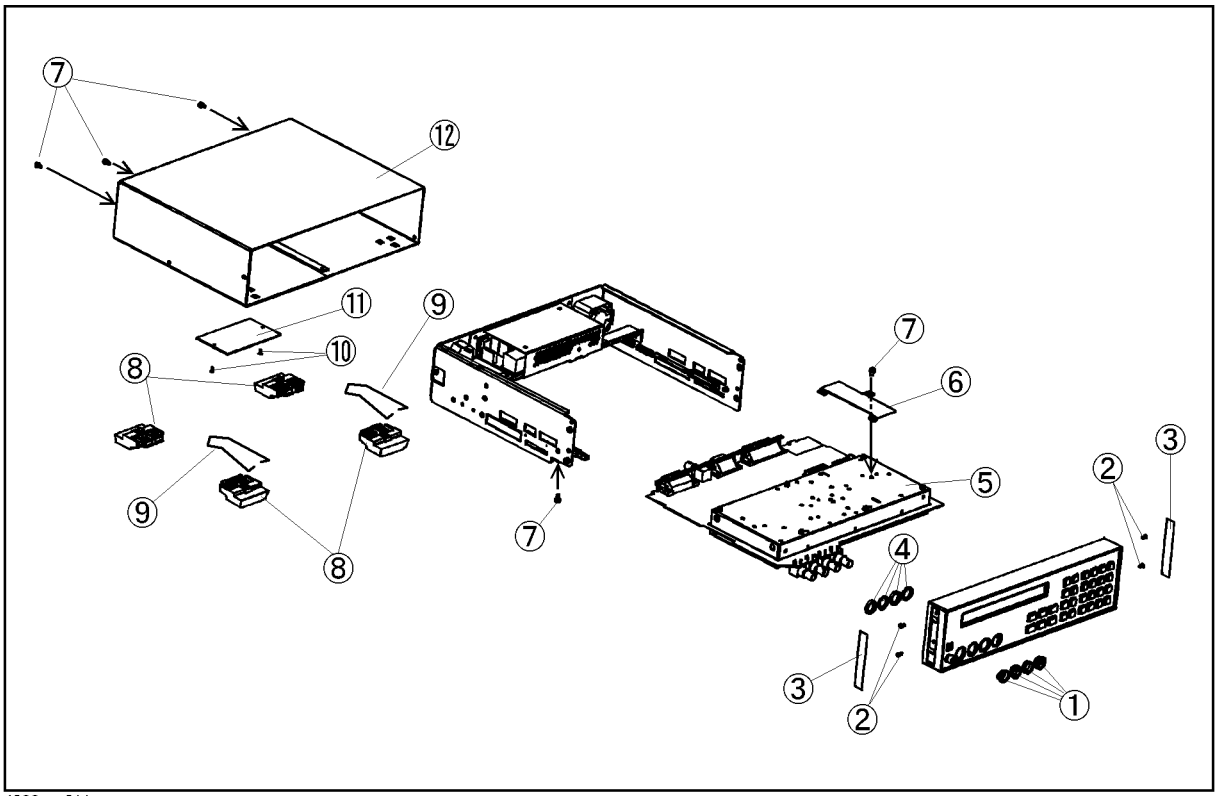
Exchange Assemblies

Under the rebuilt-exchange assembly program, certain factory-repaired and tested assemblies are available on a trade-in basis. These assemblies are offered al lower cost than a new assembly, but meet all factory specifications required of a new assembly.

The defective assembly must be returned for credit under the terms of the rebuilt-exchange assembly program. Any spare assembly stock desired should be ordered using the new assembly part number.

Replaceable Parts List

Figure 6-1 4288A Main Assemblies

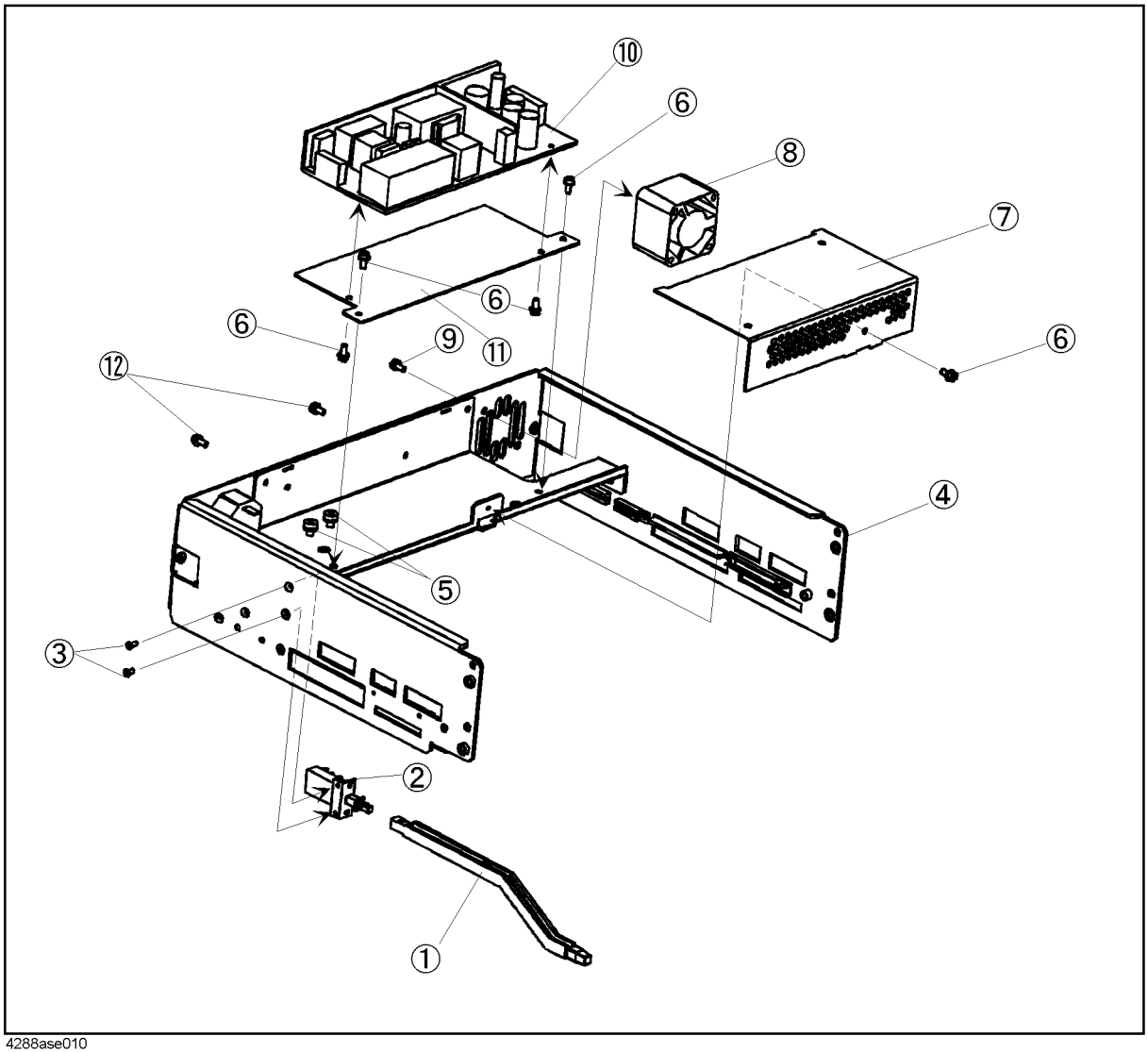


4288ase011

Table 6-1 4288A Main Assemblies

Ref. Desig.	Agilent Part Number	Check Digit	Qty.	Description
1	04288-24003	3	4	Nut
2	0515-1946C	8	4	Screw M3 T10
3	5041-9170	6	2	Side Trim
4	04288-24002	2	4	Sleeve
5	04288-66501	4	1	A1 Main Board
	04288-69501	0	1	A1 Main Board (Exchange Board)
6	04288-01212	8	1	Angle
7	0515-0430	3	5	Screw M3 T10
8	5041-9167	1	4	Foot
9	1460-1345	5	2	Tilt Stand
10	0515-0999	9	2	Screw M2.5 Pozidriv
11	04288-04002	0	1	Plate
12	04288-04001	9	1	Cover (Including Item 10 item 11)

Figure 6-2 4288A exploded view

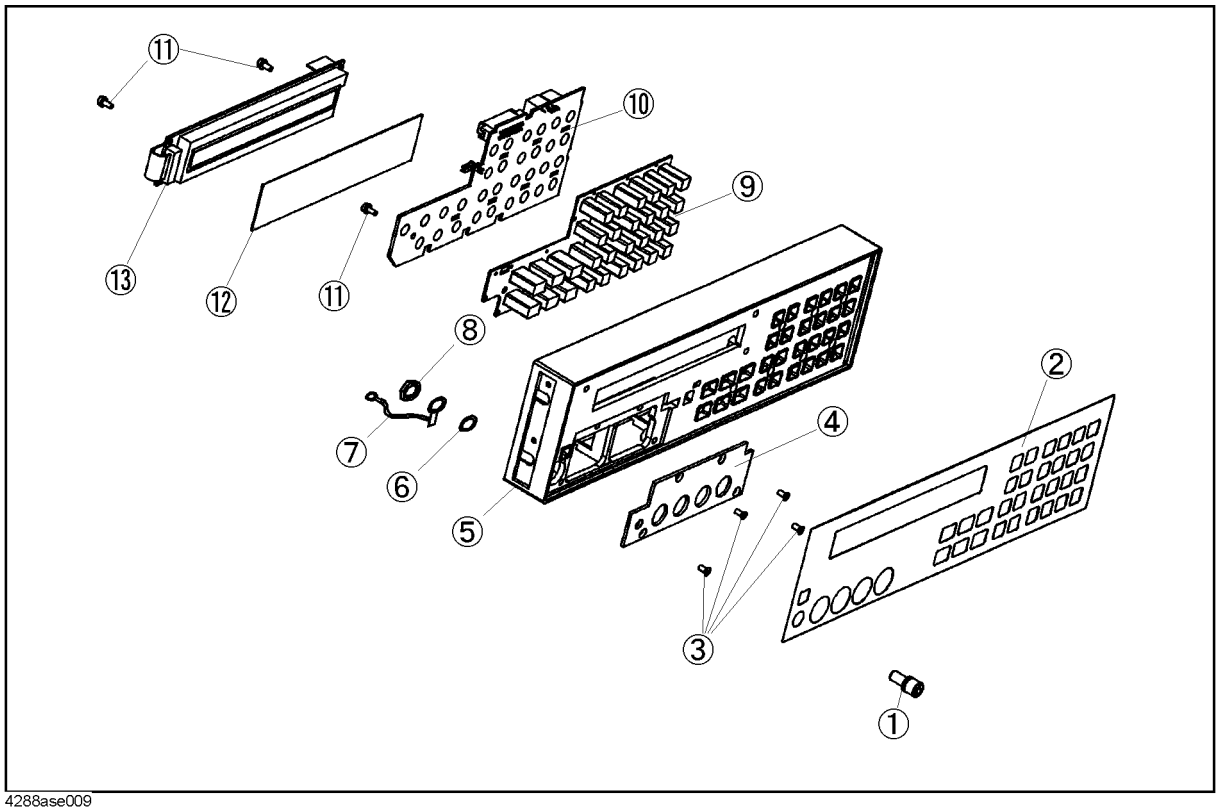


4288ase010

Table 6-2 4288A exploded view

Ref. Desig.	Agilent Part Number	Check Digit	Qty.	Description
1	04288-40002	6	1	Rod for Power Switch
2	04288-61632	2	1	Wire Assembly for Power Switch
3	0515-2028	9	2	Screw M2.5 T8
4	04288-00101	2	1	Chassis
5	0515-0390	4	2	Screw M4 T20
6	0515-0430	3	5	Screw M3 T10
7	04288-04003	1	1	Cover
8	43521-61627	1	1	Fan Assembly
9	0515-4304	8	2	Screw Tapping T20
10	0950-3920	4	1	Power Supply 30 W
11	04288-00606	2	1	Plate
12	0515-0374	4	2	Screw M3 T10

Figure 6-3 4288A Front Assembly

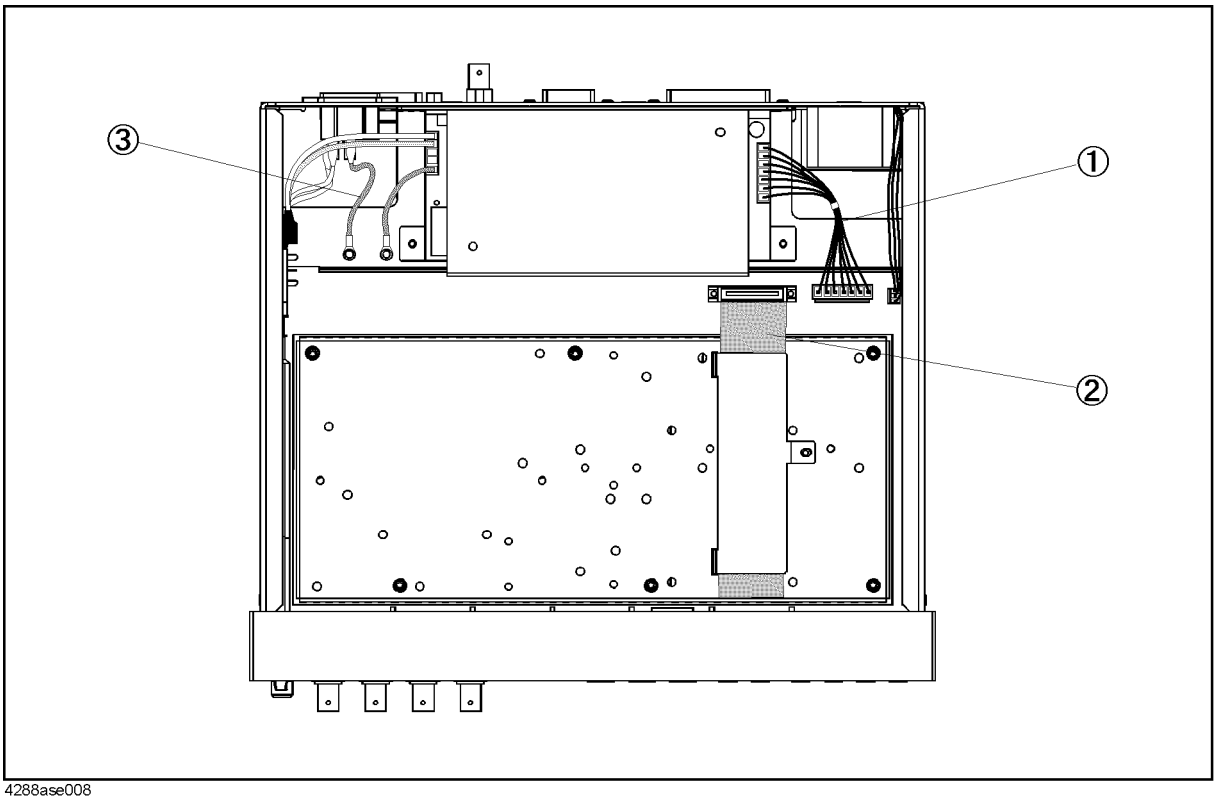


4288ase009

Table 6-3 4288A Front Assembly

Ref. Desig.	Agilent Part Number	Check Digit	Qty.	Description
1	1510-0130	1	1	Binding Post for Ground
2	04288-87121	8	1	Front Label
3	0515-1946C	8	4	Screw
4	04288-00601	7	1	Sub Panel
5	04288-40001	5	1	Front Bezel
6	2190-0067	4	1	Washer
7	04288-61601	5	1	Wire Assembly
8	2950-0006	3	1	Nut
9	04288-25151	4	1	Rubber Key
10	04288-66504	7	1	Keyboard
11	0515-0430	3	3	Screw
12	04263-25003	6	1	Filter
13	04263-61010	1	1	LCD

Figure 6-4 Cable Assemblies



4288ase008

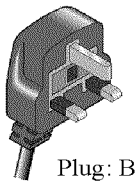
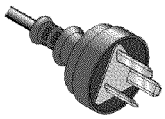
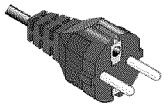
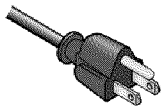
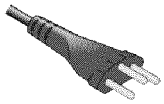
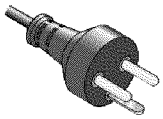
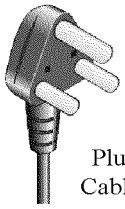
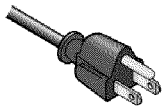
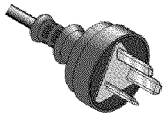
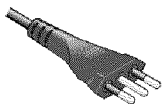
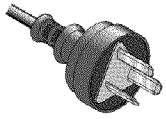
Table 6-4 4288A Front Assembly

Ref. Desig.	Agilent Part Number	Check Digit	Qty.	Description
1	04288-61631	1	1	Wire Assembly
2	04288-61610	6	1	Flat Cable Assembly
3	04288-61633	3	1	Wire Assembly

Table 6-5 Other Parts

Ref. Desig.	Agilent Part Number	Check Digit	Qty.	Description
1	2110-1017	8	1	Fuse 3A 250V
2	04288-90010	6	1	Operation Manual
3	04288-90011	3	1	Programming Manual
4	5063-9241	8	1	Rack Mount Kit (Option 1CM and 1CP)
5	5063-9226	9	1	Front Handle Kit (Option 1CN and 1CP)

Figure 6-5 Power Cables and Plug Configurations

OPTION 900 United Kingdom  Plug: BS 1363/A, 250V, 10A Cable: 8120-1351, 8120-8705	OPTION 901 Australia/New Zealand  Plug: AS 3112, 250V, 10A Cable: 8120-1369
OPTION 902 Continental Europe  Plug: CEE 7 Standard Sheet VII, 250V, 10A Cable: 8120-1689	OPTION 903 U.S./Canada  Plug: NEMA 5-15P, 125V, 10A Cable: 8120-1378
OPTION 904 U.S./Canada  Plug: NEMA 6-15P, 250V, 6A Cable: 8120-0698	OPTION 906 Switzerland  Plug: SEV Type 12, 250V, 10A Cable: 8120-2104
OPTION 912 Denmark  Plug: SR 107-2-D, 250V, 10A Cable: 8120-2956	OPTION 917 India/Republic of S. Africa  Plug: IEC 83-B1, 250V, 10A Cable: 8120-4211
OPTION 918 Japan  Plug: JIS C 8303, 125V, 12A Cable: 8120-4753	OPTION 920 Argentina  Plug: Argentine Resolution 63, Annex IV, 250V, 10A Cable: 8120-6870
OPTION 921 Chile  Plug: CEI 23-16, 250V, 10A Cable: 8120-6978	OPTION 922 China  Plug: GB 1002, 250V, 10A Cable: 8120-8376
NOTE: Each option number includes a 'family' of cords and connectors of various materials and plug body configurations (straight, 90° etc.).	

power_e

Disassembly Procedure

WARNING **The opening of covers or removal of parts is likely to expose dangerous voltages. Disconnect the instrument from all voltage sources while it is being opened.**

CAUTION SUSCEPTIBLE TO DAMAGE FROM ESD

Perform the following procedures only at a static-safety workstation and a grounding strap.

Cover Removal

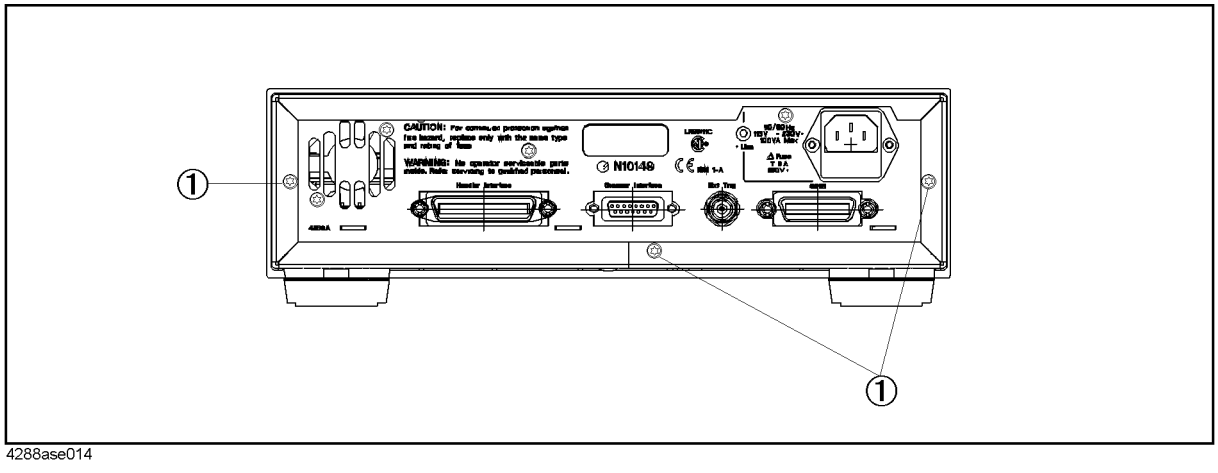
Tools Required

- Torx screwdriver, T10

Procedure

Step 1. Remove the three screws(Item 1 in Figure 6-6).

Figure 6-6 4288A Rear Side



4288ase014

Step 2. Slide the cover toward the rear while holding the front bezel.

Front Assembly Removal

Tools Required

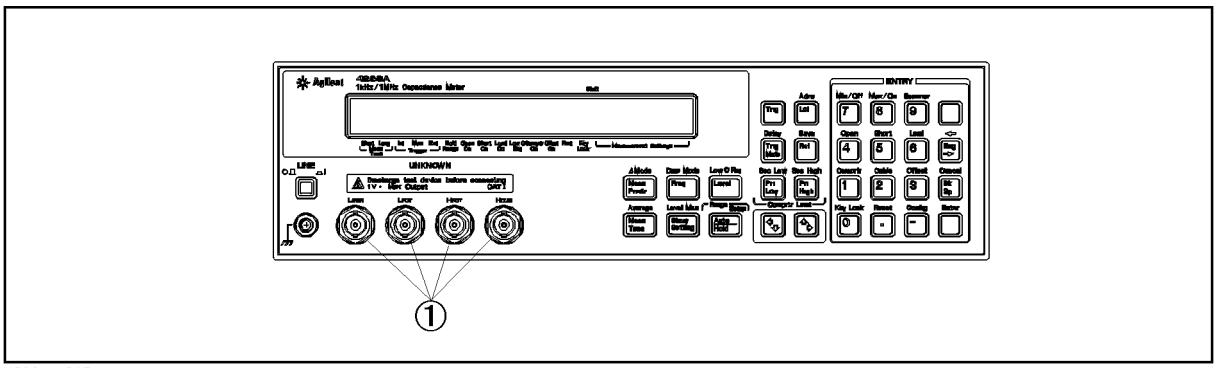
- Torx screwdriver, T10
- Box wrench 16 mm

Procedure

Step 1. Remove the cover as described in “Cover Removal.”

Step 2. Unscrew the nuts which fastens the BNC connector to the sub panel(Item 1 in Figure 6-7).

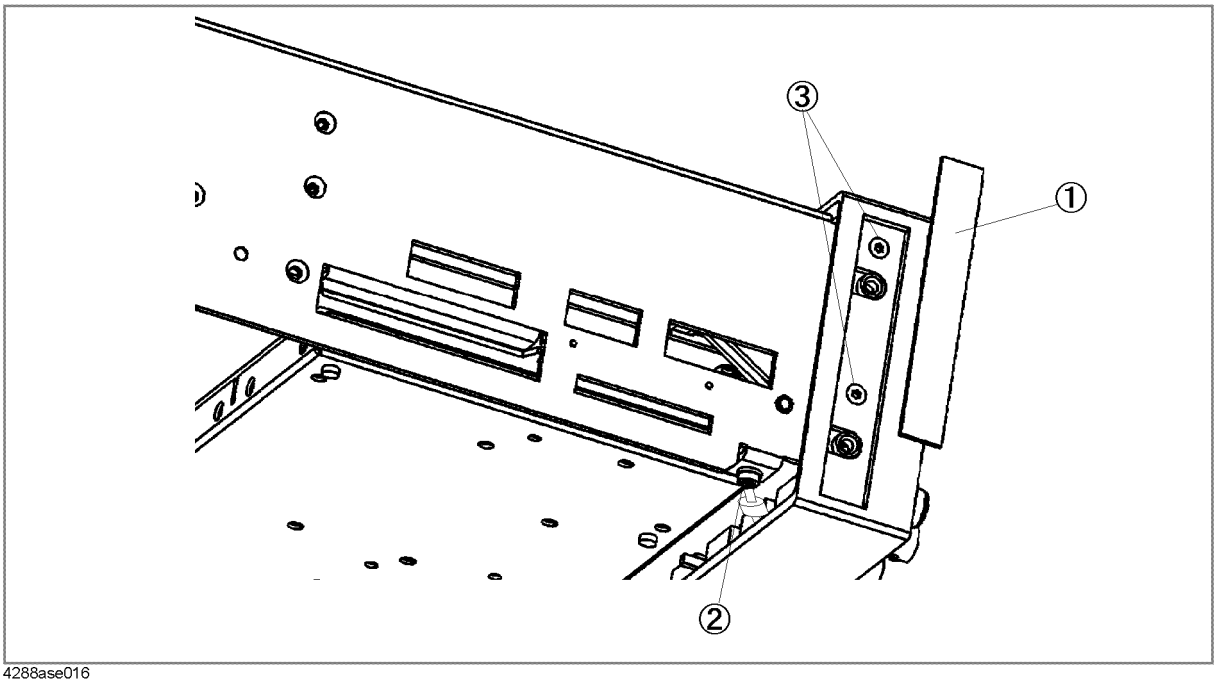
Figure 6-7 4288A Front Panel



4288ase015

Step 3. Remove the trim from both side of the front panel(Item 1 in Figure 6-8).

Figure 6-8 Front Assembly Removal



4288ase016

Step 4. Unscrew the screw which fasten the cable connecting front panel to the chassis(Item 2 in Figure 6-8).

Step 5. Remove the four screws from both side of the front panel(Item 3 in Figure 6-8).

Step 6. Disconnect all cables connected to the front panel.

Step 7. Slide the front assembly toward the front while holding the chassis.

A1 Main Board Removal

Tools Required

- Torx screwdriver, T10
- Box wrench 16 mm

Procedure

Step 1. Remove the cover as described in “Cover Removal.”

Step 2. Remove the front assembly as described in “Front Assembly Removal.”

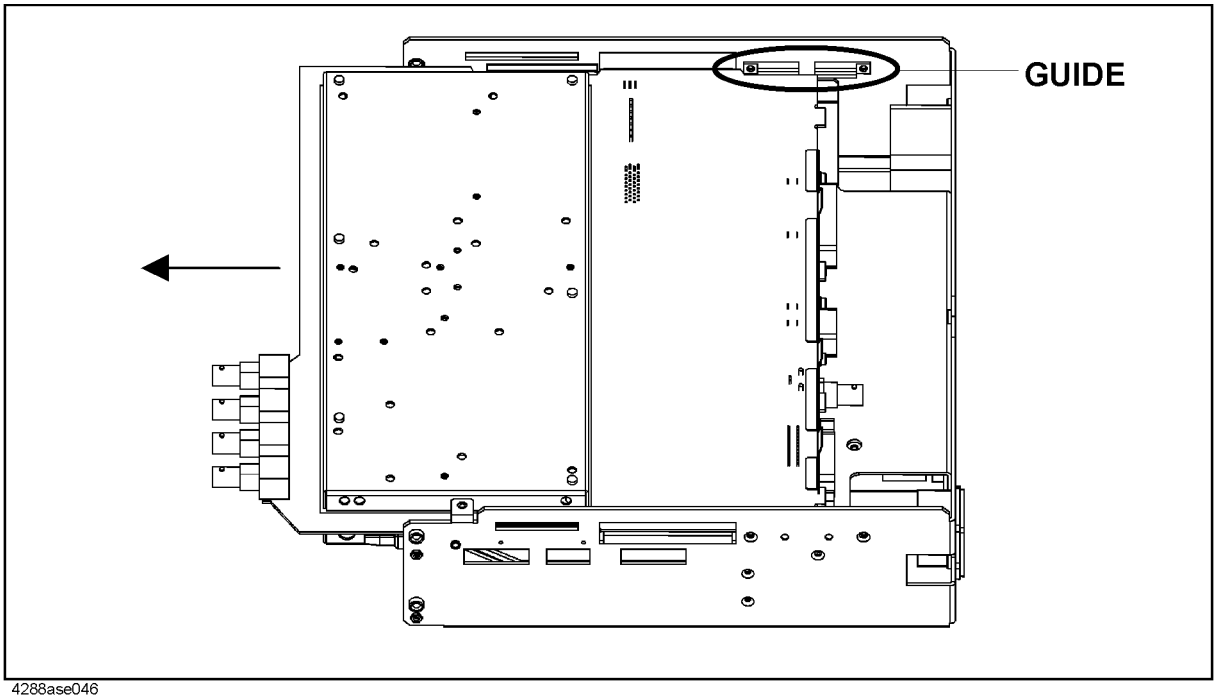
Step 3. Remove the four sleeves from BNC connectors.

Step 4. Disconnect all cables connected to the A1 main board.

Step 5. Turn the 4288A upside down.

Step 6. Slide the A1 main board toward the front until the projection of the board come off from the guide.(Refer to Figure 6-9)

Figure 6-9 Sliding A1 Main Board



4288ase046

Step 7. Lift up the A1 main board.

Power Supply Assembly Removal

Tools Required

- Torx screwdriver, T10

Procedure

Step 1. Remove the cover as described in “Cover Removal.”

Step 2. Unscrew the screw fastening the power supply cover to the chassis from the front side(Item 1 in Figure 6-10).

Step 3. Remove the power supply cover.

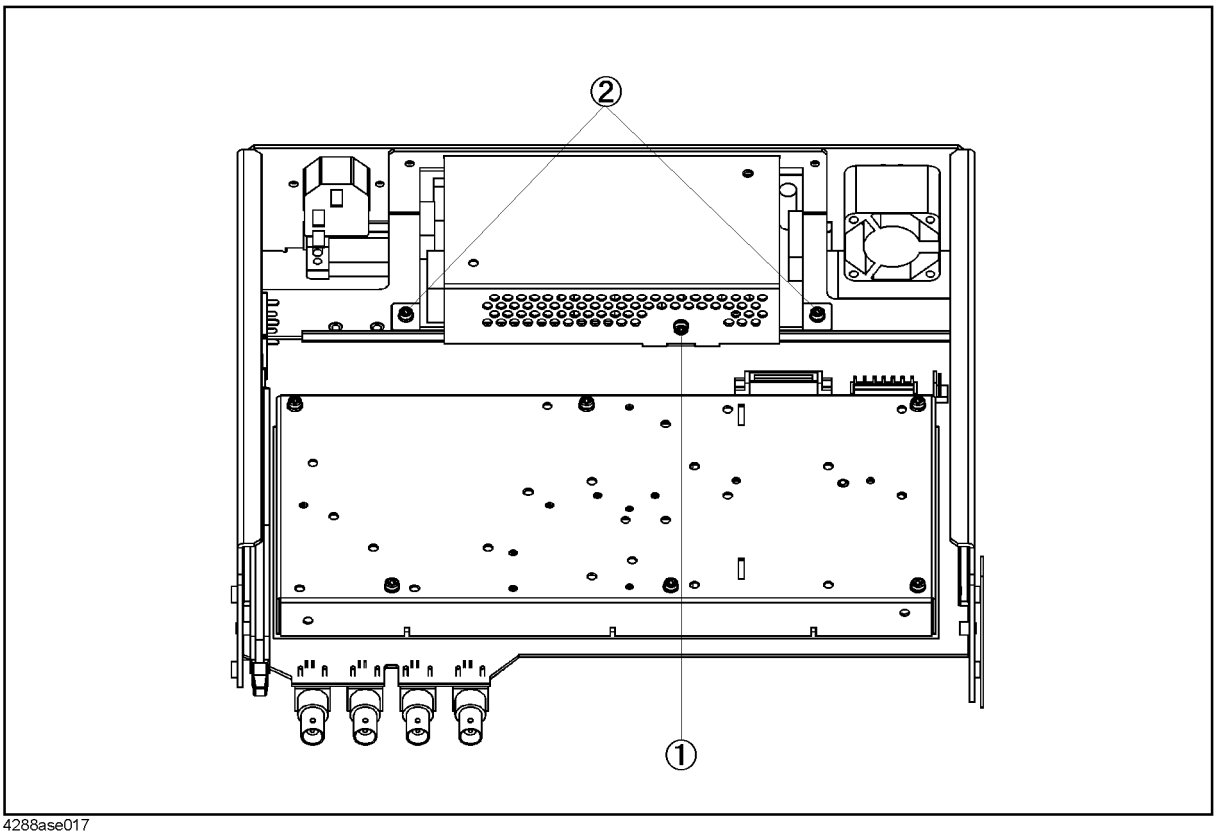
Step 4. Disconnect all cables connected to the power supply.

Step 5. Unscrew the two screws fastening the power supply from the rear side(Item 1 in Figure 6-11).

Step 6. Unscrew the two screws fastening the power supply form the top side(Item 2 in Figure 6-10).

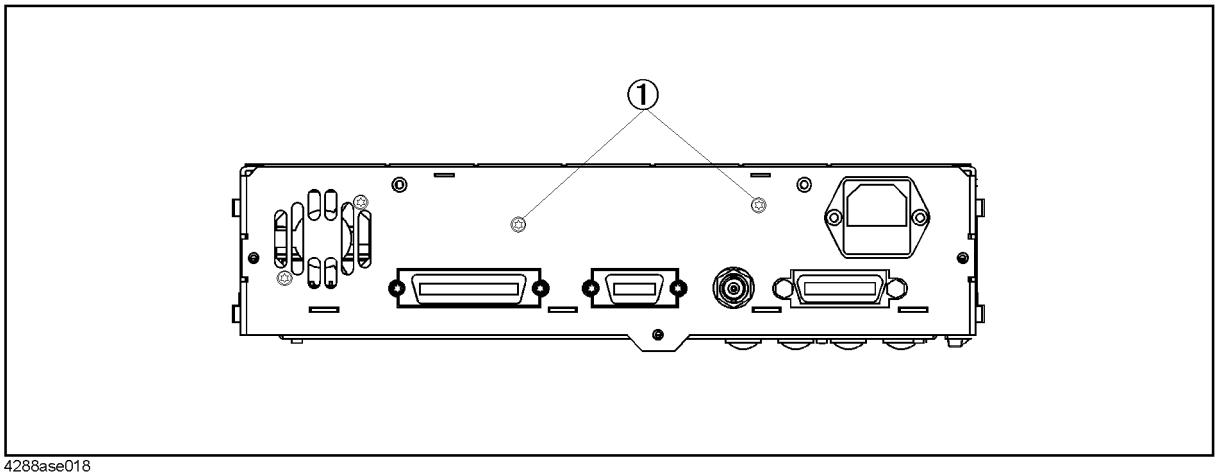
Step 7. Lift up the power supply.

Figure 6-10 Power Supply Removal



4288ase017

Figure 6-11 Power Supply Removal



4288ase018

Fan Assembly Removal

Tools Required

- Torx screwdriver, T20

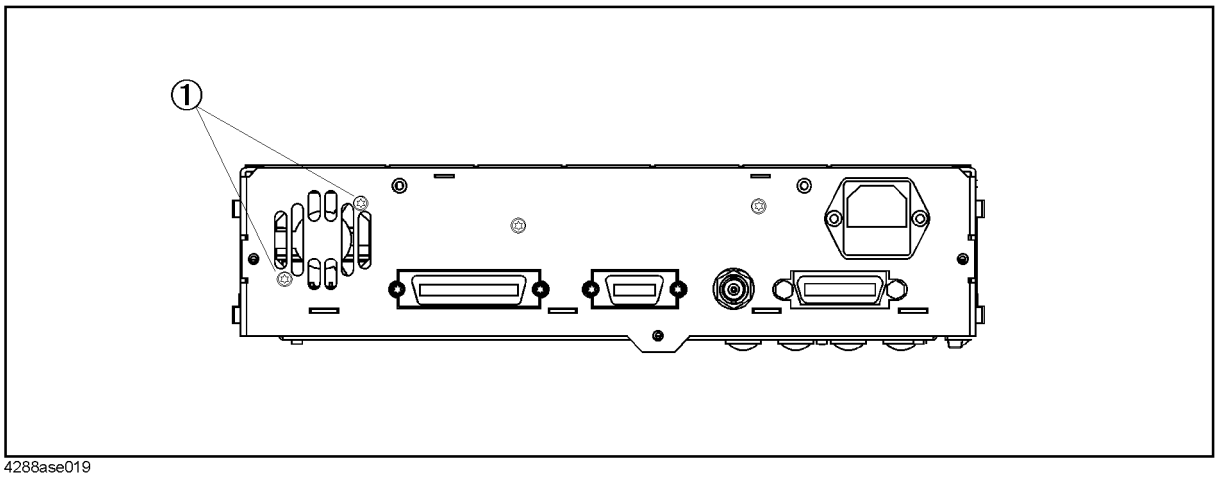
Procedure

Step 1. Remove the cover as described in “Cover Removal.”

Step 2. Disconnect the fan cable from the A1 main board.

Step 3. Unscrew the two screws from the rear side.

Figure 6-12 4288A Rear Panel



4288ase019

Power Switch Replacement

Tools required

- Torx screwdriver, T8 and T10

Procedure

Step 1. Remove the cover as described in “Cover Removal.”

Step 2. Disconnect all cables connecting the power switch to the inlet and the power supply.

Step 3. Unscrew the two screws from the side of the chassis as shown in Figure 6-13.

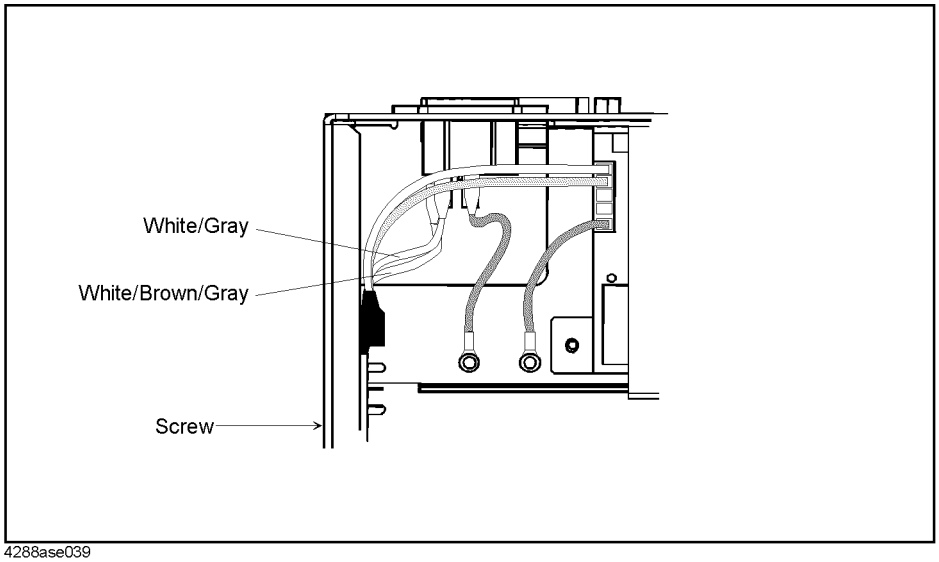
Step 4. Remove the rod from the power switch.

Step 5. Hold the power switch to the chassis with two screws.

Step 6. Set the rod to the new power switch.

Step 7. Connect the cables as shown in Figure 6-13.

Figure 6-13 **Cable Connection of the power switch**



LCD Assembly Removal

Tools Required

- Torx screwdriver, T10
- Box wrench 16 mm

Procedure

Step 1. Remove the cover as described in “Cover Removal.”

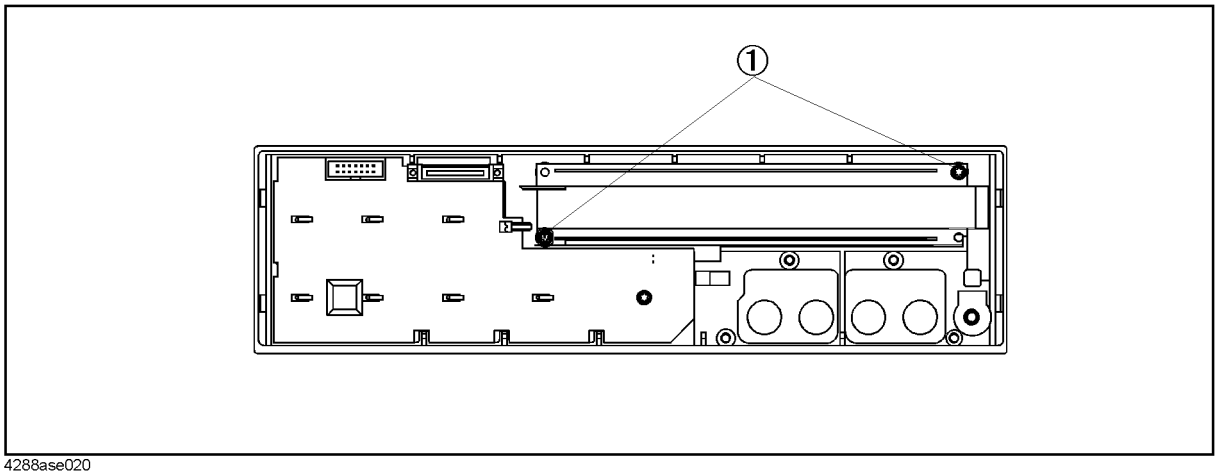
Step 2. Remove the front assembly as described in “Front Assembly Removal.”

Step 3. Place the front assembly face down.

Step 4. Disconnect the flat cable and the wire which are connected to the keyboard assembly.

Step 5. Remove the two screws which fasten the LCD to the front panel bezel(Item 1 in Figure 6-14).

Figure 6-14 Screws fastening LCD



4288ase020

Step 6. Lift up the LCD assembly.

Keyboard Assembly Removal

Tools Required

- Torx screwdriver, T10
- Box wrench 16 mm

Procedure

Step 1. Remove the cover as described in “Cover Removal.”

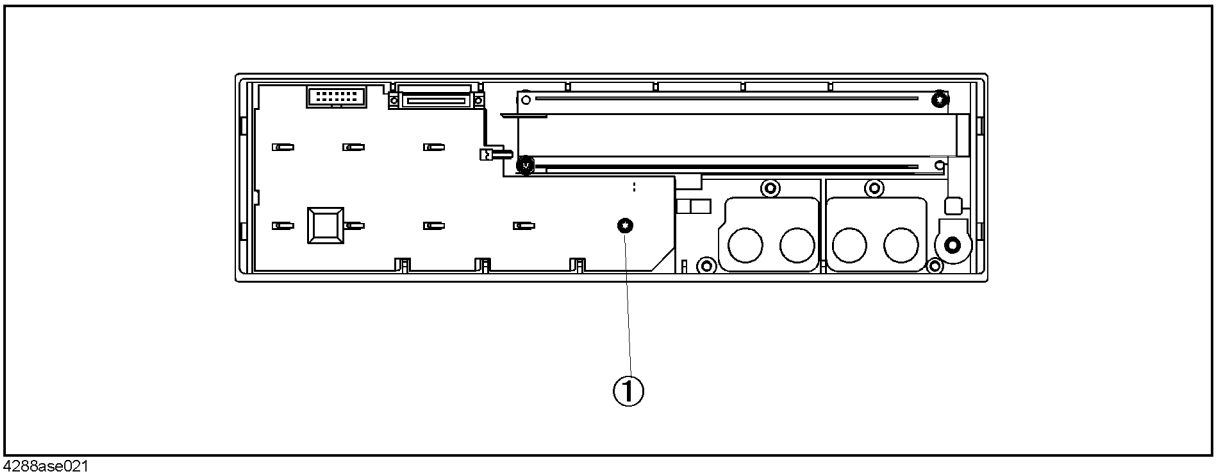
Step 2. Remove the front assembly as described in “Front Assembly Removal.”

Step 3. Place the front assembly face down.

Step 4. Disconnect the flat cable and the wire which are connected to the LCD assembly.

Step 5. Remove the two screws which fasten the keyboard to the front panel bezel(Item 1 in Figure 6-15).

Figure 6-15 **Screws fastening Keyboard Assembly**



4288ase021

Step 6. Slide the keyboard assembly to the right.

Step 7. Lift up the keyboard assembly.

Post Repair Procedure

Table 6-6 lists the required procedures that must be performed after the replacement of as assembly. These are the recommended minimum procedures to ensure that the replacement is successfully completed.

For the detailed procedure of the adjustments and updating correction constants, see Chapter 3, “Adjustment,” on page 59. For the detailed operational verification procedures see Chapter 4, “Troubleshooting,” on page 79. For detailed performance verification procedures, see Chapter 2, “Performance Test,” on page 15.

Table 6-6 Post Repair Procedure

Replaced Assembly or Part	Adjustments	Verification
Main Board	All Adjustment Items	Power on Self-Test All Performance Test Internal Test External Test
Front Keyboard	None	Power on Self-Test Front Panel Key Test
LCD	None	Power on Self-Test
Pre-Regulator	None	Power on Self-Test
Fan	None	Power on Self-Test

Firmware Installation

The firmware may not be installed into a new A1 Main Board. Install the firmware after replacing a A1 Main board.

Required Controller

Computer:	PC-AT Compatible, RAM ≥ 64 MBytes, CPU: Pentium 200MHz or faster
OS:	Windows NT®(4.0 or above), Windows 95® or Windows 98®
Application	Standard Instrument Control Library(SICL)
GPIB Card	Agilent 82350A or 82341C/D

Installation Program and Firmware

The firmware install program and the firmware of proper version are required to install the firmware. Install these files to the same directory. Their file names are as follows.

File Type	File Name
Installation Program	loader.exe
Firmware	fw_*xxxx*.m*1

*1. *xxxx* means the firmware revision. For example, fw_0100.m is the firmware revision 1.00.

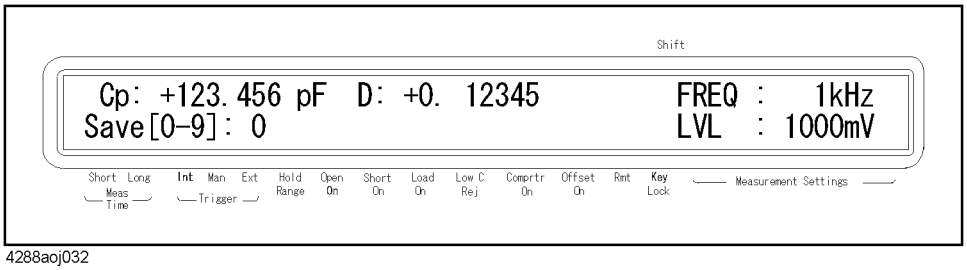
Installation procedure

Step 1. Connect the Windows PC to the 4288A with the GPIB Cable.

Step 2. The current setting is erased after the firmware update. If necessary, store the current setting according to the following procedure

1. Press blue-**[Rcl]** key on the 4288A front panel. The save location entry screen appears as shown in the following figure.

Figure 6-16 The save location entry screen



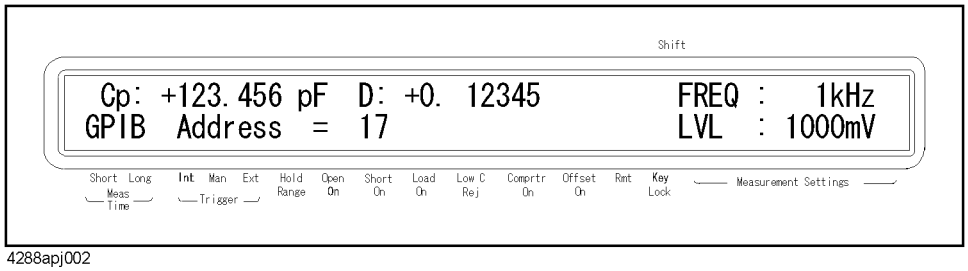
4288aoj032

2. Input the save location you desire, then press **[Enter]** key.

Step 3. Confirm the GPIB address of the 4288A according to the following procedure.

1. Press blue-**[Lcl]** key on the 4288A front panel. The GPIB address entry screen appears with the current GPIB address as shown in the following figure.

Figure 6-17 The GPIB address entry screen



4288apj002

2. Press **[Enter]** key to exit the GPIB address entry screen.

Step 4. Turn off the 4288A.

Step 5. Turn on the 4288A while pressing **[5]** key on the front panel.

Step 6. Run `loader.exe` by clicking twice the icon, then install the firmware according to the instruction.

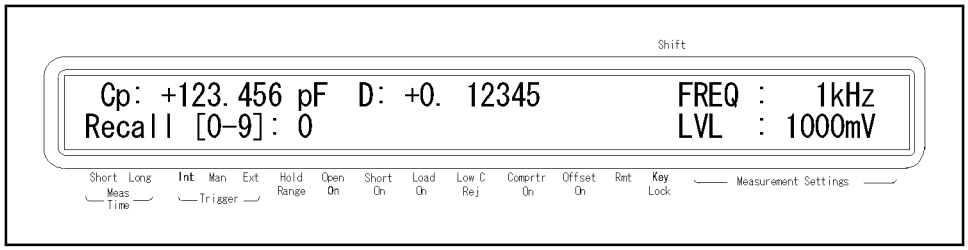
Step 7. After “Cycle Power to RUN !” is displayed on the 4288A display, turn off the 4288A, then turn on again.

Step 8. Confirm the firmware revision on the 4288A display.

Step 9. Restore the setting according to the following procedure if it is stored in Step 2.

1. Press **[Rcl]** key on the 4288A front panel. The recall location entry screen appears as shown in the following figure.

Figure 6-18 The recall location entry screen



4288aoj033

2. Input the recall location the previous setting is stored.

A Manual Changes

This appendix contains the information required to adapt this manual to earlier versions or configurations of the 4288A than the current printing date of this manual. The information in this manual applies directly to a 4288A whose serial number prefix is listed on the title page of this manual.

Manual Changes

To adapt this manual to your 4288A, refer to Table A-1 and Table A-2.

Table A-1 Manual Changes by Serial Number

Serial Prefix or Number	Make Manual Changes

Table A-2 Manual Changes by Firmware Version

Version	Make Manual Changes

Agilent Technologies uses a two-part, ten-character serial number that is stamped on the serial number plate (see Figure A-1). The first five characters are the serial prefix and the last five digits are the suffix.

Press keys to display the firmware version of 4288A.

Figure A-1 Serial Number Plate

B Power Requirement

Replacing Fuse

Fuse Selection

Select proper fuse according to the Table B-1.

Table B-1 Fuse Selection

Fuse Rating/Type	Fuse Part Number
3A 250Vac UL/CSA type Time Delay	2110-1017

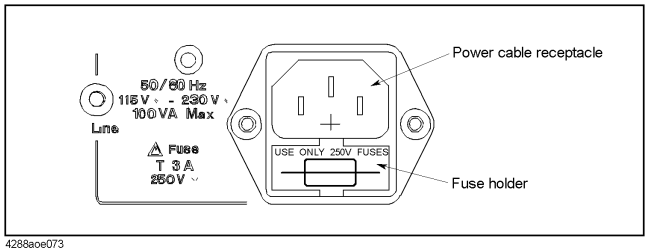
⚠ Setting up the fuse

Use the fuse that meets the following specifications.

UL/CSA type, Slo-Blo, 5x20mm miniature fuse, 3A 250V (part number: 2110-1017)

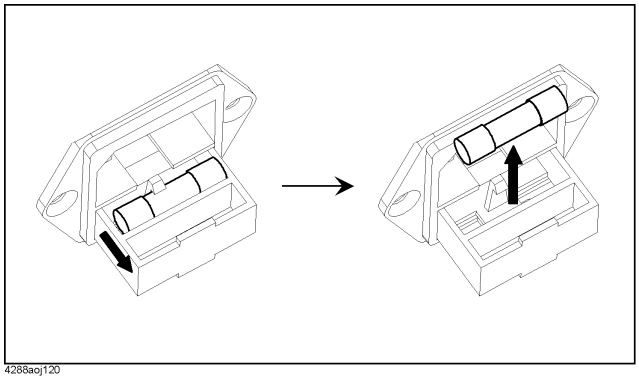
Spare fuses are available from Agilent Technologies sales office. To check or replace the fuse, disconnect the power cable and pull out the fuse holder (refer to Figure B-1) towards you (refer to Figure B-2).

Figure B-1 Fuse holder and power cable socket



4288aoe073

Figure B-2 Removing the fuse



4288aoj120

Power Requirements

The 4288A requires the following power source.

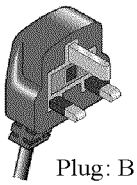
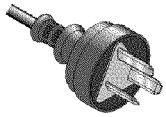
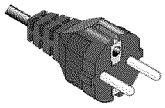
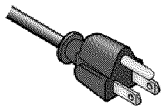
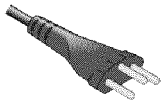
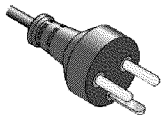
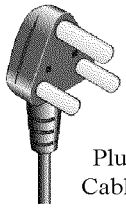
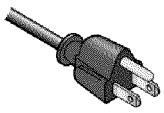
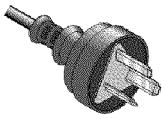
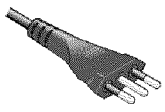
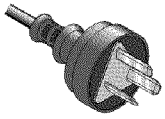
Voltage : 90 to 132 Vac, 198 to 264 Vac
Frequency : 47 to 63 Hz
Power : 300 VA maximum

Power Cable

In accordance with international safety standards, this instrument is equipped with a three-wire power cable. When connected to an appropriate ac power outlet, this cable grounds the instrument frame.
The type of power cable shipped with each instrument depends on the country of destination. Refer to Figure B-3 for the part numbers of the power cables available.

WARNING **For protection from electrical shock, the power cable ground must not be defeated. The power plug must be plugged into an outlet that provides a protective earth ground connection.**

Figure B-3 Power Cable Supplied

OPTION 900 United Kingdom  Plug: BS 1363/A, 250V, 10A Cable: 8120-1351, 8120-8705	OPTION 901 Australia/New Zealand  Plug: AS 3112, 250V, 10A Cable: 8120-1369
OPTION 902 Continental Europe  Plug: CEE 7 Standard Sheet VII, 250V, 10A Cable: 8120-1689	OPTION 903 U.S./Canada  Plug: NEMA 5-15P, 125V, 10A Cable: 8120-1378
OPTION 904 U.S./Canada  Plug: NEMA 6-15P, 250V, 6A Cable: 8120-0698	OPTION 906 Switzerland  Plug: SEV Type 12, 250V, 10A Cable: 8120-2104
OPTION 912 Denmark  Plug: SR 107-2-D, 250V, 10A Cable: 8120-2956	OPTION 917 India/Republic of S. Africa  Plug: IEC 83-B1, 250V, 10A Cable: 8120-4211
OPTION 918 Japan  Plug: JIS C 8303, 125V, 12A Cable: 8120-4753	OPTION 920 Argentina  Plug: Argentine Resolution 63, Annex IV, 250V, 10A Cable: 8120-6870
OPTION 921 Chile  Plug: CEI 23-16, 250V, 10A Cable: 8120-6978	OPTION 922 China  Plug: GB 1002, 250V, 10A Cable: 8120-8376
NOTE: Each option number includes a 'family' of cords and connectors of various materials and plug body configurations (straight, 90° etc.).	

power_e

C Error Messages

The Agilent 4288A provides error messages to indicate its operating status. This appendix describes the error messages of the 4288A in alphabetical order. To search error messages by error number, refer to the *Programming Manual*.

Error messages (alphabetical order)

Error messages are displayed in the lower row of the display of the 4288A. You can read them out using the GPIB command. This section provides the description of each error message and its remedy.

NOTE Errors with a negative error number are basically general errors defined by IEEE488.2 for GPIB instruments. On the other hand, errors with a positive error number are defined specifically for the 4288A.

A

15 **A1 board test failed**

The A1 board test at power-on has failed.

If this error occurs, the 4288A makes a beep and stops. The hardware is at fault and needs repair.

16 **ADC failure**

A problem has occurred in the A/D converter during measurement.

If this error occurs, the 4288A makes a beep and stops. The hardware is at fault and needs repair.

B

-160 **Block data error**

An error not included in error numbers between -161 and -169 occurred during the syntax analysis of block data.

-168 **Block data not allowed**

A block data element is received where the 4288A does not accept any block data element.

12 **BOOT ROM test failed**

The boot ROM test at power-on has failed.

If this error occurs, the 4288A makes a beep and stops. The hardware is at fault and needs repair.

C

18 **Calibration memory lost**

The calibration data in EEPROM has been lost at power-on.

If this error occurs, the 4288A makes a beep and stops. The hardware is at fault and needs repair.

-140 **Character data error**

An error not included in error numbers between -141 and -149 occurred during the syntax analysis of a character data element.

-148 **Character data not allowed**

A character data element (that does not violate the standard) is received where the 4288A does not accept any character data element.

-144 **Character data too long**

The length of the character data element exceeds 12 characters. (Refer to IEEE488.2,7.7.1.4.)

-100 **Command error**

A comprehensive syntax error occurs for which the 4288A cannot detect further details of the error. This error code simply indicates the occurrence of a command error that is defined in IEEE488.2,11.5.1.1.4.

25 **Correction meas failed**

A measurement failure has occurred during measuring the compensation data.

If this error occurs, the compensation data before the measurement remains (does not change).

Check if you have made the correct connection for measuring the compensation data and performed the compensation procedure correctly.

D

-230 **Data corrupt or stale**

The data is invalid or a newly initiated read operation has not been completed since the latest access.

-222 **Data out of range**

A data element (that does not violate the standard) is received out of the range defined for the 4288A.

-104 **Data type error**

The parser recognized impossible data elements. For example, numeric value or string data is expected, but block data is sent.

E

14 **EEPROM test failed**

The EEPROM test at power-on has failed.

If this error occurs, the 4288A makes a beep and stops. The hardware is at fault and needs repair.

-200 **Execution error**

A comprehensive execution error occurs for which the 4288A cannot detect further details of the error. This error code simply indicates the occurrence of an execution error that is defined in IEEE488.2,11.5.1.1.5.

-123 **Exponent too large**

The absolute value of the exponent exceeds 32,000. (Refer to IEEE488.2,7.7.2.4.1.)

-178 **Expression data not allowed**

An equation data element is received where the 4288A does not accept any equation data element.

-170 **Expression error**

An error not included in error numbers between -171 and -179 occurs during the syntax analysis of equation data.

F

17 **Fan stopped**

FAN has stopped.

If this error occurs, the 4288A makes a beep and stops. The hardware is at fault and needs repair.

13 **FLASH ROM test failed**

The flash ROM test at power-on has failed.

If this error occurs, the 4288A makes a beep and stops. The hardware is at fault and needs repair.

G

-105 **GET not allowed**

A group execution trigger (GET) is received in a program message. (Refer to IEEE488.2,7.7.)

H

-241 **Hardware missing**

The received command or Query complied with the standard but could not be executed due to hardware-related reasons (for example, the option was not installed).

I

-213 **Init ignored**

Another measurement is being executed and the measurement start request (**:INIT** command) is ignored.

-161 **Invalid block data**

Block data are expected, but the block data received are invalid for some reason. (Refer to IEEE488.2,7.7.6.2.) For example, the END message is received before the length of the block data is reached.

-101 **Invalid character**

Invalid characters exist in the program message string. For example, in a correct program message "**:CALC1:FORM CP**", an ampersand (&) is inserted by mistake to give "**:CALC1:FORM&CP**".

-141 **Invalid character data**

There are invalid characters in a character data element or the received parameter is not valid. For example, though a correct program message was "**:CALC1:FORM CP**," a wrong program message, "**:CALC1:FORM RP**," was received.

-121 **Invalid character in number**

An invalid character for the data type of the syntax analysis target is received. For example, alphabetical characters exist in a decimal value or "9" exists in octal data.

-171 **Invalid expression**

The equation data element is invalid. (Refer to IEEE488.2,7.7.7.2.) For example, parentheses are not paired or a character violates the standard.

-103 **Invalid separator**

The parser (syntax analysis program) expects a separator, but a character other than a separator is sent. For example, although the correct way is to use ";" to separate two sent program messages such as "**:CALC1:FORM CP;*OPC?**", the semicolon (;) needed to separate the program messages is missing to give "**:CALC1:FORM CP *OPC?**".

-151 **Invalid string data**

Character string data are expected, but the string data received are invalid for some reason. (Refer to IEEE488.2,7.7.5.2.) For example, the END message is received before the end quotation mark character appears.

-131 **Invalid suffix**

The suffix does not meet the syntax defined in IEEE488.2,7.7.3.2 or is inappropriate for the 4288A.

L

23 **Lockout by handler**

Entry using the front panel keys has been disabled through the handler.

You cannot clear this state using the front panel keys and GPIB command.

Set the /KEY_LOCK signal of the handler interface to HIGH.

M

-311 **Memory error**

An error was detected in the memory of the 4288A.

-109 **Missing parameter**

The number of parameters is less than required by the command. For example, although the **:CREJ:LIM** command requires one parameter such as "**:CREJ:LIM 3**", no parameter is added to give "**:CREJ:LIM**".

N

0 **(No error)**

No error has occurred.

This message is not displayed on the LCD. 0 is returned as the error number if no error has occurred in the instrument when the **:SYST:ERR?** command is sent through GPIB.

-128 **Numeric data not allowed**

A numeric value data element (that does not violate the standard) is received where the 4288A does not accept any numeric value data element.

P

-220 **Parameter error**

An error not included in error numbers between -221 and -229 occurred during the analysis of a program data element. This error occurs, for example, when you attempt to specify invalid values (values not finite when converted to an R-X format impedance value) as the LOAD correction data or LOAD correction reference data. If this error occurs, the command is ignored. This error also occurs when you attempt to specify an invalid LOAD correction reference value using front panel keys.

Parameter Type Setting		values not finite when converted to an R-X format impedance value
Primary Parameter	Secondary Parameter	
Cp	D	Independent of D value, Cp is 0
Cp	Q	Independent of Q value, Cp is 0, also Independent of Cp value, Q is 0
Cp	G	Cp and G are both 0
Cp	Rp	Independent of Cp value, Rp is 0
Cs	D	Independent of D value, Cs is 0
Cs	Q	Independent of Q value, Cs is 0, also Q is 0 independent of Cs value
Cs	Rs	Cs is 0 independent of Rs value

-108 **Parameter not allowed**

The number of parameters is larger than required by the command. For example, although the **`:CREJ:LIM`** command requires one parameter such as "**`:CREJ:LIM 3`**", two parameters are added to give "**`:CREJ:LIM 0,3`**".

20 **Previous setting lost**

The instrument setup values in backup memory have been lost at power-on.

These values are initialized to the factory-shipped state. No beep is made. Possible causes are: 72 hours or more have elapsed since turning OFF the power or the hardware is at fault.

After the firmware installation, this message is displayed.

-112 **Program mnemonic too long**

The length of the header exceeds 12 characters. (Refer to IEEE488.2,7.6.1.4.1.)

Q

-430 **Query DEADLOCKED**

This indicates the status that causes a “DEADLOCKED” Query error. (Refer to IEEE488.2,6.3.1.7.) This error occurs, for example, when both input and output buffers become full and the 4288A cannot continue processing.

-400 **Query error**

A comprehensive Query error occurs for which the 4288A cannot detect further details. This code simply indicates the occurrence of a Query error that is defined in IEEE488.2,11.5.1.1.7 and 6.3.

-410 **Query INTERRPUTED**

This indicates the status that causes an “INTERRUPTED” Query error. (Refer to IEEE488.1,6.3.2.3.) This error occurs, for example, when data byte (DAB) or GET is received after Query but before the response has been completely sent.

-420 **Query UNTERMINATED**

This indicates the status that causes an “UNTERMINATED” Query error. (Refer to IEEE488.2,6.3.2.) This error occurs, for example, when the 4288A is specified as a talker and an incomplete program message is received.

-440 **Query UNTERMINATED after indefinite response**

In a certain program message, after a Query that requests an ambiguous response is executed, another Query is received. (Refer to IEEE488.2,6.5.7.5.7.)

-350 **Queue overflow**

The queue contains a certain code, instead of the code that caused this error. This code indicates that an error has occurred due to insufficient space in the queue but it has not been recorded.

R

11 **RAM test failed**

The RAM test at power-on has failed.

If this error occurs, the 4288A makes a beep and stops. The hardware is at fault and needs repair.

22 **Recall failed**

Recalling the instrument setup from EEPROM has failed.

This error occurs when no instrument setup has been saved in the specified register on EEPROM. The instrument setup does not change and stays in the state before executing the recall.

Check if you specified the correct register number when executing the recall.

S

21 **Save failed**

Saving the instrument setup into EEPROM has failed.

Although the 4288A will not stop due to this error, the hardware is at fault and needs repair.

-221 **Setting conflict**

A program data element complying with the syntax standard is analyzed, but the 4288A cannot execute it at present.

-150 **String data error**

An error not included in error numbers between -151 and -159 occurs during the syntax analysis of a string data element.

-158 **String data not allowed**

A string data element is received where the 4288A does not accept any string data element. For example, a parameter must be enclosed with double quotation marks ("...") but they are missing.

-138 **Suffix not allowed**

A suffix is added to a numeric value element that does not permit a suffix.

-102 **Syntax error**

There is a command or data type that cannot be recognized. For example, in a correct program message "**:SYST:PRES**", a colon (:) is inserted by mistake to give "**:SYST::PRES**".

-310 **System error**

One of the "system errors" defined for the 4288A occurs.

T

-124 **Too many digits**

The number of digits of the mantissa of the decimal value data element exceeds 255 except for preceding 0s. (Refer to IEEE488.27.7.2.4.1.)

-223 **Too much data**

The received block, equation, or string type program data complies with the standard but the amount of data exceeds the limit that the 4288A can handle due to memory or device-specific conditions related to memory.

-214 **Trigger deadlock**

Indicates that the **:READ?** command was ignored because the trigger source setting was MAN or BUS.

-211 **Trigger ignored**

A trigger command or trigger signal is received and recognized by the 4288A, but it is ignored due to the timing relationship with the 4288A. For example, this happens when the 4288A's trigger system is not in the Waiting for Trigger state).

U

-113 **Undefined header**

A header not defied for the 4288A is received. For example, "***XYZ**", which is not defined for the 4288A, is received.

19 **User data lost**

The compensation data in EEPROM has been lost at power-on.

The compensation data is initialized to the factory-shipped state. Possible causes are: the hardware is at fault or the power is turned OFF during write to EEPROM.

Warning messages (WARNING)

Warning messages are displayed to warn users. They are displayed in the lower row of the display of the 4288A. You cannot read them out using the GPIB command.

WARNING: Need corr meas

When the OPEN compensation, SHORT compensation or LOAD compensation is ON, this is displayed when you change the setup of the cable length or measurement frequency shift (1 MHz). In this case, the OPEN compensation, SHORT compensation and LOAD compensation are automatically turned OFF.

WARNING: Need load meas

This is displayed when you turn ON the LOAD compensation from the front panel though the setups of the cable length and measurement frequency shift (1 MHz) differ from those when measuring/setting up the LOAD compensation data. In this case, the LOAD compensation is turned ON but you need to measure the LOAD compensation data again for accurate measurement.

WARNING: Need open meas

This is displayed when you turn ON the OPEN compensation from the front panel though the setups of the cable length and measurement frequency shift (1 MHz) differ from those when measuring/setting up the OPEN compensation data. In this case, the OPEN compensation is turned ON but you need to measure the OPEN compensation data again for accurate measurement.

WARNING: Need short meas

This is displayed when you turn ON the SHORT compensation from the front panel though the setups of the cable length and measurement frequency shift (1 MHz) differ from those when measuring/setting up the SHORT compensation data. In this case, the SHORT compensation is turned ON but you need to measure the SHORT compensation data again for accurate measurement.

WARNING: Out of limit

This is displayed if the compensation data is out of the valid range when measuring the compensation data. The valid range is as follows.

Type of compensation	Valid range
OPEN compensation	$\|Y\| < 20\ \mu S$
SHORT compensation	$\|Z\| < 20\ \Omega$
LOAD compensation	$\|Zref\| \times 0.9 < \|Z\| < \|Zref\| \times 1.1$

In the above table, Y is the measured admittance value, Z is the measured impedance value, and Zref is the LOAD compensation standard definition value.

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