HP 4155B Semiconductor Parameter Analyzer
HP 4156B Precision Semiconductor Parameter Analyzer
HP 41501B SMU/Pulse Generator Expander

Service Manual

SERIAL NUMBERS

This manual applies to instruments with serial numbers JP10E-.

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Product Warranty

This Hewlett-Packard product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, Hewlett-Packard will, at its option, either repair or replace products which prove to be defective.

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

Hewlett-Packard warrants that its software and firmware designated by Hewlett-Packard for use with an instrument will execute its programming instructions when properly installed on that instrument. Hewlett-Packard 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 modifications or misuse, operation outside of the environment specifications for the products, or improper site preparation or maintenance.

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

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Assistance

Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products.

For any assistance, contact your nearest Hewlett-Packard Sales Office.

Certification

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the **National Institute of Standards and Technology** (NIST), to the extent allowed by the Institute's calibration facility, and to the calibration facilities of other International Standards Organization members.

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 violates safety standards of design, manufacture, and intended use of the instrument. Hewlett-Packard Company assumes no liability for customer's failure to comply with these requirements.

- *GROUND THE INSTRUMENT*

  To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The power terminal and the power cable must meet International Electrotechnical Commission (IEC) safety standards.

- *DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE*

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

- *KEEP AWAY FROM LIVE CIRCUITS*

  Operation personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with 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 any unauthorized modification to the instrument. Return the instrument to a Hewlett-Packard Sales and Service Office for services and repair to ensure that safety features are maintained.

- *DANGEROUS PROCEDURE WARNINGS*

  Warnings, such as 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 present in this instrument. Use extreme caution when handling, testing, and adjusting.

Safety Symbols

The general definitions of safety symbols used on equipment or in manuals are listed below.

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

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

Indicates earth (ground) terminal.

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

Alternating current (power line).

Direct current (power line).

WARNING The 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 The caution sign denotes a hazard. It calls attention to an operating procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product.

Preface

Contents

Warning

The information in this manual is provided for use by service trained personnel only. To avoid electrical shock, do not perform any procedures in this manual, unless you are qualified to do so.

This manual contains information relating to the performance verification, adjustments, and repair of the HP 4155B Semiconductor Parameter Analyzer, HP 4156B Precision Semiconductor Parameter Analyzer, and HP 41501B SMU/Pulse Generator Expander. The manual consists of the following chapters:

1. Service Introduction — Contains the information needed before the performance verification, adjustments, and repair.
2. Performance Verification — Contains the information and instructions for performance verification.
3. Adjustments — Contains the information and instructions for adjustments.
4. Troubleshooting Procedure — Contains troubleshooting instructions.
5. Troubleshooting Reference — Contains information and operations for troubleshooting and repair.
6. Theory of Operation — Contains the theory of operation to aid in troubleshooting.
7. Replaceable Parts — Contains the replaceable parts and assembly location information.
8. Replacement Procedures — Contains the covers and assemblies removal procedures and installation procedures.
9. Error Messages — Contains meanings of the error codes.

This manual does NOT contain:

- Specifications
- Supported Printers, Plotters, and Keyboards
- Options and Accessories

Other Manuals

See the following user's manuals for more detailed information on the above topics, user operation, and programming.

User's Guide: General Information (HP part number 04156-90100)

User's Guide: Measurement & Analysis (HP part number 04156-90200)

Quick Start Guide (HP part number 04156-90300)

Programmer's Guide (HP part number 04156-90400)

HP-IB Command Reference (HP part number 04156-90500)

SCPI Command Reference (HP part number 04156-90600)

Sample Application Programs Guide Book (HP part number 04156-90700)

VXI Plug & Play Driver User's Guide (HP part number 04156-90710)

The following manuals contain service information for the HP 16440A, HP 16441A, and HP 16442A.

HP 16440A SMU/Pulse Generator Selector User's Guide (HP part number 16440-90000)

HP 16441A R-Box User's Guide (HP part number 16441-90000)

HP 16442A Test Fixture User's Guide (HP part number 16442-90000)

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Service Introduction

Warning

The information in this manual is provided for use by service trained personnel only. To avoid electrical shock, do not perform any procedures in this manual, unless you are qualified to do so.

Performance Verification Tests

Performance Verification Tests are used to verify the HP 4155B/4156B/41501B specifications. All tests can be easily performed by using the Performance Verification software (PV4155, which is on a 3.5-inch flexible disk and must be ordered separately), which runs on the HP BASIC 5.0 or later. This software conforms to MIL-STD-45662A.

Perform the tests for periodic verification of performance, for incoming inspection, and for inspection after troubleshooting. The recommended Performance Verification cycle is one year.

Performance Verification software is used also for ADC Reference Voltage/Resistance Adjustment. These references do not require periodical adjustments. For more information, see Chapter 3.

When you perform Performance Verification or ADC Reference Adjustment, the ambient temperature must be:

$23°C \pm 3°C$

For the HP 4155B/4156B/41501B specifications, see "Specifications" of the *HP 4155B/4156B User's Guide: General Information* (HP P/N 04156-90100).

Repair Policy

The HP 4155B/4156B/41501B will be repaired and calibrated in a local HP Service Center.

Most HP 4155B/4156B/41501B repairs are handled on an assembly-level replacement basis. The Power Supply units, which are OEMed, are replaced on a unit-level. The Power Supply and some other assemblies are set up as Exchange Assemblies as described in Chapter 7. Mechanical parts, LEDs, and fuses are handled on a parts-level replacement basis.

For the troubleshooting overview, see "Before Troubleshooting" in Chapter 4.

Service of HP 41501B SMU/Pulse Generator Expander

To repair or calibrate the HP 41501B, either HP 4155B or HP 4156B is required. Customers must send the HP 4155B or HP 4156B with the HP 41501B to an HP Service Office for the 41501B servicing.

Service of HP 16440A SMU/Pulse Generator Selector and HP 16441A R-Box

To repair the HP 16440A and the HP 16441A, the HP 4155B/4156B/41501B are not required if the failure is clearly caused in the HP 16440A or HP 16441A. If the failure isolation between the HP 4155B/4156B/41501B and HP 16440A/16441A is not performed, the HP 4155B/4156B/41501B are required for the repair.

For the HP 16441A performance test, the HP 4155B/4156B/41501B are not required.

Service of HP 16353A Standard Resistor Set

The HP 16353A should be calibrated and repaired at the factory via an HP Service Office. The HP 16353A requires periodical calibration. Calibrate the HP 16353A at least once a year.

Required Equipment

The following table lists the equipment required for performance tests, adjustments, and troubleshooting.

Note

Equipment should be calibrated by an instrument traceable to the National Institute of Standards and Technology (NIST) or an equivalent standard; or calibrated directly by an authorized calibration organization such as NIST. The calibration cycle should be in accordance with the stability specifications of each component.

Table 1-1. Required Equipment

Equipment	Procedure[1]			
	PV	Cal	TS[2]	Int
Computer / HP BASIC 5.0 or later / HP-IB cable	Y	Y	Y	
HP 54121T Digitizing Oscilloscope[3] (20 GHz, for PGU PV only)	Y[4]			
20 dB Attenuator (HP 33340C Opt 020), 3 ea.	Y[4]			
SMA (m) to BNC (f) Adapter (1250-1200), 3 ea.	Y[4]			
HP 3458A Digital Multimeter[3]	Y	Y	Y[5]	Y[6]
HP 16353A Standard Resistor Set[3]	Y			
Product Support Package (04155-65801):				
Calibration Adapter (04155-65001)	Y	Y		
Shorting Box for 04155-65001 Calibration Adapter (04155-65002)	Y			
Triaxial T-Adapter (1250-1551)	Y			
BNC - 4 Wire Cable (04155-61649)	Y[4]			
Triax - 3 Wire Cable (04155-61650), 2 ea.			Y	
INTLK Test Adapter (04155-65003)	Y			Y
INTLK Cable (04155-61614)	Y			Y
Mini Pin Plug - Banana Plug Cable (04155-61648)	Y	Y	Y	Y
Pull-Up Box (2.2 kΩ, 2 Mini Pin - Banana Cable) (04155-61653)				Y
R-Box I/F Test Adapter Cable (04155-61652)				Y
Module Extractor (04155-60007)[7]			Y	
PV4155 Disk (3.5-Inch, Revision A.01.00, 04155-65301)	Y	Y		
Parallel I/F Test Adapter (04155-61632)				Y
LAN I/F Test Adapter (04155-61631)				Y
Triaxial Cable (1 m, 04142-61641), 2 ea.	Y	Y		
Banana Plug - Banana Plug Cable, 2 ea. (HP 11058A)	Y	Y		
BNC-BNC Cable (61 cm, 8120-1839) 4 ea. (1 ea. for interactive test)	Y			Y
BNC T-Adapter (1250-0781), 2 ea.	Y			
BNC Shorting Cap (1250-0929)	Y			
Alligator Clip - Banana Plug Cable, 1 ea. or 2 ea.			Y	
3.5-Inch 2DD and 2HD Diskettes (for FDD Read/Write test)				Y
Torx TX15 Driver (for top/bottom cover)			Y	
Torx TX25 Driver (for side cover)			Y	
Philips (Pozidriv No 1, No 2) and Flat-Blade Screwdrivers			Y	

1 PV: Performance Verification, Cal: Voltage/Resistor Reference calibration, TS: Troubleshooting, Int: DIAG Interactive test.

2 Equipment for "PV", "Cal", and "Int" are also needed for troubleshooting.

3 Must have been calibrated within the last year.

4 Required only if the PGU is installed.

5 Or DVM that has the accuracy 0.1% or better.

6 Or DVM that has the accuracy 1% or better.

7 Attached to rear panel of HP 4155/4156/41501.

Service Kit

Product Support Package

The Product Support Package for the HP 4155A/4156A/41501A (part number 04155-65801) contains items required for performance testing and troubleshooting the HP 4155A/4156A/41501A. The contents are shown below.

Note

The PV4155 Disk (04155-65211) and the Serial I/F Test Adapter (04155-61001) are *NOT* used for the HP 4155B/4156B/41501B. The following are additional items for servicing the HP 4155B/4156B/41501B:

Part Number	Description
04155-65301	PV4155 Disk A.01.00
04155-61632	Parallel I/F Test Adapter
04155-61631	LAN I/F Test Adapter

Table 1-2. Contents of Product Support Package (04155-65801)

Part Number	Quantity	Description
04155-65001	1	Calibration Adapter
04155-65002	1	Shorting Box for 04155-65001 Calibration Adapter
04155-65211	1	PV4155 Disk (3.5-Inch, Revision 1.2)
1250-1551	1	Triaxial T-Adapter
04155-61649	1	BNC - 4 Wire Cable (1.5 m)
04155-61650	2	Triax - 3 Wire Cable
04155-65003	1	INTLK Test Adapter
04155-61614	1	INTLK Cable (1.5 m) (HP 16493J Opt. 001)
04155-61648	1	Mini Pin Plug - Banana Plug Cable (1.5 m)
04155-61653	1	Pull-Up Box (2.2 kΩ, 2 Mini Pin - Banana Cable)
04155-61652	1	R-Box I/F Test Adapter Cable (70 cm)
04155-61001	1	Serial I/F Test Adapter (for 4155A/4156A)
04155-60007	1	Module Extractor
04155-60101	1	Carrying Case

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Performance Verification

Introduction

This chapter provides the HP 4155A/4156B/41501B performance verification test procedures using the Performance Verification (PV4155) Program. All the performance verification tests can be performed without access to the interior of the instrument.

For the performance verification of the HP 16441A R-Box, See edition 2 or later of the *HP 16441A R-Box User's Guide* (HP P/N 16441-90000).

Required Equipment

The following is equipment required for the HP 4155B/4156B/41501B performance verification tests.

Description	Quantity	Model / Part Number
Digital Multimeter	1	HP 3458A
Digitizing Oscilloscope (20 GHz)	1	HP 54121T
20 dB Attenuators	3	HP 33340C #020
SMA (m)-to-BNC (f) Adapter	3	1250-1200
Standard Resistor Set	1	HP 16353A
Product Support Package	1	04155-65801
Calibration Adapter	1	04155-65001
Shorting Box	1	04155-65002
Mini Pin Plug - Banana Plug Cable	1	04155-61648
Triaxial T-Adapter	1	1250-1551
BNC - 4 Wire Cable (for PGU only)	1	04155-61649
INTLK Cable	1	04155-61614
INTLK Test Adapter	1	04155-65003
PV4155 Disk (3.5 inch)	1	04155-65301
Triaxial Cable	2	04142-61641
Banana Plug - Banana Plug Cable	2	HP 11058A
BNC-BNC Cable (50Ω , 61 cm)	4	8120-1839
BNC T-Adapter	2	1250-0781
BNC Shorting Cap	1	1250-0929

Performance Test Record

Performance Test Results can be printed out to a printer by using the PV4155 Program. An example of performance test record is at the end of this chapter.

Performance Verification Cycle

The HP 4155B/4156B/41501B requires periodic performance verification. The frequency of performance verification depends on the operating and environmental conditions under which the instrument is used. Verify the HP 4155B/4156B/41501B's performance at least once a year, using the performance tests described in this chapter.

Performance Verification Environment

Perform all performance verification tests in an ambient temperature of 23 °C ± 3 °C to keep measurement uncertainties. Allow the HP 4155B/4156B/41501B to warm up and stabilize for at least 40 minutes to ensure proper instrument performance. Also, allow the HP 3458A and the HP 54121T to warm up and stabilize for their warmup time.

Important The HP 3458A and HP 54121T must be warmed up at least:

HP 3458A: four hours
HP 54121T: one hour

Perform `ACAL` for the HP 3458A after the warmup time.

Performance Verification Test Procedures

The following procedures explain how to execute the HP 4155B/4156B/41501B performance verification tests using the PV4155 program.

Preparation

Before the tests, perform the following steps:

1. If the HP 4155B/4156B is equipped with the HP 41501B, interconnect them.
2. Connect the HP-IB cables.
   Interconnect the controller, HP 4155B/4156B, HP 3458A, HP 54121T, disk drive, and printer with interface cables. A printer is required only if you want to print the Test Records after the tests are complete.

Note HP 54121T is required only if the HP 41501B has PGUs.

---

3. Short the **Circuit Common** terminal and the chassis ground terminal of the HP 4155B/4156B rear panel with the shorting bar.
4. Confirm the HP 4155B/4156B settings on the SYSTEM: MISCELLANEOUS page by using the following procedure:
   a. Turn on the HP 4155B/4156B.

b. Press the System front-panel key on the HP 4155B/4156B.

c. Select the MISCELLANEOUS softkey to display the SYSTEM: MISCELLANEOUS page

d. Set the following in the "HP 4155 is" or "HP 4156 is" field:

```
HP 4155 or HP 4156 is:  NOT SYSTEM CONTROLLER
```

e. Confirm the HP-IB Address of the HP 4155B/4156B in the HP-IB ADDRESS field.

f. Confirm the power line frequency of the HP 4155B/4156B in the POWER LINE FREQUENCY field.

g. Make sure the **Terminals** push-switch on the HP 3458A front panel is at the **Front** position.

h. Make sure the **Guard** push-switch on the HP 3458A front panel is at the **Open** position.

i. Check the HP-IB addresses of the HP 3458A (and HP 54121T) and remember them.

Starting the PV4155 Program

Use the following procedure to start the PV4155 program . If an error message is displayed during the PV4155 execution, proceed to Chapter 4.

1. Turn the controller on and boot the HP BASIC/WS system.
   Insert BASIC 5.0 (or later) disk into the disk drive and turn your computer on. The language system loads automatically and BASIC Ready is displayed when BASIC is loaded. Remove the disk.

2. Load BASIC BIN files.
   Load the following binary (BIN) files from the BASIC Driver Disk and the BASIC Language Extensions Disk:

   Driver BIN: HPIB

   Language Extension BIN: CLOCK, ERR, IO, MAT

   If you are using an external disk drive or other storage medium, you also need to load other BIN files (for example CS80 and DISC). Remove the disk.

3. Load and run the PV4155 program as follows:

   ```
   LOAD "PV4155" Return
   RUN Return
   ```

   Change the working directory to the directory where PV4155 and related files are stored, or set MASS STORAGE IS (MSI) to the disk drive where PV4155 disk is inserted.

   After the copyright message is displayed and the program initialization is completed, the START UP MENU is displayed.

Setting Up Test Equipment Configurations

Before you begin the performance verification tests, you need to confirm/change the following items that are necessary information for the tests. Select the `RECONFIG` softkey in the START UP MENU. The RECONFIG MENU is displayed. You can confirm/change the following items in this menu.

- Unit Under Test (UUT) information (model number and HP-IB address)
- HP 3458A information (HP-IB address)
- HP 54121T information (HP-IB address)
- Printer information (type, HP-IB address, and spooling directory)
- HP 16353A Standard Resistor Set calibration values

Select an appropriate softkey to confirm/change the item values. See "RECONFIG MENU Operation" for the details.

After you have set up the configurations, select the `START UP MENU` softkey to return to the START UP MENU.

Executing Performance Verification Tests

To execute the performance verification tests, perform the following steps:

1. Display the PV MENU.
   To display the PV MENU, select the `START` softkey in the START UP MENU, then select the `PV` softkey in the MAIN MENU. Selecting the `PV` softkey initializes the HP 4155B/4156B, HP 3458A, and HP 54121T. If the HP-IB addresses are not set correctly, an error message is displayed and the PV4155 program terminates.
2. Select the test mode.
   The PV4155 has two test modes for the performance verification tests. One is the Sequential Test mode, which verifies all the units installed in the HP 4155B/4156B/41501B. The other is the Selective Test mode, which verifies one unit specified by softkeys. The test results can be saved to a disk and printed out as the test record only in the Sequential Test mode. Select the `ALL` softkey in the PV MENU to start the Sequential Test.
3. Execute the tests.
   To perform all tests sequentially, use the following steps:
   a. Select the `ALL` softkey. The message and softkeys are displayed:

      ```
      Do you want to keep results in a file ?
      ```

   b. Select the desired softkey (`YES` or `NO`). To be able to print out the test results as the test record, you must save the test results in a file (select the `YES` softkey). If you select the `NO` softkey, go to step g.
   c. Insert a disk for saving the test results. Do not remove the disk until the PV MENU is displayed again after all tests are complete, because PV4155 creates temporary files on the disk during the tests and merges them into one file after all tests are complete.

Note You can execute any BASIC statement directly whenever PV4155 program is waiting for softkey input. For example, you can execute the CAT statement to display the catalog, or you can execute the PURGE statement to purge a file.

d. Type the name of the file in which you want to save the test results, then press Return. A default filename is, for example, PV41550897 (PV41550897: Performance Verification HP 4155B, August (8) 1997). If you press Return without typing a filename, the PV4155 returns you to step b again.

Note Do not use TEMP001 through TEMP999 as your test results filename because the PV4155 creates temporary files with these names during the tests. After the tests are complete, these temporary files are automatically purged.

If you specify a file that has already been used to save the test results of a previous PV4155 execution, you can selectively resave the results of desired test items. In this case, go to step g since you can not change the contents of step e. You can perform the desired test items by using the CONTINUE softkey and the SKIP softkey to skip over undesired test items.

e. Type the serial numbers of the HP 4155B/4156B/41501B and press Return. Then enter Temperature, Humidity, Date, and operator's name as prompted. Press Return after each entry.

f. After you have finished all the entries, PV4155 asks you if the entered data are correct or not:

```
Are you sure ?
```

If you have correctly entered all the data in step e, select the YES softkey. If you select the NO softkey, PV4155 returns you to step e again. Once you select the YES softkey, you can never change the data entered in step e.

g. Perform test items in accordance with the messages that are displayed during test execution. See each test description for the details of the test method including cable connections.

Warning **Shorting the INTLK terminal enables SMU output to exceed ±42 V. Dangerous voltages may be present at SMU force, sense, and guard terminals when the INTLK terminal is shorted.**

The following shows the softkeys that are displayed during test item execution. First connect the cables in accordance with the displayed messages, then select the CONTINUE softkey to execute the test item. After the test result (PASS or FAIL) is displayed, select the CONTINUE softkey to perform the next test item. Basically, you can perform all test items by changing the cable connections, then selecting the CONTINUE softkey. After all tests are complete, PV4155 displays the PV MENU.

Softkey	Function
CONTINUE	Goes to the next procedure in the test item.
SKIP	Goes to the next unit.
EXIT	Goes to the next test item. Or if this softkey is selected after selecting the CRT softkey, exits from displaying the detailed test results.
RETRY	Performs the test item again. If the test fails, make sure the cable connections are correct, then select this softkey if you want to perform the test item again. If the test results are being saved to a disk, the new test results overwrite the old test results.
DUMP	Displays or prints the detailed test results. If the PRINTER TYPE is set to FILE SPOOL, the created file name is PV4155_D*n*(*n* is incremented from 1 to 99 repeatedly, such as 1, 2, ... , 99, 1) and the file type is ASCII (LIF ASCII).
CRT	Displays the detailed test results.
PRINTER	Prints the detailed test results.
MORE	Displays one more screen of the detailed test results.
CANCEL	Cancels printing.

SMU Voltage Accuracy Test

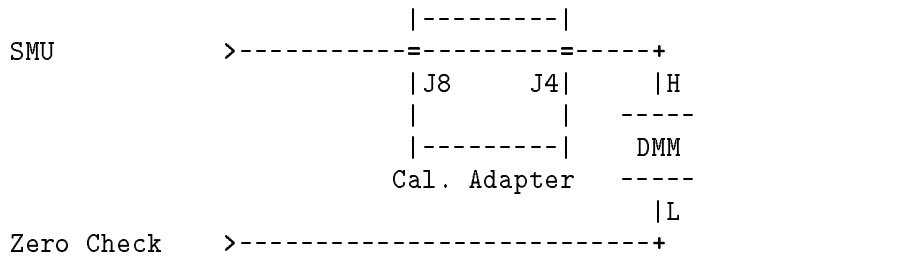
This test verifies the SMU voltage setting/measurement accuracy. This test is executed when the `V ACC.` softkey is selected in SMU TEST MENU.

Test Equipment

HP 3458A Multimeter
Calibration Adapter (04155-65001)
Triaxial Cable (1 meter, 04142-61641); 2 ea. required only for HR/HPSMU test
Triaxial T-Adapter (1250-1551); required only for HR/HPSMU test
Mini Pin Plug - Banana Plug Cable (04155-61648)
Banana Plug - Banana Plug Cable
INTLK Cable (04155-61614)
INTLK Test Adapter (04155-65003)

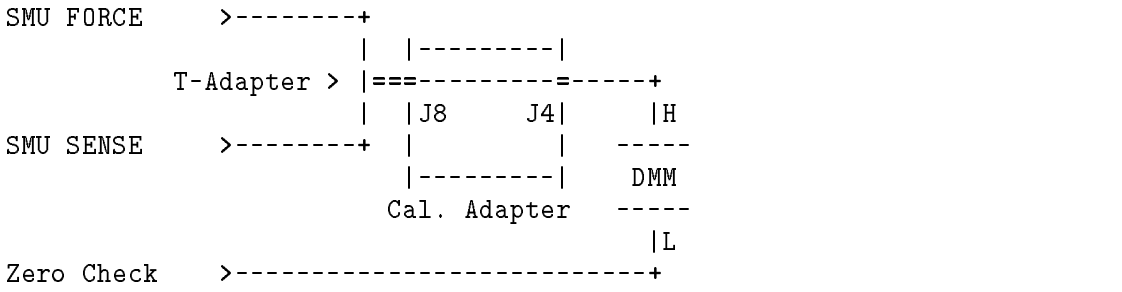
Test Method

Test Connection:



SMU <---> J8 (Triaxial Cable)
DMM-H <---> J4 (Banana Plug - Banana Plug Cable)
DMM-L <---> Zero Check (Mini Pin Plug - Banana Plug Cable)

For MPSMU



SMU FORCE/SENSE <---> J8 (Triaxial Cables (2 ea.) and Triaxial T-Adapter)
DMM-H <---> J4 (Banana Plug -Banana Plug Cable)
DMM-L <---> Zero Check (Mini Pin Plug - Banana Plug Cable)

For HRSMU/HPSMU

1. Connect the HP 4155B/4156B/41501B to the HP 3458A (DMM) as shown above.
   a. If you test HR/HPSMU, connect Triaxial T-Adapter to Calibration Adapter J8, then connect SMU FORCE and SMU SENSE to Calibration Adapter J8 with two triaxial cables. If you test MPSMU, connect SMU to Calibration Adapter J8 with a triaxial cable.
   b. Connect DMM-L to Zero Check terminal on rear panel of the HP 4155B/4156B.
   c. Connect DMM-H to Calibration Adapter J4.
2. PV4155 controls the HP 3458A to set as follows:

Function:	DCV
Auto Zero:	ON
NPLC:	100

3. PV4155 controls SMU to set as follows:

Filter:	ON
Current Compliance:	1 mA
Integ Time:	Medium

4. PV4155 controls SMU to force the specified voltage.
5. PV4155 controls the HP 3458A to make voltage measurement.
6. PV4155 controls SMU to make voltage measurement.
7. PV4155 verifies SMU voltage accuracy.

SMU Guard Potential Voltage Offset Test

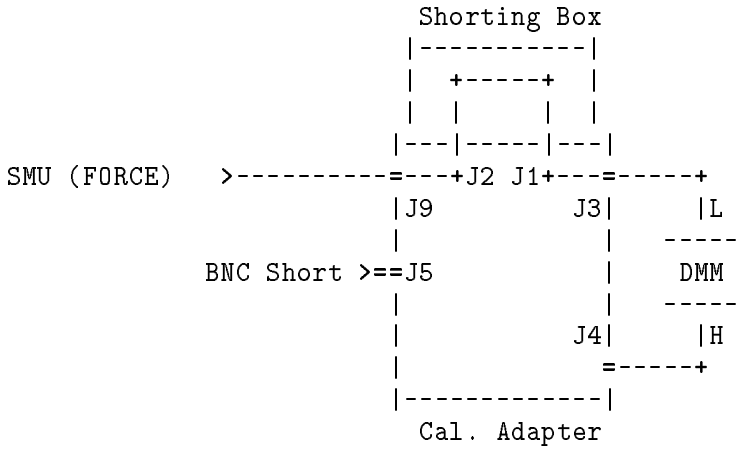
This test verifies the voltage offset level between SMU GUARD-FORCE. This test is executed when the `I ACC.` softkey is selected in SMU TEST MENU.

Test Equipment

HP 3458A Multimeter
Calibration Adapter (04155-65001)
Shorting Box (04155-65002)
Triaxial Cable (04142-61641)
Banana Plug - Banana Plug Cable; 2 ea
BNC Shorting Cap (1250-0929)

Test Method

Test Connection:



SMU (FORCE) <---> J9 (Triaxial Cable)
DMM-H <---> J4 (Banana-Banana Cable)
DMM-L <---> J3 (Banana-Banana Cable)

1. Connect the HP 4155B/4156B/41501B to the HP 3458A (DMM) as shown above.
   a. Connect DMM-L to Calibration Adapter J3.
   b. Connect DMM-H to Calibration Adapter J4.
   c. Connect SMU FORCE to Calibration Adapter J9.
   d. Connect Shorting Box to Calibration Adapter J1/J2.
   e. Connect BNC shorting cap to Calibration Adapter J5.
2. PV4155 controls the HP 3458A to set as follows:

Function:	DCV
Auto Zero:	ON
NPLC:	100

3. PV4155 controls SMU to set as follows:

Filter:	ON
Current Range:	100 nA
Output Current:	−100 nA
Voltage Compliance:	100 mV

4. PV4155 controls SMU to force the test current.
5. PV4155 controls the HP 3458A to make voltage measurement.
6. PV4155 verifies SMU guard potential offset accuracy.

SMU Current Accuracy Test (10 pA to 10 μA Range Test)

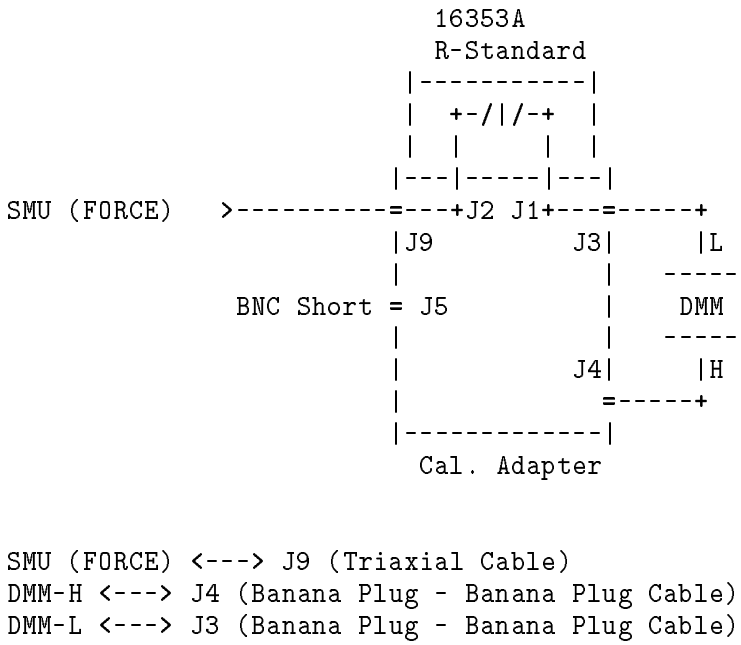
This test verifies the SMU current setting and current measurement accuracy. This test is executed when the `I ACC.` softkey is selected in SMU TEST MENU.

Test Equipment

HP 3458A Multimeter
HP 16353A Standard Resistor Set
Calibration Adapter (04155-65001)
Triaxial Cable (04155-61641)
Banana Plug - Banana Plug Cable; 2 ea
BNC Shorting Cap (1250-0929)

Test Method

Test Connection:




```
SMU (FORCE) <---> J9 (Triaxial Cable)
DMM-H <---> J4 (Banana Plug - Banana Plug Cable)
DMM-L <---> J3 (Banana Plug - Banana Plug Cable)
```

1. Connect the HP 4155B/4156B/41501B to the HP 3458A (DMM) as shown above.
   a. Connect DMM-L to Calibration Adapter J3.
   b. Connect DMM-H to Calibration Adapter J4.
   c. Connect SMU FORCE to Calibration Adapter J9.
   d. Connect R-Standard Box to Calibration Adapter J1/J2.
   e. Connect BNC shorting cap to Calibration Adapter J5.
2. PV4155 controls the HP 3458A to set as follows:
   Function: DCV

Auto Zero: ON

NPLC: 100

3. PV4155 controls SMU to set as follows:

   Filter: ON

   Voltage Compliance: 2 V

4. PV4155 controls SMU to force the specified current.
5. PV4155 controls the HP 3458A to make voltage measurement.
6. PV4155 controls SMU to make current measurement.
7. PV4155 verifies SMU current setting/measurement accuracy.

SMU Current Accuracy Test (100 μA to 1 A Range Test)

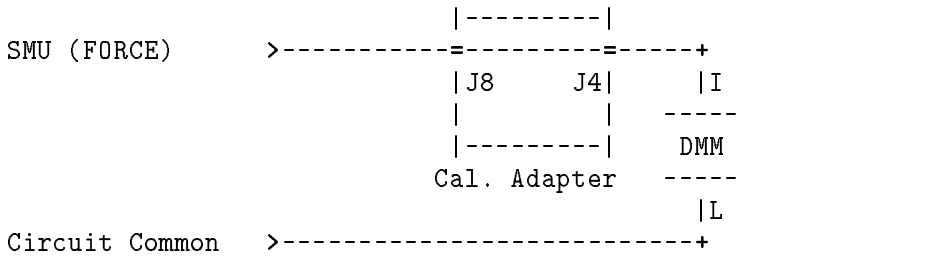
This test verifies the SMU current setting and current measurement accuracy. This test is executed when the `I ACC.` softkey is selected in SMU TEST MENU.

Test Equipment

HP 3458A Multimeter
Calibration Adapter (04155-65001)
Triaxial Cable (04155-61641)
Banana Plug - Banana Plug Cable; 2 ea

Test Method

Test Connection:



SMU (FORCE) <---> J8 (Triaxial Cable)
DMM-I <---> J4 (Banana Plug - Banana Plug Cable)
DMM-L <---> Circuit Common (Banana Plug - Banana Plug Cable)

1. Connect the HP 4155B/4156B/41501B to the HP 3458A (DMM) as shown above.
   a. Connect DMM-L to Circuit Common on rear panel of the HP 4155B/4156B.
   b. Connect DMM-I to Calibration Adapter J4.
   c. Connect SMU FORCE to Calibration Adapter J8.
2. PV4155 controls the HP 3458A to set as follows:

Function:	DCI
Auto Zero:	ON
NPLC:	100

3. PV4155 controls SMU to set as follows:

Filter:	ON
Voltage Compliance:	2 V
Integ Time:	Medium

4. PV4155 controls SMU to force the specified current.
5. PV4155 controls the HP 3458A to make current measurement.
6. PV4155 controls SMU to make current measurement.
7. PV4155 verifies SMU current setting/measurement accuracy.

SMU CMR Accuracy Test

This test verifies the SMU common mode rejection accuracy. This test is executed when the `CMR` softkey is selected in SMU TEST MENU.

Test Equipment

None

Test Method

1. Disconnect all cables and plugs from SMU. (Set SMU to “open” condition.)
2. PV4155 controls SMU to force maximum minus voltage.
3. PV4155 controls SMU to make current measurement.
4. PV4155 controls SMU to force maximum plus voltage.
5. PV4155 controls SMU to make current measurement.
6. PV4155 verifies SMU CMR accuracy.

VSU/VMU Voltage Accuracy Test

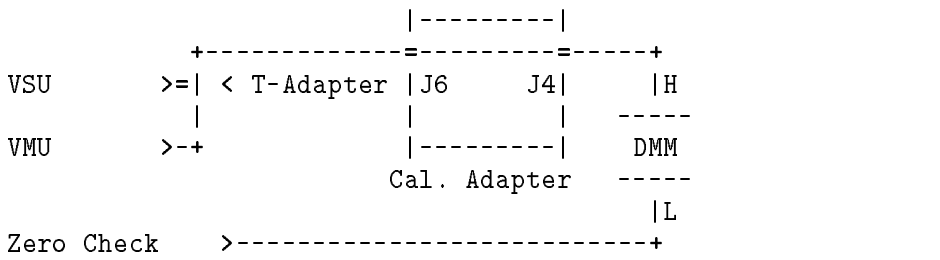
This test verifies the VSU voltage setting accuracy and VMU voltage measurement accuracy. This test is executed when the `V ACC.` softkey is selected in VSUVMU TEST MENU.

Test Equipment

HP 3458A Multimeter
Calibration Adapter (04155-65001)
BNC - BNC Cable (50 Ω, 8120-1839; 2 ea)
BNC T-Adapter (1250-0781)
Mini Pin Plug - Banana Plug Cable (04155-61648)
Banana Plug - Banana Plug Cable

Test Method

Test Connection:



VSU/VMU <---> J6 (BNC - BNC Cable (2 ea.) and BNC T-Adapter)
DMM-H <---> J4 (Banana Plug - Banana Plug Cable)
DMM-L <---> Zero Check (Mini Pin Plug - Banana Plug Cable)

1. Connect the HP 4155B/4156B to the HP 3458A (DMM) as shown above.
   a. Connect VSU to the VMU and Calibration Adapter J6 with BNC T-Adapter and BNC cables.
   b. Connect DMM-L to Zero Check terminal on rear panel of the HP 4155B/4156B with Banana Plug - Mini Pin cable.
   c. Connect DMM-H to Calibration Adapter J4 with Banana Plug cable.
2. PV4155 sets the HP 3458A as follows:

Function:	DCV
Auto Zero:	ON
NPLC:	100

3. PV4155 controls the VSU to force the test voltage.
4. PV4155 controls the HP 3458A to make voltage measurement.
5. PV4155 controls the VMU to make voltage measurement.
6. PV4155 verifies VSU/VMU voltage setting/measurement accuracy.

VMU Differential Voltage Accuracy Test

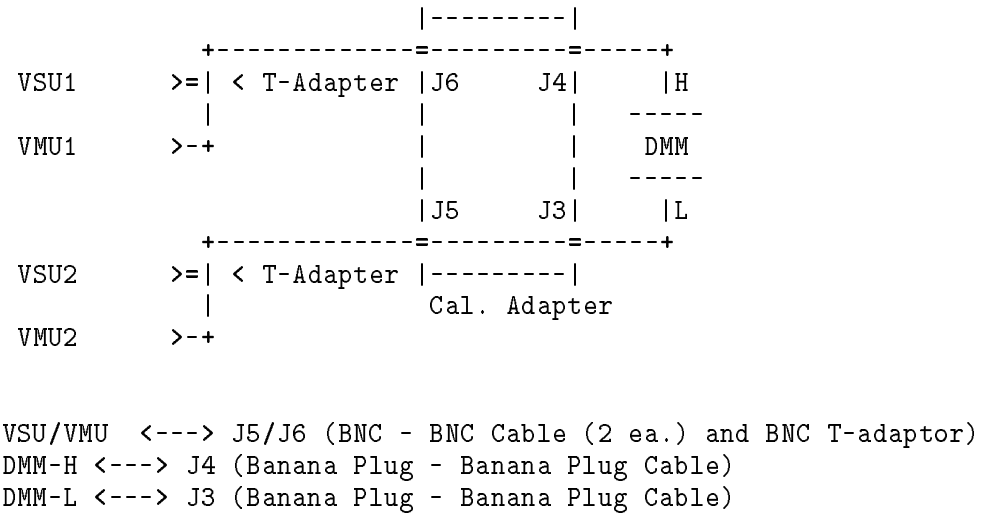
This test verifies the VMU differential voltage measurement accuracy. This test is executed when the `DIFF. V` softkey is selected in VSUVMU TEST MENU.

Test Equipment

HP 3458A Multimeter
Calibration Adapter (04155-65001)
BNC - BNC Cable (50 Ω, 8120-1839; 4 ea)
BNC T-Adapter (1250-0781; 2 ea)
Banana Plug - Banana Plug Cable; 2 ea

Test Method

Test Connection:



VSU/VMU <---> J5/J6 (BNC - BNC Cable (2 ea.) and BNC T-adaptor)
DMM-H <---> J4 (Banana Plug - Banana Plug Cable)
DMM-L <---> J3 (Banana Plug - Banana Plug Cable)

1. Connect the HP 4155B/4156B to the HP 3458A (DMM) as shown above.
   a. Connect VSU1 to the VMU1 and Calibration Adapter J6 with BNC T-Adapter and BNC cables.
   b. Connect VSU2 to the VMU2 and Calibration Adapter J5 with BNC T-Adapter and BNC cables.
   c. Connect DMM-L to Calibration Adapter J3 with Banana Plug cable.
   d. Connect DMM-H to Calibration Adapter J4 with Banana Plug cable.
2. PV4155 controls VSU2 to force 0 V.
3. PV4155 controls VSU1 to force the test voltage.
4. PV4155 controls the HP 3458A to make voltage measurement.
5. PV4155 controls VMUs to make differential voltage measurement.
6. PV4155 verifies VMU differential voltage measurement accuracy.

VMU CMR Accuracy Test

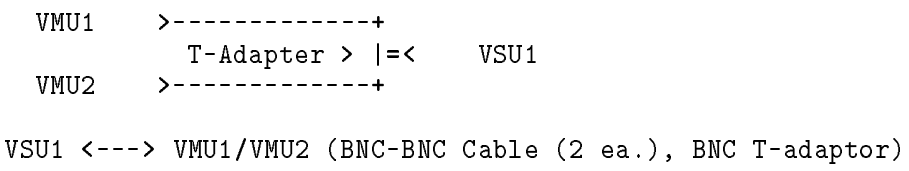
This test verifies the VMU common mode rejection error. This test is executed when the `DIFF. V` softkey is selected in VSUVMU TEST MENU.

Test Equipment

BNC - BNC Cable (50 Ω, 8120-1839; 2 ea)
BNC T-Adapter (1250-0781)

Test Method

Test Connection:



1. Connect VSU1 to VMU1/VMU2 as shown above.
2. PV4155 controls VSU1 to force −20 V.
3. PV4155 controls VMUs to make differential voltage measurement.
4. PV4155 controls VSU1 to force +20 V.
5. PV4155 controls VMUs to make differential voltage measurement.
6. PV4155 verifies VMU CMR accuracy.

PGU DC Voltage Output Accuracy Test

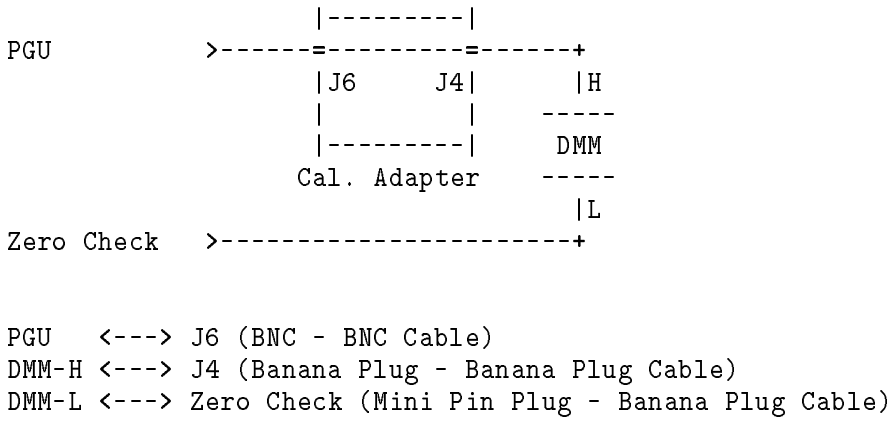
This test verifies the PGU DC voltage output accuracy. This test is executed when the `LEVEL` softkey is selected in PGU TEST MENU.

Test Equipment

HP 3458A Multimeter
Calibration Adapter (04155-65001)
BNC - BNC Cable (50 Ω, 8120-1839)
Mini Pin Plug - Banana Plug Cable (04155-61648)
Banana Plug - Banana Plug Cable

Test Method

Test Connection:




```
PGU   <---> J6 (BNC - BNC Cable)
DMM-H <---> J4 (Banana Plug - Banana Plug Cable)
DMM-L <---> Zero Check (Mini Pin Plug - Banana Plug Cable)
```

1. Connect the HP 4155B/4156B/41501B to the HP 3458A (DMM) as shown above.
2. PV4155 sets the HP 3458A as follows:

   Function: DCV

   Auto Zero: ON

   NPLC: 100
3. PV4155 controls the PGU to force the specified voltage.
4. PV4155 controls the HP 3458A to make voltage measurement.
5. PV4155 verifies PGU DC voltage output accuracy

PGU Pulse Base/Peak Level Accuracy Test

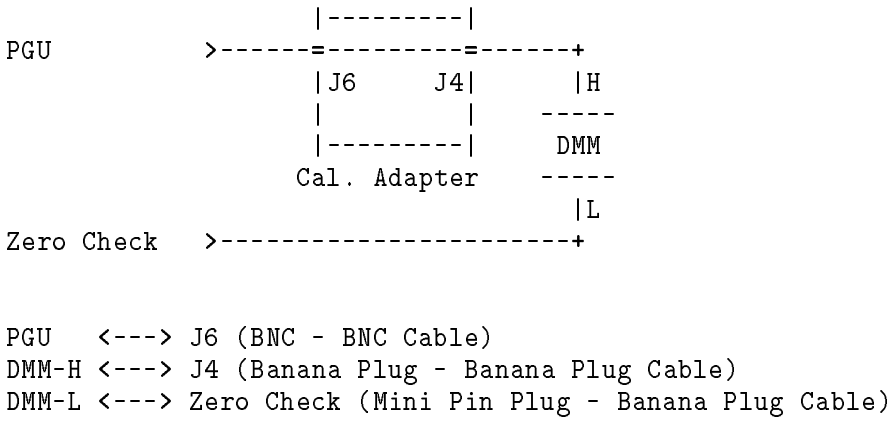
This test verifies the PGU pulse level setting accuracy. This test is executed when the `LEVEL` softkey is selected in PGU TEST MENU.

Test Equipment

HP 3458A Multimeter
Calibration Adapter (04155-65001)
BNC - BNC Cable (50 Ω, 8120-1839)
Mini Pin Plug - Banana Plug Cable (04155-61648)
Banana Plug - Banana Plug Cable

Test Method

Test Connection:




```
PGU   <---> J6 (BNC - BNC Cable)
DMM-H <---> J4 (Banana Plug - Banana Plug Cable)
DMM-L <---> Zero Check (Mini Pin Plug - Banana Plug Cable)
```

1. Connect the HP 4155B/4156B/41501B to the HP 3458A (DMM) as shown above.
2. PV4155 controls the HP 3458A to set as follows:

   Function: DCV

   Auto Zero: ON

   NPLC: 100
3. PV4155 controls the PGU to generate pulse.
4. PV4155 controls the HP 3458A to make voltage measurement.
5. PV4155 verifies PGU pulse level setting accuracy.

PGU Pulse Period Accuracy Test

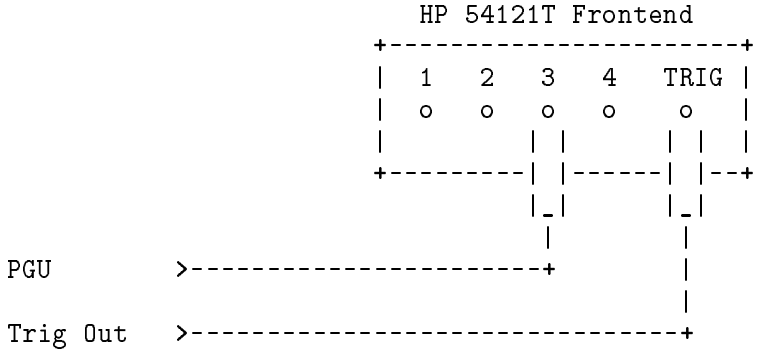
This test verifies the PGU pulse period setting accuracy. This test is executed when the `PERIOD/WIDTH` softkey is selected in PGU TEST MENU.

Test Equipment

HP 54121T Digitizing Oscilloscope
BNC - BNC Cable (50 Ω, 8120-1839; 2 ea)
20 dB Attenuator (HP 33340C Opt 020; 2 ea)
SMA (m) to BNC (f) Adapter (1250-1200; 2 ea)

Test Method

Test Connection:



1. Connect the HP 41501B to the HP 54121T as shown above.
   a. Connect PGU output to HP 54121T CH3 with 20 dB attenuator and SMA/BNC Adapter.
   b. Connect PGU Trig Out to HP 54121T TRIG with 20 dB attenuator and SMA/BNC Adapter.
2. PV4155 controls the PGU settings as follows:

Period	Width	Leading/Trailing Time
2 μs	1 μs	0.1 μs
2 s	1 s	0.1 μs

   Base Voltage: 0 V
   Peak Voltage: 5 V
   Output Impedance: 50 Ω
3. PV4155 triggers the PGU with continuous pulse output mode (free run).
4. PV4155 controls the 54121T to measure the period.
5. PV4155 verifies PGU pulse period setting accuracy.

PGU Pulse Width Accuracy Test

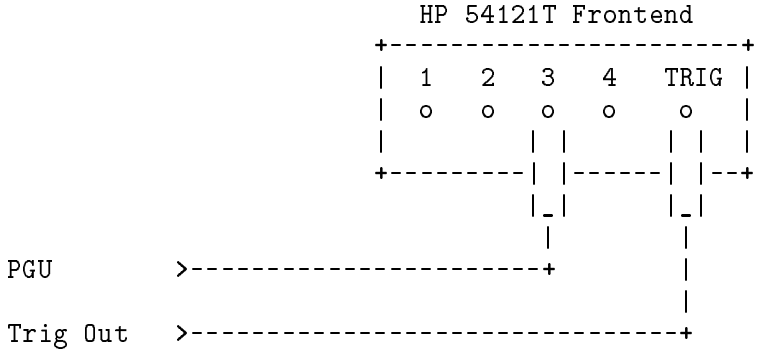
This test verifies the PGU pulse width setting accuracy. This test is executed when the `PERIOD/WIDTH` softkey is selected in PGU TEST MENU.

Test Equipment

HP 54121T Digitizing Oscilloscope
BNC - BNC Cable (50 Ω, 8120-1839; 2 ea)
20 dB Attenuator (HP 33340C Opt 020; 2 ea)
SMA (m) to BNC (f) Adapter (1250-1200; 2 ea)

Test Method

Test Connection:



1. Connect the HP 41501B to the HP 54121T as shown above.
   a. Connect PGU output to HP 54121T CH3 with 20 dB attenuator and SMA/BNC Adapter.
   b. Connect PGU Trig Out to HP 54121T TRIG with 20 dB attenuator and SMA/BNC Adapter.
2. PV4155 sets the PGU as follows:

Period	Width	Leading/Trailing Time
2 μs	1 μs	0.1 μs
2 s	1 s	0.1 μs

Base Voltage: 0 V
Peak Voltage: 5 V
Output Impedance: 50 Ω

3. PV4155 triggers the PGU with continuous pulse output mode (free run).
4. PV4155 controls the 54121T to measure the width.
5. PV4155 verifies PGU pulse width setting accuracy.

PGU Pulse Leading/Trailing Time Accuracy Test

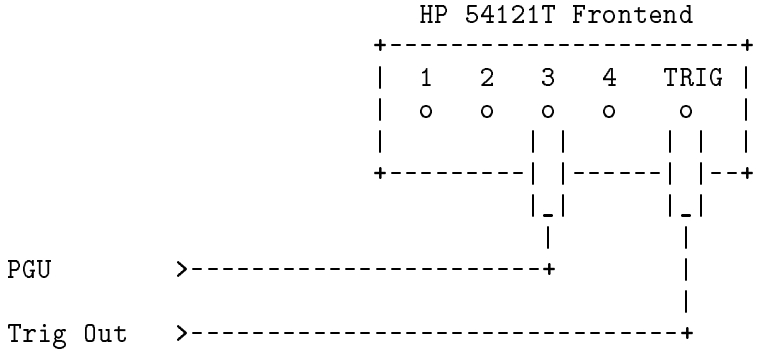
This test verifies the PGU pulse leading/trailing time accuracy. This test is executed when the `LEADING/TRAILING` softkey is selected in PGU TEST MENU.

Test Equipment

HP 54121T Digitizing Oscilloscope
BNC - BNC Cable (50 Ω, 8120-1839; 2 ea)
20 dB Attenuator (HP 33340C Opt 020; 2 ea)
SMA (m) to BNC (f) Adapter (1250-1200; 2 ea)

Test Method

Test Connection:



1. Connect the HP 41501B to the HP 54121T as shown above.
   a. Connect PGU output to HP 54121T CH3 with 20 dB attenuator and SMA/BNC Adapter.
   b. Connect PGU Trig Out to HP 54121T TRIG with 20 dB attenuator and SMA/BNC Adapter.
2. PV4155 sets the PGU as follows:

Period	Width	Leading/Trailing Time
2 μs	1 μs	100 ns
20 μs	10 μs	1 μs
200 μs	100 μs	10 μs
200 μs	100 μs	10.1 μs
2 ms	1 ms	100 μs
20 ms	10 ms	1 ms
200 ms	100 ms	10 ms

Base Voltage: 0 V
Peak Voltage: 5 V

Output Impedance: 50 Ω

3. PV4155 triggers the PGU with continuous pulse output mode (free run).
4. PV4155 controls the 54121T to measure the leading/trailing time.
5. PV4155 verifies PGU pulse leading/trailing time accuracy.

PGU Delay Time Accuracy Test

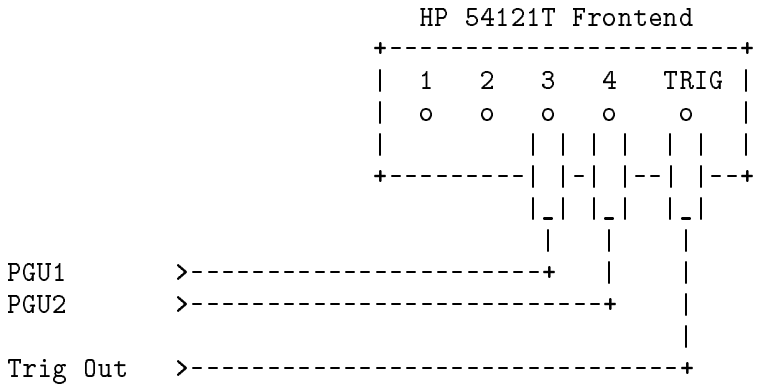
This test verifies the pulse delay time setting accuracy between PGU1 output and PGU2 output. This test is executed when the `DELAY` softkey is selected in PGU TEST MENU.

Test Equipment

HP 54121T Digitizing Oscilloscope
BNC - BNC Cable (50 Ω, 8120-1839; 3 ea)
20 dB Attenuator (HP 33340C Opt 020; 3 ea)
SMA (m) to BNC (f) Adapter (1250-1200; 3 ea)

Test Method

Test Connection:



1. Connect the HP 41501B to the HP 54121T as shown above.
   a. Connect PGU1 output to HP 54121T CH3 with 20 dB attenuator and SMA/BNC Adapter.
   b. Connect PGU2 output to HP 54121T CH4 with 20 dB attenuator and SMA/BNC Adapter.
   c. Connect PGU Trig Out to HP 54121T TRIG with 20 dB attenuator and SMA/BNC Adapter.
2. PV4155 sets the PGU as follows:

Period	Width	Leading/Trailing Time	Delay Time
2 μs	1 μs	0.1 μs	0 s

   Base Voltage: 0 V
   Peak Voltage: 5 V
   Output Impedance: 50 Ω
3. PV4155 triggers the PGUs with continuous pulse output mode (free run).
4. PV4155 controls the 54121T to measure the delay time.
5. PV4155 verifies PGU pulse delay setting accuracy.

PGU Output Impedance Accuracy Test

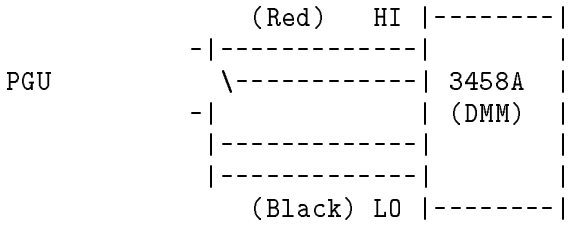
This test verifies the PGU output impedance (50 Ω) setting accuracy. This test is executed when the `OUTPUT IMP.` softkey is selected in PGU TEST MENU.

Test Equipment

HP 3458A Multimeter
BNC - 4 Wire Cable (04155-61649)

Test Method

Test Connection:



1. Connect the HP 41501B to the HP 3458A with the 04155-61649 cable (4-wire connection) as shown above.
   a. Connect red cables of 04155-61649 to DMM-H.
   b. Connect black cables of 04155-61649 to DMM-L.
2. PV4155 sets the HP 3458A as follows:

Function:	OHMF
Auto Zero:	ON
OCOMP:	ON
NPLC:	100

3. PV4155 controls the PGU to force 0 V with 50 Ω output impedance.
4. PV4155 controls the HP 3458A to make 4-wire ohms measurement.
5. PV4155 verifies PGU output impedance setting accuracy.

GNDU Voltage Offset Test

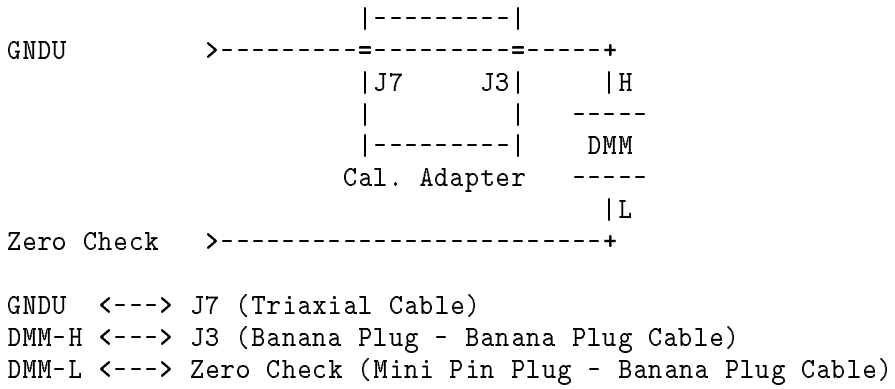
This test verifies the GNDU voltage offset accuracy. This test is executed when the `OFFSET` softkey is selected in GNDU TEST MENU.

Test Equipment

HP 3458A Multimeter
Calibration Adapter (04155-65001)
Triaxial Cable (04155-61641)
Mini Pin Plug - Banana Plug Cable (04155-61648)
Banana Plug - Banana Plug Cable

Test Method

Test Connection:



1. Connect the HP 4155B/4156B/41501B to the HP 3458A (DMM) as shown above.
2. PV4155 sets the HP 3458A as follows:

Function:	DCV
Auto Zero:	ON
NPLC:	100

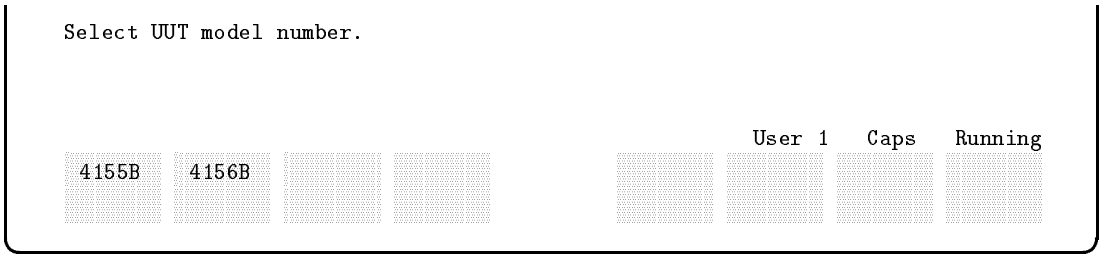
3. PV4155 controls the HP 3458A to make voltage measurement.
4. PV4155 verifies the voltage offset accuracy.

RECONFIG MENU Operation

This section describes how to set up test equipment configurations in RECONFIG MENU before you begin the performance verification tests.

UUT Entry

When the `UUT` softkey is selected in RECONFIG MENU, the following message and softkeys are displayed.



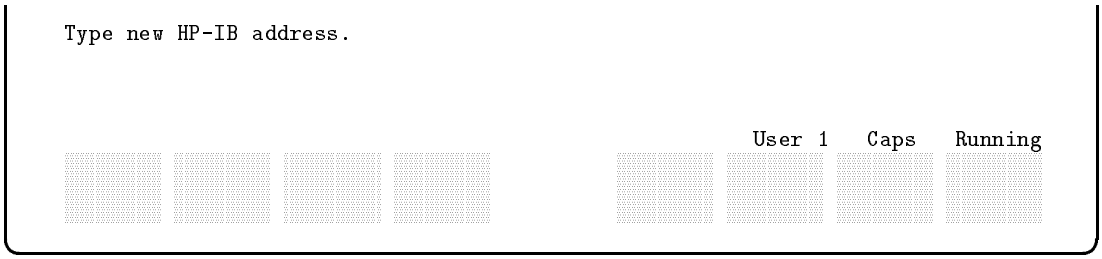
Select the UUT model number (HP 4155B or 4156B) with an appropriate softkey. Then the message `Type new HP-IB address.` is displayed. Enter the HP-IB address of the HP 4155B or 4156B to be tested, then press Return. The RECONFIG MENU is displayed after you enter the address.

HP-IB Address Entry

Select the `3458A ADDR` or `54121T ADDR` softkey in RECONFIG MENU and type the new HP-IB address for the HP 3458A or HP 54121T. Press Return. The range allowed is 700 to 3130. The lower two digits must be 30 or less. The new HP-IB address is displayed.

If you press Return without entering numeric data, the present value is retained.

After pressing Return, RECONFIG MENU is displayed again.



Printer Control Setting Entry

To change your printer control settings, use the following procedure.

1. Select the `PRINTER TYPE` softkey in RECONFIG MENU, then select the `LOCAL` softkey. If you use the SRM, select the `FILE SPOOL` softkey instead of `LOCAL`.

2. If you select the `LOCAL` softkey:

   Select the `PRINTER ADDR` softkey. The message `Type new address.` is displayed. If you use an HP-IB interface printer, enter the new printer address in the range of 700 to 3130. Then select the `HP-IB` softkey.

   If you use an RS-232C interface printer, enter the new printer address in the range of 8 to 31, then select the `RS-232C` softkey, then enter the baud rate of the RS-232C interface. The following values are allowed:

   ```
   50, 75, 110, 134, 150, 200, 300, 600, 1800, 2400, 3200,
   4800, 9600, 19200
   ```

3. If you select the `FILE SPOOL` softkey:

   Select the `SPOOL DIR.` softkey. The message `Enter new spooling directory in double quotations.` is displayed. Enter the new spooling directory. For example, type:

   `"/spool:REMOTE"` (Return)

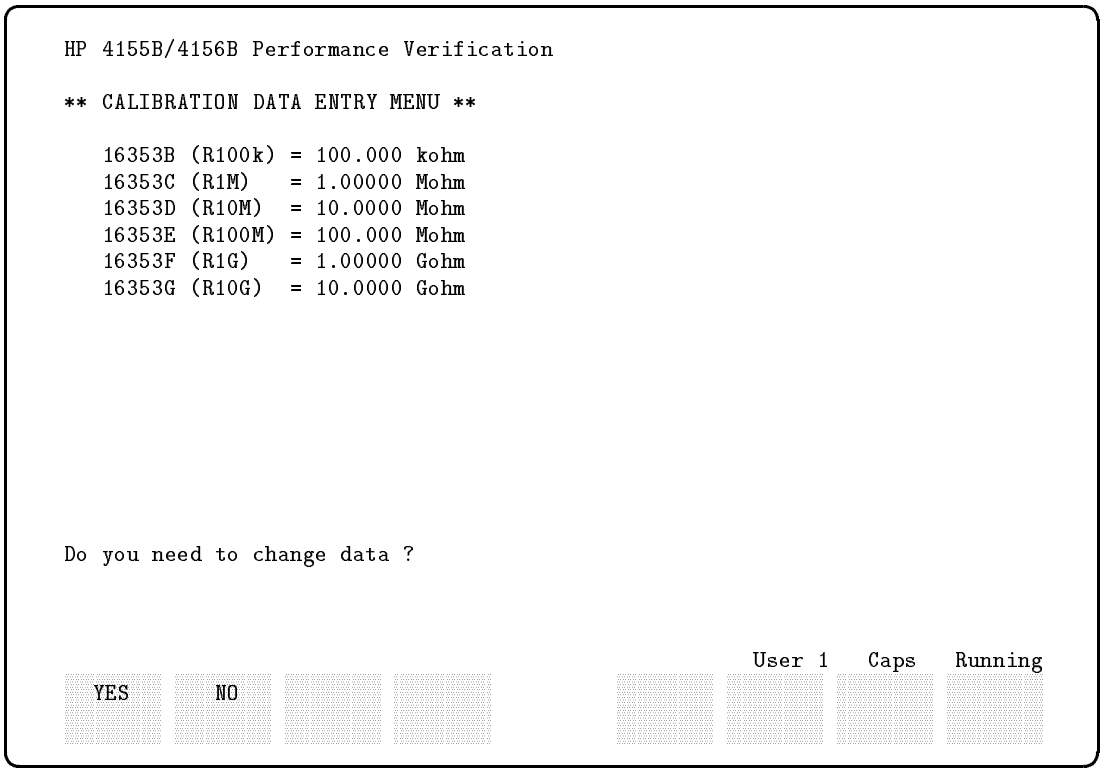
   If you do not enter a volume specifier, the volume specifier of the current mass storage unit is used.

After you have entered all the items, RECONFIG MENU is displayed again.

HP 16353A Calibration Data Entry

To change the HP 16353A Standard Resistor Set Calibration Data, use the following procedure.

1. Select the `16353A DATA` softkey in RECONFIG MENU, the following is displayed:



2. Select the YES softkey. (If you select the NO softkey instead of YES, the RECONFIG MENU is displayed again.)
3. Type in the new calibration data value for the HP 16353B 100 kohm resistor and press Return. Do not enter the k suffix because it is automatically supplied by the program. For example, if you want to enter 100.05 kohm for the 100 kohm resistor value, enter only 100.05, then press Return. Allowable resistor values are within ± 1% of the nominal value.
4. Enter the 1M, 10M, 100M, 1G, and 10 Gohm resistor calibration data values in the same way as in step 3. Do not enter the M or G suffixes.
5. When all data are entered, the message Are you sure? is displayed. If you have entered all the values correctly, then select the YES softkey. To retain the old data, select the NO softkey. The RECONFIG MENU is displayed.

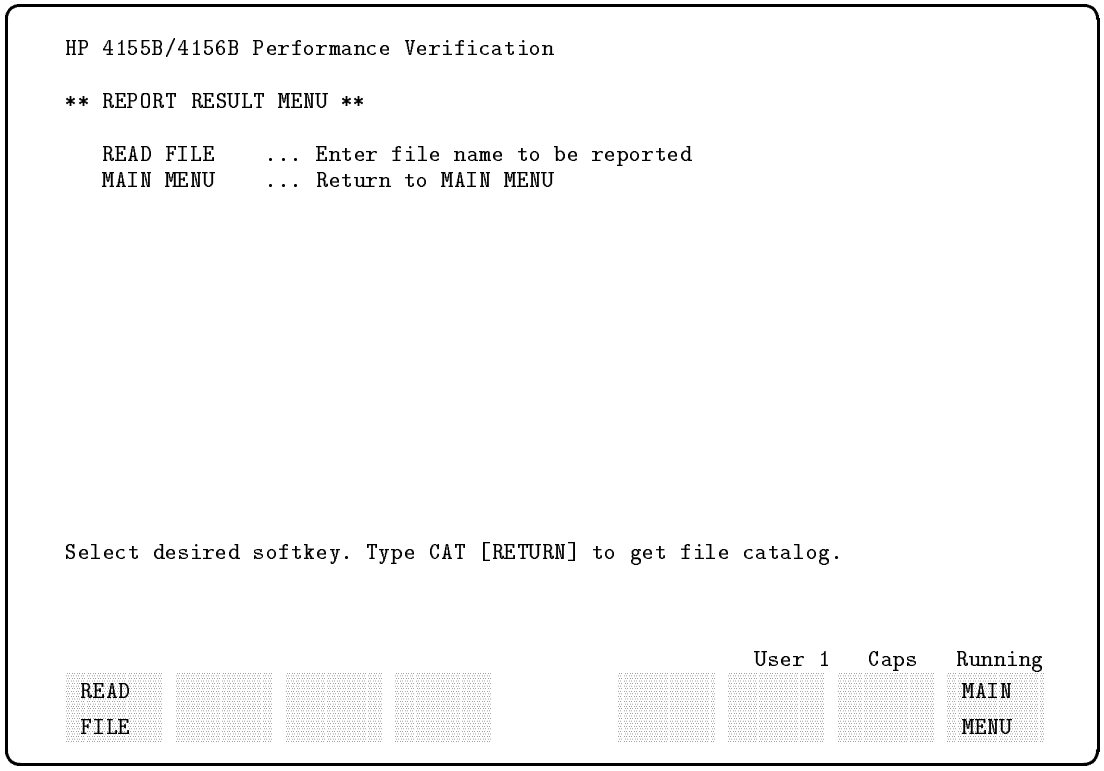
Reporting Test Results

The test results can be printed out by the printer or displayed on the CRT. The instruments are not required to report the test results. To report the test results, use the following procedure:

1. Display the MAIN MENU.
2. Select the `REPORT RESULT` softkey. The `REPORT` program must exist on the working directory or the current mass storage unit. If `REPORT` does not exist on there, the following message is displayed:

   ```
   Insert 'REPORT' into the current mass storage device. Then press CONTINUE.
   ```

3. The REPORT RESULT MENU shown in the following figure is displayed:



Softkey	Function
`READ FILE`	Enables test results to be reported.
`MAIN MENU`	Displays the MAIN MENU.

4. Remove the PV4155 disk, then insert the disk that contains the test results. Execute the `CAT` statement to see the catalog of the disk so that you can confirm the filename of the test result data.
5. Select the `READ FILE` softkey. The following message is displayed:

   ```
   Type file name.  Press RETURN to cancel.
   ```

6. Type the name of the file that you want to report. Then press Return. If you press Return without typing the file name, the REPORT RESULT MENU is displayed again.

   If you want to report the file from the mass storage unit that is not specified as the current mass storage unit, type the mass storage unit specifier after the file name; such as, `PV41550897:,700,1`.

Note

When you perform step 7, the PV4155/REPORT executes the following BASIC statement to use memory volume ":MEMORY,0,15".

```
INITIALIZE ":MEMORY,0.15"
```

If you already use that memory volume, move your data to another memory volume or it will be lost when you perform step 7.

7. Select the desired softkey (`CRT` or `PRINTER`).

   - `CRT` softkey is selected

     The first screen of test results is displayed on the CRT. Select the `MORE` softkey to report the next screen. If all the test results have been displayed, the REPORT RESULT MENU is displayed again.

   - `PRINTER` softkey is selected

     a. `Type report number.` is displayed. If you want to print a report number on the test record, type the report number with maximum 14 characters, then press Return. If not, press Return without typing any characters.

     b. Select the `RECONFIG` softkey. Change the printer control settings to your desired settings. After you finish changing the settings, select the `RETURN` softkey. See "Printer Setting for REPORT RESULT" for the details.

     c. Select the `PRINT` softkey. The test results are printed as the Test Record. During printing, the `CANCEL` softkey is displayed. If you select this key, printing is canceled. When printing is complete, the REPORT RESULT MENU is displayed again.

Note

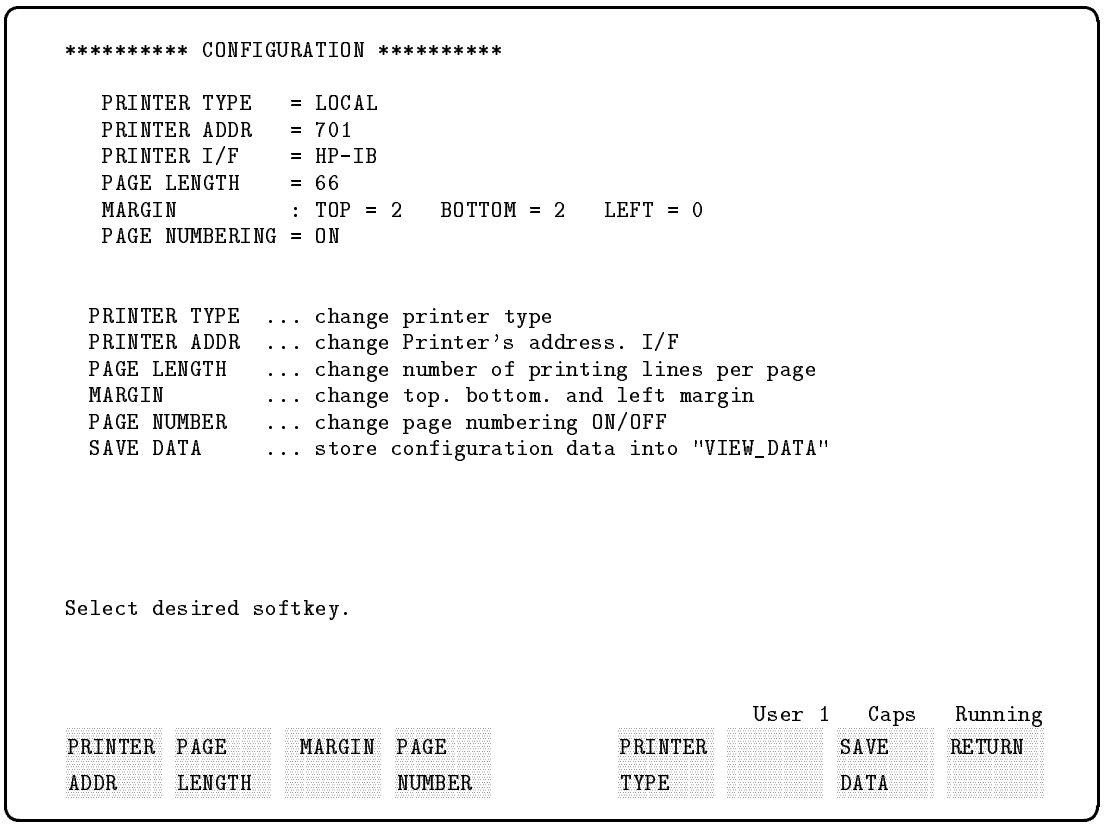
If a test fails, the following characters are printed or displayed on the `Fail` column of the test record.

- If the test result is over the maximum value: `>>>`
- If the test result is under the minimum value: `<<<`

Printer Setting for REPORT RESULT

This section describes how to change the configuration of the printer to print test results using the REPORT RESULT function.

The following is the REPORT RESULT printer configuration page.



Softkey	Function
PRINTER ADDR	(Displayed when PRINTER TYPE is set to LOCAL.) This softkey is for changing the address of the printer (select code and HP-IB address).

SPOOL DIR.	(Displayed when PRINTER TYPE is set to FILE SPOOL.) This softkey is for changing the spool directory of the SRM system.
	After selecting this softkey, the following message appears, and the current spooling command is displayed at the keyboard input line.
	`Enter new spooling directory in double quotations.`
	Enter the new spooling directory. For example,
	`"/spool:REMOTE".`

PAGE LENGTH	For changing the page length (lines/page) of the printer. The allowable range is 17 for disabled PAGE NUMBER (19 for enabled PAGE NUMBER) through 32767.

`MARGIN` For changing the top, bottom, and left margins.

After selecting this softkey, the message `Type new margin (top, bottom, left).` is displayed. Enter the three values, separated by commas. For example, enter: `4,4,2`

The top margin, bottom margin, and page length settings must satisfy the following conditions:

top margin ≥ 0, bottom margin ≥ 0

if `PAGE NUMBER` is enabled, then:

top margin + bottom margin < page length − 6

if `PAGE NUMBER` is disabled, then:

top margin + bottom margin < page length − 8

`PAGE NUMBER` For enabling and disabling page number and test result file name to be printed on the bottom of each page.

`PRINTER TYPE` For changing the printer type. If you select this softkey, the `LOCAL` and `FILE SPOOL` softkeys are displayed for selecting or changing the presently set printer.

`SAVE DATA` For saving or resaving the setting data of REPORT RESULT RECONFIG MENU into the file `VIEW_DATA`.

When you select the `REPORT RESULT` softkey in the MAIN MENU, if the `VIEW_DATA` file is stored in the current mass storage unit, all settings of REPORT RESULT RECONFIG MENU are read from this file. If the `VIEW_DATA` file does not exist, the settings are as follows:

PAGE LENGTH:	66 lines/page
MARGIN:	Top: 2 line, Bottom: 2 line, Left: 0 space
PAGE NUMBERING:	ON
Other settings:	the settings of RECONFIG MENU directly under the START UP MENU.

`RETURN` For returning to the previous menu.

```
================================================================================
          P E R F O R M A N C E    T E S T    R E C O R D
================================================================================
Test Facility:

 Hewlett-Packard                          Report No. ______________________

 _________________________________        Date _____________29 August 1997

 _________________________________        Customer _________________________

 _________________________________        Tested by _____________________MO

                                          Temperature   ________25 degree C

                                          Humidity  ___________________50 %

                                          Line Frequency _______Hz(nominal)


HP 4155B  Semiconductor Parameter Analyzer

 Serial Number: _____________JP10E00104

 Serial Number (HP 41501B): ____JP10E00107

Special Notes:

 ______________________________________________________________________________

 ______________________________________________________________________________

 ______________________________________________________________________________

 ______________________________________________________________________________









*PV415505_2*                     --- 1/   ---
```

Test Record Example (1/18)

Model: HP 4155B Report No.: Date: 29 August 1997

Test Equipment Used:

	Description	Model No.	Trace No.	Cal Due Date
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				

PV415505_2 --- 2/ ---

Test Record Example (2/18)

Model: HP 4155B Report No.: Date: 29 August 1997

TEST DESCRIPTION	Minimum	Results	Maximum	Uncertainty	Fail
ADC Reference Values					
+7V Reference	+6.530 V	+6.945680V	+7.370 V		
-7V Reference	-7.370 V	-6.945430V	-6.530 V		
100 ohm	99.500 ohm	100.1350 ohm	100.500 ohm		
10 kohm	9.950kohm	10.0001kohm	10.050kohm		
1 Mohm	0.995Mohm	999.9850kohm	1.005Mohm		
100 Mohm	99.000Mohm	99.7422Mohm	101.000Mohm		
SMU Accuracy Test					
Voltage Setting Accuracy Test					
SMU 1					
2 V	-2 V	-2.0015 V	-1.99989 V	-1.9985 V	24.5uV
	0 V	-900.0000uV	+50.75178uV	+900.0000uV	3.50uV
	+2 V	+1.9985 V	+1.99992 V	+2.0015 V	24.5uV
20 V	-20 V	-20.0100 V	-20.00000 V	-19.9900 V	630uV
	0 V	-4.0000mV	-705.56239uV	+4.0000mV	230uV
	+20 V	+19.9900 V	+19.99853 V	+20.0100 V	630uV
40 V	-40 V	-40.0190 V	-40.00065 V	-39.9810 V	1.03mV
	0 V	-7.0000mV	+1.04337mV	+7.0000mV	230uV
	+40 V	+39.9810 V	+39.99672 V	+40.0190 V	1.03mV
100 V	-100 V	-100.0550 V	-99.99665 V	-99.9450 V	2.23mV
	0 V	-15.0000mV	+1.71649mV	+15.0000mV	230uV
	+100 V	+99.9450 V	+99.99264 V	+100.0550 V	2.23mV
SMU 5					
2 V	-2 V	-2.0015 V	-2.00000 V	-1.9985 V	24.5uV
	0 V	-900.0000uV	+9.56363uV	+900.0000uV	3.50uV
	+2 V	+1.9985 V	+1.99990 V	+2.0015 V	24.5uV
20 V	-20 V	-20.0100 V	-19.99963 V	-19.9900 V	630uV
	0 V	-4.0000mV	-48.74047uV	+4.0000mV	230uV

PV415505_2 --- 3/ ---

Test Record Example (3/18)

Model: HP 4155B Report No.: Date: 29 August 1997

TEST DESCRIPTION			Minimum	Results	Maximum	Uncertainty	Fail
		+20 V	+19.9900 V	+19.99897 V	+20.0100 V	630uV	
	40 V	-40 V	-40.0190 V	-39.99961 V	-39.9810 V	1.03mV	
		0 V	-7.0000mV	+103.05968uV	+7.0000mV	230uV	
		+40 V	+39.9810 V	+39.99889 V	+40.0190 V	1.03mV	
	100 V	-100 V	-100.0550 V	-100.00078 V	-99.9450 V	2.23mV	
		0 V	-15.0000mV	+543.04521uV	+15.0000mV	230uV	
		+100 V	+99.9450 V	+99.99575 V	+100.0550 V	2.23mV	
	200 V	-200 V	-200.1200 V	-199.98559 V	-199.8800 V	4.78mV	
		0 V	-30.0000mV	+1.32519mV	+30.0000mV	780uV	
		+200 V	+199.8800 V	+199.98248 V	+200.1200 V	4.78mV	

Voltage Measurement Accuracy Test

SMU 1							
	2 V	-2 V	-2.0010 V	-1.99995 V	-1.9988 V	24.5uV	
		0 V	-649.2482uV	+24.00000uV	+750.7518uV	3.50uV	
		+2 V	+1.9988 V	+1.99996 V	+2.0010 V	24.5uV	
	20 V	-20 V	-20.0060 V	-20.00002 V	-19.9940 V	630uV	
		0 V	-2.7056mV	-700.00000uV	+1.2944mV	230uV	
		+20 V	+19.9925 V	+19.99880 V	+20.0045 V	630uV	
	40 V	-40 V	-40.0117 V	-40.00096 V	-39.9897 V	1.03mV	
		0 V	-1.9566mV	+1.04000mV	+4.0434mV	230uV	
		+40 V	+39.9857 V	+39.99748 V	+40.0077 V	1.03mV	
	100 V	-100 V	-100.0317 V	-99.99790 V	-99.9616 V	2.23mV	
		0 V	-3.2835mV	+1.50000mV	+6.7165mV	230uV	
		+100 V	+99.9576 V	+99.99480 V	+100.0276 V	2.23mV	
SMU 5							

PV415505_2 --- 4/ ---

Test Record Example (4/18)

Model: HP 4155B Report No.: Date: 29 August 1997

TEST DESCRIPTION		Minimum	Results	Maximum	Uncertainty	Fail
2 V	-2 V	-2.0011 V	-2.00004 V	-1.9989 V	24.5uV	
	0 V	-690.4364uV	-2.00000uV	+709.5636uV	3.50uV	
	+2 V	+1.9988 V	+1.99993 V	+2.0010 V	24.5uV	
20 V	-20 V	-20.0056 V	-20.00028 V	-19.9936 V	630uV	
	0 V	-2.0487mV	-160.00000uV	+1.9513mV	230uV	
	+20 V	+19.9930 V	+19.99934 V	+20.0050 V	630uV	
40 V	-40 V	-40.0106 V	-40.00112 V	-39.9886 V	1.03mV	
	0 V	-2.8969mV	-120.00000uV	+3.1031mV	230uV	
	+40 V	+39.9879 V	+39.99952 V	+40.0099 V	1.03mV	
100 V	-100 V	-100.0358 V	-100.00620 V	-99.9658 V	2.23mV	
	0 V	-4.4570mV	-100.00000uV	+5.5430mV	230uV	
	+100 V	+99.9608 V	+99.99770 V	+100.0308 V	2.23mV	
200 V	-200 V	-200.0656 V	-200.00140 V	-199.9056 V	4.78mV	
	0 V	-8.6748mV	+400.00000uV	+11.3252mV	780uV	
	+200 V	+199.9025 V	+199.98560 V	+200.0625 V	4.78mV	

Guard Potential Offset Test

SMU 1					
	-1.0000mV	-47.6024uV	+1.0000mV		
SMU 5					
	-1.0000mV	+301.2426uV	+1.0000mV		

Current Setting Accuracy Test

SMU 1						
100mA	-100mA	-100.1700mA	-100.00530mA	-99.8300mA	5.50uA	
	-10mA	-10.0620mA	-10.00581mA	-9.9380mA	1.45uA	
	+10mA	+9.9380mA	+9.99513mA	+10.0620mA	1.45uA	
	+100mA	+99.8300mA	+100.00448mA	+100.1700mA	5.50uA	

PV415505_2 --- 5/ ---

Test Record Example (5/18)

Model: HP 4155B Report No.: Date: 29 August 1997

		TEST DESCRIPTION	Minimum	Results	Maximum	Uncertainty	Fail
10mA	-10mA		-10.0160mA	-10.00051mA	-9.9840mA	400nA	
	-1mA		-1.0052mA	-999.58376uA	-994.8000uA	130nA	
	+1mA		+994.8000uA	+1.00006mA	+1.0052mA	130nA	
	+10mA		+9.9840mA	+10.00079mA	+10.0160mA	400nA	
1mA	-1mA		-1.0017mA	-1.00012mA	-998.3000uA	40.0nA	
	-100uA		-100.6200uA	-99.98422uA	-99.3800uA	13.0nA	
	+100uA		+99.3800uA	+99.96634uA	+100.6200uA	13.0nA	
	+1mA		+998.3000uA	+1.00001mA	+1.0017mA	40.0nA	
100uA	-100uA		-100.1600uA	-100.00523uA	-99.8400uA	4.30nA	
	-10uA		-10.0520uA	-9.99964uA	-9.9480uA	1.60nA	
	+10uA		+9.9480uA	+9.99497uA	+10.0520uA	1.60nA	
	+100uA		+99.8400uA	+100.00894uA	+100.1600uA	4.30nA	
10uA	-10uA		-10.0170uA	-10.00065uA	-9.9830uA	921pA	
	-1uA		-1.0062uA	-999.87760nA	-993.8000nA	270pA	
	+1uA		+993.8000nA	+1.00019uA	+1.0062uA	270pA	
	+10uA		+9.9830uA	+9.99976uA	+10.0170uA	921pA	
1uA	-1uA		-1.0016uA	-1.00005uA	-998.4000nA	139pA	
	-100nA		-100.5200nA	-99.99182nA	-99.4800nA	29.6pA	
	+100nA		+99.4800nA	+100.02544nA	+100.5200nA	29.6pA	
	+1uA		+998.4000nA	+1.00007uA	+1.0016uA	139pA	
100nA	-100nA		-100.1700nA	-100.00247nA	-99.8300nA	16.2pA	
	-10nA		-10.0620nA	-9.99463nA	-9.9380nA	3.01pA	
	+10nA		+9.9380nA	+10.00545nA	+10.0620nA	3.01pA	
	+100nA		+99.8300nA	+100.00309nA	+100.1700nA	16.2pA	
10nA	-10nA		-10.0570nA	-10.00122nA	-9.9430nA	8.76pA	

PV415505_2 --- 6/ ---

Test Record Example (6/18)

Model: HP 4155B Report No.: Date: 29 August 1997

TEST DESCRIPTION		Minimum	Results	Maximum	Uncertainty	Fail
	-1nA	-1.0120nA	-999.71140pA	-988.0000pA	918fA	
	+1nA	+988.0000pA	+999.99285pA	+1.0120nA	918fA	
	+10nA	+9.9430nA	+10.00051nA	+10.0570nA	8.76pA	
1nA	-1nA	-1.0080nA	-1.00029nA	-992.0000pA	866fA	
	-100pA	-103.5000pA	-100.04202pA	-96.5000pA	90.6fA	
	+100pA	+96.5000pA	+100.06566pA	+103.5000pA	90.6fA	
	+1nA	+992.0000pA	+1.00028nA	+1.0080nA	866fA	
SMU 5						
1 A	-1 A	-1.0055 A	-1.00119 A	-994.5000mA	140uA	
	-100mA	-101.0000mA	-100.10671mA	-99.0000mA	32.0uA	
	+100mA	+99.0000mA	+100.05403mA	+101.0000mA	32.0uA	
	+1 A	+994.5000mA	+1.00116 A	+1.0055 A	140uA	
100mA	-100mA	-100.1700mA	-100.00291mA	-99.8300mA	5.50uA	
	-10mA	-10.0620mA	-9.99768mA	-9.9380mA	1.45uA	
	+10mA	+9.9380mA	+9.99840mA	+10.0620mA	1.45uA	
	+100mA	+99.8300mA	+100.00657mA	+100.1700mA	5.50uA	
10mA	-10mA	-10.0160mA	-9.99981mA	-9.9840mA	400nA	
	-1mA	-1.0052mA	-999.84708uA	-994.8000uA	130nA	
	+1mA	+994.8000uA	+999.91061uA	+1.0052mA	130nA	
	+10mA	+9.9840mA	+10.00012mA	+10.0160mA	400nA	
1mA	-1mA	-1.0017mA	-1.00010mA	-998.3000uA	40.0nA	
	-100uA	-100.6200uA	-100.06618uA	-99.3800uA	13.0nA	
	+100uA	+99.3800uA	+100.04492uA	+100.6200uA	13.0nA	
	+1mA	+998.3000uA	+1.00010mA	+1.0017mA	40.0nA	
100uA	-100uA	-100.1600uA	-99.99506uA	-99.8400uA	4.30nA	

PV415505_2 --- 7/ ---

Test Record Example (7/18)

Model: HP 4155B Report No.: Date: 29 August 1997

	TEST DESCRIPTION	Minimum	Results	Maximum	Uncertainty	Fail
		-10uA	-10.0520uA	-10.00100uA	-9.9480uA	1.60nA	
		+10uA	+9.9480uA	+10.00097uA	+10.0520uA	1.60nA	
		+100uA	+99.8400uA	+99.99751uA	+100.1600uA	4.30nA	
	10uA	-10uA	-10.0170uA	-10.00012uA	-9.9830uA	921pA	
		-1uA	-1.0062uA	-1.00079uA	-993.8000nA	270pA	
		+1uA	+993.8000nA	+999.54388nA	+1.0062uA	270pA	
		+10uA	+9.9830uA	+10.00010uA	+10.0170uA	921pA	
	1uA	-1uA	-1.0016uA	-1.00004uA	-998.4000nA	139pA	
		-100nA	-100.5200nA	-100.02133nA	-99.4800nA	29.6pA	
		+100nA	+99.4800nA	+100.00007nA	+100.5200nA	29.6pA	
		+1uA	+998.4000nA	+1.00004uA	+1.0016uA	139pA	
	100nA	-100nA	-100.1700nA	-100.00745nA	-99.8300nA	16.2pA	
		-10nA	-10.0620nA	-10.00458nA	-9.9380nA	3.01pA	
		+10nA	+9.9380nA	+9.99986nA	+10.0620nA	3.01pA	
		+100nA	+99.8300nA	+99.99597nA	+100.1700nA	16.2pA	
	10nA	-10nA	-10.0570nA	-9.99833nA	-9.9430nA	8.76pA	
		-1nA	-1.0120nA	-999.61627pA	-988.0000pA	918fA	
		+1nA	+988.0000pA	+999.20115pA	+1.0120nA	918fA	
		+10nA	+9.9430nA	+9.99815nA	+10.0570nA	8.76pA	
	1nA	-1nA	-1.0080nA	-1.00017nA	-992.0000pA	866fA	
		-100pA	-103.5000pA	-100.08707pA	-96.5000pA	90.6fA	
		+100pA	+96.5000pA	+99.91737pA	+103.5000pA	90.6fA	
		+1nA	+992.0000pA	+999.89926pA	+1.0080nA	866fA	

Current Measurement Accuracy Test

SMU 1	

PV415505_2 --- 8/ ---

Test Record Example (8/18)

Model: HP 4155B Report No.: Date: 29 August 1997

TEST DESCRIPTION		Minimum	Results	Maximum	Uncertainty	Fail
100mA	-100mA	-100.1353mA	-100.00360mA	-99.8753mA	5.50uA	
	-10mA	-10.0458mA	-10.00580mA	-9.9658mA	1.45uA	
	+10mA	+9.9551mA	+9.99490mA	+10.0351mA	1.45uA	
	+100mA	+99.8745mA	+100.00070mA	+100.1345mA	5.50uA	
10mA	-10mA	-10.0125mA	-10.00044mA	-9.9885mA	400nA	
	-1mA	-1.0026mA	-999.57000uA	-996.5838uA	130nA	
	+1mA	+997.0594uA	+1.00007mA	+1.0031mA	130nA	
	+10mA	+9.9888mA	+10.00074mA	+10.0128mA	400nA	
1mA	-1mA	-1.0014mA	-1.00010mA	-998.8175uA	40.0nA	
	-100uA	-100.3842uA	-99.97800uA	-99.5842uA	13.0nA	
	+100uA	+99.5663uA	+99.96300uA	+100.3663uA	13.0nA	
	+1mA	+998.7055uA	+999.97300uA	+1.0013mA	40.0nA	
100uA	-100uA	-100.1252uA	-100.00470uA	-99.8852uA	4.30nA	
	-10uA	-10.0296uA	-9.99920uA	-9.9696uA	1.60nA	
	+10uA	+9.9650uA	+9.99520uA	+10.0250uA	1.60nA	
	+100uA	+99.8889uA	+100.00820uA	+100.1289uA	4.30nA	
10uA	-10uA	-10.0136uA	-10.00085uA	-9.9876uA	921pA	
	-1uA	-1.0039uA	-999.94000nA	-995.8776nA	270pA	
	+1uA	+996.1893nA	+1.00014uA	+1.0042uA	270pA	
	+10uA	+9.9868uA	+9.99982uA	+10.0128uA	921pA	
1uA	-1uA	-1.0013uA	-1.00005uA	-998.8535nA	139pA	
	-100nA	-100.2918nA	-99.99200nA	-99.6918nA	29.6pA	
	+100nA	+99.7254nA	+100.01800nA	+100.3254nA	29.6pA	
	+1uA	+998.8720nA	+1.00004uA	+1.0013uA	139pA	
100nA	-100nA	-100.1325nA	-100.00450nA	-99.8725nA	16.2pA	

PV415505_2 --- 9/ ---

Test Record Example (9/18)

Model: HP 4155B Report No.: Date: 29 August 1997

		TEST DESCRIPTION	Minimum	Results	Maximum	Uncertainty	Fail
		-10nA	-10.0346nA	-9.99720nA	-9.9546nA	3.01pA	
		+10nA	+9.9654nA	+10.00220nA	+10.0454nA	3.01pA	
		+100nA	+99.8731nA	+99.99870nA	+100.1331nA	16.2pA	
	10nA	-10nA	-10.0562nA	-10.00092nA	-9.9462nA	8.76pA	
		-1nA	-1.0097nA	-999.70000pA	-989.7114pA	918fA	
		+1nA	+989.9929pA	+999.92000pA	+1.0100nA	918fA	
		+10nA	+9.9455nA	+9.99999nA	+10.0555nA	8.76pA	
	1nA	-1nA	-1.0083nA	-1.00008nA	-992.2874pA	866fA	
		-100pA	-103.5420pA	-100.01500pA	-96.5420pA	90.6fA	
		+100pA	+96.5657pA	+100.03800pA	+103.5657pA	90.6fA	
		+1nA	+992.2826pA	+1.00009nA	+1.0083nA	866fA	
SMU 5							
	1 A	-1 A	-1.0065 A	-1.00006 A	-995.8865mA	140uA	
		-100mA	-100.9067mA	-99.98400mA	-99.3067mA	32.0uA	
		+100mA	+99.2540mA	+99.95300mA	+100.8540mA	32.0uA	
		+1 A	+995.8575mA	+1.00004 A	+1.0065 A	140uA	
	100mA	-100mA	-100.1329mA	-100.00210mA	-99.8729mA	5.50uA	
		-10mA	-10.0377mA	-9.99860mA	-9.9577mA	1.45uA	
		+10mA	+9.9584mA	+9.99670mA	+10.0384mA	1.45uA	
		+100mA	+99.8766mA	+100.00220mA	+100.1366mA	5.50uA	
	10mA	-10mA	-10.0118mA	-9.99971mA	-9.9878mA	400nA	
		-1mA	-1.0028mA	-999.82000uA	-996.8471uA	130nA	
		+1mA	+996.9106uA	+999.89000uA	+1.0029mA	130nA	
		+10mA	+9.9881mA	+9.99993mA	+10.0121mA	400nA	
	1mA	-1mA	-1.0014mA	-1.00006mA	-998.7977uA	40.0nA	

PV415505_2 --- 10/ ---

Test Record Example (10/18)

Model: HP 4155B Report No.: Date: 29 August 1997

	TEST DESCRIPTION	Minimum	Results	Maximum	Uncertainty	Fail
	-100uA	-100.4662uA	-100.05700uA	-99.6662uA	13.0nA	
	+100uA	+99.6449uA	+100.03800uA	+100.4449uA	13.0nA	
	+1mA	+998.7995uA	+1.00005mA	+1.0014mA	40.0nA	
100uA	-100uA	-100.1151uA	-99.99540uA	-99.8751uA	4.30nA	
	-10uA	-10.0310uA	-10.00060uA	-9.9710uA	1.60nA	
	+10uA	+9.9710uA	+10.00120uA	+10.0310uA	1.60nA	
	+100uA	+99.8775uA	+99.99660uA	+100.1175uA	4.30nA	
10uA	-10uA	-10.0131uA	-10.00049uA	-9.9871uA	921pA	
	-1uA	-1.0048uA	-1.00080uA	-996.7852nA	270pA	
	+1uA	+995.5439nA	+999.52000nA	+1.0035uA	270pA	
	+10uA	+9.9871uA	+10.00032uA	+10.0131uA	921pA	
1uA	-1uA	-1.0012uA	-1.00003uA	-998.8376nA	139pA	
	-100nA	-100.3213nA	-100.01700nA	-99.7213nA	29.6pA	
	+100nA	+99.7001nA	+100.00100nA	+100.3001nA	29.6pA	
	+1uA	+998.8427nA	+1.00003uA	+1.0012uA	139pA	
100nA	-100nA	-100.1375nA	-100.00550nA	-99.8775nA	16.2pA	
	-10nA	-10.0446nA	-10.00200nA	-9.9646nA	3.01pA	
	+10nA	+9.9599nA	+10.00180nA	+10.0399nA	3.01pA	
	+100nA	+99.8660nA	+99.99750nA	+100.1260nA	16.2pA	
10nA	-10nA	-10.0533nA	-10.00066nA	-9.9433nA	8.76pA	
	-1nA	-1.0096nA	-999.78000pA	-989.6163pA	918fA	
	+1nA	+989.2011pA	+999.48000pA	+1.0092nA	918fA	
	+10nA	+9.9431nA	+10.00049nA	+10.0531nA	8.76pA	
1nA	-1nA	-1.0082nA	-1.00010nA	-992.1712pA	866fA	
	-100pA	-103.5871pA	-99.99800pA	-96.5871pA	90.6fA	

PV415505_2 --- 11/ ---

Test Record Example (11/18)

Model: HP 4155B Report No.: Date: 29 August 1997

TEST DESCRIPTION		Minimum	Results	Maximum	Uncertainty	Fail
	+100pA	+96.4174pA	+99.96100pA	+103.4174pA	90.6fA	
	+1nA	+991.8993pA	+999.98200pA	+1.0079nA	866fA	
CMR Accuracy Test						
SMU 1		-4.0000uA	+4.1000nA	+4.0000uA		
SMU 5		-8.0000uA	+4.0000nA	+8.0000uA		
VSU/VMU Accuracy Test						
Voltage Setting Accuracy Test						
VSU 1						
20 V	-20 V	-20.0200 V	-20.00073 V	-19.9800 V	480uV	
	0 V	-10.0000mV	-105.55542uV	+10.0000mV	80.0uV	
	+20 V	+19.9800 V	+20.00042 V	+20.0200 V	480uV	
VSU 2						
20 V	-20 V	-20.0200 V	-20.00008 V	-19.9800 V	480uV	
	0 V	-10.0000mV	+933.70304uV	+10.0000mV	80.0uV	
	+20 V	+19.9800 V	+20.00012 V	+20.0200 V	480uV	
Voltage Measurement Accuracy Test						
VMU 1						
2 V	-2 V	-2.0003 V	-1.99967 V	-1.9991 V	23.5uV	
	0 V	-346.3294uV	-130.00000uV	+53.6706uV	2.50uV	
	+2 V	+2.0004 V	+2.00101 V	+2.0016 V	23.5uV	
20 V	-20 V	-20.0057 V	-20.00102 V	-19.9957 V	480uV	
	0 V	-1.1056mV	-80.00000uV	+894.4446uV	80.0uV	
	+20 V	+19.9954 V	+20.00096 V	+20.0054 V	480uV	
VMU 2						

PV415505_2 --- 12/ ---

Test Record Example (12/18)

Model: HP 4155B Report No.: Date: 29 August 1997

TEST DESCRIPTION		Minimum	Results	Maximum	Uncertainty	Fail
2 V	-2 V	-2.0000 V	-1.99943 V	-1.9988 V	23.5uV	
	0 V	+708.6475uV	+914.00000uV	+1.1086mV	2.50uV	
	+2 V	+1.9993 V	+1.99990 V	+2.0005 V	23.5uV	
20 V	-20 V	-20.0051 V	-20.00022 V	-19.9951 V	480uV	
	0 V	-66.2970uV	+940.00000uV	+1.9337mV	80.0uV	
	+20 V	+19.9951 V	+20.00058 V	+20.0051 V	480uV	

Differential Voltage Measurement Accuracy Test

VMU 1 / VMU 2						
.2 V	-.2 V	-200.9377mV	-200.78020mV	-200.6177mV	12.6uV	
	0.0 V	-482.0271uV	-371.00000uV	-282.0271uV	11.0uV	
	+.2 V	+199.8567mV	+200.03600mV	+200.1768mV	12.6uV	
2.0 V	-2.0 V	-2.0005 V	-1.99994 V	-1.9993 V	28.0uV	
	0.0 V	-576.8248uV	-364.00000uV	-176.8248uV	12.0uV	
	+2.0 V	+1.9994 V	+1.99999 V	+2.0006 V	28.0uV	

VMU CMR Accuracy Test

VMU 1 / VMU 2					
	-520.0000uV	-6.60000uV	+520.0000uV		

GNDU Accuracy Test					
	-100.0000uV	-21.83952uV	+100.0000uV		

PGU Accuracy Test

DC Voltage Setting Accuracy Test

PGU 1					
-40 V	-40.4500 V	-39.99809 V	-39.5500 V	1.03mV	
-21 V	-21.2600 V	-20.99683 V	-20.7400 V	650uV	
-20 V	-20.2500 V	-19.99956 V	-19.7500 V	630uV	
+0 V	-50.0000mV	-2.95538mV	+50.0000mV	230uV	

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Test Record Example (13/18)

Model: HP 4155B Report No.: Date: 29 August 1997

TEST DESCRIPTION	Minimum	Results	Maximum	Uncertainty	Fail
+20 V	+19.7500 V	+19.99171 V	+20.2500 V	630uV	
+21 V	+20.7400 V	+20.99593 V	+21.2600 V	650uV	
+40 V	+39.5500 V	+39.99614 V	+40.4500 V	1.03mV	
PGU 2					
-40 V	-40.4500 V	-39.99650 V	-39.5500 V	1.03mV	
-21 V	-21.2600 V	-20.99476 V	-20.7400 V	650uV	
-20 V	-20.2500 V	-19.99681 V	-19.7500 V	630uV	
+0 V	-50.0000mV	+401.25438uV	+50.0000mV	230uV	
+20 V	+19.7500 V	+20.00182 V	+20.2500 V	630uV	
+21 V	+20.7400 V	+21.00346 V	+21.2600 V	650uV	
+40 V	+39.5500 V	+40.00407 V	+40.4500 V	1.03mV	
Pulse Level Setting Accuracy Test					
PGU 1					
-40.0 V	-41.2500 V	-39.86469 V	-38.7500 V	1.06mV	
0 V	-450.0000mV	-1.10224mV	+450.0000mV	230uV	
-21.0 V	-21.6800 V	-21.01707 V	-20.3200 V	689uV	
0 V	-260.0000mV	-48.47739mV	+260.0000mV	230uV	
-20.0 V	-20.6500 V	-19.93342 V	-19.3500 V	671uV	
0 V	-250.0000mV	-6.59274mV	+250.0000mV	230uV	
-2.1 V	-2.2130 V	-2.08943 V	-1.9870 V	356uV	
0 V	-71.0000mV	-13.83999mV	+71.0000mV	230uV	
-2.0 V	-2.1100 V	-1.99314 V	-1.8900 V	355uV	
0 V	-70.0000mV	-9.03794mV	+70.0000mV	230uV	
-.1 V	-153.0000mV	-98.91485mV	-47.0000mV	327uV	
0 V	-51.0000mV	-8.86834mV	+51.0000mV	230uV	
+.1 V	+47.0000mV	+101.59034mV	+153.0000mV	327uV	
0 V	-51.0000mV	-8.69750mV	+51.0000mV	230uV	
+2.0 V	+1.8900 V	+1.99046 V	+2.1100 V	355uV	
0 V	-70.0000mV	-9.29890mV	+70.0000mV	230uV	

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Test Record Example (14/18)

Model: HP 4155B Report No.: Date: 29 August 1997

TEST DESCRIPTION	Minimum	Results	Maximum	Uncertainty	Fail
+2.1 V	+1.9870 V	+2.11849 V	+2.2130 V	356uV	
0 V	-71.0000mV	-10.58817mV	+71.0000mV	230uV	
+20.0 V	+19.3500 V	+19.89713 V	+20.6500 V	671uV	
0 V	-250.0000mV	-15.42753mV	+250.0000mV	230uV	
+21.0 V	+20.3200 V	+21.05015 V	+21.6800 V	689uV	
0 V	-260.0000mV	-24.77102mV	+260.0000mV	230uV	
+40.0 V	+38.7500 V	+39.80732 V	+41.2500 V	1.06mV	
0 V	-450.0000mV	-21.03900mV	+450.0000mV	230uV	
PGU 2					
-40.0 V	-41.2500 V	-39.86177 V	-38.7500 V	1.06mV	
0 V	-450.0000mV	-7.53657mV	+450.0000mV	230uV	
-21.0 V	-21.6800 V	-21.02302 V	-20.3200 V	689uV	
0 V	-260.0000mV	-38.62961mV	+260.0000mV	230uV	
-20.0 V	-20.6500 V	-19.93271 V	-19.3500 V	671uV	
0 V	-250.0000mV	-3.12482mV	+250.0000mV	230uV	
-2.1 V	-2.2130 V	-2.09320 V	-1.9870 V	356uV	
0 V	-71.0000mV	-5.12325mV	+71.0000mV	230uV	
-2.0 V	-2.1100 V	-1.99300 V	-1.8900 V	355uV	
0 V	-70.0000mV	-4.90303mV	+70.0000mV	230uV	
-.1 V	-153.0000mV	-98.77918mV	-47.0000mV	327uV	
0 V	-51.0000mV	-4.33686mV	+51.0000mV	230uV	
+.1 V	+47.0000mV	+101.39969mV	+153.0000mV	327uV	
0 V	-51.0000mV	-4.04473mV	+51.0000mV	230uV	
+2.0 V	+1.8900 V	+1.99095 V	+2.1100 V	355uV	
0 V	-70.0000mV	-2.07447mV	+70.0000mV	230uV	
+2.1 V	+1.9870 V	+2.11665 V	+2.2130 V	356uV	
0 V	-71.0000mV	+1.51230mV	+71.0000mV	230uV	
+20.0 V	+19.3500 V	+19.89383 V	+20.6500 V	671uV	
0 V	-250.0000mV	+18.73880mV	+250.0000mV	230uV	
+21.0 V	+20.3200 V	+21.03593 V	+21.6800 V	689uV	
0 V	-260.0000mV	+18.31570mV	+260.0000mV	230uV	
+40.0 V	+38.7500 V	+39.79345 V	+41.2500 V	1.06mV	
0 V	-450.0000mV	+38.07629mV	+450.0000mV	230uV	

Test Record Example (15/18)

Model: HP 4155B Report No.: Date: 29 August 1997

TEST DESCRIPTION		Minimum	Results	Maximum	Uncertainty	Fail
Period Setting Accuracy Test						
PGU 1						
	2us	+1.9580us	+2.00037us	+2.0420us	8.25ns	
	2 s	+1.9600 s	+1.99997 s	+2.0400 s	8.25ms	
PGU 2						
	2us	+1.9580us	+2.00025us	+2.0420us	8.25ns	
	2 s	+1.9600 s	+1.99992 s	+2.0400 s	8.25ms	
Width Setting Accuracy Test						
PGU 1						
	1us	+968.0000ns	+1.00415us	+1.0320us	4.58ns	
	1 s	+970.0000ms	+999.99100ms	+1.0300 s	4.12ms	
PGU 2						
	1us	+968.0000ns	+1.00322us	+1.0320us	4.58ns	
	1 s	+970.0000ms	+1.00000 s	+1.0300 s	4.12ms	
Leading Edge Setting Accuracy Test						
PGU 1						
	100ns	+85.0000ns	+98.72360ns	+115.0000ns	1.08ns	
	1us	+940.0000ns	+987.55700ns	+1.0600us	10.8ns	
	1.01us	+949.5000ns	+1.00974us	+1.0705us	10.9ns	
	10us	+9.4900us	+9.97186us	+10.5100us	108ns	
	10.1us	+9.5850us	+10.16050us	+10.6150us	109ns	
	100us	+94.9900us	+99.72110us	+105.0100us	1.08us	
	101us	+95.9400us	+101.10900us	+106.0600us	1.09us	
	1ms	+949.9900us	+995.52100us	+1.0500ms	10.8us	
	1.01ms	+959.4900us	+1.01547ms	+1.0605ms	10.9us	

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Test Record Example (16/18)

Model: HP 4155B Report No.: Date: 29 August 1997

TEST DESCRIPTION	Minimum	Results	Maximum	Uncertainty	Fail
10ms	+9.5000ms	+10.04330ms	+10.5000ms	108us	
PGU 2					
100ns	+85.0000ns	+100.27900ns	+115.0000ns	1.08ns	
1us	+940.0000ns	+1.02001us	+1.0600us	10.8ns	
1.01us	+949.5000ns	+1.02032us	+1.0705us	10.9ns	
10us	+9.4900us	+9.98580us	+10.5100us	108ns	
10.1us	+9.5850us	+10.09180us	+10.6150us	109ns	
100us	+94.9900us	+99.25040us	+105.0100us	1.08us	
101us	+95.9400us	+101.04100us	+106.0600us	1.09us	
1ms	+949.9900us	+995.59700us	+1.0500ms	10.8us	
1.01ms	+959.4900us	+1.01775ms	+1.0605ms	10.9us	
10ms	+9.5000ms	+10.01160ms	+10.5000ms	108us	
Trailing Edge Setting Accuracy Test					
PGU 1					
100ns	+85.0000ns	+99.00080ns	+115.0000ns	1.08ns	
1us	+940.0000ns	+987.81000ns	+1.0600us	10.8ns	
1.01us	+949.5000ns	+1.01238us	+1.0705us	10.9ns	
10us	+9.4900us	+9.94295us	+10.5100us	108ns	
10.1us	+9.5850us	+10.15780us	+10.6150us	109ns	
100us	+94.9900us	+99.65870us	+105.0100us	1.08us	
101us	+95.9400us	+101.42200us	+106.0600us	1.09us	
1ms	+949.9900us	+996.03700us	+1.0500ms	10.8us	
1.01ms	+959.4900us	+1.02289ms	+1.0605ms	10.9us	
10ms	+9.5000ms	+9.98692ms	+10.5000ms	108us	
PGU 2					

PV415505_2 --- 17/ ---

Test Record Example (17/18)

Model: HP 4155B Report No.: Date: 29 August 1997

TEST DESCRIPTION	Minimum	Results	Maximum	Uncertainty	Fail
100ns	+85.0000ns	+100.71300ns	+115.0000ns	1.08ns	
1us	+940.0000ns	+1.02505us	+1.0600us	10.8ns	
1.01us	+949.5000ns	+1.01607us	+1.0705us	10.9ns	
10us	+9.4900us	+10.03520us	+10.5100us	108ns	
10.1us	+9.5850us	+10.07840us	+10.6150us	109ns	
100us	+94.9900us	+99.62730us	+105.0100us	1.08us	
101us	+95.9400us	+101.13000us	+106.0600us	1.09us	
1ms	+949.9900us	+1.00062ms	+1.0500ms	10.8us	
1.01ms	+959.4900us	+1.01108ms	+1.0605ms	10.9us	
10ms	+9.5000ms	+10.08360ms	+10.5000ms	108us	
Delay Time Setting Accuracy Test					
PGU 1 / PGU 2					
0 s	-40.0000ns	+2.79540ns	+40.0000ns	7.40ns	
Output Impedance Accuracy Test					
PGU 1					
	47.5000ohm	50.00672ohm	52.5000ohm	1.00mohm	
PGU 2					
	47.5000ohm	49.90788ohm	52.5000ohm	1.00mohm	

[END OF REPORT]

Test Record Example (18/18)

3

Adjustments

ADC Reference Adjustment

This section describes the adjustment procedure of the ADC reference values (voltages and resistances). You can perform the ADC reference adjustment by using the Performance Verification (PV4155) software. For the required equipment, see chapter 1.

The HP 4155B/4156B does *NOT* require periodical ADC reference adjustment to keep the documented specifications.

Perform the ADC reference adjustment only if the following condition is satisfied:

- The Performance Verification failed but Self-Calibration and Self-Test pass. (You *can* perform the ADC reference adjustment for the adjustment or troubleshooting purpose.)

Note

The ADC module for replacement also has the calibrated data, which is written at factory. So the HP 4155B/4156B will work correctly without the ADC calibration.

See also "If ADC Adjustment Fails" in chapter 4 before you perform the ADC reference adjustment.

Adjustment Environment

Perform the ADC adjustment with the following conditions:

- Ambient temperature is 23 ± 3 °C.
- HP 4155B/4156B is warmed up (at least 40 minutes).
- HP 3458A is periodically calibrated, warmed up (at least four hours), and you executed ACAL of the HP 3458A after the warmup.

Procedure

To perform the ADC reference adjustment, use the following procedure:

1. Run PV4155.
   Start the PV4155 program, and set up the following in the RECONFIG MENU. See chapter 2 for the details.
   - Unit Under Test (UUT) information
   - HP 3458A information
2. Display the ADJUST MENU.

   To display the ADJUST MENU, select the `ADJUST` softkey in the MAIN MENU. Selecting the `ADJUST` softkey initializes the HP 4155B/4156B and HP 3458A. If the HP-IB addresses are not set correctly, an error message is displayed and the PV4155 program terminates.

The ADJUST MENU shows the following three softkeys:

Softkey	Function
READ DATA	For displaying the present ADC reference values.
EXECUTE	For executing the ADC reference adjustment.
MAIN MENU	For returning to the MAIN MENU.

3. Confirm the present ADC reference data.

   Select the READ DATA softkey to confirm the reference values and the date of the last update. If the values had been updated within one year, stop the operation and proceed to chapter 4, “Troubleshooting Procedures”. (To return to the ADJUST MENU, select the EXIT softkey.)

4. Perform the adjustment.

   Select the EXECUTE softkey to start the ADC reference adjustment, then follow the displayed instructions.

   The ADC voltage adjustment is executed first, then the ADC resistance adjustment will be executed.

   When the ADC voltage adjustment is finished, the adjustment result is displayed on the LCD.

   To continue, select the UPDATE softkey. The ADC voltage reference values are updated and the ADC resistance adjustment is executed. If you select the CANCEL softkey, the PV4155 program stops and the ADC reference values are not updated.

   The same operation is required when the ADC resistance adjustment is finished.

ADC Voltage Reference Adjustment

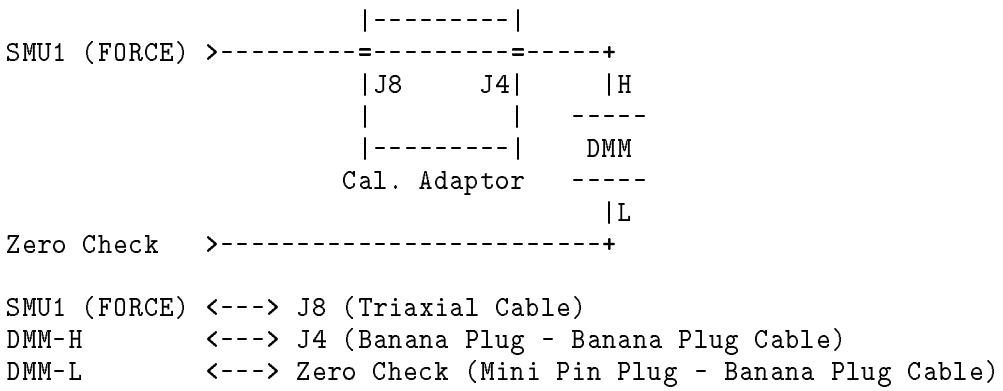
This adjustment verifies the ADC +7V reference and −7V reference values.

Test Equipment

HP 3458A Multimeter
Calibration Adapter (04155-65001)
Triaxial Cable (04142-61641)
Mini Pin Plug - Banana Plug Cable (04155-61648)
Banana Plug - Banana Plug Cable

Test Method

Test Connection:



1. Connect the HP 4155B/4156B to the HP 3458A (DMM) as shown above.
2. PV4155 controls the HP 3458A to set as follows:

Function:	DCV
Auto Zero:	ON
NPLC:	100

3. PV4155 controls the HP 4155B/4156B to force the ADC +7V reference by using SMU1.
4. PV4155 controls the HP 3458A to make voltage measurement.
5. PV4155 controls the HP 4155B/4156B to force the ADC −7V reference by using the SMU1.
6. PV4155 controls the HP 3458A to make voltage measurement. If the measured ADC voltage reference values are not within the following limits, PV4155 displays the measured values and stops, and the ADC voltage reference values are not updated.

Voltage Reference	Tolerance
+7V	6.95 ± 0.42 V
−7V	−6.95 ± 0.42 V

ADC Resistance Reference Adjustment

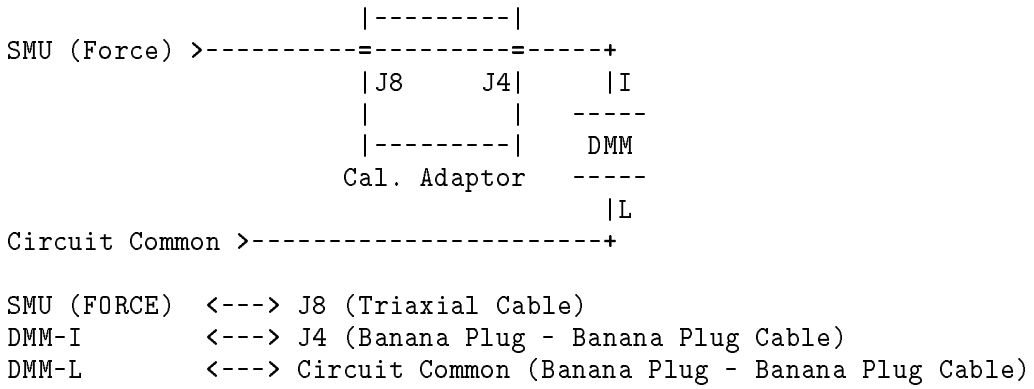
This adjustment verifies the ADC 100 Ω, 10 kΩ, 1 MΩ, and 100 MΩ reference values.

Test Equipment

HP 3458A Multimeter
Calibration Adapter (04155-65001)
Triaxial Cable (04142-61641)
Banana Plug - Banana Plug Cable

Test Method

Test Connection:



1. PV4155 checks the Common Mode Rejection (CMR) of each SMU and determines one SMU to use for the adjustment.
2. Connect the HP 4155B/4156B to the HP 3458A (DMM) as shown above.
3. PV4155 controls the multimeter to set as follows:

   Function: DCV

   Auto Zero: ON

   NPLC: 100
4. PV4155 controls the HP 4155B/4156B to force the currents through the resistance references.
5. PV4155 controls the HP 3458A to make current measurement.
6. PV4155 controls the HP 4155B/4156B to make voltage measurement on inner circuit.

7. PV4155 calculates the resistance reference values with the above results.

   If the calculated ADC resistance reference values are not within the following limits, PV4155 displays the calculated values and stops, and the ADC resistance reference values are not updated.

Resistance Reference	Tolerance
100 ohm	100 ± 0.5 Ω
10 kohm	10 kΩ ± 0.05 kΩ
1 Mohm	1 MΩ ± 0.005 MΩ
100 Mohm	100 MΩ ± 1 MΩ

4

Troubleshooting Procedures

Warning

The information in this manual is provided for use by service trained personnel only. To avoid electrical shock, do not perform any procedures in this manual, unless you are qualified to do so.

Potential shock hazard. Dangerous voltages may be present on the board assembly (includes shield cover) for up to 10 seconds after you set the LINE switch to OFF.

- **Power Supply Module: Max. ±340 V**
- **Other modules and Mother Board of HP 4155B/4156B: Max. ±150 V**
- **Other modules and Mother Board of HP 41501B: Max. ±270 V**

Dangerous voltages (maximum of ±340 V) may be present in the HP 41501B when the HP 41501B LINE switch is ON, even if the LINE indicator is not lit.

Before Troubleshooting

How to Use This Chapter

- Troubleshooting procedures in this chapter are categorized by failure symptom. To perform the troubleshooting, go to suitable paragraph beginning with "If.... " after reading this section "Before Troubleshooting".

  The paragraph titles for the troubleshooting are as follows:

  - "If HP 4155B/4156B Does Not Turn On (Fan Does Not Rotate at All)"
  - "If HP 41501B Does Not Turn On"
  - "If Shutdown Occurs (Automatic Turn Off a Few Seconds After Turn-On)"
  - "If LCD Screen Is Blank, or Power-On Page Is Not Displayed (But "LINE" LED Is Lit)"
  - "If Part of LCD Is Wrong, Dark, or No Display, or If Color of Power-On Page Is Incorrect."
  - "If Self-Test or Self-Calibration Fails"
  - "If Performance Verification (PV4155) Fails"
  - :
  - :

  For example, if your HP 4155B does not turn on, go to "If HP 4155B/4156B Does Not Turn On (Fan Does Not Rotate at All)" directly.

  It is useful to use the table of contents of this manual to search for suitable paragraph.

- During the troubleshooting, see also the following paragraphs in chapter 5 if necessary.
  - Performing the Self-Test
  - Performing Only CPU Self-Test from HP-IB
  - Setting to "NOT SYSTEM CONTROLLER" When LCD Displays Nothing
  - Searching for the HP-IB address When LCD Displays Nothing
  - Symptoms When Only Fuse Fails
  - Hints for Trouble Isolation
- For the locations of the assemblies and parts specified in this chapter, see chapter 7.
- For the replacement procedures, see chapter 8.
- For the theory of operation, see chapter 6.
- For the repair policy, see "Repair Policy" in chapter 1.
- Abbreviations used in this chapter:
  - Mainframe: HP 4155B or HP 4156B
  - Expander: HP 41501B

Troubleshooting Tools Overview

The troubleshooting in this chapter is performed by using the following tools:

- Built-In Diagnostics function (Self-Test and Interactive Tests)
- PV4155 Performance Verification (plus ADC Reference Adjustment) Software
- Voltmeter (for example, +5V reference voltage check)

When you use the above tools, you may also perform the following to isolate the problem.

- Disconnect the connection between two assemblies, then perform test.
- Remove an assembly, then perform test.
- Swap one SMU module and another SMU module, then perform test.
- Remove the Power Supply, and turn on the Power Supply only.

After Repair

In most cases, no adjustments are needed after repair. (ADC Reference Adjustment is not needed.) See chapter 3 for more information.

If you have replaced the following modules, perform the PV4155 Performance Verification after the replacement.

- Power Supply, ADC, SMU, VSU/VMU, PGU, GNDU&I/F, Motherboard

For other parts, use the built-in diagnostics test (Self-Test or Interactive test) for confirmation after the replacement.

If you have replaced the CPU module of the HP 4155B/4156B, you need to set the `POWER LINE FREQUENCY` field (`50 Hz` or `60 Hz`) on the SYSTEM: MISCELLANEOUS page after the replacement. You may also need to update the firmware. See "Replacing the CPU Module" in Chapter 8 and "Updating the Firmware" in Chapter 8 for more information.

Notes for Troubleshooting

Warning

Dangerous voltages of maximum 100 V may be present at bottom cover of HRSMU or MPSMU module in the HP 4155B/4156B/41501B. If you remove the rear panel, be aware of this.

- Before an assembly replacement, try to reconnect the cable or reinstall the assembly to check the connections. Sometimes bad connections cause problems.
- Before you send HP-IB commands to the HP 4155B/4156B from a computer, set the HP 4155B/4156B to `NOT SYSTEM CONTROLLER` on the SYSTEM: MISCELLANEOUS page. If the HP 4155B/4156B is set to `SYSTEM CONTROLLER`, the HP 4155B/4156B does not respond to the HP-IB commands.

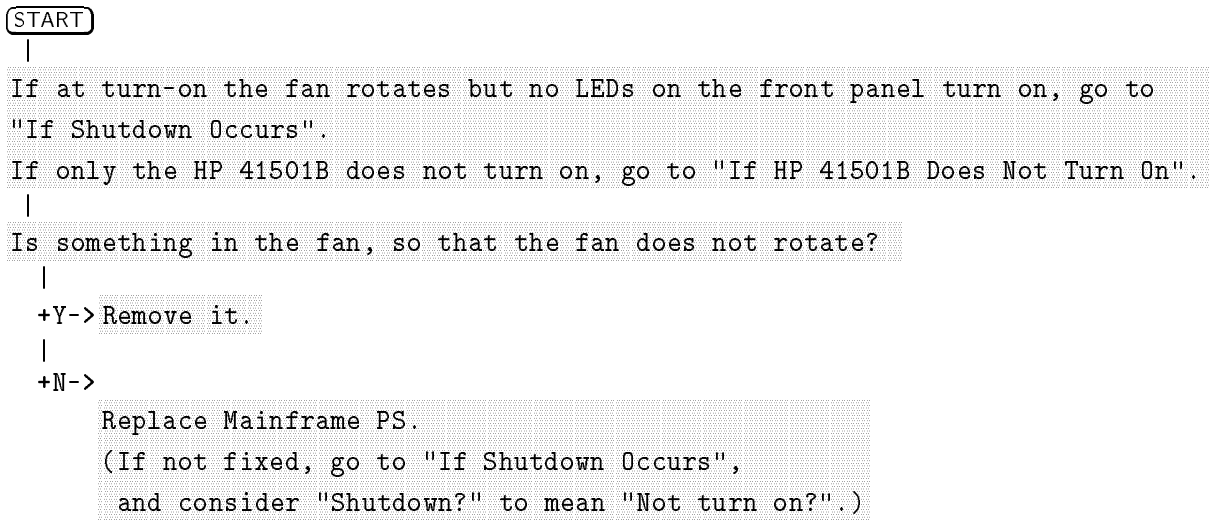
Caution

- Do not block the air opening of side covers. Blocking may result in thermal damage.

If HP 4155B/4156B Does Not Turn On (Fan Does Not Rotate at All)

Example cause for this is:

- PS fail.



Memo

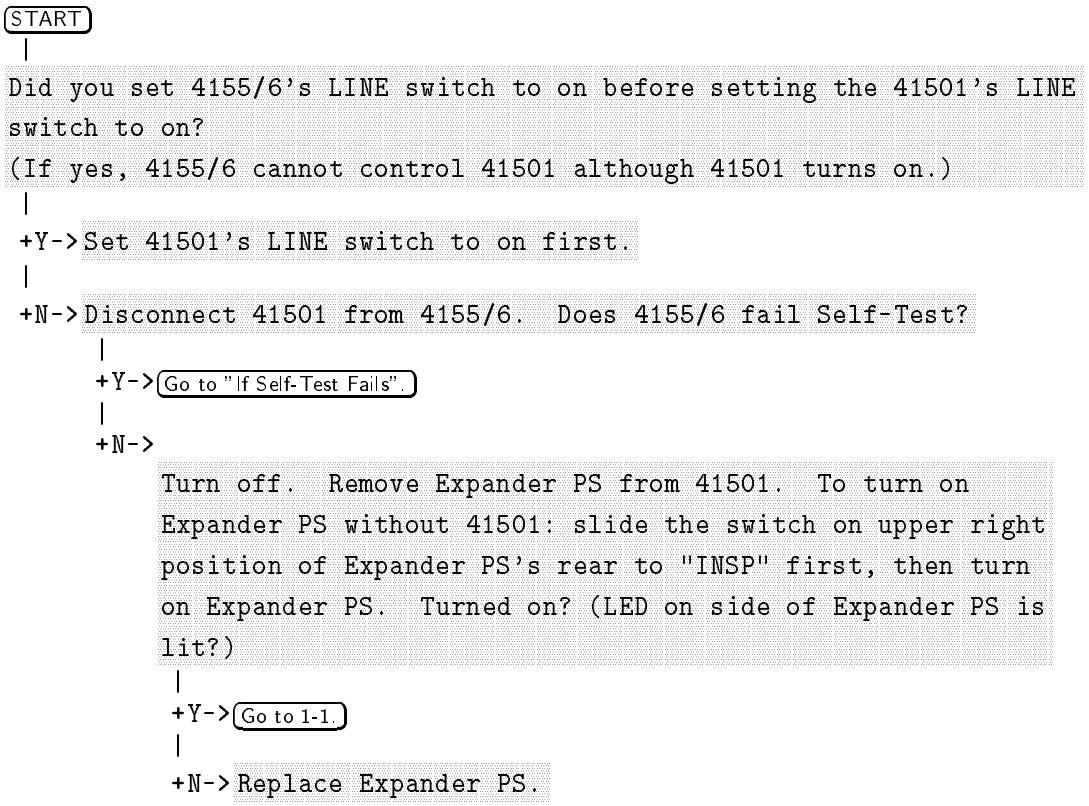
If HP 41501B Does Not Turn On

Example cause for this is:

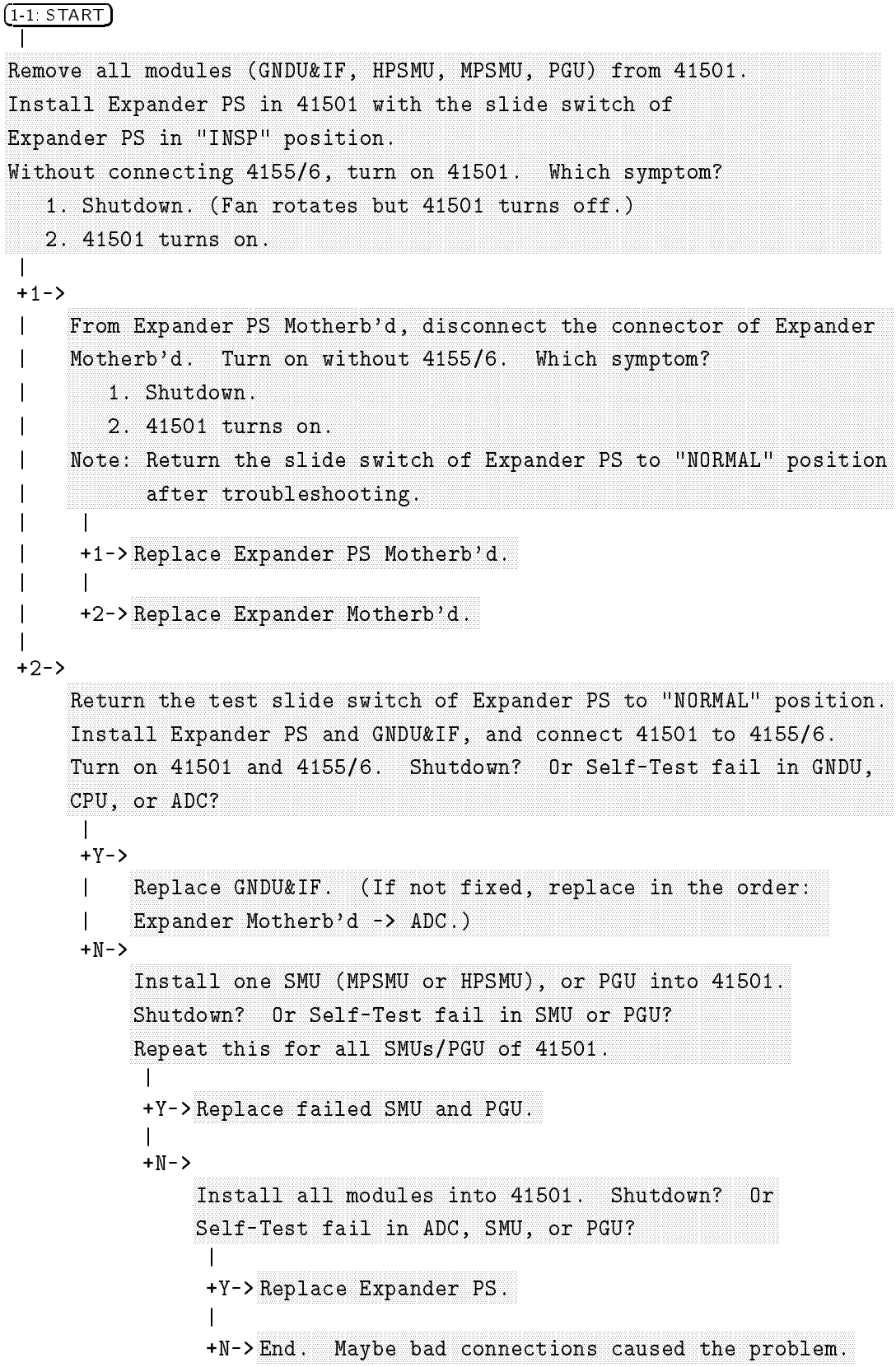
- PS fail.

If the HP 41501B does not turn on, the HP 4155B/4156B displays an error message and turns on the HIGH VOLTAGE LED:

```
CAUTION 309: The SMU AND PULSE GENERATOR EXPANDER isn't turned on.
Turn on the expander, then cycle power.
```



1-1: Expander PS Turns On When Removed From HP 41501B



If Shutdown Occurs (Automatic Turn Off a Few Seconds After Turn-On)

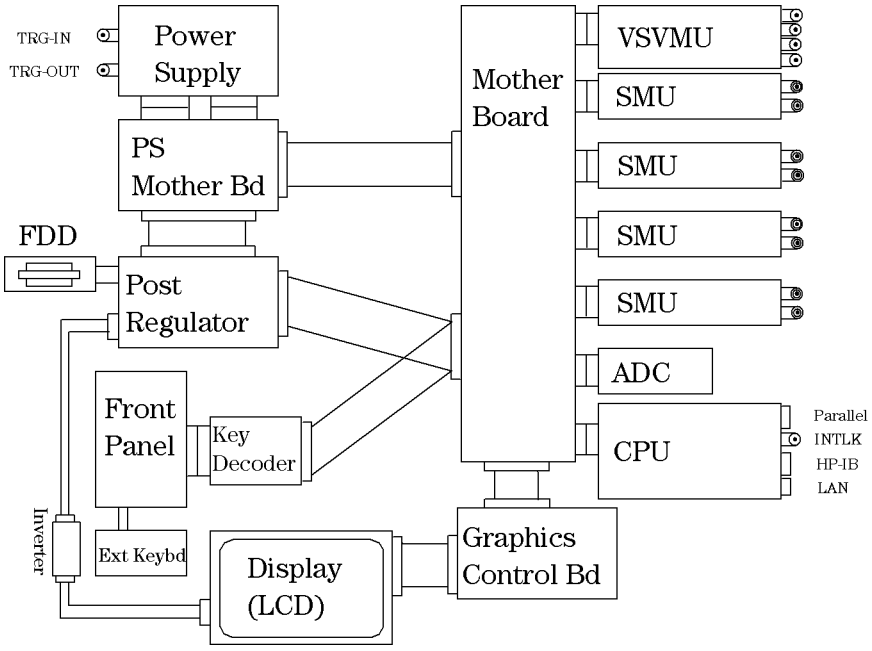
Perform this section for the following case.

After you set the LINE switch to on, the front panel LEDs are lit only for a few seconds, then automatically the HP 4155B/4156B turns off. (The fan is rotating.)

Example causes for this are:

- PS fail.
- Shorting of the PS output line outside/inside the PS causes the PS self-shutdown.
- Failure of ADC +/−5V references causes over-voltage in measurement units (HRSMU/MPSMU/VSU/PGU; The HPSMU does not have the over voltage detector), and shutdown occurs. The over-voltage in the SMU may occur during the Power-On Self-Test and Self-Calibration. The over-voltage in the VSVMU may occur before Power-On Self-Test after turn-on.
- ADC is disconnecting from the Motherboard. This is because +/−5 V references do not exist, which causes the overvoltage in the SMU and VS.
- CPU fail.
- Unstable or noisy AC line. When the AC line has momentary power loss, or lower voltage than the regulation, the HP 4155B/4156B/41501B turns off, then turns on if they are recovered. The lower voltage might cause continuous turn on and off.

START
|
Shutdown occurs only when R-Box or SMU/PG Selector is connected?
+Y->
| Repair R-Box, or SMU/PG Selector. See its Service Manual
| (R-Box: 16441-90000; SMU/PG Selector: 16440-90000).
| (Possible cause: Shorted relay power supply line in R-Box/Selector
| causes shutdown by detecting the overcurrent in the Mainframe PS.)
|
+N-> Is 4155/6 with Expander?
+Y->
| Turn off 4155/6 and Expander, and disconnect Expander from
| 4155/6, then turn on 4155/6 without Expander. Shutdown?
| |
| +Y-> Go to 1-1 (Shutdown by 4155/6 Mainframe).
| +N-> Go to 1-2 (Shutdown by Expander).
+N-> Go to 1-1 (Shutdown by 4155/6 Mainframe).

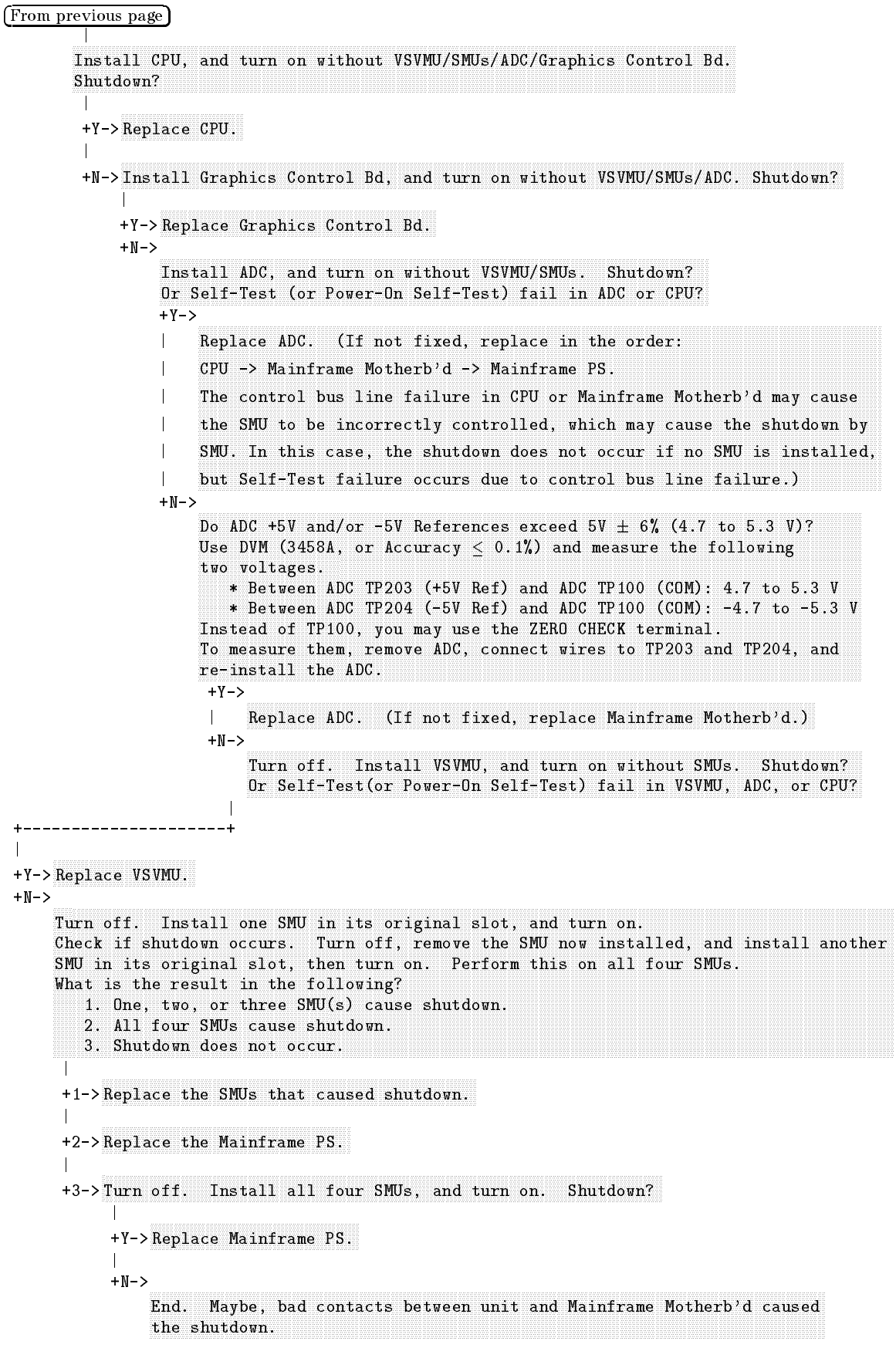


Block Diagram

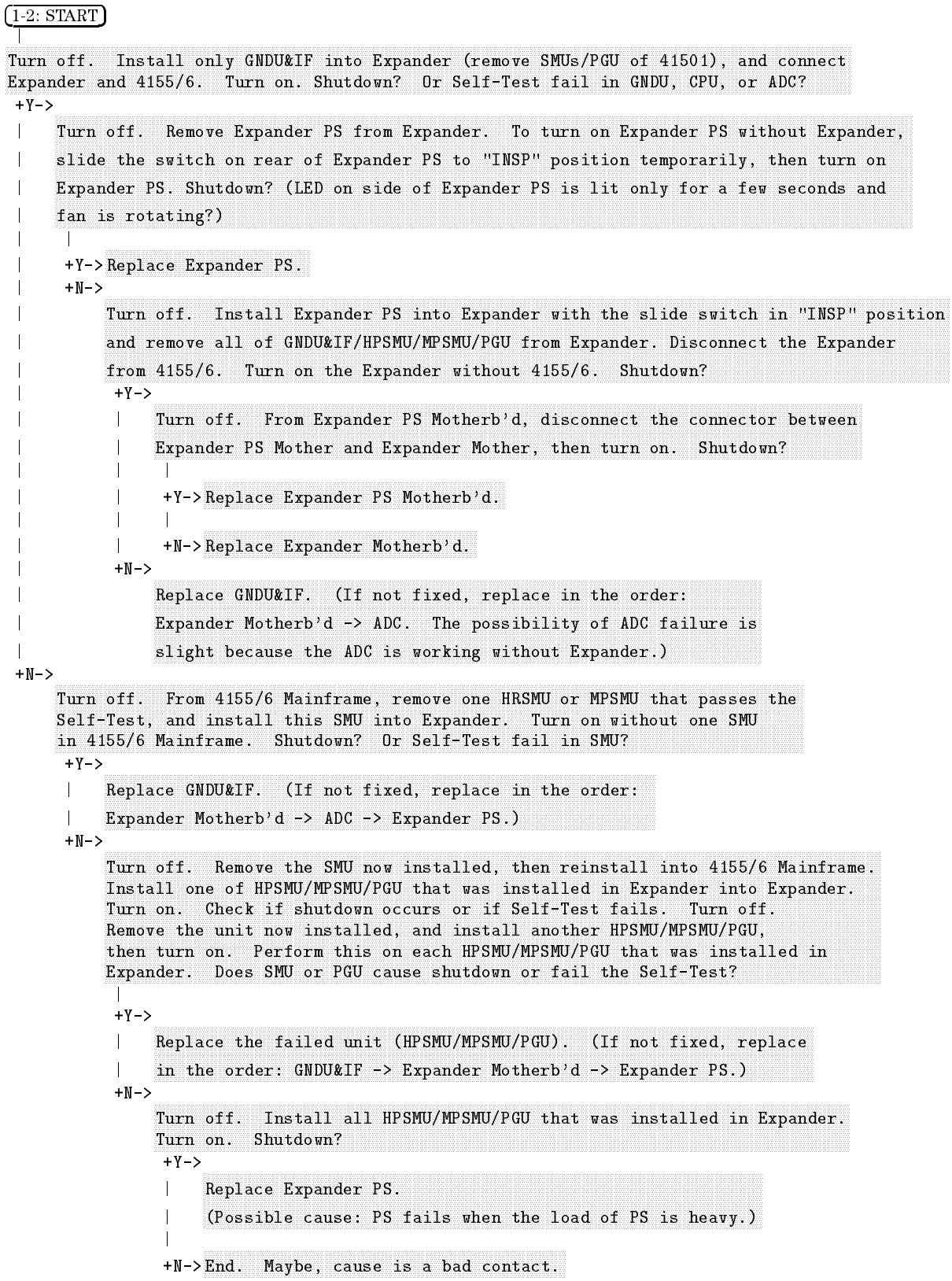
Note

The LCD failure should not cause the shutdown because the Post Regulator limits the current into the LCD.

1-1: Shutdown Caused by 4155/6 Mainframe (without Expander/R-Box/Selector)



1-2: Shutdown Caused by Expander



Memo

If LCD Screen Is Blank, or Power-On Page Is Not Displayed (But "LINE" LED Is Lit)

Example causes for this are:

- CPU fail
- Graphics Control Board fail
- LCD fail
- LCD power supply block fail of Post Regulator

Note

For the turn-on sequence when the HP 4155/4156 is working correctly, see "Miscellaneous Operations" in chapter 5.

START

```
NOTE: The following troubleshooting is when CHANNEL DEFINITION page or
SELF-CALIBRATION/DIAGNOSTICS page is not displayed after power-on,
but when the "LINE" LED is lit.
Or when nothing is displayed after power-on.
Or when you cannot distinguish what page is displayed.
If SELF-CALIBRATION/DIAGNOSTICS page is displayed, go to
"If Self-Test Fails".
```

Go to next page.

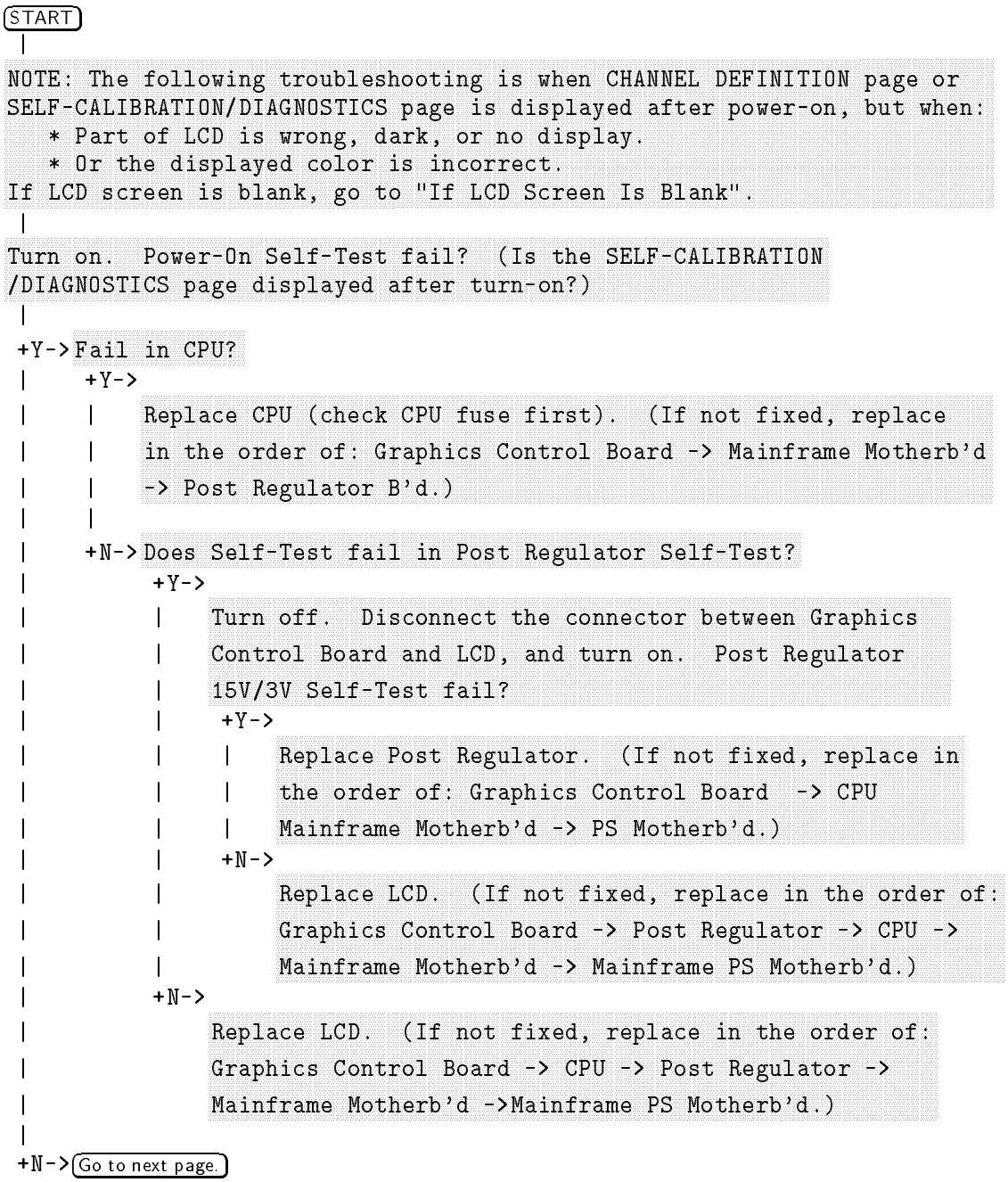
From previous page

```
|
Remove disk from FDD, if it is inserted (because a setup file may display
a non-Power-On page).  Turn on.  Does one or more of the following fail symptoms
occur at power-on? (Incorrect power-on sequence?)
   * All LEDs or all LEDs except HIGH VOLTAGE remain on for more than
     10 seconds after power-on.
   * All LEDs or all LEDs except HIGH VOLTAGE never light
     even for a moment within 10 seconds after power-on.
 +Y->
 |   Replace CPU.  (If not fixed, replace in the order of:
 |   Mainframe Motherb'd -> Post Regulator B'd.)
 +N->
     To perform the CPU Self-Test from a computer, perform the following:
        1. Wait three minutes after power-on to wait for completion of
           Power-On Self-Test.
        2. Set the 4155/6 to "NOT SYSTEM CONTROLLER".
        3. Search for the HP-IB address of the 4155/6 if you do not know it.
        4. Perform the CPU Self-Test (or all Self-Tests) from a computer.
           Does Self-Test fail in CPU?  Or does the program hang up at ENTER statement
           (no data response)? Or does it hang up at the first OUTPUT statement
           (no response, no Self-Test execution)?
      +Y->
      |   Replace CPU.  (If not fixed, replace in the order: Graphics Control Board ->
      |   Mainframe Motherb'd -> Post Regulator.)
      |
      +N->Perform CPU Graphic Memories (309) Self-Test (single test).  Fail?
           |
           +Y->Replace Graphics Control Board.  (If not fixed, replace in the
           |   order of: CPU -> Mainframe Motherb'd -> Post Regulator ->
           |   Mainframe PS Motherb'd.)
           |
           +N->
               From a computer, perform the Post Regulator (or all)
               Self-Test.  Fail (Error code: 24062, 24063, or 24064)?
                +Y->
                |   Turn off.  Disconnect the connector between Graphics
                |   Control Board and LCD, and turn on.  Perform the Post
                |   Post Regulator Self-Test from a computer.  Fail (Error
                |   code: 24062, 24063, or 24064)?
                |    +Y->
                |    |   Replace Post Regulator.  (If not fixed, replace in
                |    |   the order of: CPU -> Mainframe Motherb'd ->
                |    |   Mainframe PS Motherb'd.)
                |    +N->
                |        Replace LCD.  (If not fixed, replace in the order
                |        of: Graphics Control Board -> Post Regulator -> CPU
                |        -> Mainframe Motherb'd -> Mainframe PS Motherb'd.)
                +N->
                    Replace LCD.  (If not fixed, replace in the order of:
                    Graphics Control Board -> Post Regulator -> CPU -> Mainframe Motherb'd ->
                    Mainframe PS Motherb'd.)
```

If Part of LCD Is Wrong, Dark, or No Display, or If Color of Power-On Page Is Incorrect.

Example causes for this are:

- CPU fail
- Graphics Control Board fail
- LCD fail
- LCD power supply block fail of Post Regulator



From previous page

Perform CPU Graphic Memories (309) Self-Test (single test). Fail?

+Y-> Replace Graphics Control Board. (If not fixed, replace in the order of: CPU -> Post Regulator -> Mainframe Motherb'd -> Mainframe PS Motherb'd.)

+N->

Display the "All White" (201) LCD test pattern on the DIAGNOSTICS page. Which is the result?

1. Vertical stripe occurs. Or color is completely non-white.
2. Correct (Pass).

+1-> Replace Graphics Control Board. (If not fixed, replace in the order of: LCD -> CPU -> Mainframe Motherb'd -> Post Regulator -> Mainframe PS Motherb'd.)

+2-> Replace CPU. (If not fixed, replace in the order of: LCD -> Graphics Control Board Mainframe Motherb'd -> Post Regulator -> Mainframe PS Motherb'd.)

If Self-Test or Self-Calibration Fails

The Self-Test/Self-Calibration error codes due to hardware failures are categorized in the following table. An error code indicates that the unit specified by the error code failed. For example, "Self-Test fails in VSVMU?" is equal to "Does error 100xx occur?"

Table 4-1.
Self-Test and Self-Calibration Error Codes for Hardware Failure

Failure Unit	Error Numbers[1]
VSVMU	100xx, xx: 11–15, 30–52, 92
SMU1	101xx, xx: 11–15, 20–25, 92
SMU2	102xx, xx: 11–15, 20–25, 92
SMU3	103xx, xx: 11–15, 20–25, 92
SMU4	104xx, xx: 11–15, 20–25, 92
SMU5	105xx, xx: 11–15, 20–26, 92
SMU6	106xx, xx: 11–15, 20–25, 92
PGU	107xx, xx: 11–15, 60–73, 92
GNDU&IF	108xx, xx: 11–15, 75, 92
ADC	109xx, xx: 11–15, 05–08, 92 1yy00–1yy08, yy:00–09, 11 1yy90, yy:00–09, 11 1yy91, yy:00–09, 11
CPU	1yy97, yy: 00–09, 11 230xx, xx: 10–92
Keyboard/Key-Decoder	24071, 24072, 24073, 24100 (Front Key Circuit and Ext Key Controller tests)
Post Regulator	24041, 24042, 24062, 24063, 24064 (FDD Controller and 12/15/3V tests)

1 For "1yyxx" error codes, "1yy" shows the Self-Test/Self-Calibration number, "xx" shows error meaning.
For "2yyyx" error codes, "yyy" shows the Self-Test/Self-Calibration number, "x" shows error meaning.
For 111xx (xx: 90–97), perform Self-Test number 100 to 109 individually.
For 1yy90, perform ADC Self-Test.
For 1yy82 or 1yy97, perform CPU test.

The error numbers from 1 to 9999 are for errors that are *not* Self-Test/Self-Calibration errors. For example, input value is out of range, or HP-IB command syntax error.

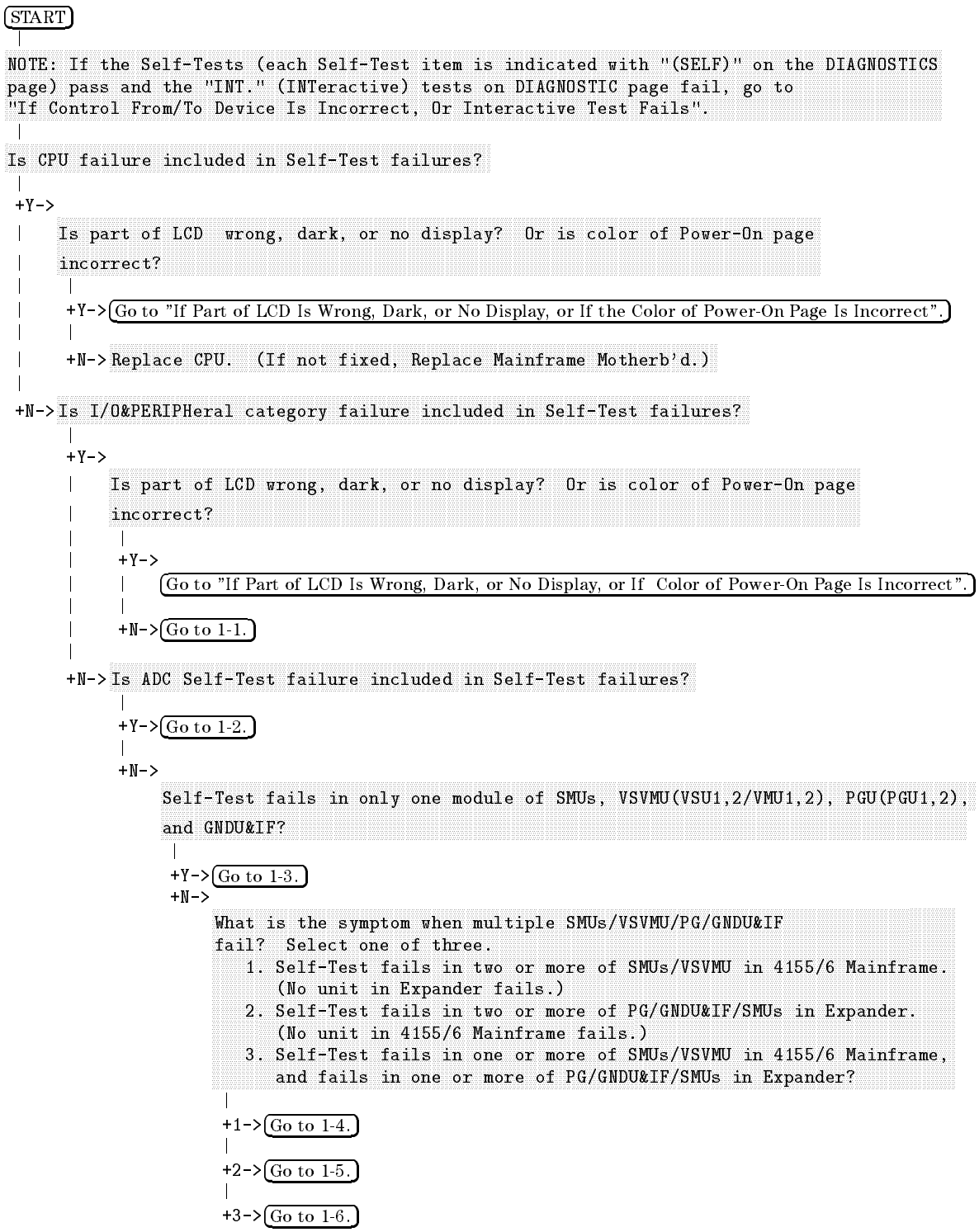
For an overview of the Self-Test and Self-Calibration tests, see "Built-In Diagnostics Function" in chapter 5.

For the Self-Test and Self-Calibration error meanings, see "Diagnostics Errors" in chapter 9.

Note

- Even if two or more of error codes occur for a Self-Test item, only one error code is displayed. To read all error codes, move the cursor to the failed test item field. All error codes (maximum seven) will be displayed on the bottom of the LCD.
- If ADC Self-Test failed, or CPU Self-Test failed with error code 23061 to 23077, the HP 4155B/4156B does not recognize measurement units (SMU, VSVMU, PGU, GNDU, SMUC-ROM, ADC-ROM, R-Box Control Self-Test, SMU/PGU Selector Control Self-Test).
- If the HP 4156B does not recognize SMU1 due to above reason, or you remove the SMU1 from the HP 4156B, the HP 4156B shows itself is the HP 4155B in the following items, but other operation including measurements can be operated as a HP 4156B.
  - SYSTEM: MISCELLANEOUS page: model name is displayed as `HP 4155B`.
  - *IDN? response data: model name is returned as "HP 4155B".
  - Printer/Plotter header output: model name is drawn as "HP 4155B".
- If Post Regulator Self-Test fails, LCD might be unusual because this means that power supply for LCD has a failure.
- If a measurement unit fails in Self-Test, the measurement unit cannot perform outputs and measurements. The output of failed unit is set to open.
- If CPU Self-Test (301) fails, the HP 4155B/4156B might not be able to perform any controls including the HP-IB control.

Note If ambient temperature changes rapidly, or the instrument is not warmed up, Self-Test may fail. When the HP 4155B/4156B passes the Self-Test after warmup, the HP 4155B/4156B is working correctly.



1-1: Self-Test Fail in I/O & PERIPHeral Category

I/O & PERIPHeral Category Self-Test consists of:

- Post Regulator Test
  - Flexible Disk Controller Test (Error Codes: 24041, 24042)
  - Post Regulator Test (Error Codes: 24062, 24063, 24064)
    When Post Regulator test fails, display is usually unusual.
- Keyboard/Key-Decoder Test
  - Front Key Circuit Test (Error Codes: 24071–24073)

Note

During 407 Front Key Circuit Self-Test, do not press any front keys. If you do, the test might fail.

  - External Key Controller Test (Error Code: 24100)
  - DIAG 409 Front Key LED Test (Visual test)
    This is one of the interactive tests. Perform this test when one of the above two tests fails. When the LEDs are lit as follows, this test is pass.

    1. All LEDs are lit, then turn off.
    2. “MEASUREMENT” LED is lit.
    3. “Standby” LED is lit.
    4. “Run” LED is lit
    5. “Blue” LED is lit.
    6. “HIGH VOLTAGE” LED is lit.
    7. All LEDs turn off.
    8. After this test, “Blue” LED is lit if it was lit (blue key enable state) before this test.

1-1: START

What is the failure symptom in I/O & PERIPHeral Category Self-Test (or all Self-Test)?
Select from 1 to 5.
If LCD displays nothing, test from HP-IB. In this case, set 4155/6 to
NOT SYSTEM CONTROLLER and search for the HP-IB address before the test.

	Post Regulator Test			Keyboard/Key-decoder Test		
	Flexible Disk Controller 24041/24042	Post Regulator 24062 24063/24064	Front Key Circuit 24071-73	Ext Key Controller 24100	Front Key LED	
1	FAIL	pass	pass	pass	pass	
2	pass	FAIL	pass	pass	pass	
3	FAIL	FAIL	pass	pass	pass	
4	pass	pass	FAIL in any of these tests			
5	FAIL in any of these tests		FAIL in any of these tests			

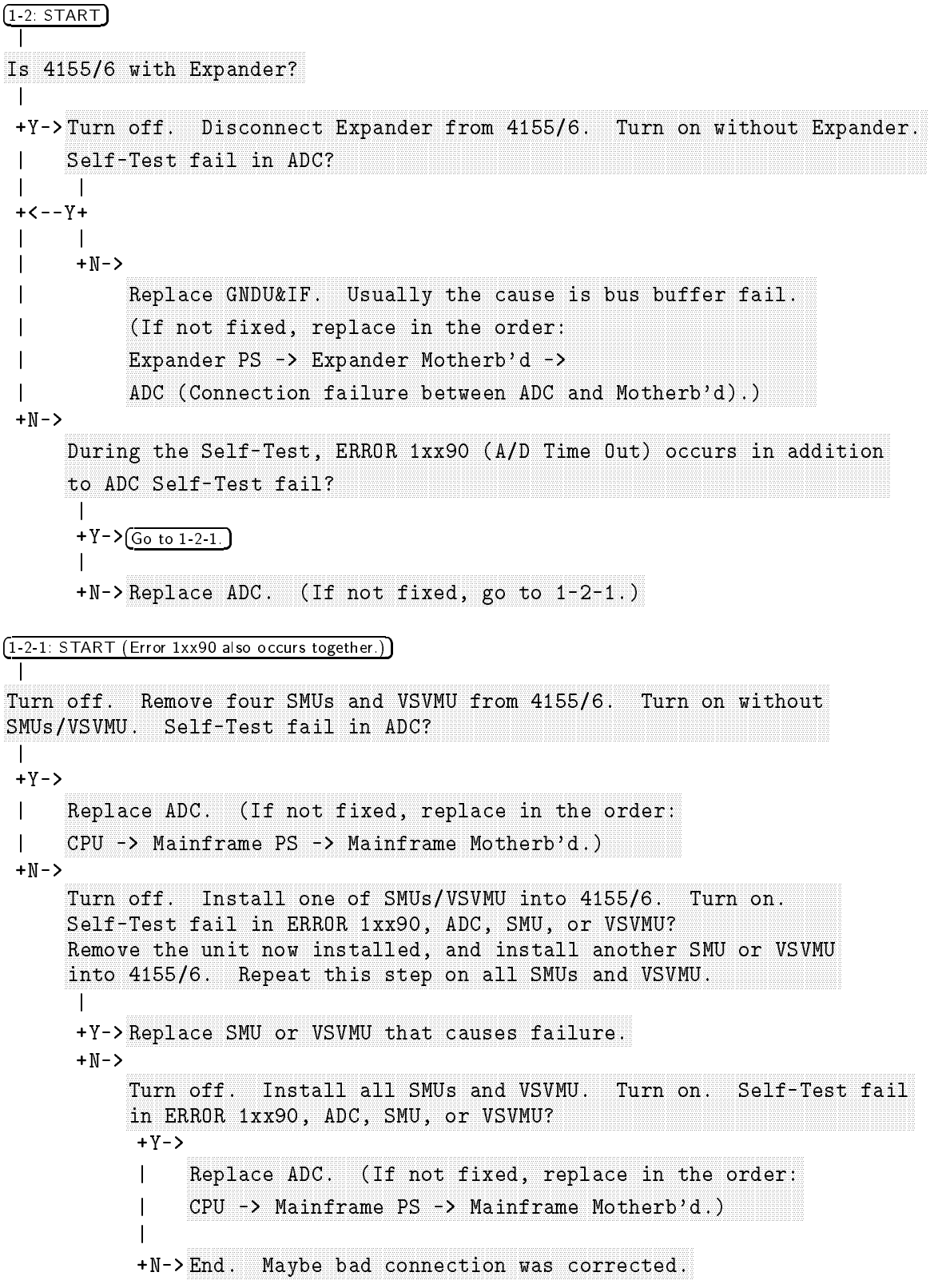
+1->
Turn off. Fuse on Post Regulator is blown?
(When the fuse is blown, error code is usually 24042.)
+Y->
Replace the fuse. Perform FDD Read/Write test to operate FDD. The fuse blown again? (Usually the fuse is blown at turn-on. Operating the FDD (performing FDD Read/Write test) may also blow the fuse.)
+Y->Replace FDD and cable between FDD and Post Regulator.
+N->End.
+N->
Turn off. Disconnect cable between FDD and Post Regulator. Turn on without FDD connection.
Flexible Disk Controller Self-Test fail?
+Y->
Replace Post Regulator. (If not fixed, replace in the order: CPU -> Key Decoder -> Mainframe Motherb'd.)
+N->
Replace FDD and cable between FDD and Post Regulator.
(If not fixed, replace in the order:
Post Regulator -> CPU -> Key Decoder -> Mainframe Motherb'd.)

Go to next page.

From previous page.

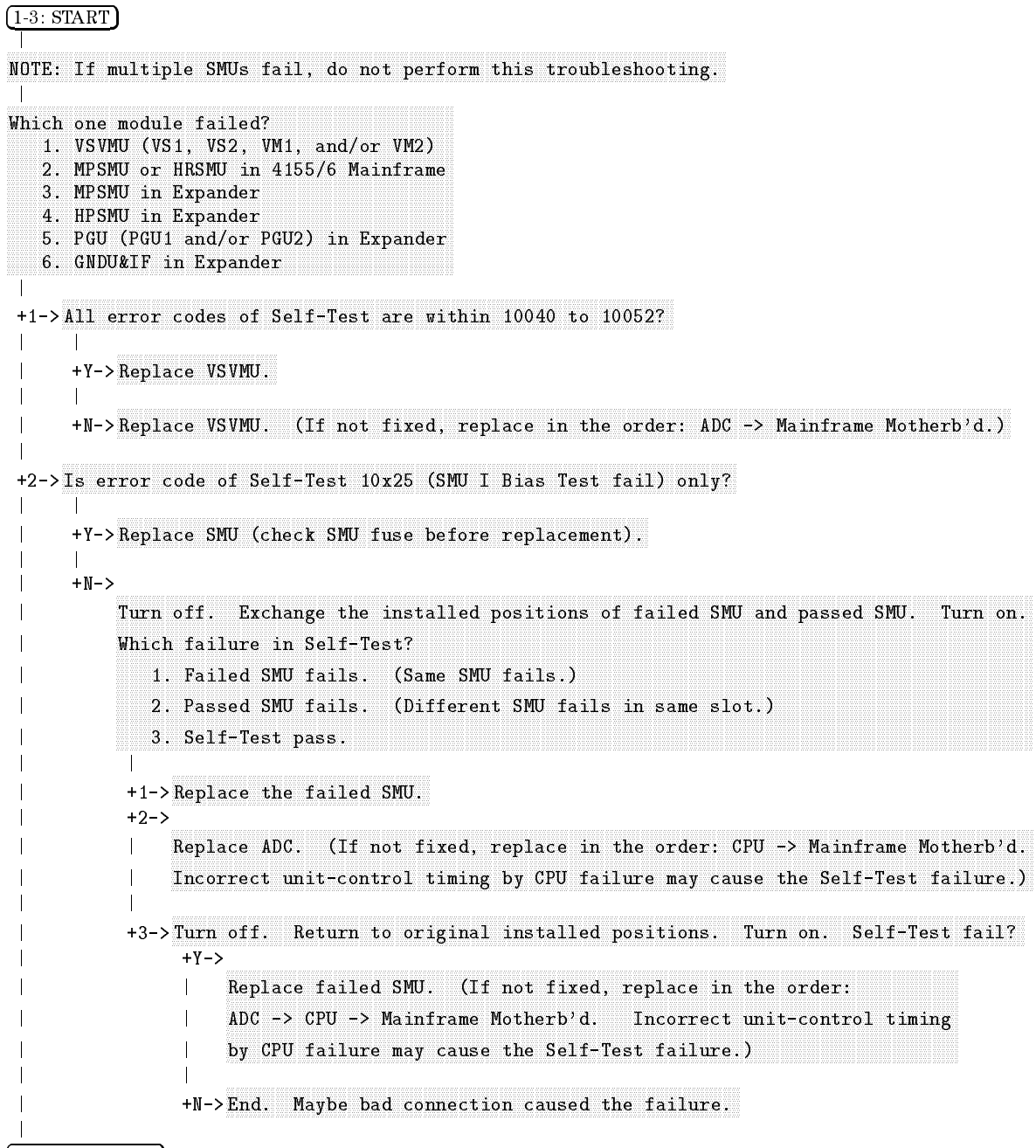
```
 |
+2->
 |    Turn off.  Disconnect the connector between Graphics Control Board and LCD.
 |    Turn on without LCD connection. From a computer, perform the Post Regulator
 |    Self-Test (or all Self-Test) because LCD is not connected.  Post Regulator
 |    Self-Test fail?  When Post Regulator Self-Test fails, LCD is usually unusual.
 |     +Y->
 |     |    Replace Post Regulator.  (If not fixed, replace in the order:
 |     |    CPU -> Mainframe Motherb'd -> Key Decoder.)
 |     |
 |     +N->Replace LCD.
+3->
 |    Replace Post Regulator.  (If not fixed, replace in the order:
 |    CPU -> Mainframe Motherb'd -> Key Decoder.)
 |
+4->Only Front Key LED test fail?
 |     +Y->
 |     |    Go to "LED Display Is Incorrect, or Front Key LED Test Fails" in
 |     |    section, "If Control From/To Internal/External Device Is Incorrect, Or
 |     |    Interactive Test Fails".
 |     N->
 |        Turn off.  Remove Key Decoder from Front Panel Assembly, and connect Key Decoder
 |        to cable from Mainframe Motherb'd.  Turn on without Front Keyboard and Front Rubber
 |        Key connections.  Self-Test fail in Keyboard/Key-decoder test?
 |         +Y->
 |         |    Replace Key Decoder.  (If not fixed, replace in the order:
 |         |    CPU -> Mainframe Motherb'd -> Post Regulator.)
 |         +N->
 |              Replace Front Keyboard.  (If not fixed, Replace in the order:
 |              Key Decoder -> CPU -> Mainframe Motherb'd -> Post Regulator.)
+5->
     Turn off.  Remove Front Panel Assembly (Front Keyboard and Key Decoder) from 4155/6.
     Turn on without Front Panel Assembly.  Self-Test fail in both the Post Regulator test
     and Keyboard/Key-decoder test?
     However, do not consider Errors 24072 and 24100 to be Keyboard/Key-decoder test fail
     because these errors are due to removing Key Decoder board.
      +Y->
      |    Replace Post Regulator.  (If not fixed, replace in the order:
      |    CPU -> Mainframe Motherb'd -> Key Decoder.)
      |
      +N->Replace Key Decoder.  (If not fixed, replace Front Keyboard.)
```

1-2: Self-Test Fail in ADC



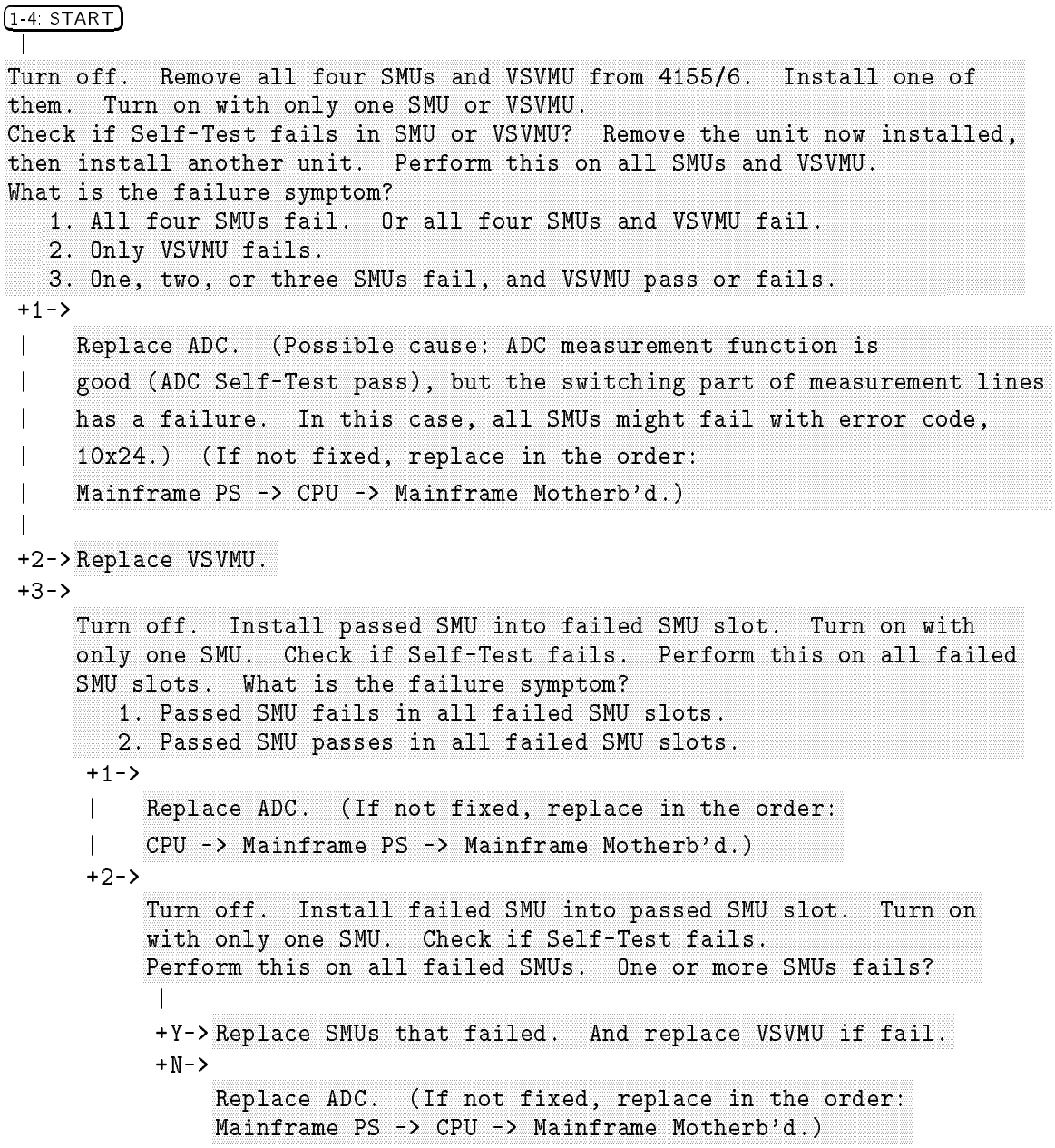
Memo

1-3: Self-Test Fail in Only One Module of SMUs/VSVMU/PGU/GNDU&IF

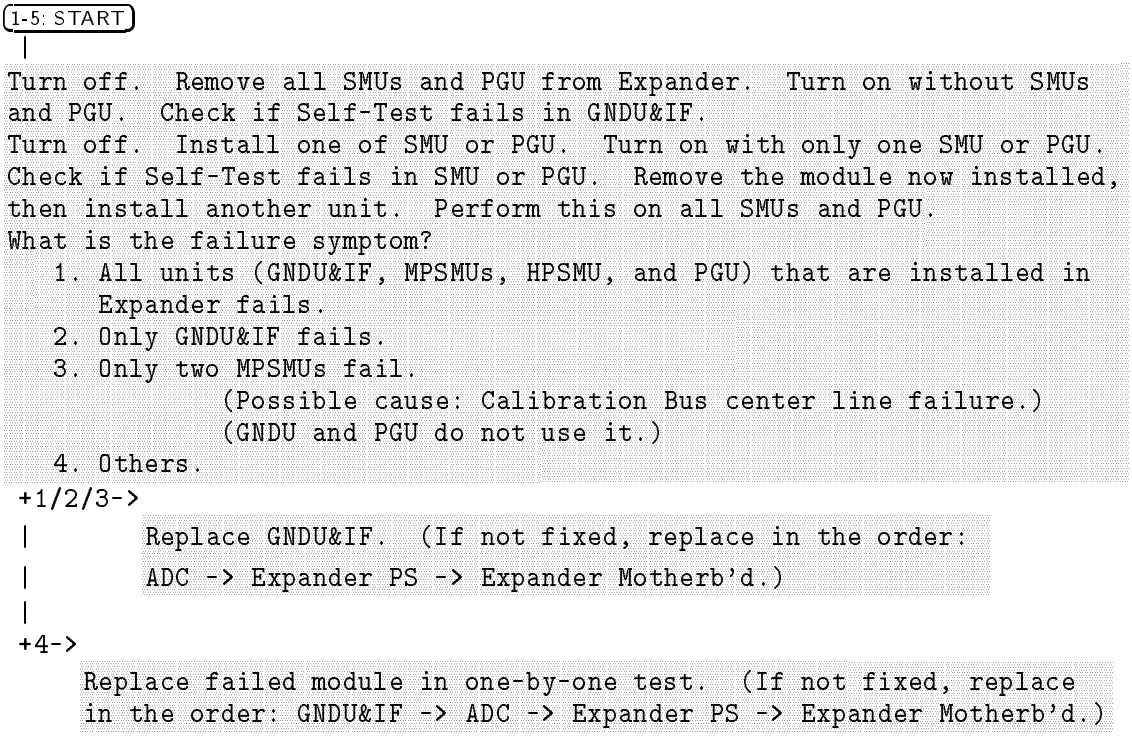


```
From previous page.
 |
+3->Is error code of Self-Test 10x25 (SMU I Bias Test fail) only?
|    |
|    +Y->Replace MPSMU.
|    +N->
|        Turn off.  Exchange the installed position of failed MPSMU and passed MPSMU.
|        Turn on.  Which failure in Self-Test?
|           1. Failed SMU fails.  (Same SMU fails.)
|           2. Passed SMU fails.  (Different SMU fails in same slot.)
|           3. Self-Test pass.
|            |
|         +1->Replace the failed SMU (Check SMU fuse before replacement).
|         +2->
|         |    Replace GNDU&IF.  (If not fixed, replace in the order:
|         |    Expander Motherb'd -> ADC.  CPU is usually OK
|         |    because 4155/6 Mainframe passes the Self-Test.)
|         |
|         +3->
|              Turn off.  Return to original installed positions.  Turn on.
|              Self-Test fail?
|               |
|              +Y->
|               |    Replace failed SMU.  (If not fixed, replace in the order:
|               |    GNDU&IF -> Expander Motherb'd -> ADC.  CPU should be OK because
|               |    4155/6 Mainframe passes the Self-Test.)
|               |
|              +N->End.  Maybe bad connection caused the failure.
+4->
|    Is error code of Self-Test 10x25 (SMU I Bias Test fail) or
|    10x26 (HPSMU V Switch Test fail) only?
|     |
|    +Y->
|    |    Replace HPSMU.  (If not fixed, replace in the order:
|    |    Expander Motherb'd -> Expander PS Motherb'd.  This failure might be due to
|    |    break in printed circuit pattern of PS line on board.)
|    |
|    +N->
|        Turn off.  Remove HPSMU, and remove one HRSMU or MPSMU from 4155/6 Mainframe.
|        Then install the removed HRSMU/MPSMU into bottom slot of HPSMU slots.  Turn on.
|        Self-Test fail in SMU?
|         |
|         +Y->Replace GNDU&IF.  (If not fixed, replace in the order:
|         |    Expander Motherb'd -> ADC.)
|         |
|         +N->Replace HPSMU (check SMU fuse before replacement).
|              (If not fixed, replace Expander PS.)
|
+5->Replace PGU.  (If not fixed, replace in the order:
|    GNDU&IF -> Expander Motherb'd -> ADC.)
|
+6->Replace GNDU&IF.
```

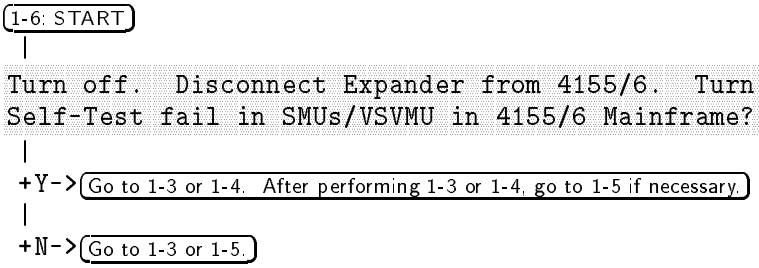
1-4: Self-Test Fail in Multiple Modules of SMUs/VSVMU in 4155/6 Mainframe Only



1-5: Self-Test Fail in Multiple Modules of SMUs/PGU/GNDU&IF in Expander Only



1-6: Self-Test Fail in SMU/VSVMU in 4155/6 Mainframe and PGU/GNDU&IF in Expander



If Performance Verification (PV4155) Fails

Example causes when the Self-Test passes and the PV4155 fails are:

- ADC Adjustment data (Calibration data for V/R references) is incorrect. For example, the ADC Adjustment is not performed for more than three years, or a failed SMU was used in the ADC Adjustment.

  Especially for the following cases, it is recommended to perform the ADC Adjustment.

  - When one module fails the PV4155 and all the PV 4155 results of all the other modules are greater than +60% of the test limit. For example, test limits are 10±1 and all the results are greater than 10.6.
  - When one module fails the PV4155 and all the PV 4155 results of all the other modules are greater than −60% of the test limit. For example, test limits are 10±1 and all the results are less than 9.4.
  - When multiple modules fail the PV4155 and all the PV 4155 results of all the other modules are greater than midpoint of the test limit. For example, test limits are 10±1 and all the results are greater than 10.0.
  - When multiple modules fail the PV4155 and all the PV 4155 results of all the other modules are less than midpoint of the test limit. For example, test limits are 10±1 and all the results are less than 10.0.

- Settling time increase by stray capacitance increase due to the degradation of the printed circuit boards, cables, or capacitors. The degradation also may occur due to humidity absorption or stains.
- Output relay failure.
- Self-Calibration Bus circuit failure. This can cause multiple modules to fail.
- Oscillation that the SMU Oscillation Detector cannot detect.

Note

Before the troubleshooting, confirm that you performed the PV4155 correctly. To do the performance verification correctly:

- In the PV4155 software, input the correct calibration data of the HP 16353A Standard Resistors.
- Ground the HP 4155B/4156B/41501B using three-conductor ac power cables.
- To reduce noise, connect the **Circuit Common** and the chassis ground terminals together with the shorting-bar installed on the chassis ground terminal.

  If you remove rear panel and perform the PV4155 for troubleshooting, short between the Circuit Common terminal on the VSVMU module and chassis of CPU module or the chassis of PS module. If you also remove the VSVMU module, use the chassis of VSVMU slot instead of Circuit Common terminal.
- Set the correct Power Line Frequency (`50 Hz` or `60 Hz`) on the SYSTEM: MISCELLANEOUS page
- The power line must satisfy the following conditions:
  - Voltage: 90 V to 264 V
  - Frequency: 47 Hz to 63 Hz
  - Voltage distortion: $\leq$ 10%
  - No abnormal line power noise or spikes
- Warmup: 40 minutes
- Temperature: 23 °C ± 3 °C, change of temperature should be less than ±1 °C after the Self-Calibration. The Self-Calibration is automatically performed in the PV4155 software.

  For Military Standard (MIL-STD) calibration or ADC adjustment, 23 °C ± 3 °C is required, although the specification temperature is 23 °C ± 5 °C.
- Do not block the air opening of side covers.

```
START
 |
NOTE: If Self-Test fails, go to "If Self-Test or Self-Calibration Fails"
first.  If ADC Adjustment fails in PV4155, go to "If ADC Adjustment Fails".
 |
PV fails in only one module of SMUs/VSVMU/PGU/GNDU&IF?
 +Y->
 |    All PV results in all modules (SMUs/VSVMU/PGU/GNDU. Includes fail module.
 |    module.) are all greater than +60% of test limits?  For example, test
 |    limits 10±1 and all results are greater than 10.6.  Or all greater
 |    than -60% of test limits?  For example, test limits 10±1 and all
 |    results are less than 9.4.
 |     |
 |     +Y->Perform ADC Adjustments.  Retry PV.  PV fail?
 |     |    |
 |     +<--Y+
 |     |    +N->End.
 |     +N->
 |          Which one module fails PV?
 |             1. MPSMU or HRSMU in 4155/6 Mainframe.
 |             2. MPSMU in Expander.
 |             3. HPSMU in Expander.
 |             4. VSVMU in Mainframe.
 |             5. GNDU&IF in Expander.
 |             6. PGU in Expander.
 |           |
 |           +1->Go to 1-1.
 |           +2->Go to 1-2.
 |           +3->Go to 1-3.
 |           +4->
 |           |    Replace VSVMU.  (If not fixed, do in the order:
 |           |    [Perform ADC Adjustments.] -> [Replace ADC.] ->
 |           |    [Replace Mainframe PS. (Example is when noise occurs in
 |           |    +/-35Va line.  If +/-35Va line has noise, VSVMU is
 |           |    influenced more than other units because only VSVMU
 |           |    uses it in the main power amplifier circuit.  SMU main
 |           |    power amplifier uses +/-135Va line.)])
 |           +5->
 |           |    Replace GNDU&IF.  (If not fixed, do in the order:
 |           |    [Perform ADC Adjustments.] -> [Replace ADC.] ->
 |           |    [Replace Expander PS. (Possible cause is that noise
 |           |    occurs in -7Va line, which is used only in GNDU.)])
 |           +6->
 |                Replace PGU.  (If not fixed, replace in the order:
 |                GNDU&IF -> ADC -> Expander Motherb'd.)
 |
 +N->Go to 2.
```

1-1: Only One MPSMU or HRSMU in 4155/6 Mainframe Fails PV

```
(1-1: START)
 |
Turn off.  Exchange the installed positions of failed SMU and passed SMU.  Turn on.
Which failure in PV?
   1. Failed SMU fails.  (Same SMU fails.)
   2. Passed SMU fails.  (Different SMU fails in same slot.)  3. PV pass.
 +1->
 |   Replace the failed SMU.  (If not fixed, do in the order:
 |   [Perform ADC Adjustments.] -> [Replace ADC.] -> [Replace Mainframe Motherb'd.])
 +2->
 |   Replace ADC.  (If not fixed, replace in the order: CPU -> Mainframe Motherb'd.
 |   Incorrect unit-control timing by CPU failure may cause the Self-Test failure.)
 |
 +3->Turn off.  Return the installed positions.  Turn on.  PV fail?
      +Y->
      |   Replace failed SMU.  (If not fixed, do in the order:
      |   [Perform ADC Adjustments.] -> [Replace ADC.] -> [Replace Mainframe Motherb'd.])
      |
      +N->End.  Maybe bad connection caused the failure.
```

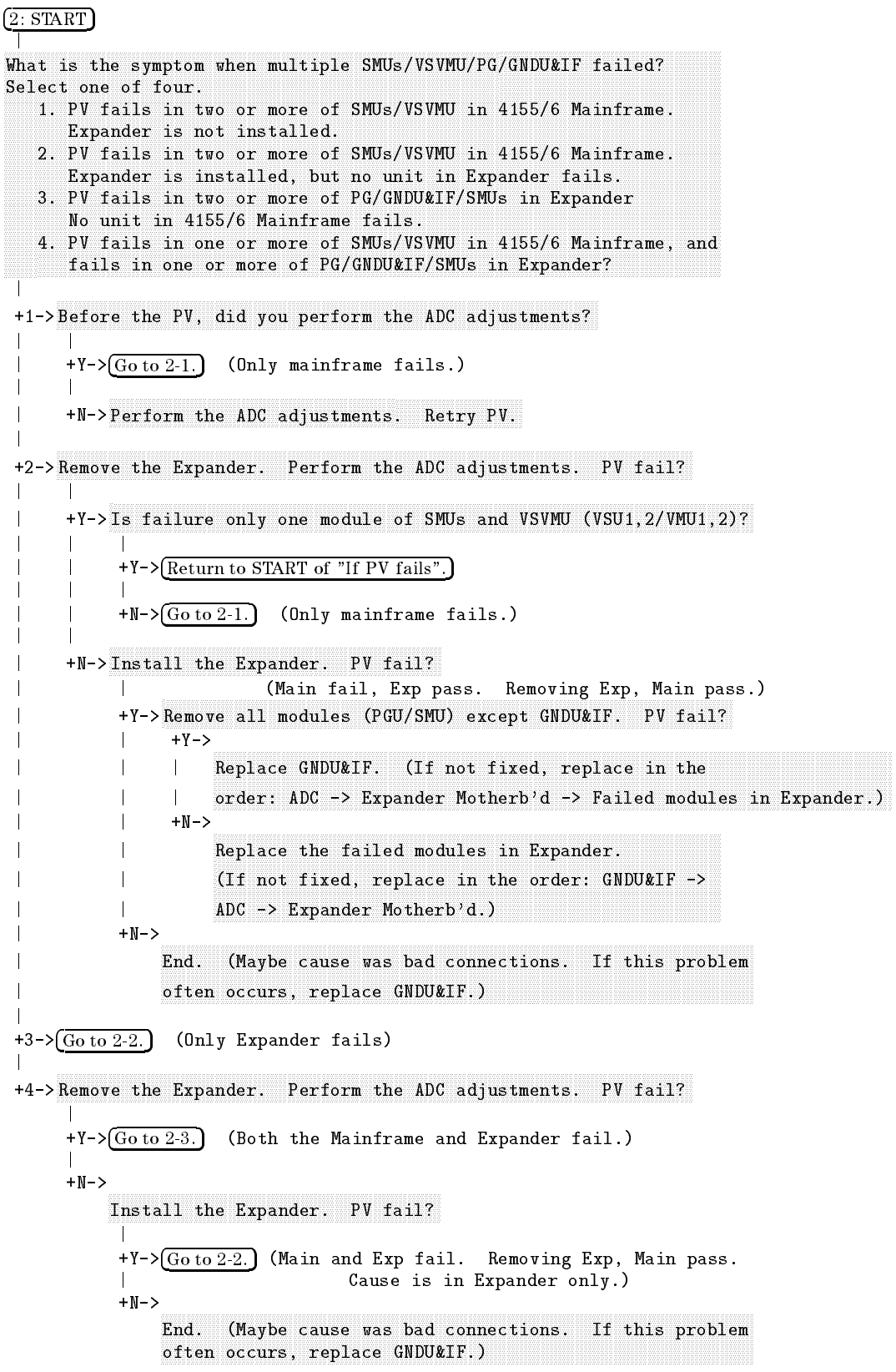
1-2: Only One MPSMU in Expander Fails PV

```
(1-2: START)
 |
Turn off.  Exchange the installed positions of failed SMU and pass SMU.  Turn on.
Which failure in PV?
   1. Failed SMU fails.  (Same SMU fails.)
   2. Passed SMU fails.  (Different SMU fails in same slot.)  3. PV pass.
 +1->
 |   Replace the failed SMU.  (If not fixed, do in the order:
 |   [Perform ADC Adjustments.] -> [Replace GNDU&IF.] -> [Replace ADC.])
 +2->
 |   Replace GNDU&IF.  (If not fixed, replace in the order: ADC -> Expander Motherb'd.)
 |
 +3->Turn off.  Return the installed positions.  Turn on.  PV fail?
      +Y->
      |   Replace failed SMU.  (If not fixed, do in the order:
      |   [Perform ADC Adjustments.] -> [Replace ADC.] -> [Replace Expander Motherb'd.])
      |
      +N->End.  Maybe bad connection caused the failure.
```

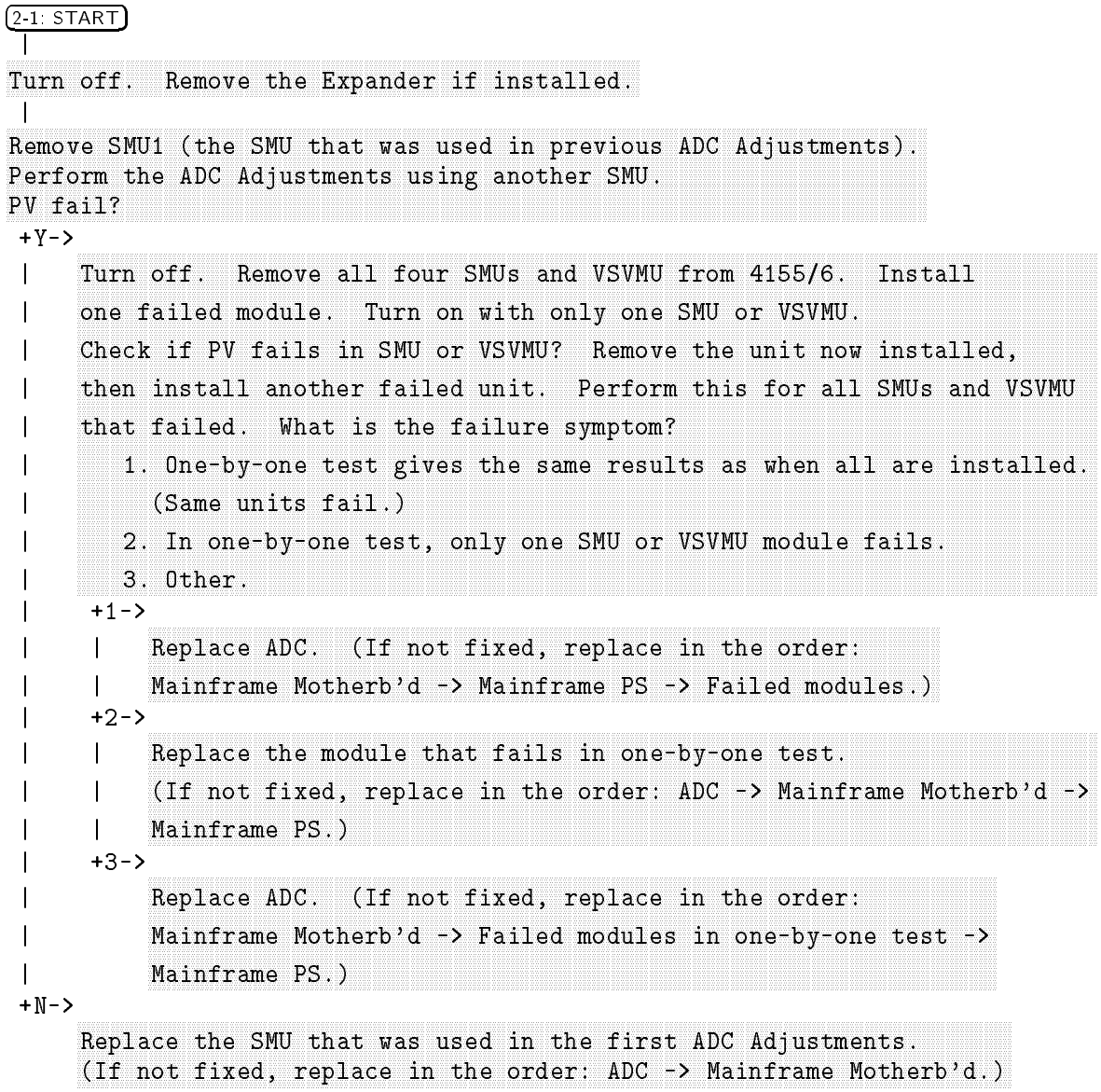
1-3: Only HPSMU in Expander Fails PV

```
(1-3: START)
 |
Turn off.  Remove HPSMU, and remove one HRSMU or MPSMU from 4155/6 Mainframe.
Then install the removed HRSMU/MPSMU into bottom side slot of HPSMU slots.  Turn on.
PV fail in SMU in HPSMU slots?
 +Y->
 |   Replace GNDU&IF.  (If not fixed, do in the order:
 |   [Perform ADC Adjustments.] -> [Replace ADC.] -> [Replace Expander PS.])
 +N->
     Replace HPSMU.  (If not fixed, do in the order:
     [Perform ADC Adjustments.] -> [Replace GNDU&IF.] -> [Replace Expander PS.])
```

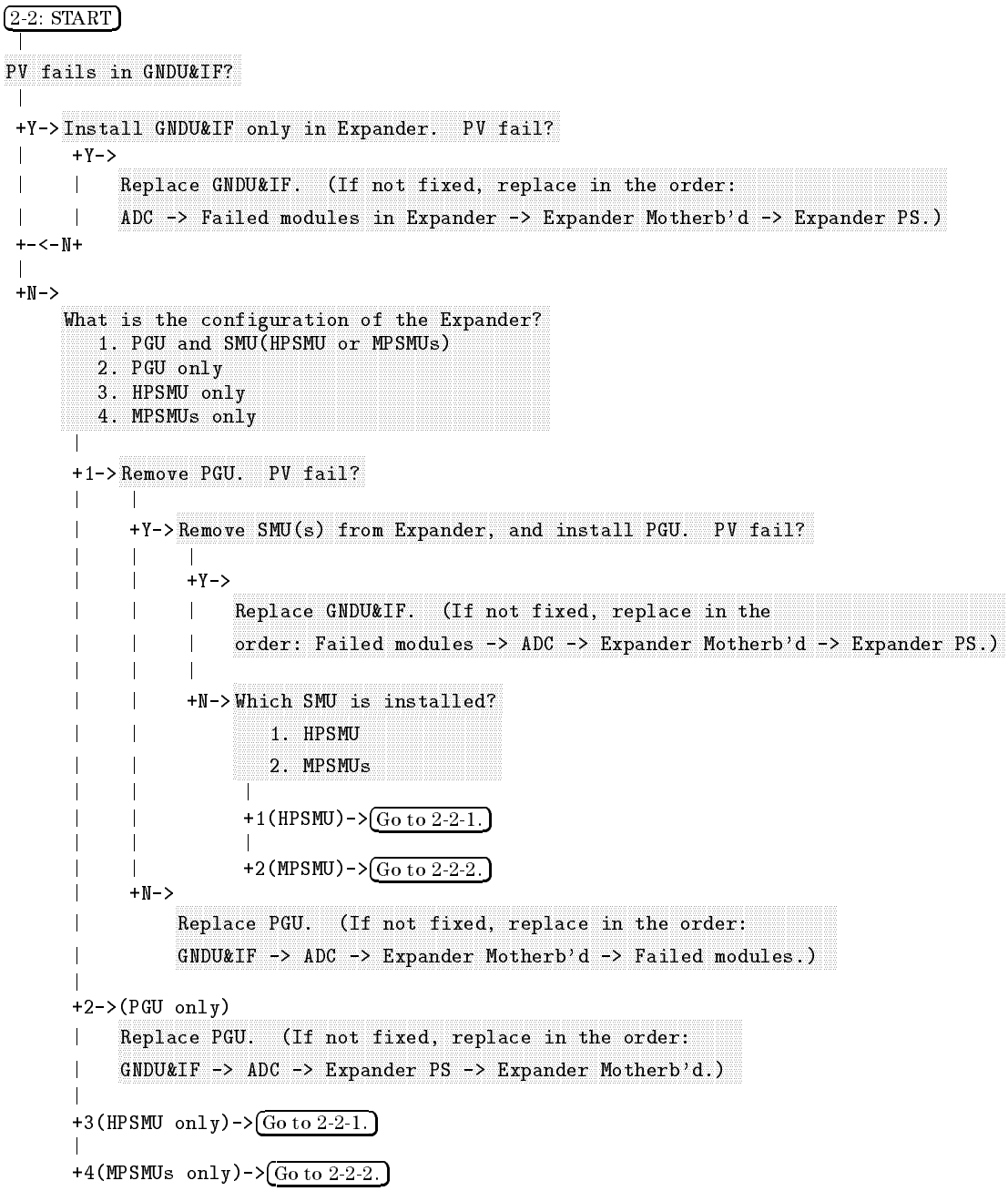
2: PV Fails in Multiple Modules.



2-1: Multiple Modules Fail PV in 4155/6 Mainframe Without Expander



2-2: Multiple Modules Fail PV in Expander Only



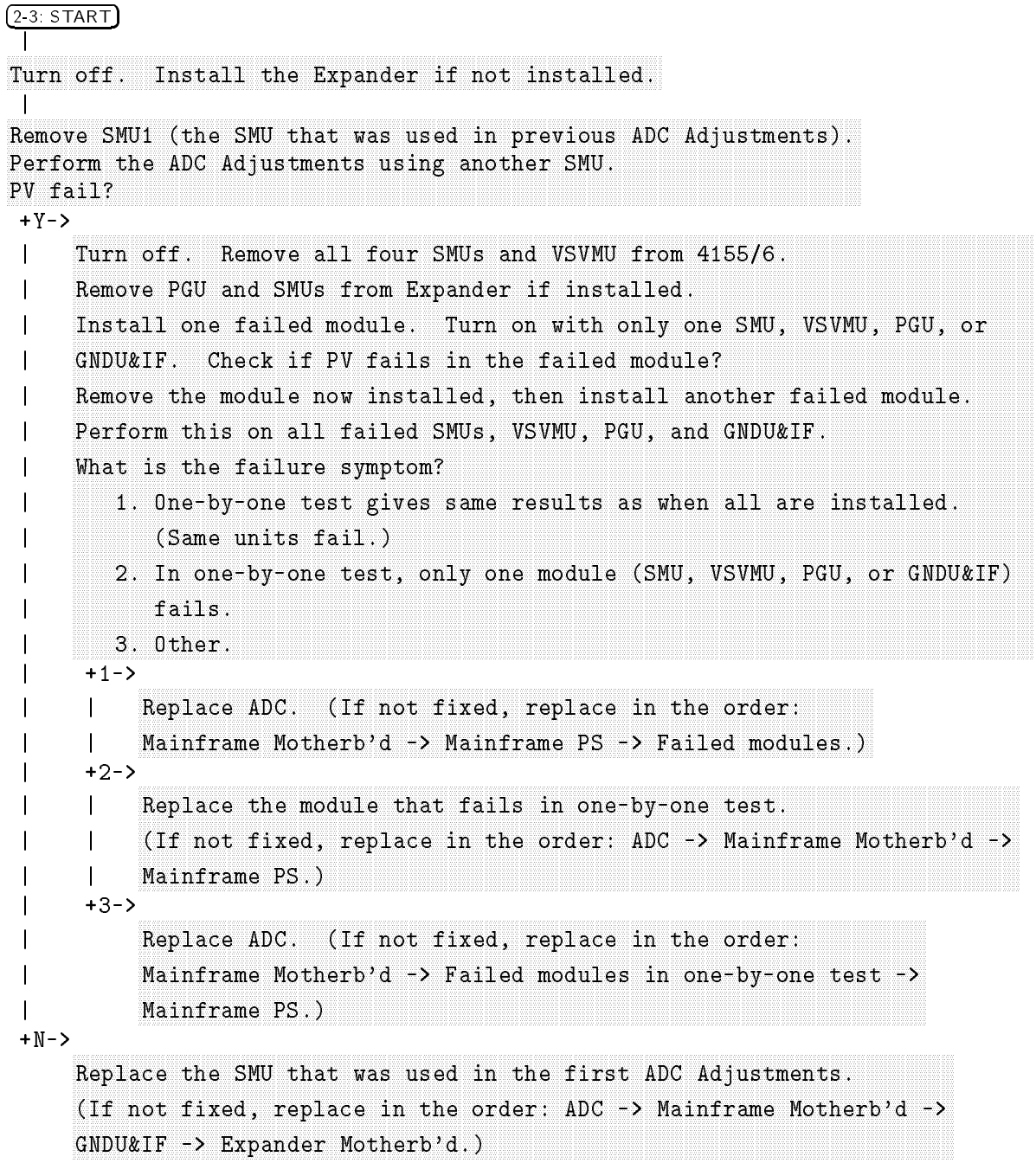
2-2-1: START (HPSMU)

```
 |
Remove PGU and HPSMU if installed.  Remove one SMU from Mainframe, and
install it into the HPSMU slot that has the connector.
PV Fail?
 |
 +Y->
 |    Replace GNDU&IF.  (If not fixed, replace in
 |    the order: ADC -> PGU(if installed)  -> Expander Motherb'd ->
 |    Expander PS -> HPSMU.)
 +N->
      Replace HPSMU.  (If not fixed, replace in
      the order: Expander PS -> GNDU&IF -> ADC -> Expander Motherb'd.)
```

2-2-2: START (MPSMU)

```
 |
Disconnect Expander from Mainframe.
Remove one SMU from Mainframe, and
install one failed MPSMU of Expander into Mainframe.  Do PV.
Repeat this on the other failed MPSMU if the other MPSMU of Expander
also fails the PV.
PV fail in either or both MPSMUs?
 +Y->
 |    Replace the failed MPSMU.  (If not fixed,
 |    replace in the order: GNDU&IF -> Expander Motherb'd.)
 +N->
      Replace GNDU&IF.  (If not fixed, replace in the order:
      ADC -> Expander Motherb'd -> Expander PS.)
```

2-3: PV Fails in Both the 4155/6 Mainframe and Expander



Memo

If ADC Adjustment Fails

If the measured value of Voltage/Resistance Reference in the ADC Adjustment exceeds the limit, or cannot be registered, perform the following troubleshooting.

V/R Reference Measured Value Exceeds Limit

To register the measured V/R Reference values using the PV4155, those values must be within the following table limits, which are checked by the PV4155. If exceeding the limit, the ADC or something has a failure.

Table 4-2. V/R Reference Limits

Reference	Limit at Measurement (Average of 3 Measurements)	Max. Measurement Dispersion of 3 Measurements (Measurement Repeatability)
+7V Reference	+6.95 V ±0.42 V[1] (+6.53 to +7.37 V, ±6.043%)	30 μV
−7V Reference	−6.95 V ±0.42 V[1] (−6.53 to −7.37 V, ±6.043%)	30 μV
100 Ω	100 Ω ±0.5 Ω (99.5 to 100.5 Ω, ±0.5%)	5 mΩ
10 kΩ	10 kΩ ±50 Ω (9950 to 10050 Ω, ±0.5%)	0.5 Ω
1 MΩ	1 MΩ ±5 kΩ (995 to 1005 kΩ, ±0.5%)	50 Ω
100 MΩ	100 MΩ ±1 MΩ (99 to 101 MΩ, ±1%)	50 kΩ

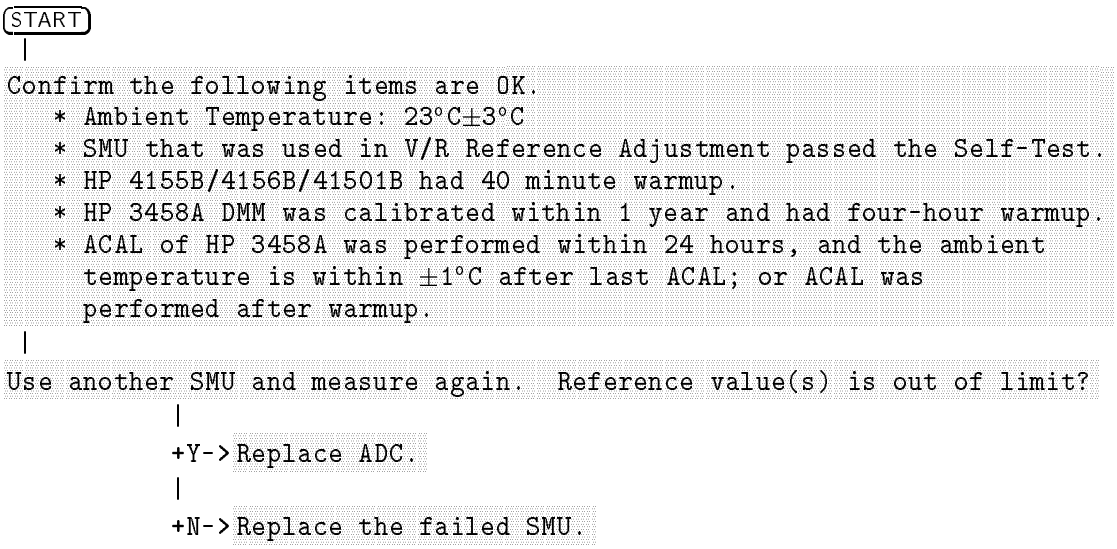
1 The difference of +7V and −7 References must be within 0.3%

Note

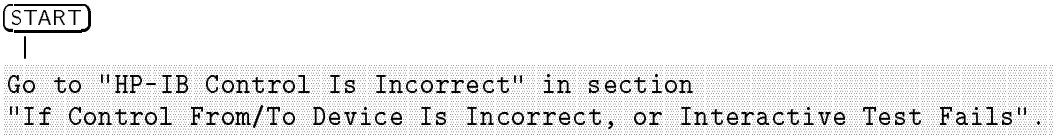
The long-term stability of the +7 V Reference should be within about 0.01%/year. Therefore, the change from the last year calibration will be within about ±700 μV. If you get the value over ±700 μV, retry the measurement and confirm whether you get the correct value.

For R References, the stabilities are:

- 100 Ω: about 0.1%/year
- 10 kΩ: about 0.04%/year
- 1 MΩ: about 0.1%/year
- 100 MΩ: about 0.5%/year



V/R Reference Measured Value Within Limits Cannot Be Registered



If Control From/To Device Is Incorrect, Or Interactive Test Fails

Note For LCD failure, go to “If Part of LCD Is Wrong, Dark, or No Display, or If Color of Power-On Page Is Incorrect.”.

HP-IB Control Is Incorrect

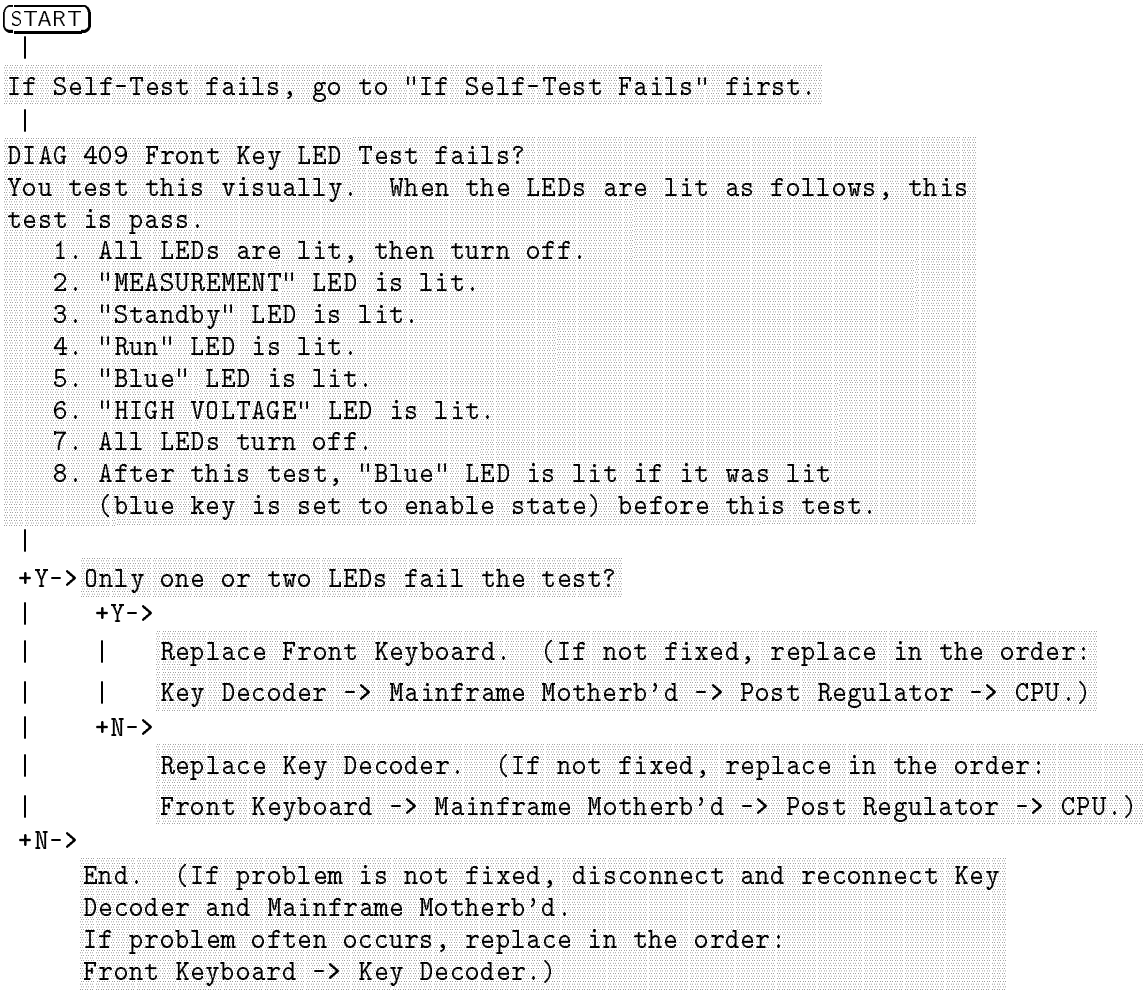
Failure cause is usually CPU (HP-IB Buffer/Driver/Controller), HP-IB Cable, or HP-IB Connector.

```
START
 |
NOTE: If you send HP-IB commands from a computer, you must set
the HP 4155B/4156B to "NOT SYSTEM CONTROLLER".  If this is not set,
HP 4155B/4156B does not respond to HP-IB commands.

If Self-Test fails, go to "If Self-Test Fails" first.
 |
Remove HP-IB cable and perform CPU HP-IB Controller Self-Test.  Fail?
 |
 +Y->Replace CPU.
 |
 +N->
     Replace HP-IB cable and execute the failed HP-IB control commands
     again.  Fail?
      |
      +Y->Replace CPU
      |
      +N->Replace HP-IB cable
```

Note If you use a printer/plotter that the HP 4155B/4156B does not support, the operation will not be guaranteed.

LED Display Is Incorrect, or Front Key LED Test Fails



Parallel I/F Control is Incorrect, or Parallel I/F Test Fails

Failure cause is usually CPU (Buffer/Driver), cable, or connector because the Self-Test (305 Parallel I/F Controller Self-Test) passes.

Note

- During DIAG 401 Parallel I/F Interactive test, do not touch any key and rotary knob, and do not send any command to HP 4155B/4156B. If you do, this test might fail.
- If you use a printer/plotter that the HP 4155B/4156B does not support, the operation will not be guaranteed.
- If Self-Test fails, go to "If Self-Test Fails" first.

```
START
 |
DIAG 401 Parallel I/F test fails?
(Parallel I/F Test Adapter (P/N: 04155-61632) is needed in the test.)
 |
 +Y->Replace CPU.
 +N->
     Replace parallel I/F cable.
```

Ext Trig In/Out Control is Incorrect, or Trigger Input/Output Test Fails

```
START
 |
If Self-Test fails, go to "If Self-Test Fails" first.
 |
Check the following:
* BNC cable (open/short test).
* Trigger In/Out settings on MEAS: OUTPUT SEQ page.
* Instrument that is connected to Ext Trig In or Out terminal has TTL
  trigger signal and 20 μs or longer trigger pulse width.
 |
DIAG 402 Trigger Input/Output test fail?
 +Y->
 |   Replace CPU.  (If not fixed, replace in the order of: Post Regulator ->
 |   Mainframe Motherb'd -> Mainframe PS.)
 |
 +N->
     Replace CPU.
     (CPU failure cause is usually that short pulse width is not recognized,
     or that Input/Output Buffer of CPU exceeds the TTL specification.
     This test is performed with about 1 ms width pulse.
     Less than about 1 ms pulse is not tested.  (But generally it is
     OK if DIAG 402 Trigger Input/Output test is OK.) )
```

Intlk or External LED Control is Incorrect, or Interlock & LED Test Fails

Note

- See “Performing the Interactive Tests” in next chapter if you get to know the Intlk and LED control.
- If Self-Test fails, go to “If Self-Test Fails” first.

Intlk Control is Incorrect

```
START
 |
DIAG 403 INTLK&LED test fail?
 +Y->
 |    If cable, Interlock switch, and related connections are OK, replace
 |    CPU.
 +N->
      End.  4155/6 has no problem.  Correct the Interlock switch circuit
      made by user.
```

External LED Control is Incorrect

```
START
 |
DIAG 403 INTLK&LED test fail?
 +Y->
 |    If the external LED, cable, and related connections are OK, replace
 |    CPU.
 +N->
      End.  4155/6 has no problem.  Correct the external LED circuit made
      by user.
```

Front Panel HIGH VOLTAGE LED Control is Incorrect

```
START
 |
Go to "LED Display Is Incorrect, or Front Key LED Test Fails" in this
section.
```

FDD Read/Write is Incorrect, or Flexible Disk Read/Write Test Fails

Failure cause is usually FDD failure or diskette failure if the Post Regulator and FDD Controller passes Self-Test.

Caution

- If you use a diskette that exceeded the life specification, the FDD head can be damaged. And the damaged head damages diskettes. Usually, a diskette has life specification of 10,000,000 passes on the same track. The diskette rotation speed is 300 rpm (revolutions per minutes). Therefore, the life of that disk is 23 days (= 10^7/(300rpm×60minutes×24hours)), if you access the same track continuously.
- A broken FDD will damage the diskette. So, always use a diskette that you don't need.

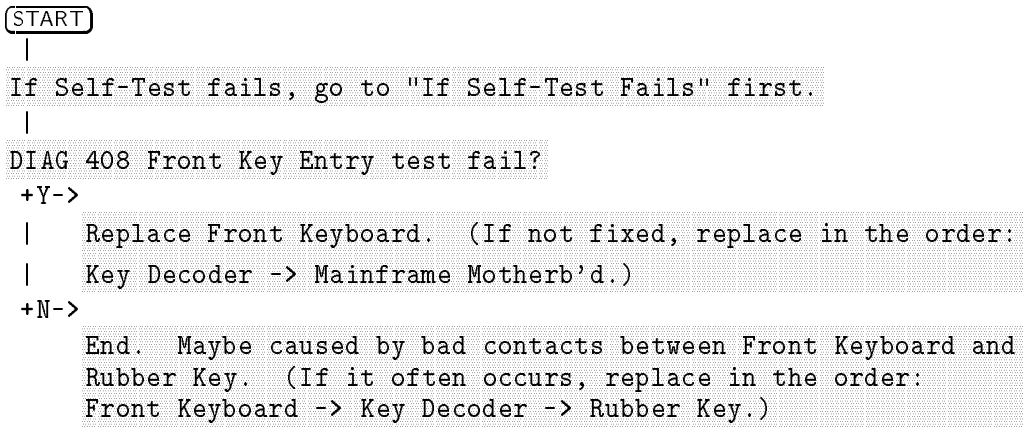
Note

- If you replace the FDD or Post Regulator, replace also the cable between the FDD and Post Regulator because cable connection becomes bad if connection and disconnection is repeated. The allowable number of connections/disconnections is 20 times.
- If Self-Test fails, go to "If Self-Test Fails" first.
- The 2HD (double-sided high density) diskette that is formatted for 2DD cannot be used for the HP 4155B/4156B.

```
START
 |
DIAG 405 Flexible Disk Read/Write test fail?  (Before this test, prepare a
3.5 inch diskette (2DD or 2HD).
Note that disk contents are erased by the test.
Also initialize the disk with MSDOS or HP LIF format using the
4155/6 SYSTEM: FILER: DISK OPERATION page if the disk is not
initialized.)
 +Y->
 |    Post Regulator fuse blown?
 |     +Y->
 |     |    Replace fuse on Post Regulator.  DIAG 405 Flexible Disk
 |     |    Read/Write test fail?
 |     |     |
 |     |     +Y-> Replace FDD, FDD cable, and fuse (if blown).
 |     |     |
 |     |     +N-> End.
 |     |
 |     +N->
 |          Replace FDD.  (If not fixed, replace in the order:
 |          Post Regulator -> CPU -> Mainframe Motherb'd.)
 +N->
      End.  4155/6 has no problem.  Check the user's diskette.  If this
      test often fails when the diskette is used within the diskette
      specification, replace FDD.
```

Control from Front Key / Rotary Knob is Incorrect, or Front Key Entry Test Fails

Failure cause is usually Front Keyboard failure (shorted line, bad contact, etc.).



Control from External Keyboard is Incorrect, or External Key Entry Test Fails

Failure cause is usually the external keyboard failure if 410 External Key Controller Self-Test passes.

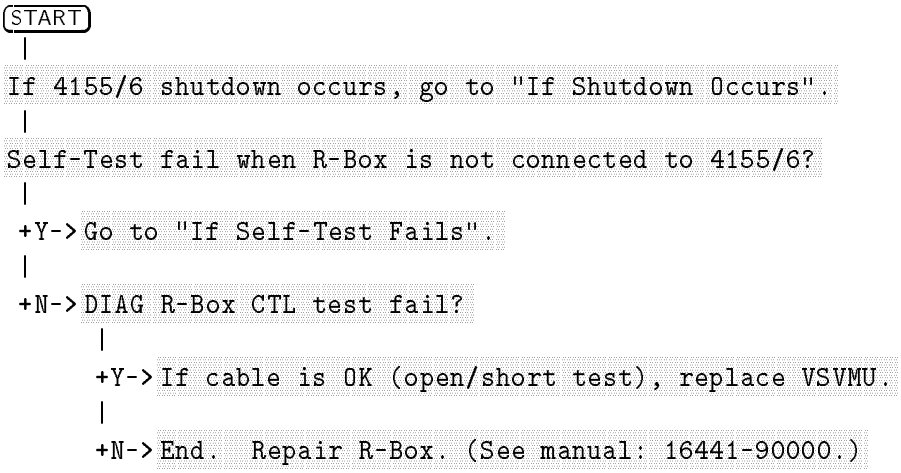
Note

- If you use a keyboard that the HP 4155B/4156B does not support, the operation will not be guaranteed.
- If Self-Test fails, go to "If Self-Test Fails" first.

```
START
 |
DIAG 411 External Key Entry test fail?
 +Y->
 |    Connect external keyboard to 4155/6.  Is an LED (Num Lock,
 |    Caps Lock, or Scroll Lock) on external keyboard lit?
 |     |
 |     +Y->Replace external keyboard.  DIAG 411 External Key Entry test fail?
 |     |     +Y->
 |     |     |    Replace Key Decoder.  (If not fixed, replace Front Keyboard.)
 |     |     |
 |     |     +N->End.  (If not fixed, replace Front Keyboard.)
 |     |
 |     +N->On "Keyboard" interface on front panel,  check voltage
 |          on power supply line for keyboard, which is center pin of left row in
 |          "Keyboard" interface.  4.5 V to 5.5 V?
 |           |
 |           |  Keyboard Interface Pin Assignment:
 |           |
 |           |       No connection --> o  o <-- clock (5V at open)
 |           |    Power Supply 5V --> o    o <-- GND
 |           |        No connection --> oo <-- data (5V at open)
 |           |
 |           |       The clock signal is forced when an external keyboard is connected.
 |           |
 |           +Y->Replace external keyboard.  DIAG 411 External Key Entry test fail?
 |           |     |
 |           |     +Y->Replace Key Decoder.  (If not fixed, replace Front Keyboard.)
 |           |     |
 |           |     +N->End.  (If not fixed, replace Front Keyboard.)
 |           |
 |           +N->Key Decoder fuse (F1: 2110-1123) blown?
 |                 +Y->
 |                 |    Replace fuse.  DIAG 411 External Key Entry test fail?
 |                 |     +Y->
 |                 |     |    Replace external keyboard.  (If not fixed,
 |                 |     |    replace in the order: Key Decoder -> Front Keyboard.)
 |                 |     |
 |                 |     +N->End.
 |                 |
 |                 +N->Replace Front Keyboard.  (If not fixed, replace Key Decoder.)
 +N->
      End.  Maybe caused by bad contacts between 4155/6 and external keyboard.
      (If it often occurs, replace in the order: Front Keyboard -> Key Decoder.)
```

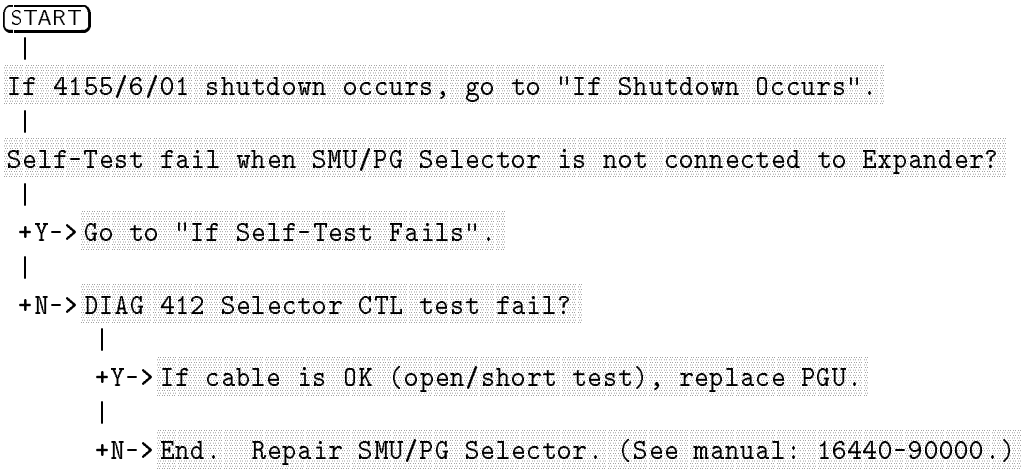
R-Box Control is Incorrect, or R-Box Control Test Fails

Failure cause is usually R-Box failure if VSVMU passes the Self-Test. (R-Box control path in the VSVMU is: Control Logic (gate array) → Buffer → **To R-Box** Connector)



SMU/PG Selector Control is Incorrect, or SMU/PGU Selector Control Test Fails

Failure cause is usually HP 16440A SMU/PG Selector failure if PGU passes the Self-Test. (Control path in the PGU is: Control Logic (gate array) → Buffer → **To SMU/Pulse Generator Selector Interface** Connector)



5

Troubleshooting Reference

Warning

The information in this manual is provided for use by service trained personnel only. To avoid electrical shock, do not perform any procedures in this manual, unless you are qualified to do so.

Potential shock hazard. Dangerous voltages may be present on the board assembly (includes shield cover) for up to 10 seconds after you set the LINE switch to OFF.

- **Power Supply Module: Max. ±340 V**
- **Other modules and Mother Board of HP 4155B/4156B: Max. ±150 V**
- **Other modules and Mother Board of HP 41501B: Max. ±270 V**

Dangerous voltages (maximum of ±340 V) may be present in the HP 41501B when the HP 41501B LINE switch is ON, even if the LINE indicator is not lit.

This chapter describes troubleshooting step details in Chapter 4, and also contains operation and reference information for troubleshooting.

Built-In Diagnostics Function

The HP 4155B/4156B/41501B is equipped with a diagnostics function. This function is separated into two large categories: Self-Tests and Interactive Tests. The Self-Tests are automatically performed without your assistance. The Interactive Tests are performed with your assistance, such as cable connection, and visual check. The following figure shows each test item of the Self-Tests and Interactive Tests.

At turn-on, the Power-On Self-Test is automatically performed. The Power-On Self-Test is all Self-Tests except that the Host DRAM test (Test 301) is partly performed.

The diagnostics function verifies that the HP 4155B/4156B/41501B is operating but does not verify that the output and measurement will be accurate.

System: CALIB/DIAG (Selfcalibration / Diagnostics) Page

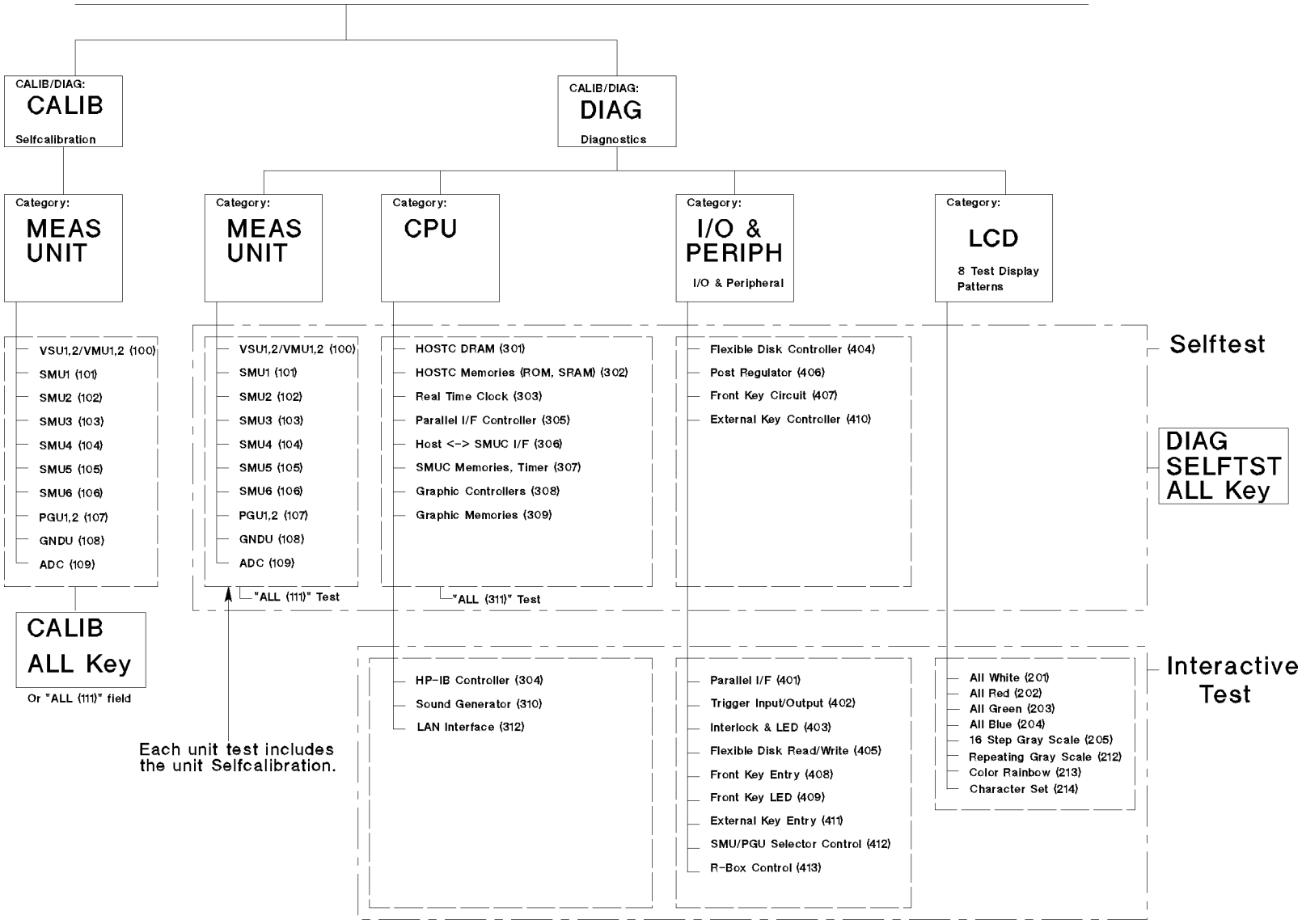


Table 5-1. Built-in Diagnostic Function (1 of 2)

Test Category	Test Name (Test Number for Remote Control)	Self	Int	Test Time[1]
Power-On Test[2]	Power-On Test	Y		30 s[3] / 50 s[4]
All Self-Tests	DIAG SELFTST ALL	Y		40 s[3] / 65 s[4]
Measurement Units	All Meas Unit Tests (111)	Y		25 s[3] / 50 s[4]
	VSU1,2/VMU1,2 (100)	Y		2 s
	SMU1 (101)	Y		6 s[5] / 4 s
	SMU2 (102)	Y		6 s[5] / 4 s
	SMU3 (103)	Y		6 s[5] / 4 s
	SMU4 (104)	Y		6 s[5] / 4 s
	SMU5 (105)	Y		4 s
	SMU6 (106)	Y		4 s
	PGU1,2 (107)	Y		18 s
	GNDU (108)	Y		2 s
	ADC (109)	Y		1 s
CPU	All CPU Self-Tests (311)	Y		8 s
	HOSTC DRAM (301)	Y		1 s
	HOSTC Memories (ROM, SRAM) (302)	Y		1 s
	Real Time Clock (303)	Y		1 s
	HP-IB Controller (304)		Y	>1 s
	Parallel I/F Controller (305)	Y		1 s
	Host <-> SMUC I/F (306)	Y		1 s
	SMUC Memories, Timer (307)	Y		3 s
	Graphic Controllers (308)	Y		1 s
	Graphic Memories (309)	Y		1 s / 35 s[6]
	Sound Generator (310)[7]			
	LAN Interface (312)		Y	>3 s
I/O&PERIPH	Parallel I/F (401)		Y	>1 s
	Trigger Input/Output (402)		Y	>1 s
	Interlock & LED (403)		Y	>2 s
	Flexible Disk Controller (404)	Y		1 s
	Flexible Disk Read/Write (405)		Y	>120 s
	Post Regulator (406)	Y		1 s
	Front Key Circuit (407)	Y		1 s
	Front Key Entry (408)		Y	>1 s
	Front Key LED (409)[8]		Y	6 s
	External Key Controller (410)	Y		1 s
	External Key Entry (411)		Y	>1 s
	SMU/PGU Selector Control (412)		Y	-
	R-Box Control (413)		Y	-

1 Approximate values. This is test time when the test passes. If the test fails, it takes more time. For Power-On test, it may take maximum 3 minutes (due to wait for response, etc.). For DIAG SELFTST ALL, it may take maximum 2 minutes.

2 All Self-Tests except a part of HOSTC DRAM (301) test are performed. Includes the startup time.

3 For HRSMUs and without HP 41501B.

4 For HPSMU and PGU in the HP 41501B, and for HRSMUs.

5 For HRSMU.

6 When performed as a single test.

7 This test is also performed in DIAG SELFTST ALL or All CPU Self-Tests.

8 This test is also performed in DIAG SELFTST ALL.

Table 5-2. Built-in Diagnostic Function (2 of 2)

Test Category	Test Name (Test Number for Remote Control)	Self	Int	Test Time
LCD (Test Patterns)	All White (201)		Y	-
	All Red (202)		Y	-
	All Green (203)		Y	-
	All Blue (204)		Y	-
	16 Step Gray Scale (205)		Y	-
	Repeating Gray Scale (212)		Y	-
	Color Rainbow (213)		Y	-
	Character Set (214)		Y	-

Note

- VSU/VMU/SMU/PGU/GNDU Self-Test: also performs the ADC Self-Test before each of these test.
- 309 Graphic Memories Self-Test: in DIAG SELFTST ALL, Power-On Test, and All CPU Self-Tests, a part of this test is performed. Usually you do not need to perform this full test. However, you should perform it if the LCD is not normal, which is a symptom of graphic memory problems.
- 401 Parallel I/F Interactive Test: during the test, do not touch any key and rotary knob, and do not send any command to HP 4155B/4156B. If you do, this test fails.
- 407 Front Key Circuit Self-Test: do not press any front keys during the test. If you do, the test might fail.
- When you perform measurement unit Self-Test, the HP 4155B/4156B first sets the unit output switch (Force/Sense/Guard) to off, then performs the test. After test, the switch is returned to on and the output is 0 V.
- When the HP 4155B/4156B performs measurement unit Self-Test, the HP 4155B/4156B also performs Self-Calibration. The Self-Calibration is used as a part of Self-Test.
- For information about the Self-Test failure, see also “If Self-Test or Self-Calibration Fails” in chapter 4 “Troubleshooting Procedures”.

Sequence of DIAG SELFTST ALL

1. Measurement Unit Self-Test
   - ADC → VSU/VMU → SMU1 → SMU2 → ... → SMU6 → PGU →GNDU
     Actually, the ADC Self-Test is performed before each measurement unit Self-Test.
2. CPU Self-Test
   - 301 → 302 → 303 → 305 → ... → 310
3. I/O & Peripheral Self-Test
   - 404 → 406 → 407 → 409 → 410

Sequence of Power-On Test

1. Boot-Up Test
   a. (LEDs are turned on.)
   b. (Beep sound stops.)
   c. ROM Checksum test (Self-Test 302).
   d. Other startup tests
   e. (LEDs are turned off.)
   f. (Copyright message is displayed.)
2. Power-On Self-Test
   a. (`step #1 / 9` is displayed.)
   b. CPU Self-Test Part 1 (tested by Host Controller)
      - 301 (short test) → 303 → 305 → 306 → 308 → 309 → 310 (880 Hz/50 ms beep only)
        The ROM Checksum test (subtest) in 302 test is not performed here, but is performed in Boot-Up Test c.
   c. I/O & Peripheral Self-Test (tested by Host Controller)
      - 404 → 406 → 407 → 409 → 410
   d. (`step #2 / 9`, `step #3 / 9`, and `step #4 / 9` are displayed. During this, a part of software initialization is performed.)
   e. (`step #5 / 9` is displayed.)
   f. CPU Self-Test Part 2 (tested by SMU Controller)
      - 307
   g. Measurement Unit Self-Test (tested by SMU Controller)
      - For HP 4155B
        i. ADC → SMU1 → SMU2 → SMU3 → SMU4 → VSVMU
        ii. SMU5 → SMU6 → PGU → GNDU
      - For HP 4156B
        i. ADC → SMU1 (Error code 10x20 – 10x23 part) → ... → SMU4 (10x20 – 10x23 part) → VSVMU
        ii. SMU5 → SMU6 → PGU → GNDU → SMU1 (10x24 – 10x26 part) → ... → SMU4 (10x24 – 10x26 part)

h. (The Host Controller receives the Self-Test result (CPU Self-Test Part2 and Measurement Unit Self-Test results) from the SMU Controller. If the Self-Test result is not sent from the SMU Controller due to hardware failure within 90 seconds after displaying `step #5 / 9`, the Host Controller does not receive the result, and goes to next step. This can be caused by SMU Controller fail, Self-Test 306 fail, +5Va fail, instrument emergency status, and so on. The SMU Controller also does not send the result to Host Controller when the hardware is in an abnormal condition (emergency status).)
i. (`step #6 / 9` is displayed, and the hardware initialization is performed.)
j. (`step #7 / 9` is displayed, and the rest of software initialization is performed.)
k. (`step #8 / 9` is displayed, and customized files are loaded if exists.)
l. (`step #9 / 9` is displayed, which shows all the tests are complete.)

Note

- If Boot-Up Test fails, the HP 4155B/4156B might not be able to perform any controls including the HP-IB control.
- If ROM checksum test fails, MEASUREMENT LED blinks. Also, HIGH VOLTAGE LED is lit, other LEDs turn off, and LCD is blank. These are caused due to CPU module failure.

Performing the Self-Test

Required Equipment

- None

Procedure

- Select (SYSTEM), `CALIB/DIAG`, `DIAG SELFTST ALL`.

Note

- For DIAG SELFTST ALL, pass/fail is displayed at bottom of LCD as `DIAG SELF-TEST ALL: PASS` or `DIAG SELF-TEST ALL: FAIL`.
- If a failure exists, the Self-Test execution may take a maximum of 2 minutes.
- 407 Front Key Circuit Self-Test: do not press any front keys during the test. If you do, the test might fail.
- If ambient temperature changes rapidly, or the instrument is not warmed up, Self-Test may fail. When the HP 4155B/4156B passes the Self-Test after warmup, the HP 4155B/4156B is working correctly.

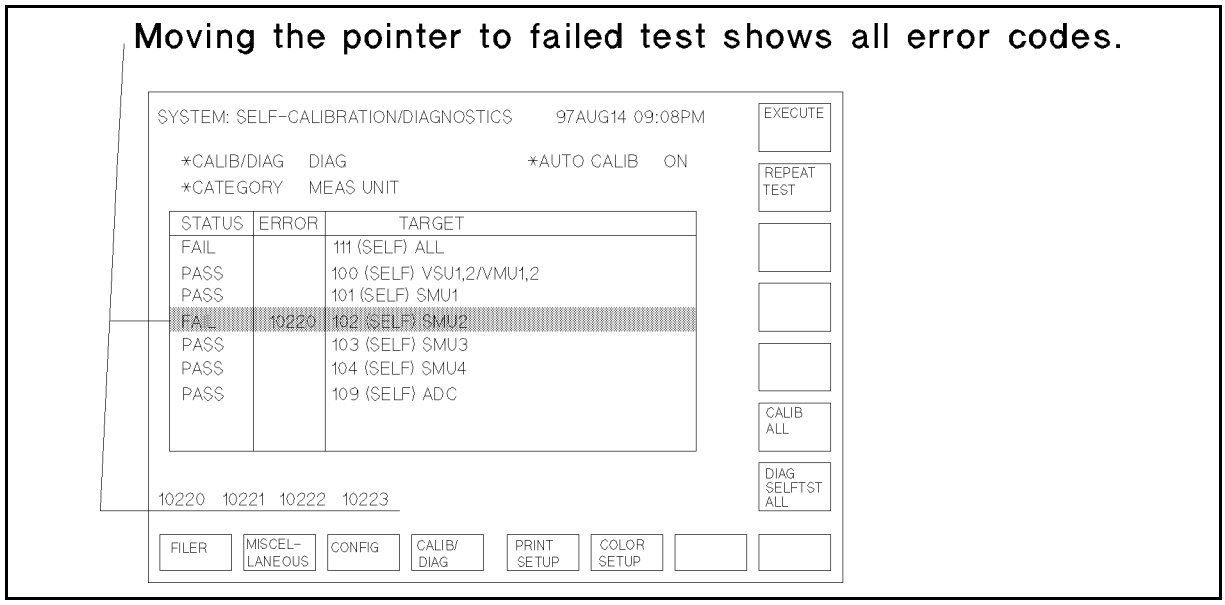


Figure 5-1. Reading All the Error Codes For Front Panel Operation

Note

- For front panel operation, even if two or more of error codes occur in each Self-Test item, only one error code is displayed in the error code field. To read all error codes, move the cursor to the failed test item field. All error codes will be displayed at bottom of the LCD.
- Each Self-Test item can have the first seven test error codes. If you perform the DIAG SELFTEST ALL, CPU ALL, or MEAS UNIT ALL test, and seven error codes appear, perform the failed test (subtest) item individually to get all error codes.

  For example, if SMU1, SMU2, and SMU3 fail in DIAG SELFTST ALL, and the first seven error codes are for SMU1 and SMU2, no error code is displayed for the SMU3 test even if it fails. Also, all error codes for SMU2 may not be displayed. In this case, perform SMU2 and SMU3 tests individually, respectively. So you can see up to seven error codes for each test (SMU2 and SMU3 tests).

From HP-IB

To perform the Self-Test from a computer via HP-IB, execute the following program.

Note

- Before you execute the following program from a computer, set the HP 4155B/4156B to NOT SYSTEM CONTROLLER. If you execute this program with SYSTEM CONTROLLER, the HP 4155B/4156B does not respond.
- ":DIAG:TEST:ERR?" does not return the response data (DIAG error codes) if you specify a unit that is not installed. Instead, System error 180 "Illegal setup. Target module is not installed." occurs.
- For the following program, you cannot perform Self-Test 309. See "Performing Only CPU Self-Test 309 from HP-IB".

```
10  DIM Diag_err$[42]
20  A=717                 ! Specify the HP-IB address.
30  CLEAR A
40  OUTPUT A;"*RST;*CLS"  ! Set to power-on default conditions.
50  !
70  DATA 404, 406, 407, 410, 311                        ! Selftest No
80  DATA 109, 100, 101, 102, 103, 104, 105, 106, 107, 108
100 No_of_tests=15
110 !
120 FOR I=1 TO No_of_tests
130   READ Test_no
140   OUTPUT A;":DIAG:TEST";Test_no ! Start Selftest.
160   PRINT "Test#";Test_no;": ";
170   Get_sys_err(A,Err_flag)       ! Check system errors.
180   IF Error_flag=0 THEN          ! If no system error.
190     OUTPUT A;";*WAI;:DIAG:TEST:ERR?";Test_no  ! Get DIAG error codes.
200                                 ! *WAI: Wait for Selftest completion.
210     ENTER A; Diag_err$
220     PRINT "DIAG Error Codes-- ";Diag_err$
230     Get_sys_err(A,Err_flag)     ! Check System Errors.
240   END IF
250 NEXT I
260 PRINT "Completed."
270 END
280 SUB Get_sys_err(A,Err_flag) ! Check System Errors and print them.
290   DIM Sys_err$[100]
300   Err_flag=0
310   FOR I=1 TO 5                  ! Can record up to first five system
320     OUTPUT A;":SYST:ERR?"       !                              errors.
330     ENTER A;Sys_err,Sys_err$
340     IF Sys_err=0 THEN
350       SUBEXIT
360     ELSE
370       PRINT "System Error";Sys_err;Sys_err$
380       Err_flag=1
390     END IF
400   NEXT I
410 SUBEND
```

The result from the HP-IB control will be shown like below.

```
Test# 404 : DIAG Error Codes-- 0             <-- 0: No error
Test# 406 : DIAG Error Codes-- 0
Test# 407 : DIAG Error Codes-- 0
Test# 410 : DIAG Error Codes-- 0
Test# 311 : DIAG Error Codes-- 0
Test# 109 : DIAG Error Codes-- 0
Test# 100 : DIAG Error Codes-- 0
Test# 101 : DIAG Error Codes-- 0
Test# 102 : DIAG Error Codes-- 10220,10221,10222,10223,10224,10225
Test# 103 : DIAG Error Codes-- 0
Test# 104 : DIAG Error Codes-- 0
Test# 105 : DIAG Error Codes-- 0     <-- SMU5=HPSMU, SMU6 not installed.
Test# 106 : System Error 180 "Illegal setup. Target module is not installed."
Test# 107 : DIAG Error Codes-- 10760,10766,10768,10772,10761,10767,10769
Test# 108 : DIAG Error Codes-- 0
  Completed.
```

Performing Only Post Regulator Self-Test from Front Panel

To perform only the "Post Regulator" Self-Test from front panel, select (SYSTEM), CALIB/DIAG, DIAG, IO & PERIPH, and using (⇩), move the pointer to 406 (SELF) Post Regulator, then EXECUTE.

Performing Only CPU Self-Test from HP-IB

```
10  DIM Err$[42]
20  A=717                ! Specify the 4155B/4156B HP-IB address.
30  CLEAR A
40  OUTPUT A;"*rst;*cls" ! Set to power-on default conditions.
50  !
60  Test_no=311          ! 311: Test number of CPU Selftest
70  OUTPUT A;":diag:test";Test_no;";*wai;:diag:test:err?";Test_no
80  ENTER A;Err$         ! *WAI: Wait for Selftest completion.
90  PRINT "Error Code: ";Err$
100 END
```

Note

- If a failure exists, the Self-Test execution may take maximum 2 minutes.
- Before you execute the above program from a computer, set the HP 4155B/4156B to NOT SYSTEM CONTROLLER. If you execute this program with SYSTEM CONTROLLER, the HP 4155B/4156B does not respond.

Performing Only Post Regulator Self-Test from HP-IB

```
10  DIM Err$[42]
20  A=717                ! Specify the 4155B/4156B HP-IB address.
30  CLEAR A
40  OUTPUT A;"*RST;*CLS" ! Set to power-on default conditions.
50  !
60  Test_no=406          ! 406: Test number of Post Reg. Selftest
70  OUTPUT A;":DIAG:TEST";Test_no;";*WAI;:DIAG:TEST:ERR?";Test_no
80  ENTER A;Err$         ! *WAI: Wait for Selftest Completion.
90  PRINT "Error Code: ";Err$
100 END
```

Note

- If a failure exists, the Self-Test execution may take maximum 2 minutes.
- Before you execute the above program from a computer, set the HP 4155B/4156B to NOT SYSTEM CONTROLLER. If you execute this program with SYSTEM CONTROLLER, the HP 4155B/4156B does not respond.

Performing Only CPU Self-Test 309 from HP-IB

```
10  DIM Err$[42]
20  A=717                ! Specify the 4155B/4156B HP-IB address.
30  CLEAR A
40  OUTPUT A;"*rst;*cls" ! Set to power-on default conditions.
50  !
60  Test_no=309          ! 309: CPU Graphic Memories (DRAM, VRAM) Selftest
70  OUTPUT A;":diag:test";Test_no;";*wai;:diag:test:err?";Test_no
80  !
90  REPEAT               ! Wait for message to be displayed.
100   OUTPUT A;":diag:test:RES?"
110   ENTER A;Result
120 UNTIL Result=-1      ! -1: Pause Status, -3: During Test
130 !
140 OUTPUT A;":diag:test:cont"   ! Send "Continue" instruction.
150 !
160 T1=TIMEDATE
170 Wait_time=90         ! Wait for reboot (90 s).
180 LOOP                 ! Display elapsed time.
190   T2=TIMEDATE
200   DISP T2-T1;"sec", "(Wait for ";Wait_time;"sec)"
210   WAIT 1
220 EXIT IF (T2-T1) > Wait_time
230 END LOOP
240 BEEP
250 !
260 OUTPUT A;":diag:test:err?";Test_no
270 ENTER A;Err$
280 PRINT "Error Code: ";Err$
290 END
```

Note

- When the single test of Self-Test 309 is complete, the HP 4155B/4156B automatically restarts up. In that restart, no Self-Test is performed.
- If CPU Self-Test 309 fails, the result is displayed as follows:
  - After the test and automatic restart, the result is displayed in the 309 test field of the DIAGNOSTICS page.
  - If the test fails, MEASUREMENT LED is blinking until automatic restart.
- If a failure exists, the Self-Test execution may take maximum 2 minutes.
- Before you execute the above program from a computer, set the HP 4155B/4156B to `NOT SYSTEM CONTROLLER`. If you execute this program with `SYSTEM CONTROLLER`, the HP 4155B/4156B does not respond.
- In the above program, `Wait_time` for restart is set to 90 seconds, which is maximum restart time when the HP 4155B/4156B has a hardware failure. When the HP 4155B/4156B has no hardware failure, you can change it to 10 seconds, which is normal restart time.

Performing the Interactive Tests

The DIAGNOSTICS page Interactive (INT.) tests consist of:

- In the CPU Category:
  - HP-IB Controller test
  - Sound Generator test
  - LAN Interface test
- In the I/O & PERIPHeral Category:
  - Parallel I/F test
  - Trigger Input/Output test
  - Interlock & LED test
  - Flexible Disk Read/Write test
  - Front Key Entry test
  - Front Key LED test
  - External Key Entry test
  - Selector Control test (only for with the HP 41501B)
  - R-Box Control test
- In the LCD (Test Pattern) Category:
  - All White
  - All Red
  - All Green
  - All Blue
  - 16 Step Gray Scale
  - Repeating Gray Scale
  - Color Rainbow
  - Character Set

Note

This section describes the front panel operation. But you can do the Interactive Tests (except 304 HP-IB Controller Test) from remote. In the case, see the *SCPI Command Reference*.

HP-IB Controller Test

Note that this test asserts the SRQ, and this test fails if an external HP-IB device asserts the SRQ during this test. To test correctly, disconnect the HP-IB cable from the HP 4155B/4156B.

Required Equipment

- None

Procedure

1. Remove the HP-IB cable from the HP 4155B/4156B. Or turn off the all external HP-IB devices if they are connected.
2. Perform the test.

Sound Generator Test

Required Equipment

- None

Procedure

1. Confirm that a sound (440 Hz) generates for about 1 second, and higher-pitched sound (880 Hz) for about 1 second.

DIAG Selftest All and CPU Selftest All also performs the Sound Generator test routine. In the Power-On Test, a sound (880 Hz) generates for about 50 ms.

LAN Interface Test

Required Equipment

- LAN I/F Test Adapter (04155-61631)

Procedure

1. Attach LAN I/F Test Adapter (HP P/N 04155-61631, which is shorted between Pin 1&3 and between 2&6, and has no connections for other pins) to the **LAN** connector on the rear.
2. Press the `CONTINUE` softkey.

Parallel I/F Test

Note that during the test, do not touch any key and rotary knob, and do not send any commands to the HP 4155B/4156B. Or this test fails.

Required Equipment

- Parallel Interface Test Adapter (04155-61632)

Procedure

1. Attach Parallel Interface Test Adapter (HP P/N 04155-61632, which is shorted between Pin 1&10, between 14&15, between 16&11, and between 17&12) to the **Parallel Interface** connector on the rear.
2. Press the `CONTINUE` softkey.

Parallel Interface (25-Pin) Pin Assignment

Table 5-3. Parallel Interface (25-Pin) Pin Assignment

Pin No[1]	Signal (Direction)	Pin No[2]	Signal (Direction)
1	nSTROBE (Out)	14	nAUTOFD (Out)
2	DATA1 (Out)	15	nFAULT (In)
3	DATA2 (Out)	16	nINIT (Out)
4	DATA3 (Out)	17	nSELECTIN (Out)
5	DATA4 (Out)	18	GND
6	DATA5 (Out)	19	NC[3]
7	DATA6 (Out)	20	NC
8	DATA7 (Out)	21	NC
9	DATA8 (Out)	22	NC
10	nACK (In)	23	NC
11	BUSY (In)	24	NC
12	ERROR (In)	25	NC
13	SELECT (In)	-	-

1 Upper row numbered from left.

2 Lower row numbered from left.

3 No connection.

Trigger Input/Output Test

Required Equipment

- BNC Cable

Procedure

1. Connect **Ext Trig In** and **Out** connectors on the rear panel with a BNC cable.
2. Press the `CONTINUE` softkey.

Interlock & LED Test

Required Equipment

- INTLK Test Adapter (04155-65003), or HP 16442A Test Fixture
- INTLK Cable, 1.5 m (04155-61614 or 16493J Opt 001); or 3 m (16493J Opt 002)

Procedure

When you use the INTLK Test Adapter.

1. Connect the **Intlk** terminal and INTLK Test Adapter with the INTLK Cable.
2. Set the INTLK Test Adapter switch to **1** (ON).
3. If `Interlock switch is: CLOSED` is displayed, and the HIGH VOLTAGE LED is lit, and the INTLK Test Adapter LED is lit, the (Intlk Short) test is pass.
4. Set the INTLK Test Adapter switch to **0** (OFF).
5. If `Interlock switch is: OPEN` is displayed, and the HIGH VOLTAGE LED is not lit, and the INTLK Test Adapter LED is not lit, the (Intlk Open) test is pass.

When you use the HP 16442A Test Fixture.

1. Connect the **Intlk** terminal and the HP 16442A with the INTLK Cable.
2. Close the HP 16442A Lid.
3. If `Interlock switch is: CLOSED` is displayed, and the HIGH VOLTAGE LED is lit, and the HP 16442A High Voltage LED is lit, the (Intlk Short) test is pass.
4. Open the HP 16442A Lid.
5. If `Interlock switch is: OPEN` is displayed, and the HIGH VOLTAGE LED is not lit, and the HP 16442A High Voltage LED is not lit, the (Intlk Open) test is pass.

Block Diagram of Intlk Control

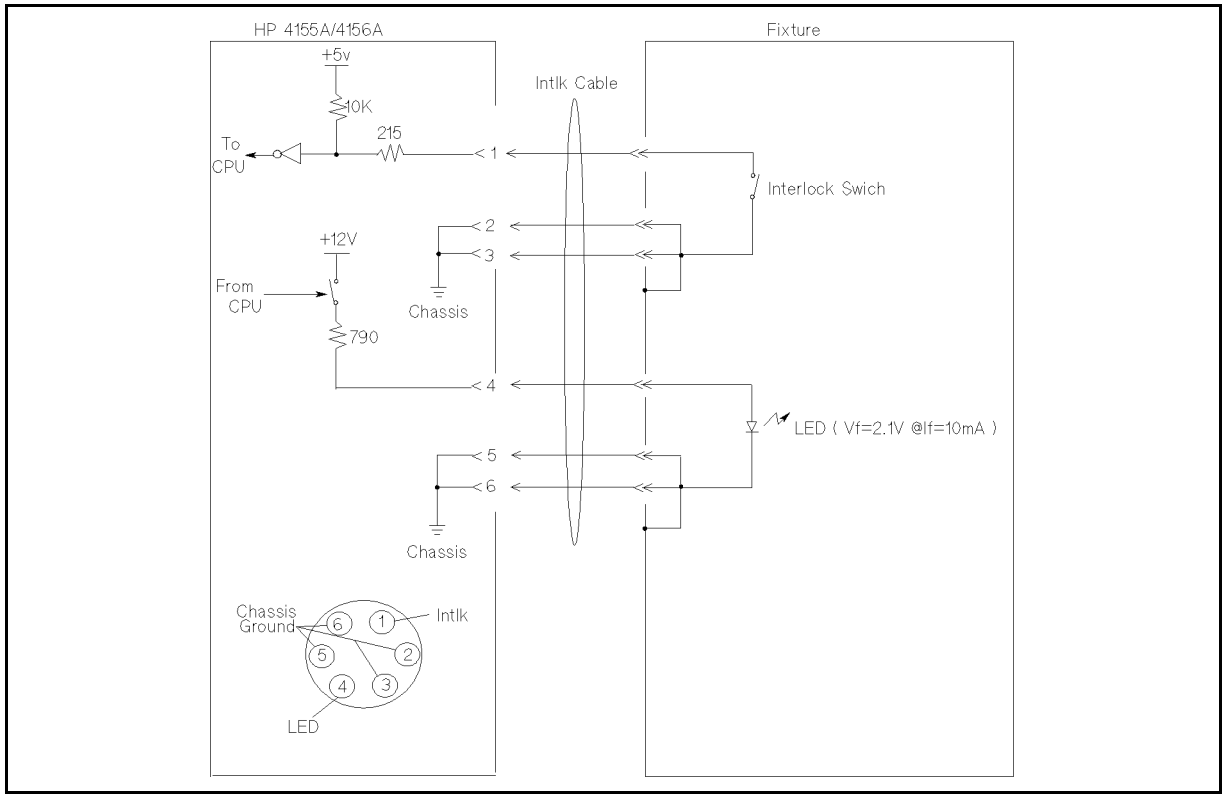


Figure 5-2. Block Diagram of Intlk Control

Intlk connector pin assignment is:

Top right line (Pin 1)	Intlk line. When you want to force a voltage greater than 40 V, this line must be set to low (or chassis ground). If you do not apply any voltage to this line, this line has 5 V (Serial resistance is 10 kΩ), and the HP 4155B/4156B cannot force high voltages. In the HP 16442A Test Fixture, when the fixture lid is opened, the Intlk line is open. And when it is closed, the Intlk line is connected to chassis ground.
Bottom left line(Pin 4)	External LED drive line. The 16442A Test Fixture uses this line for the fixture LED. When forcing high voltages, this line is active (2 V if LED is connected. 12 V if nothing is connected. Serial resistance is 790 Ω.). When not forcing high voltages, this line is open. The LEDs that have the characteristics of "Vf = 2.1 V at If = 10 mA" are recommended as the external LED. Note that part number 16087-60013/-60014/-60015 Warning Indicator (which is recommended when you use the HP 41423A High Voltage Source/Monitor Unit for the HP 4142B) should not be used as the External LED for the HP 4155B/4156B.
Other lines (Pin 2/3/5/6)	Return current lines for Interlock switch and external LED. In the HP 16442A Test Fixture, Pin 2 and 3 are for Interlock switch, and Pin 5 and 6 are for LED.

Flexible Disk Read/Write Test

Required Equipment

- 3.5-Inch Floppy Disk (2DD)
- 3.5-Inch Floppy Disk (2HD)

Procedure

1. Before the test, initialize the disk with DOS or HP LIF format if it is not initialized. You can also do it on the SYSTEM:FILER page.
2. Remove a disk if it is inserted. Press the `CONTINUE` softkey.
3. Insert a disk. Press the `CONTINUE` softkey.
4. Check whether the displayed `Format` (`HP LIF` or `DOS`) and `Media` (`2HD` or `2DD`) is correct or not.
5. Perform this test on 2HD and 2DD.

Front Key Entry Test

Required Equipment

- None

Procedure

1. Press any key on the front panel.
2. If the pressed key is displayed, the test is pass.
3. Rotate the Knob clockwise on the front panel.
4. If `The knob turned : CW` is displayed, the test is pass.
5. Rotate the Knob counter-clockwise on the front panel.
6. If `The knob turned : CCW` is displayed, the test is pass.

Front Key LED Test

Required Equipment

- None

Procedure

Front Key LED test is confirmed visually. When the LEDs are lit as follows, this test pass.

1. All LEDs are lit, then turn off.
2. “MEASUREMENT” LED is lit.
3. “Standby” LED is lit.
4. “Run” LED is lit.
5. “Blue” LED is lit.
6. “HIGH VOLTAGE” LED is lit.
7. All LEDs turn off.
8. After this test, “Blue” LED is lit if it was being lit (if the blue key is set to enable state) before this test.

DIAG Selftest All also performs the Front Key LED test routine.

External Key Entry Test

Required Equipment

- Keyboard. Use a keyboard that is supported by the HP 4155B/4156B.

Procedure

1. Press any key on the external Keyboard.
2. If the pressed key is displayed, the test is pass.

SMU/PGU Selector Control Test

Note If the HP 41501B does not have the PGU, this test does not appear on the DIAGNOSTICS page.

Required Equipment

- Voltmeter (accuracy $\leq \pm 1\%$)
- 2 Mini Pin Plug - Banana Plug Cable (04155-61653)
- Banana Plug - Banana Plug Cable

Procedure

1. Select (SYSTEM), `CALIB/DIAG`, `DIAG`, `I/O & PERIPH`, `412 (INT.) Selector CTL` field, and `EXECUTE`.

2. To perform 20 V Line Test, connect as follows, and measure the voltage. If it is within the test limit that is shown in the following table, it passes.

   a. Selector Interface Pin 7 ↔ 04155-61653 Black wire
   b. 04155-61653 Black wire pin jack↔ 04155-61653 Red wire pin
   c. Voltmeter High ↔ 04155-61653 Banana plug
   d. Voltmeter Low ↔ Circuit Common Terminal, with Banana plug - banana plug cable

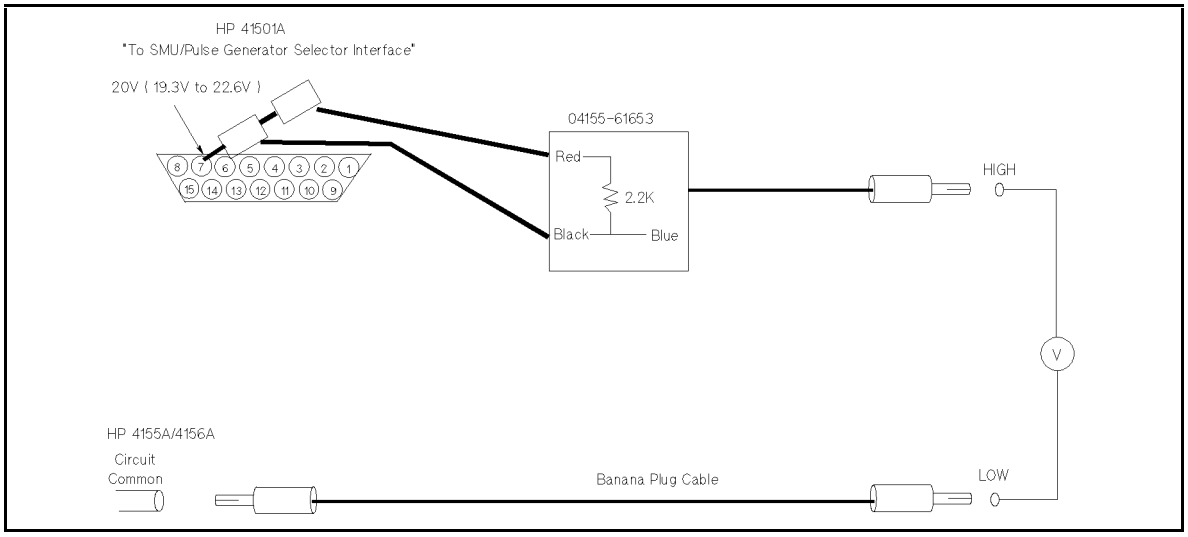


Figure 5-3. 20 V Line Test

Table 5-4. 20 V Line Test

Pin No	Test Limit
Pin 7 (20 V)	19.3 V to 22.6 V

3. To perform Control Lines Test, connect as follows, and measure the voltages as shown in the following tables.

   a. Selector Interface Pin 7 ↔ 04155-61653 Red wire
   b. Voltmeter High ↔ 04155-61653 Banana plug
   c. Voltmeter Low ↔ Circuit Common Terminal, with Banana plug - banana plug cable
   d. 04155-61653 Black wire ↔ Specified pin that is shown in the following table.

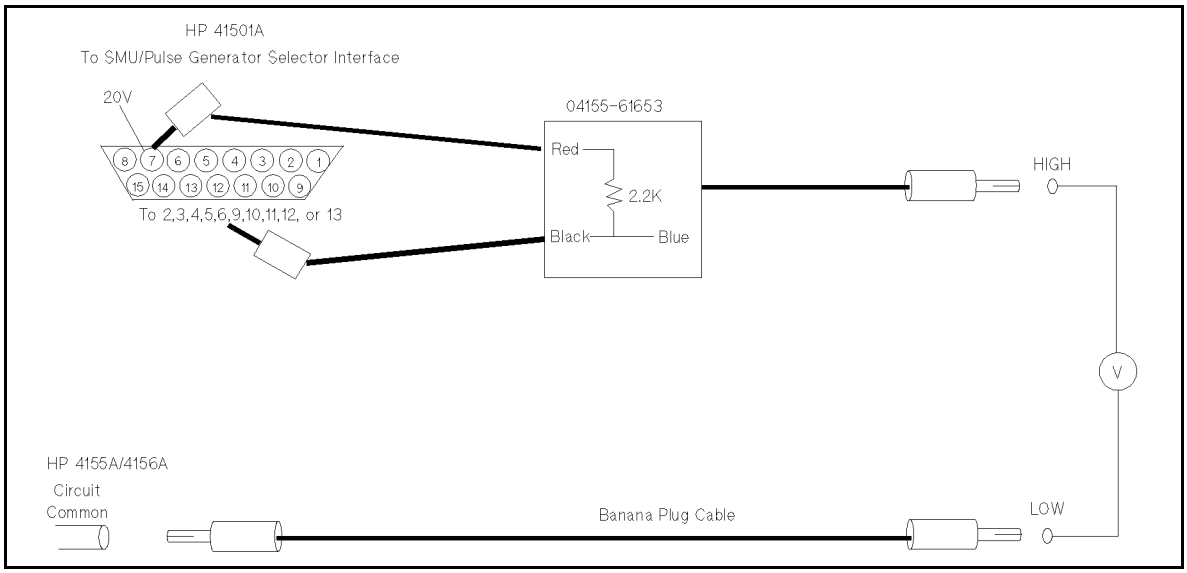


Figure 5-4. Control Lines Test

Table 5-5.
SMU/PG Selector Interface Pin Number Assignment (Rear View)

8	7	6	5	4	3	2	1
15	14	13	12	11	10	9	– – –

Table 5-6. CH1 Control Output Test

Tested Pin	CH1 Setting			
	ALL OFF	SMU ON	PGU ON	PGU OPEN (Sub SW off)
Pin 9 (CH1 SMU ON)	Ⓗ[1]	Ⓛ	H	H
Pin 10 (CH1 PGU ON Sub)	H	Ⓗ	Ⓛ	H
Pin 11 (CH1 PGU ON Main)	H	Ⓗ	L	Ⓛ

1 H: 19.3 V to 22.6 V
L: 0 V to 1 V
You usually need to perform only the tests indicated with Ⓗ and Ⓛ instead of all.

Table 5-7. CH2 Control Output Test

Tested Pin	CH2 Setting		
	ALL OFF	SMU ON	PGU ON
Pin 12 (CH2 SMU ON)	Ⓗ	Ⓛ	H
Pin 13 (CH2 PGU ON)	H	Ⓗ	Ⓛ

Table 5-8. CH3 Control Output Test

Tested Pin	CH3 Setting			
	ALL OFF	SMU ON	PGU ON	PGU OPEN (Sub SW off)
Pin 2 (CH3 SMU ON)	Ⓗ	Ⓛ	H	H
Pin 3 (CH3 PGU ON Sub)	H	Ⓗ	Ⓛ	H
Pin 4 (CH3 PGU ON Main)	H	Ⓗ	L	Ⓛ

Table 5-9. CH4 Control Output Test

Tested Pin	CH4 Setting		
	ALL OFF	SMU ON	PGU ON
Pin 5 (CH4 SMU ON)	Ⓗ	Ⓛ	H
Pin 6 (CH4 PGU ON)	H	Ⓗ	Ⓛ

Block Diagram of SMU/PG Selector Interface Control

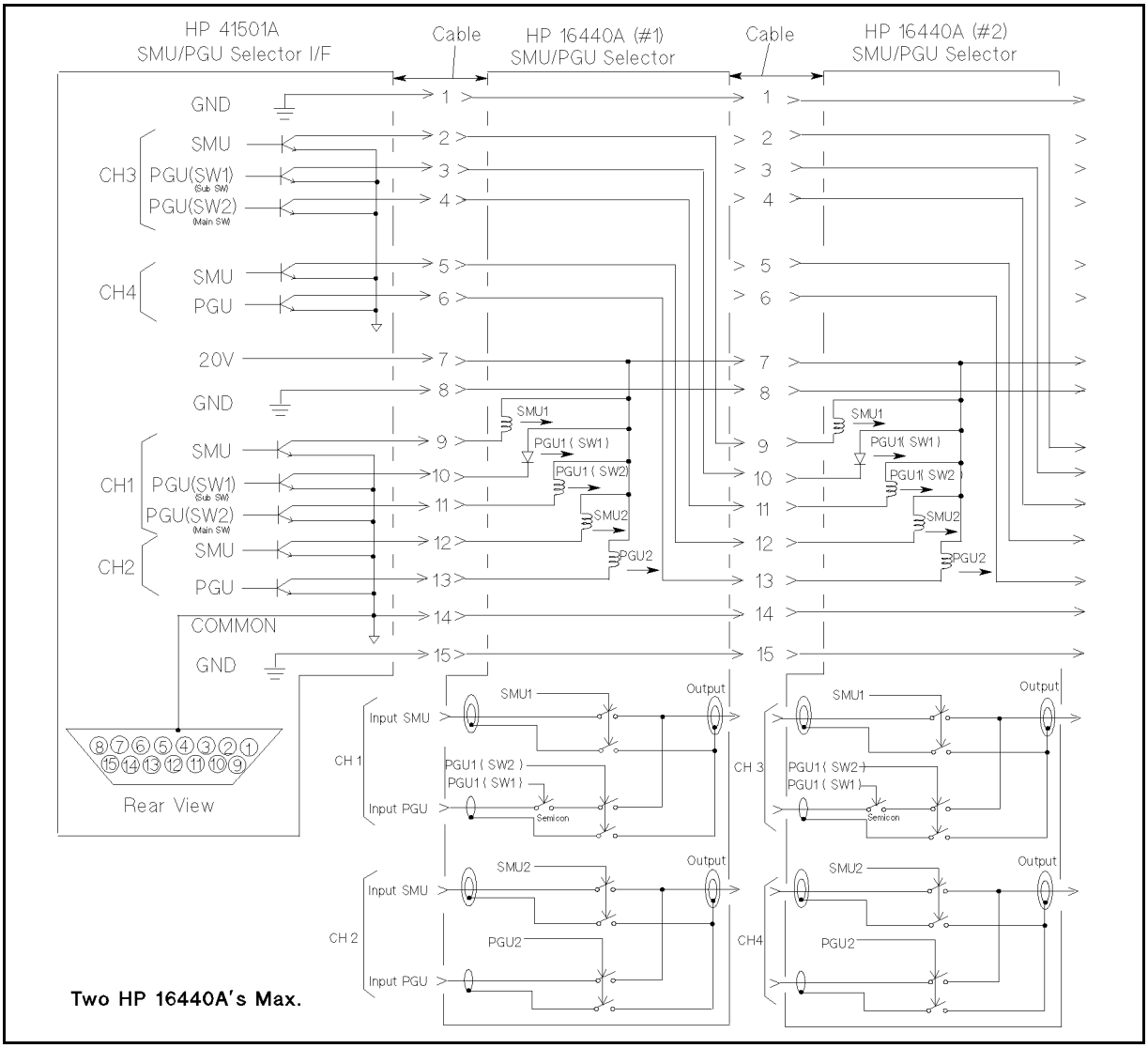


Figure 5-5. Block Diagram of SMU/PG Selector Interface Control

R-Box Control Test

Required Equipment

- Voltmeter (accuracy $\leq \pm 1\%$)
- R-Box I/F Test Adapter Cable (04155-61652)
- 2 Mini Pin Plug - Banana Plug Cable (04155-61653)
- Banana Plug - Banana Plug Cable

Procedure

1. Select (SYSTEM), `CALIB/DIAG`, `DIAG`, `I/O & PERIPH`, `413 (INT.) R-box CTL` field, and `EXECUTE`.
2. To perform 20 V Line test, connect as shown below, and measure the voltage. If it is within the test limit that is shown in the following table, it passes.

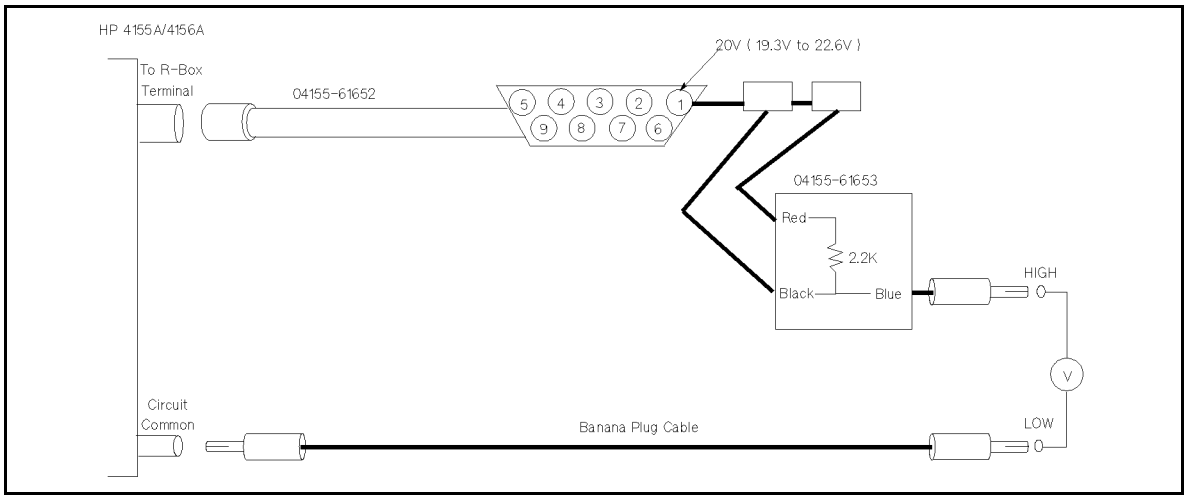


Figure 5-6. 20 V Line Test

Table 5-10. 20 V Line Test

Pin No	Test Limit
Pin 1 (20 V)	19.3 V to 22.6 V

3. To perform Control Lines Test, connect as follows, and measure the voltages as shown in the following two tables.
   a. Connect the Black wire of 04155-61653 to pin 3, 4, 5, 6, 7, or 8.
   b. Set the CH1 or CH2 to 0, 10 k, 100 k, or 1 MΩ.
   c. Measure the voltage.

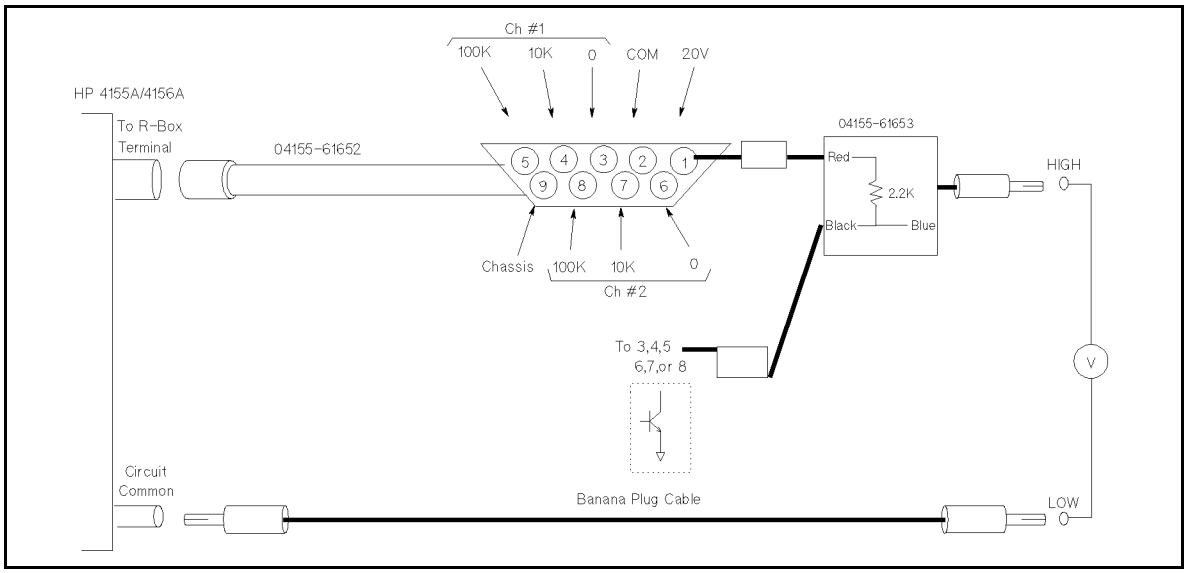


Figure 5-7. Control Lines Test

Table 5-11. CH1 Control Output Test

Tested Pin	CH1 Setting			
	0 Ω	**10 kΩ**	**100 kΩ**	**1 MΩ**
Pin 3 (CH1 0 Ω)	Ⓛ[1]	H	H	Ⓗ
Pin 4 (CH1 10 kΩ)	Ⓗ	Ⓛ	H	Ⓗ
Pin 5 (CH1 100 kΩ)	H	Ⓗ	Ⓛ	Ⓗ

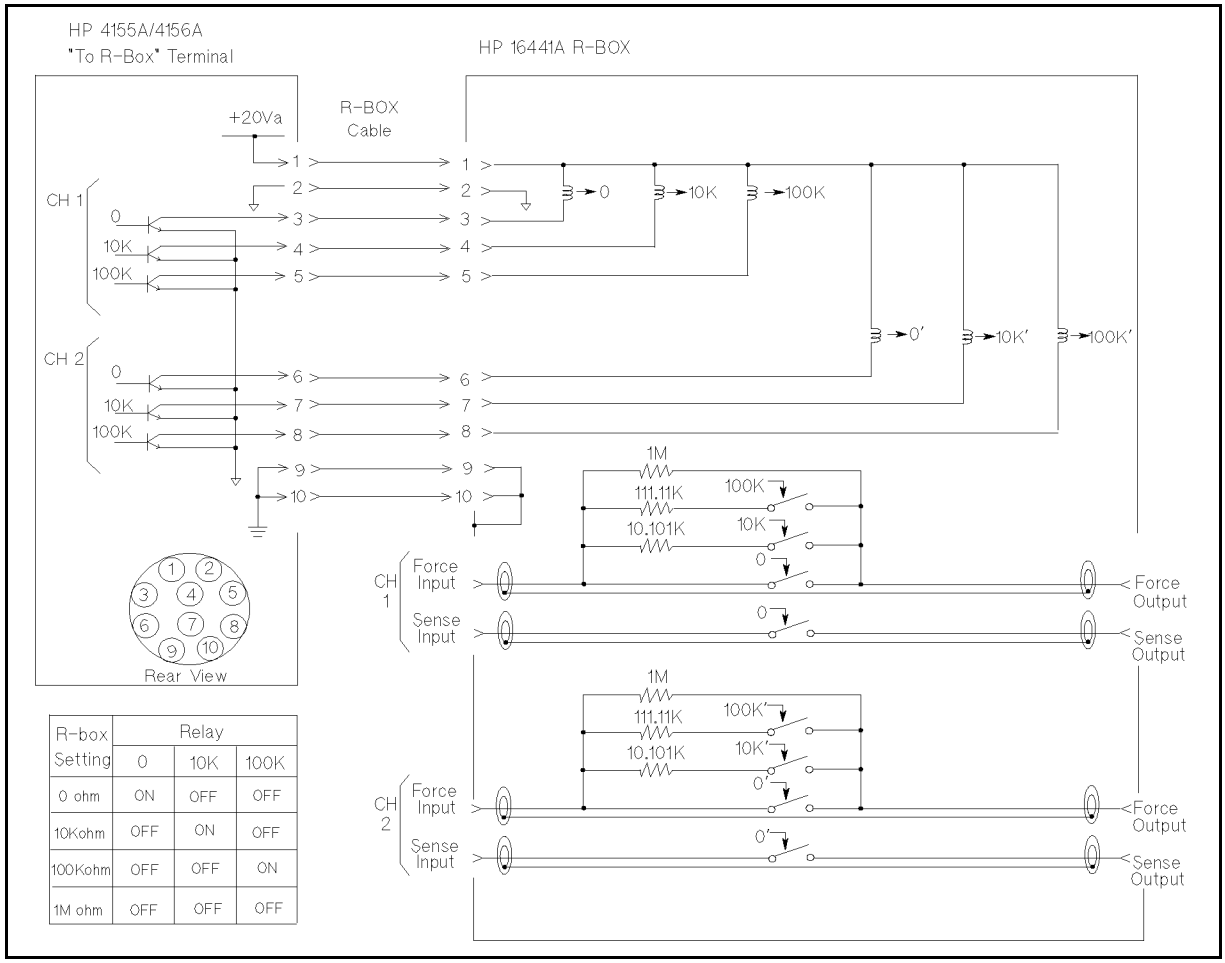
1 H: 19.3 V to 22.6 V
L: 0 V to 1 V
You usually need to perform only the tests indicated with Ⓗ and Ⓛ instead of all.

Table 5-12. CH2 Control Output Test

Tested Pin	CH2 Setting			
	0 Ω	**10 kΩ**	**100 kΩ**	**1 MΩ**
Pin 6 (CH2 0 Ω)	Ⓛ[1]	H	H	Ⓗ
Pin 7 (CH2 10 kΩ)	Ⓗ	Ⓛ	H	Ⓗ
Pin 8 (CH2 100 kΩ)	H	Ⓗ	Ⓛ	Ⓗ

1 H: 19.3 V to 22.6 V
L: 0 V to 1 V
You usually need to perform only the tests indicated with Ⓗ and Ⓛ instead of all.

Block Diagram of R-Box Interface Control



R-box Setting	Relay		
	0	10K	100K
0 ohm	ON	OFF	OFF
10Kohm	OFF	ON	OFF
100Kohm	OFF	OFF	ON
1M ohm	OFF	OFF	OFF

Figure 5-8. Block Diagram of R-Box Interface Control

LCD Test

Required Equipment

- None

Procedure

- To display a test pattern, select `LCD` on DIAGNOSTICS page, then select desired test pattern.
- To exit from a text pattern, press any key.

Test Pattern Description

The test patterns are used at the factory for troubleshooting; but they are usually not necessary for field service. The following is a description of the test patterns.

All White (201). This pattern is used to verify the light output of the LCD and to check for color purity.

All Red (202) / All Green (203) / All Blue (204). These patterns are used to verify the color purity of the LCD and also the ability to independently control each color.

16 Step Gray Scale (205). This pattern is used to verify that the palette chip on GSP block can produce 16 different amplitudes of color (in this case, gray). The staircase pattern will quickly show missing or stuck data bits.

Repeating Gray Scale (212). This is similar to the 16 step gray scale but is repeated 32 times across the screen. Each of the 3 outputs of the video palette will then show 32 ramps (instead of one staircase) between each horizontal sync pulse. This pattern is used to troubleshoot the pixel processing circuit of GSP block.

Color Rainbow (213). This pattern quickly shows the ability of the GSP block to display 15 colors plus white. The numbers written below each bar indicate the tint number used to produce that bar (0 & 100: pure red, 33: green, 67: pure blue).

Character Set (214). This pattern is provided to conveniently show the user all the different types and sizes of characters available. Three sets of characters are drawn in each of the three character sizes.

Miscellaneous Operations

This section describes service operations.

Installing HP 41501B SMU/Pulse Generator Expander

1. Set the HP 4155B/4156B LINE switch and HP 41501B LINE switch to off.
2. Put the HP 4155B/4156B on the HP 41501B.
3. Remove the blank panel labeled **To Expander Box Interface** from the rear panel of the HP 4155B/4156B.
4. Insert the interface board from the HP 41501B into the HP 4155B/4156B, then attach it with the thumbscrews.

Warning

The HP 4155B/4156B is just placed on the top of the HP 41501B without attaching it securely. So, be very careful when handling.

Weights:

- **HP 4155B/4156B: about 21 kg**
- **HP 41501B: about 16 kg**

Turning On

Power Requirements

- 90 to 264 V
- 50 Hz or 60 Hz (47 to 63 Hz)
- 10% maximum voltage distortion
- 450 VA maximum for HP 4155B/4156B
- 350 VA maximum for HP 41501B

Operating Environment

Clearance around cooling fans:	150 mm behind, 70 mm sides, 12 mm above and below
Temperature:	+10 °C to +40 °C
Humidity:	20% to 80% RH at 29 °C
Altitude:	2000 m maximum (6,600 ft)

Caution

Do not block the air opening on either side covers because the HP 4155B/4156B/41501B intakes air for cooling the inside from there. If the airflow is restricted, the internal operating temperature will be higher, which reduces the instrument reliability or causes instrument failure.

Storage Environment.

Temperature:	−22 °C to +60 °C
Humidity:	5% to 90% RH at 39 °C
Altitude:	4600 m maximum (15,300 ft)

Turning On HP 4155B/4156B With HP 41501B

When the HP 41501B is installed, *turn on the HP 41501B first*.

If the HP 41501B is not turned on, the HP 4155B/4156B asserts the following error message at power-on and does not power up:

```
CAUTION 309: The SMU AND PULSE GENERATOR EXPANDER isn't turned on. Turn on the
expander, then cycle main frame power.
```

If you do not want to use the HP 41501B, disconnect the HP 41501B from the HP 4155B/4156B.

Note

For the HP 4155B/4156B, no "System Software Disk" is needed. All system software is stored in the ROMs.

Turn-On Sequence

When the HP 4155B/4156B is working correctly, the turn-on sequence is as follows:

1. Generates a beep sound for about 0.3 second.
2. All the front panel LEDs (MEASUREMENT, HIGH VOLTAGE, Standby, Run, and Blue-key) are lit at the same time for about 0.3 second.

3. All the front panel LEDs are turned off.
4. Copyright message is displayed.
5. Power-On Self-Test is performed. (This takes between 0.5 and 1 minute, depending on the configuration—with or without HP 41501B, and modules in HP 41501B.)

Note

If some tests in the Power-On Self-Test fail, it may take a maximum of three minutes to finish the turn-on sequence due to waiting time for response.

6. The CHANNEL DEFINITION page is displayed if the Self-Test passes. The SELF-CALIBRATION/DIAGNOSTICS page is displayed if the Self-Test fails.
7. Blue-key LED is lit.

Note

If you turn on with a diskette that includes `INIT.MES`, `INIT.DAT`, and/or `AUTOST` file(s), it is possible to display another page after the Power-On Self-Test. However, if the Power-On Self-Test fails, the HP 4155B/4156B always displays the SELF-CALIBRATION/DIAGNOSTICS page.

To Satisfy the Specifications of Measurements

To satisfy the specifications of measurements, do the following before you begin measurements.

- Set the power line frequency for measurement integration time, 50 Hz or 60 Hz, in the SYSTEM: MISCELLANEOUS page.
- Allow the HP 4155B/4156B/41501B to warm up for a minimum of 40 minutes.
- Perform the Self-Calibration (SYSTEM, CALIB/DIAG, CALIB ALL) before you begin measurements.
- Integ Time: Medium or Long
- Kelvin connection (Sense terminal) is used for HRSMU, HPSMU, and GNDU.
- Temperature: 23 °C ± 5 °C, change of temperature should be less than 1 °C after the Self-Calibration.
- Ground the HP 4155B/4156B/41501B using three-conductor ac power cables.
- Connect the **CIRCUIT COMMON** and **CHASSIS GROUND** terminals with the shorting-bar on the HP 4155B/4156B rear panel. Or connect the ground of the external instrument/device to the HP 4155B/4156B's circuit common if you use the external instrument/device together. If you do not connect the circuit common to the ground, measurements may be affected by noise.

SYSTEM Page Overview

When you press the System front-panel key, the following softkeys are displayed.

FILER	FILER page is for file operations. When you press the System key, this page is displayed.
MISCELLANEOUS	MISCELLANEOUS page is for miscellaneous system settings, such as HP-IB address, network settings, and built-in clock.
CONFIG	CONFIGURATION page displays software revision and the HP 4155B/4156B's configuration.
CALIB/DIAG	SELF-CALIBRATION/DIAGNOSTICS page.
PRINT SETUP	PRINT/PLOT SETUP page.
COLOR SETUP	COLOR SETUP page is for screen color setting.

FILER Page

The FILER page is for executing file operations, such as saving and getting the measurement data or setup data files, on diskette or internal memory (four memories, MEM1 to MEM4). MEM1 to MEM4 are also used in Measurement Curve Overlay (Store/Recall) function on the GRAPHICS: DISPLAY SETUP page.

Available File Operations:	File Catalog, Save, Get, Copy, Purge, Rename, Disk Initialization, Disk Copy

MISCELLANEOUS Page

The MISCELLANEOUS page is for miscellaneous system settings, such as HP-IB addresses and built-in clock.

HP 4156B is	Sets the 4155B/4156B to System Controller or Not System Controller for HP-IB operation.

System Controller

When an external computer controls the HP 4155B/4156B via the HP-IB, set the HP 4155B/4156B to NOT SYSTEM CONTROLLER.

When the HP 4155B/4156B controls an HP-IB device (printer, plotter, etc.) from the front panel or built-in IBASIC, set the HP 4155B/4156B to SYSTEM CONTROLLER.

In other cases, the setting of SYSTEM CONTROLLER/NOT SYSTEM CONTROLLER is meaningless.

If the HP 4155B/4156B is set to SYSTEM CONTROLLER and you send HP-IB commands from your computer to the HP 4155B/4156B, the following symptom may occur. (In this case, you should set NOT SYSTEM CONTROLLER.)

- No response from HP 4155B/4156B
- HP BASIC ERROR 170 I/O operation not allowed
- HP BASIC ERROR 173 Active/system controller req'd

HP 4156B under HP-IB ADDRESS	Sets HP-IB address of the HP 4155B/4156B.
HARD COPY under HP-IB ADDRESS	Sets printer or plotter HP-IB address connected to the HP 4155B/4156B.
REMOTE CONTROL	Sets the remote control command mode to HP 4155/56 or HP 4145. If you change the mode, the HP 4155B/4156B is reset, so setup data is lost. The HP 4145 Syntax Command Set has the same syntax as for the HP 4145A/B Command Set. So you can execute HP 4145A/B programs on the HP 4155B/4156B with minimum modifications. However, this mode does not support all the HP 4155B/4156B functions. If you use both modes in your programs, switch the mode by using the remote command, each time you use the other command set.
CLOCK	Sets the present date and time for system clock.

System Clock

The system clock will be kept for about two to seven days after turn off, by a capacitor (1 F). The capacitor is fully charged about ten minutes after turning on the HP 4155B/4156B. When the capacitor is perfectly discharged, the clock is set to “97AUG01 00:00:00”.

BEEP	Sets the usage of beep sound.
SCREEN SAVE	Sets the period to start the blank screen saver function.
LP TIMEOUT	Sets the time out period for connecting a remote (network) printer.
POWER LINE FREQUENCY	Sets your power line frequency, 50 Hz or 60 Hz. This is used for measurement integration time.

Power Line Frequency: 50 Hz / 60 Hz

If this setting is incorrect, the noise reduction function does not work effectively, and the measurements will not meet the specifications.

HP 4156B NETWORK SETUP	Sets the hostname, IP address, and other information of the HP 4155B/4156B.
NETWORK PRINTER SETUP	Sets the hostnames, IP addresses, and other information of network printers.
NETWORK DRIVE SETUP	Sets the hostnames, IP addresses, and remote mount directories of network drives (file servers).

CONFIGURATION Page

The CONFIGURATION page is for displaying software revision and the HP 4155B/4156B's configuration.

`SOFTWARE REVISION` Shows the software (ROM) revisions of:

- `HOSTC` Host Controller ROM in CPU module. The Host controller includes the built-in IBASIC software.
- `SMUC` SMU Controller ROM in CPU module. The SMU controller controls all the source units and monitor units.
- `ADC` ADC Controller ROM in ADC module

`CONFIGURATION` Shows the HP 4155B/4156B's hardware configuration.

*CONFIGURATION

SLOT	UNIT
0	VSU1, VSU2, VMU1, VMU2
1	SMU1: HR
2	SMU2: HR
3	SMU3: HR
4	SMU4: HR
5	SMU5: MP
6	SMU6: MP
7	PGU1, PGU2
8	GNDU

Figure 5-9. Configuration Table

SELF-CALIBRATION/DIAGNOSTICS Page

The SELF-CALIBRATION/DIAGNOSTICS page is for executing Self-Calibration and diagnostics.

`AUTO CALIB` Sets Auto Self-Calibration on or off. If this field is set to `ON`, Self-Calibration is performed automatically every 30 minutes. During measurement or stress forcing, the Self-Calibration is not performed until after the completion of the measurement or stress forcing.

For diagnostics, see "Built-In Diagnostics Function".

PRINT/PLOT SETUP Page

The PRINT/PLOT SETUP page and the Plot/Print key are for setting the following print/plot parameters. "Language" and "Resolution" are specified on the PRINT/PLOT window.

- Printer/Plotter Interface (HP-IB, Parallel, or Network)
- Form Feed (Enable or Disable)
- Color or Monochrome—Black and White
- Language (PCL, HR-PCL, HP-GL, TIFF, or HR-TIFF)—specified by Plot/Print key
- Number of lines and number of characters per line
- Resolution (75 dpi – 600 dpi; dpi: dots per inch)—specified by Plot/Print key
  Set this field to the same value as the actual printer resolution setting.
- Paper Size and Paper Orientation
- Output Item Selection (Title, Date&Time, Page No, User Comment on MEASURE/STRESS pages, Print/Plot (User) Comment on the page output by Plot/Print key, Graph Trace (for HP-GL), Graph Grid (for HP-GL), etc.)
- Printer/Plotter Initialization Command before Print/Plot
- Printer/Plotter Command after Print/Plot

COLOR SETUP Page

The COLOR SETUP page is for setting the following parameters.

- Screen Colors
- Brightness
- Printer Color Number (Fixed Color mode only)

Initial Settings

Settings Stored in EEPROM/Flash ROM

The following settings except network settings are stored in the EEPROM (Electrical Erasable Programmable ROM). The network settings are stored in a part of Flash ROM. These settings are not erased even if you turn off the HP 4155B/4156B.

- SYSTEM: MISCELLANEOUS page:
  - `SYSTEM CONTROLLER` / `NOT SYSTEM CONTROLLER`
  - HP-IB address (HP 4155B/4156B and Hardcopy)
  - Power Line Frequency (50 Hz or 60 Hz)
  - Network Settings

Default Initial Settings

When you turn on the HP 4155B/4156B without a diskette, the HP 4155B/4156B is set to the default settings. (See “Measurement Unit Initial Settings (Idle State)”.)

User-Defined Initial Settings

HP 4155B/4156B can automatically get the following files from a diskette after applying power, and set the HP 4155B/4156B according to the files.

`INIT.DAT`	Measurement setup and measurement data file
`INIT.MES`	Measurement setup file. If the `INIT.DAT` file exists, this file is not used.
`INIT.STR`	Stress setup file
`INIT.CST`	Customize file
`MEM*.DAT`	Measurement setup and measurement data file for internal memory. Where MEM* means MEM1, MEM2, MEM3, or MEM4, which correspond to the four internal memory areas. Priority: `MEM*.DAT` > `MEM*.MES` > `MEM*.STR` For example, if both `MEM1.DAT` and `MEM1.MES` exist, `MEM1.MES` is not used.
`MEM*.MES`	Measurement setup file for internal memory.
`MEM*.STR`	Stress setup file for internal memory.
`AUTOST`	If this IBASIC program file exists, this file is automatically loaded and started after loading the other user-defined initial setting files.

Note

If you turn on with a diskette that includes `INIT.MES`, `INIT.DAT`, and/or `AUTOST` file(s), it is possible to display another page after the Power-On Self-Test.

The `INIT.MES` or `INIT.DAT` file can display the following pages if you have saved to the file by using the SAVE function. (This is not possible if you have used the RENAME or COPY function).

- GRAPH/LIST: GRAPH page
- GRAPH/LIST: LIST page
- KNOB SWEEP page
- CHANNELS: CHANNEL DEFINITION page

Customize File (*.CST)

The customize file stores the following settings.

- All SYSTEM page settings except EEPROM/Flash ROM-stored settings
- In the STRESS SETUP page:
  - Pulse Count (only when pulse count mode is set), `HOLD TIME`, `STRESS`, `FILTER`
- In the STRESS FORCE page:
  - `STRESS`, `STATUS`
- In the LIST: SPREADSHEET: ASCII SAVE area:
  - `UNIT`, `DELIMITER`, `STRING MARK`
- `DESTINATION` file (File or Printer/Plotter) displayed by (Plot/Print) key.

Measurement Unit Initial Settings (Idle State)

After startup, all the measurement units are in the Idle State. After measurement, Stress force, and Standby are completed, the units are returned to the Idle State. In this state, output switches of all the measurement units are on, and all outputs are 0 V.

The following are the conditions of the measurement unit.

SMU:	0 V output at 20 V range, 100 μA compliance at 100 μA range
VSU:	0 V output at 20 V range
PGU:	0 Vdc output at 20 V range, Output impedance: LOW
GNDU:	0 V output
HP 16441A R-Box:	0 Ω is connected.
HP 16440A Selector:	SMU is connected.

Reading the Contents of Failure Recorder

Procedure

1. Press: (SYSTEM)
2. Press: "green" ( )
3. Press the right most softkey of eight softkeys at the bottom of LCD. The following page will appear.

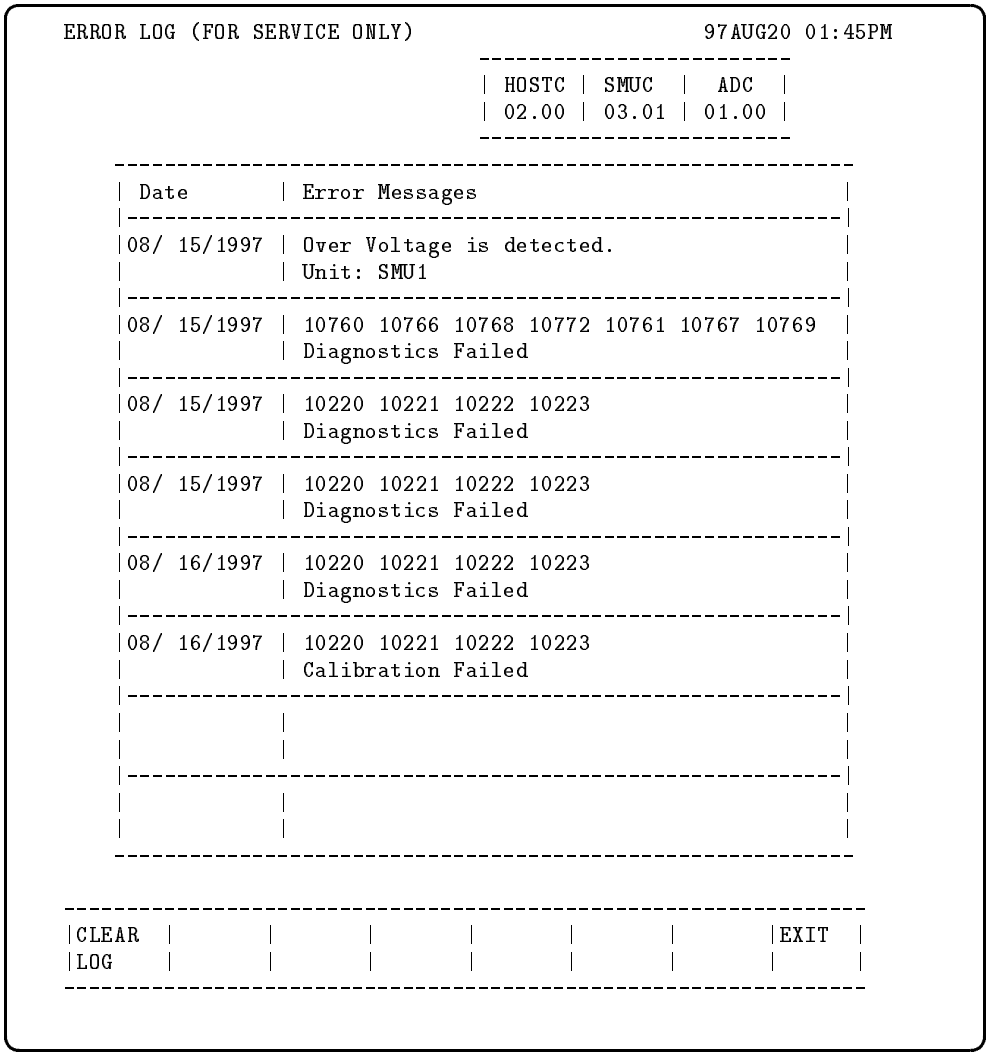


Figure 5-10. Error Log Page

Failure Recorder

The HP 4155B/4156B records the following most recent eight errors. These are recorded into EEPROM (Electrical Erasable Programmable ROM) on the CPU module.

- Self-Test error.
- Self-Calibration and Auto Self-Calibration error.
- Interactive-Test error.

- Source unit output shutdown error.
- Panic error by software bug or hardware failure.
  The following are also the Panic errors.
  - BUS ERROR
  - ADDRESS ERROR
  - ILLEGAL INSTRUCTION
  - DIVIDED BY ZERO
  - PRIVILEGE VIOLATION
  - OTHER EXCEPTION

You can dump this page by using the Plot/Print key.

Controlling the HP 4155B/4156B from External Computer

Setting to "NOT SYSTEM CONTROLLER"

To control the HP 4155B/4156B from an external computer, set the HP 4155B/4156B to NOT SYSTEM CONTROLLER. Select System, MISCELLANEOUS, NOT CONTROLLER.

For System Controller, see "SYSTEM Page Overview".

Changing the HP-IB Address

To change the HP-IB address, select SYSTEM, MISCELLANEOUS, then type the HP-IB address in the field.

Or from remote, if you set the address to 17 for example:

```
OUTPUT @hp4155;":SYST:COMM:GPIB:ADDR 17"
```

Setting HP-IB Control from Remote to Local

When the HP 4155B/56B is set to remote, the LOCAL softkey appears. To set to LOCAL, press this softkey.

The HP 4155B/4156B has no indicators of "TALK", "LISTEN", and "SRQ".

Setting to "NOT SYSTEM CONTROLLER" When LCD Displays Nothing

1. Turn on the HP 4155B/4156B. If already on, turn off, then on to set the default setting.
2. Wait for three minutes because it may take to power-up due to the hardware failure.
3. Press SYSTEM.
4. Wait two seconds. If a diskette is inserted in the FDD, you need more time until the disk access is completed.
5. In eight softkeys at bottom of LCD, press second softkey from the left (this is the MISCELLANEOUS key.).
6. In seven softkeys at right-side of LCD, press second softkey from the top (this is the NOT CONTROLLER key.).

Searching for the HP-IB Address When LCD Displays Nothing

If the LCD display nothing, you need to search for the HP-IB address to send the remote command. Use the following program.

The setting at factory shipment is “17”.

Note Before executing this program, set the HP 4155B/4156B to NOT SYSTEM CONTROLLER.

```
10  ! RE-SAVE "ADRS_SEARCH"
20    Selcode=7              ! Specify your HP-IB Select Code before "RUN".
30    ON TIMEOUT Selcode,.2 GOTO Next_adrs  ! Timeout: 0.2 sec
40    FOR I=0 TO 30
50      IF I=21 THEN I=22    ! 21: For System controller
60      Adrs=Selcode*100+I
70      PRINT Adrs
80      A=SPOLL(Adrs)
90      PRINT Adrs;": Exists (SPOLL=";A;")" ! When HP-IB device exists.
100 Next_adrs:NEXT I
110   PRINT "Completed."
120   END
```

Setting the Power Line Frequency of Measurement Integration Time

To set the power line frequency for measurement integration time, select (SYSTEM), MISCELLANEOUS. Then, set POWER LINE FREQUENCY.

Setting the System Clock

To set the system clock, select (SYSTEM), MISCELLANEOUS. Then, set CLOCK, and select SET.

Reading the System Software ROM Revision Number

To reading the ROM revision number, select (SYSTEM), CONFIG.

Or from remote, send:

```
OUTPUT @hp4155;":*IDN?"
ENTER @hp4155;A$
```

Where, A$ = HEWLETT-PACKARD,*model#*,0,*HOSTC-Rev#*:*SMUC-Rev#*:*ADC-Rev#*

For example,

```
HEWLETT-PACKARD,4156B,0,02.00:03.01:01.00
```

Reading the Registered Calibration Data of V/R References

```
10  A=717
20  CALL Read_cal_data(A)
30  END
40  SUB Read_cal_data(A)
50    CLEAR A
60    PRINT "Calibrated Value","Calibrated Date"
70    !
80    R=0                     ! R=0: For V References
90    FOR Ref_value=1 TO 2    ! 1: For +7V Ref,  2: For -7V Ref
100      GOSUB Read_data
110   NEXT Ref_value
120   !
130   R=1                     ! R=1: For R References
140   FOR Ref_value=0 TO 3    ! 0: 100ohm, 1: 10kohm, 2: 1Mohm, 3: 100Mohm
150     GOSUB Read_data
160   NEXT Ref_value
170   !
180   SUBEXIT
190   !
200 Read_data: !     Read the V/R References calibration data
210   OUTPUT A;"SMUC:REFDAT?";R,Ref_value   ! Read Ref calibrated values
220   ENTER A;Refdata,Year,Month,Day        !                   and date
230   PRINT Refdata;TAB(20);Year;Month;Day
240   RETURN
250 SUBEND
```

Execution Result Example:

```
Calibrated Value    Calibrated Date
 6.968121           1997  8  6         <-- +7 V Reference
-6.967911           1997  8  6         <-- -7 V Reference
 100.1331           1997  8  6         <-- 100 ohm
 10000.33           1997  8  6         <-- 10 kohm
 1.000081E+6        1997  8  6         <-- 1 Mohm
 9.958031E+7        1997  8  6         <-- 100 Mohm
```

Note

The SMUC:REFDAT? command is for service only, which is not described in the manual for users.

Registering the Calibrated Data of V/R References

Normally you perform the registration of the calibration data of V/R References using the PV4155 software. If you need to change the values without the measurements, use the following program.

Note

If you register −7 V Reference data, you must observe the following because the HP 4155B/4156B automatically performs an internal calibration (ADC linearity correction), which is performed only when you register −7 V Reference data.

- Ambient Temperature: 23 ±3°C (NOT ±5°C)
- Warmup: 40 minutes
- Before registering −7 V Reference data, +7 V Reference data must be updated if necessary. (+7 V Reference data is also used in the internal calibration.)

```
10    A=717                 ! Specify the HP-IB address of HP 4155B/6B
20    Year=1997             ! Specify the calibrated date; year,
30    Month=7               !                              month,
40    Day=7                 !                              day.
50    !    R,Ref_type,Calib_data     Specify "Calib_data".  0 means no change.
55    !                              Do not change "R" and "Ref_type".
60    DATA 0,1,       6.96812      ! +7V Ref Calib data = 6.96812 V
70    DATA 0,2,       0            ! -7V Ref Calib data,  0: no change
80    DATA 1,0,       0            ! 100 ohm Calib data,  0: no change
90    DATA 1,1,       10000.3      ! 10 kohm Calib data = 10000.3 ohm
100   DATA 1,2,       0            ! 1 Mohm  Calib data,  0: no change
110   DATA 1,3,       9.95803E+7   ! 100Mohm Calib data = 9.95803E+7
120   !
130   PRINT "********* Before Change *********"
140   CALL Read_cal_data(A)
150   !
160   FOR I=1 TO 6
170     READ R, Ref_type, Calib_data
180     IF Calib_data < > 0 THEN
190       OUTPUT A;"SMUC:REFDATA";R,Ref_type,Calib_data,Year,Month,Day
200     END IF
210   NEXT I
220   !
230   PRINT "********* After Change *********"
240   CALL Read_cal_data(A)
250   END
260   !
270  SUB Read_cal_data(A)
280   CLEAR A
290   PRINT "Calibrated Value","Calibrated Date"
300    !
310    R=0                     ! R=0: For V References
320    FOR Ref_value=1 TO 2    ! 1: For +7V Ref,  2: For -7V Ref
330      GOSUB Read_data
340   NEXT Ref_value
350   !
360   R=1                    ! R=1: For R References
370   FOR Ref_value=0 TO 3    ! 0: 100ohm, 1: 10kohm, 2: 1Mohm, 3: 100Mohm
380     GOSUB Read_data
390   NEXT Ref_value
400   !
410   SUBEXIT
420   !
430 Read_data: !     Read the V/R References calibration data
440   OUTPUT A;"SMUC:REFDAT?";R,Ref_value   ! Read Ref calibrated values
450   ENTER A;Refdata,Year,Month,Day        !                   and date
460   PRINT Refdata;TAB(20);Year;Month;Day
470   RETURN
480 SUBEND
```

Execution Result Example:

```
********* Before Change *********
Calibrated Value    Calibrated Date
 6.9682             1997  8  1         <-- +7 V Reference
-6.967911           1997  8  1         <-- -7 V Reference
 100.1331           1997  8  1         <-- 100 ohm
 10000.9            1997  8  1         <-- 10 kohm
 1.000081E+6        1997  8  1         <-- 1 Mohm
 9.958E+7           1997  8  1         <-- 100 Mohm
********* After Change *********
Calibrated Value    Calibrated Date
 6.96812            1997  8  6         <-- +7 V Reference
-6.967911           1997  8  6         <-- -7 V Reference
 100.1331           1997  8  6         <-- 100 ohm
 10000.3            1997  8  6         <-- 10 kohm
 1.000081E+6        1997  8  6         <-- 1 Mohm
 9.95803E+7         1997  8  6         <-- 100 Mohm
```

Note

The `SMUC:REFDAT?` and `SMUC:REFDATA` commands are for service only, which are not described in the manual for users.

Using Built-In IBASIC

When you send commands from the HP 4155B/4156B's built-in IBASIC (HP Instrument BASIC version 2.0) to the HP 4155B/4156B, use the HP-IB address: 800 to 831. Any value between 800 and 831 can be used.

When you use an external HP-IB device that is connected to the HP-IB interface of the HP 4155B/4156B, the HP-IB interface select code is "7". For example, if the printer is at "1", send the command to address "701" to control the printer, with the `SYSTEM CONTROLLER` setting.

When you use the internal disk drive, you can omit specifying the mass storage address. For example, `CAT` shows the catalog of the disk. You can specify the address as ":INTERNAL,4".

Note

- The HP 4155B/4156B built-in IBASIC cannot use an external disk drive.
- IBASIC Memory Size:
  - Program (Text) Area: 16 KB
  - Variable/Stack Area: 500 KB
  - Common Variable Area: 600 KB
    If you perform the following operations, Common Variable Area is also used, so memory of this area decreases during the operation.
    - Hardcopy: 200 KB typical, 350 KB maximum
    - Disk copy: 200 KB
  - You cannot expand the IBASIC memory size.

To edit an IBASIC program:

Front-panel: (IBASIC) Display `EDIT` Enter

External Keyboard: F9 E D I T Enter

To quit the IBASIC Editor:

Front-panel: `End edit`

External Keyboard: F8 (End edit)

To run the program:

Front-panel: Run or `Run`

External Keyboard: F3 (RUN) or Ctrl+U

To return to regular screen:

Front-panel: (IBASIC) Display

External Keyboard: F9

Symptoms When Only Fuse Fails

If a failure is caused by blown fuse only, the symptoms of the HP 4155B/4156B are as follows. Therefore, if the HP 4155B/4156B has any of the following symptoms, replacing a fuse might fix the failure.

- CPU fuse:
  - All LEDs are lit, or only the HIGH VOLTAGE LED is lit.
  - LCD screen is blank.
- Post Regulator fuse (F1 for FDD):
  - Flexible Disk Controller (404) Self-Test fails with error code 24042.
  - FDD Read/Write (405) Interactive Test fails with error code 24051.
- Post Regulator fuse (F2 for Inverter):
  - Post Regulator (406) Self-Test fails with error code 24063.
  - LCD screen is blank.
- HRSMU/MPSMU fuse:
  - Self-Test fails with error codes 10x20, 10x21, 10x22, 10x23, 10x24, and 10x25.
- HPSMU fuse: Self-Test fail with error codes 10520, 10521, 10522, 10523, 10524, 10525, and 10526.
- Key Decoder fuse:
  - External keyboard cannot enter any characters.
  - LEDs (Num Lock, Caps Lock, Scroll Lock) on an external keyboard do not light.

Note

- Other failures can also cause same symptoms as above.
- In Power-On Self-Test, all error codes listed above may not be displayed if another unit also fails because the Power-On Self-Test cannot display more than seven error codes.

CPU Board Jumper and DIP Switch Settings

The jumper and DIP switches on CPU Board must be set as follows. They are not used for servicing, but for the factory.

- All Jumpers: “N” positions
- All Bits of DIP Switches: “OFF” positions

Hints for Trouble Isolation

- When you want to perform the Self-Test with some assemblies removed, the minimum hardware configuration for performing the Self-Test is:

  - Power Supply
  - CPU
  - Post Regulator
  - Motherboard and PS Motherboard

  - ADC if you perform an SMU or VSU/VMU Self-Test
  - If you perform the HP 41501B Self-Test:
    - ADC of HP 4155B/4156B
    - GNDU&IF
    - Expander Power Supply
    - Expander Motherboard and Expander PS Motherboard

  If the LCD and Front Panel assembly are not installed, perform the Self-Test from HP-IB.

Note

- If you disconnect the Key Decoder, the following Self-Test errors occur. But it is normal operation. Do not consider this to be a Self-Test fail.
  - Error 24072: Front Key Circuit (407) Self-Test fail.
  - Error 24100: External Key Controller (410) Self-Test fail.
- If you remove SMU1 from the HP 4156B, the HP 4156B is considered to be an HP 4155B for the following items, but for all other operations including measurements, it can be operated as an HP 4156B.
  - SYSTEM: MISCELLANEOUS page: displayed model name is `HP 4155B`.
  - *IDN? response data: returned model name is "HP 4155B".
  - Printer/Plotter header output: printed/plotted model name is "HP 4155B".

- You can perform PV4155 with the following configurations for trouble isolation.

  - Any configuration of SMUs and VSU/VMU. For example, remove three SMUs, and leave only one SMU.
  - Any configuration of SMUs and PGU in the HP 41501B. For example, only the GNDU&IF is installed.
  - HP 4156B's HRSMU is installed into the HP 41501B's MPSMU slot. However, the HRSMU will be tested as an MPSMU.

- If two or more SMUs fails in the same PV4155 test, suspect the ADC or ADC adjustment. On the other hand, if two SMUs fail in different PV4155 tests, suspect both SMUs. When you perform the ADC adjustment, using another SMU might help the trouble isolation.

- If an SMU fails, swap the SMUs in SMU1/2/3/4 slots. Watch whether the failure moves or not. If the failure moves, suspect the moved SMU. If not, suspect the slot (ADC, Motherboard, or CPU). Figure 5-11 shows installable slots for SMU.

  If four SMUs fail in the Self-Test, suspect the ADC, Motherboard, or Power Supply module. However first install only one SMU and perform the Self-Test, then repeat this on other three SMUs to check whether only one SMU causes the Self-Test failure of other three SMUs.

- Note that an unstable or noisy AC line may cause the following:
  - Instrument power supply failure. If the power supply failure often occurs, suspect the AC line.
  - Shutdown.
  - Instrument turns off once, then powers up again. Or instrument repeats this continuously. This is mainly caused by the ac voltage going down.
  - Measurement noise. High-power electric machines, such as motor/air-conditioner/wafer-prober, near the HP 4155B/4156B may affect the power line waveform.

  To correct this, fix the AC line, or use an Automatic Voltage Regulator (AVR).
- If you can not reproduce a problem symptom:
  - Perform the Repeat-Self-Test.
  - Change the ambient temperature.
  - Read the contents of Failure Recorder (error log).
  - Check the ac power line on the customer's site.

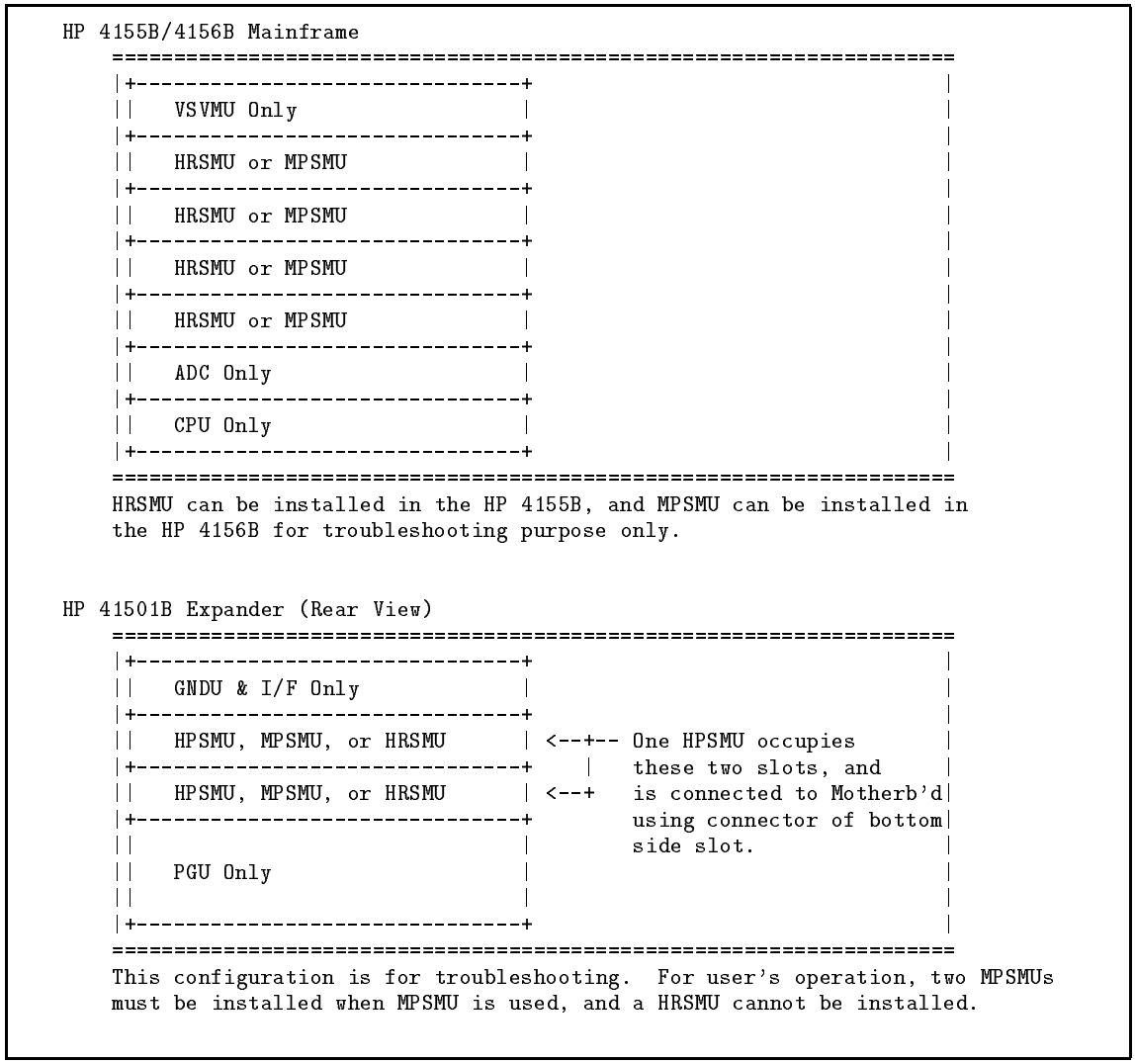


Figure 5-11. Installable Slots for SMU

6

Theory of Operation

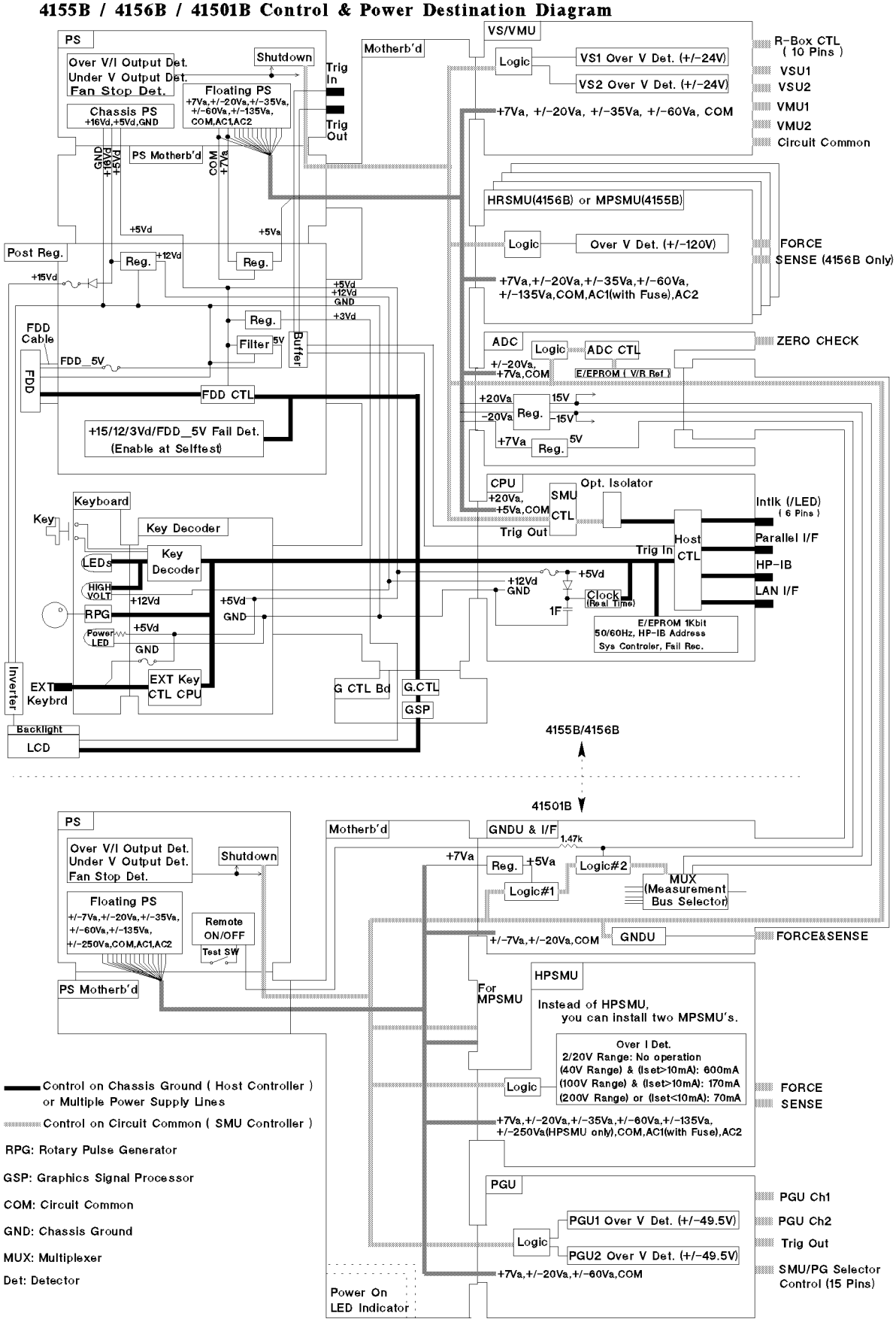
This chapter contains the theory of operation for troubleshooting.

Overall Block Diagram

The following two figures show:

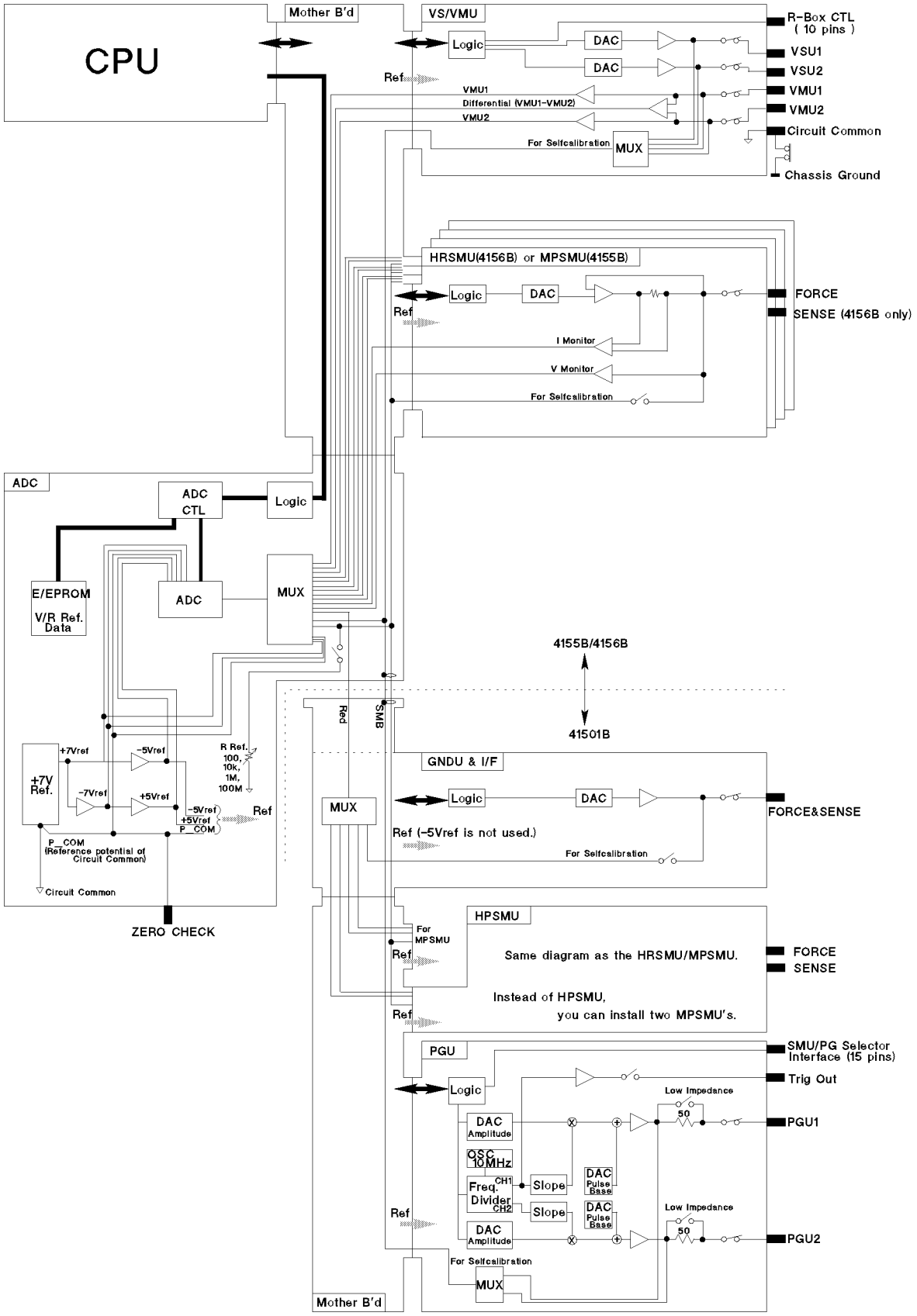
- Overall Control and Power Destination Diagram
- Overall Measurement Diagram

4155B / 4156B / 41501B Control & Power Destination Diagram



6-2 Theory of Operation

4155B / 4156B / 41501B Measurement Diagram



Measurement Units

The HP 4155B/4156B is equipped with:

- Four SMUs (Medium Power SMUs (MPSMUs) for HP 4155B; High Resolution SMUs (HRSMUs) for HP 4156B)
- Two VSUs (Voltage Source Units)
- Two VMUs (Voltage Monitor Units)

The HP 41501B can be equipped with:

- One GNDU (Ground Unit)
- One HPSMU (High Power SMU) or two MPSMUs (MPSMU is identical to that of HP 4155B/4156B.)
- Two PGUs (Pulse Generator Units)

HP 4155B/4156B/41501B Measurement Units

HP 4155B/4156B

SMU4: MPSMU for 4155B, HRSMU for 4156B

SMU3: MPSMU for 4155B, HRSMU for 4156B

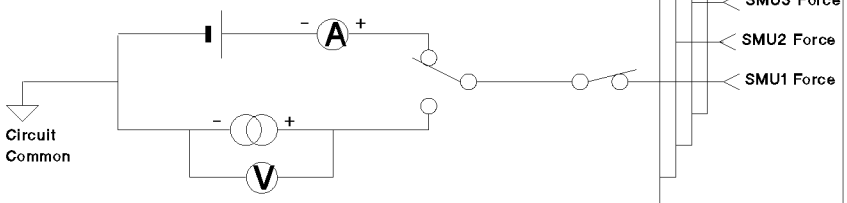
SMU2: MPSMU for 4155B, HRSMU for 4156B

SMU1: MPSMU(Medium Power SMU) for 4155B, HRSMU(High Resolution SMU) for 4156B

SMU: Source Monitor Unit
100V/100mA/2W
(20V/100mA, 40V/50mA, 100V/20mA)

I Output Reso.: 100fA (10fA for HRSMU)
I Measure Reso.: 10fA (1fA for HRSMU)
V Output Reso.: 100uV
V Measure Reso.: 2uV

V Range: 2/20/40/100V
I Range: 1nA–100mA (10pA–100mA for HRSMU)

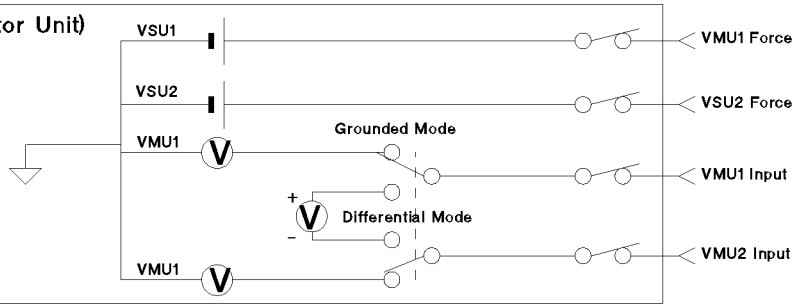


VSU/VMU (V Source Unit / V Monitor Unit)

VSU: 20V/100mA/2W
1mV Resolution
Range: 20V

VMU: 20V for Grounded
2uV Resolution
Range: 2V/20V

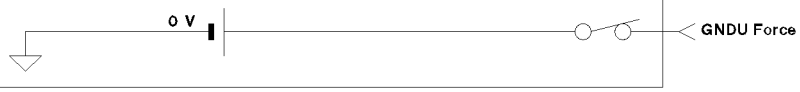
2V for Differential
1uV Resolution
Range: 0.2/2V



HP 41501B

GNDU (Ground Unit)

0 V / 1.6 A
(Accuracy: 0+/–100uV)



Optional: 1 ch HPSMU or 2 ch MPSMUs

SMU5: HPSMU (High Power SMU) 200V/1A/20W (20V/1A, 40V/500mA, 100V/125mA, 200V/50mA)

Resolution: Same as MPSMU.
V Range: MPSMU ranges + 200V range
I Range: MPSMU ranges + 1A range

SMU5 Force

or

SMU6: MPSMU

SMU5: MPSMU

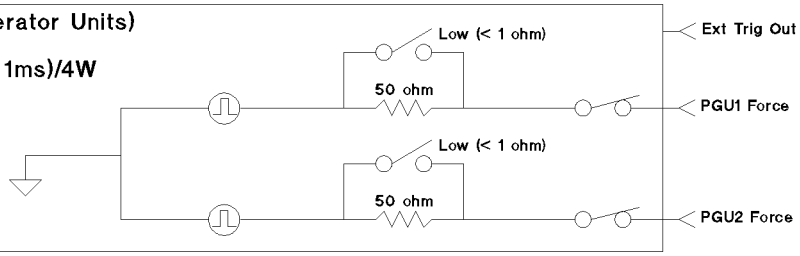
* HRSMU cannot be installed for SMU5 and SMU6.

SMU6 Force
SMU5 Force

Optional: 2 ch PGUs (Pulse Generator Units)

40Vp-p/100mA(200mApeak for < 1ms)/4W

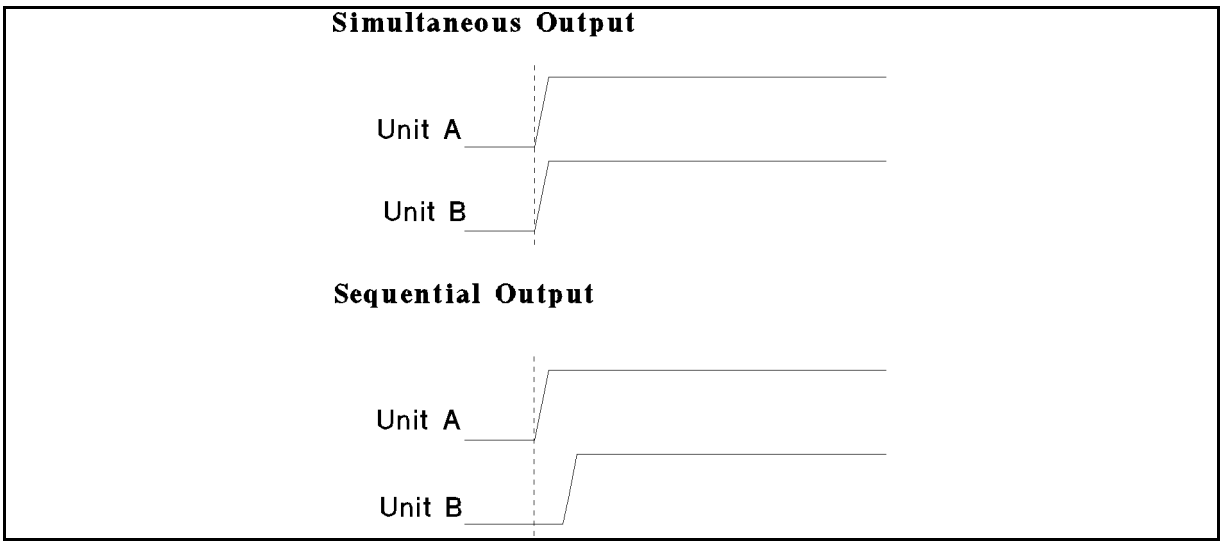
Width: 1us (500kHz) – 9.99 s
Transition: 100ns – 10 ms
Period: 2us – 10s
DC source function as pulse base value
Ext Trig Out function for External PG



* Any one SMU can force pulse-like output by changing DC output fast.
  Pulse width: 500us min. (Period > width + 4 ms)
* Must order at least one of HPSMUx1, MPSMUx2, or PGUx2 for 41501B order.

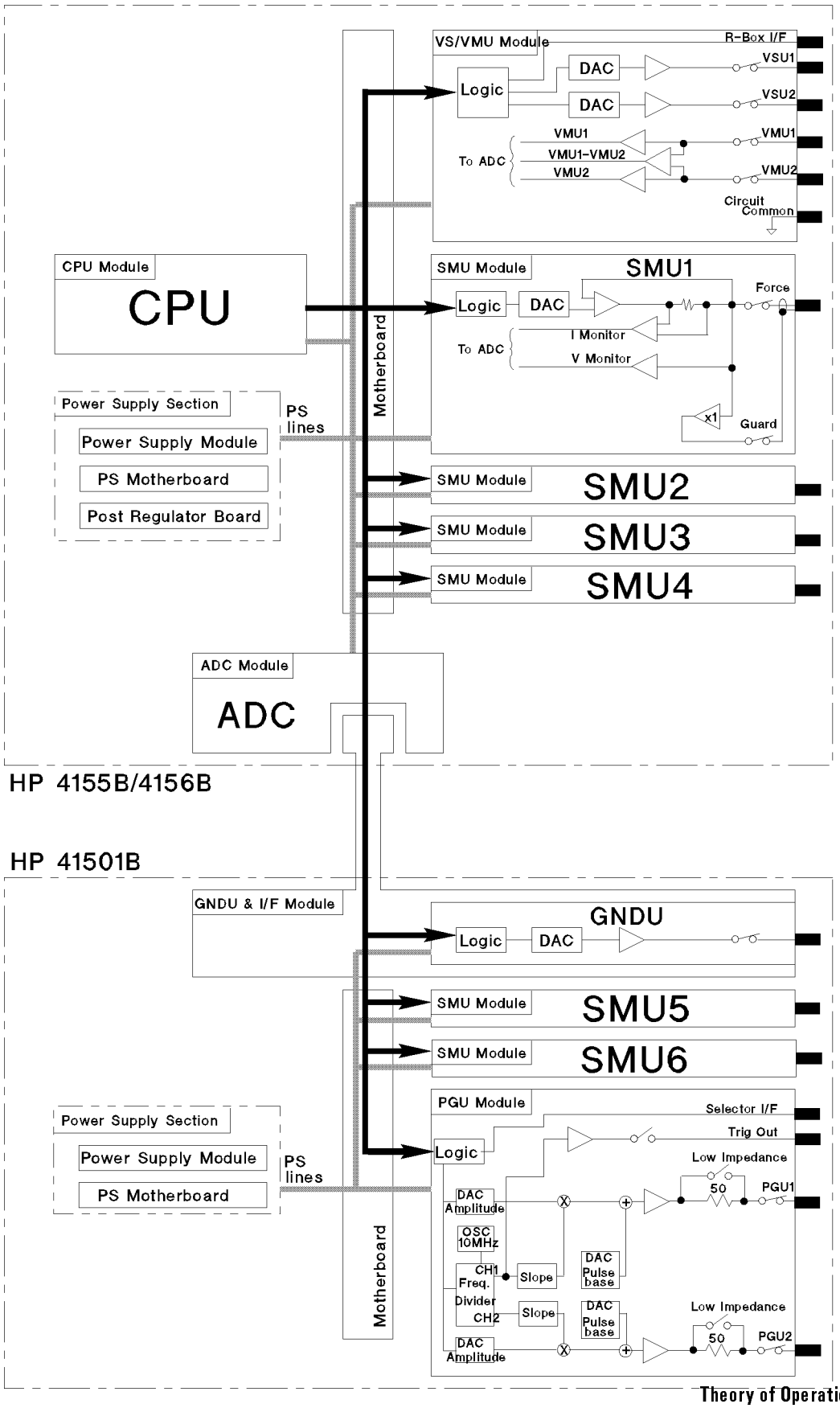
Output Diagram

- Each measurement-unit module (VSU/VMU, SMU, GNDU, and PGU) includes all circuits for the output. That is, each module has everything from DAC (Digital to Analog Converter) to output terminal. Therefore, the output circuit of each module is independent of the other modules.
  - Because each module has a DAC, the simultaneous output of multiple units is possible. (The simultaneous output can be set in the Sampling Measurements or Stress Forcing. This function is used when you strictly set the output forcing time.)
  - The DAC of GNDU is used for highly accurate ZERO output.
- The CPU (CPU module) controls all measurement-unit modules. For the HP 4155B/4156B Mainframe, the CPU module is connected to each measurement-unit through the Motherboard. For the HP 41501B Expander, the ADC module and GNDU&I/F module provide the connection.



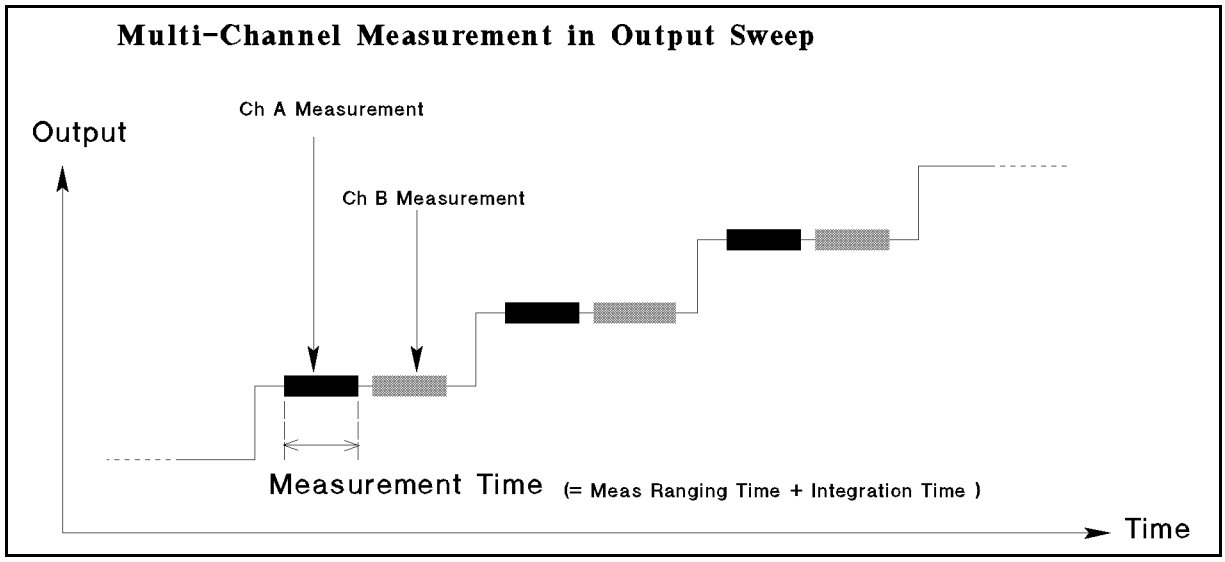
Simultaneous Output

Output Flow Diagram



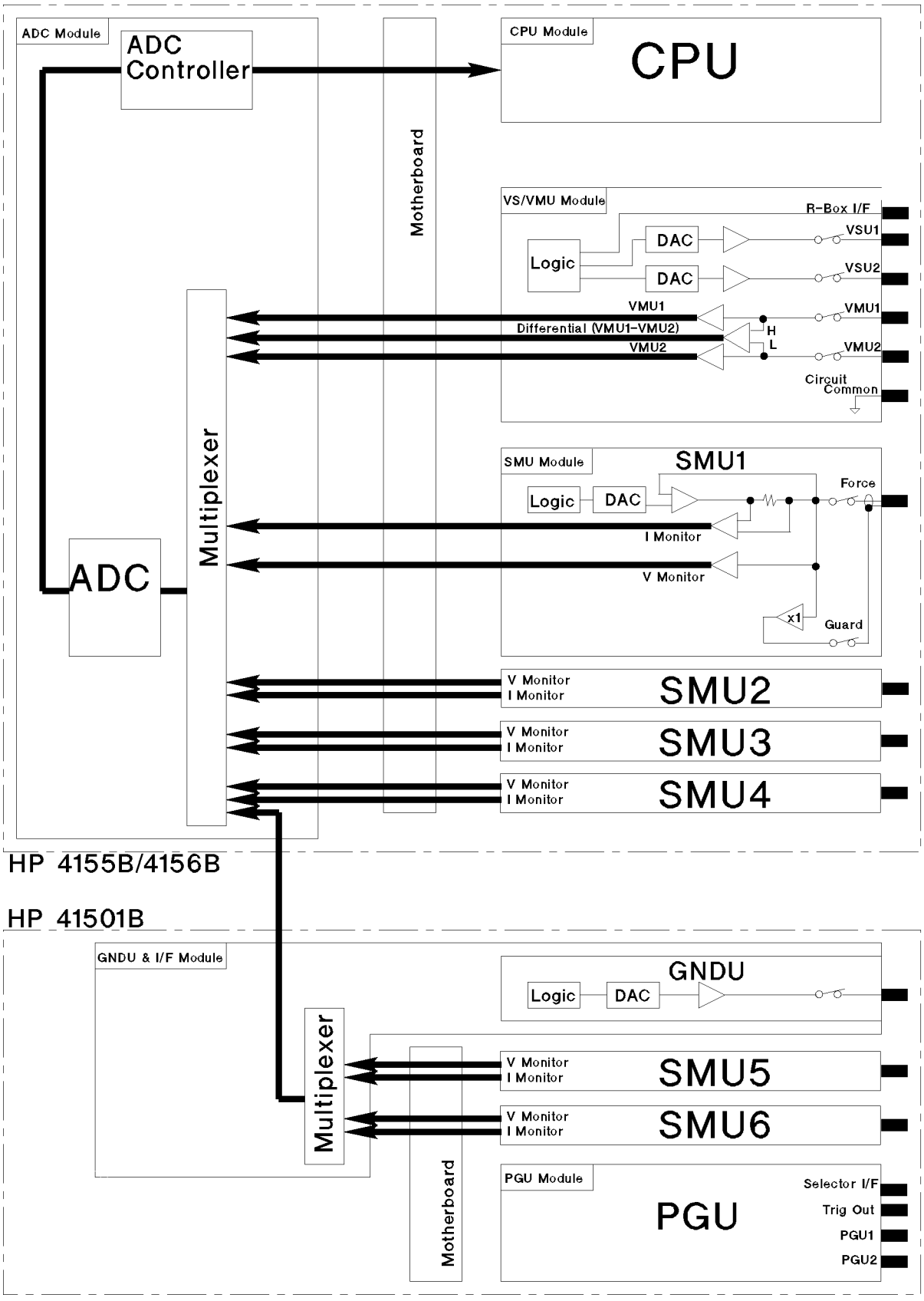
Measurement Diagram

- One ADC (Analog to Digital Converter) is used for all measurements. The inputs are switched by the Multiplexer on the ADC module.
  - Because there is only one ADC, when you perform multi-channel measurements, the timing for each channel is slightly different. The time difference consists of:
    - Measurement integration time (Maximum setting: 100 PLCs (Power Line Cycles))
    - Measurement range change time by auto ranging
- The monitor amplifier in each measurement-unit module normalizes the input voltage/current to 0 to ±8. The normalized voltage is sent to the ADC module. For example, if the SMU voltage measurement range is 100 V and the ADC-converted value 8 V, the measurement voltage is 100 V.
- The differential monitor of VMU is for highly accurate VMU1–VMU2 low voltage measurement. The available ranges are 0.2 V and 2 V. (2 V and 20 V ranges for grounded measurements.)



Multi-Channel Measurement in Output Sweep

Measurement Flow Diagram



Control Diagram

CPU Module

The CPU module consists of Host Controller and SMU Controller.

Host Controller (HOSTC)

Host Controller is the main controller, and controls:

- Front panel (Key, Rotary Knob, LEDs, and External keyboard)
- LCD
- FDD
- HP-IB, Parallel Interface, LAN Interface, Trigger In/Out, and Interlock (Intlk)

SMU Controller (SMUC)

SMU Controller controls all the source units and monitor units.

To force an output, the SMU controller:

1. Receives the setting data from Host Controller.
2. Sets the hardware of measurement units.

To measure an output, the SMU controller:

1. Receives the ADC-converted value from the ADC.
2. Calculates the measurement value.
3. Sends the measurement value to the Host Controller.

Front Key

The front key input is detected as follows:

1. Each front rubber key has a carbon pad behind the key, which is a electrical conductor. If a key is pressed, two points on the Front Keyboard is shorted.
2. The shorted point is detected by the Key Decoder.
3. The Key Decoder sends the key code to the CPU.

1 F Capacitor

By a 1 F capacitor, the system clock is kept for about two to seven days after turn off. The capacitor is fully charged about ten minutes after turning on the HP 4155B/4156B. When the capacitor is perfectly discharged, the clock is set to “97AUG01 00:00:00”.

Graphics Control Board

The Graphics Control Board provides an interface between CPU and LCD. The Graphics Control Board receives the graphics signal processing command data from CPU, and converts it to the necessary digital video signals, then sends the signals to the LCD.

ADC Module

ADC Controller

ADC Controller performs:

- Analog to digital conversion control, such as the Integration time setting.
- Sampling Interval control
- ADC Self-Calibration/Self-Test
- Calculation of the ADC correction value.

EEPROM

EEPROM on the ADC module stores the calibration data of ADC (V/R References). The ADC module for replacement also has the calibrated data, which is written at factory. So the HP 4155B/4156B will work correctly without the ADC calibration.

LCD

LCD is an 8.4-inch TFT type (640×480 VGA) with associated drive circuitry. It receives digital horizontal and vertical sync signals, and red, green, and blue (RGB) digital video signals.

FDD

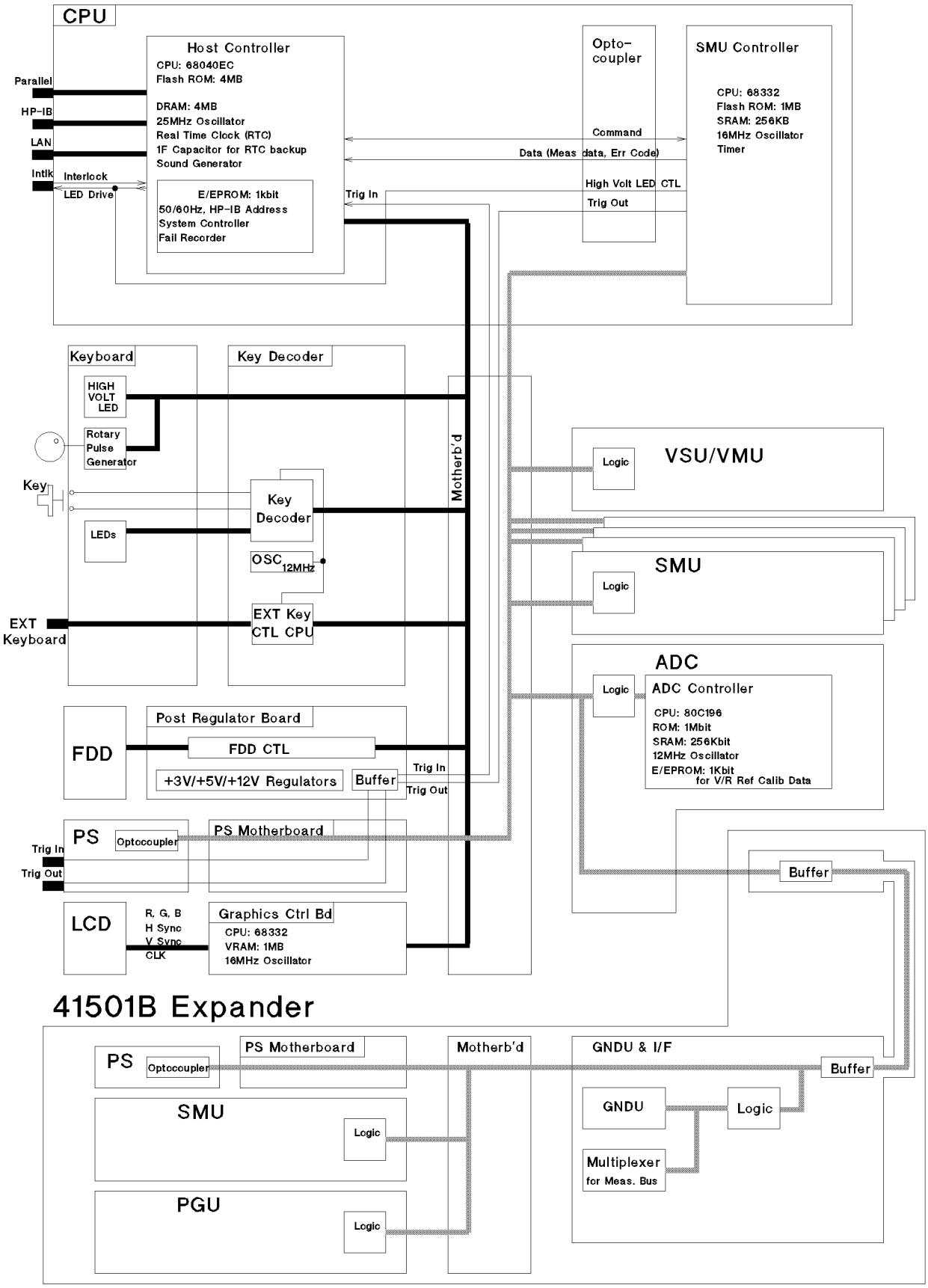
For a 2HD (high density) or 2DD (double density) 3.5-inch flexible disk. The 2DD formatting on a 2HD disk is not allowed.

FDD Controller

FDD Controller is on the Post Regulator Board.

It uses a 24 MHz clock signal that is generated on the Post Regulator Board.

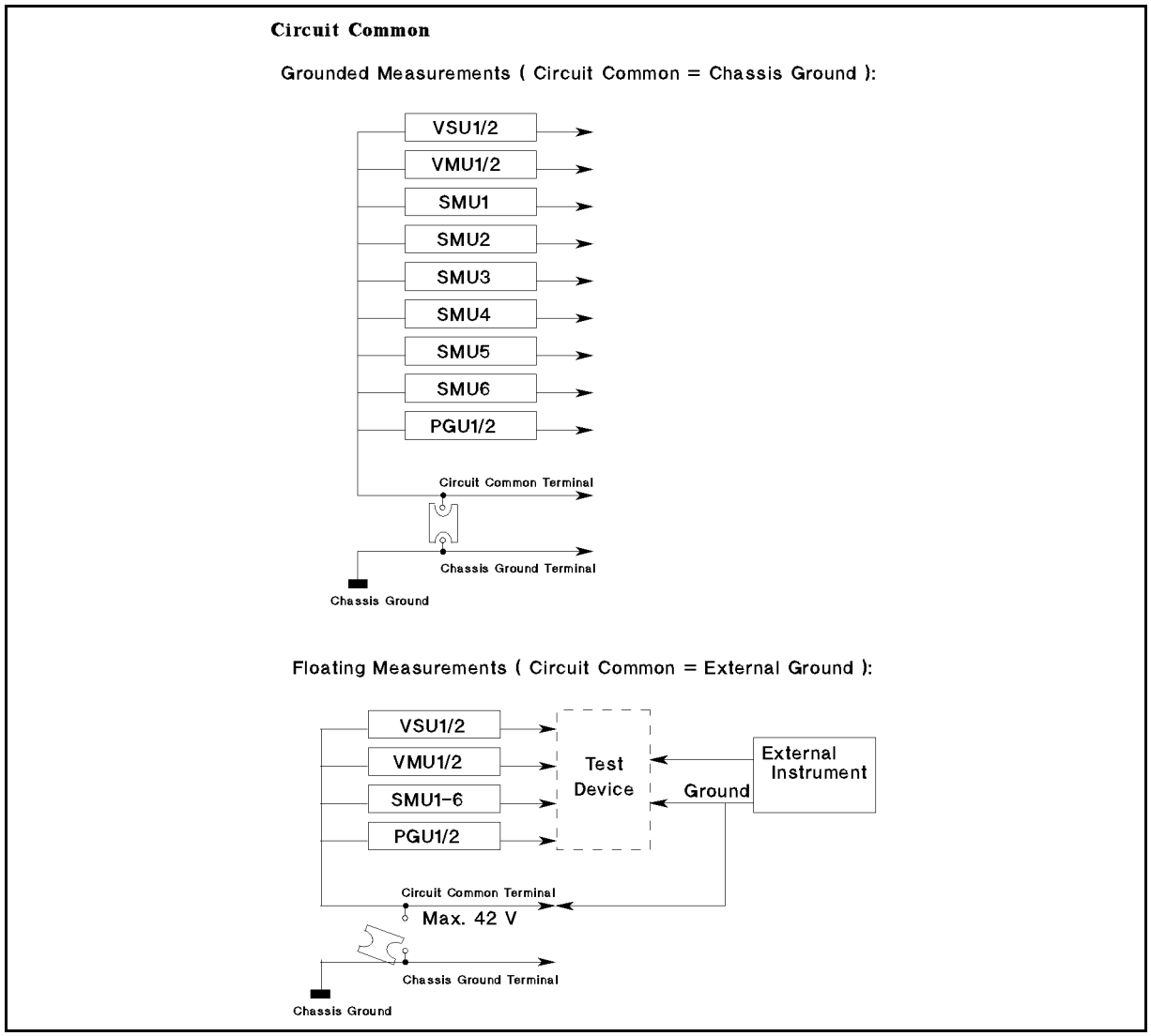
4155B / 4156B / 41501B Control Diagram



Memo

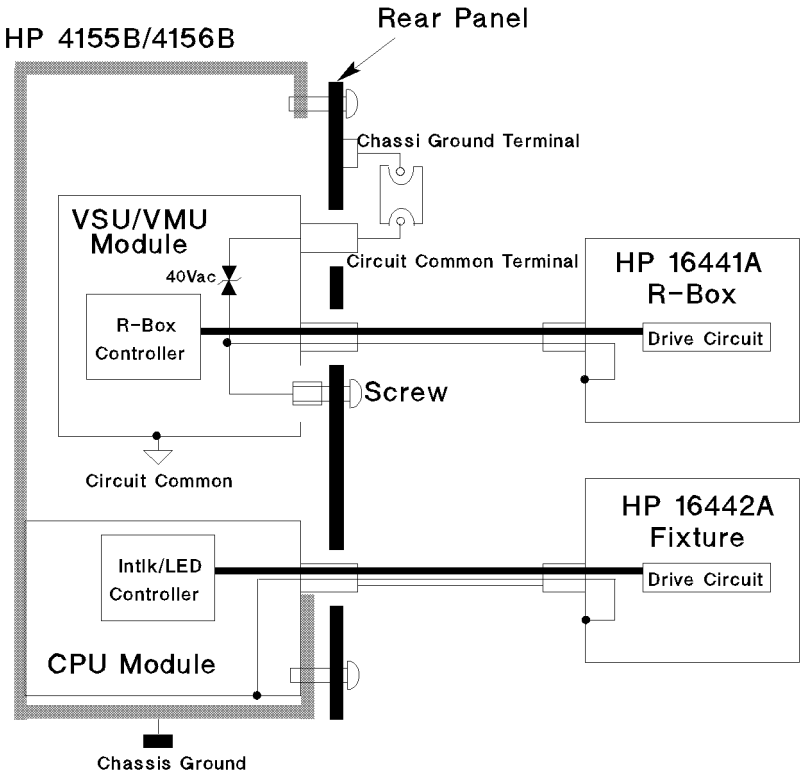
Circuit Common and Chassis Ground

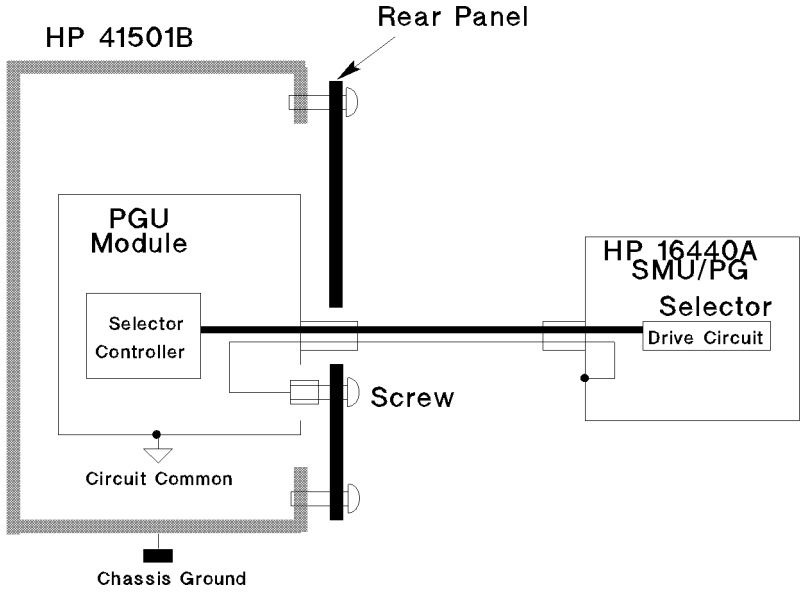
- The Circuit Common and Chassis Ground terminals on the rear panel are used when making floating or grounded measurements. When the test device is grounded by external instrument (wafer-prober or external sources, etc.), use the floating measurements to prevent the noise of ground loops. The HP 4155B/4156B/41501B forces and measures voltage or current referenced to external ground (±42 V maximum). If the external ground is greater than ±42 V referenced to Chassis Ground, the HP 4155B/4156B/41501B may be damaged. And note that the voltage appears on the outer conductor of Force terminals, which are the Circuit Common.
- When you do not perform the floating measurements, connect the Chassis Ground and Circuit Common with the shorting-bar for noise reduction and safety.
- To connect the chassis of R-Box and Selector to the HP 4155B/4156B chassis ground, the screw on the rear panel is also used.



Circuit Common and Chassis Ground Terminals

Ground Connection for Accessory Chassis





Mainframe Power Supply Destination

Post Regulator

Post Regulator filters and regulates some outputs of (switching regulator) Power Supply again.

+15Vd	For inverter for LCD.
+12Vd	For "High Voltage" LED control, and 1 F capacitor for clock backup. +12 V ±5%, 70 mA maximum.
+3Vd	For LCD.
+5Va	For CPU (SMU Controller section). +5 V ±3%, 0.8 A max.

Circuit Ground

The dashed box in the following figure shows the circuits on the Circuit Common. The rest is on the chassis ground. In the CPU module, to isolate between the chassis ground and Circuit Common, the optocouplers are used in the Host Controller and SMU Controller communication.

+5V/+15V/−15V in SMU/VSVMU/ADC Module

+5 V, +15 V, and −15 V are regulated in each module (SMU, VSVMU, or ADC).

+5 V (±5%)	Regulated from +7Va.
+15 V (±5%)	Regulated from +20Va.
−15 V (±5%)	Regulated from −20Va.

Fuses

In Post Regulator:	For FDD +5V. For inverter +15V.
In Key Decoder:	For external keyboard +5V.
In CPU module:	For Host Controller section +5V.
In SMU module:	For 14.4Vp. This is used for SMU floating power supply.

4155B / 4156B Mainframe Power Supply Destination

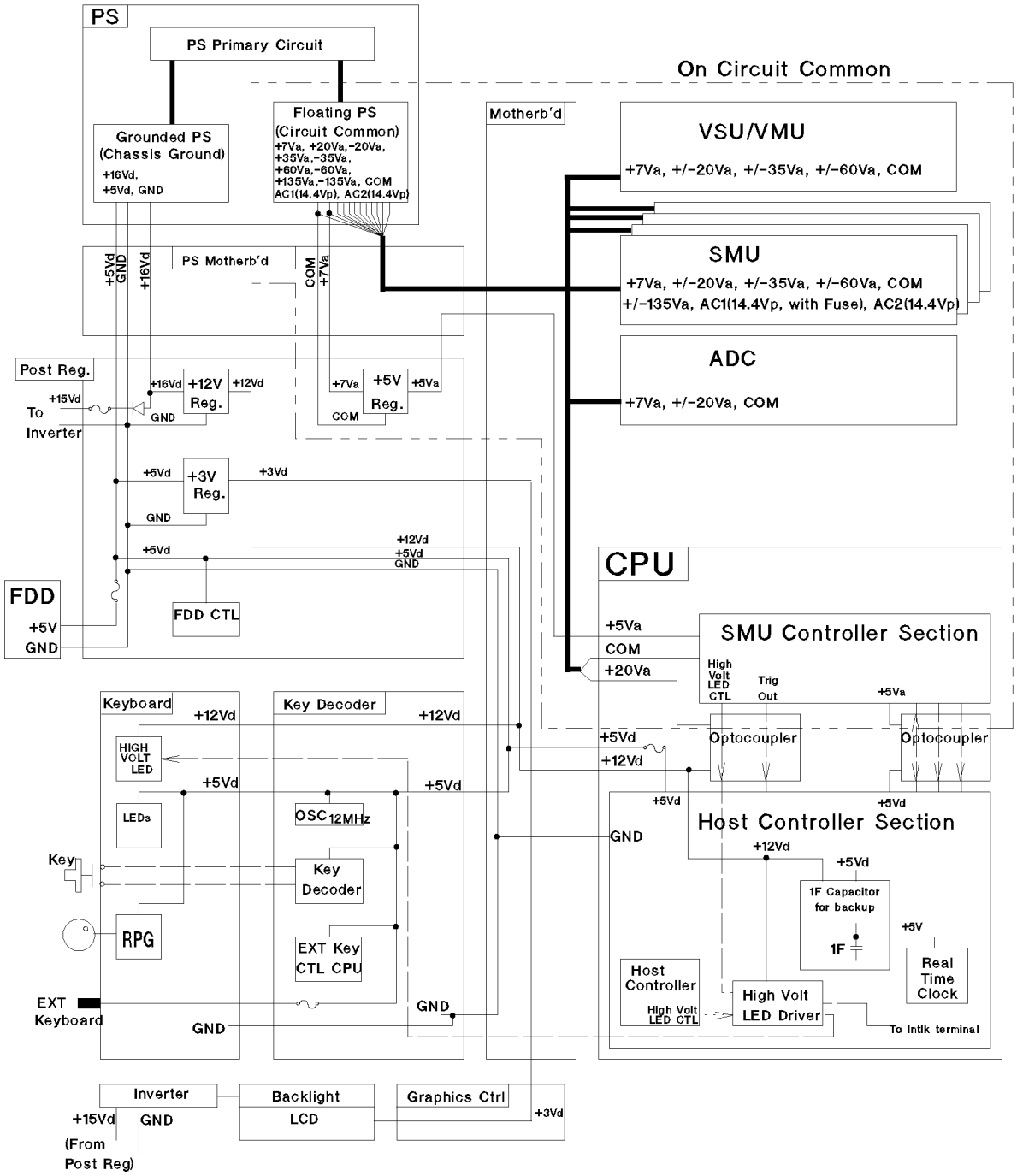


Table 6-1.
HP 4155B/4156B Power Supply Output Voltages and Protection Circuit

Signal	Output Voltage	Current	Common	Built-in Protection Circuit		
				Over Current	Over Voltage	Under Voltage
+16Vd	+17.5 Vdc ±7.5% (16.1875 to 18.8125 V)	0 to 1.2 A	Chassis	110%	21.5±2V	12.5±2V
+5Vd	+5.1 Vdc ±3% (4.947 to 5.253 V)	1 to 4 A	Chassis	110%	6.2±0.7V	3.8±0.7V
+135Va	+133 Vdc ±7.5% (123.025 to 142.975 V)	0 to 0.2 A	Circuit	110%	170±17V	100±10V
+60Va	+58.5 Vdc ±6% (54.99 to 62.01 V)	0 to 0.8 A	Circuit	110%	75±7.5V	45±5V
+35Va	+36 Vdc ±7.5% (33.3 to 38.7 V)	0 to 1 A	Circuit	110%	45±5V	27±5V
+20Va	+21 Vdc ±7.5% (19.425 to 22.575 V)	0.1 to 1.6 A	Circuit	110%	26±3V	14±2V
+7Va	+6.8 Vdc ±12% (5.984 to 7.616 V)	0.1 to 3.4 A	Circuit	110%	9±1V	5±1V
−7Va	−6.8 Vdc ±12% (−5.984 to −7.616 V)	0 to 1.6 A	Circuit	110%	−9±1V	−5±1V
−20Va	−21 Vdc ±7.5% (−19.425 to −22.575 V)	0.1 to 1.6 A	Circuit	110%	−26±3V	−14±2V
−35Va	−36 Vdc ±7.5% (−33.3 to −38.7 V)	0 to 1 A	Circuit	110%	−45±5V	−27±5V
−60Va	−58.5 Vdc ±6% (−54.99 to −62.01 V)	0 to 0.8 A	Circuit	110%	−75±7.5V	−45±5V
−135Va	−133 Vdc ±7.5% (−123.025 to −142.975 V)	0 to 0.2 A	Circuit	110%	170±17V	100±10V
AC1	14.4 Vac-peak ±10% (12.96 to 15.84 Vp)	0 to 0.28 A	Circuit	None	None	None
AC2	14.4 Vac-peak ±10% (12.96 to 15.84 Vp)	0 to 0.28 A	Circuit	None	None	None

Table 6-2. HP 4155B/4156B Power Supply Output Destinations

Signal	CPU	LCD	FDD	Key B'd	Key Deco	VSU VMU	SMU	ADC	GNDU &I/F
+16Vd (+12Vd)	Y	-	-	Y	-	-	-	-	-
+16Vd (+15Vd)	-	Y[1]	-	-	-	-	-	-	-
+5Vd	Y	-	Y	Y	Y	-	-	-	-
+5Vd (+3Vd)	-	Y	-	-	-	-	-	-	-
+7Va	-	-	-	-	-	Y	Y	Y	-
+7Va (+5Va)	Y	-	-	-	-	-	-	-	Y
-7Va (not used)	-	-	-	-	-	-	-	-	-
+20Va	Y	-	-	-	-	Y	Y	Y	Y
−20Va	-	-	-	-	-	Y	Y	Y	Y
+35Va	-	-	-	-	-	Y	Y	-	-
−35Va	-	-	-	-	-	Y	Y	-	-
+60Va	-	-	-	-	-	Y	Y	-	-
−60Va	-	-	-	-	-	Y	Y	-	-
+135Va	-	-	-	-	-	-	Y	-	-
−135Va	-	-	-	-	-	-	Y	-	-
AC1 (14.4Vp)	-	-	-	-	-	-	Y	-	-
AC2 (14.4Vp)	-	-	-	-	-	-	Y	-	-

1 For inverter.

Table 6-3. HP 4155B/4156B Power Supply Pin Assignment

Connector	Pin No.	Signal
16-pin Connector	A1,B1	Chassis Ground
	A2,B2	Chassis Ground
	A3,B3	Chassis Ground
	A4,B4	Chassis Ground
	A5,B5	+5Vd
	A6,B6	+5Vd
	A7,B7	+5Vd
	A8,B8	+5Vd
	A9,B9	+5Vd
	A10,B10	Chassis Ground
	A11,B11	Chassis Ground
	A12,B12	+16Vd
	A13,B13	Chassis Ground
	A14	Trig In
	B14	Trig Out
	A15	Trig In
	B15	Trig Out
	A16,B16	Chassis Ground
25-pin Connector	A1,B1	No connection
	A2,B2	+135Va
	A3,B3	+60Va
	A4,B4	+35Va
	A5,B5	+20Va
	A6,B6	+20Va
	A7,B7	+7Va
	A8,B8	+7Va
	A9,B9	+7Va
	A10,B10	Circuit Common
	A11,B11	AC1
	A12,B12	AC2
	A13,B13	Circuit Common
	A14,B14	Circuit Common
	A15	Power Fail (PWRF)
	B15	Circuit Common
	A16	Remote Shut Down (RSDWN)
	B16	No connection
	A17,B17	Circuit Common
	A18,B18	−7Va
	A19,B19	−7Va
	A20,B20	−20Va
	A21,B21	−20Va
	A22,B22	−35Va
	A23,B23	−60Va
	A24,B24	−135Va
	A25,B25	No connection

Table 6-4. Power Supply Unit Pin Assignment (Rear View)

A25	A24	A23	· · · · ·	A2	A1	A16	A15	A14	· · · · ·	A2	A1
B25	B24	B23	· · · · ·	B2	B1	B16	B15	B14	· · · · ·	B2	B1

Memo

Expander Power Supply Destination

Expander Power Supply Module

Expander Power Supply is turned on when the Mainframe Power Supply is turned on. That is, when the +7Va power line in the Mainframe Power Supply is turned on, the +5Va_adc power line is turned on, then the Expander Power Supply is turned on by the Remote Power On/Off circuit.

Remote Power On/Off Circuit

When the input voltage of Remote On/Off Circuit is greater than 0.8 V, the Expander Power Supply turns on. When that is less than 0.8 V, the Expander Power Supply turns off.

Note that the Expander Power Supply is turned on/off by the Mainframe Power Supply Output. It is not by the CPU.

Test Switch. The Expander Power Supply has a test switch. This is used when you remove the Expander Power Supply from the HP 41501B, and you turn it on for the check.

+250Va/−250Va Outputs

+250Va and −250Va are used in the HPSMU only.

−7Va Output

−7Va is used in the GNDU only.

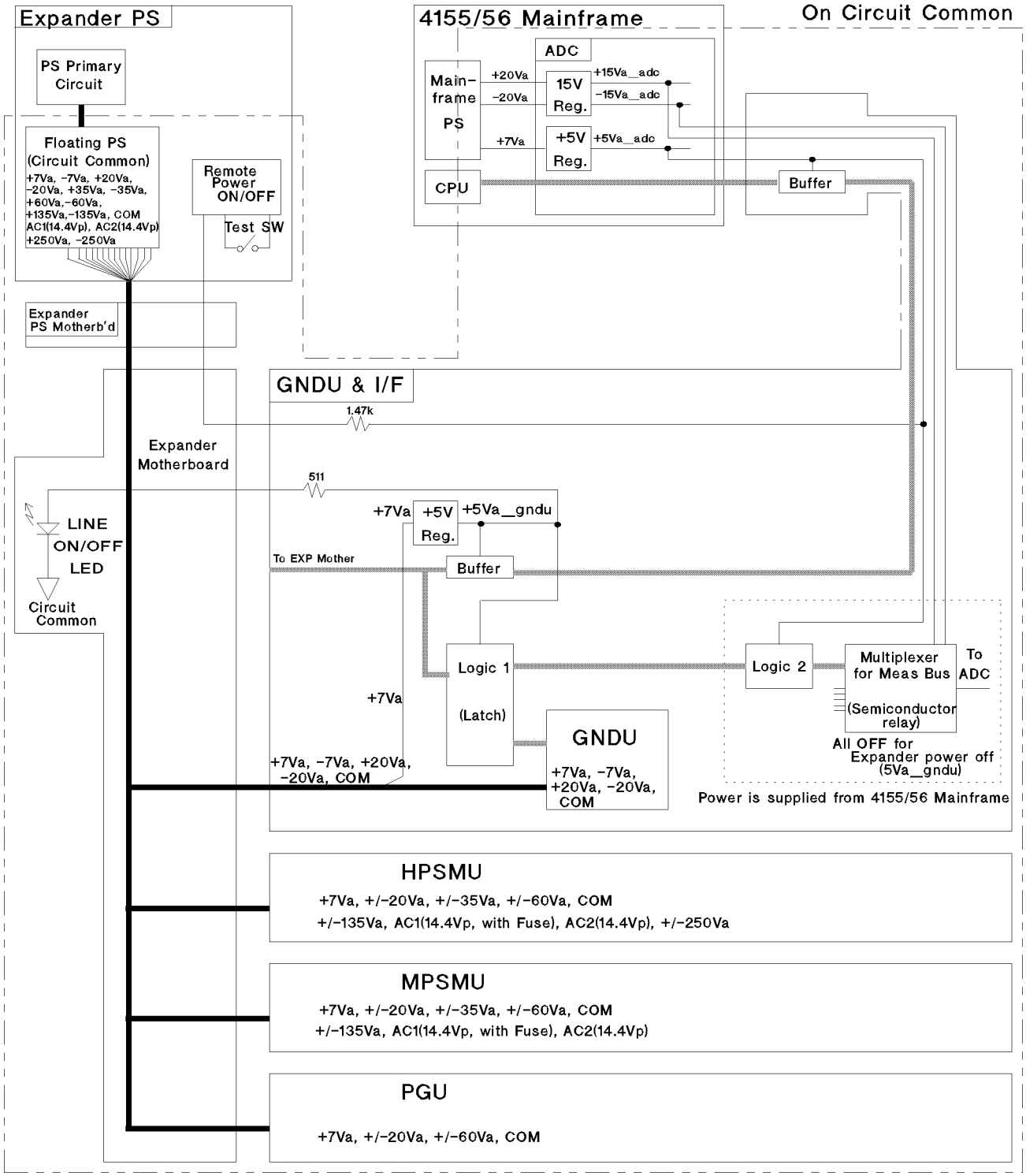
Mainframe Power Supply

In the HP 41501B Expander, the Mainframe Power Supply Outputs are used:

- For Expander Power Supply remote on/off.
- To surely disconnect all semiconductor switches in the Multiplexer for Measurement Bus when the HP 41501B is turned off.

  (Voltage reference lines and SMU/PGU Overvoltage detection line are also disconnected by semiconductor switch when the HP 41501B is turned off. See later sections.)

41501B Expander Power Supply Destination



HP 41501B Power Supply

Table 6-5.
HP 41501B Power Supply Output Voltages and Protection Circuit

Signal	Output Voltage	Current	Common	Built-in Protection Circuit		
				Over Current	Over Voltage	Under Voltage
+250Va	+248 Vdc ±10.1% (222.952 to 273.048 V)	0 to 0.07 A	Circuit	110%	315±32V	185±19V
+135Va	+136 Vdc ±10.3% (121.992 to 150.008 V)	0 to 0.2 A	Circuit	110%	170±17V	100±10V
+60Va	+59.5 Vdc ±12.6% (52.003 to 66.997 V)	0 to 0.8 A	Circuit	110%	75±7.5	45±5V
+35Va	+36 Vdc ±11.1% (32.004 to 39.996 V)	0 to 1 A	Circuit	110%	45±5V	27±5V
+20Va	+20 Vdc ±12.5% (17.5 to 22.5 V)	0.1 to 1.6 A	Circuit	110%	26±3V	14±2V
+7Va	+7.0 Vdc ±14.3% (5.999 to 8.001 V)	0.1 to 3.4 A	Circuit	110%	9±1V	5±1V
−7Va	−7.0 Vdc ±14.3% (−5.999 to −8.001 V)	0 to 1.6 A	Circuit	110%	9±1V	5±1V
−20Va	−20 Vdc ±12.5% (−17.5 to −22.5 V)	0.1 to 1.6 A	Circuit	110%	−26±3V	−14±2V
−35Va	−36 Vdc ±11.1% (−32.994 to −39.996 V)	0 to 1 A	Circuit	110%	−45±5V	−27±5V
−60Va	−59.5 Vdc ±12.6% (−52.003 to −66.997 V)	0 to 0.8 A	Circuit	110%	−75±7.5V	−45±5V
−135Va	−136 Vdc ±10.3% (−121.992 to −150.008 V)	0 to 0.2 A	Circuit	110%	−170±17V	−100±10V
−250Va	−248 Vdc ±10.1% (−222.952 to −273.048 V)	0 to 0.07 A	Circuit	110%	−315±32V	−185±19V
AC1	14.4 Vac-peak ±15% (12.24 to 16.56 Vp)	0 to 0.28 A	Circuit	None	None	None
AC2	14.4 Vac-peak ±15% (12.24 to 16.56 Vp)	0 to 0.28 A	Circuit	None	None	None

Table 6-6. HP 41501B Power Supply Output Destinations

Signal	HPSMU	MPSMU	PGU	GNDU &I/F	4155/6[1]
+7Va	Y	Y	Y	Y	-
−7Va	-	-	-	Y	-
+20Va, −20Va	Y	Y	Y	Y	-
+35Va, −35Va	Y	Y	-	-	-
+60Va, −60Va	Y	Y	Y	-	-
+135Va, −135Va	Y	Y	-	-	-
+250Va, −250Va	Y	-	-	-	-
AC1, AC2 (14.4Vp)	Y	Y	-	-	-

1 No output is supplied to the HP 4155B/4156B Mainframe.

Table 6-7. HP 41501B Power Supply Pin Assignment

Connector	Pin No.	Signal
25-pin Connector	A1,B1	+250Va
	A2,B2	+135Va
	A3,B3	+60Va
	A4,B4	+35Va
	A5,B5	+20Va
	A6,B6	+20Va
	A7,B7	+7Va
	A8,B8	+7Va
	A9,B9	+7Va
	A10,B10	Circuit Common
	A11,B11	AC1
	A12,B12	AC2
	A13,B13	Circuit Common
	A14,B14	Circuit Common
	A15	Power Fail (PWRF)
	B15	Circuit Common
	A16	No connection
	B16	Remote On (RON)
	A17,B17	Circuit Common
	A18,B18	−7Va
	A19,B19	−7Va
	A20,B20	−20Va
	A21,B21	−20Va
	A22,B22	−35Va
	A23,B23	−60Va
	A24,B24	−135Va
	A25,B25	−250Va

Table 6-8. Power Supply Unit Pin Assignment (Rear View)

A25	A24	A23	. . . . .	A2	A1
B25	B24	B23	. . . . .	B2	B1

Voltage References and Zero Check Terminal

Zero Check Terminal

The Zero Check terminal is the reference point/potential of Circuit Common. Therefore, it is the reference potential of HP 4155B/4156B. The specification of voltage output/measurement accuracy is defined in reference to this point.

For example, 0 V output accuracies are:

HRSMU:	±400 μV
MPSMU:	±(900 μV + (Output Current) × 0.3)
HPSMU:	±900 μV
VSU:	±(10 mV + (Output Current) × 0.2)
GNDU:	±100 μV
PGU:	±50 mV

Because the referential potential of Circuit Common is separated from current path of Circuit Common, the potential difference does not occur in all the measurement units.

Voltage References

The reference voltages are supplied from the ADC module.

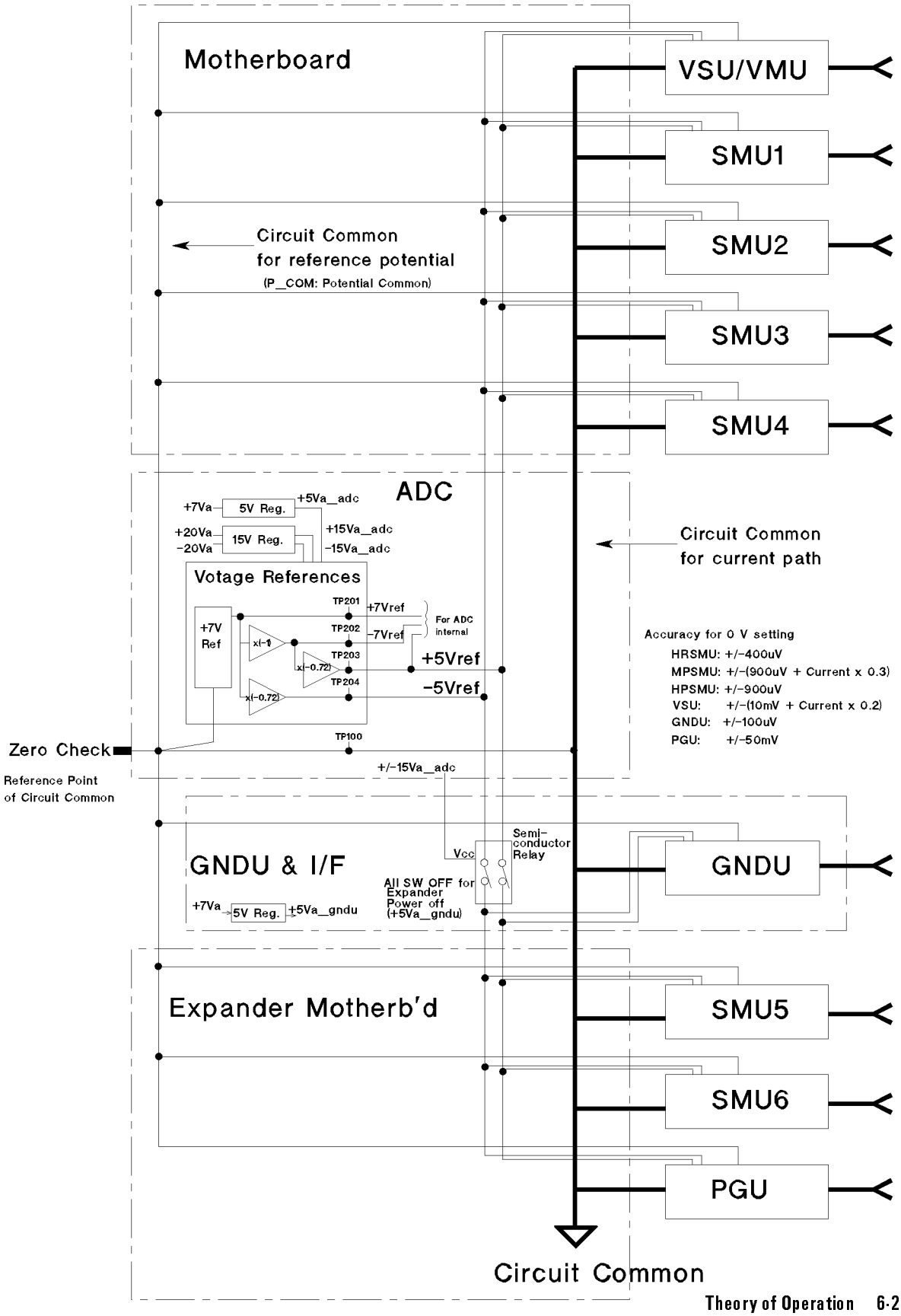
The ADC uses the following reference voltages:

- +7Vref, –7Vref, +5Vref, Potential Common (Zero Check)

The measurement units use the following reference voltages:

- +5Vref, –5Vref, Potential Common (Zero Check)

Voltage References (& Zero Check Terminal)



Self-Calibration Path (Measurement Bus & Self-Calibration Bus)

The Self-Calibration is performed by forcing the output internally and measuring the output. During the Self-Calibration, the outputs are not forced outside because all output switches are set to off.

When you perform the Self-Test, the Self-Calibration is also performed. Also the Self-Calibration is a kind of test because there are limits of measurement value for Self-Calibration (for example, [V measure] < [V set] ±5%).

Self-Calibration Bus

- The Self-Calibration Bus connects the output of measurement unit and the ADC directly (without monitor amplifier). This is for accurate Self-Calibration.
- All measurement units have the Self-Calibration Bus.
- Maximum voltage is limited to 10 V because the maximum ADC input is 10 V. To self-calibrate the voltages greater than 10 V, the normal measurement bus (V/I Monitor lines) is used.
- There are two Self-Calibration Buses: for SMU and for VSVMU/PGU. The VSVMU/PGU Self-Calibration bus is also used as a guard line of the SMU Self-Calibration Bus. During the SMU Self-Calibration, the SMU Guard output is connected to the VSVMU/PGU Self-Calibration Bus. Between the Mainframe and Expander, a coaxial cable is used for guard. The outerconductor is the Guard (VSVMU/PGU Self-Calibration Bus).

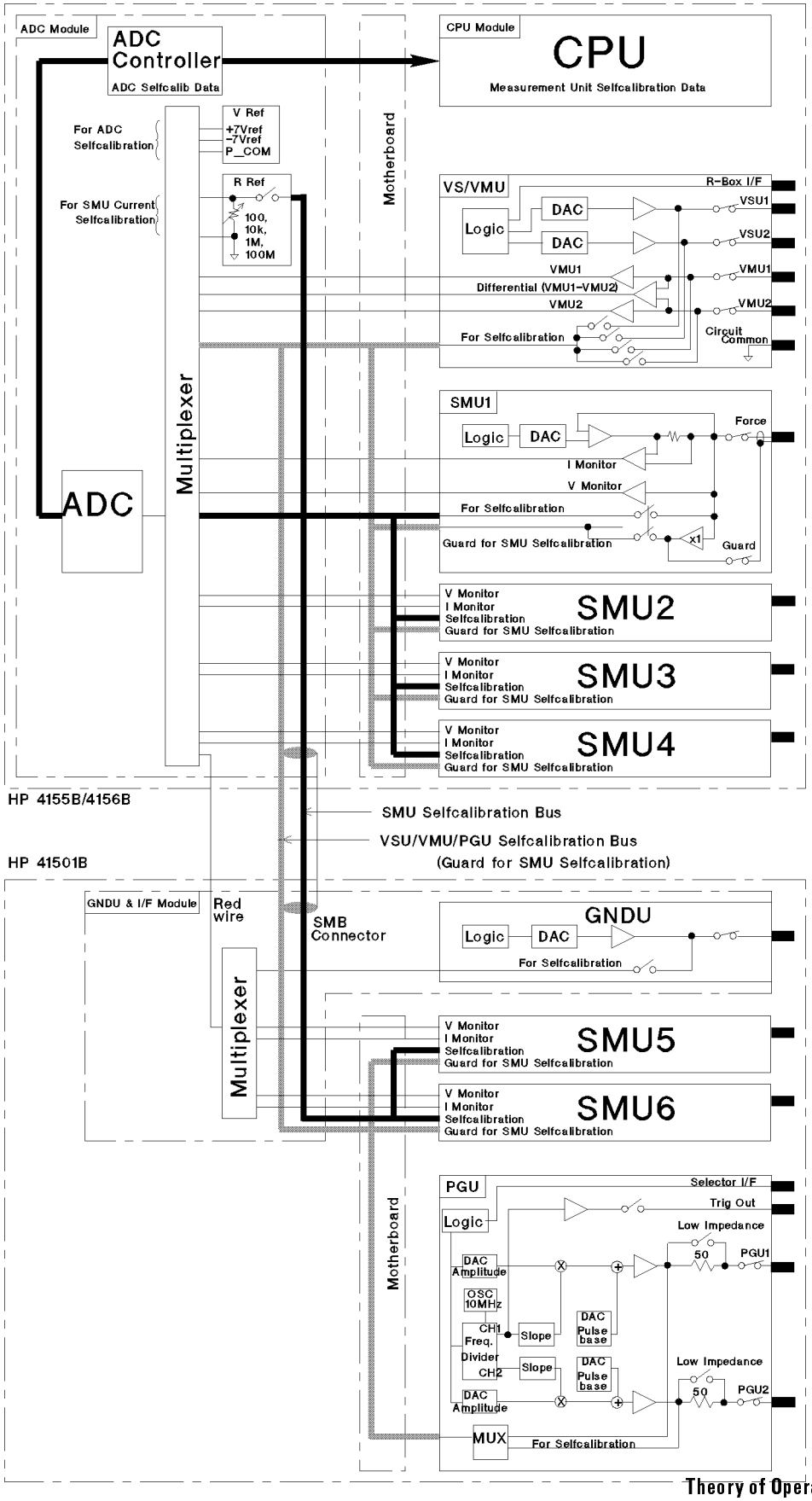
ADC Self-Calibration

The ADC Self-Calibration/Self-Test uses the +7Vref, −7Vref, and Potential Common.

The R reference and the Multiplexer switches are not tested.

Therefore, even if the Multiplexer switch or R Reference fails, the ADC Self-Calibration/Self-Test can be pass, and the Measurement Unit Self-Test can be fail.

Selfcalibration Path (Measurement Bus & Selfcalibration Bus)



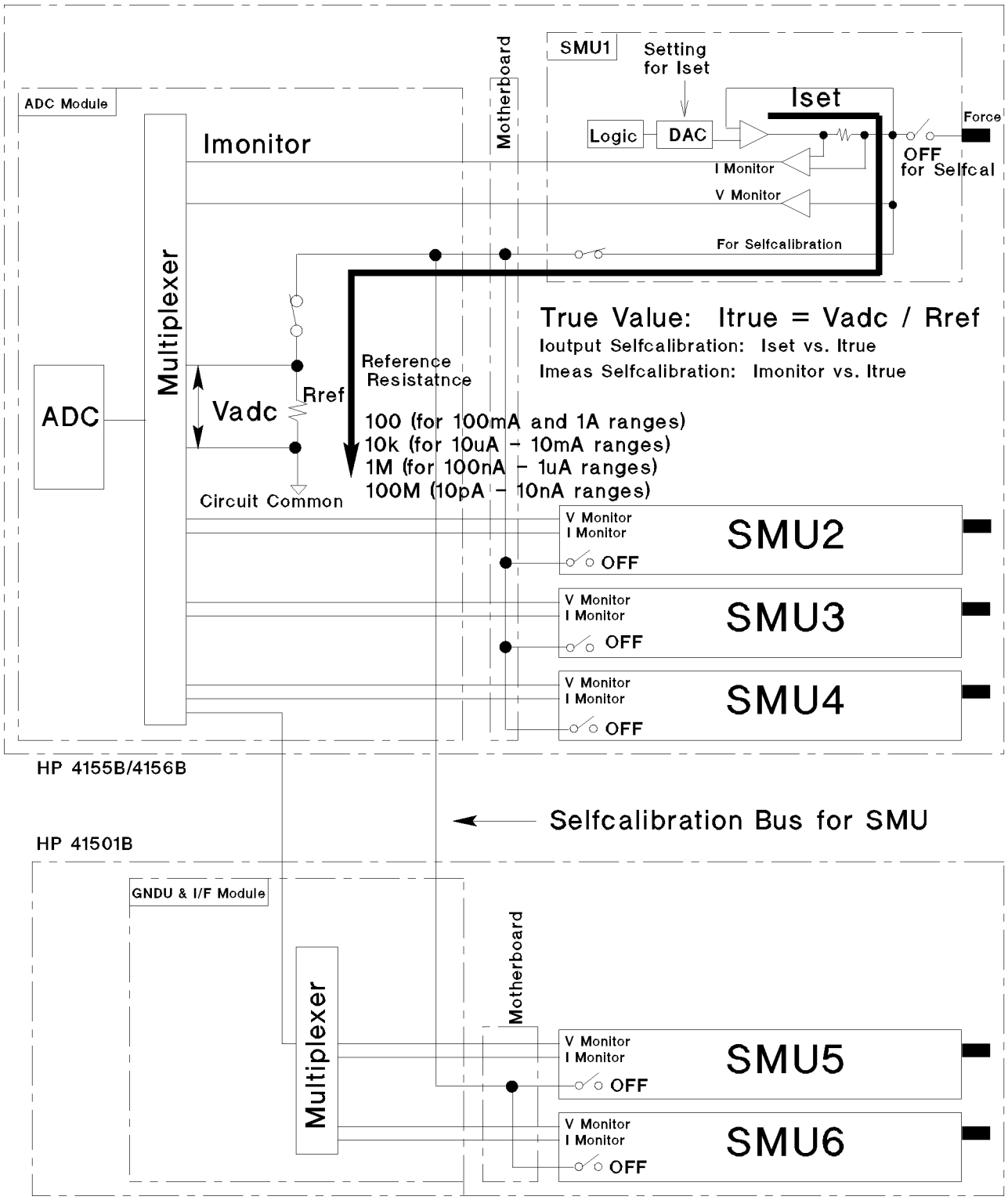
SMU Current Self-Calibration Path (R Reference)

- To self-calibrate the current output:
  - SMU forces a current (Iset) to R Reference whose value is known by calibration, through Self-Calibration Bus.
  - ADC measures the Vadc, which is voltage of R reference.
  - CPU calculates [Vadc / Rref], which is the true value of Iset.
- To self-calibrate the current measurement:
  - SMU forces a current (Iset).
  - SMU measures the current (Imonitor).
  - ADC measures the Vadc.
  - CPU calculates [Vadc / Rref], which is the true value of Imonitor.
- R Reference has four resistances:

100 Ω:	For 100 mA and 1 A ranges Self-Calibration.
10 kΩ:	For 10 μA to 10 mA ranges Self-Calibration.
1 MΩ:	For 100 nA to 1 μA ranges Self-Calibration.
100 MΩ:	For 10 pA to 10 nA ranges Self-Calibration.

SMU Current Output/Measurement Selfcalibration Path

Example for SMU1 selfcalibration



Abnormal Condition Detectors

Power Supply AC Input Monitor

If the AC LINE voltage goes down to 80 Vac, the HP 4155B/4156B/41501B Power Supplies automatically turn off. If the voltage recovers and exceeds 80 Vac, the HP 4155B/4156B/41501B automatically turn on again.

If this occurs, monitor the AC LINE first. Usually, this means the supplying AC LINE is abnormal. For example, momentary power loss occurs, or voltage sags occur, or the tops of AC LINE waveform are clipped. The sags and clipped tops tend to occur when the power used exceeds the supply capability of the AC LINE.

Power Supply Over V / Over I / Under V / Fan Stop Detectors

If the Mainframe Power Supply or Expander Power Supply detects an overvoltage, overcurrent, undervoltage, or fan stop, the power supply automatically shuts down by Emergency Shutdown function.

To recover this, you have to set the LINE switch to off, then back on.

When the HP 4155B/4156B Power Supply shuts down, the HP 41501B Power Supply also always shuts down. On the other hand, when the HP 41501B Power Supply shuts down, but the HP 4155B/4156B has no problem, the HP 4155B/4156B does not shut down. The HP 4155B/4156B shows an error message.

Shutdown Sequence:

1. Detector notifies CPU within 15 ms after the detection.
2. Power Supply starts turning off. The outputs can be kept at least 3 ms after CPU notification.
3. CPU sets all source unit outputs (DACs) to 0 V, and all source unit output switches to OFF, then stops the FDD operation if during the disk access. This step cannot always be performed because the power down is already started. When source units are set to 0 V, the order is from higher voltage to lower voltage units.

Measurement Unit Over V/I Detectors

If the SMU, VSU, or PGU detects an overvoltage or overcurrent:

1. The detector notifies CPU.
2. CPU starts to set all source unit outputs (DACs) to 0 V, and all source unit output switches to OFF, then stops the FDD operation if during the disk access.
3. CPU waits for 15 ms.
4. If the abnormal voltage or current is corrected, only an error message displayed, and the shutdown does not occur. If not corrected, the CPU turns the Power Supply OFF by Emergency Shutdown function.

Table 6-9. Measurement Unit Detectors for Protection

Unit	Over Voltage Detector	Over Current Detector
HRSMU	Y (±120 V on Force)	—--
MPSMU	Y (±120 V on Force)	—--
HPSMU	—--	Y[1]
VSU1	Y (±24 V on Force)	—--
VSU2	Y (±24 V on Force)	—--
VMU1/VMU2	—--[2]	—--
PGU1	Y (±49.5 V on Force)	—--
PGU2	Y (±49.5 V on Force)	—--

1 See the following table.

2 The VMU can endure up to 200 V input, although the measurement is up to 20 V.

Table 6-10. HPSMU Overcurrent Detector Detection Value

Voltage Range (Range Max. Current)	Current Output or Measurement Range	Detection Value
2V, 20 V (1 A)	100 mA, 1 A	None
	≤ 10 mA	70 mA
40 V (500 mA)	100 mA, 1 A	600 mA
	≤ 10 mA	70 mA
100 V (125 mA)	100 mA, 1 A	170 mA
	≤ 10 mA	70 mA
200 V (50 mA)	All	70 mA

Emergency Shutdown Function

If either of the following occurs, the HP 4155B/4156B/41501B or HP 41501B automatically shuts down to prevent damage (power is off, but LINE switch stays in ON position).

- When Mainframe Power Supply or Expander Power Supply detects an abnormal condition (except the detection by the AC Input Monitor).
- When measurement unit detects an overvoltage or overcurrent, and the abnormal condition is not corrected even if the output switches of all measurement units are set to off.

In this case, the power supply is locked into the power-off setting. To turn back on, perform:

1. Set the LINE switch to OFF once.
2. Wait for 10 seconds or more.
3. Set the LINE switch to ON.

If the AC Line Monitor detects an abnormal condition, the power supply is turned off, but is not locked into the power-off setting. Therefore, if the abnormal condition is corrected, the power supply (that is, HP 4155B/4156B/41501B) automatically boots up.

Causes

An abnormal voltage or current on internal circuits can be caused by:

- Improper connection between the instrument and test devices.
- Overvoltage or overcurrent input.
- SMU Guard output is shorted to an output or another SMU Guard.
- AC LINE that has an abnormal voltage, impulses, surges.
- Hardware failure.

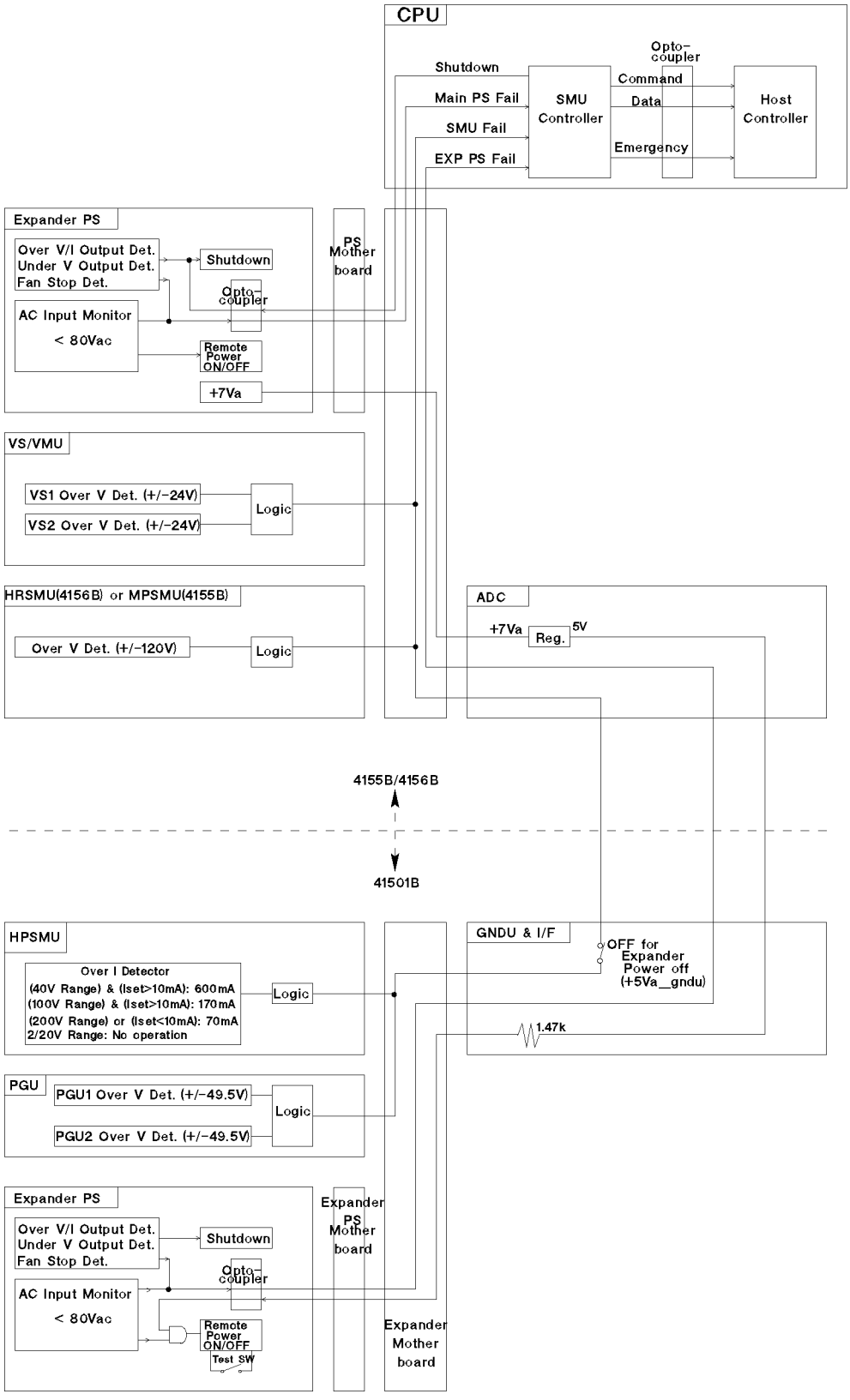
Note

- An ADC failure can cause overvoltages in the HRSMU/MPSMU/VSU/PGU.

  For example, if the ADC module is not connected to the Motherboard, the HP 4155B/4156B shuts down by overvoltage of the measurement units. This is because the measurement unit loses the Voltage Reference, and the amplifiers are saturated.

- Any assembly failure, except the following two, can cause the shutdown.
  - LCD failure does not cause shutdown because the Post Regulator limits the current into the LCD.
  - Front rubber key failure does not cause shutdown.

4155B / 4156B / 41501B Abnormal Condition Detectors



Auto Ranging Measurement

The SMU and VMU unit search for and measure at the range that provides the highest resolution as follows:

- V measurement

  The unit changes ranges (up or down one range at a time) until the measurement value is between 10% and 110% of the range, then the unit performs the measurement.

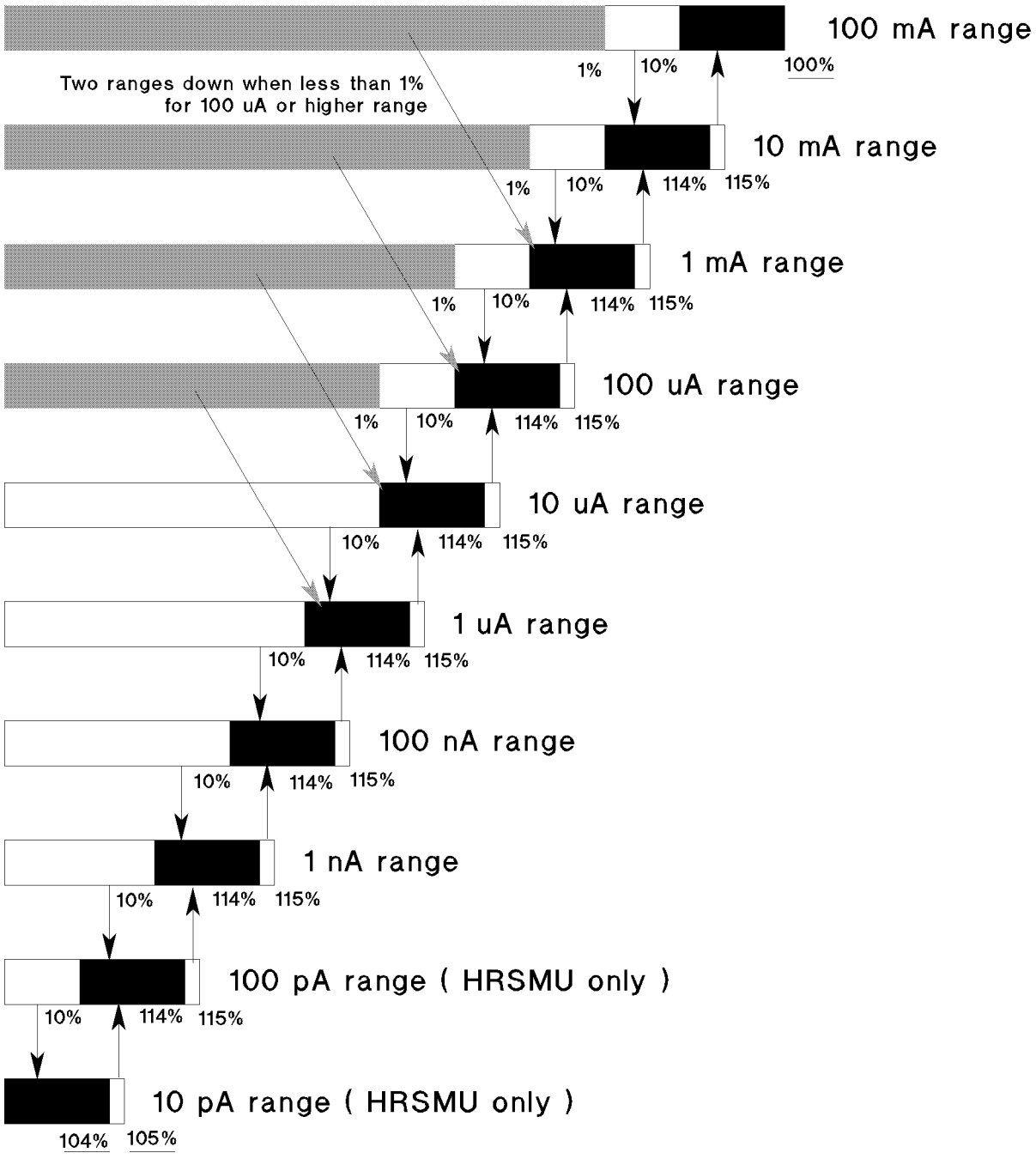
- I measurement

  The unit changes ranges (up or down one range at a time) until the measurement value is between 10% and 114% of the range, then the unit performs the measurement.

  Exception: If the present range is 100 μA or higher range and the measurement value is less than 1 % of the present range, the range changes down two ranges instead of one range.

  If the present range is 10 pA range, the unit changes to the next higher range when the measurement value exceeds 104% of the range.

SMU Current Measurement Auto Ranging



7

Replaceable Parts

This chapter contains replaceable parts information.

Exchange Program

The following table lists the assemblies covered by the Exchange Program. This program allows customers (who return their failed assembly to HP) to purchase rebuilt assemblies at a much lower price than for a new assembly. When ordering an exchange assembly, be sure to use the exchange program part numbers listed.

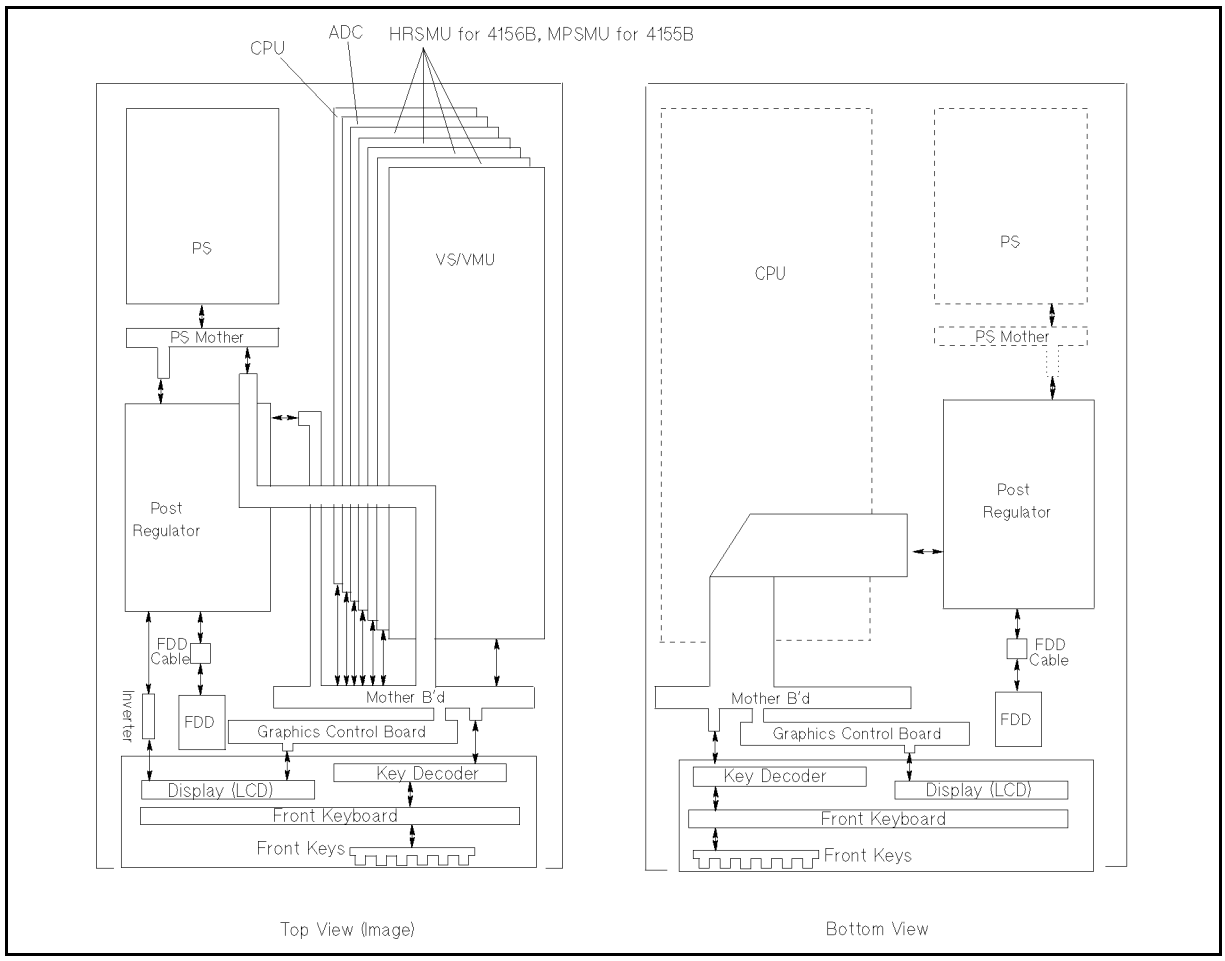
Table 7-1. Exchange Program Assemblies

Assembly Name	New Assembly Part Number	Exchange Program Part Number
Power Supply	04155-60043	04155-69043
CPU	04155-66541	04155-69541
MPSMU	04155-66544	04155-69544
HRSMU	04156-66543	04156-69543
Expander Power Supply	41501-60043	41501-69043
HPSMU	41501-61051	41501-69051

Replaceable Parts Lists

HP 4155B/4156B (Mainframe) Assemblies

The electrical part of the HP 4155B/4156B (Mainframe) consists of the assemblies shown in the following figure and Table 7-2. Except for the FDD cable, each cable between two assemblies is included with one of the assemblies.



HP 4155B/4156B Assembly Location

Differences between HP 4155B and HP 4156B

The differences between the HP 4155B and HP 4156B are as follows:

- Front Panel Label (Model Number and Product Name)
- Rear Panel (HRSMU has the SENSE terminal, but MPSMU does not.)
- Four HRSMUs for HP 4156B, and four MPSMUs for HP 4155B
- Serial Number

Table 7-2. HP 4155B/4156B (Mainframe) Replaceable Assemblies

Assembly Name	New Assembly Part Number	Exchange Program Part Number	Description
(Mainframe) PS	04155-60043	04155-69043	Power Supply
(Mainframe) PS Motherboard	04155-66550	none	PS Motherboard
Post Regulator[1]	04155-66549	none	Post Regulator
LCD	2090-0574	none	8.5-Inch Color TFT LCD
Inverter	0950-2924	none	Inverter for LCD
(Not shown)	2090-0566	none	LCD Lamp (Backlight)[2]
FDD[1]	0950-3109	none	Floppy Disk Drive
FDD Cable	04155-61620	none	CA-FL-RBN 26PIN
CPU	04155-66541	04155-69541	CPU
Graphics Control Board	04155-66559	none	Graphics Control Board
ADC	04155-66502	none	ADC
HRSMU	04156-66543	04156-69543	HRSMU
MPSMU	04155-66544	04155-69544	MPSMU
VSVMU	04155-66545	none	VSU and VMU
(Mainframe) Motherboard	04155-66548	none	Motherboard
Key Decoder	04155-66547	none	Keyboard Decoder
Front Keyboard	04155-66546	none	Keyboard[3]
Front Keys	04155-40043	none	Rubber Key[4]
Front Panel	04155-65141	none	4155B Front Panel
Front Panel	04156-65141	none	4156B Front Panel

1 Replacing the FDD cable together is recommended because the allowable number of connections/disconnections is 20 times. Post Regulator board assembly includes the heat sink.

2 The LCD Lamp has a life specification (8,000 to 10,000 hours).

3 Contact board for front panel keys and LEDs.

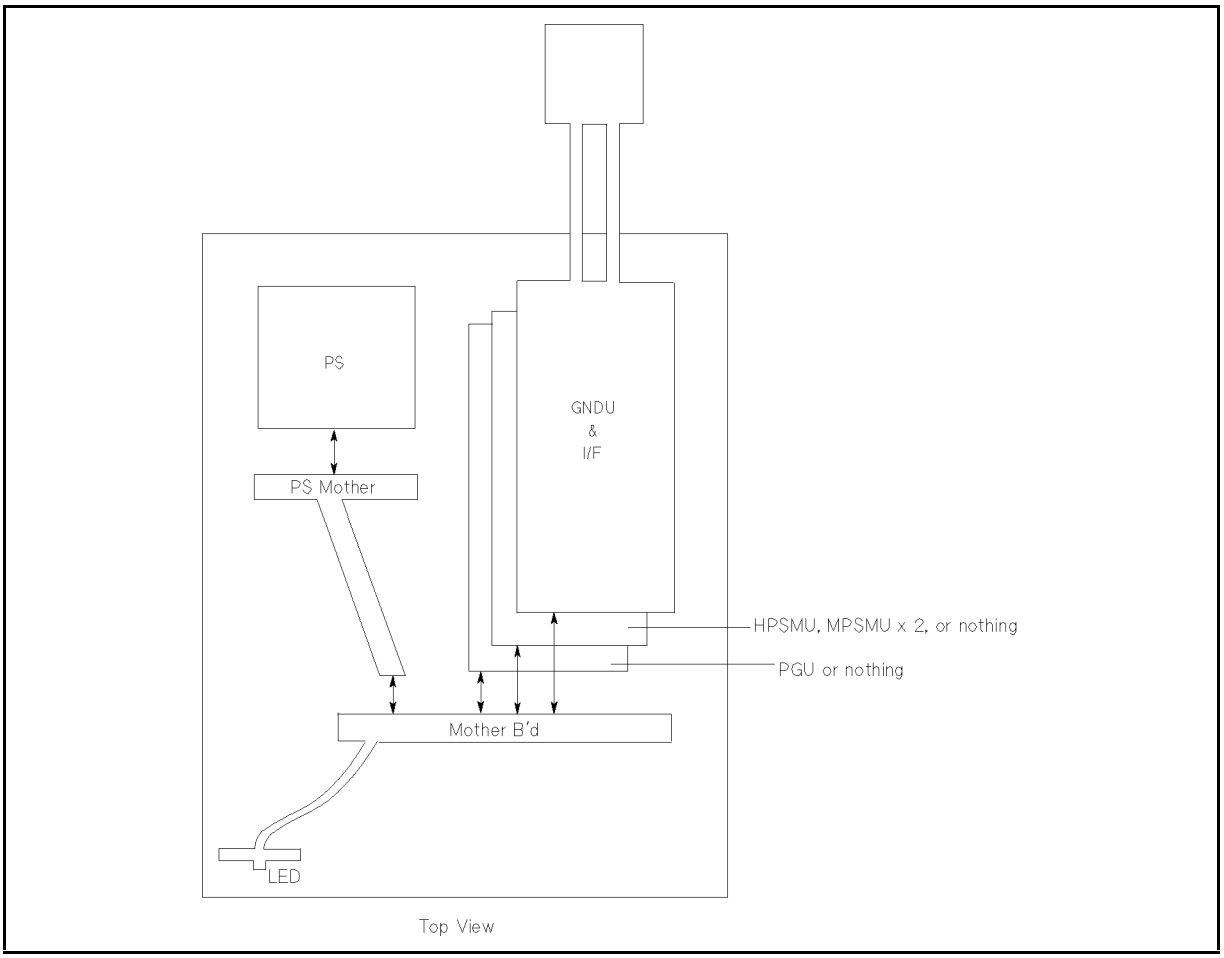
4 This part consists of three rubber pieces including all keys.

Warning **Dangerous voltages of maximum 100 V may be present at bottom cover of HRSMU or MPSMU module in the HP 4155B/4156B/41501B. If you remove the rear panel, be aware of this.**

HP 41501B Assemblies

The electrical part of the HP 41501B consists of four assembles and three optional assemblies. (See the following figure and Table 7-3.) PGU and HPSMU (or two MPSMUs) are optional.

The MPSMU is identical to that of the HP 4155B. The MPSMU occupies one slot, but the HPSMU occupies two slots.



HP 41501B Assembly Location

Table 7-3. HP 41501B (Expander) Replaceable Assemblies

Assembly Name	New Assembly Part Number	Exchange Program Part Number	Description
(Expander) PS	41501-60043	41501-69043	Power Supply
(Expander) PS Motherboard	41501-66550	none	PS Motherboard
(Expander) Motherboard[1]	41501-66508	none	Motherboard
GNDU&IF	41501-61001	none	GNDU and I/F Board
HPSMU	41501-61051	41501-69051	HPSMU
MPSMU	04155-66544	04155-69544	MPSMU
PGU	41501-61013	none	PGU

1 The LED board for LINE on/off indicator and the cable for connecting to the PS Motherboard are included in this (Motherboard) assembly.

Fuses

Table 7-4. Fuses

Assembly Name	Designator	Part Number	Description
CPU	F1	2110-0935	FUSE-SMT 5A 125V
Post Regulator	F1[1],F2[2]	2110-1123	FUSE-SMT 2A 125V
Key Decoder	F1	2110-1123	FUSE-SMT 2A 125V
HRSMU	F1	2110-0665	FUSE 1A 125V
MPSMU	F1	2110-0665	FUSE 1A 125V
HPSMU	F1	2110-0665	FUSE 1A 125V

1 For Inverter.

2 For FDD.

HP 4155B/4156B Chassis

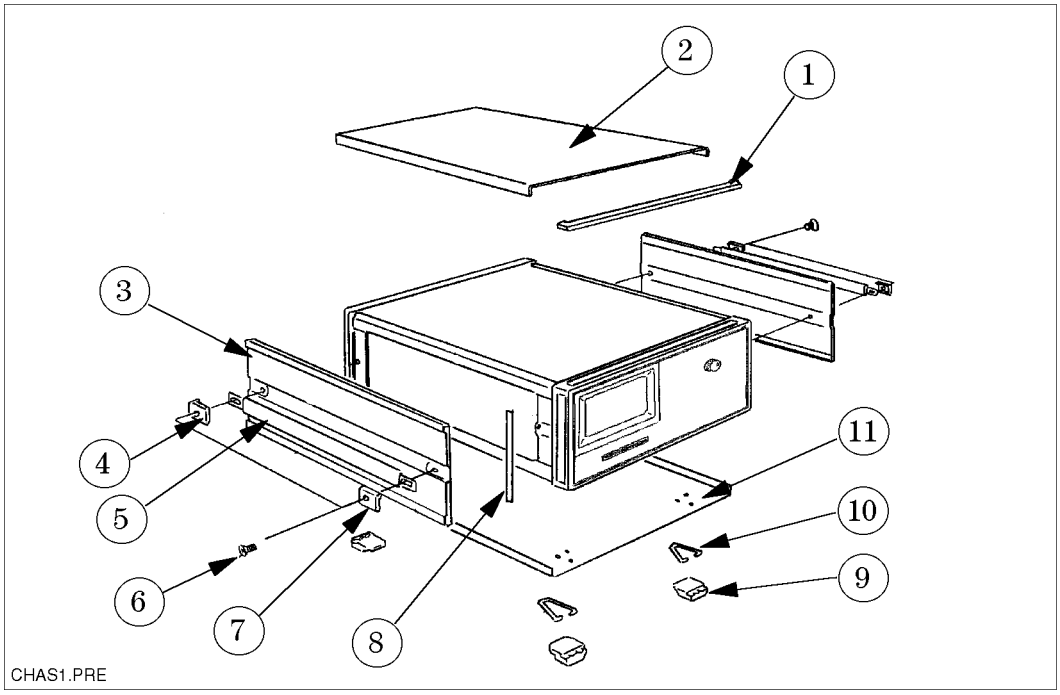


Figure 7-1. HP 4155B/4156B Chassis Parts Location (1 of 2)

Table 7-5. HP 4155B/4156B Chassis Replaceable Parts (1 of 2)

Reference Designation	Part Number	Quantity	Description
1	5041-9176	1	Top Trim
2	5002-1048	1	Top Cover
	0363-0125	2	Gasket (185 mm for each)
3	5002-3990	2	Side Cover
	0905-1246	4	Gasket (500 mm for each)
4	5041-9187	2	Rear Cap
5	5063-9211	2	Strap Handle
6	0515-1384	4	Screw M5
7	5041-9186	2	Front Cap
8	5041-9173	2	Side Trim
9	5041-9167	4	Foot
10	1460-1345	2	Tilt Stand
11	5002-1089	1	Bottom Cover
	0363-0125	2	Gasket (185 mm for each)

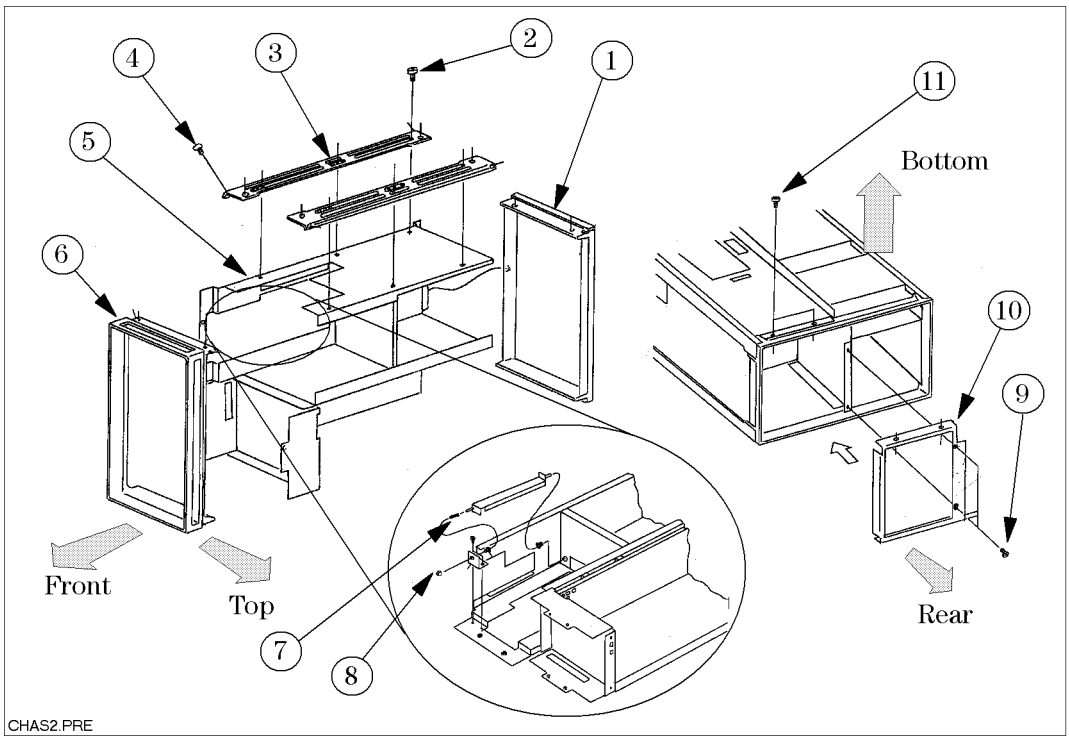


Figure 7-2. HP 4155B/4156B Chassis Parts Location (2 of 2)

Table 7-6. HP 4155B/4156B Chassis Replaceable Parts (2 of 2)

Reference Designation	Part Number	Quantity	Description
1	5021-5808	1	Rear Frame
	0905-1401	4	Gasket (total 310 mm)
2	0515-2079	14[1]	Screw M4
3	5021-5838	4	Corner Strut
4	0515-1668	16	Screw MTRC SPCLY
5	04155-60045	1	(Main) Chassis Assembly
	04155-00144	1	Chassis (for Motherboard)
6	5022-1190	1	Front Frame
7	1460-2360	1	Spring (for LINE On/Off Switch)
8	5041-0564	1	Key Cap (for LINE On/Off Switch)
9	0515-0914	2	Flathead Screw M3
10	04155-00242	1	(Rear) Subframe (without S/N and CSA Labels)
11	0515-1719	2	Screw M4
Not shown	0160-4822	2	Capacitor 1000 pF (between Rear Frame and Inner Top Cover)

1 Six screws are for left side corner struts and eight are for right side.

HP 4155B/4156B Front Panel

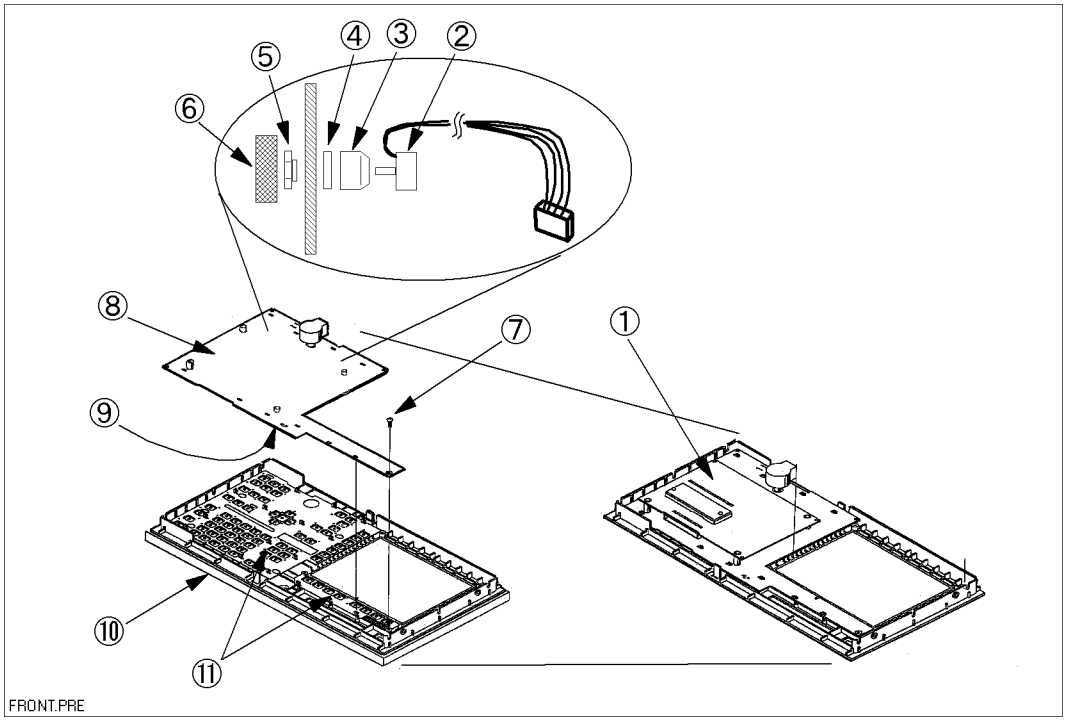


Figure 7-3. HP 4155B/4156B Front Panel Assembly Parts Location (1 of 2)

Table 7-7.
HP 4155B/4156B Front Panel Assembly Replaceable Parts (1 of 2)

Reference Designation	Part Number	Quantity	Description
1	04155-66547	1	Keyboard Decoder
2	0960-1283	1	Rotary Pulse Generator
3	04155-24051	1	Spacer
4	2190-0347	1	WSHR-FL MTLC
5	04155-24050	1	NUT
6	04155-40045	1	Knob (for MARKER)
7	0515-1550	1	Screw M3
8	04155-66546	1	Keyboard (Contact Board for Rubber key and LEDs)
9	1252-5309	1	Connector (External Keyboard Connector on Keyboard)
10	04155-65141	1	Front Panel for HP 4155B (Panel, Label, and Gasket (0905-1401))
	04156-65141	1	Front Panel for HP 4156B (Panel, Label, and Gasket (0905-1401))
11	04155-40043	1	Rubber key (consists of three rubber keys)

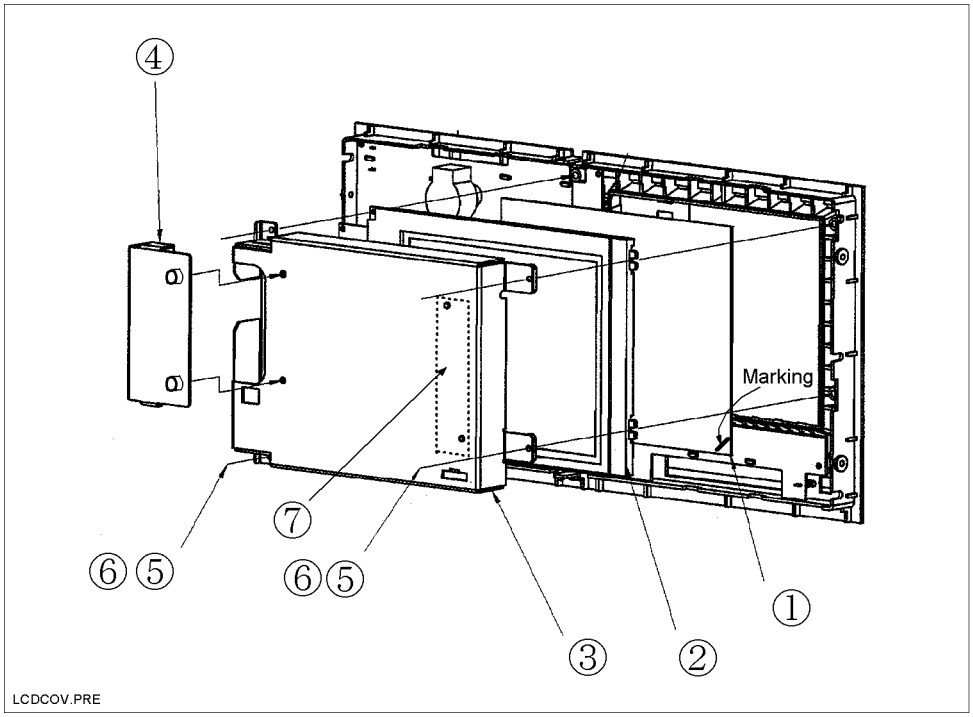


Figure 7-4. HP 4155B/4156B Front Panel Assembly Parts Location (2 of 2)

Table 7-8.
HP 4155B/4156B Front Panel Assembly Replaceable Parts (2 of 2)

Reference Designation	Part Number	Quantity	Description
1	04155-40044	1	Filter
2	2090-0574	1	LCD
Not shown	04155-61617	1	LCD Flat Cable
3	04155-04054	1	Cover
4	04155-04055	1	Cover
	0400-0163	1	Grommet (35 mm)
5	0515-1550	4	Screw M3
6	3050-0891	4	WSHR-FL M3
7	0950-2924	1	Inverter
	0515-2727	2	Screw M2 L6
	3050-1066	2	WSHR-FL M2
	04155-61642	1	Post-Reg—Inverter Cable

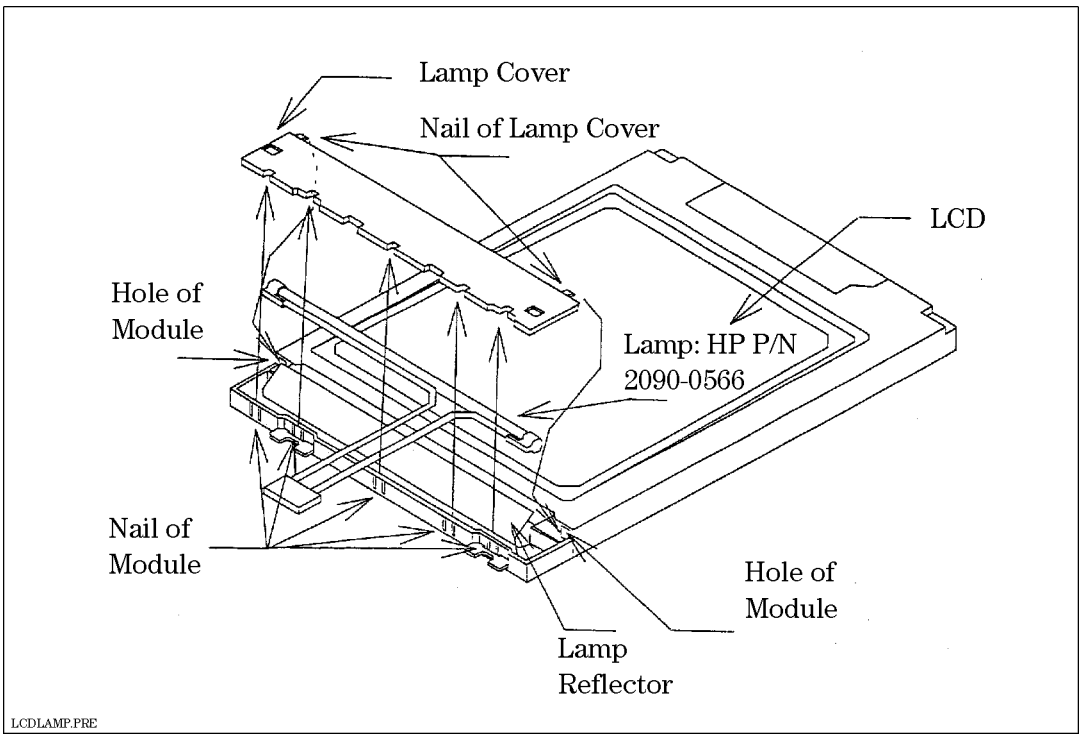


Figure 7-5. HP 4155B/4156B Front Panel: LCD Lamp (2090-0566)

HP 4155B/4156B Rear Panel

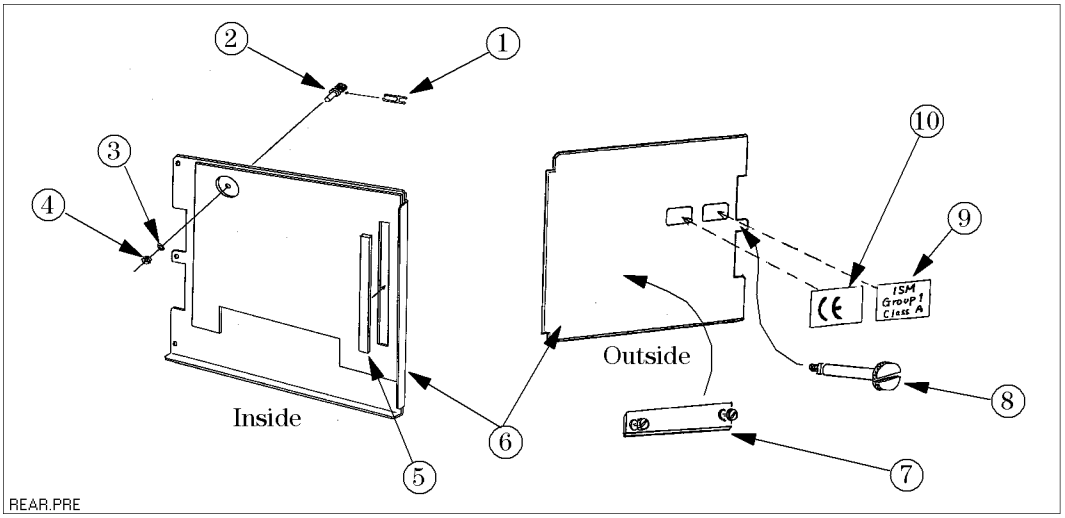


Figure 7-6. HP 4155B/4156B Rear Panel Parts Location

Table 7-9. HP 4155B/4156B Rear Panel Replaceable Parts

Reference Designation	Part Number	Quantity	Description
1	5000-4206	1	Shorting Link (Shorting Bar)
2	1510-0130	1	Binding Post (Chassis Ground Terminal)
3	2190-0084	1	Washer (for Binding Post)
4	2950-0006	1	Nut (for Binding Post)
5	0905-1401	1	Gasket (8.9 cm)
6	04155-00241	1	Rear Panel for HP 4155B
	04156-00241	1	Rear Panel for HP 4156B
7	04155-00208	1	Blank Panel for Expander I/F Slot
8	04155-60007	1	Module Extractor
9	5080-3902	1	Label “ISM Group 1 Class A”
10	5182-0440	1	Label “CE”
——	0515-1550	6	Screw M3 (to fix the rear panel to frame)

CPU Module

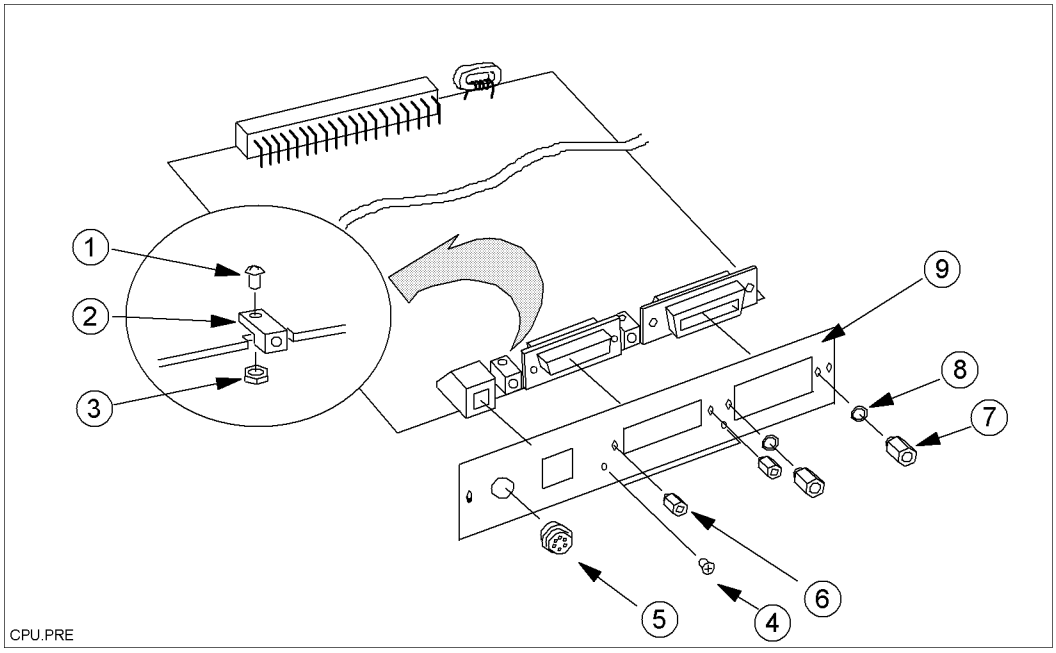


Figure 7-7. CPU Module (04155-66541) Parts Location

Table 7-10. CPU Module (04155-66541) Replaceable Parts

Reference Designation	Part Number	Quantity	Description
1	0515-1550	2	Screw, M3L8
2	1531-0314	2	Clevis
3	0535-0031	2	Nut, HEX with lock washer
4	0515-0914	2	Flathead Screw, MECH M3L5
5	1252-1419	1	Connector, 6-pin female (Intlk connector) with a washer and a nut
6	0380-3070	2	STDF-HEX .25-IN (for Parallel I/F Connector)
7	0380-0643	2	STDF-HX .327-IN (for HP-IB Connector)
8	2190-0577	2	Lock Washer, HLCL (for HP-IB Connector)
9	04155-00243	1	Panel (CPU Module Rear Panel)
F1	2110-0935	1	FUSE-SMT 5A 125V

ADC Module

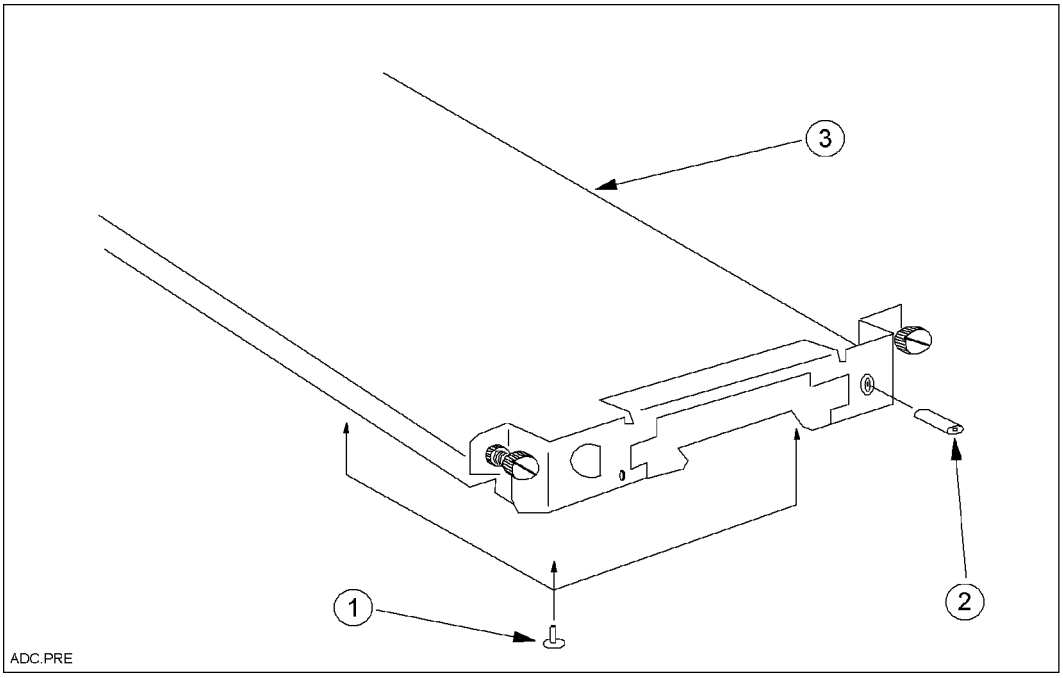


Figure 7-8. ADC Module (04155-66502) Parts Location

Table 7-11. ADC Module (04155-66502) Replaceable Parts

Reference Designation	Part Number	Quantity	Description
1	6960-0016	6	Plug Hole (for ADC Module Chassis)
2	1251-2151	1	Connector, SGL CONT (Zero Check Terminal)
3	04155-04020	1	Chassis

HRSMU Module

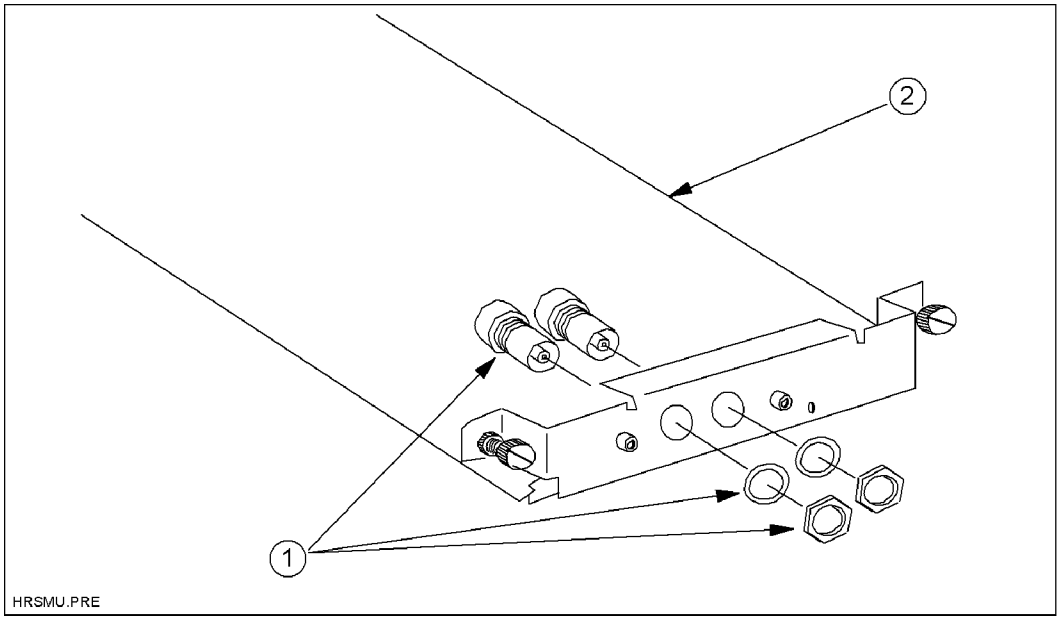


Figure 7-9. HRSMU Module (04156-66543) Parts Location

Table 7-12. HRSMU Module (04156-66543) Replaceable Parts

Reference Designation	Part Number	Quantity	Description
1	1250-2484	2	Connector, RF Triaxial with a washer and a nut (for Force and Sense)
2	04156-04001	1	Chassis

MPSMU Module

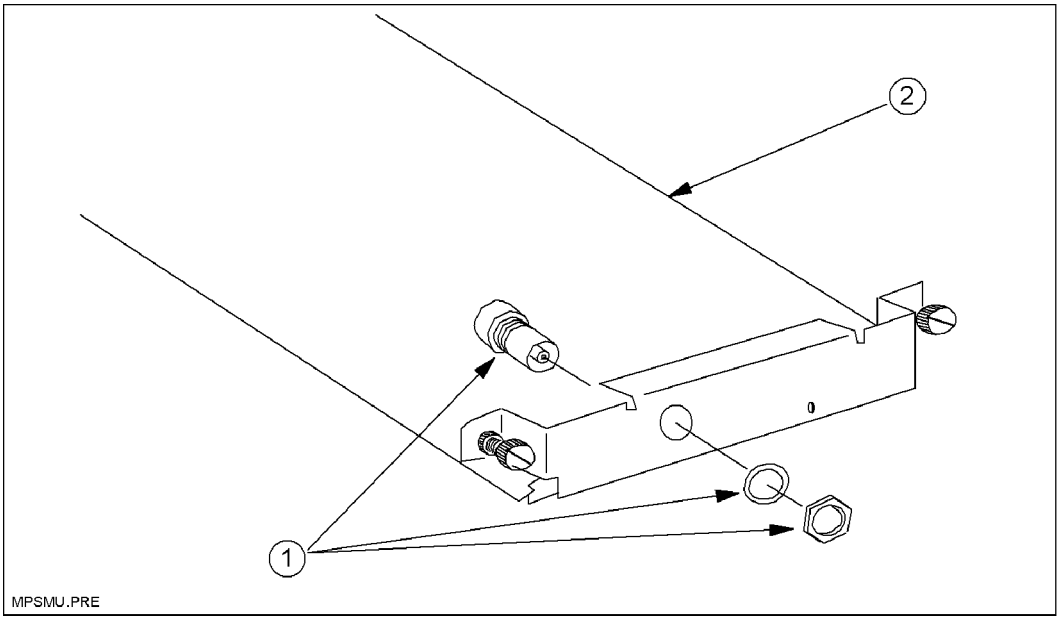


Figure 7-10. MPSMU Module (04155-66544) Parts Location

Table 7-13. MPSMU Module (04155-66544) Replaceable Parts

Reference Designation	Part Number	Quantity	Description
1	1250-1906	1	Connector, RF Triaxial with a washer and a nut (for Force)
2	04155-04006	1	Chassis

VSU/VMU Module

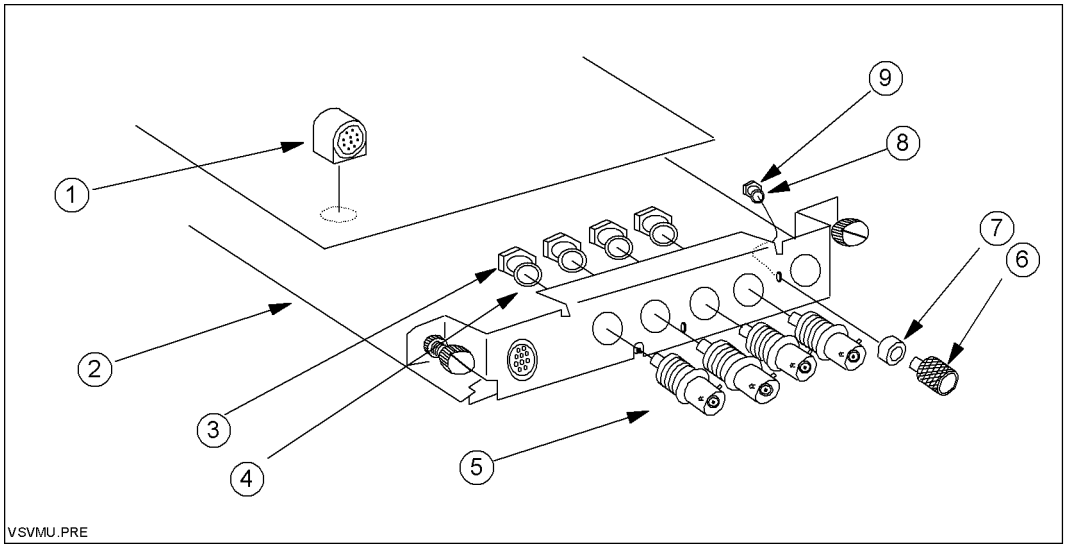


Figure 7-11. VSU/VMU Module (04155-66545) Parts Location

Table 7-14. VSU/VMU Module (04155-66545) Replaceable Parts

Reference Designation	Part Number	Quantity	Description
1	1252-5466	1	Connector, 10-pin female (R-Box Connector)
2	04155-04007	1	Chassis
3	2950-0001	4	Nut, HEX-DBL-CHAM
4	2190-0016	4	Lock Washer, internal teeth
5	1250-0083	4	Connector, RF BNC (VSU1,2, VMU1,2)
6	1510-0130	1	Binding Post SGL (Circuit Common Terminal)
7	04142-24022	1	Spacer
8	2190-0084	1	Lock Washer, internal teeth
9	2950-0006	1	NUT-HEX-DBL-CHAM

HP 41501B Chassis

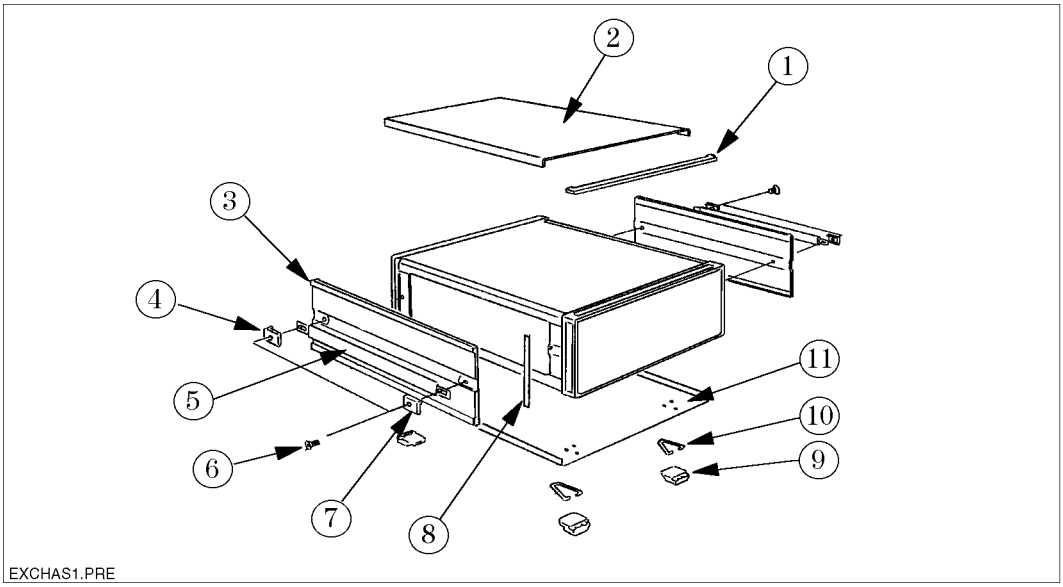


Figure 7-12. HP 41501B Chassis Parts Location (1 of 2)

Table 7-15. HP 41501B Chassis Replaceable Parts (1 of 2)

Reference Designation	Part Number	Quantity	Description
1	5041-9176	1	Top Trim
2	5002-1048	1	Top Cover
3	5002-3986	1	Side Cover (Right, with Air Holes)
	5002-3945	1	Side Cover (Left, without Air Holes)
4	5041-9187	2	Rear Cap
5	5063-9211	2	Strap Handle
6	0515-1384	4	Screw M5
7	5041-9186	2	Front cap
8	5041-9172	2	Side Trim
9	5041-9167	4	Foot
10	1460-1345	2	Tilt Stand
11	5002-1089	1	Bottom Cover

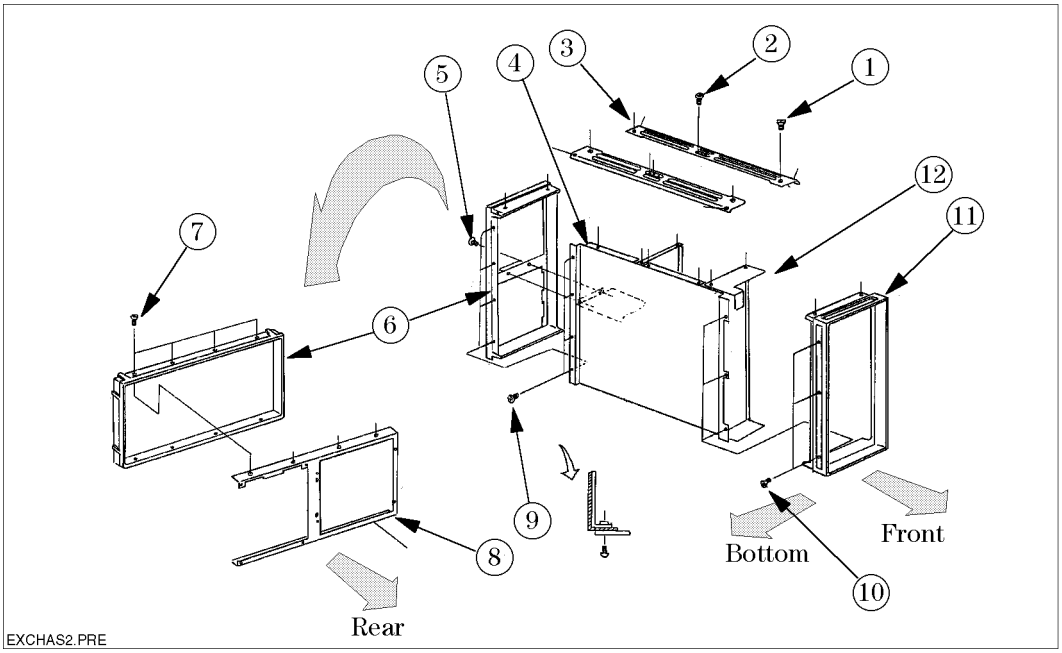


Figure 7-13. HP 41501B Chassis Parts Location (2 of 2)

Table 7-16. HP 41501B Chassis Replaceable Parts (2 of 2)

Reference Designation	Part Number	Quantity	Description
1	0515-1668	16	Screw MTRC SPCLY
2	0515-2079	12	Screw, M4
3	5021-5838	4	Corner Strut
4	41501-60006	1	Main Chassis
	41501-00102	1	Chassis (for Motherboard)
5	0515-0914	2	Flathead Screw, M3
6	5021-5806	1	Rear Frame
7	0515-2079	4	Screw, M4
8	41501-00204	1	Rear Subframe (without S/N and CSA Labels)
9	0515-1719	4	Screw, M4
10	0515-1012	3	Flathead Screw, M4
11	5022-1189	1	Front Frame
12[1]	5041-0564	1	Key Cap (for LINE On/Off Switch)
	1460-2360	1	Spring (for LINE On/Off switch)
——	41501-04008	2	Blank Cover at Rear Panel (When no SMU is installed.)
——	41501-04010	1	Blank Cover at Rear Panel (When no PGU is installed.)

1 See Figure 7-2 for detail illustration.

HP 41501B Front Panel

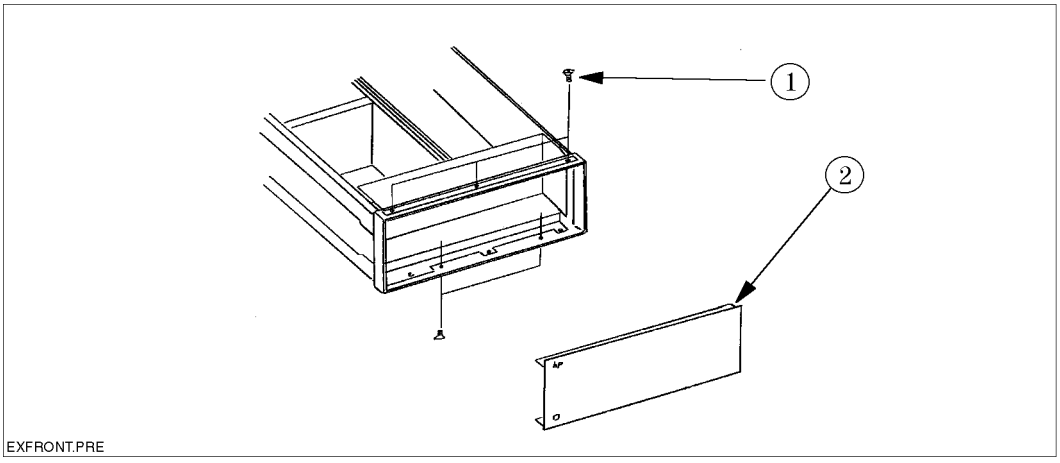


Figure 7-14. HP 41501B Front Panel Parts Location

Table 7-17. HP 41501B Front Panel Replaceable Parts

Reference Designation	Part Number	Quantity	Description
1	0515-1012	5	Screw M4
2	41501-65141	1	Front Panel for 41501B (Panel and Label)

HP 41501B Rear Panel

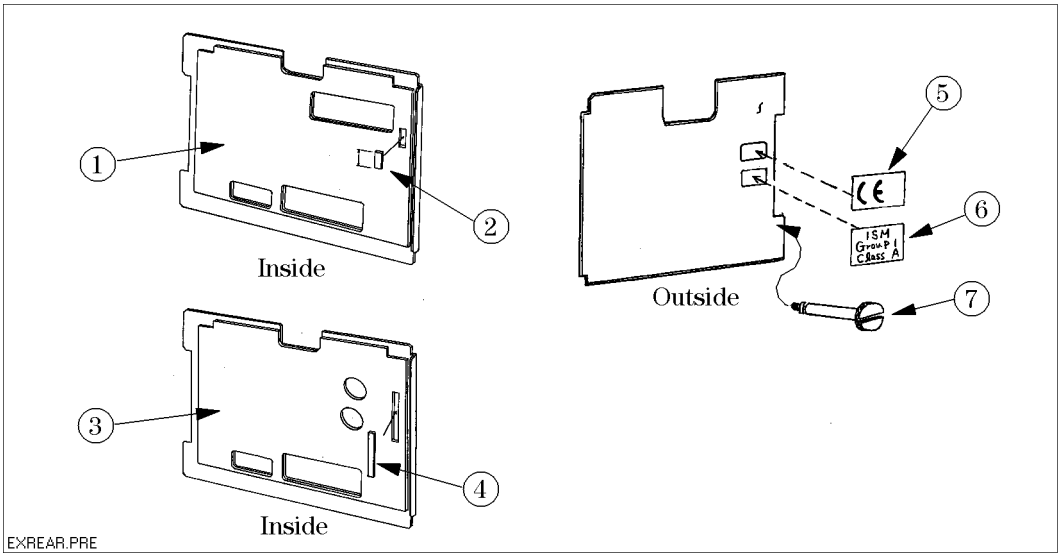


Figure 7-15. HP 41501B Rear Panel Parts Location

Table 7-18. HP 41501B Rear Panel Replaceable Parts

Reference Designation	Part Number	Quantity	Description
1	41501-00205	1	Rear Panel for no MPSMU Installed
2	0905-1401	1	Gasket (1.1 cm) for no MPSMU Installed
3	41501-00203	1	Rear Panel for MPSMU Installed
4	0905-1401	1	Gasket (3.8 cm) for MPSMU Installed
5	5182-0440	1	Label “CE”
6	5080-3902	1	Label “ISM Group 1 Class A”
7	04155-60007	1	Module Extractor
——	0515-1550	3[1]	Screw M3 (to fix the rear panel to frame)

1 Four screws when PGU is installed.

HP 41501B Motherboard

Table 7-19. HP 41501B Motherboard (41501-66508) Replaceable Parts

Reference Designation	Part Number	Quantity	Description
1	1990-0485	1	LED-VISIBLE (for LINE ON/OFF)

GNDU & I/F Module

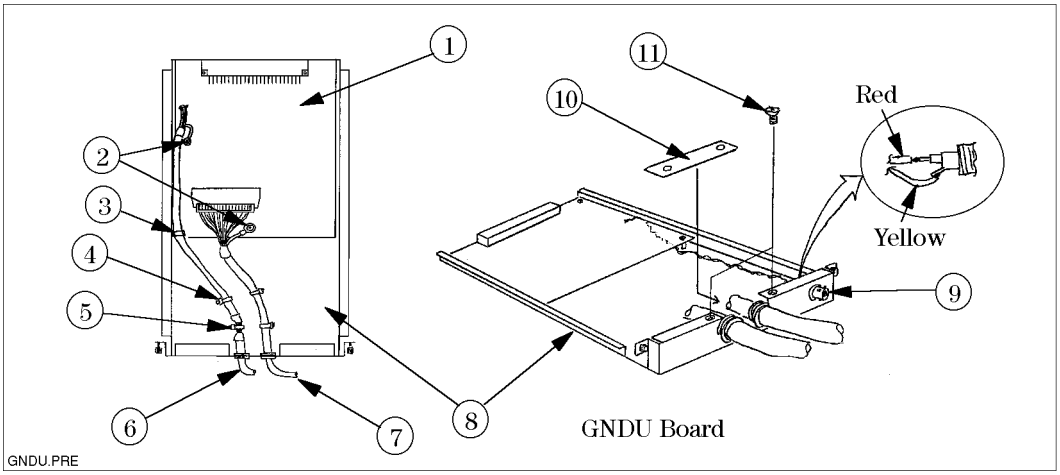


Figure 7-16. GNDU & I/F Module (41501-61001) Parts Location (1 of 2)

Table 7-20.
GNDU & I/F Module (41501-61001) Replaceable Parts (1 of 2)

Reference Designation	Part Number	Quantity	Description
1	41501-66516	1	GNDU Board
2	0515-1550	2	Screw M3
3	1400-0249	1	Tie (on GNDU Board)
4	1400-0493	3	Tie (on GNDU Chassis)
5	1400-1413	1	Tie, Metal (on GNDU Chassis)
6	41501-61696	1	Analog Cable (4 Wires, with 2 Grommets (0400-0275)
7	41501-61695	1	Digital Cable (80 wires)
8	41501-04001	1	Chassis (for GNDU Board)
9	1250-1906	1	Triaxial Connector with a washer and a nut (for GNDU)
10	04155-00602	1	Plate
11	0515-0914	2	Screw M3 (for Panel)

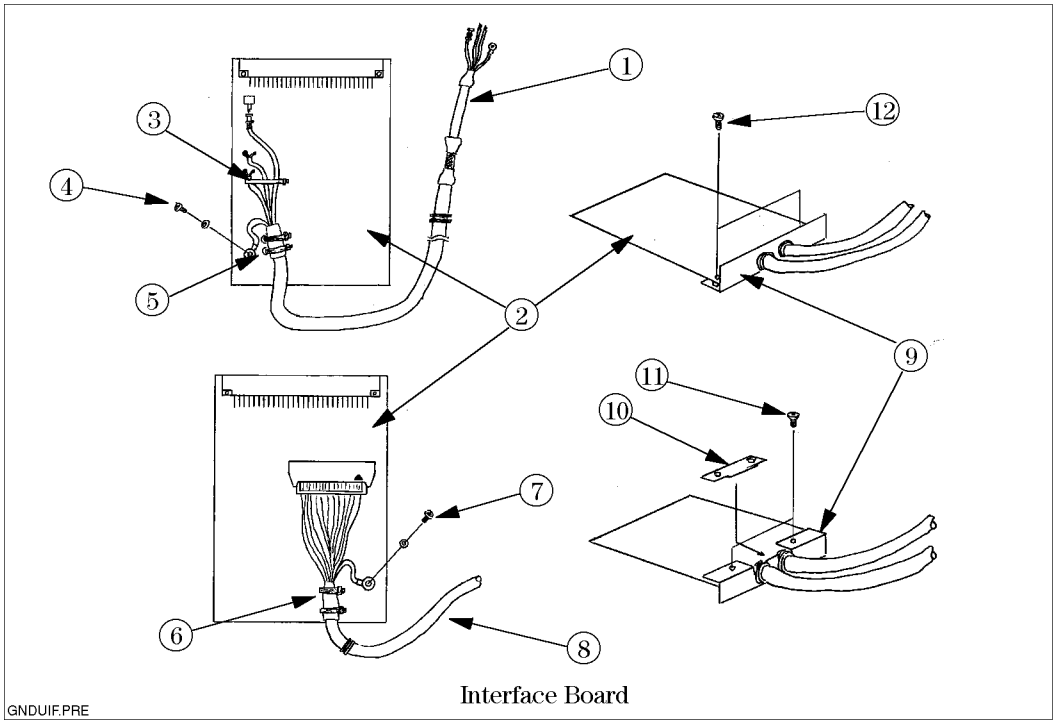


Figure 7-17. GNDU & I/F Module (41501-61001) Parts Location (2 of 2)

Table 7-21.
GNDU & I/F Module (41501-61001) Replaceable Parts (2 of 2)

Reference Designation	Part Number	Quantity	Description
1	41501-61696	1	Analog Cable (4 Wires, with 2 Grommets (0400-0275)
2	41501-66515	1	Interface Board (Installed in ADC.)
3	1400-0249	1	Tie (on I/F Board)
4	0515-0924	1	Screw M3
	2190-0584	1	Washer
5	1400-0493	2	Tie (for Analog Cable)
6	1400-0493	2	Tie (for Digital Cable)
7	0515-0924	1	Screw M3
	2190-0584	1	Washer
8	41501-61695	1	Digital Cable (80 wires)
9	04155-00204	1	Panel for Interface Board
10	04155-00602	1	Plate
11	0515-0914	2	Screw M3
12	0515-1550	2	Screw M3

HPSMU Module

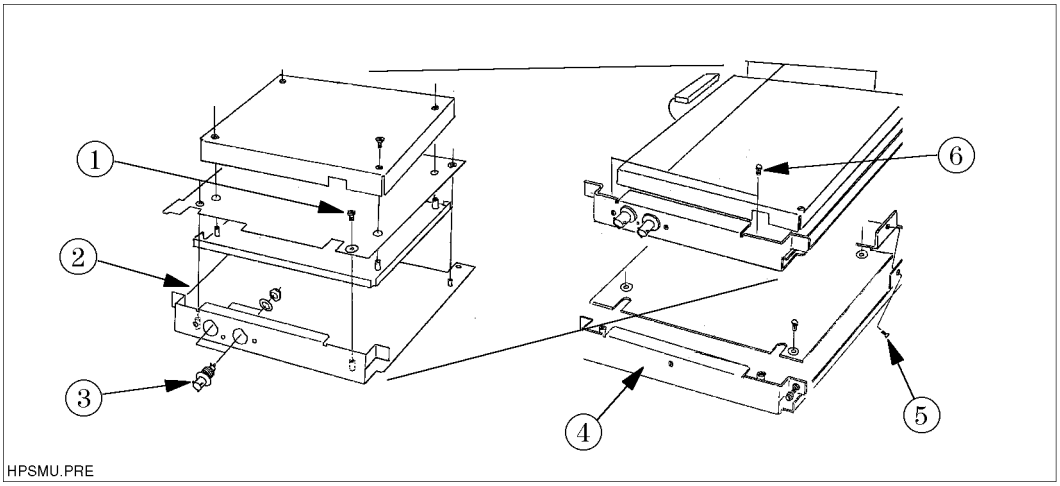


Figure 7-18. HPSMU Module (41501-61051) Parts Location

Table 7-22. HPSMU Module (41501-61051) Replaceable Parts

Reference Designation	Part Number	Quantity	Description
1	0515-1550	4	Screw M3
2	41501-04005	1	Chassis for Force/Sense Connectors
3	1250-1906	2	Triaxial Connector with a washer and a nut (for Force and Sense)
4	41501-04054	1	Chassis for Bottom
5	0515-0914	1	Flathead Screw, M3 L6
6	0515-1550	12	Screw, M3 L8

PGU Module

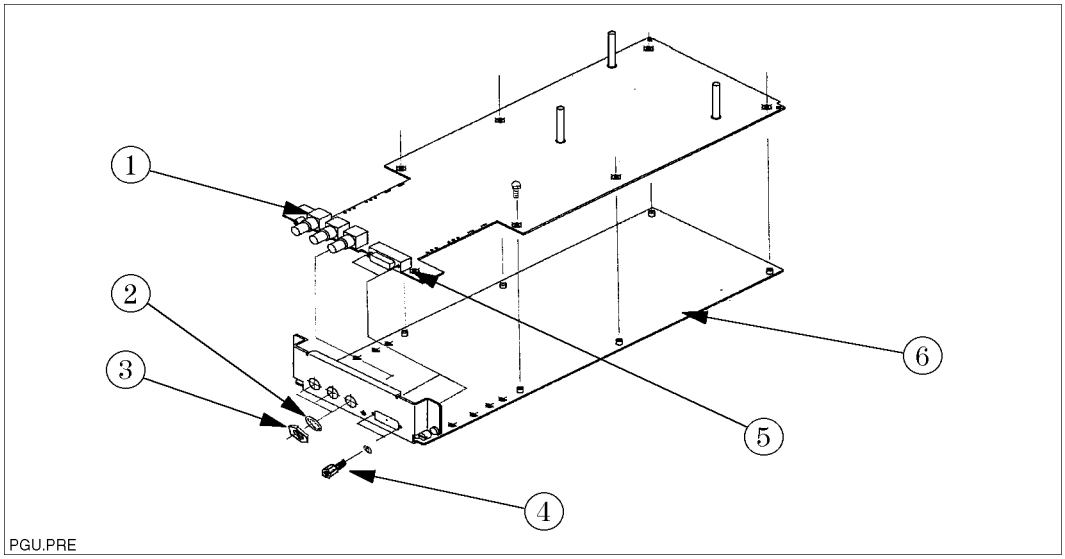


Figure 7-19. PGU Module (41501-61013) Parts Location

Table 7-23. PGU Module (41501-61013) Replaceable Parts

Reference Designation	Part Number	Quantity	Description
1	1250-1842	3	BNC Connector (PGU1, 2, Trig Out)
2	2190-0054	3	Lock Washer
3	2950-0054	3	Nut
4	1251-5436	1	SCRLK F
5	1252-1481	1	AUI Connector, 15 pins (for SMU/PGU Selector I/F)
6	41501-04003	1	Chassis

8

Replacement Procedures

This chapter contains the assemblies replacement procedures.

Warning **Only personnel with knowledge of electronic circuitry and an awareness of the hazards involved should remove and install any printed circuit board assemblies.**

Removing the Expander (HP 41501B)

1. Turn off power, then remove the power cable.
2. With a flatblade screwdriver, loosen the two screws on the interface board that comes from the HP 41501B.
3. Gently pull the interface board.

Removing the Top/Bottom/Side Covers

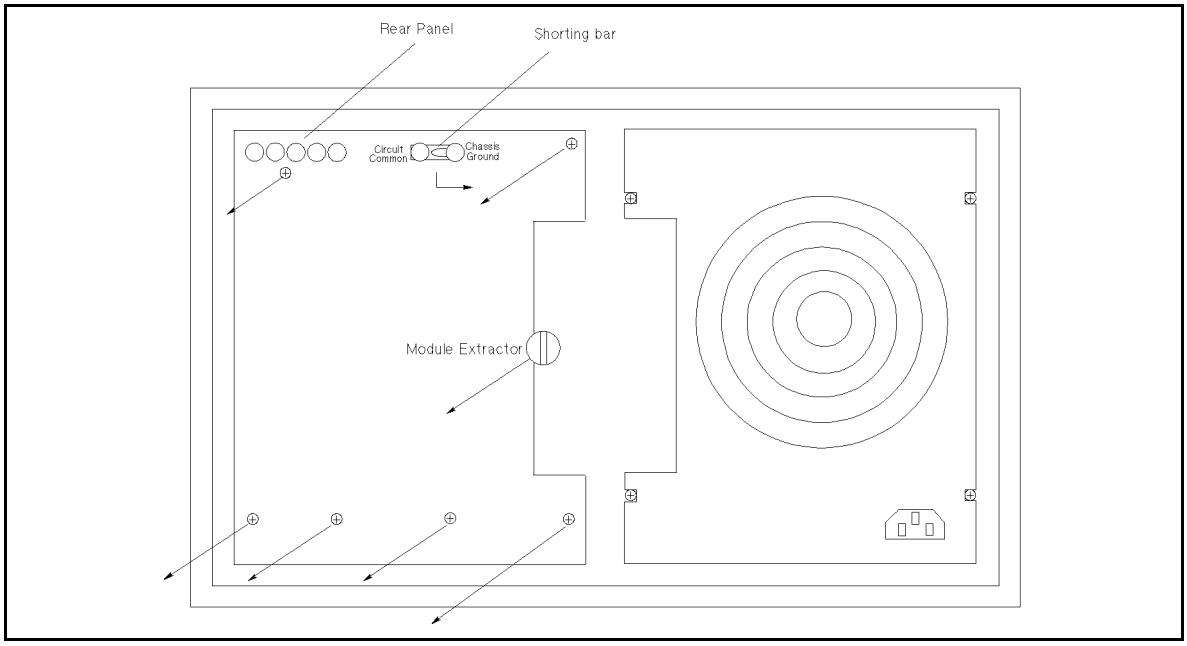
1. Turn off power, then remove the power cable.
   - To remove top or bottom cover, use a Torx TX15 driver.
   - To remove side cover, use a Torx TX25 driver.

Note The top and bottom covers are secured tight because of the shield gaskets on the frame struts. Slap the cover several times while loosening the torx screw so that the screw does not fall off.

Removing the Rear Panel

Warning **Dangerous voltages of maximum 100 V may be present at bottom cover of HRSMU or MPSMU module in the HP 4155B/4156B/41501B. If you remove the rear panel, be aware of this.**

1. Turn off power, then remove the power cable.
2. Remove the Module Extractor, which is shown in the following figure.
3. Remove the screws that are shown in the following figure.
4. Loosen the **Circuit Common** terminal and Chassis Ground terminal to remove the shorting bar from **Circuit Common** terminal.
5. Remove the rear panel.



Replacing the CPU Module

1. To confirm the present firmware revisions, turn on power, then select (System), CONFIG. Write the displayed revision numbers for confirmation after the replacement:

   HOSTC: Rev. _____
   SMUC: Rev. _____

2. Turn off power, then remove the power cable.
3. See "Removing the Rear Panel", and remove the rear panel.
4. Remove the CPU module using same method as described in next paragraph "Removing the SMU/PS/PGU/VSVMU/ADC Module".

Caution If you remove the shield cover of the CPU module, note the following.

- CPU board has the parts on the back of the board, too.
- CPU board has a super-capacitor (1 F, 5 V), which is for system clock.

5. Install new CPU module.
6. Turn on.
7. To set the power line frequency for measurement integration time, select (SYSTEM), MISCELLANEOUS. Then, set the POWER LINE FREQUENCY.
8. Confirm the firwmware revisions. If the revisions are older than the original revisions, update the firmware. (See "Updating the Firmware".)

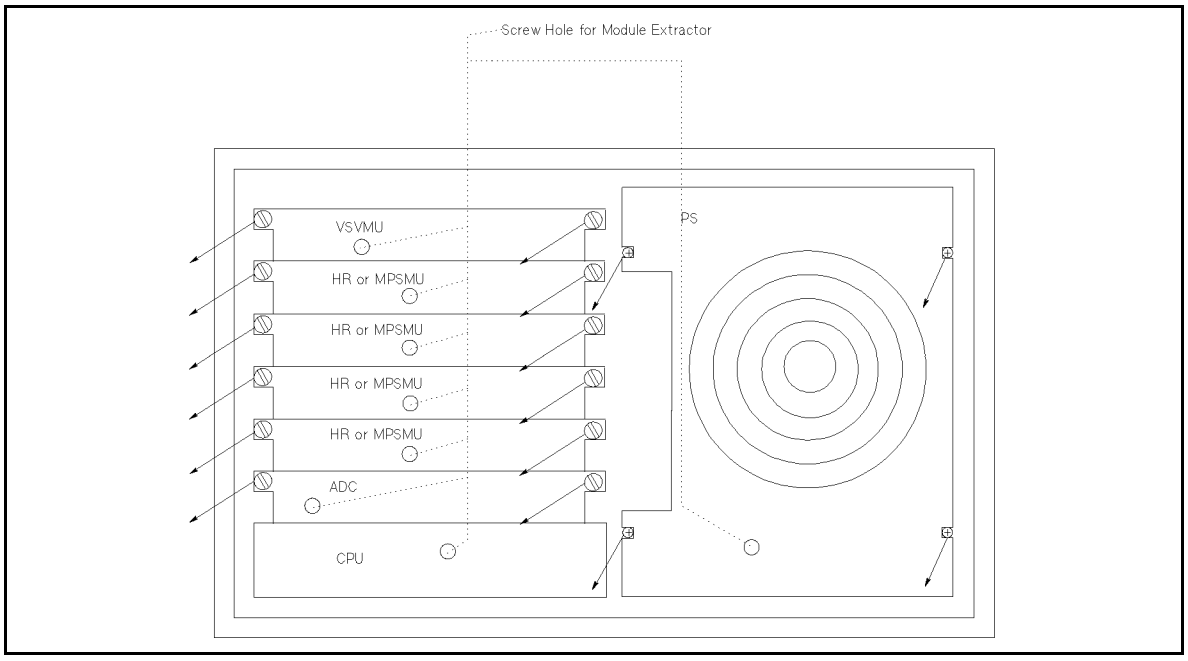
Removing the SMU/PS/PGU/VSVMU/ADC Module

1. Turn off power, then remove the power cable.
2. See “Removing the Rear Panel”, and remove the rear panel.
3. With a flatblade screwdriver, loosen the screws on a module that you remove, which are shown in the following figure.
4. See the following figure to screw the Module Extractor into the screw hole for the Module Extractor.

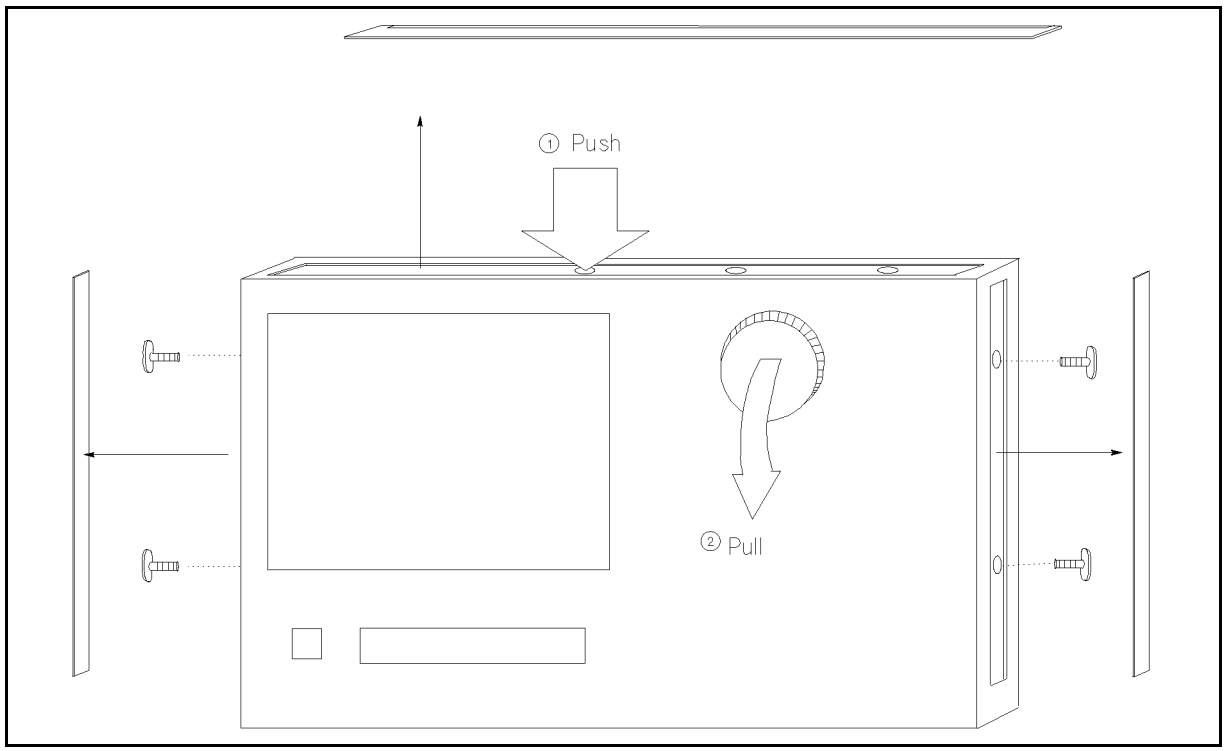
Caution

- To avoid electrostatic damage (ESD), it is recommended to use an anti-static mat and wrist strap.
- After removing a module, hold the module so that the printed circuit board of the module does not bend. Bending the board can damage the printed patterns.
- Oil, perspiration, fibrous dust, and dirt degrade the insulation of the circuit, and reduces measurement accuracy. It is recommended to wear rubber gloves when handling the modules.

5. Pull the screwed Module Extractor to remove the module.



Removing the Front Panel Assembly



Caution

The flat cable between the LCD and the graphics control board is not long enough to place the front panel assembly horizontally. Remove the shield cover for the flat cable and then disconnect the cable from the LCD to prevent damage to the cable. See Figure 7-4.

Removing the Graphics Control Board

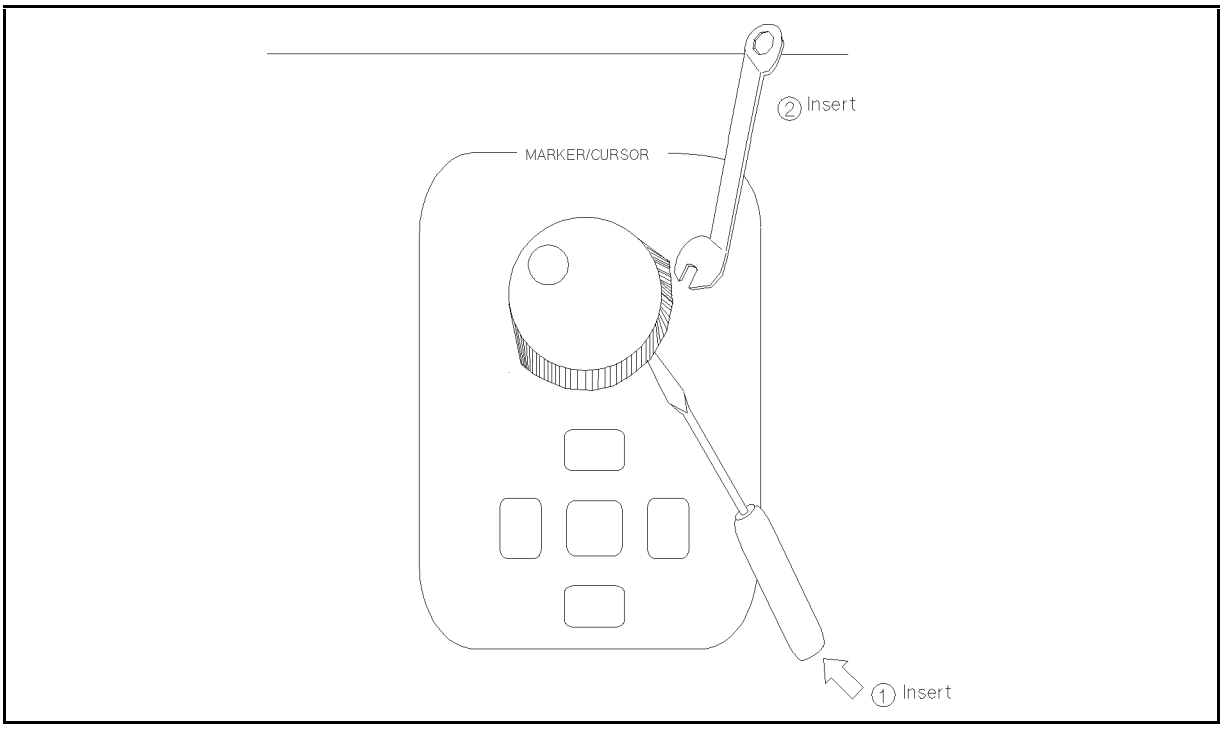
1. Turn off power, then remove the power cable.
2. Remove the Front Panel Assembly.
3. Remove the screws on the shield cover for the Graphics Control Board to remove the shield cover.
4. Remove the screws on each corner on the Graphics Control Board to remove the board.

Removing the Rotary Knob

The knob can be removed by pulling the knob. The knob can be installed by pressing the knob. No screw or glue is used.

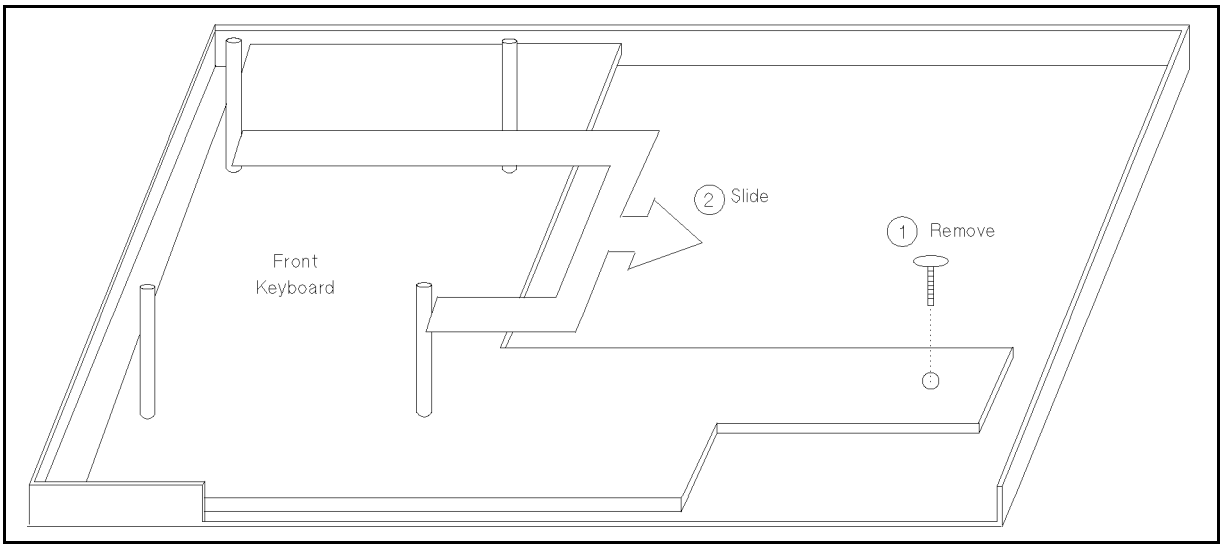
If pulling the knob is difficult:

1. Insert a flatblade screwdriver between the knob and the front panel, and make a space for inserting a spanner.
2. Insert the spanner and remove the screwdriver.
3. Use the spanner and pull the knob out.



Removing the Front Keyboard or Front Keys

1. Turn off power, then remove the power cable.
2. Remove the Rotary Knob.
3. Remove the Front Panel Assembly.
4. Remove the screws on each corner on the Key Decoder Board to remove the Key Decoder Board.
5. Perform ① and ② in the following figure.



Removing the Key Decoder

1. Turn off power, then remove the power cable.
2. Remove the Front Panel Assembly.
3. Remove the screws on each corner on the Key Decoder Board.
4. Pull the Key Decoder Board to disconnect the connector.

Removing the LCD or LCD Lamp

1. Turn off power, then remove the power cable.
2. Remove the Front Panel Assembly.
3. See Figure 7-4 or Figure 7-5.

Note To remove the LCD Lamp, lift up the Lamp Cover slightly and unlatch the plastic nails of the LCD to remove the Lamp Cover. Plastic nails are easily damaged—be careful.

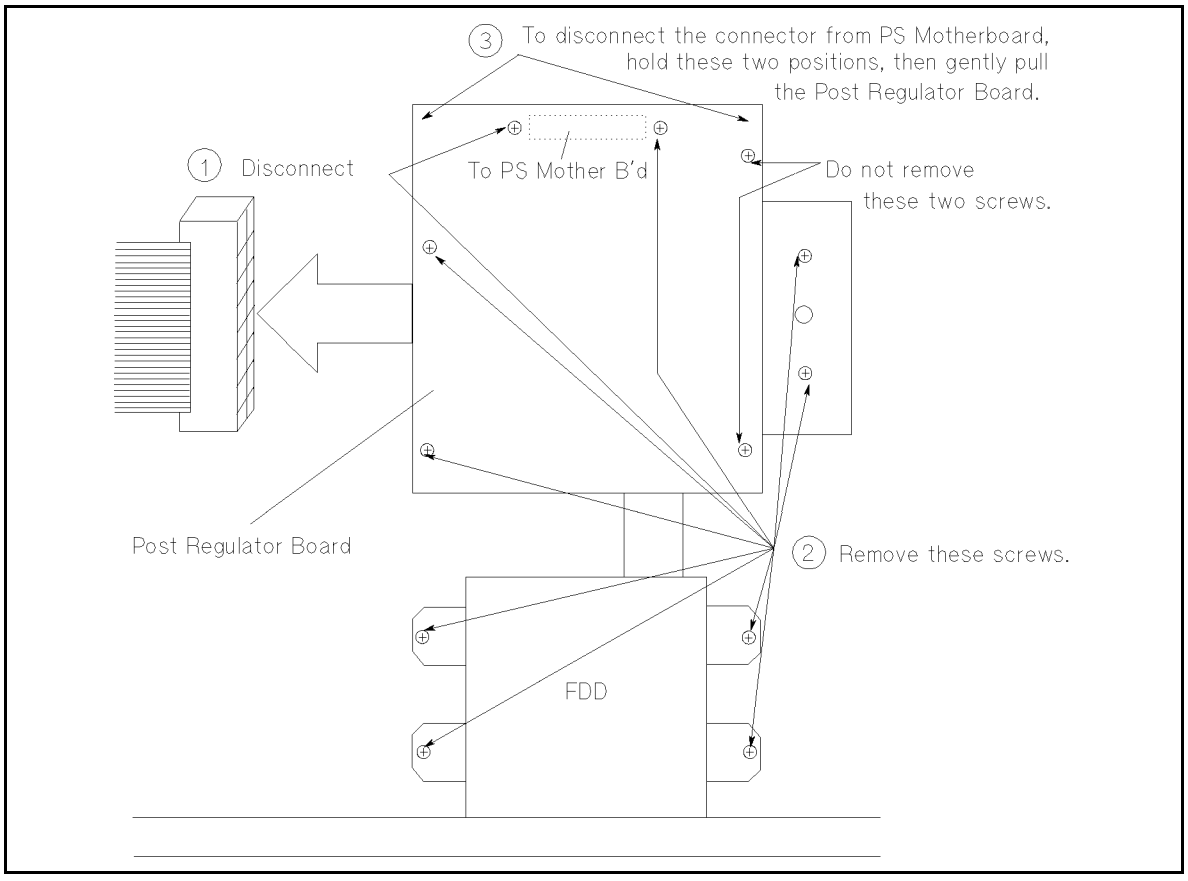
Note The LCD Lamp has a life specification (8,000 to 10,000 hours).

Replacing the FDD or Post Regulator Board

1. Turn off power, then remove the power cable.
2. Remove the bottom cover.
3. Disconnect Cable ① in the following figure.
4. Perform Procedure ② in the following figure (remove six screws on Post Regulator Board and remove four screws on the FDD).
5. Perform Procedure ③ in the following figure.

Note

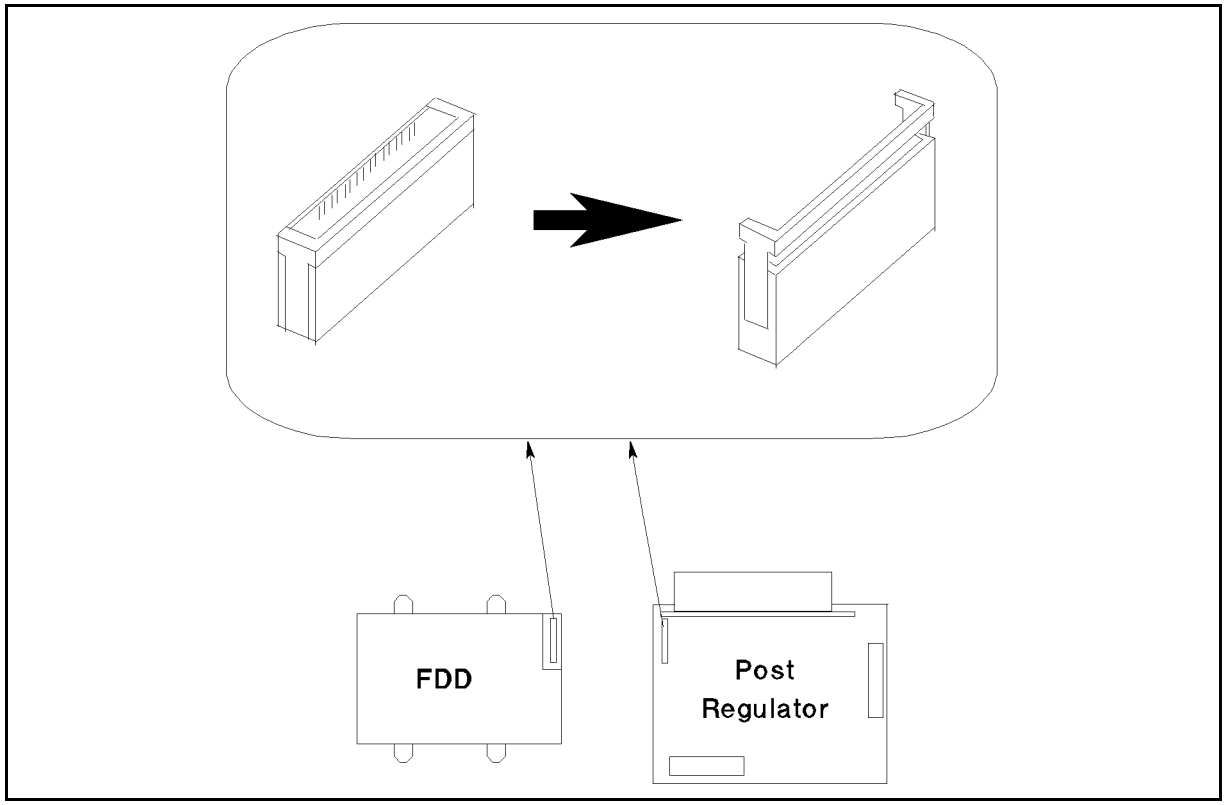
- If disconnecting the connector is difficult, remove top cover and PS, then disconnect the connector.
- If you do not want to remove the Post Regulator when removing the FDD, remove the Cable between FDD and Post Regulator, then remove the FDD from bottom side.



6. Remove FDD and Post Regulator together.

Note

- When replacing the FDD or Post Regulator, replace also the cable between them. Because cable connection becomes bad if connection and disconnection is repeated. The allowable number of connection/disconnections is 20 times.
- To connect the cable, lift up the clamp part of the connector which is shown below, and insert the cable end into connector, then push the clamp part down.

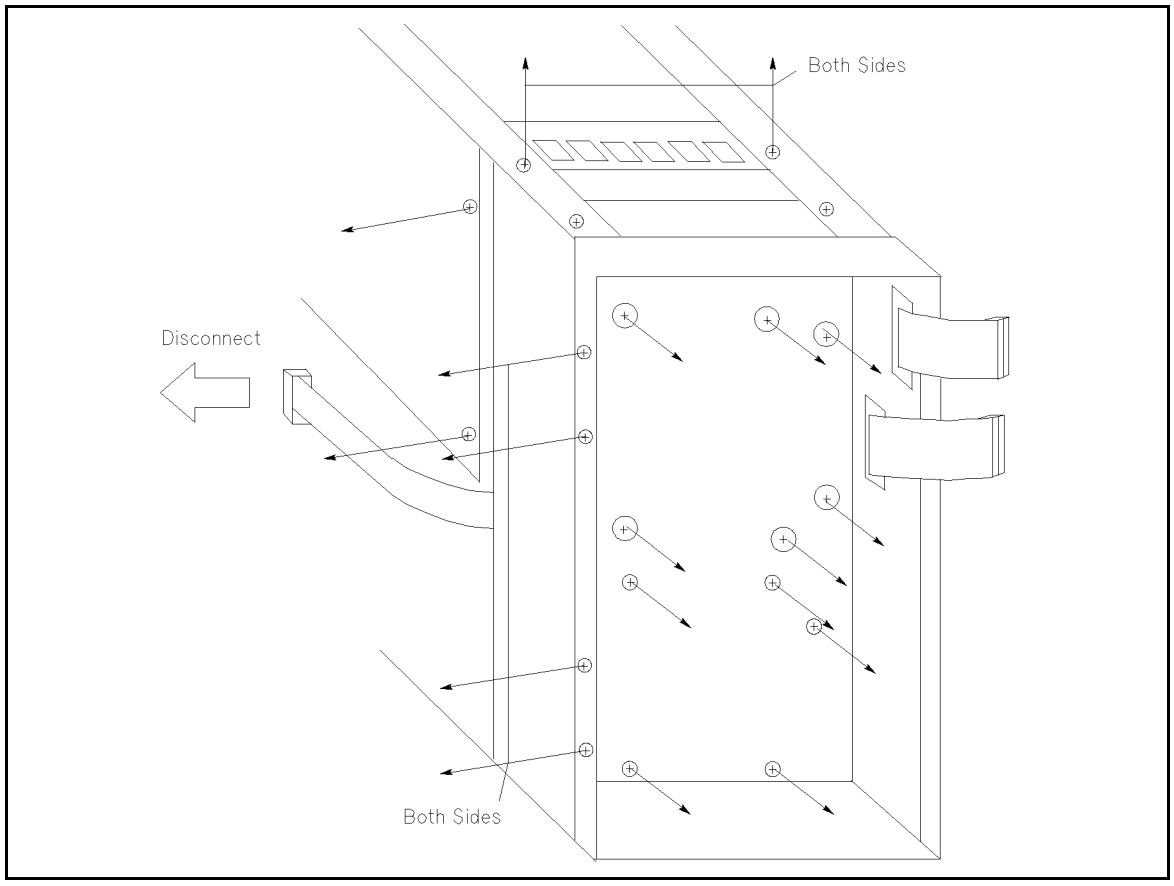


Disconnecting the Cable Between Post Regulator and PS-Motherboard

1. Turn off power, then remove the power cable.
2. Remove the PS and top cover.
3. Disconnect the connector.

Removing the Motherboard

1. Turn off power, then remove the power cable.
2. Remove the VSVMU, SMUs, ADC, CPU, and Front Panel Assembly.
3. Remove the top cover, side covers, and bottom cover.
4. Disconnect the top cable as shown in the following figure.
5. Remove the screws shown in the following figure.
6. Disconnect the FDD cable from the FDD.
7. Disconnect the cable from the Post Regulator.
8. Pull out the front chassis with the Motherboard.
9. Remove the two screws fixing the Motherboard to the front chassis at the lower part.
10. Slide the Motherboard (with the cables) to remove it.



Removing the PS-Motherboard

1. Turn off power, then remove the power cable.
2. Remove the PS and top cover.
3. Remove the PS-Motherboard.

Removing the Expander Motherboard

1. Turn off power, then remove the power cable.
2. Remove the GND&IF, SMU(s), and PGU.
3. Remove the top cover, right side cover, and front cover.
4. Remove the top shield panel.
5. From the front shield panel side, remove the five screws fixing the Motherboard to the chassis.
6. Remove the two center screws fixing the front shield panel to the chassis.
7. From the right side, remove the two screws fixing the front shield panel to the two frame struts.
8. From the Motherboard side, remove the two screws fixing the Motherboard to the front shield panel.
9. Disconnect the flat cable.
10. Slide the Motherboard to remove it.
11. Remove the front LED panel and the Motherboard.

Removing the Expander PS-Motherboard

1. Turn off power, then remove the power cable.
2. Remove the PS and top cover.
3. Remove the PS-Motherboard.

Updating the Firmware

1. To confirm the present ROM revisions, turn on power, then select System, CONFIG. Write the displayed revision numbers for confirmation after the replacement:

   ```
   HOSTC:  Rev. _____
   SMUC:   Rev. _____
   ADC:    Rev. _____
   ```

2. Turn off power, then insert the "UPDATE MASTER disk".
3. Turn on power. The firmware update screen will appear.
4. Select the YES primary softkey. The firmware installer program starts.
5. Follow the displayed instructions. (Remove/insert the diskettes.)
6. When firmware update is completed, remove the diskette and cycle power.
7. Confirm the new firmware revisions.
8. Perform the selftest for operation check: select System, CALIB/DIAG, and DIAG SELFTST ALL.

When you replace the ADC Controller ROM (ADC), use the following procedure.

Caution

To avoid electrostatic damage (ESD), it is recommended to use an anti-static mat and wrist strap.

1. Turn off power, then remove the power cable.
2. If the HP 41501B is connected to the HP 4155B/4156B, disconnect the HP 41501B from the HP 4155B/4156B.
3. Remove the rear panel of the HP 4155B/4156B.
4. Remove the ADC module.
5. Replace the ROM.
6. Re-install the ADC module.
7. Turn on power, then confirm the revisions.
8. Perform the selftest for operation check: select System, CALIB/DIAG, and DIAG SELFTST ALL.

Firmware Revisions

Table 8-1. Firmware Revisions

Date	HOSTC CPU (Host Controller)	SMUC on CPU (SMU Controller)	ADC on ADC (A/D Controller) U506 04155-85xx7
97.9	Rev 2.00	Rev 3.01	Rev 1.00 04155-85117

9

Error Messages

If HP 4155B/4156B is not operated correctly, or if diagnostics or calibration fails, error codes and error messages are displayed.

If measurement or forcing stress are not performed correctly, measurement data status is displayed at bottom of GRAPHICS, LIST, KNOB SWEEP, or STRESS FORCE page.

This section describes the following:

- Diagnostics Errors
- System Errors
- Measurement data status
- SCPI Command Errors

Diagnostics Errors

The following are the error codes that are displayed at the bottom of the SYSTEM: SELF-CALIBRATION/DIAGNOSTICS page if errors occur when you perform Self-Calibration or diagnostics.

Up to seven error codes can be displayed at the bottom of the SYSTEM: SELF-CALIBRATION/DIAGNOSTICS page. To display the error codes, move pointer to a desired test item.

Error codes for measurement unit.
Error codes for measurement units are 5-digit numbers:

1*xxyy*

xx: measurement unit

00: VSU1,2 and VMU1,2

01 to 06: SMU1 to SMU6

07: PGU1,2

08: GNDU

09: AD converter

11: Cannot be classified. Only for All Meas Unit Tests (111).

yy: error number

Error code for CPU and I/O & peripherals.
Error codes for CPU and peripherals are 5-digit numbers:

2*wwwz*

www: test item number (on SYSTEM: SELF-CALIBRATION/DIAGNOSTICS page).

z: test number

Measurement Unit Errors

Measurement Unit Common Errors

1xx00 Self-Calibration data value overflow. Measurement-line switching circuit in the ADC or measurement unit (measurement line from measurement unit to ADC) may have failed.

1xx05 Same as 10905. ADC test is performed as a pretest for measurement unit Self-Calibration/Self-Test.

1xx06 Same as 10906. ADC test is performed as a pretest for measurement unit Self-Calibration/Self-Test.

1xx07 Same as 10907. ADC test is performed as a pretest for measurement unit Self-Calibration/Self-Test.

1xx08 Same as 10908. ADC test is performed as a pretest for measurement unit Self-Calibration/Self-Test.

1xx11 Overvoltage occurred for a measurement unit.

1xx12 Overcurrent occurred for a measurement unit.

1xx15 System Error 309 (Measurement unit that HP 4155B/4156B does not support is detected.) occurred.

1xx82 HOSTC did not receive a measurement data from SMUC. This error is reported from SMUC before performing Self-Test or Self-Calibration, but is not a Self-Test/Self-Calibration error. Perform CPU Self-Test.

1xx90 Communication between ADC and CPU (SMUC) failed and reached timeout during Self-Calibration or Self-test for a measurement unit. Perform ADC Self-Test.

1xx91 FIFO (first-in, first-out) Buffer on AD converter overflowed during PGU Self-Calibration because SMU Controller took long time to read measurement data from AD Controller. CPU or ADC module may have a failure.

1xx92 Self-Calibration, Auto-Self-Calibration, or diagnostics aborted due to an emergency condition or *RST command. This error does not occur at Power-on Self-Test.

1xx97 Command or data communication between HOSTC and SMUC failed and reached timeout. Perform CPU Self-Test.

VSU/VMU Errors

10031 VSUs and VMUs failed function check. Tests 10032 to 10038 are skipped.

10032 VSUs failed gain or offset Self-Calibration. Tests 10033 to 10038 are skipped.

10033 VMUs failed gain or offset Self-Calibration. Tests 10034 to 10038 are skipped.

10034 VMUs failed differential mode 2 V range gain or offset Self-Calibration. Tests 10035 to 10038 are skipped.

10035 VSUs failed gain and offset Self-Calibration, VMUs failed gain and offset Self-Calibration, or VMU failed differential mode 2 V range gain and offset Self-Calibration. Tests 10036 to 10038 are skipped.

10036 VMUs failed differential mode 0.2 V range gain or offset measurement. Tests 10037 and 10038 are skipped.

10037 VMUs failed differential mode 0.2 V range gain and offset Self-Calibration. Test 10038 is skipped.

10038 VMUs and VSUs failed CMR (Common Mode Rejection) amp Self-Calibration.

10040 VSU1 and VMU1 failed ±20 V measurement Self-Test in 20 V range.

10041 VSU2 and VMU2 failed ±20 V measurement Self-Test in 20 V range.

10042 VSU1 and VMU2 failed ±20 V measurement Self-Test in 20 V range.

10043 VMU2 and VMU1 failed ±20 V measurement Self-Test in 20 V range.

10044 VSU1 and VMU1 failed ±2 V measurement Self-Test in 2 V range.

10045 VSU2 and VMU2 failed ±2 V measurement Self-Test in 2 V range.

10046 VSU1 and VMU2 failed ±2 V measurement Self-Test in 2 V range.

10047 VSU2 and VMU1 failed ±2 V measurement Self-Test in 2 V range.

10048 VMUs and VSUs failed differential 2 V range Self-Test. This test measures ±2 V by VMUs in differential mode. (VSU1 is connected to VMU1, and VSU2 is connected to VMU2. VSU1 forces 0 V. VSU2 forces 2 V).

10049 VMUs and VSUs failed differential 2 V range Self-Test. This test measures 0 V by VMUs in differential mode. (VSU1 is connected to VMU1, and VSU2 is connected to VMU2. VSU1 forces 0 V.)

10050 VMUs and VSUs failed differential 0.2 V range Self-Test. This test measures 0 V by VMUs in differential mode. (VSU1 is connected to VMU1, and VSU2 is connected to VMU2. VSU1 forces 0 V.)

10051 VMUs and VSUs failed differential 2 V range Self-Test. This test measures 0 V by VMUs in differential mode. (VSU2 is connected to VMU1 and 2, and forces 0 V.)

10052 VMUs and VSUs failed differential 0.2 V range Self-Test. This test measures 0 V by VMUs in differential mode. (VSU2 is connected to VMU1 and 2, and forces 0 V.)

SMU Errors

10x20 SMU failed function check. If a measurement overflow occurs during the function check, Tests 10x21 to 10x26 are not performed.

10x21 SMU failed CMR (Common Mode Rejection) amp Self-Calibration.

10x22 SMU failed oscillation detector test.

10x23 SMU failed V set and V measure Self-Calibration.

10x24 SMU failed I set and I measure Self-Calibration.

10x25 SMU failed I bias test.

If the PGU fails with any test in Tests 10760 to 10769, Tests 10770 to 10773 are not performed.

10526 HPSMU failed V switch test.

PGU Errors

If any of error 10760 to 10769 occurs, tests 10770 to 107773 are not performed.

10760 PGU1 failed pulse gain Self-Calibration.

10761 PGU2 failed pulse gain Self-Calibration.

10762 PGU1 failed pulse offset Self-Calibration.

10763 PGU2 failed pulse offset Self-Calibration.

10764 PGU1 failed voltage Self-Calibration of base value.

10765 PGU2 failed voltage Self-Calibration of base value.

10766 PGU1 failed leading time Self-Calibration.

10767 PGU2 failed leading time Self-Calibration.

10768 PGU1 failed trailing time Self-Calibration.

10769 PGU2 failed trailing time Self-Calibration.

10770 PGU1 failed slope offset Self-Calibration.

10771 PGU2 failed slope offset Self-Calibration.

10772 PGU1 failed slope sampling Self-Calibration.

10773 PGU2 failed slope sampling Self-Calibration.

GNDU Error

10875 GNDU failed offset Self-Calibration.

ADC Errors

If the ADC fails in any test, the measurement unit Self-Test (for example: SMU Test) is not performed. Also the SMU/PGU Selector Control Interactive Test (Test 412) is not displayed.

10905 AD converter failed ROM or RAM Self-Test. If this error occurs by V/R references calibration, the recorded calibration value of +7V or −7V reference might exceed the limit of +6.95 V ±10% or −6.95 V ±10%. These values are checked in the ROM/RAM Self-Test.

10906 Successive approximation AD converter failed Self-Calibration.

10907 Integrating type AD converter failed Self-Calibration.

10908 Communication between ADC and CPU (SMUC) failed and reached timeout during ADC Self-Calibration/Self-test. AD converter did not return completion status within certain time after sending calibration or Self-Test command.

CPU Test Errors

HOSTC DRAM (301) Self-Test

23010 Host DRAM failed Self-Test.

HOSTC Memories (ROM, SRAM) (302) Self-Test

23021 Host ROM failed checksum test.

23022 Host SRAM failed read and write test.

23023 EEPROM failed read and write test.

Real Time Clock (303) Self-Test

23030 Real-time clock failed timer test.

HP-IB Controller (304) Interactive Test

23040 HP-IB controller failed Self-Test. This test sets some settings, then checks the status.

Parallel I/F Controller (305) Self-Test

23050 Parallel interface controller failed Self-Test. This test sets some settings, then checks the status.

HOSTC <-> SMUC I/F (306) Self-Test

23061 Command communication between HOSTC and SMUC failed and reached timeout. Host controller sends a command and does not receive acknowledge from SMU controller.

23062 Data communication from SMUC to HOSTC failed and reached timeout. Host controller failed receiving response from SMU controller after sending a command.

SMUC Memories, Timer (307) Self-Test

23071 SMU controller ROM failed checksum test.

23072 SMU controller on-board SRAM failed read and write test.

23073 SMU controller internal SRAM failed read and write test.

23074 SMU controller internal timer failed Self-Test.

23075 SMU controller timer does not operate with correct frequency.

23076 SMU controller failed power on Self-Test. HOSTC did not receive acknowledge from SMUC. Communication fail timeout between HOSTC and SMUC.

23077 Command or data communication between HOSTC and SMUC failed and reached timeout.

Graphics Controllers (308) Self-Test

23080 Access to Graphics system processor failed in read and write test.

Graphic Memories (309) Self-Test

23092 Graphic memories (VRAM) failed read and write test.

LAN Interface (312) Interactive Test

24065 LAN interface failed loopback test.

I/O & Peripheral Errors

Parallel I/F (401) Interactive Test

During this test, do not touch any key and rotary knob, and do not send any command to HP 4155B/4156B. If you do, this test fails.

24017 Parallel interface failed data line test.

24018 Parallel interface failed control line test.

Trigger Input/Output (402) Interactive Test

24021 Trigger output test failed or reached timeout.

24022 Trigger input test failed.

Flexible Disk Controller (404) Self-Test

24041 Flexible disk drive controller test failed.

24042 Flexible disk drive 5 V power line test failed. This test is performed at 5 V power line on the Post Regulator board.

Flexible Disk Read/Write (405) Interactive Test

24051 Flexible disk drive failed diskette change test.

24052 Flexible disk drive failed read and write test.

Post Regulator (406) Self-Test

24062 12 V source output on post regulator failed.

24063 15 V source output on post regulator failed.

24064 3 V source output on post regulator failed.

Front Key Circuit (407) Self-Test

Do not press any front keys during this test. If you do, the test might fail.

24071 A front-panel key is stuck in pressed position.

24072 Front key assembly may be disconnected.

24073 Front-panel key controller is not functioning properly.

External Key Controller (410) Self-Test

24100 External key controller failed Self-Test.

SMU/PGU Selector Control (412) Interactive Test

24120 Selector test reached timeout.

R-Box Control (413) Interactive Test

24130 R-Box test reached timeout.

System Errors

The following are the error codes and their messages that may occur when you operate HP 4155B/4156B. The error codes and messages are displayed in a message window or in the message display area at the bottom of the page.

1 `Syntax error. Input should be integer number.`

3 `Syntax error. Input should be real number.`

4 `Syntax error. Unrecognized parameter.`

5 `Illegal setup. The parameter is out of range.`

6 `DATA buffer full. Too many APPEND.`

7 `DATA buffer full. Too many points.`

8 `Cannot define more than 6 User Vars.`

9 `Syntax error. First char should be Alphabet.`

10 `Syntax error. Must be alphanumeric.`

11 `Name must be set for user function/variable.`
Name setup cannot be omitted when setting a user function or a user variable name.

12 `Syntax error. Unknown variable name.`

13 `System error. HOSTC received invalid data.`
Data communication from SMUC to HOSTC failed and reached timeout. Perform CPU Self-Test.

14 `System error. Unable to communicate with SMUC.`
Command communication between HOSTC and SMUC failed and reached timeout. Perform CPU Self-Test.

15 `System error. Illegal command to SMUC.`
Firmware error.

16 `Illegal operation. Too many LIST data.`

17 `Unable to display data list. Not enough memory.`

18 `Device I/O error. Unable to print out.`
HP 4155B/4156B or printer/plotter may have failed.

19 `Filer error. File name is required.`

20 `Filer error. File Type is required.`

21 `System error. Realtime clock has problem.`
Real time clock circuit of CPU module fails. Replace the CPU module.

22 `Not 4155B/4156B file.`

23 `File was created by old revision.`

24 `File may be corrupt.`

25 `Zero offset meas failed for <unit name>.`
Offset value is too large, so Zero offset measurement is aborted.

26 `Too big offset for 10 pA Range of <unit name>.`
Offset value is too large, so offset cannot be canceled perfectly.

27 `System busy. Measuring.`

28 System busy. Forcing stress.

29 System error. EEPROM write error.
EEPROM control circuit does not work correctly. Perform the Self-Test 302.

30 CAUTION 30: Fixture open. Measurement aborted.

31 Auto calibration was aborted.

32 Auto calibration failed.

33 No data in internal memory.

34 Illegal data. File may be corrupt.

35 System busy. Unable to save/get when MEAS/STR.

36 System busy. Unable to change Y-axis.

37 System error. SMUC lost data.
Communication between ADC and CPU (SMUC) failed and reached timeout during measurement. Perform the Self-Test for measurement units. If the Self-Test passes, error is due to CPU module failure or firmware error.

38 Buffer overflowed. Aborted.

39 Syntax error. Undisplayable character.

40 Illegal setup. One unit assigned several CH.

41 Illegal disk. Revision mismatch.

42 Read error occurred.

43 File name is not LIF type.

44 File name is not DOS type.

45 File name is not LIF/DOS type.

46 Volume label is not LIF type.

47 Volume label is not DOS type.

48 Incorrect memory number.

49 Source and Target are same.

50 Unable to copy. Memory full.

51 Unable to copy. SRC and TGT mem num is same.
You cannot specify same memory number in both SOURCE and TARGET name fields.

52 Illegal suffix.

53 System busy. Emergency handling.

54 System busy. Measuring.

55 System busy. Executing cal/diag.

56 System busy. Executing auto calibration.

57 System busy. Printing out hard copy.

58 Unable to copy HP4145 data file to memory.

59 Unable to graph plot. Recover error state.
Unable to print out or plot out when error message is displayed.

60 `Cal/diag must be performed in the idle state.`
Calibration and Diagnostics cannot be performed unless the HP 4155B/4156B is in the idle state. For example, this error is displayed if the SCPI calibration command is sent when HP 4155B/4156B is not in the idle state.

61 `ADC time out.`
The AD converter has caused a time out. Perform 109: ADC test on the SYSTEM: SELF-CALIBRATION/DIAGNOSTICS page.

62 `ADC FIFO overflow.`
The AD converter has caused a FIFO overflow. A data transfer error occurred between the AD converter and the SMUC. Suspect the ADC failure first. Next suspect the SMUC section failure on CPU.

63 `SMUC failed to send data to HOSTC.`
The SMU controller failed to send data to the host controller. Retry the measurement. If this error is still displayed, recycle the power by turning the instrument off and then on again.

64 `TIFF format supports SCREEN DUMP only.`
The TIFF format is only supported by the SCREEN DUMP function.

65 `TIFF image can only be written to a FILE.`
A TIFF image can only be written to a FILE. The HP 4155B/4156B cannot output TIFF format images to a printer or plotter.

66 `HR TIFF format supports DUMP and GRAPH PLOT.`
A high resolution TIFF image is only supported by the DUMP and GRAPH PLOT functions.

67 `HR TIFF image can only be written to a FILE.`
A high resolution TIFF image can only be written to a FILE.

100 `VAR1 is not assigned.`

101 `VAR1 assigned to multiple Channels.`

102 `VAR2 assigned to multiple Channels`

103 `VAR1' assigned to multiple Channels.`

104 `VAR1 and VAR1' must be same MODE.`

105 `Cannot set multiple SMUs to pulse mode`

106 `Cannot use VAR when SAMPLING.`

107 `Cannot use SMU pulse when SAMPLING.`

108 `Duplicate variable names exist.`

109 `The setup is not finished.`

110 `Standby chan cannot use R-BOX resistor`
For standby channel, you cannot use R-Box resistor.

111 `Common chan cannot use R-BOX resistor.`
For common mode channel, you cannot use R-Box resistor.

112 `VAR1 step number is out of range.`

113 `START and STOP have different sign.`

115 `SMU pulse Period must be >= Width+4ms.`

116 `VAR1 output power too large for unit.`

117 VAR1' output power too large for unit.

118 VAR2 output power too large for unit.

119 TOT SMP TM=AUTO is for LINEAR only.
AUTO can be specified for total sampling time *only when* LINEAR sampling mode is selected.

120 Only LINEAR when init int <= 480 μs.
When initial interval is set to 480 μs or less, you *cannot* specify LOG or THINNED-OUT sampling mode.

121 For LINEAR set AUTO if init int<=480μs
When initial interval is set to 480 μs or less *and* when LINEAR sampling mode is set, AUTO must be set in TOTAL SAMP. TIME field.

122 TOT SP TM must be>=INIT INT×(NOofSMP−1)
Total sampling time must be set in the following range:
total sampling time ≥ *initial interval* × (*number of samples* − 1)

123 STOP CONDITION NAME is not set.

124 PGU pulse Period must be > Width.

125 PGU pulse Period must be >= Delay.

126 PG leading/trailing must be same range
PGU leading and trailing time must be set in the same range. For details about the ranges, see "Measurement Units" in *HP 4155B/4156B User's Dictionary Reference*.

127 PGU Leading must be <= 0.8×WIDTH.
Leading time must satisfy the following equation.
leading time ≤ *pulse width* × 0.8

128 PGU Trailing must be <= 0.8×(Peri-Wid).
Trailing time must satisfy the following equation.
trailing time ≤ (*pulse period* - *pulse width*) × 0.8

129 SMU I range must be <= Compliance range.

130 SYNC channel is not assigned.
At least one SYNC channel must be specified.

131 Assigned more than 4 SYNC channels.

132 Set INIT INT>=2ms for multi-CH MEAS.
When you perform multi-channel measurements, initial interval must be 2 ms or more.

133 Use FIXED range when INIT INT<2ms.
When you use auto ranging or limited auto ranging measurement, you must set initial interval to 2 ms or more.

134 Cannot disable STBY-ON ch in Stress.
On STRESS: CHANNEL DEFINITION page, you cannot disable (delete entries in row) channels that are set to STBY ON on the CHANNELS: CHANNEL DEFINITION page.

135 Undefined symbol in user function.

136 Syntax error in user function.

137 Too few arguments in user function.

138 Too many arguments in user function.

139 User function area is full.

140 Recursive call in user function.

141 User function is undefined.

142 Stack overflow in user function.

143 COMMON channel FCTN must be CONST.

144 COMMON channel FCTN must be NSYNC.

145 System busy. Unable to change page when MEAS.

146 System busy. Unable to change page when STRS.

147 Ineffective page in this setup.

148 X axis is not assigned.

149 Y1 axis is not assigned.

150 ENABLE DELAY must be <= 32767×INIT INT
For sampling measurements, when stop condition is set to ENABLE, *enable delay* must be *initial interval* × 32767 or less.

151 No unit is set to STANDBY ON.

152 System busy. MEASURING (or 4145 USER MODE).

153 MIN, MAX have different sign in LOG.

154 Can do such operation only for USER VAR.

155 Illegal setup. The name was already used.

156 User variable is used in user function.
If a user variable is used in user functions, the user variable cannot be deleted.

157 AUTO Analysis is undefined.

158 TOT SAMP TIME must be<=INIT INT×32767.
Total sampling time must be *initial interval* × 32767 or less and 1×10^{11} or less.

159 Measure channel is not assigned.

160 Unable to find approximate data.

161 Illegal graph scale setup.

163 The Sweep/Pulse Polarity is not same.

164 SYNC can not be set for standby CH.

165 Set value is too small for range.
For LOG sweep measurement, start and stop value must be equal or more than setup resolution. For sweep measurement, step value of VAR1 and VAR2 must be equal or more than setup resolution.

166 PGU Peak/Base difference must be <= 40V

170 Use Sweep/Bias instead of SMU Pulse.

171 Knob Sweep sets VAR1' to CONST.
If you set VAR1' for knob sweep measurement, the VAR1' channel forces a constant value equal to START value. VAR1' cannot be a sweep source for Knob Sweep measurement.

172 Cannot do SAMPLING when Knob Sweep.

173 |STEP| must be <= |STOP-START|.

174 Cannot set CONT AT ANY if PCOMP is ON.
When you set power compliance, you cannot select CONT AT ANY secondary softkey.

175 CONST setup must be<=unit output range.

176 Pulse BASE must be <= unit output range.

177 PGU pulse WIDTH must be >= setup res.
Pulse width of PGUs must be greater than or equal to unit setup resolution.

178 TRIG OUT DELAY is too long.
Trigger out delay must be 32.7 ms or pulse width you specified, whichever is shorter.

179 Cannot ENABLE stop if INIT INT < 2 ms.
When initial interval is set to less than 2 ms, you cannot set stop condition.

180 Illegal setup. Target module is not installed.

181 Illegal setup. Invalid command.

182 Cannot define more than 6 User functions.

183 Cannot define more than 8 data vars in lists.

184 Cannot define more than 2 display data vars.

185 ASCII format does not allow block transfer.

186 Block size mismatched with data format.

187 Y2 axis is not assigned.

188 List name is not assigned.

189 The specified name is not list name.

190 Illegal file type is requested.

191 System busy. Printing out hard copy.

192 Unable to set. Another controller is on bus.

193 Unable to specify this name here.

194 PGU Pulse DELAY must be >= setup res.
PGU pulse delay time must be $\geq$ setup resolution.

195 Cal/Diag failed. Cannot use unit.

196 Compliance too low to force pulse.

197 Compliance too high to force pulse.

198 Two VPULSE PGUs must be same STBY.

199 Two VPULSE PGUs must be same FCTN.

200 Improper parameter for file operation.
An option for the file system command has been set up incorrectly.

201 System error. Filer memory overflow.

202 Filer error. Integer overflow.

203 `Bad volume specifier.`
Volume label for mass storage is incorrect. Initialization may have been performed on an incompatible system, or the disk may be defective.

204 `Filer error. File type is wrong.`

205 `Filer error. EOF found.`

206 `Filer error. EOR found.`

207 `File error. Illegal DISK parameter.`
Illegal disk parameter was detected. The mass storage device is set up incorrectly.

210 `File error. Unable to execute. File open.`
Unable to perform the requested file operation. The file is already open. Close the file and retry the operation.

211 `Unable to operate the device. File is open.`
Unable to perform the requested file operation on the specified device because the device has a file open.

212 `File error. DISK or DISK drive may be broken.`
DISK or DISK drive hardware may be in need of service.

213 `Filer error. DISK record is not found.`

214 `File error. DISK recode address error.`
Unable to find recode because the mass storage device has a problem.

215 `Filer error. DISK record data error.`

216 `File error. DISK system error.`
The hardware or the device are causing a problem.

217 `File error. Bad volume label.`
The mass storage has an incorrect volume label. Verify the volume number is set correctly.

218 `System error. No interface found.`
The network interface was not found because of a wrong select code setup. Verify the select code is set correctly.

219 `File error. Device timeout.`
Time-out occurred on the device.

220 `Filer error. Undefined I/O path.`

221 `Filer error. Permission denied.`

222 `File error. Too many files open.`
Unable to open multiple files at the same time. Close the file that is currently open before opening a second file.

223 `Unable to PURGE the file or directory.`
Unable to purge the file or the directory, for example, permission denied.

224 `Filer error. The directory is not empty.`

225 `Filer error. No DISK in the drive.`

226 `Filer error. Initialization failed.`

227 `Filer error. Invalid DISK volume label.`

228 File error. DISK volume label is undefined.
Volume label is undefined or was not found. Verify the volume number is set correctly.

229 Filer error. DISK is not initialized.

230 Filer error. Checkread error.

231 Filer error. Bad HFS DISK.

232 Filer error. DISK is full.

233 Filer error. Directory is full.

234 Filer error. File name is undefined.

235 Filer error. File name is wrong.

236 Filer error. The file name is already used.

237 Filer error. Bad device type.

238 Filer error. Unable to use wildcard.

239 Filer error. Operations failed.

241 Filer error. The target type is wrong.

242 Filer error. The file is protected.

243 Filer error. DISK is protected.

244 System error. Unable to verify.

245 Filer error. Unable to copy between LIF/DOS.

246 Filer error. Reason Unknown.

265 HOLD TM must be>=0 when INIT INT>=2ms.

280 VAR1' output value is out of range.

282 Set INIT INT > 640 μs for THINNED-OUT.
When you perform thinned-out sampling measurements, the initial interval must be more than 640 μs.

284 Sampling range must be <= 11decades.

286 Cannot execute cal/diag after power fail.
If HP 4155B/4156B/41501B has a power loss, turn off power once, then turn on again.

288 MEAS not finished. Incomplete data deleted.
If you press Stop front-panel key before the specified measurement finishes, incomplete measurement data is deleted.

289 STBY ON ch MODE(MEAS/STR) must be same

290 Cannot use unit after power fail.

292 VAR1' parameters must be >= output res
Start, stop, and step value of VAR1' channel must be unit output resolution or more.

293 Cal/Diag aborted (failed on some units).
Self-Calibration or diagnostics was aborted by receiving *RST command.

300 `CAUTION 300: Over voltage is detected.`
Press "OK" to exit from this error message window. This error does not occur by the Power Supply Unit emergency signal.

301 `CAUTION 301: Over Current is detected.`
Press "OK" to exit from this error message window. This error does not occur by the Power Supply Unit emergency signal.

302 `CAUTION 302: Power failure at Main Frame.`
A momentary power loss occurred in the HP 4155B/4156B mainframe. (Power Supply detects the power failure). Turn off HP 4155B/4156B once, then turn on again.

303 `CAUTION 303: Power failure at Expander Box.`
LINE switch of HP 41501B was turned off. Or a momentary power loss might have occurred. Turn off HP 4155B/4156B/41501B once, then turn on them again.

305 `CAUTION 305: Cannot shutdown Main Frame.`
Mainframe Power Supply continued to assert "Power Fail" signal to CPU in order to notify the PS power failure, but Mainframe Power Supply does not turn off. Suspect Mainframe Power Supply or CPU.

306 `CAUTION 306: Emergency. Reason unknown.`
An emergency occurred on an empty slot. Or an emergency occurred on an existing slot, but overvoltage or overcurrent detector does not detect it. This error does not occur by the Power Supply Unit emergency signal.

307 `CAUTION 307: Cannot shutdown Power Supply.`
Mainframe Power Supply does not shut down within one second after CPU sent the shutdown instruction to Mainframe Power Supply. Suspect Mainframe Power Supply or CPU.

308 `CAUTION 308: Unknown emergency (SMUC time out).`
A measurement unit or Power Supply unit asserts an emergency condition, but the cause is unknown due to command communication failure timeout between HOSTC and SMUC in the CPU module. Perform CPU Self-Test. Suspect the CPU failure first. Next suspect the Power Supply (power supply line failure for SMUC circuit (+5Va)).

309 `CAUTION 309: The SMU AND PULSE GENERATOR EXPANDER isn't turned on. Turn on the expander, then cycle main frame power`
At power-on, LINE switch of HP 41501B is not set to on before turning on HP 4155B/4156B. Turn off HP 4155B/4156B once, and set the LINE switch of HP 41501B to on, then turn on HP 4155B/4156B.

310 `CAUTION 310: Unsupported unit detected in Slot X: (Unit Y). Turn off the power and extract the unit`
A unit that HP 4155B/4156B cannot control is installed. Replace the indicated unit. Other SMU/VSVMU/ADC/PGU/GNDU may also cause this error.

320 `Not enough memory. Cannot display ≥ 200 files.`
HP 4155B/4156B cannot display more than 199 files on the FILE CATALOG because of an internal memory limitation. If you create more than 199 files, move the additional files to another directory.

321 `Too many links.`
The file has too many links. Remove extra links or use symbolic links.

322 `File system down or network disconnected.`
Unable to access the network directory. The file system was down or the network was disconnected.

323 `The network address is already used.`
A process has already been bound to the address. The current process must finish before the new process can use the address.

324 `Change dir failed. File is not a directory.`
Change directory failed because you specified a file, not a directory.

325 `Unable to open file. Deadlock occurred.`
Unable to open the file. Deadlock occurred in the resource where you tried to open the file.

326 `Device not present. Unsupported file type.`
Device or driver was not found to open the file. Unable to open file because the file type is not supported.

327 `Interrupted system call.`
The lpr driver received a signal from the system, that interrupted the data transfer from the lpr driver.

328 `lpd time out occurred. Try again ?`
A time out occurred when trying to connect to the lpd server because the lpd server did not respond.

329 `lpd print server cannot be recognized.`
Unable to recognize the lpd print server. Verify the address setup or setup syntax is correct.

330 `lpd server connection failed or was denied.`
The lpd server connection failed, or was denied, because the lpd server was already connected or the server was blocked.

331 `lpr data transfer failed.`
Data transfer from the lpr server failed because lpr data communication was disconnected. Verify the network is working properly and check to see if the server is up.

332 `Unable to print out. Not enough device space.`
Unable to print out because the device connection failed. There is not enough available space in the buffer for the communication.

334 `lpr failed data transfer. Data size mismatch.`
Unable to print out because the lpr server failed data transfer. The size of the data was not the expected size.

335 `lpr Network interface is down. Try again ?`
The network interface cannot be found because the network interface for the lpr server is down.

336 `Unable to print out. Reason unknown.`
Network connection failed. The reason for the failure is unknown.

337 `Cannot set 0.0.0.0 for HP 4155/6B IP address.`
When a valid host name for the HP 4155B/4156B network setup is specified, the IP address of the HP 4155B/4156B cannot be set to `0.0.0.0`.

338 `Cannot set 0 (zero) for HP 4155/6B User ID.`
When a valid host name for the HP 4155B/4156B network setup is specified, the User Id of the HP 4155B/4156B cannot be set to 0(zero).

339 `No response from NFS. Try again ?`
There is no response from the Network File System (NFS) when trying to mount

a network disk. Verify the network is operating properly and the file export executed properly.

340 `Host name must be ≤ 15 alphanumeric character.`
HP 4155B/4156B host name must be 15 or less alphanumeric characters.

344 `System busy. Cannot execute US/US42 command.`
Unable to move to FLEX command control mode, because the `US` or `US42` command cannot be executed while system is busy; making measurement, operating file functions, executing calibration or diagnostics, printing, emergency, and so on.

350 `Unable to transfer data. Name buffer full.`
Cannot maintain the buffer required for transferring data.

351 `File operation was interrupted by system call.`
The lpr driver received a signal from the system, which interrupted an open, read, or write operation.

352 `Network is down after receiving a reset.`
The network is down after receiving a reset. Try again after network recovers.

353 `Network is down. No response from server.`
Network is down. There in no response from the server.

354 `Operation canceled.`
Operation canceled by user. For example, an abort command was sent.

355 `Cannot create file/dir. Change permission.`
Write permission is not set for the directory where you are trying to create a file or subdirectory.

357 `Unable to go to the dir. Permission denied.`
Network File System server cannot move to the specified directory. To access the directory, change the permissions.

358 `Select UPDATE/ADD to update/add printer setup.`
To update or add your new or modified network printer setup, the `UPDATE` or `ADD` secondary softkey must be selected after finishing the initial setup.

363 `Duplicate file names exist.`
The same file name cannot be used for multiple files.

364 `No such file or directory.`
The Network File System cannot find the specified file or directory.

365 `Unable to read or write to directory.`
A file read or write operation cannot be performed in the specified directory.

366 `Invalid argument. Check command syntax.`
Specified argument did not work when executing the command. Verify the command syntax and argument are correct.

367 `Seek operation failed.`
Seek for file operation failed, or append write failed to open the specified file.

368 `NFS Software caused connection abort.`
Network file system (NFS) was disconnected. Verify the NFS server is operating correctly.

369 `Connection reset by peer. Remote disconnected.`
Remote connection was terminated. Verify the remote setup and the executed operation are correct. Verify the local and remote systems are operating properly.

370 `Unable to transfer data. Communication down.`
Data cannot be transferred because the communication was shutdown.

371 `NFS Connection refused.`
Connection to NFS was refused. Verify the refused device was properly exported.

372 `Connection failed. Socket was not sent.`
NFS Connection failed because the socket was not sent.

373 `Too many levels of symbolic links.`
The file is linked to itself, or the linked file is linked back to the file.

375 `Cross-device link.`
Unable to hard link different physical file systems. Hard link must be done to same file system.

377 `Unable to use this protocol.`
Unable to use this protocol on the network.

378 `This protocol is not supported.`
This protocol is not supported on the network.

381 `This type of protocol is not supported.`
This type of protocol is not supported on the network.

386 `System busy. Saving/getting text files.`
The HP 4155B/4156B cannot be interrupted by other operations. For example, text files cannot be saved or retrieved while making measurements.

387 `Unable to access file. The file is locked.`
Unable to write to this file. The file is locked by another process.

388 `No such device or address.`
The HP 4155B/4156B cannot find the specified network device or address. Verify the correct device file exists, the select code/major number/minor number are correct, and that the device is correctly connected (high speed or low speed port).

389 `System busy. File operation is in progress.`
File operation is in progress. During a file operation, the HP 4155B/4156B cannot perform other operations, such as making measurements, changing setup fields, printing and so forth.

391 `Network printer connection time out.`
A time out occurred when connecting the network printer to the print server or NFS server.

392 `Network File System server is down.`
Server for the Network File System is down. Contact your network system administrator.

393 `Communication to desired server failed.`
Communication to desired server failed.

394 `System busy. Mounting device.`
When mounting a device, the HP 4155B/4156B cannot be interrupted by another operation, such as making a measurement.

400 `System error. Undefined method. System bug.`

401 `System bug. Invalid parameter.`

402 `System bug. Inconsistency.`

410 `Unable to display. Number must be <10001.`
Unable to display the measurement results because the data size of the result is too large. The number of the measurement results must be less than 10001.

411 `Connection failed. Set Destination address.`
Network connection to destination failed. Verify the destination address is set correctly.

412 `Address family not supported.`
Specified address family is not supported for the currently used socket.

Measurement Data Status

If measurement or stress force cannot be performed correctly, the measurement data status is displayed at the bottom of the GRAPHICS, LIST, KNOB SWEEP, or STRESS FORCE page. The status indicates hardware and calculation errors.

The status format depends on the displayed page as follows:

GRAPH/LIST: GRAPHICS and KNOB SWEEP page

Status is displayed in following format:

`STATUS:` *AB AB AB (A A A A A A A A C)*

- *AB AB AB* is for X, Y1, and Y2 axis respectively. No Y2 for KNOB SWEEP.
- *A A A A A A A A C* is for SMU1 to SMU6, VMU1, VMU2, and PGU1/2 respectively.

Where, *A*, *B*, and *C* mean as follows:

A hardware status error. If multiple errors occur, numbers are added and displayed as a hexadecimal number.

1 : AD converter overflow.

2 : Oscillation

4 : Other channel reached compliance limit.

8 : This channel reached compliance limit.

B data error. If multiple errors occur, numbers are added and displayed as a hexadecimal number.

1 : stack register overflow

2 : calculation error

4 : only one data for delta measurement. At least 2 data needed.

C PGU status

1 : PGU average output current exceeds 100 mA.

For non-measurement channels, "_" is displayed.

GRAPH/LIST: LIST page

Status on GRAPH/LIST: LIST page is displayed in following format:

`STATUS:` *AB AB AB AB AB AB AB AB* (*A A A A A A A A C*)

- *AB AB AB AB AB AB AB AB* is for the up to 8 LIST variables that can be set up.
- *A A A A A A A A C* is for SMU1 to SMU6, VMU1, VMU2, and PGU1/2 respectively.

Where, *A*, *B*, and *C* mean as follows:

A hardware status error. If multiple errors occur, numbers are added and displayed as a hexadecimal number.

1 : AD converter overflow.

2 : Oscillation

4 : Other channel reached compliance limit.

8 : This channel reached compliance limit.

B data error. If multiple errors occur, numbers are added and displayed as a hexadecimal number.

1 : stack register overflow

2 : calculation error

4 : only one data for delta measurement. At least 2 data needed.

C PGU status

1 : PGU average output current exceeds 100 mA.

For non-measurement channels, "_" is displayed.

STRESS: STRESS FORCE page

Status on STRESS: STRESS FORCE page is displayed in following format:

`STATUS:` *A C*

Where, *A* and *C* mean as follows:

A hardware status error. If multiple errors occur, numbers are added and displayed as a hexadecimal number.

2 : Oscillation.

4 : Some channel has reached compliance limit.

C PGU status

1 : PGU average current exceeds 100 mA.

SCPI Command Errors

SCPI (Standard Commands for Programmable Instruments) is a universal programming language for electronic test and measurement instruments, and based on IEEE 488.1 and IEEE 488.2.

Error Messages are classified by error number as listed in the following table:

Table 9-1.

Error Range	Error Category
0	No error
−100 to −199	Command Error
−200 to −299	Execution Error
−300 to −399	Device-Dependent Error
−400 to −499	Query Error
100 to 32767	HP 4155B/4156B specific error

Negative error numbers (Command Error, Execution Error, Device-Dependent Error, Query Error) are standard SCPI errors.

Positive error numbers are HP 4155B/4156B specific errors, not standard SCPI errors.

When HP 4155B/4156B is in the remote control state, the occurrence of an error (except for error number 0 or Emergency Error) sets the corresponding bit in the Standard Event Status Register. An Emergency Error sets the corresponding bit in the Emergency Status Register.

Table 9-2.

Error Category	Standard Event Status Register Bit
Command Error	bit5
Execution Error	bit4
Device-Specific Error	bit3
Query Error	bit2
Emergency Error	(sets Emer. Status register)
Others	bit3

No Error

This message indicates that HP 4155B/4156B has no errors.

0 `No error`

The error queue is completely empty. Every error/event in the queue has been read or the queue was purposely cleared by power-on, *CLS, and so on.

Command Error

−100 `Command error`

Generic syntax error that cannot be determined more specifically.

−101 `Invalid character`

An invalid character for the type of a syntax element was received; for example, a header containing an ampersand.

−102 `Syntax error`

An unrecognized command or data type was received; for example, a string was received when the HP 4155B/4156B does not accept strings.

−103 `Invalid separator`

An illegal character was received when a separator was expected; for example, the semicolon was omitted after a program message unit.

−104 `Data type error`

An improper data type was received; for example, numeric data was expected but string data was received.

−105 `GET not allowed`

A group execute trigger was received within a program message.

−108 `Parameter not allowed`

Too many parameters for the command were received.

−109 `Missing parameter`

Fewer parameters were received than required for the command.

−110 `Command header error`

An error was detected in the header. This error message is reported if the HP 4155B/4156B cannot determine the more specific header errors −111 through −114.

−111 `Header separator error`

An illegal character for a header separator was received; for example, no white space followed the header.

−112 `Program mnemonic too long`

The header contains more than twelve characters.

−113 `Undefined header`

An undefined command header was received; for example, `*XYZ`.

−114 `Header suffix out of range`

The value of a numeric suffix attached to a program mnemonic is out of range; for example, `:PAGE:CHAN:SMU7:MODE V` specifies illegal SMU number 7.

−120 `Numeric data error`

Numeric (including the nondecimal numeric types) data error. This error message is reported when the HP 4155B/4156B cannot determine the more specific errors −121 through −128.

−121 `Invalid character in number`

An invalid character for the data type was received; for example, an alphacharacter was received when the type was decimal numeric.

−123 `Exponent too large`

The magnitude of the exponent was larger than 32000.

−124 `Too many digits`

The mantissa of a decimal numeric data contained more than 255 digits excluding leading zeros.

−128 `Numeric data not allowed`

Numeric data is not allowed in this position for this command header.

−130 `Suffix error`

An error was detected in the suffix. This error message is reported if the HP 4155B/4156B cannot determine the more specific suffix errors −131 through −138.

−131 `Invalid suffix`

The suffix does not follow the correct syntax or the suffix is inappropriate.

−134 `Suffix too long`

The suffix contains more than 12 characters.

−138 `Suffix not allowed`

A suffix was received after a numeric parameter that does not allow suffixes.

−140 `Character data error`

An error was detected in a character parameter. This error message is reported if the HP 4155B/4156B cannot determine the more specific errors −141 through −148.

−141 `Invalid character data`

Either the character parameter contains an invalid character or the particular element received is not valid for the command header.

−144 `Character data too long`

The character parameter contains more than 12 characters.

−148 `Character data not allowed`

A character parameter is not allowed for this position.

−150 `String data error`

An error was detected in a string parameter. This error is reported if the HP 4155B/4156B cannot determine a more specific error −151 and −158.

−151 `Invalid string data`

An invalid string parameter data was received; for example, an END message was received before the terminal quote character.

−158 `String data not allowed`

A string parameter data was received but was not allowed at this point.

−160 `Block data error`

An error was detected in a block data. This error is reported if the HP 4155B/4156B cannot determine more specific errors −161 and −168.

−161 `Invalid block data`

An invalid block data was received; for example, an END message was received before the length was satisfied.

−168 `Block data not allowed`

A legal block data was received but was not allowed at this point.

−170 `Expression error`

An error was detected in an expression. This error is reported if the HP 4155B/4156B cannot determine more specific errors −171 and −178.

−171 `Invalid expression`

The expression was invalid; for example, unmatched parentheses or an illegal character.

−178 `Expression data not allowed`

An expression was received but was not allowed at this point.

Execution Error

The HP 4155B/4156B reports −2XX errors when it is unable to perform a valid programming command.

−200 `Execution error`

Generic execution error for the HP 4155B\4156B that cannot be determined more specifically.

−201 `Invalid while in local`

A command is not executable while the HP 4155B/4156B is in local mode due to a Hard Local Control.

−202 `Settings lost due to rtl`

A setting associated with a Hard Local Control was lost when the HP 4155B/4156B changed to Local State (LOCS) from Remote State (REMS) or to Local with Lockout State (LWLS) from Remote with Lockout State (RWLS).

−210 `Trigger error`

−211 `Trigger ignored`

A GET(Group Execution Trigger), *TRG, or triggering signal was received and recognized by the HP 4155B/4156B but was ignored because of timing considerations; for example, the HP 4155B/4156B was not ready to respond.

−214 `Trigger deadlock`

The trigger source for the initiation of a measurement is set to GET (Group Execution Trigger) and subsequent measurement query is received. The measurement cannot be started until a GET is received.

−220 `Parameter error`

A parameter related error occurred and the HP 4155B/4156B cannot determine the more specific errors −221 through −224.

−221 `Settings conflict`

A specified parameter setting could not be executed due to the present device state.

−222 `Data out of range`

Interpreted value of the program was out of range as defined by the HP 4155B/4156B.

−223 `Too much data`

Too much parameters for the HP 4155B/4156B was received.

−224 `Illegal parameter value`

Illegal parameter value was received.

−230 `Data corrupt or stale`

Possibly invalid data; new reading started but not completed since last access.

−231 `Data questionable`

Measurement accuracy is suspect.

−240 `Hardware error`

A hardware problem in the HP 4155B/4156B. This error message is reported if the HP 4155B/4156B cannot detect the more specific error −241.

−241 `Hardware missing`

A program command or query could not be executed because of missing hardware; for example, an option was not installed.

−250 `Mass storage error`

A mass storage error occurred. This error message is reported if the HP 4155B/4156B cannot determine the more specific errors −251 through −258.

−251 `Missing mass storage`

A program command or query could not be executed because of missing mass storage.

−252 `Missing media`

A program command or query could not be executed because of a missing media.

−253 `Corrupt media`

A program command or query could not be executed because of corrupt media; for example, bad disk or wrong format.

−254 `Media full`

A program command or query could not be executed because the media was full; for example, there is no room on the disk.

−256 `File name not found`

A program command or query could not be executed because the file name on the disk was not found.

−257 `File name error`

A program command or query could not be executed because the file name on the disk was in error.

−258 `Media protected`

A program command or query could not be executed because the media was protected.

−260 `Expression error`

An expression related error occurred. This error message is reported if the HP 4155B/4156B cannot detect the more specific error −261.

−261 `Math error in expression`

An expression could not be executed due to a math error; for example, a divide-by-zero was attempted.

Device-Specific Error

−3XX errors indicate that the HP 4155B/4156B has detected an error that is not a command error, a query error, or an execution error; some device operations did not properly complete, possibly due to an abnormal hardware or firmware condition. These codes are also used for Self-Test response errors.

−350 `Queue overflow`

This code is entered into the queue instead of the code that caused the error. This code indicates that there is no room in the queue and an error occurred but was not recorded.

Query Error

−400 `Query error`

Generic query error for the HP 4155B/4156B that cannot be determined more specifically.

−410 `Query INTERRUPTED`

A condition causing an INTERRUPTED query error occurred; for example, a query followed by DAB or GET before a response was completely sent.

−420 `Query UNTERMINATED`

A condition causing an UNTERMINATED query error occurred; for example, the HP 4155B/4156B was addressed to talk and an incomplete program message was received. Check command syntax.

−430 `Query DEADLOCKED`

A condition causing a DEADLOCKED query error occurred; for example, both input buffer and output buffer are full and the HP 4155B/4156B cannot continue.

−440 `Query UNTERMINATED after indefinite response`

A query was received in the same program message after a query requesting an indefinite response was executed.

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